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Revision 2

200 West Pump and Treat Operations and Maintenance Plan

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company
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200 West Pump and Treat Operations and Maintenance Plan

Project No: 200-ZP-1 Document Type: PMP Program/Project: 200 West Pump and Treat

S. A. Simmons
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Executive Summary

This operations and maintenance (O&M) plan outlines the activities necessary to operate, maintain, and monitor the performance of the 200 West pump and treat (P&T), from startup of operations through decommissioning of the system. The 200 West P&T is a major component of the remedial action selected for cleanup of the 200-ZP-1 Groundwater Operable Unit (OU), located in the 200 West Area of the Hanford Site.

The remedy selected in the *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington*[1] (hereafter referred to as the Record of Decision [ROD]) includes a groundwater P&T system, monitored natural attenuation, flow-path control, and institutional controls (ICs). These remedy components are combined to meet the objective of achieving established groundwater cleanup levels for all contaminants of concern (COCs) in the 200-ZP-1 OU within 125 years. The COCs identified for the 200-ZP-1 OU are carbon tetrachloride, total chromium (trivalent and hexavalent), nitrate, trichloroethene, iodine-129, technetium-99, and tritium.

The ROD requires that 95 percent of the mass of COCs in groundwater be removed in 25 years. This mass removal will primarily be accomplished by operation of the 200 West P&T, which is designed to capture and treat contaminated groundwater and reduce the mass of COCs throughout the 200-ZP-1 OU. Treated groundwater will be reinjected into the aquifer to attain flow-path control. This O&M plan addresses the activities required to operate, maintain, and monitor the 200 West P&T to ensure that these objectives are met. Implementation and oversight of the remedy's IC provisions are performed in accordance with the *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Actions*.[2]

This document discusses the operational philosophy for the P&T system, as well as the programs and procedures in place for preventative, routine, and corrective maintenance. These measures ensure that the system will perform as intended and operates safely and efficiently.

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[1] EPA, Ecology, and DOE, 2008, *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington.

[2] DOE/RL-2001-41, 2012, *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Actions*, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Short- and long-term performance monitoring will be conducted to ensure that the system is performing in accordance with the objectives of the ROD. This plan outlines how monitoring will be conducted and the periodic reporting that will document system performance and monitoring results. This periodic reporting includes 5-year reviews under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*.[3]

After the remedial action objectives have been attained, the 200 West P&T will be shut down and permanently taken out of service through the decontamination and decommissioning process. This O&M plan provides a summary of the documents that will likely be developed to guide both interim and final decontamination and decommissioning activities.

Safe operation of the 200 West P&T is an overarching goal that affects all activities associated with O&M of the system. This plan provides an overview of the health and safety plan that addresses safe operation of the P&T system, including key hazards that may be encountered during O&M of the system and procedures for mitigating those hazards.

[3] *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002.

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Terms

ALARA	as low as reasonably achievable
AMP	air monitoring plan
ARAR	applicable or relevant and appropriate requirement
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CHPRC	CH2M HILL Plateau Remediation Company
CM	compliance matrix
COC	contaminant of concern
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FBR	fluidized bed reactor
GAC	granular activated carbon
gpm	gallons per minute
HAB	Hanford Advisory Board
HASP	health and safety plan
HCP EIS	*Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*
HEIS	Hanford Environmental Information System
IC	institutional control
IX	ion exchange
MCL	maximum contaminant level
MNA	monitored natural attenuation
MTCA	*Model Toxics Control Act*
NA	not available
NCP	National Contingency Plan
NTU	nephelometric turbidity unit
O&M	operations and maintenance

OU	operable unit
P&T	pump-and-treat
PMP	performance monitoring plan
QA	quality assurance
QAPP	quality assurance program plan
RAO	remedial action objective
RL	U.S. Department of Energy, Richland Operations Office
ROD	Record of Decision
SAP	sampling and analysis plan
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
Tri-Parties	U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology
USGS	U.S. Geological Survey
VPGAC	vapor-phase granular activated carbon
WMP	waste management plan

1 Introduction

The 200 West pump and treat (P&T) is a major component of the final remedial action selected in the *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington* (EPA et al., 2008) (hereafter referred to as the Record of Decision [ROD]). This operations and maintenance (O&M) plan outlines the activities necessary to operate, maintain, and monitor performance of the 200 West P&T from operations through decommissioning. The scope of this plan includes O&M, performance monitoring and reporting, 5-year remedy reviews, health and safety, and quality assurance (QA).

The O&M plan was prepared by the U.S. Department of Energy (DOE), Richland Operations Office (RL) in accordance with the following:

- 40 CFR 300.435(f), "National Oil and Hazardous Substances Pollution Contingency Plan," "Remedial Design/Remedial Action, Operation and Maintenance" (hereafter referred to as the National Contingency Plan [NCP])
- DOE/RL-2008-78, *200 West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan*
- EPA 540-F-01-004, *Operation and Maintenance in the Superfund Program*

This O&M plan presents information based on the current system design. This plan is not intended to be updated or revised each time a minor change to the constructed facility is made or each time a facility operational procedure is modified. Instead, this plan will be updated or revised when relevant or substantive changes are made to the operating system or its supporting primary documents. It is assumed that the O&M plan will be updated periodically to allow for incorporation of minor changes to the plan's primary supporting documents as the remedy moves through its lifecycle. Supporting documents include the compliance matrix (CM), the air monitoring plan (AMP), sampling and analysis plan (SAP), groundwater performance monitoring plan (PMP), and waste management plan (WMP).

1.1 Purpose of This Plan

Maintaining an adequate and functioning O&M program throughout a remedy's lifecycle is critical for successful implementation and ultimate achievement of the remedial action objectives (RAOs). The O&M measures described in this plan are designed to provide guidance on implementation of the requirements necessary for maintaining the remedy to ensure protection of human health and the environment. This O&M plan serves as an administrative document that describes how O&M of the remedy will be conducted.

Although a majority of this O&M plan addresses the activities necessary for the long-term O&M of the 200 West P&T, requirements for O&M of the other remedy components are also described, including site-specific inspection, sampling and analysis, and routine reporting. Institutional controls (ICs) for the Hanford Site are already in place, as described in the *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Action* (DOE/RL-2001-41). Therefore, inspection and annual reporting on ICs for the 200-ZP-1 Operable Unit (OU) will be performed in accordance with the Sitewide IC Plan (DOE/RL-2001-41).

This O&M plan contains the following information:

- **Chapter 1 — Introduction:** Presents a detailed description of the various components comprising the selected remedy.

- **Chapter 2 — Organization, Operations, and Optimization:** Describes the organizational structure supporting operations of the 200 West P&T, the O&M program, and process optimization activities conducted to ensure that RAOs for the P&T system are achieved.
- **Chapter 3 — Operations and Maintenance:** Describes the 200 West P&T routine and nonroutine O&M activities conducted to ensure that the P&T system achieves its operational up-time goal.
- **Chapter 4 — Monitoring:** Describes routine sampling and analysis of the groundwater treatment plant's influent and effluent conducted to ensure that applicable or relevant and appropriate requirements (ARARs) are met. This chapter also describes the sampling and analysis conducted within the OU groundwater monitoring well network to track remedial action progress. Sampling within the groundwater treatment plant to assess the performance of individual treatment processes is not addressed in this O&M plan but will be covered in operational procedures.
- **Chapter 5 — Periodic Reporting and Closure:** Describes the periodic reports that will be prepared to summarize remedial action progress and the approach that may be used to transition the remedy from active P&T operations to natural attenuation, implementation of ICs, and eventual closure once RAOs have been met.
- **Chapter 6 — Decontamination and Decommissioning:** Summarizes the process that will be used for decontamination and decommissioning (D&D) of P&T system equipment once a determination has been made that the equipment is no longer required.
- **Chapter 7 — Safety, Health, and Quality:** Summarizes health and safety practices and other measures used to ensure overall safety during implementation of the selected remedy.
- **Chapter 8 — References:** Provides a list of references cited in this plan.

This O&M plan provides additional information on the scope of routine activities to be conducted in conjunction with implementation of the selected remedy. The appendices included with this plan provide supporting documentation, as follows:

- **Appendix A:** Provides the CM for the 200 West P&T. Summarizes the approach used to ensure that the fully implemented remedy complies with the ARARs identified in Appendix A of the ROD.
- **Appendix B:** Provides the WMP for the 200 West P&T. Describes the management of the various waste streams associated with implementation of the selected remedy and routine operation of the P&T system.
- **Appendix C:** Provides the AMP for the 200 West P&T. Describes the evaluation performed to assess potential atmospheric air affects associated with groundwater treatment operations and the sampling and analysis conducted to ensure that air discharges comply with ARARs.
- **Appendix D:** Provides the SAP for the 200 West P&T. Describes the sampling and analysis conducted to characterize the treatment plant's influent, effluent, and associated waste streams.
- **Appendix E:** Provides the PMP for the 200-ZP-1 Groundwater OU remedial action. Describes the methods used to collect the data necessary to assess performance of the remedial action, specifically the 200 West P&T, monitored natural attenuation (MNA) and flow-path control elements of the selected remedy.

Figure 1-1 identifies notable regulatory decisions, documentation, and events in regard to the 200 West P&T.

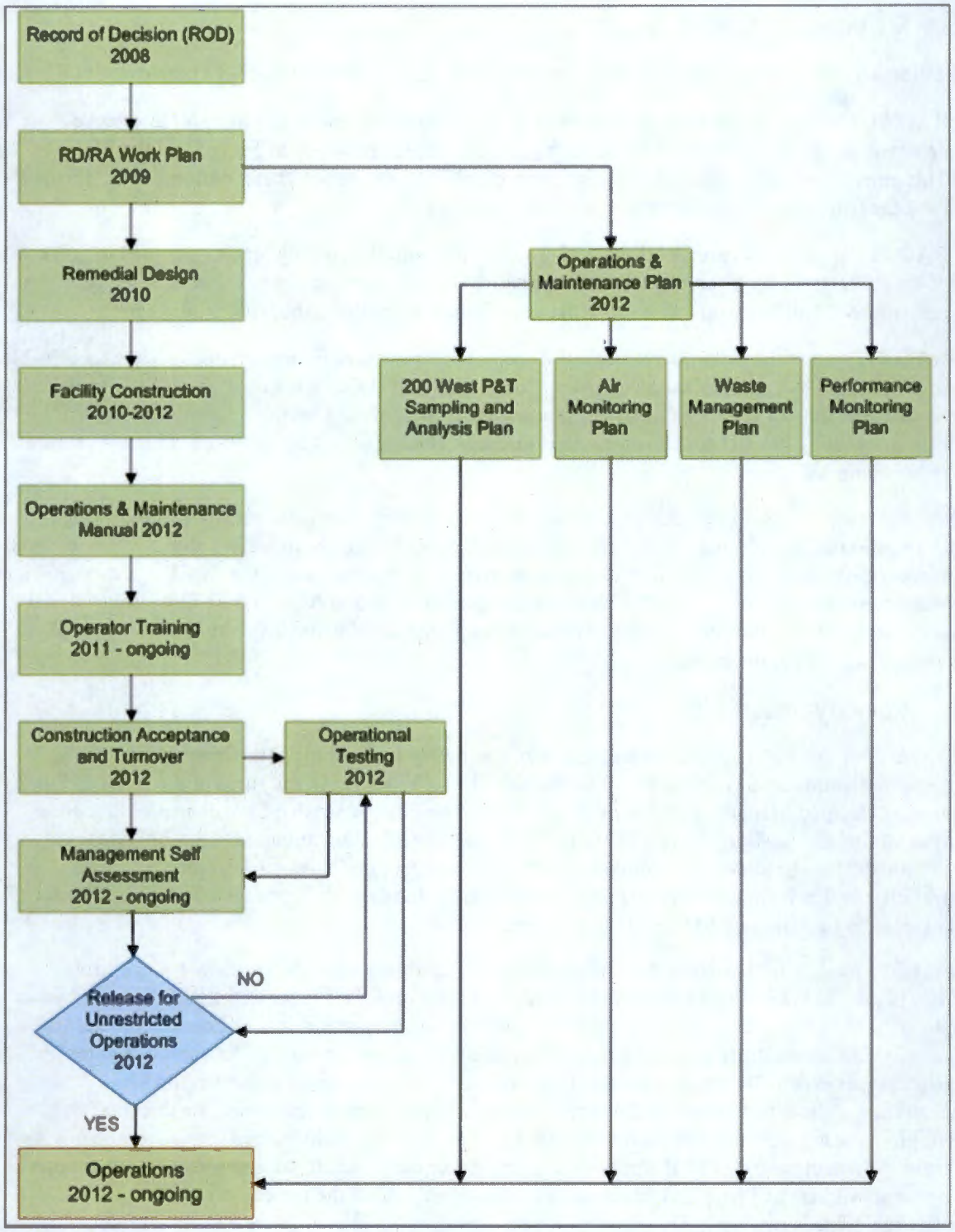

Figure 1-1. Notable 200 West P&T Regulatory Decisions, Documentation, and Events

1.2 Statement of Remedy Goals

The following RAOs are specified in the ROD (EPA et al., 2008) for the 200-ZP-1 Groundwater OU:

- **RAO #1:** Return 200-ZP-1 OU groundwater to beneficial use (restore groundwater to achieve domestic drinking water levels) by achieving cleanup levels (provided in Table 11 of the ROD). This objective is to be achieved within the entire 200-ZP-1 OU groundwater plumes. The estimated time frame to achieve cleanup levels is within 150 years.[4]
- **RAO #2:** Apply ICs to prevent the use of groundwater until the cleanup levels (provided in Table 11 of the ROD) have been achieved. Within the entire OU groundwater plumes, ICs must be maintained and enforced until cleanup levels are achieved, which is estimated to be within 150 years.[4]
- **RAO #3:** Protect the Columbia River and its ecological resources from degradation and unacceptable impact caused by contaminants originating from the 200-ZP-1 OU. This final objective is applicable to the entire 200-ZP-1 OU groundwater plumes. Protection of the Columbia River from impact caused by 200-ZP-1 OU contaminants must last until cleanup levels are achieved, which is estimated to be within 150 years.[4]

The final cleanup levels for 200-ZP-1 OU groundwater contaminants of concern (COCs) following implementation of the selected remedy are identified in the ROD and are listed in Table 1-1. The cleanup levels were developed using federal drinking water maximum contaminant levels (MCLs); the criteria and equations provided in WAC 173-340-720(4)(b)(iii)(A) and (B), and WAC 173-340-720(7)(b) ("Model Toxics Control Act—Cleanup," "Ground Water Cleanup Standards"); and the federal and state drinking water standards for radionuclides.

1.3 Remedy Description

The DOE's 200 Areas National Priorities List site, commonly referred to as the Central Plateau, encompasses approximately 190 km^2 (75 mi^2) within the 1,517 km^2 (586 mi^2) area of the Hanford Site (Figure 1-2) located in south-central Washington State. The *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) site identification number for the 200 Areas is WA 1890090078. The 200-ZP-1 Groundwater OU is one of four groundwater OUs located on the Central Plateau. Each groundwater OU has its own plan of study and enforceable schedule, and each OU will eventually have its own ROD and cleanup action as needed.

The selected remedy for the 200-ZP-1 Groundwater OU combines P&T, MNA, flow-path control, and ICs to meet the objective of achieving cleanup levels for all COCs in the 200-ZP-1 OU in 125 years (Table 1-1). The effectiveness of the P&T system will diminish over time as COC concentrations are reduced, whereas the effectiveness of natural attenuation is relatively constant. As a result, natural attenuation will eventually become the dominant mechanism for continued reduction of COC concentrations. The effectiveness of the remedy is further enhanced by controlling the direction and rate of groundwater flow throughout the 200-ZP-1 OU using strategically placed extraction and injection wells for flow-path control. The ICs provide protection from exposure to groundwater contamination for both site workers and potential future users of groundwater until the remedy is complete (see Section 1.3.2.3).

[4] The RAOs identify that the estimated time frame to achieve cleanup is within 150 years. The expected outcome of the selected remedy is that 200-ZP-1 OU groundwater will be returned to a level that supports future use as a potential domestic drinking water supply in 125 years (EPA et al., 2008).

Table 1-1. Final Cleanup Levels for the 200-ZP-1 Groundwater OU

COC	Units	Final Cleanup Level	Cleanup Level Basis
Carbon tetrachloride	µg/L	3.4[a,b]	MTCA Method B
Chromium (total)	µg/L	100	Federal/state MCL
Hexavalent chromium	µg/L	48[c]	MTCA Method B
Nitrate-nitrogen	µg/L	10,000[d]	Federal/state MCL
Trichloroethene[e]	µg/L	1[a,b]	MTCA Method B
Iodine-129	pCi/L	1	Federal MCL
Technetium-99	pCi/L	900	Federal MCL
Tritium	pCi/L	20,000	Federal MCL

a. The *Model Toxics Control Act* (MTCA) Method B cleanup levels for carbon tetrachloride and trichloroethene are from the Washington State Department of Ecology's Cleanup Levels and Risk Calculations (CLARC) table, current as of September 25, 2008 (Ecology, 2008).

b. The DOE will clean up COCs for the 200-ZP-1 OU subject to WAC 173-340, "Model Toxics Control Act - Cleanup" (carbon tetrachloride and trichloroethene), so the excess lifetime cancer risk does not exceed 1×10^{-5} at the conclusion of the remedy.

c. There is no MCL specific to hexavalent chromium.

d. Nitrate may be expressed as total nitrate (NO_3) or as nitrogen (N). The MCL for nitrate as NO_3 is 45,000 µg/L, and the same concentration expressed as nitrate-N is 10,000 µg/L.

e. Trichloroethene is another name for trichloroethylene, the COC identified in the *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington* (EPA et al., 2008).

COC = contaminant of concern

DOE = U.S. Department of Energy

MCL = maximum contaminant level

1.3.1 Pump-and-Treat System Description

The 200 West P&T is designed to capture and treat contaminated groundwater to reduce the mass of carbon tetrachloride, total chromium (trivalent and hexavalent), nitrate, trichloroethene, iodine-129, and technetium-99 throughout the 200-ZP-1 OU. The system design also includes provisions for future treatment of groundwater from the 200-UP-1 OU, including removal of uranium. Following treatment, the water is reinjected into the aquifer to serve as a recharge source and to promote flow-path control (Figure 1-3). The 200 West P&T facility is located south of T Plant in the 200 West Area (Figure 1-4). The 90 percent design was presented in the *200 West Area Groundwater Pump-and-Treat Remedial Design Report* (DOE/RL-2010-13) and the system was constructed in calendar years 2010 and 2011.

The facility can treat up to 9,464 L/min (2,500 gallons per minute [gpm]) of extracted groundwater using two parallel treatment trains. The extraction and injection well network includes 23 extraction wells and 18 injection wells. The number and location of these wells were dependent on site-specific conditions. Figure 1-5 provides the layout of the injection wells, extraction wells, and conveyance piping in the 200 West Area.

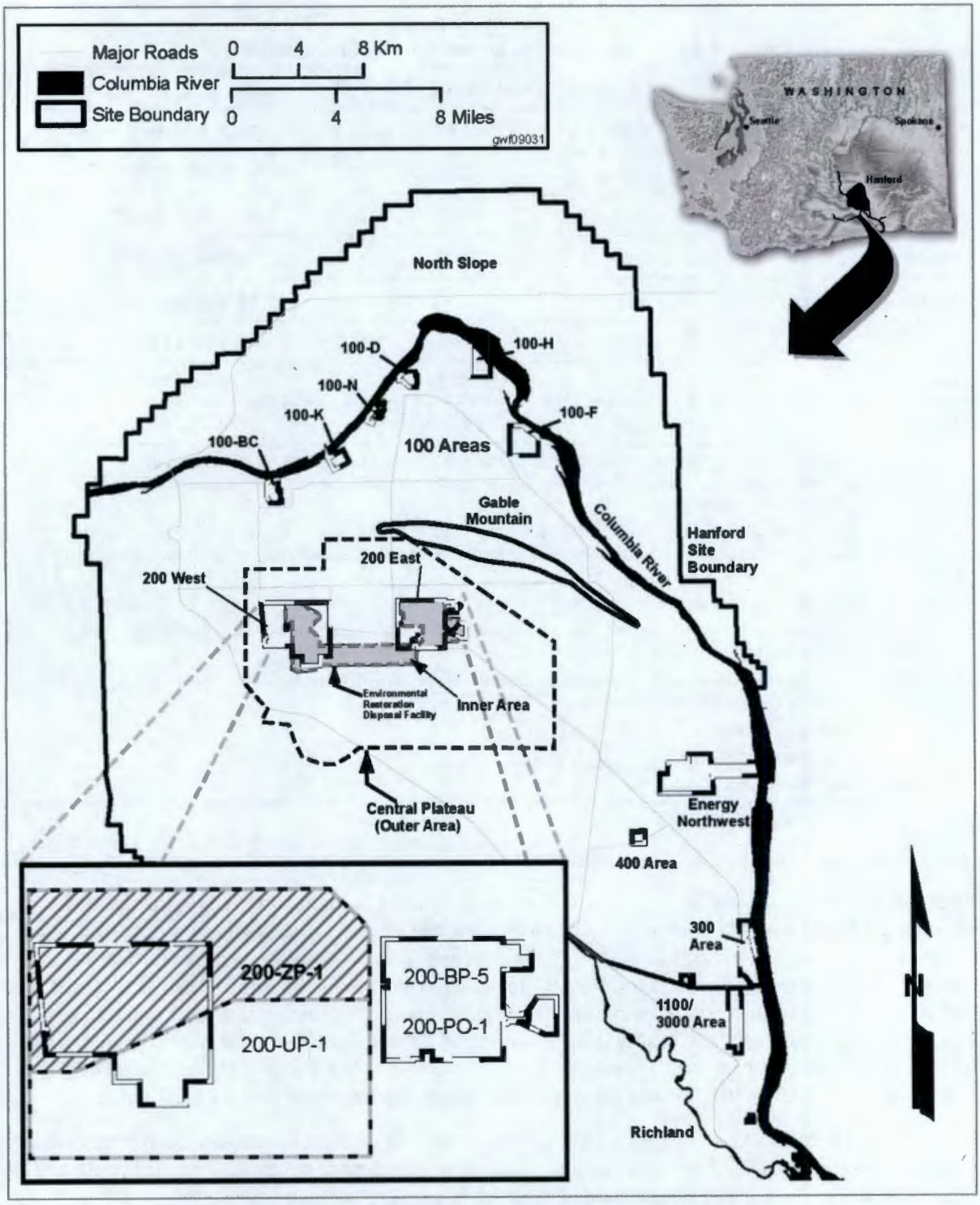

Figure 1-2. Hanford Site Map Showing Central Plateau Groundwater OUs

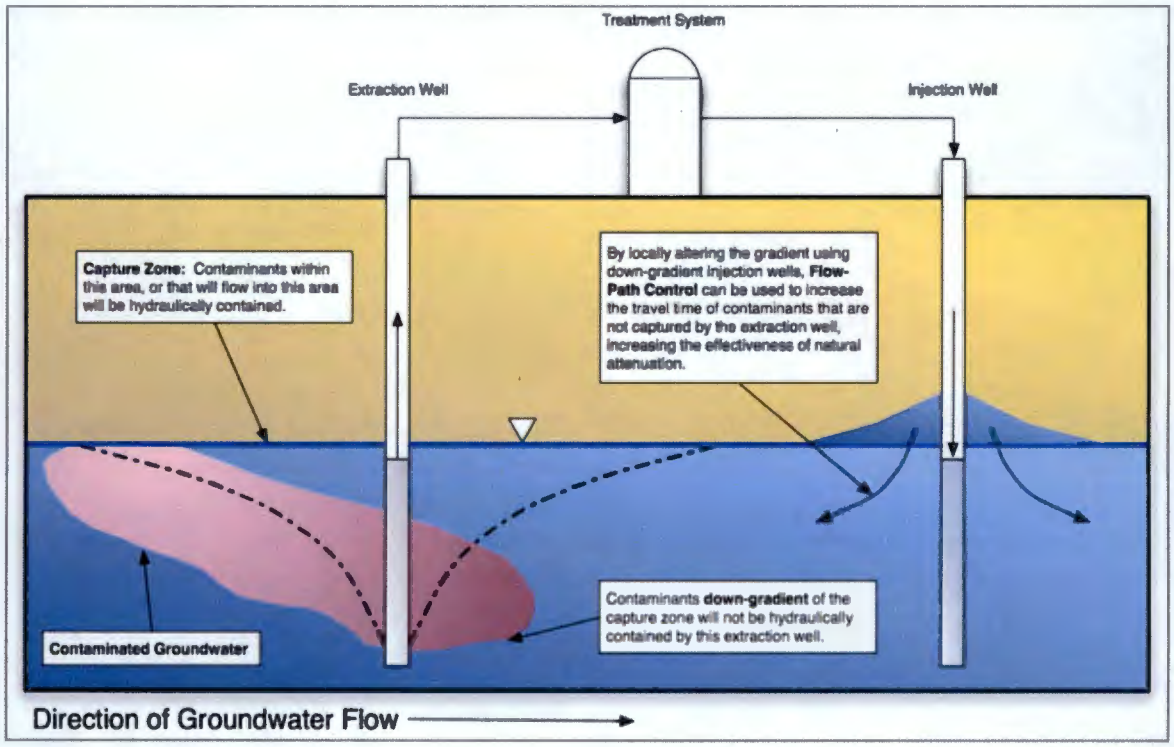

Figure 1-3. Conceptual Summary of the 200 West P&T

The design of the facility included the ability to add a third treatment train (also in parallel) within the existing facility footprint and infrastructure, increasing the design flow rate to 14,195 L/min (3,750 gpm). The need for additional treatment capacity will be based on the treatment capacity required for 200-ZP-1 OU groundwater and groundwater that may be extracted as part of the final remedy for the 200-UP-1 OU.

The groundwater treatment approach involves multiple treatment steps to remove the various COCs (Table 1-1). The relationship between each unit process and the targeted COCs is presented in Table 1-2. Additional information on each treatment step is provided in the following subsections.

1.3.1.1 Technetium-99 Ion Exchange System

Groundwater from selected wells in the 200-ZP-1 and 200-UP-1 OUs (after separate pre-treatment for uranium) is pre-treated to reduce technetium-99 to less than 900 pCi/L (Figure 1-6). Influent groundwater is first filtered to remove fine particulate matter. The groundwater then flows to the technetium-99 ion-exchange (IX) vessels before passing through a final set of filters and ultimately being transferred to the central treatment facility.

Prior to the IX resin reaching its loading limit, the resin will be removed from the vessel by sluicing it with treated water from the resin column into a carbon tetrachloride stripping tank (Figure 1-7), where the resin will be fully submerged with treated water. The tank will be heated and air will be bubbled through the resin bed to mix the bed and strip off carbon tetrachloride. The stripping water will be pumped to the equalization tank at the central treatment facility for treatment. The vapor emissions from the carbon tetrachloride stripping tank will be treated with vapor-phase granular activated carbon (VPGAC).

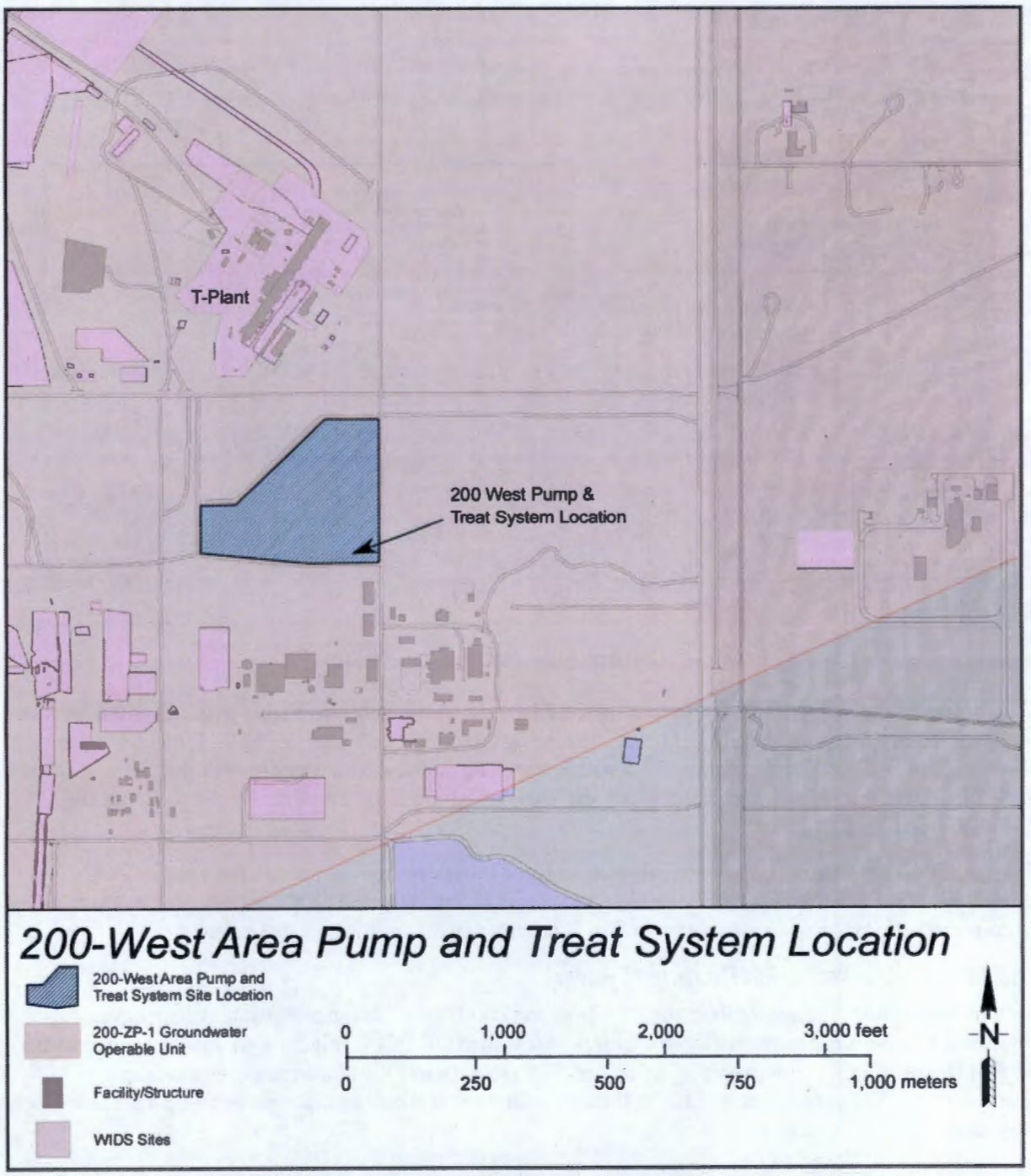

Figure 1-4. 200 West P&T Location

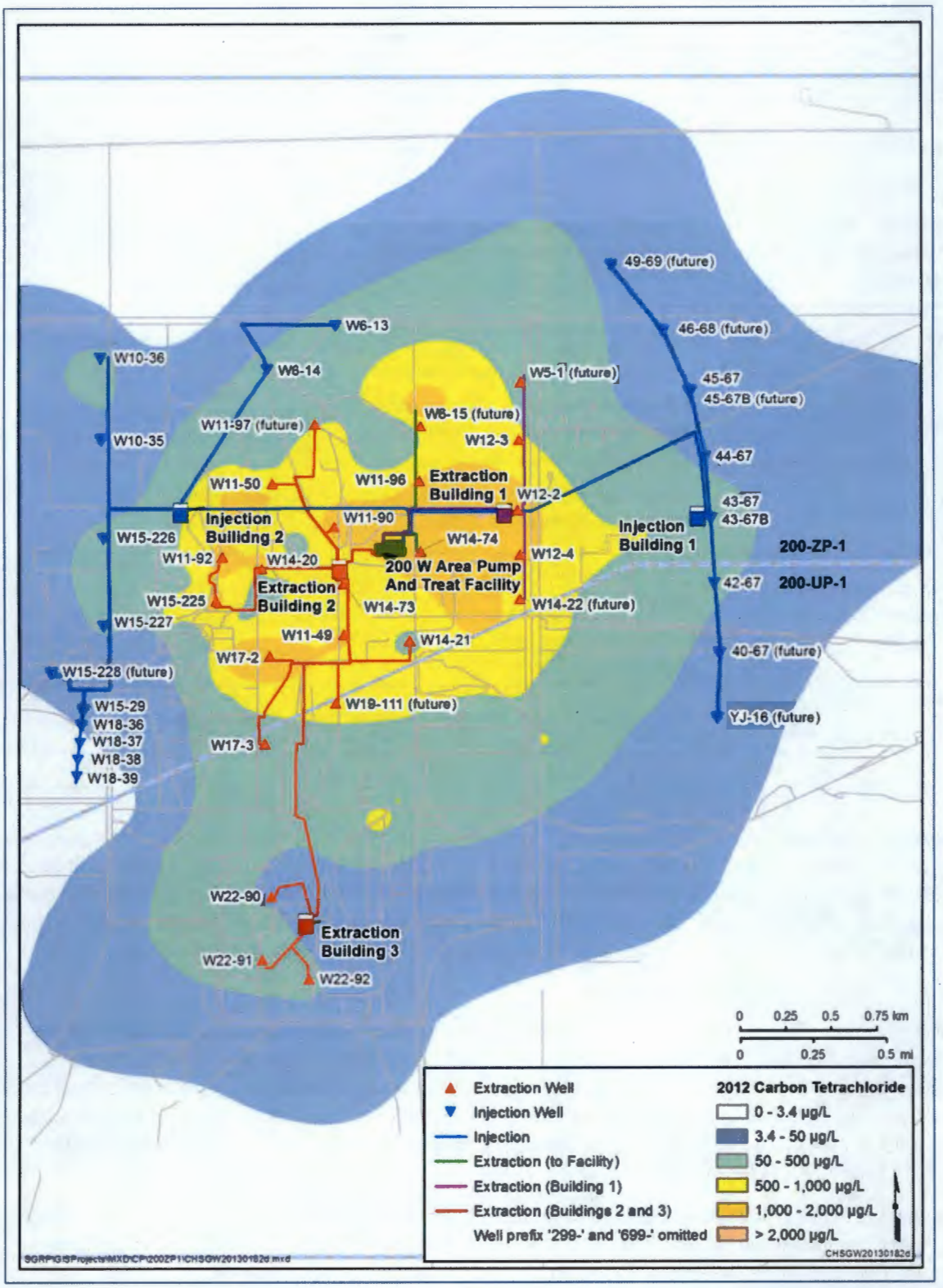

Figure 1-5. Extraction and Injection Well Locations and Conveyance Pipe Routing for the 200 West P&T

Table 1-2. 200 West P&T Unit Process Descriptions

Unit Process	Process Benefit	Targeted Parameter
Ion exchange	Removal of technetium-99, iodine-129, and uranium	Technetium-99 Iodine-129 Uranium*
Anoxic/anaerobic Biodegradation (fluidized bed reactor)	Removal of nitrate, carbon tetrachloride, and trichloroethene, and conversion of hexavalent chromium to trivalent form	Nitrate Carbon tetrachloride Trichloroethene Hexavalent chromium
Aerobic biodegradation	Degradation/removal of residual organic carbon substrate	Biochemical oxygen demand
Membrane filtration	Removal of particles, biomass, and precipitated trivalent chromium	Trivalent chromium Turbidity and biochemical oxygen demand
Air stripping	Removal of volatile organic compounds carbon tetrachloride and trichloroethene	Carbon tetrachloride Trichloroethene
Sludge thickening	Thicken biological solids for dewatering process	Solids content
Sludge dewatering	Reduce water content to allow for landfill disposal	Water content
Treated water chemistry adjustment	Provide treated water stability	pH and alkalinity

* Uranium treatment is only required for groundwater from the 200-UP-1 Operable Unit.

The resin in the strip tank will be sluiced with treated water to a container to allow drainage (Figure 1-8). The drained water will be collected and pumped back into the feed tank (Figure 1-6). The dewatered resin will be transported for placement at the Environmental Restoration Disposal Facility (ERDF). The spent resin will be profiled to verify that the ERDF limits for technetium-99, iodine-129, uranium, and carbon tetrachloride are met. If these limits cannot be met, stabilization of the resin may be required.

1.3.1.2 Uranium Ion-Exchange System

The P&T system design considers the need for treatment of other constituents (e.g., uranium) that may be captured by the 200 West Area extraction wells. While not COCs for the 200-ZP-1 OU, these constituents may be encountered from sources related to the other adjacent groundwater OUs, such as the 200-UP-1 OU. Following initial operations, the 200 West P&T will need to be expanded to provide the necessary treatment capability for contaminated groundwater from the 200-UP-1 OU in accordance with the 2012 interim ROD for that OU.

Based on the need to address uranium concentrations, groundwater from these sources will be pre-treated to remove uranium using IX resin vessels prior to conveyance to the technetium-99 IX pre-treatment system. The uranium IX pre-treatment system will be similar to the technetium-99 IX system described above.

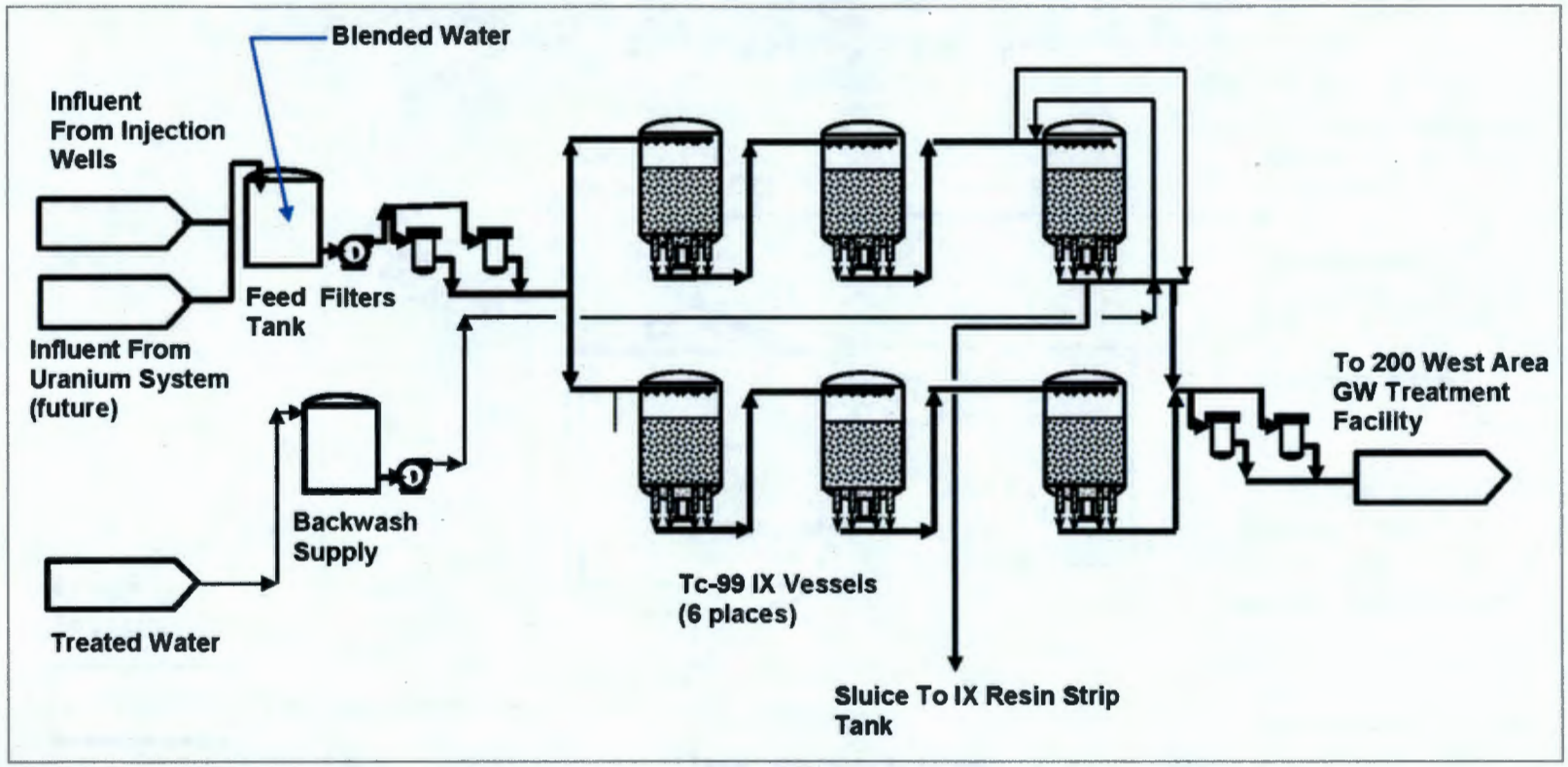

Figure 1-6. Technetium-99 IX Process Schematic

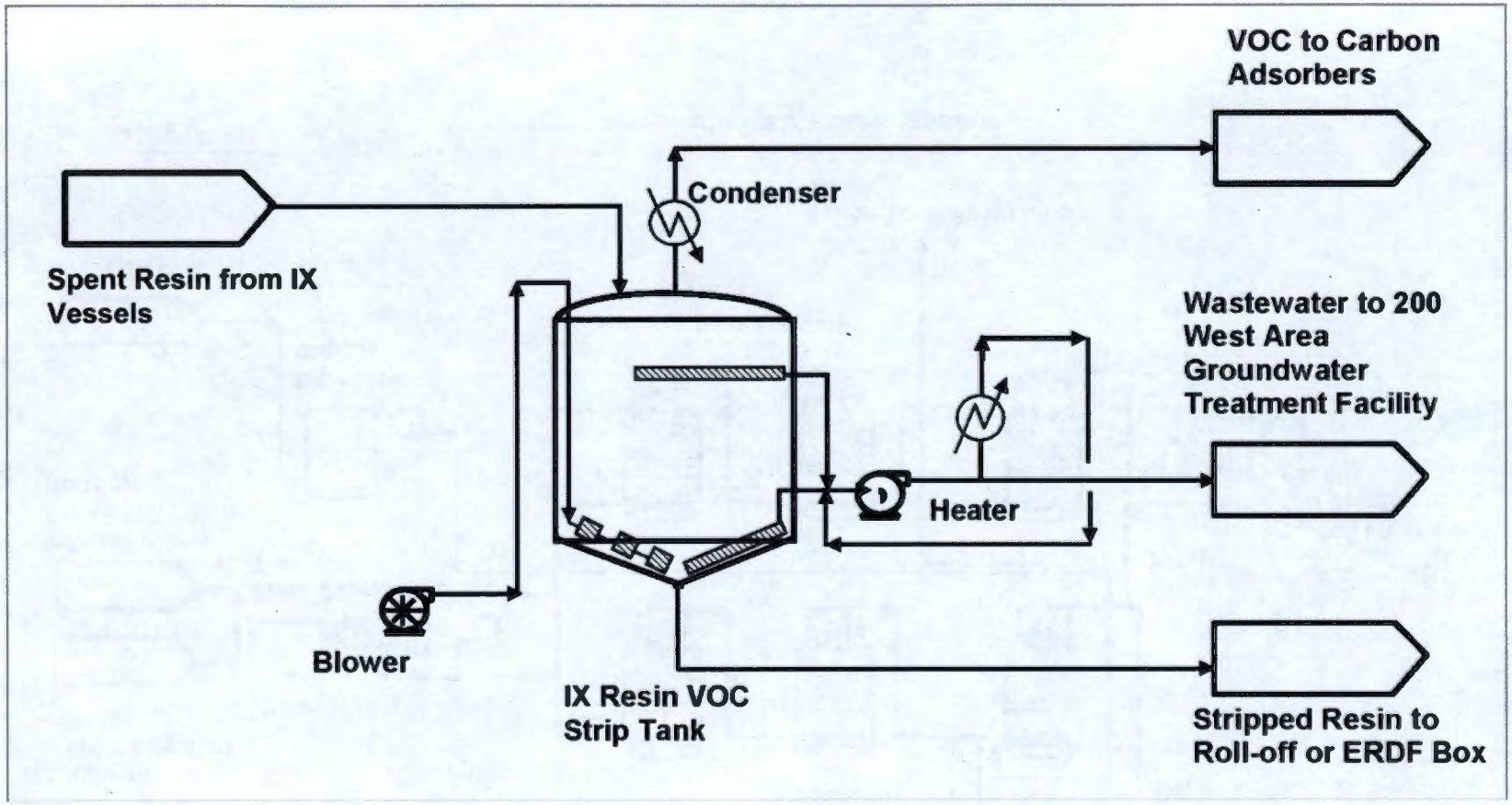

Figure 1-7. Technetium-99 IX Resin Strip Tank Schematic

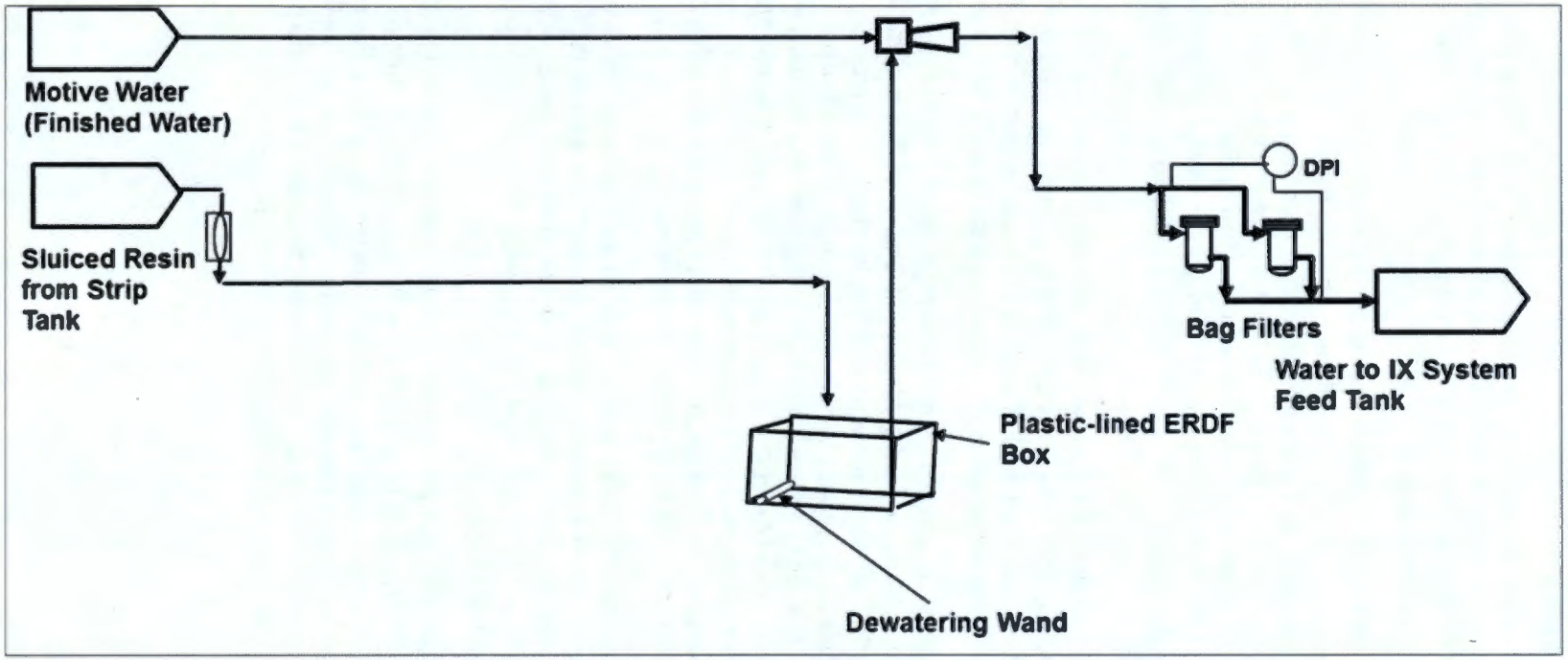

Figure 1-8. Technetium-99 IX Resin Dewatering Schematic

1.3.1.3 200 West Pump and Treat

The treatment processes for carbon tetrachloride and nitrate removal at the 200 West P&T are configured in two parallel 4,732 L/min (1,250 gpm) treatment trains to accommodate flow rates up to 9,464 L/min (2,500 gpm). The treatment facility infrastructure is designed to accommodate a third treatment train, if required, to increase the total treatment capacity to 14,195 L/min (3,750 gpm).

Water from the technetium-99 IX system flows to the central treatment facility where it is blended in an equalization tank (Figure 1-9) with extracted groundwater conveyed through transfer pumps serving several extraction wells or directly to the facility from individual extraction wells. Water is pumped from the equalization tank to a recycle tank and then into the bottom of the fluidized bed reactor (FBR), creating upflow to suspend the granular activated carbon (GAC) bed media to which microorganisms attach and grow. Within the FBR, nitrate is converted to nitrogen gas (denitrification) and carbon tetrachloride is degraded by the microorganisms under anoxic conditions (i.e., in the absence of dissolved oxygen).

An organic carbon substrate and phosphorus are added to the FBR to serve as the electron donor and to provide nutrients to promote microbial growth. As the microbes grow on the GAC, the fluidized bed height expands, and excess biomass is removed by shear forces resulting from normal flow through the FBR. Additional excess biomass is removed with a biomass separator and flows out with the effluent.

The effluent from the FBR flows by gravity to aerobic membrane tanks (Figure 1-10) for removal of residual carbon substrate through aerobic biodegradation and removal of total suspended solids, including biomass generated in the FBR. The membrane tanks have aeration capacity to provide sufficient oxygen for maintaining the aerobic biological process to reduce the residual carbon substrate. The membrane tanks have an aeration zone followed by a membrane zone with submerged membranes for filtration. The aeration zone is maintained by a blower that diffuses air into the tank. A second blower for the membrane zone provides air scouring to remove accumulated organic debris from the membrane surface to maintain its water permeability. The aeration and air-scouring processes also strip off carbon tetrachloride. Vapor emissions are collected for treatment with VPGAC.

The membrane zone contains multiple modules of vertically strung membrane fibers. Water is filtered by applying a slight vacuum to the end of each fiber, which draws the water through the tiny pores into the fibers. The filters remove solids that are retained in the tank concentrate. A portion of the concentrate is recycled to the first compartment of the membrane tank to maintain the biomass concentration necessary to reduce biochemical oxygen demand.

Solids from the membrane tanks are pumped to rotary drum thickeners (Figure 1-11). Thickened sludge leaving the rotary drum thickeners is sent to aeration tanks. As the solids concentration in the aeration tanks decreases, less flow is bypassed around the thickeners; conversely, as the solids concentration in the tank increases, more flow is bypassed around the thickening process. Polymer is added upstream of the rotary drum thickeners to thicken the solids, as necessary. The aeration tanks also provide further digestion of biomass and maintain aerobic conditions for odor control.

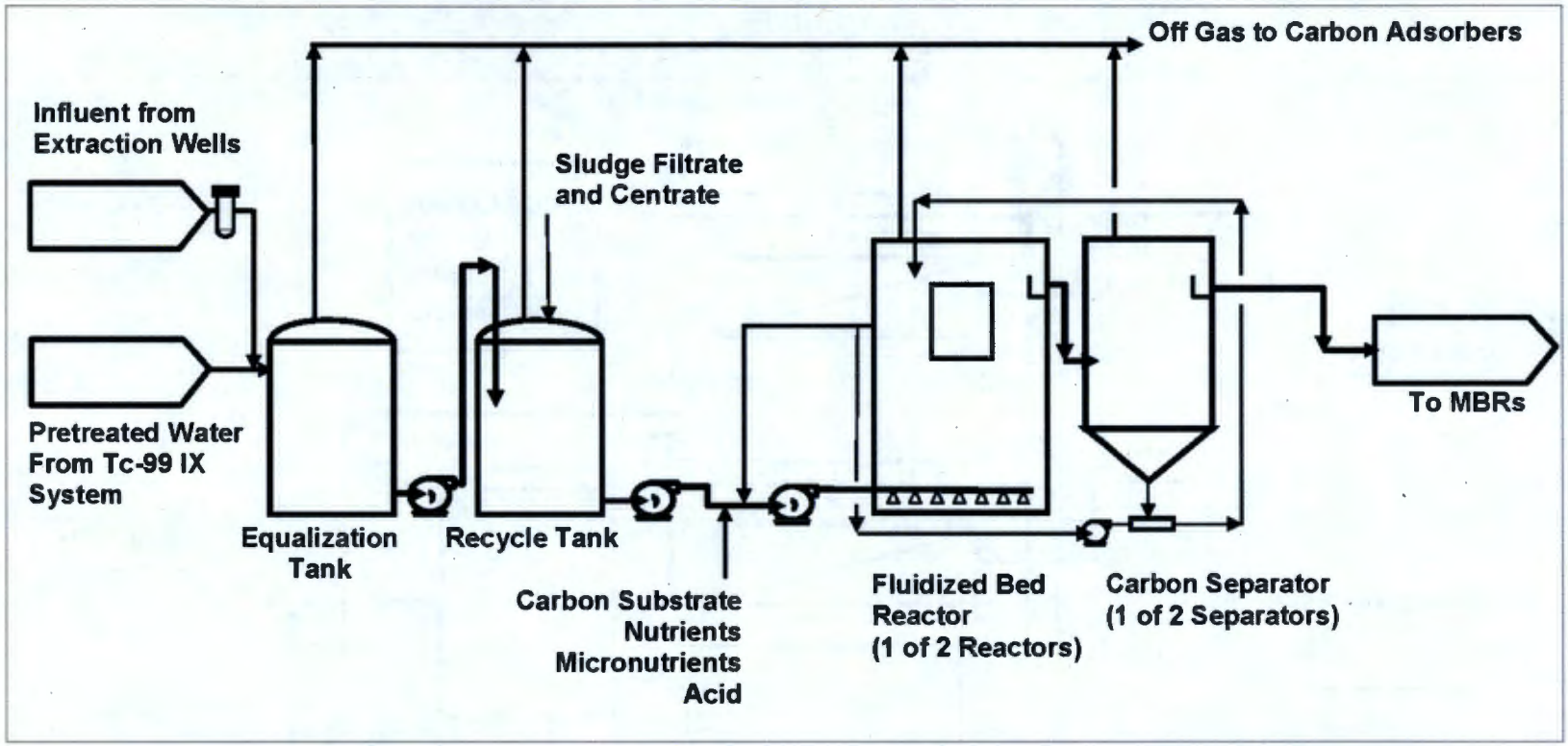

Figure 1-9. Biological Process — Anoxic FBR Schematic

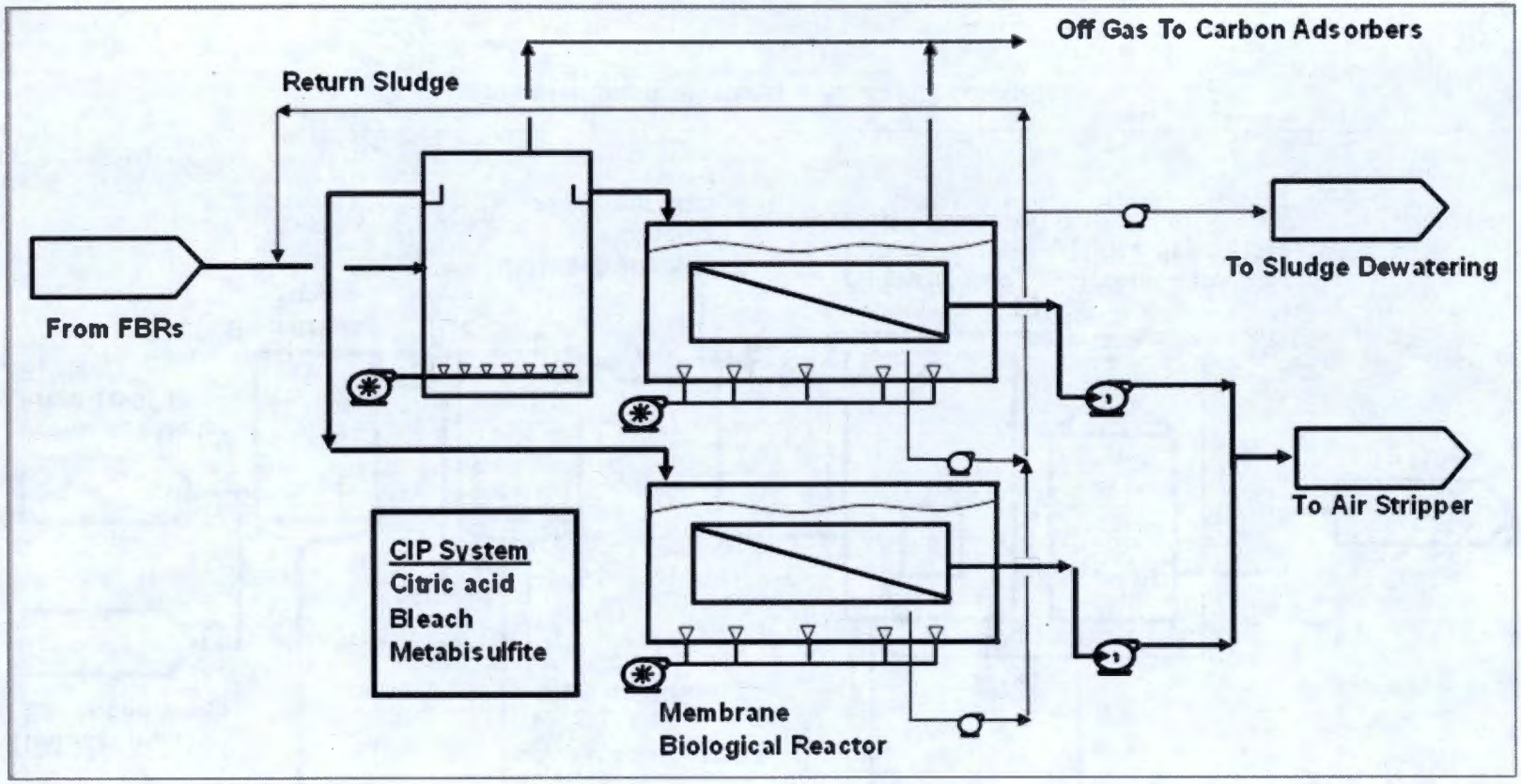

Figure 1-10. Biological Process — Membrane Bioreactor Schematic

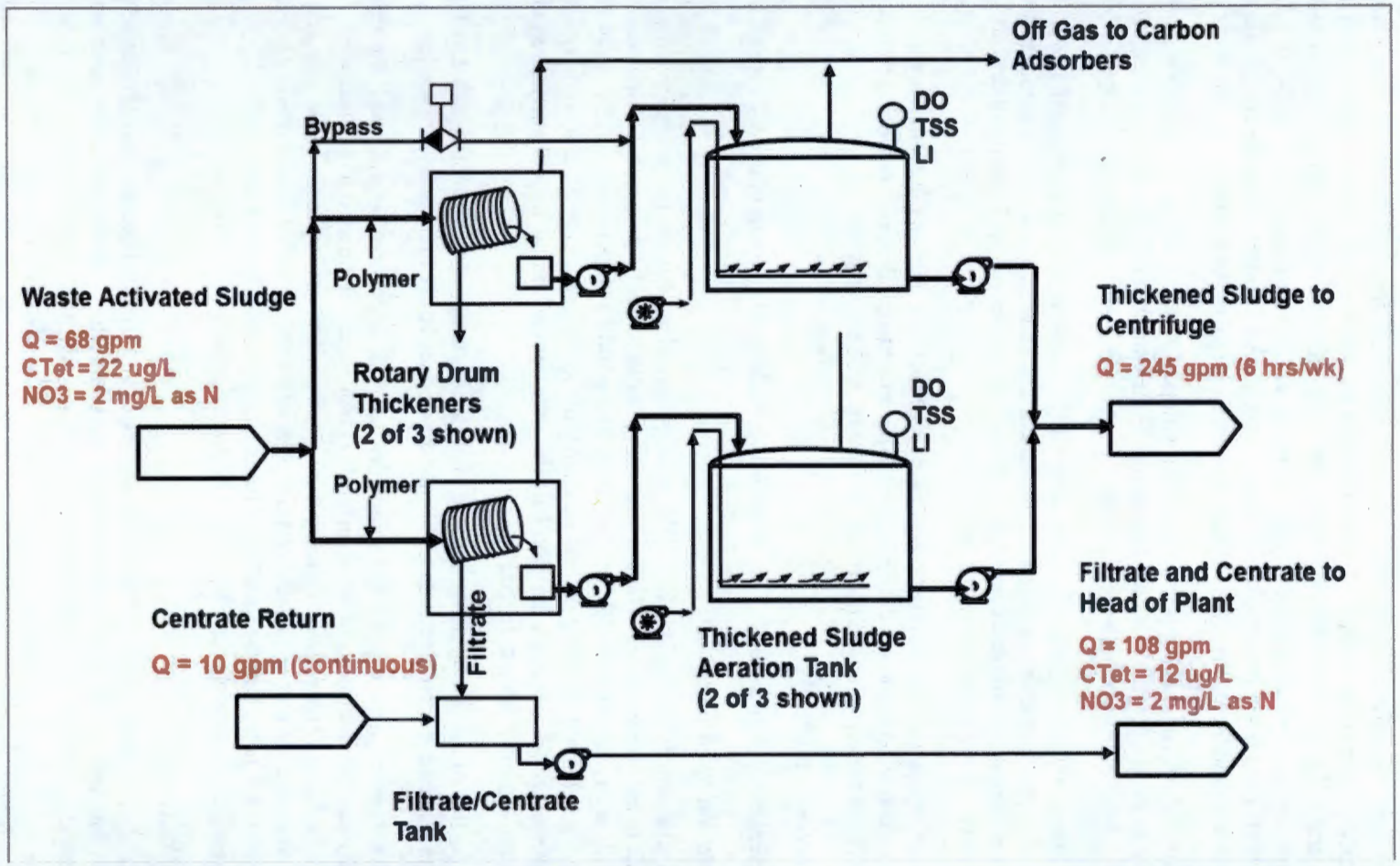

Figure 1-11. Solids Handling System — Thickeners and Thickened Sludge Aeration Tank Schematic

The thickened solids are then pumped from the sludge holding tank to centrifuges for dewatering (Figure 1-12). Polymer is added upstream of the centrifuges to aid in solids dewatering. A screw conveyor is used to move the dewatered sludge from the centrifuge to a lime stabilization system where a mechanical mixer (e.g., pug mill) mixes lime with the thickened sludge. This controls free water to meet ERDF disposal criteria and prevents further decomposition and generation of objectionable gasses and odors. Once the lime is added, the conditioned sludge is transferred by screw conveyor into ERDF containers for disposal. The filtrate from the rotary drum thickeners and centrate from the centrifuges are piped to a collection tank and then to the recycle tank located upstream of the FBR.

The treated water from the membranes is pumped to an air stripper (Figure 1-13) to remove the remaining carbon tetrachloride and other volatile organic compounds. The air stripper effluent is then pumped to an effluent tank. Acid is added upstream of the effluent tank through an in-line static mixer to adjust pH.

Off-gas from the stripper, influent equalization tank, strip tanks (technetium-99 and uranium), FBRs, membrane tanks, sludge holding tanks, rotary drum thickeners, and centrifuges is combined and treated by VPGAC. To avoid buildup of radionuclides in the VPGAC, air streams to the VPGAC system are pre-treated by a demister to minimize liquid carryover.

The air stripper tower is piped so this treatment step can occur before the FBR in the event that the degradation of the carbon tetrachloride in the FBR is less than anticipated. Process monitoring conducted during operations is used to determine the optimum configuration of the air stripper.

1.3.2 Other Remedy Components

This subsection describes the components of the groundwater remedy that augment the P&T system.

1.3.2.1 Monitored Natural Attenuation

In addition to P&T, the remedy for the 200-ZP-1 OU includes natural attenuation processes for reducing COC concentrations to the cleanup levels. Natural attenuation will eventually become the dominant mechanism for continued reduction of COC concentrations in the 200-ZP-1 OU as the effectiveness of the P&T system decreases over time. Because there is no viable treatment technology for removing tritium from the groundwater in the P&T system, the short half-life of tritium will allow natural attenuation to reduce its concentration to meet cleanup levels.

For the remaining portion of the carbon tetrachloride and nitrate (as well as tritium) not captured by the P&T component, natural attenuation processes will be used to reduce concentrations to cleanup levels.

Natural attenuation processes include biotic and abiotic degradation, dispersion, sorption, and, for tritium, natural radioactive decay. Monitoring conducted under this O&M plan will be used to evaluate the effectiveness of the P&T and natural attenuation processes, as described in Chapters 3 and 4. Fate and transport analyses conducted as part of *Feasibility Study Report for the 200-ZP-1 Groundwater Operable Unit* (DOE/RL-2007-28) indicate that the time frame necessary to reduce the remaining COC concentrations to acceptable levels through MNA will be approximately 100 years.

1.3.2.2 Flow-Path Control

The flow-path control component of the 200-ZP-1 Groundwater OU remedial action consists of injecting treated groundwater into the aquifer upgradient and downgradient of the groundwater contaminant plume. Injecting water at these locations contains the contaminant plume and, as a result, maintains the higher concentration areas within the extraction well capture zone and also increases the time available for natural attenuation processes to reduce contaminant concentrations not captured by the extraction wells.

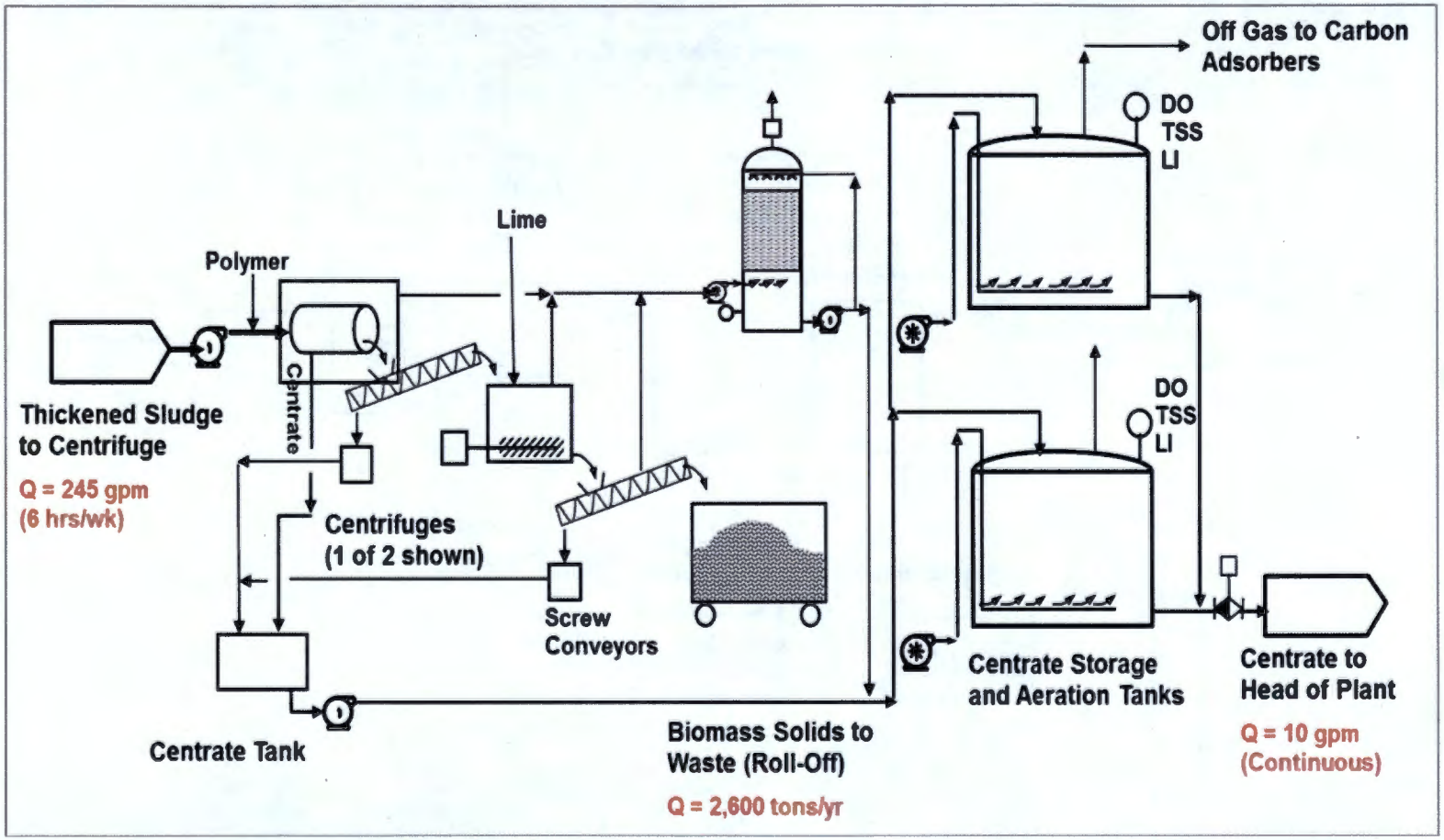

Figure 1-12. Solids Handling System — Centrifuge Dewatering and Lime Treatment Schematic

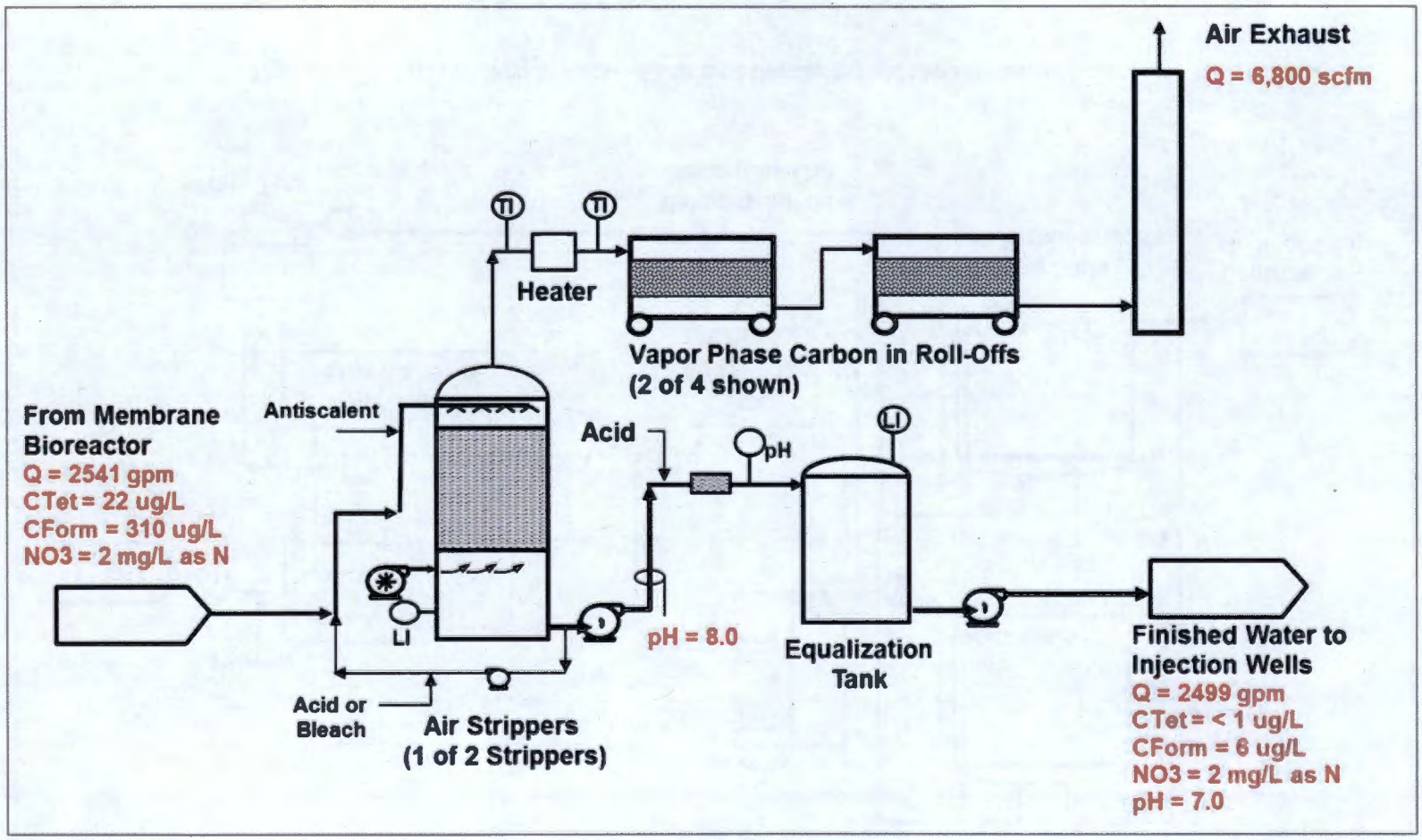

Figure 1-13. Air Stripper System Schematic

Flow-path control minimizes the potential for groundwater in the northern portion of the aquifer to flow northward through Gable Mountain Gap toward the Columbia River. The injection wells are located to redirect groundwater flow to the east, which provides the longest flow path to the river (about 26 km [16 mi]). Monitoring data collected under this O&M plan will be assessed to determine the effectiveness of flow-path control, as described in Chapters 3 and 4.

1.3.2.3 Institutional Controls

The 200-ZP-1 OU ROD requires ICs for 200-ZP-1 OU groundwater until cleanup levels are met. A description of these controls and their implementation is provided in the Sitewide IC plan (DOE/RL-2001-41). The following specific controls are required by the ROD for the 200-ZP-1 OU (EPA et al., 2008):

- No intrusive work shall be allowed in the 200-ZP-1 OU unless the U.S. Environmental Protection Agency (EPA) has approved the plan for such work and that plan is followed.
- The DOE shall prohibit well drilling in the 200-ZP-1 OU, except for monitoring, characterization, or remediation wells authorized in EPA-approved documents.
- Groundwater use in the 200-ZP-1 OU is prohibited, except for limited research purposes, monitoring, and treatment authorized in EPA-approved documents. The Sitewide IC plan (DOE/RL-2001-41) contains the ICs and implementing details prohibiting well drilling and groundwater use in the 200-ZP-1 OU, as defined in the ROD.
- The DOE shall post and maintain warning signs along pipelines conveying untreated groundwater that caution site visitors and workers of potential hazards from the 200-ZP-1 OU groundwater.
- In the event of any unauthorized access to the site (e.g., trespassing), DOE shall report such incidents to the Benton County Sheriff's Office for investigation and will consider administrative debarment of the trespasser, as well as prosecution in state or federal court, as deemed appropriate.
- Activities that would disrupt or lessen the performance of the P&T, MNA, and flow-path control components of the remedy are to be prohibited.
- The DOE shall prohibit activities that would damage the P&T, MNA, and flow-path control components (e.g., extraction wells, injection wells, piping, treatment plant, and monitoring wells).
- The DOE shall report on the effectiveness of ICs for the 200-ZP-1 OU remedy in an annual report, or on an alternative reporting frequency specified by EPA. Such reporting may be for this OU alone or may be part of a Hanford Sitewide annual report.
- The DOE will prevent the development and use of property above the 200-ZP-1 OU for residential housing, elementary and secondary schools, childcare facilities, and playgrounds.
- Land-use controls will be maintained until cleanup levels are achieved and the concentrations of hazardous substances in groundwater are at such levels to allow for unrestricted use and exposure, and EPA authorizes the removal of restrictions.

Most of the land within the 200-ZP-1 OU has been designated by DOE, through the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (HCP EIS) (DOE/EIS-0222-F), for industrial exclusive use for the foreseeable future. Because this area contains facilities that will have long-term responsibility for disposal or storage of hazardous substances, the possibility that this property could qualify for transfer of title out of the federal government is remote, especially in light of the

exacting requirements of CERCLA Section 120(h) for transfers of contaminated federal land. Because the 200 Areas were principally withdrawn from the public domain, if the land ever became surplus to the needs of DOE, federal law requires that it be turned over to the Bureau of Land Management. Nevertheless, as a general policy to ensure continuity of ICs that have been selected as part of remedial actions at the Hanford Site, DOE has made the following commitments to EPA Region 10:

- DOE will provide notice to EPA at least 6 months prior to transfer or sale of the land within the 200-ZP-1 OU, so EPA can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs.
- If it is not possible for DOE to notify EPA at least 6 months prior to transfer or sale, then DOE will notify EPA as soon as possible, but no later than 60 days prior to the transfer or sale of property subject to ICs.
- In addition to the land transfer notice and discussion provisions above, DOE further agrees to provide EPA with similar notice, within the same time frames, as to federal-to-federal transfer of property. DOE shall provide a copy of the executed deed or transfer assembly to EPA.

2 Organization, Operations, and Optimization

This chapter describes the 200 West P&T project organization, O&M program, and the system's optimization process.

2.1 Project Organization

Figure 2-1 provides the organizational structure supporting the 200 West P&T. Management responsibilities and inter-relationships are described in the following subsections.

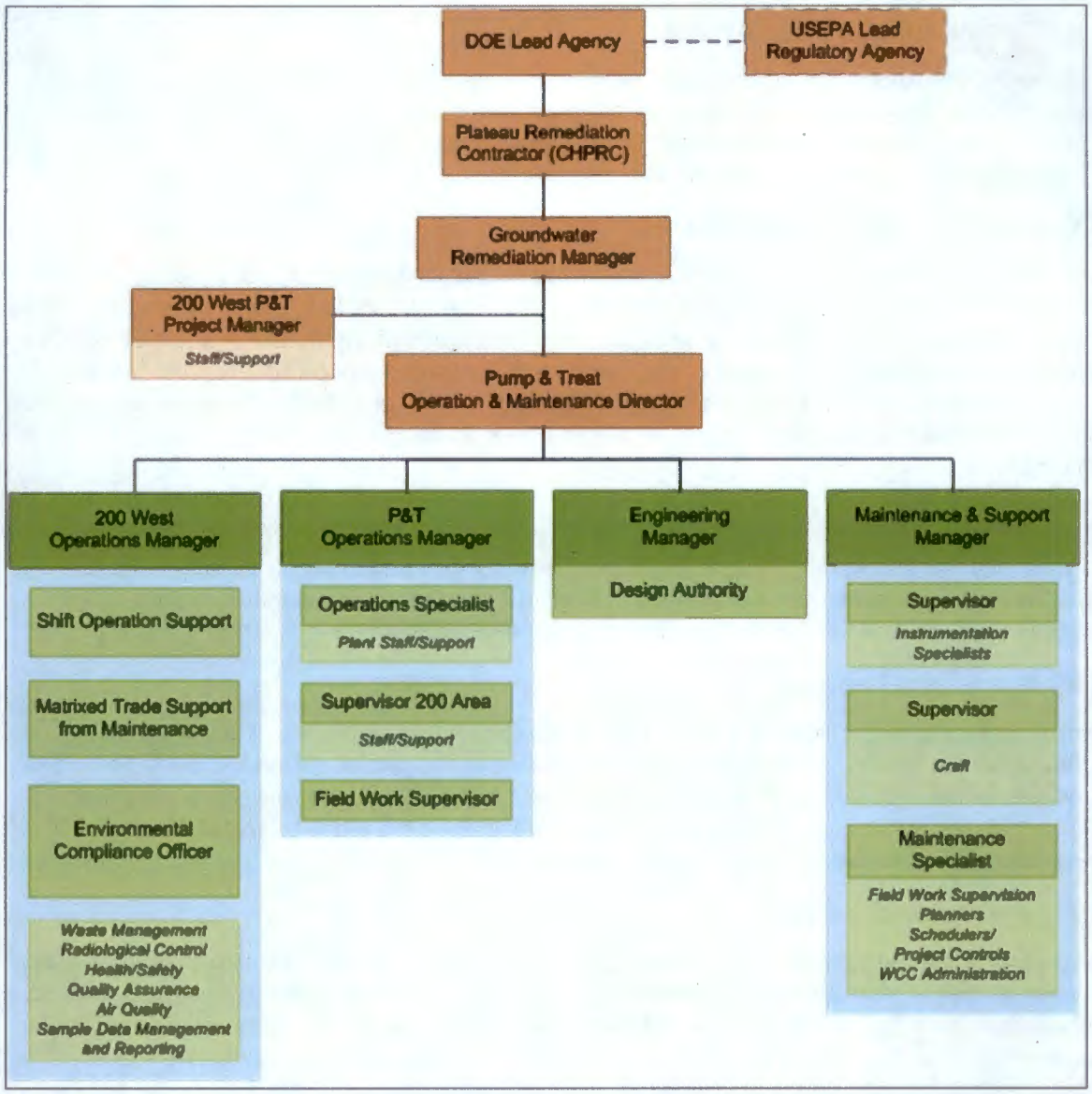

Figure 2-1. Organization Chart for 200 West P&T O&M

2.1.1 Groundwater Remediation Manager

The groundwater remediation manager provides oversight for activities and coordinates with RL, EPA, and CH2M HILL Plateau Remediation Company (CHPRC) management. In addition, support is provided to the 200 West P&T project manager to ensure that work is performed safely and cost effectively.

2.1.2 200 West P&T Project Manager

The project manager is responsible for the budget and schedule for the 200 West P&T, direct management of documents and requirements, and subcontracted tasks. The 200 West P&T project manager coordinates with and reports to RL and CHPRC management on 200 West P&T activities.

2.1.3 Operations/Maintenance Director

The operations/maintenance director is responsible and accountable for the O&M of the P&T system. Responsibilities include ensuring that appropriate operations support functions (e.g., radiological protection and safety) are available to support operations activities, and for verifying that O&M procedures have been prepared, approved, and implemented.

2.1.4 200 West P&T Operations Manager

The 200 West P&T operations manager assists with startup and development of operational guides, and performs training and performance evaluations for the 200 West P&T facility. Additional responsibilities include the following: implementing operator and operations management training programs, evaluating and directing the process of the treatment plant, analyzing operational process control procedure and making recommendations to the project manager, maintaining accurate operational records and preparing reports as required by the project manager, monitoring the records, and reviewing all plant operating records.

2.1.5 Chief Engineer

The chief engineer has overall management responsibility for the practice of engineering within CHPRC's Soil and Groundwater Remediation Project. The chief engineer is responsible for the assignment and approval of qualifications for the design authorities.

2.1.6 Maintenance Manager

The maintenance manager supervises all preventive and corrective maintenance of 200 West P&T facilities; plans, schedules, and directs maintenance of a variety of specialized mechanical and electrical equipment, including buildings, structures, and grounds; assigns, coordinates, and supervises personnel and materials required for the maintenance and repair of facilities; and estimates cost and time for all aspects of maintenance, repair, and construction work.

2.1.7 Maintenance Supervisors

Maintenance supervisors are responsible for preparing and executing facility maintenance-related work activities. As part of work planning, the maintenance supervisor conducts pre-work reviews, automated job hazard analyses, and walkdowns with the work team; ensures that all work documents are technically accurate, current, and have been approved and released for work performance; coordinates with other organizations to fully support the field work activities and ensures that craft personnel are adequately trained and qualified; implements planned and unplanned maintenance in accordance with facility operational priorities; and conducts post-job reviews and technical work document closure upon completion of the field activities.

2.1.8 Environmental Compliance Officer

The environmental compliance officer reviews plans, procedures, and technical documents to ensure that environmental requirements have been addressed; identifies environmental issues that affect operations and develops cost-effective solutions; and responds to environmental/regulatory issues or concerns raised by RL and/or the lead regulatory agency. The environmental compliance officer also oversees project implementation for compliance with applicable internal and external environmental requirements.

2.1.9 Design Authority

The design authority is responsible and accountable for review and approval of the functional design criteria and for final acceptability of a structure, system, or component. The design authority also identifies applicable regulatory and safety requirements. The design authority's responsibilities related to operations include reviewing and approving functional design criteria, design changes, construction submittals, and requests for information; performing engineering inspections for design compliance; and reviewing and approving procedures.

2.1.10 Quality Assurance Engineer

The QA engineer is matrixed to the 200 West P&T project manager and is responsible for QA issues on the project. Responsibilities include overseeing implementation of project QA requirements, reviewing project documents (including SAPs and the QA project plan), and participating in QA assessments.

2.1.11 Health and Safety

The Health and Safety organization is responsible for coordinating industrial safety and health support within the project, as carried out through health and safety plans (HASPs), job hazard analyses, and other pertinent safety documents required by federal regulations or internal primary contractor work requirements. In addition, the Health and Safety organization provides assistance to project personnel in complying with applicable health and safety standards and requirements. The Health and Safety organization coordinates with Radiological Engineering to determine personal protective equipment requirements.

2.1.12 Radiological Engineering

The Radiological Engineering lead is responsible for radiological/health physics support within the project. Specific responsibilities include conducting as low as reasonably achievable (ALARA) reviews, exposure and release modeling, and radiological controls optimization for all work planning. In addition, the Radiological Engineering lead identifies radiological hazards and implements appropriate controls to maintain worker exposures ALARA (e.g., requiring personal protective equipment). The Radiological Engineering lead also interfaces with the project Health and Safety contact, and plans and directs radiological control technician support for all activities.

2.1.13 Field Work Supervisor

The field work supervisor is responsible for planning and coordinating field resources and ensures that workers are appropriately trained and available. Operations field work supervisors also participate in continuing training to help maintain system/process-related knowledge of the 200 West P&T.

2.1.14 Contract Laboratories

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

2.1.15 Sample Management and Reporting

Sample Management and Reporting coordinates the laboratory analytical work and ensures that the laboratories conform to Hanford Site internal laboratory QA requirements (or their equivalent), as approved by DOE and EPA. Sample Management and Reporting receives analytical data from the laboratories, enters the data into the Hanford Environmental Information System (HEIS) database, and arranges for data validation. Sample Management and Reporting is responsible for informing the project manager of any issues reported by the analytical laboratories.

2.1.16 Waste Management Lead

The Waste Management lead communicates policies and procedures, and also ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner. Other responsibilities include receiving data from the field team lead to initiate waste designations, profiles, and other documents to confirm compliance with waste acceptance criteria.

2.2 Operations and Maintenance Program

The O&M program adopted for the 200 West P&T was based on the O&M programs developed for existing P&T systems in the 100 and 200 Areas (e.g., 200-ZP-1 interim P&T system). This O&M program relies on an automated electronic information management platform for creating, storing, and updating the components of the O&M program on the Hanford local area network. The O&M program information specific to the 200 West P&T was uploaded into the electronic platform after the remedial design report was finalized and vendor information submittals were received during construction. The electronic information residing in this platform references the location of any supporting information not contained within the system (e.g., hardcopy vendor submittal information). The information contained within the electronic platform addresses the following topics, as appropriate:

- System description, including an overview of system equipment and treatment processes
- Operating parameters and procedures for the facility, including each of the critical unit processes (e.g., biological systems and air stripping)
- Vendor equipment specifications (e.g., fundamental technical information concerning each unit's process step, construction materials, and pump curves)
- System O&M information, including equipment manufacturer and vendor-supplied O&M manuals (specific to individual system components or equipment)
- Preventive and corrective maintenance information for monitoring system equipment and process operations
- Standard operating procedures addressing system and component repairs
- Master equipment and spare parts list
- System transient condition response actions and procedures
- Emergency response plan
- Warranty data and information

- Training procedures
- Process liquid stream sampling and reporting requirements

The operator training necessary to operate and maintain the P&T system includes required health and safety training and specialized training by equipment vendors or design personnel. A training plan was issued and included in the O&M program.

2.3 Operations and Process Optimization

System performance assessment is conducted during operations to monitor P&T system operations to ensure that each system is operating in accordance with the approved specifications, and is operational and functional. Data collected during this assessment include the following:

- Process monitoring data
- Performance monitoring data
- Air monitoring data
- Waste management data
- Preventative and corrective maintenance data

The data collected during operations are used for process optimization. Figure 2-2 provides an overview of O&M and monitoring inputs for process optimization. Process optimization is ongoing and relies on remedy performance monitoring data. The data are evaluated to make decisions on the scope of the future modifications and expansion to the 200 West P&T.

Performance monitoring, air monitoring, and waste management data are provided to EPA in a quarterly briefing presentation and are summarized in the performance monitoring report (described in Section 5.1 of this O&M plan).

Figure 2-2 also shows the decision process that is used to determine whether RAOs are being achieved, and whether system expansion or modification is necessary. If it is determined that RAOs are not achievable, even with additional system expansion or modification, a demonstration of technical impracticability and modification of RAOs may be necessary.

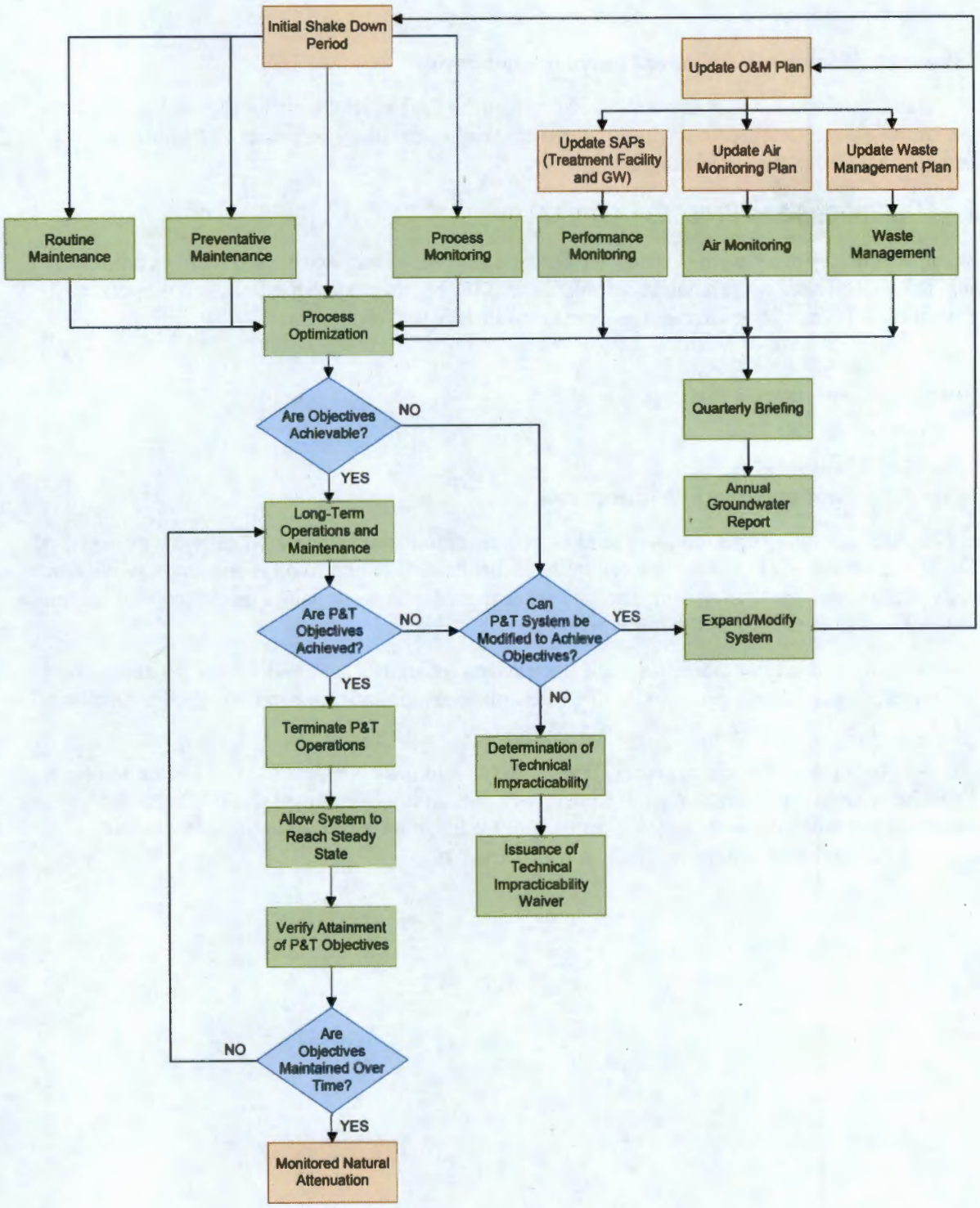

Figure 2-2. System Optimization, Modification, and Long-Term Operation

3 Operations and Maintenance

This chapter presents information associated with routine and nonroutine O&M of the 200 West P&T and other remedy components requiring O&M. An effective O&M program is essential for successful completion of the 200-ZP-1 OU remedial action. A thorough and well-implemented preventative maintenance program ensures that equipment is properly maintained and provides for early detection of problems.

3.1 Pump-and-Treat System Operational Criteria

Routine operation of the 200 West P&T consists of drawing groundwater from a network of extraction wells, pre-treating a portion of the flow to remove technetium-99 (and, in the future, uranium), combining the pre-treated stream with the balance of flow, and conveying the blended stream to the central treatment facility for the removal of COCs and other constituents. Following treatment, the treated water is returned to the aquifer through a series of injection wells.

The treatment system has the capacity to treat 9,464 L/min (2,500 gpm). Operational up-times are expected to average 80 percent. The operational up-time is calculated using a 12-month rolling average.

3.2 Routine and Preventive Operations and Maintenance

Routine and preventative maintenance of P&T system components is performed in accordance with engineering evaluations and approved procedures. An overall preventative maintenance schedule was developed for equipment (e.g., extraction well pumps, transfer pumps, and blowers) using the information provided in these procedures and according to manufacturer/vendor guidelines. The schedule is incorporated into the O&M program.

Routine and preventative maintenance activities are documented in accordance with work control procedures, and the work packages are maintained in project records. A general summary of maintenance activities is provided in the annual report.

3.3 Transient Conditions

During routine P&T system operation, instances may occur where periodic sampling or other information identifies the presence of COCs in the final effluent stream at concentrations above the ROD cleanup levels, or where the influent stream contains a new contaminant (not identified in the ROD) at concentrations greater than a federal or state drinking water MCL or other protective level. In these instances, confirmation sampling may be performed and individual treatment processes may be evaluated to assess treatment efficiency. During such events, the P&T system will continue to operate at the previous flow rate or the throughput rate may be reduced.

If the presence of a transient condition is confirmed, the event will be documented in the operating record, along with the following information:

- Concentration of COCs detected that exceeded ROD cleanup levels, or the concentration of new contaminants that exceeded MCLs or other protective concentrations
- Location(s) and date(s) sampled
- Concentrations of COCs or new contaminants detected during previous sampling events
- Corrective actions taken

Significant transient conditions will be discussed with the regulatory agencies at the periodic briefings and will be summarized in the annual report.

3.4 Corrective Maintenance

Corrective maintenance consists primarily of unplanned repairs or replacement of system components after components have failed. Typical examples include worn-out pumps, leaky pipe joints, and failed electronic components. If a failure occurs, the system will be evaluated to determine if there is an alternative operating configuration, the possible cause of the problem, and what actions should be taken to correct the problem. Corrective maintenance activities will then be performed in accordance with approved maintenance procedures and/or the manufacturer's recommended procedures.

Corrective maintenance activities will be documented in the job control system, and a summary of these activities will be provided in the annual report. Depending on the scope of corrective maintenance activities, the routine and preventative maintenance schedule may be reviewed and modified.

3.5 Operations and Maintenance Practices, Inspection, and Training

Routine inspection and maintenance activities are necessary to ensure the long-term integrity and success of the remedy. This section summarizes typical inspection and maintenance needs for the proper care and efficient operation of each remedy component, with primary emphasis on the 200 West P&T. Equipment-specific inspection forms and a preventative maintenance schedule will be developed using information contained in the manufacturer/vendor-supplied manuals. The forms will be incorporated into the O&M program.

Anticipated repair, replacement, and rehabilitation are also discussed in this section. Repair includes those activities of a routine nature that maintain the remedy in a well-kept condition. Replacement covers those activities performed when a worn-out component, or portion thereof, is replaced. Rehabilitation refers to a set of activities performed as necessary to bring deteriorated equipment back to its original condition. Repair, replacement, and rehabilitation actions are expected to conform to the original as-built plans and specifications.

The majority of the inspection and maintenance work will be performed using work packages developed from manufacturer recommendations and/or approved procedures. The following subsections summarize several of the key activities associated with the 200 West P&T inspection and maintenance program.

3.5.1 Personnel Training Program

Operations personnel will undergo classroom and on-the-job training. This training will cover facility startup, facility shutdown, operation adjustments, and other topics to be determined. The training will enable the operators to experience a number of routine and nonroutine events prior to actual hands-on contact with operations and equipment.

In addition to operator training, operations personnel undergo other Hanford Site training as required. The 200 West P&T operations manager will periodically review the training records of active O&M personnel to determine if additional or refresher training is required.

3.5.2 Hazard Communication Program

CHPRC maintains a hazard communication program to inform employees of hazards that may be encountered in the work place. The scope of this training is covered under an existing operating procedure

in accordance with the 29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response."

3.5.3 Routine Procedures

A number of approved routine procedures were developed for inclusion in the O&M program to provide operators with the information necessary to perform typical day-to-day activities, such as the following:

- Housekeeping inspections
- Conveyance piping inspections
- Waste storage area inspections
- Instrument calibrations
- Inspections of facility equipment and machinery, and routine adjustments
- Inspections of tanks, secondary containment devices, and sumps

3.5.4 Treatment Facility Operation Procedures

Treatment system startup and shutdown are described in operations procedures. These procedures provide the necessary information and direction to properly start up, operate, and shut down the radionuclide pre-treatment facilities and the central treatment facility. These procedures include the operational steps needed to place the system into a normal operating lineup and place the system in service. These procedures also include the steps for performing a routine system shutdown. In addition, the following operating procedures may also be prepared as individual activities as determined by operations for inclusion in the O&M program:

- IX resin changeout
- VPGAC changeout for regeneration
- FBR and membrane bioreactor operations
- Filter changeout
- Changeout of chemical tank and bulk chemical storage

3.5.5 Treatment Process Monitoring

Sampling of influent and effluent from individual treatment processes is conducted to assess performance and changeout requirements (IX resin and VPGAC), and to ensure optimum FBR, membrane aeration tank, and air stripper performance under one or more operating procedures. These procedures were developed based on information supplied in the equipment manufacturers' manuals and by experience gained during startup operations.

3.5.6 Waste Handling Procedures

All waste streams associated with operation and decommissioning of the 200 Area P&T are managed in accordance with the WMP (see Appendix B).

3.5.7 Safety Equipment Procedures

Approved operating procedures were developed to address the use and maintenance of safety equipment within the radionuclide pre-treatment facility and the central treatment facility.

3.5.8 Emergency Equipment Inspection and Maintenance Procedures

Approved operating procedures were developed to address the use, inspection, and maintenance of portable fire extinguishers, emergency lights, tank alarms, spill cleanup, and other protection systems.

3.5.9 Emergency Response Procedures

Approved operating procedures were developed to address the steps to be taken when an emergency indicator is triggered or an abnormal condition occurs. These procedures include the operational steps for determining the cause of an emergency, isolating it, and shutting down the system (if necessary) so influent or effluent will not be discharged from the containment system.

3.6 Inspection Requirement

The following subsections describe typical inspections for the 200 West P&T.

3.6.1 Extraction and Injection Well Inspection and Rehabilitation

Extraction and injection wellhead piping and fittings and aboveground conveyance piping are visually inspected periodically to detect leaks. The inspection findings are documented in a paper or electronic format that is maintained in the work control system.

Extraction and injection well performance often declines over time, resulting in lower throughput. Reduction in extraction well production or injection well capacity (if it occurs) can be corrected using routine well development and rehabilitation procedures (DOE/RL-2010-78, *200 West Area Groundwater Pump-and-Treat Facility Extraction and Injection Well Maintenance Plan*). The 200 West P&T O&M plan shall allow for addition of sodium hypochlorite or other chemical(s) for the purpose of preventing bio-fouling in the injection wells and other treatment system components, as desired.

To assess the need for well maintenance, extraction well pumping and injection rates are correlated with water-level measurements at each well to detect changes that could potentially affect well performance. Steadily declining pumping water levels at extraction wells or steadily increasing water levels at injection wells may indicate the need for well maintenance. An extraction and injection well monitoring and maintenance plan was developed to support 200 West P&T operations (DOE/RL-2010-78). Extraction and injection well maintenance and rehabilitation are discussed in the annual performance monitoring report.

3.6.2 Monitoring Well Inspections

The physical condition of monitoring wells is documented in field logbooks during each sampling event. Conditions requiring maintenance or repair are noted and communicated to the 200 West P&T operations manager.

3.6.3 Conveyance Piping Inspection

A majority of the conveyance piping between the extraction wellheads and the treatment building is located aboveground. During operations, flow monitoring for early leak detection is used. Flow-meter measurements are taken between the wellhead and the transfer station and/or between the transfer station and the 200 West P&T. If a difference of ±5 percent occurs between flow at the facility and/or transfer building and at the wellhead, an alarm will be triggered. The well pump and pipeline will then automatically shut down, and the potential leak will be inspected.

A majority of the conveyance piping between the injection wellheads and the treatment building is also located aboveground. During operations, flow monitoring is used in the same manner as the extraction

conveyance piping for the piping that conveys treated groundwater to the western injection wells in the vicinity of the 200 West Area burial grounds. This supports the nuclear safety basis requirements for the burial grounds. Since groundwater treated at the 200 West P&T is regarded to no longer contain the F001 through F005 listed waste codes (Tri-Party Agreement Change Notice TPA-CN-525, June 2012), flow monitoring is not needed for the conveyance piping for the eastern injection wells located near the Hanford meteorological tower. However, visual inspections for leaks occur during normal-shift operator rounds.

3.6.4 General Inspections

Daily (i.e., normal work days, currently Monday through Thursday) observations and inspections are performed as specified in facility procedures. Facility component inspections (e.g., tank inspections, fence and posting observations, and site physical conditions) are also performed. Routine inspections are performed for support systems such as decontamination equipment, spill kits, eye washes, safety showers, and fire extinguishers. Inspections of nonroutine activities (e.g., groundwater monitoring, sampling, or short-term tests) are completed as indicated in the individual plans controlling those activities.

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4 Monitoring

As described in the ROD and summarized in Chapter 1, the selected remedy combines P&T, MNA, flow-path control, and ICs to achieve the RAOs. This chapter describes the monitoring program implemented to assess performance of the 200-ZP-1 Groundwater OU remedy. The sampling design presented in this chapter is based on the evaluations and groundwater monitoring activities presented in the *Performance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action* (DOE/RL-2009-115).

Monitoring data will be collected over the lifecycle of the remedy to evaluate its performance and optimize effectiveness. Groundwater quality and groundwater elevation data are collected and evaluated to determine progress toward the specific performance monitoring goals shown in Table 4-1. The monitoring locations, monitoring period and frequency, parameters measured, and data uses are summarized in Table 4-2. Performance monitoring consists of short- and long-term monitoring tasks during various periods of the remedial action. Reviews of hydraulic and contaminant monitoring networks occur periodically, and individual wells are added or removed, as appropriate. Evaluations of monitoring frequencies and parameters also occur periodically for each location and are revised as appropriate.

4.1 Performance Monitoring

The performance monitoring program consists of water-level measurements and groundwater sampling using a monitoring well network. The following subsections briefly summarize the planned data collection associated with baseline monitoring, short-term monitoring (first through third years), and long-term monitoring (fourth to twenty-fifth years).

4.1.1 Baseline Monitoring

Baseline monitoring was conducted in 2011 and 2012 to characterize the initial groundwater flow field and COC distribution. Current and future data are compared with baseline conditions to evaluate changes resulting from pumping operations.

A single round of groundwater elevation data was collected from the monitoring well network to provide a baseline set of hydraulic data used to evaluate groundwater flow directions and gradients (horizontal and vertical) in the 200 West Area prior to P&T system startup. The hydraulic monitoring well network (Figure 4-1; Appendix E, Figure E-6) includes a network of monitoring wells screened at depth intervals within the aquifer that cover elevations ranging from the basalt bedrock to the water table surface. A few of the monitoring wells are located in close proximity to several of the extraction wells. The monitoring wells cover a spatial area that exceeds the boundaries of the COC plumes (except nitrate) and the P&T system. A majority of the measurements are collected manually but are supplemented with data obtained from wells equipped with transducers and data loggers. The data from the baseline event were used to construct groundwater elevation contour maps for determining groundwater elevations, flow directions, and gradients prior to system startup.

During the baseline sampling event, groundwater samples were collected from the monitoring well network (Figure 4-2; Appendix E, Figure E-7) and analyzed for COCs, other potential contaminants listed in Table 4-3, and the biogeochemical and field screening parameters listed in Table 4-4.

Baseline samples were also collected from the groundwater extraction wells during the well installation and development process and from the combined treatment plant influent. The samples were analyzed for the contaminants listed in Table 4-3.

Table 4-1. Performance Monitoring Goals and Data Requirements

Performance Monitoring Goals[a]	Data Requirements			
	Groundwater Sample Data from Monitoring Wells	Sample Data from Extraction Wells/ Treatment Plant Influent	Groundwater Elevations	Extraction/ Injection Well and System Flow Data[b]
1a. Determine if there are any new releases of COCs.	X			
1b. Determine if any new releases of COCs could impact the treatment process (the effectiveness of the remedy).	X	X		X
1c. Evaluate if any new releases are outside of the hydraulic capture zone of the P&T system.			X	
2. Determine if potentially toxic and/or mobile transformation products are being generated within OU groundwater.	X			
3. Determine if changes are occurring in environmental conditions (hydrogeological, geochemical, or microbial) that may reduce the efficacy of the P&T system, natural attenuation processes, and flow-path control actions.	X		X	
4. Verify that contamination is not expanding downgradient, laterally, or vertically.	X		X	
5a. Verify and/or predict if the P&T system will remove at least 95 percent of the mass of COCs in 25 years or less.	X	X	X	X
5b. Determine if the current remedy design is predicted to achieve cleanup levels for all COCs within 125 years.	X	X	X	X
6. Determine if remediation has been successfully completed.	X	X	X	

a. From the *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington* (EPA et al., 2008).

b. Extraction rate, injection rate, and flow volumes.

COC = contaminant of concern

OU = operable unit

P&T = pump and treat

Table 4-2. Performance Monitoring Plan

Data	Location[a]	Baseline	Short-Term Operations and Optimization[b]	Long-Term Operations and Monitoring[c]	Post-P&T	Frequency[d]	Parameters[d]	Data Use
Groundwater elevations	Hydraulic monitoring network	X				Once.	Manual or automatic measurement of groundwater levels.	Constructing groundwater elevation contour maps for determining groundwater elevations, flow directions, and gradients before system startup.
	Hydraulic monitoring network		X	X		Annually to semicontinuously.	Combination of manual and automatic measurement of groundwater levels.	Monitoring sustainability of extraction rates and rebalancing flow rates. Constructing contour maps for evaluating groundwater flow directions and hydraulic gradients, and hydraulic capture and flow control.
	Hydraulic monitoring network				X	At least every 5 years.	Combination of manual and automatic measurement of groundwater levels.	Evaluating flow directions and hydraulic gradients.
Groundwater monitoring (contaminants, biogeochemical, and field screening)	Contaminant-specific monitoring network Networks to be evaluated annually		X	X		Annually. Evaluate reduction in frequency at some wells from annually to biennially.	COCs and other contaminants (Table 4-3). Biogeochemical and field screening (Table 4-4). To be reviewed periodically for reductions in analytes.	Constructing three-dimensional contaminant plume shells, evaluating concentration trends, evaluating plume boundaries, evaluating plume capture, determining if there are any new releases or transformation products, and predicting and confirming progress toward performance goals.
	Contaminant monitoring network (to be evaluated)				X	At least every 5 years. To be evaluated.	Selected COCs and other contaminants (Table 4-3). Biogeochemical and field screening (Table 4-4).	Evaluating progress toward monitored natural attenuation performance goals.
Influent monitoring (contaminants)	Extraction wells	X				Once.	All contaminants in Table 4-3.	Determining groundwater contaminant distribution at system startup.
	Extraction wells		X[a]	X		Quarterly during initial P&T operation. Possible reduction to semiannual or annual after contaminant plume stabilizes. Reviewed periodically for reduction in analytes.	All contaminants in Table 4-3.	Calibrating COC plume shells, calculating mass removing and optimizing mass removal performance for each well, and monitoring for new COCs.
	Combined treatment plant influent		X			Monthly.	Table 4-3.	Calculating contaminant mass removal.
Flow rates and volumes	Extraction wells, injection wells, and combined treatment plant influent		X	X		Semicontinuously.	Automatic measurements of instantaneous flow and totalized flow rates.	Monitoring sustainability of extraction and injection rates, rebalancing flow rates, calculating COC mass removal. Input to groundwater model and plume shell calibration. Evaluating flow control.

a. Hydraulic and contaminant monitoring networks are reviewed periodically and individual wells added or dropped, as appropriate.

b. During initial P&T operations.

c. After contaminant concentrations and system operations have stabilized.

d. Monitoring frequencies and parameters are periodically evaluated and revised as appropriate for each location.

COC = contaminant of concern

P&T = pump and treat

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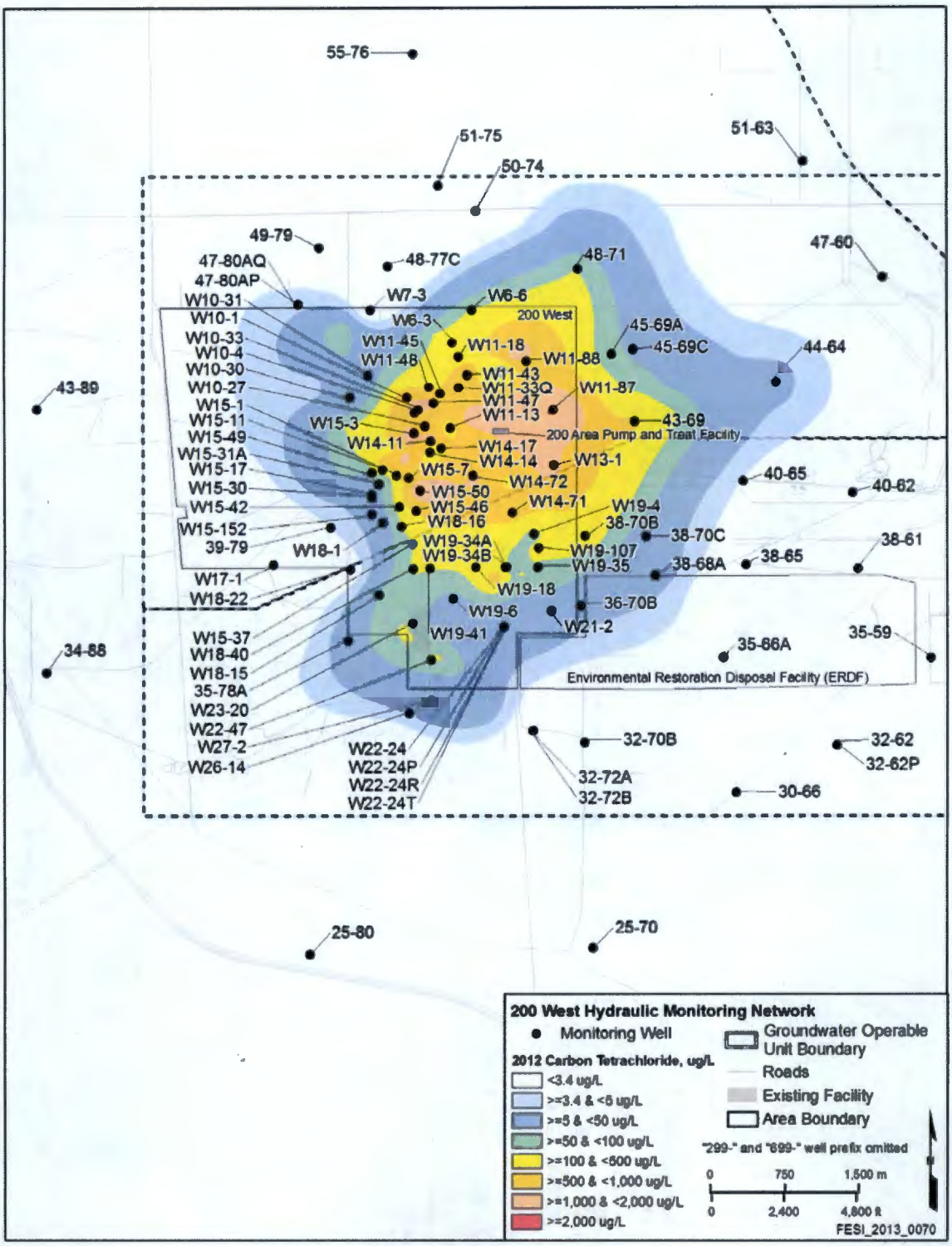

Figure 4-1. Hydraulic Monitoring Well Network

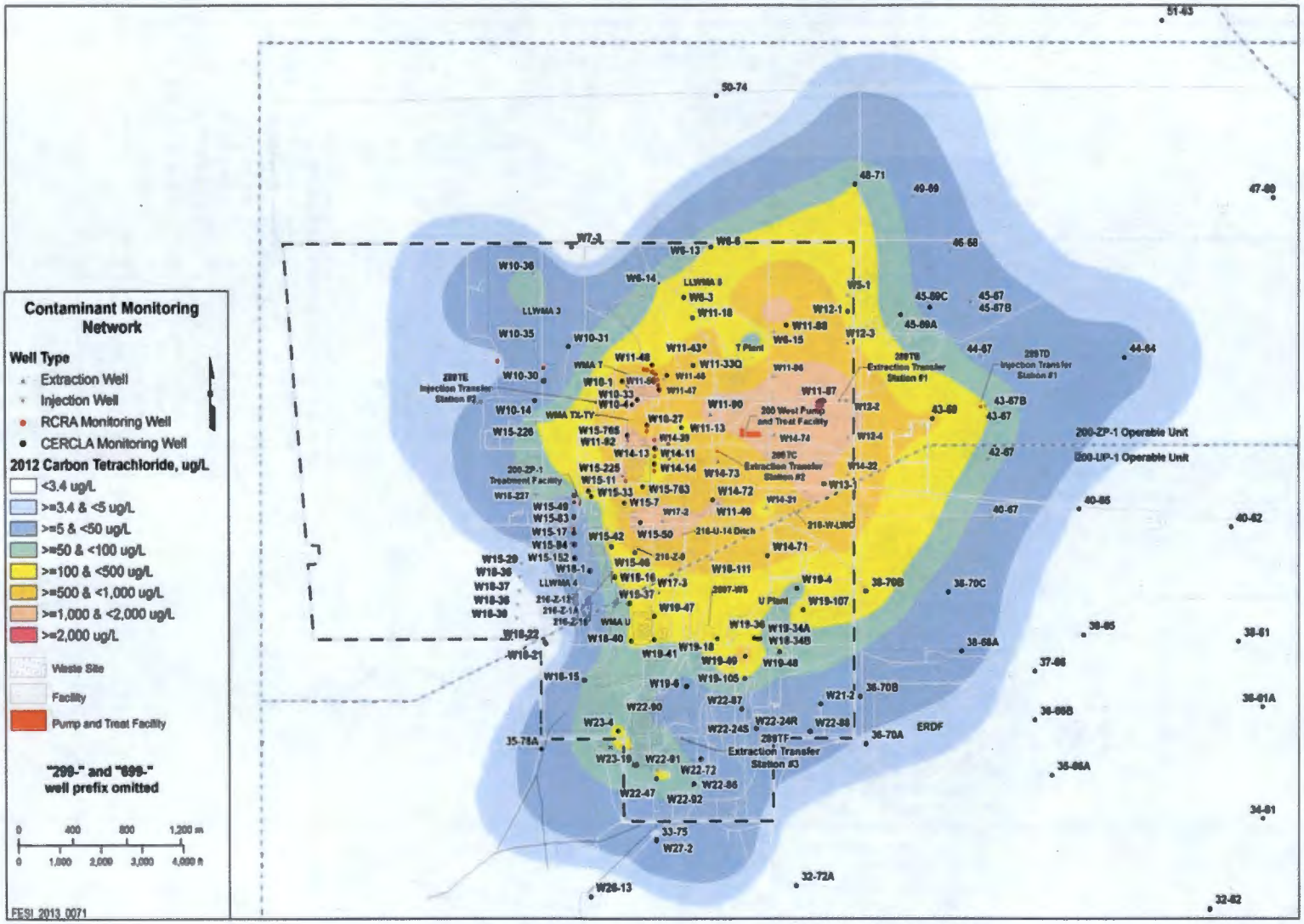

Figure 4-2. Contaminant Monitoring Well Network

Table 4-3. Contaminant Monitoring Constituents

Constituent	Acceptable Detection Limit	Units	Data Use
COCs			
Carbon tetrachloride	3.4	µg/L	Delineate carbon tetrachloride plume
Chromium (total)	100	µg/L	Delineate chromium plume
Hexavalent chromium	48	µg/L	Delineate chromium plume
Nitrate	10,000[b]	µg/L as N	Delineate nitrate plume
Trichloroethene	1[a]	µg/L	Delineate trichloroethene plume
Iodine-129	1	pCi/L	Delineate iodine-129 plume
Technetium-99	900	pCi/L	Delineate technetium-99 plume
Tritium	20,000	pCi/L	Delineate tritium plume
Other Potential Contaminants			
Uranium (from 200-UP-1 OU)	30[b]	µg/L	Delineate uranium plume
Chloroform	70[b]	µg/L	Evaluate carbon tetrachloride natural attenuation
Dichloromethane	5[b]	µg/L	Evaluate carbon tetrachloride natural attenuation
Chloromethane	NA[c]	NA	Evaluate carbon tetrachloride natural attenuation
cis-1,2-Dichloroethene	70[b]	µg/L	Evaluate carbon tetrachloride natural attenuation
Vinyl chloride	2[b]	µg/L	Evaluate carbon tetrachloride natural attenuation
Chloride	1,000	µg/L	Evaluate chlorinated solvent natural attenuation
Nitrite	1,000[b]	µg/L as N	Evaluate nitrite natural attenuation

a. DOE will clean up COCs for the 200-ZP-1 OU subject to WAC 173-340, "Model Toxics Control Act - Cleanup" (carbon tetrachloride and trichloroethene), so the excess lifetime cancer risk does not exceed 1×10^{-5} at the conclusion of the remedy.

b. Federal drinking water standard.

c. No federal drinking water standard has been promulgated for this constituent.

COC = contaminant of concern

DOE = U.S. Department of Energy

NA = not available

OU = operable unit

Table 4-4. Biogeochemical and Field Screening Monitoring Parameters

Constituent	Preferred Method	Units	Data Use
Biogeochemical Parameters			
Total organic carbon	EPA 415.1*	mg/L	Evaluate natural attenuation
Total dissolved solids	EPA 160.1*	mg/L	Evaluate natural attenuation, identify new releases
Sulfate	EPA 300.0A*	mg/L	Evaluate natural attenuation
Sulfide	EPA 9215*	mg/L	Evaluate natural attenuation
Iron	EPA 6010B*, 200.8, 6020, or equivalent	µg/L	Evaluate natural attenuation
Manganese	EPA 6010B*, 200.8, 6020, or equivalent	µg/L	Evaluate natural attenuation
Alkalinity	EPA 310.1*	mg/L as CO_3	Evaluate natural attenuation
Carbonate content (bicarbonate and carbonate)	EPA 310.1*	mg/L as CO_3 and HCO_3	Evaluate natural attenuation
Field Screening Parameters			
Temperature	Hach HQ40d or equivalent	°C	Evaluate well purge for sampling
pH	Hach HQ40d or equivalent	pH unit	Evaluate well purge for sampling
Specific conductance	EPA 1201.1*	mS/cm	Evaluate well purge for sampling
Turbidity	Hach 2100P turbidimeter HQ40d or equivalent	NTU	Evaluate well purge for sampling
Dissolved oxygen	Hach HQ40d or equivalent	mg/L	Evaluate natural attenuation
Reduction-oxidation potential	USGS, *National Field Manual for the Collection of Water-Quality Data*	mV	Evaluate natural attenuation

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

NTU = nephelometric turbidity unit

USGS = U.S. Geological Survey

4.1.2 Short-Term Performance Monitoring

Performance monitoring is conducted during P&T operations to obtain data used to evaluate progress, assess aquifer and COC plume response to pumping, and optimize extraction and injection well pumping rates for system performance.

While the P&T system is operating, groundwater elevation data are collected from the hydraulic monitoring well network on an annual basis. Additional wells will be equipped with transducers or existing transducer locations will be shifted as needed. Water-level data are used to monitor the sustainability of extraction rates and the need to rebalance flow rates to optimize capture zone boundaries. Water-level data are also used to construct groundwater elevation contour maps for evaluating groundwater flow directions, hydraulic gradients, and hydraulic capture and flow control.

Flow rates are measured in each extraction and injection well and for the combined treatment plant influent using in-line flow meters on a semicontinuous basis. This information is recorded by the programmable logic controller and is extracted as needed for use in optimizing flow rates and calculating COC mass removed. Results are also used as input parameters to the numerical groundwater flow and plume shell models described in the 200-ZP-1 OU PMP (DOE/RL-2009-115).

Groundwater samples will be collected from the monitoring well network annually (Figure 4-2) until determined through concurrence from EPA and RL. The samples are analyzed for COCs and other potential contaminants listed in Table 4-3 and the biogeochemical and field screening parameters listed in Table 4-4. The monitoring plan is evaluated annually to determine if wells should be dropped from or added to the network, or if any monitoring frequency changes are warranted. Results are used to construct three-dimensional contaminant plume shells; evaluate concentration trends, plume boundaries, and plume capture; and determine if there are any new releases or occurrences of COC transformation products. The concentration trends and plume models are used to confirm and predict progress toward performance goals.

Monitoring results will be communicated in quarterly briefings and documented in the annual P&T report and CERCLA 5-year review.

4.1.3 Long-Term Performance Monitoring

The following subsections summarize the requirements for long-term performance monitoring of P&T system operations and post-P&T MNA.

4.1.3.1 Long-Term Operations and Monitoring During Pump-and-Treat

Long-term P&T system monitoring includes collecting groundwater elevation data on an annual basis. Results are used to confirm continued hydraulic capture and flow control.

Flow rates are measured in each extraction well and injection well and for the treatment facility influent using in-line flow meters on a semicontinuous basis. Results are used to adjust (increase, decrease, or shut down) extraction and injection well flow rates to optimize flow patterns and to calculate the COC mass removed. Additionally, results are used as input parameters to the groundwater and plume shell models.

Groundwater samples are collected from the monitoring well network annually or once every 5 years in preparation for the CERCLA 5-year review. The monitoring program will be evaluated prior to initiating long-term operations to adjust monitoring locations and frequencies. Samples are analyzed for COCs and other potential contaminants listed in Table 4-3 and for the biogeochemical and field screening parameters listed in Table 4-4. The results are used to construct three-dimensional contaminant plume

shells; evaluate concentration trends, plume boundaries, and plume capture; and determine if there are any new releases or transformation products. The concentration trends and plume models are used to confirm and predict progress toward performance goals. Modeling will also be used to optimize flow rates to maximize mass recovery of contamination.

Monitoring results will be communicated in quarterly briefings and documented in the annual P&T report and CERCLA 5-year review.

4.1.3.2 Long-Term Operations and Monitoring After Pump-and-Treat

The frequency of hydraulic monitoring in the monitoring wells will be evaluated based on how rapidly the water table stabilizes after shutdown of the P&T system. At a minimum, a synoptic set of hydraulic monitoring data will be collected from the hydraulic monitoring well network every 5 years in accordance with the 5-year review requirement described in the ROD. Results will be used to evaluate groundwater flow patterns, hydraulic gradients, and COC plume migration.

Groundwater samples will be collected from the monitoring well network at least every 5 years. The monitoring plan will be re-evaluated at the completion of long-term operations to determine monitoring locations and frequencies. The samples will be analyzed for COCs, other potential contaminants listed in Table 4-3, and the biogeochemical and field screening parameters listed in Table 4-4. Concentration trends and plume models will be used to confirm and predict progress toward natural attenuation performance goals.

Monitoring results will be communicated in quarterly briefings and documented in the annual P&T report and CERCLA 5-year review.

4.2 Compliance Matrix

The CM for the 200-ZP-1 OU is presented in Appendix A. The purpose of the CM is to consolidate 200-ZP-1 OU compliance requirements such as federal and state ARARs and other conditions established in the ROD and in the remedial action/remedial design work plan (DOE/RL-2008-78).

The CM assembles, in one location, a comprehensive summary of compliance requirements for the selected remedy, including air and groundwater monitoring obligations and associated reporting requirements. The overarching objective of the CM is to provide the 200 West P&T project team (particularly the 200 Area P&T operations manager, the environmental compliance officer, and the waste management representative) with the means to track the status of remedy requirements. This capability will confirm that compliance performance is satisfactory and will avoid, or rapidly correct, potential noncompliance issues. The CM does not replicate specific project methodologies and procedures used to meet required actions (e.g., the PMP or AMP), but rather provides the most expedient means for a reviewer to locate where this reference information can be obtained. As a practical reference, the CM is formatted into a table of 200-ZP-1 OU requirements that addresses the remedy's RAOs and ARARs. The table cites a particular requirement, the source and location of the requirement (i.e., ROD or approved remedial design/remedial action work plan), a brief description of the requirement, whether the requirement has been achieved, and/or the location where compliance procedures and methods for meeting the requirement are documented.

The CM is a dynamic tool that should be updated to document the status of the required reduction of COCs throughout the 200-ZP-1 OU in the specific time periods approved by the ROD.

4.3 Air Emissions

The AMP, provided in Appendix C, is required because contaminated groundwater from the 200-ZP-1 OU is treated in an aboveground facility with the potential to emit hazardous air pollutants. As required by the ROD, the P&T system reduces the mass of COCs and other contaminants or treatment byproducts. The treatment system consists of IX for removal of radionuclides (technetium-99 and uranium); an anoxic FBR for removal of nitrate, metals, and carbon tetrachloride; an aerobic membrane bioreactor for the removal of residual carbon substrate, total suspended solids, biomass, carbon tetrachloride; and an air stripper to remove remaining carbon tetrachloride. Off-gas from the stripper, FBR, membrane bioreactor, and biomass sludge thickener is commingled and treated with VPGAC prior to discharge via powered exhaust. A scrubber is used to remove any ammonia associated with biomass sludge. Compliance with Washington State requirements for radiological and air toxic emissions has been demonstrated by the calculations and modeling described in the AMP. Abatement controls and environmental monitoring for air toxic and radiological constituents are described in Sections C3 and C4 of the AMP, respectively.

4.4 Waste Management

The WMP, provided in Appendix B, is required because waste from the extraction and treatment of groundwater from the 200-ZP-1 OU is generated and needs to be managed consistently with the substantive requirements of federal and state regulations identified as ARARs, in accordance with CERCLA Section 121. Throughout the conduct of this P&T remedial action, every effort will be made to minimize waste generation. All 200-ZP-1 OU investigation-derived and remediation waste is managed in accordance with the WMP. The WMP establishes the requirements for the management and disposal of the remediation waste generated from the 200 West P&T and the investigation-derived waste generated from the groundwater investigation and monitoring activities at the 200-ZP-1 Groundwater OU.

In addition to the waste generated from P&T operations, the WMP also includes the requirements for management and disposal of investigation-derived waste generated from the installation, monitoring, sampling, maintenance, and decommissioning of wells at the 200-ZP-1 Groundwater OU in accordance with the *Environmental Restoration Program Strategy for Management of Investigation-Derived Waste* (Ecology et al., 1999).

4.5 Cultural/Ecological Resources

Managing the cultural and biological resources of the Hanford Site is an essential component of RL resource trust responsibilities. Effective cultural and biological resource management is accomplished by implementing a program to ensure that all DOE facilities and programs comply with existing cultural resources and biological executive orders, laws, and regulations. DOE's Hanford Cultural and Historic Resources Program conducts resource reviews on the Hanford Site before any project is initiated that involves disturbances to the land. If 200-ZP-1 OU P&T activities extend to areas beyond those previously surveyed, a "Request for Cultural and/or Ecological Resources Review for the Hanford Site" (Hanford Site Form RL-665) will be prepared and submitted. This review will establish compliance monitoring requirements, as appropriate, consistent with the Hanford Cultural and Historic Resources Program. Remedial activities will be coordinated to comply with any restrictions identified by the review with regard to endangered species, critical habitat, migratory birds, and cultural and archaeological resources.

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5 Periodic Reporting and Closure

This chapter describes periodic reporting for the 200 West P&T while the system is in operation, as well as final remedial action closure reporting once the 200-ZP-1 OU RAOs have been met. A brief description of the CERCLA 5-year review process is also presented. The reports discussed in this chapter may be prepared as individual project-specific reports, or they may be combined into area-specific (i.e., Central Plateau annual report) or Hanford Sitewide reports.

5.1 Periodic System Operations and Remedy Performance Report

The water-level and groundwater quality monitoring data to be collected (described in Chapter 4) are evaluated and reported on an annual basis. The data evaluation and reporting frequency may change in the future as aquifer and plume response to pumping are better understood. A performance monitoring report, which is applicable for the early years of P&T system operation, would include information on P&T operations (average flow rates, contaminant monitoring results from the system and from the hydraulic monitoring well network, mass removal, etc.), progress toward meeting remedial goals, and conclusions.

5.2 CERCLA 5-Year Review

In accordance with the NCP (40 CFR 300.430[f][4][ii]), DOE and EPA have agreed to conduct 5-year reviews for the 200 Areas because the selected remedy will not achieve levels that allow for unlimited use and unrestricted exposure within 5 years. Reviews will begin within 5 years after initiation of the remedial action, at the time of the next periodic Hanford Site consolidated 5-year review, and will be conducted for this OU every 5 years until cleanup levels established in the ROD are attained. The reviews will be conducted pursuant to CERCLA Section 121(c) and as provided in current EPA guidance (EPA 540-R-01-007, *Comprehensive Five-Year Review Guidance*).

5.3 Closure Report

This section describes the final remedial action closure report and provides a brief summary of typical report content.

The remedy implementation process includes a remedial action phase, which involves construction and successful operation of the 200 West P&T.

During operations, routine O&M activities are required to maintain the remedy's effectiveness and integrity. The O&M phase is completed when the groundwater cleanup goals specified in the ROD are achieved. For the 200-ZP-1 OU, the O&M phase will include operation of the 200 West P&T and then MNA following P&T system shutdown.

A final remedial action report is prepared to document the cleanup activities that occurred and compliance with ROD requirements.

The final remedial action report will be prepared using the format provided in *Close Out Procedures for National Priorities List Sites* (EPA 540-R-98-016). The final remedial action report includes the following suggested primary sections:

- Chapter 1, Introduction
- Chapter 2, Summary of Site Conditions
- Chapter 3, Demonstration of Cleanup Activity Quality Assurance/Quality Control
- Chapter 4, Monitoring Results

- Chapter 5, Performance Standards and Construction Quality Control
- Chapter 6, Summary of Operation and Maintenance
- Chapter 7, Summary of Remediation Costs
- Chapter 8, Protectiveness
- Chapter 9, Five-Year Review
- Chapter 10, References

Additional information on the final remedial action reports is provided in EPA 540-R-98-016.

5.4 Records Management

The following records are associated with O&M of the 200 West P&T:

- Operating logs
- Field logbooks and laboratory reports
- Operating costs
- Emergency and transient condition events
- P&T system maintenance

6 Decontamination and Decommissioning

This chapter specifies the plans that will be in place to address D&D of the P&T system after the RAOs have been attained. Anticipated future land use after completion of P&T system D&D is also discussed.

Decontamination is a process whereby contaminants that have accumulated on or in equipment, tools, or treatment systems are removed or neutralized so they no longer present a hazard to human health or the environment. Decontamination efforts associated with 200 West P&T have been grouped into two activities: (1) activities that are interim (i.e., involved with day-to-day operations), and (2) activities that are associated with the final shutdown and decommissioning of the facility.

Decommissioning is the process of removing a facility that is no longer needed from service and removing and/or disposing equipment and materials in a manner that protects worker and public health and the environment. Under authority delegated by Executive Order 12580, *Superfund Implementation*, DOE is responsible for evaluating whether conditions at sites under DOE's jurisdiction pose a significant threat of release of hazardous substances, as defined by CERCLA. If a significant threat of release is identified, DOE is authorized to conduct removal action, remedial action, and any other response measures consistent with the NCP.

The *Policy on Decommissioning of Department of Energy Facilities Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* (DOE and EPA, 1995) establishes that decommissioning activities at facilities located on DOE sites will be conducted as nontime-critical removal actions under CERCLA, unless circumstances at the facility make it inappropriate. DOE will conduct a removal site evaluation, as directed by the NCP, to assess site conditions and determine whether a release or substantial threat of release exists at the facility. At any facility for which DOE conducts a removal site evaluation, DOE will consult with EPA and provide EPA with, as requested, information necessary for EPA to review such evaluation. At any facility where DOE determines that a release or substantial threat of release has not occurred, DOE will consult with EPA and provide any information necessary for EPA to evaluate such determination. Further guidance on decommissioning of DOE facilities is provided by DOE G 430.1-4, *Decommissioning Implementation Guide*.

6.1 Interim Decontamination and Decommissioning

Detailed procedures for decontamination of equipment and other miscellaneous items will be developed as part of an interim D&D plan. Decontamination of the tanks, containers, and equipment associated with the 200 West P&T involves removing and disposing wastes present in containers, and decontaminating the interiors of tanks, containers, and associated ancillary equipment that were in contact with waste, as necessary. Decontamination and disposal of equipment and miscellaneous items will be conducted in accordance with the procedures and criteria of the decontamination plan including, as appropriate, the requirements of WAC 173-303-070 ("Dangerous Waste Regulations," "Designation of Dangerous Waste") and 40 CFR 268.45 ("Land Disposal Restrictions," "Treatment Standards for Hazardous Debris"), as adopted in entirety by WAC 173-303-140, "Dangerous Waste Regulations: Land Disposal Restrictions."

Disposal of waste streams from D&D is discussed in the WMP (Appendix B). In general, spent decontamination water and other liquid waste streams generated during the decontamination process that are compatible with the 200 West P&T will be reintroduced into the P&T system for treatment. Those waste streams that are not compatible with 200 West P&T and all decontamination fluids (i.e., water and/or nonhazardous cleaning solutions) generated from cleaning equipment, tools, and materials will be contained and transported to the Purgewater Storage and Treatment Facility or the Effluent Treatment Facility if waste acceptance criteria can be met. If the waste acceptance criteria cannot be met,

pre-treatment may be necessary, or another suitable disposal facility may be identified, as authorized by EPA.

6.2 Final Decontamination and Decommissioning

Final D&D of the 200 West P&T will be addressed after DOE, EPA, and the Washington State Department of Ecology (Ecology) (i.e., the Tri-Parties) determine that active remediation is complete or the treatment system is no longer required. The D&D requirements will be addressed in a future D&D plan, which will be developed and submitted near the end of the active remediation time frame. This will likely occur at least 25 years after startup of the P&T system. Final D&D of the 200 West P&T will be performed in accordance with ARARs and applicable guidance.

Decontamination of the P&T system is expected to include the following activities:

- Remove and dispose liquids from tanks, piping, and process equipment.
- Remove and dispose IX and other resins, filters, and media.
- Remove and dispose all waste solids.
- Drain transfer piping and dispose the liquid.
- Winterize buildings and leave the facility for evaluation of further use at a later date. Periodic inspections of the buildings will be necessary for long-term care.

Once a determination is made that no further use of the 200 West P&T is required, decommissioning is expected to include the following activities:

- Remove and dispose conveyance and process piping
- Salvage equipment and materials that can be used elsewhere on the Hanford Site
- Demolish building, tanks, and structures
- Perform site restoration

Extraction and injection wells will be evaluated for use as groundwater monitoring wells (sampling and water levels). Those wells not retained for monitoring purposes will be decommissioned in accordance with WAC 173-160-381 ("Minimum Standards for Construction and Maintenance of Wells," "What Are the Standards for Decommissioning a Well?").

The site will be returned to its pre-operational condition to the extent feasible considering cost and intended future use (see Section 6.3). The wells that are used in conjunction with the 200 West P&T will continue to be used for groundwater monitoring. If a well is no longer needed, it will be decommissioned in accordance with WAC 173-160-381. Waste materials generated as part of D&D activities will be managed and disposed as addressed in the WMP (Appendix B).

6.3 Future Land and Groundwater Use

This section describes the anticipated future land, groundwater, and surface water uses applicable to the 200-ZP-1 OU. The following sections summarize the anticipated uses presented in the ROD.

6.3.1 Anticipated Future Land Use

The reasonably anticipated future land use for the core zone of the Central Plateau is industrial (DOE worker) for at least 50 years and then industrial (DOE or non-DOE worker) thereafter. DOE has

worked for several years with cooperating agencies to define land-use goals for the Hanford Site. The cooperating agencies and stakeholders included the National Park Service, Tribal Nations, the states of Washington and Oregon, local county and city governments, economic and business development interests, environmental groups, and agricultural interests.

The Future for Hanford: Uses and Cleanup, The Final Report of the Hanford Future Site Uses Working Group (Drummond, 1992) was an early product of the efforts to develop land-use assumptions. The report recognized that the Central Plateau would be used to some degree for waste management activities for the foreseeable future. Following the report, DOE issued the HCP EIS (DOE/EIS-0222-F) and the associated HCP EIS ROD (64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement [HCP EIS]") in 1999. The HCP EIS analyzes the potential environmental impacts of alternative land-use plans for the Hanford Site and considers the land-use implication of ongoing and proposed activities. Under the preferred land-use alternative selected in the HCP EIS ROD, the Central Plateau was designated for industrial exclusive use, defined as areas suitable and desirable for treatment, storage, and disposal of hazardous, dangerous, radioactive, and nonradioactive wastes, as well as related activities.

Subsequent to the HCP EIS, the Hanford Advisory Board (HAB) issued "Consensus Advice #132: Exposure Scenarios Task Force on the 200 Area" (02-HAB-0006). The HAB acknowledged that some waste would remain in the core zone of the Central Plateau when cleanup is complete. The goal identified in the HAB report is for the core zone to be as small as possible and not to include contaminated areas outside the Central Plateau's fenced areas. The HAB further stated that waste within the core zone should be stored and managed to make it inaccessible to inadvertent intruding humans and biota, and that DOE should maximize the potential for any beneficial use of the accessible areas of the core zone. The HAB advised that risk scenarios for waste management areas of the core zone should include a reasonable maximum exposure to a worker/day user and to an intruder.

In response to 02-HAB-0006, and for the purposes of the 200-ZP-1 OU remedial action, the Tri-Parties agreed to assume the following reasonably anticipated future land use: continuing industrial land use for at least 50 years, including ongoing active waste treatment, storage and/or new disposal (especially in the ERDF) of hazardous, dangerous, radioactive, and nonradioactive wastes. Following that period, the area above the 200-ZP-1 OU area is anticipated to continue in industrial use. Starting at least 100 years after active waste management (roughly 150 years from present), the potential for inadvertent intrusion into subsurface waste may increase because the majority of the present Hanford Site will have been opened to nonindustrial uses and less-restrictive public access, and knowledge of residual hazards within the remaining controlled access area may not be as widely held among the public as at present. As long as residual contamination remains above levels that allow for unrestricted use, ICs will continue to be required.

6.3.2 Potential Future Ground and Surface Water Uses

The NCP establishes the following national expectation for cleanup of groundwater at CERCLA sites: "EPA expects to return useable ground waters to their beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site" (40 CFR 300.430). EPA generally defers to state agency definitions of useable groundwater provided under the various comprehensive state groundwater protection programs administered by the states across the country.

Based on physical yield and natural water quality, the state of Washington, through its groundwater protection program, has determined that the aquifer setting for the 200-ZP-1 OU meets the *Washington Administrative Code* definition for potable groundwater and for beneficial use, and it has been recognized by the state as a potential source of domestic drinking water. For the next 150 years, as long as the

anticipated land use remains industrial, it is unlikely that 200-ZP-1 OU groundwater will be used as a drinking water source because drinking water is provided from a central water treatment facility.

Current uses of the Columbia River are anticipated to continue in the future. Given the local hydrogeology at the 200-ZP-1 OU, the remedial action for 200-ZP-1 OU groundwater will also protect the Columbia River and its ecological resources from degradation and unacceptable impact caused by contaminants originating from the 200-ZP-1 OU.

7 Health, Safety, and Quality

7.1 Health and Safety

The *Soil and Groundwater Remediation Project Site Specific Health and Safety Plan (HASP)* (SGW-41472) meets the requirements set forth in 29 CFR 1910.120. The HASP contains the applicable core functions and guiding principles of the Integrated Safety Management System. The HASP governs safe performance of routine facility O&M activities, including facility inspection and surveillance, equipment replacement, maintenance, housekeeping, and sampling. It also governs personnel safety training requirements, control of recognized health and safety hazards, use of personal protective equipment, facility access requirements, and contingencies (e.g., fire, spills, accidents, personnel injuries, and incident reporting).

The HASP is not a stand-alone document. It is supplemented by other procedures governing work control, conduct of operations, industrial safety, maintenance, and waste handling. Major elements of the HASP are summarized in the following subsections.

7.1.1 Visitor Requirements

Visitors to the site shall sign in (and out) at the site office and be briefed on the HASP. Visitors are not allowed into control zones when the process system is breached unless the following training requirements are met:

- Monitoring/sampling protocols
- Site control measures
- Spill containment/control
- Decontaminations procedures
- Medical surveillance

7.1.2 Facility Upset Conditions

The HASP covers procedures and requirements for the following potential facility upset conditions:

- Minor and life threatening injuries
- Fire
- Chemical exposure
- Radiological exposure
- Area alarms

7.1.3 Hazard Control

Control of the following hazards that are likely present during O&M activities is a primary element of the HASP:

- Confined spaces
- Bloodborne pathogens
- Biological hazards
- Compressed gases
- Chemical hazards
- Illumination
- Adverse weather
- Dust
- Excavations
- Portable ladders
- Scaffolding
- Manual lifting

- Heat and cold stress
- Radiological hazards
- Waste control
- Elevated work
- Electrical hazards
- Fire hazards
- Pinch points
- Hand tools
- Standing water
- Noise
- Powered industrial trucks (forklifts)
- Man lifts, cranes, and rigging
- Pressure systems
- Sanitation
- Vehicle parking
- Walking and work surfaces (slip/trip/fall)
- Motor vehicles

7.1.4 Facility Response Plan

The HASP includes a facility response plan which includes the following elements:

- Emergency response organization
- Emergency equipment (location descriptions and capabilities)
- Implementation procedures for the facility response plan
- Emergency response procedures
- Plan location and amendment procedures

7.2 Quality

Overall QA for the O&M plan will be implemented in accordance with the CHPRC QA program management plan and environmental quality assurance program plan (QAPP).

The environmental QAPP includes the overall structure, requirements, implementation methods, and responsibilities, which require that program and project plans be developed to ensure effective implementation of the QA requirements for CHPRC's environmental activities. The environmental QAPP is a management tool that documents the quality system for planning, implementing, documenting, and assessing the effectiveness of the environmental activities; *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989) implementation; data operations; and other environmental programs. The environmental QAPP includes the QAPP requirements for implementation of the Soil & Groundwater Remediation Project and the D&D Project.

These QA activities use a graded approach based on potential impacts to the environment, safety, health, reliability, and continuity of operations. The QA for sampling activities and performance monitoring is discussed in Appendices D and E of this O&M plan and the 200-ZP-1 OU PMP (DOE/RL-2009-115).

The SAPs prepared to support the 200 West P&T include a QAPP, which is used to support the sampling and characterization activities. Other specific activities include QA implementation, responsibilities and authority, document control, QA records, and audits.

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Appendix A

Compliance Matrix for the 200 West Pump and Treat

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A2 References **A-11**

Table

Table A-1. 200 West Pump and Treat Compliance Matrix A-3

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Terms

ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
ASIL	acceptable source impact levels
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COC	contaminant of concern
DOE	U.S. Department of Energy
ECR	ecological compliance review
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
IC	institutional control
IDW	investigation-derived waste
LDR	land disposal restrictions
MCL	maximum contamination level
MCLG	maximum contamination level goal
MNA	monitored natural attenuation
NAPL	nonaqueous phase liquid
O&M	operations and maintenance
OSWER	Office of Solid Waste and Emergency Response
P&T	pump and treat
PNNL	Pacific Northwest National Laboratory
RA	remedial action
RACT	reasonably achievable control technology
RAO	remedial action objective
RCRA	*Resource Conservation and Recovery Act of 1976*
RD	remedial design
RL	U.S. Department of Energy, Richland Operations Office
ROD	Record of Decision
RW	remediation waste
SQER	small quantity emissions rates

SWITS	Solid Waste Information and Tracking System
WPLIS	waste packaging and labeling instruction sheet

A Compliance Matrix for the 200 West Pump and Treat

A1 Introduction and Purpose

This compliance matrix (Table A-1) presents the requirements established for the 200-ZP-1 Groundwater Operable Unit (OU) remedial action as applicable to the 200 West Pump and Treat (P&T). This is the final action selected in the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) *Record of Decision, Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington* (EPA et al., 2008) (hereafter referred to as the Record of Decision [ROD]).

The purpose of the compliance matrix is to consolidate the 200-ZP-1 Groundwater OU compliance requirements, such as federal and Washington State applicable or relevant and appropriate requirements (ARARs) and other conditions included in the ROD, with a cross reference of requirement locations is listed in the "Source Documents" column of Table A-1. It assembles, in one location, a comprehensive summary of compliance requirements for the selected remedy including air and groundwater monitoring obligations and associated reporting requirements. The overarching objective of the compliance matrix is to provide the 200 West P&T operations team (particularly the operations manager, the environmental compliance officer, and the waste management lead) with the means to track the status of remedy requirements. This capability will ensure confirmation that compliance performance is satisfactory, and it will allow the operations team to avoid, or rapidly correct, potential noncompliance issues. The compliance matrix does not replicate project-specific methodologies and procedures used to meet required actions; rather, this matrix provides the most expedient means for a user to locate where this reference information can be obtained.

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Table A-1. 200 West Pump and Treat Compliance Matrix

Line #	Source Documents	Requirement	Compliance Methodology	Comments
1	200-ZP-1 ROD (Part I, 4.2), 200-ZP-1 ROD (Part II, 13.5)	The remedial action decisions for the source-control OUs are being made under the enforcement strategies and schedules contained in the Hanford Tri-Party Agreement and will consider the nature and characteristics of the principal threat materials found in the source-control OUs. The closure and cleanup decisions made for the RCRA-regulated units will also consider the nature and characteristics of the principal threat materials found in those units.	"There are no known contaminant source materials such as NAPLs in the 200-ZP-1-OU groundwater that would serve as a source of principal threat materials" (ROD, Section 11.0, p. 54).	No further action required for 200-ZP-1 OU.
2	200-ZP-1 ROD (Part I, 4.3.1), 200-ZP-1 ROD (Part II, 12.2.1), 200-ZP-1 ROD (Part II, 12.4)	The system will capture and treat contaminated groundwater to reduce the mass of carbon tetrachloride, total chromium (trivalent and hexavalent), nitrate, trichloroethene, iodine-129, and technetium-99, throughout the 200-ZP-1 OU by a minimum of 95 percent in 25 years.	Remedy design details are provided in the approved RD/RA work plan (DOE/RL-2008-78), the RDR (DOE/RL-2010-13), the PMP (DOE/RL-2009-115), and the O&M plan (DOE/RL-2009-124).	Contaminant treatment and monitoring procedures associated with the groundwater pump and treat system are provided in DOE/RL-2009-115, and the following appendices of the O&M plan: Appendix D ("200 West Pump and Treat Sampling and Analysis Plan"), and Appendix E ("200 West Pump and Treat Groundwater Sampling and Analysis Plan"). Performance of the 200 West P&T will be communicated to EPA during quarterly briefings and summarized in the performance monitoring report.
3	200-ZP-1 ROD (Part I, 4.3.2), 200-ZP-1 ROD (Part II, 12.2.2), DOE/RL-2008-78 (2.1)	Monitoring locations, points of compliance and specifications will be developed as part of RD/RA documents to provide data on performance. Monitoring will provide the following: • Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological, or other changes) that may reduce the efficacy of the pump and treat system, natural attenuation processes, and the flow path control actions. • Identify potentially toxic and/or mobile transformation products. • Verify that contamination is not expanding downgradient, laterally or vertically subsequent to the period of time over which the P&T component has been functional. • Detect new releases of contaminants of concern to the environment that could impact the effectiveness of the remedy. • Verify attainment of remediation requirements. RD/RA documents will be reviewed and approved by EPA.	MNA design details are provided in the approved RD/RA work plan (DOE/RL-2008-78), the RDR (DOE/RL-2010-13), the PMP (DOE/RL-2009-115), and the O&M plan (DOE/RL-2009-124).	Natural attenuation monitoring, and hydraulic control measures are described in the O&M plan and in its Appendix E ("200 West Pump and Treat Groundwater Sampling and Analysis Plan"). MNA performance will be summarized in the performance monitoring report.
4	200-ZP-1 ROD (Part I, 4.3.3), 200-ZP-1 ROD (Part II, 12.2.3), DOE/RL-2008-78 (2.1.3)	Groundwater modeling is required to locate extraction wells, estimate rates, and locate injection wells for flow-path control in accordance with RD/RA documents. Flow-path control shall be used as follows: • To slow natural eastward flow of most groundwater to keep COCs in the capture zone. • To minimize potential for groundwater in the northern portion of the aquifer to flow through Gable Cap to the Columbia River. RD/RA documents will be reviewed and approved by EPA.	Flow-path control details are provided in the approved RD/RA work plan (DOE/RL-2008-78), the RDR (DOE/RL-2010-13), the PMP (DOE/RL-2009-115), and the O&M plan (DOE/RL-2009-124).	Flow-path control monitoring methods are described in the PMP (DOE/RL-2009-115), and the O&M plan and its Appendix E ("200 West Pump and Treat Groundwater Sampling and Analysis Plan"). Flow-path control performance will be summarized.

Table A-1. 200 West Pump and Treat Compliance Matrix

Line #	Source Documents	Requirement	Compliance Methodology	Comments
5	200-ZP-1 ROD (Part I, 4.3.4), 200-ZP-1 ROD (Part II, 12.2.4), DOE/RL-2008-78 (2.1.4)	200-ZP-1 OU groundwater use will be restricted through ICs and land-use controls until cleanup levels are achieved. No later than 180 days after the ROD is signed, DOE shall update the *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions* (DOE/RL-2001-41) to include ICs required by this ROD and specify the implementation and maintenance actions that will be taken, including periodic inspections. A land use control boundary map for the 200-ZP-1 OU is required. The ICs required of DOE through the completion of this 200-ZP-1 OU remedy are as follows: • Control access to prevent unacceptable exposure of humans to contaminants in groundwater. Visitors entering any site areas must be badged and escorted at all times. • Prohibit intrusive work unless approved in a plan by EPA. • Prohibit well drilling except for authorized wells. • Prohibit groundwater use except for authorized research purposes, monitoring, and treatment. • Post and maintain warning signs along pipelines conveying untreated groundwater that caution site visitors and workers of potential hazards. • Report any unauthorized access to the Site (e.g., trespassing) to Benton County Sheriff's Office for investigation and evaluation of possible prosecution. • Prohibit activities that disrupt or lessen the performance of the P&T, MNA, and flow-path control. • Prohibit activities that damage P&T, MNA, and flow-path control components (e.g., extraction, injection. monitoring wells, piping, or treatment plant). • Report on effectiveness of institutional controls in an annual report, or an alternative reporting frequency specified by EPA. Reporting may be for this OU alone or part of a Sitewide report. • Provide notice to EPA at least six months prior to any transfer or sale of any land subject to ICs (including federal to federal transfers). If not possible, then no later than 60 days prior to transfer or sale. In addition provide a copy of executed deed or transfer assembly to EPA. • Prevent development and use of property for residential housing, elementary and secondary schools, childcare facilities and playgrounds. • Maintain ICs until cleanup levels are achieved. Concentrations of hazardous substances are at levels that allow unrestricted use and exposure, and EPA authorizes removal of ICs.	Implementation, maintenance, and periodic inspection requirements for ICs at the Hanford Site are described in DOE/RL-2001-41.	A land-use control map has been prepared and is included in the ROD as Figure 12. DOE/RL-2001-41 was revised March 3, 2009, to Rev. 3 to incorporate the ICs identified in 200-ZP-1 ROD.
6	200-ZP-1 ROD (Part I, 5.0)	Required at a minimum every 5 years if a remedy is selected that result in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure.	DOE and EPA have agreed to conduct 5-year reviews in accordance with 40 CFR 300.430[f][4][ii], until COCs are reduced below the cleanup levels established in this ROD.	Reviews begin 5 years after initiation of the remedial action (2012) to ensure that the selected remedy is protective of human health and the environment.

Table A-1. 200 West Pump and Treat Compliance Matrix

Line #	Source Documents	Requirement	Compliance Methodology	Comments
7	200-ZP-1 ROD (Part II, 12.1)	Treatment residuals generated as part of this action are expected to meet waste disposal criteria for onsite disposal in the ERDF. Waste that does not meet ERDF waste acceptance criteria will be sent offsite for treatment and disposal. Any offsite disposal will require a facility acceptability determination by EPA that the facility can receive CERCLA waste.	The 200-ZP-1 OU treatment residuals meeting the waste acceptance criteria will be disposed of in ERDF. Waste that does not meet ERDF waste acceptance criteria will be evaluated for additional treatment at an onsite or offsite facility prior to ERDF disposal.	Treatment residual disposal/treatment will occur on an as-needed basis and will follow applicable waste management functions identified in the O&M plan, Appendix B ("Waste Management Plan for the 200 West Pump and Treat"). As described in Appendix B, the 200-ZP-1 IDW and remediation waste will be stored in the OU. CERCLA dangerous wastes and temporary storage areas for waste awaiting sampling and designation will be inspected weekly. Nondangerous waste storage areas will be inspected monthly or at the frequency defined in the waste control plan that was developed for IDW for the 200-ZP-1 OU. Accumulation, staging, storage, profiling, packaging, and labeling details for each waste are documented on the WPLIS. Disposal records are maintained in the Hanford Site SWITS database.
8	200-ZP-1 ROD (Part II, 12.3)	New information and data collected during the engineering design or implementation of the selected remedy.	Major changes will be documented in the form of a memorandum in the Administrative Record file, a CERCLA ESD, or a ROD amendment, as appropriate.	As necessary.
9	200-ZP-1 ROD (Part II, 13.2)	EPA OSWER Directive 9234.1-06, *Applicability of Land Disposal Restrictions to RCRA and CERCLA Ground Water Treatment Reinjection Superfund Management Review: Recommendation No. 26* (dated December 27, 1989), provides guidance on issues regarding whether LDRs apply to reinjection of groundwater.	This guidance states that EPA construes the provisions of RCRA Section 3020 to be applicable instead of LDR provisions contained in RCRA Sections 3004(f), (g), and (m), to reinjection of contaminated groundwater into an underground source of drinking water, which is part of a CERCLA response action.	Per the ROD, LDRs do not apply to reinjection of treated groundwater from the 200-ZP-1 Groundwater OU because this is a CERCLA action.
10	200-ZP-1 ROD (Part II, 13.2)	The NCP (40 CFR 300.430[f][5][ii][B] and [C]) require that a ROD describe the federal and state ARARs that the selected remedy will attain and any ARARs the remedy will not meet, the waiver invoked, and the justification for any waivers.	Appendix A of the ROD provides a definitive list of ARARs to be attained by the selected remedy, organized by federal requirements (Table A-1) and Washington State requirements (Table A-2). Table A-3 describes "to-be-considered" criteria that were used in developing the remedy. These ARARs are repeated in the RD/RA work plan (DOE/RL-2008-78, Appendix A, Table A-1).	See requirements which correspond to the tables listed for chemical-, location-, and action-specific requirements.
11	200-ZP-1 ROD (Part II, Table 11), ARAR (40 CFR 141.61), ARAR (40 CFR 141.62), ARAR (40 CFR 141.66), ARAR (WAC 173-340-720([4][b][iii][A] and [B]), ARAR (WAC 173-340-720[7][b])	The final cleanup levels identified in the ROD for 200-ZP-1 OU groundwater are federal and state drinking water MCLs and state groundwater cleanup standards (where more stringent than MCLs). • Carbon tetrachloride: 3.4 µg/L • Chromium (total): 100 µg/L • Chromium (hexavalent): 48 µg/L • Nitrate (as nitrate, N): 10,000 µg/L • Trichloroethene (TCE): 1 µg/L • Iodine-129: 1 pCi/L • Technetium-99: 900 pCi/L • Tritium: 20,000 pCi/L	Groundwater wells will be sampled to monitor the progress of remediating contaminated groundwater to achieve final cleanup levels. Monitoring will begin during the early stages of construction and will continue throughout treatment and closure to ensure that cleanup levels have been met. Following extraction, the COCs in groundwater (except tritium) will be treated to achieve cleanup levels. The treated groundwater will then be returned to the aquifer through injection wells. COC biological degradation products will be treated as part of the P&T and MNA components of the remedy.	MCL/MCLG measurements are described in the O&M plan, and in the following Appendices of the O&M Plan: • Appendix D, "200 West Pump and Treat Sampling and Analysis Plan" • Appendix E, "200 West Pump and Treat Groundwater Sampling and Analysis Plan"

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Line #	Source Documents	Requirement	Compliance Methodology	Comments
12	ARAR (WAC 173-218-040), ARAR (42 USC 6939b, Section 3020[b]), ARAR (WAC 173-218-120)	Establishes requirements to allow injection of groundwater that contains hazardous waste back into the aquifer during implementation of a CERCLA remedy. Injection wells used to return treated groundwater to an aquifer must meet the classification criteria of a Class IV well, and shall be abandoned following completion of the remedial action.	Extracted groundwater from the 200-ZP-1 OU will be treated to achieve cleanup levels before returning it to the aquifer through the injection wells. Treated effluent will be periodically tested prior to injection into the aquifer. Periodic testing (grab samples) will be used to demonstrate compliance. Treatment system may continue to operate if discharge concentrations are greater than cleanup levels. Injection wells will be decommissioned in accordance with the standards specified in the regulation.	Effluent measurements are described in the O&M plan, and, as appropriate, in the following appendices of the O&M plan: • Appendix D, "200 West Pump and Treat Sampling and Analysis Plan" • Appendix E, "200 West Pump and Treat Groundwater Sampling and Analysis Plan"
13	ARAR (16 USC 469aa-mm, et seq.)	Requires that remedial actions at the 200-ZP-1 OU will not cause the loss of any archaeological or historic data. This act mandated preservation of data and does not require protection of the actual historical sites	In 1987 and 1988, a comprehensive archaeological resources review of the Central Plateau was conducted that included an examination of samples collected from undisturbed portions of the 200 West Area. The inventory reported no significant surface archaeological finds.	Cultural and ecological survey results and recommendations are listed in SGW-48726 (Appendix B) and are maintained in the project files.
14	ARAR (16 USC 470, Section 106, et seq.)	Requires federal agencies to consider the impacts of their undertaking on cultural properties through identification, evaluation, and mitigation processes.	In 1987 and 1988, a comprehensive archaeological resources review of the Central Plateau was conducted that included an examination of samples collected from undisturbed portions of the 200 West Area. The inventory reported no significant surface archaeological finds.	Cultural and ecological survey results and recommendations are listed in SGW-48726 (Appendix B) and are maintained in the project files.
15	ARAR (16 USC 1531[a], et seq., and 16 USC 1536[c], et seq.)	Prohibits actions by federal agencies that are likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of habitat critical to them. Mitigation measures must be applied to actions that occur within critical habitats or surrounding buffer zones of listed species in order to protect the resource.	Results from previous surveys documented in ECR-2009-200-22/23 and *Hanford Draft Tank Closure and Waste Management EIS for the Hanford Site, Richland, Washington* (DOE/EIS-0391, October 2009). Compliance procedures with EIS requirements are established in the *Ecological Compliance Assessment Management Plan* (DOE/RL-95-11, Rev. 2, dated September 2006) and the *Hanford Site Biological Resources Management Plan* (DOE/RL-96-32, dated 2001).	Evidence of listed species and/or their critical habitat requires a Request for Cultural and/or Ecological Resources Review (Hanford Form RL-665). Responsibility for conducting the ecological compliance review is assigned to the PNNL. Actions requiring an ecological compliance review include the following: (1) if the project occurs outside of a building, (2) if biota are present at the affected site, or (3) if an excavation permit is required for the action.
16	ARAR (25 USC 3001, et seq.)	Establishes federal agency responsibility for discovery of human remains, associated and unassociated funerary objects, sacred objects, and items of cultural patrimony. Requires consultation with the Native American Tribes in the event of discovery.	Comprehensive archaeological resource surveys of the fenced portions of the 200 Areas indicate that minimal resources exist in project area (DOE/EIS-0391, *Hanford Draft Tank Closure and Waste Management EIS for the Hanford Site, Richland, Washington*, dated October 2009). Compliance procedures with cultural and archaeological requirements are provided in the *Hanford Cultural Resources Management Plan* (DOE/RL-98-10).	Expansion of 200-ZP-1 Groundwater OU remedial action activities to areas beyond those previously surveyed requires a Cultural Resource Review Request (Hanford Form RL-665) from PNNL.

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Line #	Source Documents	Requirement	Compliance Methodology	Comments
17	ARARs: (WAC 173-160-161) (WAC 173-160-171) (WAC 173-160-181) (WAC 173-160-400) (WAC 173-160-420) (WAC 173-160-430) (WAC 173-160-440) (WAC 173-160-450) (WAC 173-160-460)	 Well planning and construction. Well location requirements. Preserving natural barriers between aquifers. Standards for resource protection wells and geotechnical borings. Construction requirements for resource protection wells. Minimum casing standards. Equipment cleaning standards. Well sealing requirements. Decommissioning for resource protection wells.	All monitoring, injection, and extraction wells completed for the 200-ZP-1 OU remediation activities will meet the substantive requirements of these regulations.	Well construction information is provided in the following documents: • *Hanford Site Well Management Plan* (DOE/RL-2003-13, Rev.0, dated June 2003) • *Sampling and Analyses Plan for the First Set of Remedial Action Wells in the 200-ZP-1 Groundwater Operable Unit* (DOE/RL-2008-57, Rev. 0, dated December 2008)
18	ARAR (WAC 173-303-016)	Identifies those materials that are and are not solid wastes.	Waste materials generated from the 200-ZP-1 OU remedial action will be evaluated for solid waste properties in accordance with the substantive requirements of WAC 173-303-016.	The O&M plan, Appendix B ("Waste Management Plan for the 200 West Pump and Treat"), waste designation and corresponding waste profiles are completed by the Waste Management lead. The waste profiles are documented on the WPLIS.
19	ARAR (WAC 173-303-017)	Identifies materials that are and are not solid wastes when recycled.	IDW and remediation waste generated during the 200-ZP-1 OU remedial action that can be recycled will meet the substantive portion of these requirements.	The O&M plan, Appendix B ("Waste Management Plan for the 200 West Pump and Treat") waste designation and corresponding waste profiles are completed by the Waste Management lead. The waste profiles are documented on the WPLIS.
20	ARAR (WAC 173-303-070[3])	Establishes whether a solid waste is, or is not, a dangerous waste or an extremely hazardous waste.	Substantive requirements apply to IDW and remediation waste generated from 200-ZP-1 OU remedial activities. Media and treatment residuals generated from the 200-ZP-1 OU will be designated according to the procedures identified in WAC 173-303-070(3).	The O&M plan, Appendix B ("Waste Management Plan for the 200 West Pump and Treat) states that IDW and remediation waste that come into contact with 200-ZP-1 OU groundwater will be designated with a F001 through F005 RCRA-listed waste codes, at a minimum. Waste designation and corresponding waste profiles are completed by the Waste Management lead. The waste profiles are documented on the WPLIS.
21	ARAR (WAC 173-303-120[3] and [5])	These regulations define the requirements for recycling materials that are solid and dangerous waste. Specifically, WAC 173-303-120(3) provides for the management of certain recyclable materials.	IDW and remediation waste generated from the 200-ZP-1 OU remedial action will be reviewed against the requirements for recyclable materials. If recyclable materials are generated, they will be managed according to the substantive requirements of WAC 173-303-120(3).	The O&M plan, Appendix B ("Waste Management Plan for the 200 West Pump and Treat") designation and corresponding waste profiles are completed by the Waste Management lead. The waste profiles are documented on the WPLIS.

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Line #	Source Documents	Requirement	Compliance Methodology	Comments
22	ARAR (WAC 173-303-170), ARAR (WAC 173-303-200)	Establishes the requirements for dangerous waste generators. For purposes of this remedial action, WAC 173-303-170(3) includes the substantive provisions of WAC 173-303-200 by reference. WAC 173-303-200 further includes certain substantive standards from WAC 173-303-630 and -640 by reference. These requirements include the substantive portions of WAC 173-303-630 ("Use and Management of Containers") and WAC 173-303-640 ("Tank Systems"). Dangerous waste will be treated by the selected remedy; thus the substantive portions of WAC 173-303-640(4) ("Containment and Detection of Releases [from Tank Systems]") apply to key design and operational requirements. Secondary containment for new tank systems and ancillary equipment which includes the collection piping must be provided with secondary containment, except for aboveground piping that is visually inspected for leaks daily. A variance from daily inspections may be obtained per the requirements of WAC 173-303-640(4)(9) and as approved by Ecology.	IDW and remediation waste generation actions will meet the substantive requirements of WAC 173-303-170 and -200. Aboveground piping in the 200-ZP-1 OU without secondary containment will be visually inspected and recorded in accordance with these requirements, and approved variances.	TPA-CN-525 established the following: • Deleted the requirement for daily pipe walk downs with reliance on flow meter monitoring for pipeline leak detection. • Set inspection frequency for wellheads to be once per week. • Regard the treated groundwater to "no longer contain" F001 through F005 listed waste.
23	ARAR (WAC 173-303-64620[4])	Establishes requirements for corrective action for releases of dangerous wastes and dangerous constituents including releases from solid waste management units.	Corrective action requirements for the 200-ZP-1 OU will be completed under CERCLA authority. The selected remedy of this ROD meets the state of Washington's requirements as an acceptable final remedy.	Washington's RCRA authorized *Hazardous Waste Management Act* and dangerous waste regulations give Ecology corrective action jurisdiction over the 200-ZP-1 OU concurrent with CERCLA. As stated in the ROD (Section 10.8, p. 53, "State Acceptance"), Ecology supports and accepts the 200-ZP-1 OU remedy under the Tri-Party Agreement and the CERCLA program as satisfying corrective action requirements.
24	ARAR (WAC 173-350-300), ARAR (WAC 173-304-190, WAC 173-304-200[2], WAC 173-304-460), ARAR (RCW 70.95)	Establishes requirements for the onsite storage of solid waste that is not radioactive or dangerous wastes. Establishes the requirements for managing temporary storage of solid waste in onsite containers and the collection and transportation of solid waste.	Solid waste generated from the 200-ZP-1 OU will be stored onsite and managed in leak-proof containers that meet the substantive requirements of this standard. IDW and remediation waste solid wastes stored in the 200-ZP-1 OU will meet the substantive requirements of this standard.	O&M plan, Appendix B ("Waste Management Plan for the 200 West Pump and Treat"). The 200-ZP-1 IDW and remediation waste solid wastes stored onsite will be managed to meet the requirements of this standard. Wastes destined for solid waste landfills shall also meet applicable requirements. Nondangerous waste storage areas will be inspected monthly or at the frequency defined in the waste control plan that was developed for IDW. O&M plan, Appendix B ("Waste Management Plan for the 200 West Pump and Treat"). Nondangerous solid wastes will be accumulated in safe and sanitary containers and will be inspected monthly or at the frequency defined in the waste control plan. Waste accumulation, staging, storage, profile, packaging, and labeling details for each waste is documented on the WPLIS.
25	ARAR (WAC 173-400-040), ARAR (WAC 173-400-113)	Requires all sources of air contaminants to meet emission standards for visible, particulate, fugitive, odors, and hazardous air emissions. Requires the use of reasonably available control technology. This state regulation is as (or more) stringent than the equivalent federal program requirement.	200-ZP-1 OU emission control equipment will meet the substantive requirements of these standards. The emission control equipment for radionuclides includes ion-exchange columns to remove technetium-99, iodine-129, and future removal of uranium. The DOE guide *Calculating Potential to Emit Radionuclide Releases and Doses* (DOE/RL-2006-29) was used to calculate the unabated release potential for radiological constituents. Modeled results show that potential radionuclide emissions are determined to be from a minor source as described in WAC 246-247.	As described in O&M plan, Appendix C ("Air Monitoring Plan for the 200 West Pump and Treat") and Appendix D ("200 West Pump and Treat Sampling and Analysis Plan"), quarterly sampling for annual determination of compliance with SQERs and ASILs will be performed. Sample results will be documented in the performance monitoring report. Additional modeling to confirm compliance with ASILs will be completed if emissions exceed calculated/ modeled values.

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Line #	Source Documents	Requirement	Compliance Methodology	Comments
26	ARAR (WAC 173-460-030 and -060), ARAR (WAC 173-460-070)	Requires that new sources of air emissions meet emission requirements. The owner/operator of a new toxic air pollutant source that is likely to increase toxic air pollutant emissions shall demonstrate that emissions from the source are sufficiently low to protect human health and safety from potential carcinogenic and/or other toxic effects.	200-ZP-1 OU emission control equipment to assure air toxics emission standards are not exceeded include the following: • Anaerobic fluidized bed bioreactor for removal of nitrate, metals, and carbon tetrachloride • Aerobic membrane bed reactor for removal of residual carbon substrate, total suspended solids, biomass, and carbon tetrachloride • Packed bed tower air stripper to remove remaining carbon tetrachloride and other volatile organic compounds • Off-gas from the air stripper, fluidized bed reactor, membrane bed reactor, and sludge thickener will be comingled and treated by granular activated carbon prior to discharge via powered exhaust • Biomass sludge will be treated with lime to reduce odors and ammonia; a scrubber will be used to remove ammonia	As described in O&M plan, Appendix C ("Air Monitoring Plan for the 200 West Pump and Treat") and Appendix D ("200 West Pump and Treat Sampling and Analysis Plan"), quarterly sampling will be performed for annual determination of compliance with SQERs and ASILs. Sample results will be documented in the performance monitoring report. Additional modeling to confirm compliance with ASILs would be completed if emissions exceed calculated/ modeled values.
27	ARAR (WAC 173-480-050[1]), ARAR (WAC 173-480-070[2])	Radionuclide emission control units are required to meet the emission standards identified in WAC 246-247 (as applicable). Requires every reasonable effort to maintain radioactive materials in effluents to unrestricted areas ALARA. Control equipment of facilities operating under ALARA shall be defined as reasonably achievable control technology. Requires compliance with the public dose standard by calculating exposure (in curies) at maximum point of exposure and compare to public dose standard.	200-ZP-1 OU emission control equipment to ensure that radiation emission standards are not exceeded includes ion-exchange columns to remove technetium-99, iodine-129, and future removal of uranium. The DOE guide *Calculating Potential to Emit Radionuclide Releases and Doses* (DOE/RL-2006-29) was used to calculate the unabated release potential for radiological constituents. Modeled results show that potential radionuclide emissions are determined to be from a minor source per WAC 246-247.	Periodic confirmatory measurement as described in O&M plan, Appendix C ("Air Monitoring Plan for the 200 West Pump and Treat) will be used to confirm emissions do not exceed criteria. Measurements consist of engineering calculations combined with the results of the Hanford Site Near-Facility Environmental Monitoring Program (HNF-EP-0538, dated June 2008), which are summarized in an annual environmental monitoring report. Existing near facility monitoring network will be used with monitoring locations added if needed.
28	ARAR (WAC 246-247-035[1][a][ii])	Incorporates the requirements of 40 CFR 61, Subpart H by reference. Requires that emissions of radionuclides to the ambient air from DOE facilities shall not exceed amounts that would cause any member of the public to receive, in any year, an effective dose equivalent of greater than 10 mrem/yr.	200-ZP-1 OU emission control equipment will meet the substantive requirements of these standards. The emission control equipment for radionuclides includes ion-exchange columns to remove technetium-99, iodine-129, and future removal of uranium.	O&M plan, Appendix C ("Air Monitoring Plan for the 200 West Pump and Treat') has results that show control equipment is consistent with applicable best or reasonably achieved control technologies. The DOE guide *Calculating Potential to Emit Radionuclide Releases and Doses* (DOE/RL-2006-29) was used to calculate the unabated release potential for radiological constituents. The modeled results show that potential radionuclide emissions are determined be from a minor source per WAC 246-247. Periodic confirmatory measurement will be used to monitor radiological emissions that consist of engineering calculations combined with the results of the Hanford Site Near-Facility Monitoring Program (HNF-EP-0538, dated June 2008), which are summarized in an annual environmental monitoring report. Notification will be provided to EPA in the event any air sample that exceeds 10 percent of the values listed in Table 2 of Appendix E in the 40 CFR 61, as measured in the Hanford near-facility ambient air monitors.
29	ARAR (WAC 173-303-071)	Describes those categories of wastes that are excluded from the requirements of WAC 173-303 (excluding WAC 173-303-050) because they are generally not dangerous or are regulated under other state and federal programs or are recycled in ways that do not threaten public health or the environment.	Wastes generated from 200-ZP-1 OU remedial action will be reviewed against the categories identified in WAC 173-303-071.	O&M plan, Appendix B ("Waste Management Plan for the 200 West Pump and Treat") designation and corresponding waste profiles are completed by the Waste Management lead. The waste profiles are documented on the WPLIS.

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Line #	Source Documents	Requirement	Compliance Methodology	Comments
30	ARAR (WAC 173-303-073)	Establishes the conditional exclusions and the management requirements of special wastes, as defined in WAC 173-303-040.	IDW and remediation waste generated during the remedial action will be reviewed against these exclusions.	O&M plan, Appendix B ("Waste Management Plan for the 200 West Pump and Treat") designation and corresponding waste profiles are completed by the Waste Management lead. The waste profiles are documented on the WPLIS.
31	ARAR (WAC 173-303-077)	Identifies those wastes exempted from regulation under WAC 173-303-140 and WAC 173-303-170 through -9906 (excluding WAC 173-303-960). These wastes are subject to regulation under WAC 173-303-573.	IDW and remediation waste generated from the 200-ZP-1 OU remedial action will be reviewed against universal waste criteria and will comply with the substantive requirements provided in WAC 173-303-573.	O&M plan, Appendix B ("Waste Management Plan for the 200 West Pump and Treat") designation and corresponding waste profiles are completed by the Waste Management lead. The waste profiles are documented on the WPLIS.
32	ARAR (WAC 173-303-120[3] and [4])	These regulations define the requirements for recycling materials that are solid and dangerous waste. Specifically, WAC 173-303-120(3) provides for the management of certain recyclable materials.	IDW and remediation waste generated from the 200-ZP-1 OU remedial action will be reviewed against the requirements for recyclable materials. If recyclable materials are generated, the material will be managed according to the substantive requirements of WAC 173-303-120(3).	O&M plan, Appendix B ("Waste Management Plan for the 200 West Pump and Treat") designation and corresponding waste profiles are completed by the Waste Management lead. The waste profiles are documented on the WPLIS.
33	ARAR (WAC 173-303-140[4])	Establishes state standards for land disposal of dangerous waste and incorporates, by reference, the federal restrictions of 40 CFR 268 that are relevant and appropriate to solid waste that is designated as dangerous or mixed waste. The requirements prohibit the placement of restricted RCRA hazardous waste in land-based units such as landfills surface impoundments, and waste piles until treated to standards considered protective for disposal. Specific treatment standards are included in requirements.	200-ZP-1 OU remediation waste and IDW dangerous waste destined for onsite land disposal will be managed in accordance with these restrictions.	Treatment residuals disposal/treatment occurs on an as-needed basis and will follow applicable waste management functions identified in the O&M plan, Appendix B ("Waste Management Plan for the 200 West Pump and Treat"). Waste designation and corresponding waste profiles are completed by the Waste Management lead. The waste profiles are documented on the WPLIS. Waste acceptance criteria for disposal at ERDF including LDRs are provided in WCH-191, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*.
34	ARAR (WAC-246-040[3] and [4]), ARAR (WAC 246-247-075[1][2][3][4][8])	Requires that emissions be controlled to ensure that radiation emission standards are not exceeded from new construction and existing sources. Establishes monitoring, testing, and quality assurance requirements for emissions.	200-ZP-1 OU emission control equipment will meet the substantive requirements of these standards. The emission control equipment for radionuclides includes ion-exchange columns to remove technetium-99, iodine-129, and future removal of uranium.	Periodic confirmatory measurement, as described in O&M plan, Appendix D ("200 West Pump and Treat Sampling and Analysis Plan"), will be used to confirm emissions do not exceed criteria. Measurements consist of engineering calculations combined with the Hanford Site Near-Facility Environmental Monitoring Program (HNF-EP-0538), which is summarized in an annual environmental monitoring report. Existing near-facility monitoring network will be used. Monitoring locations will be added if needed.

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WAC 173-303-050, "Department of Ecology Cleanup Authority."

WAC 173-303-070, "Designation of Dangerous Waste."

WAC 173-303-071, "Excluded Categories of Waste."

WAC 173-303-073, "Conditional Exclusion of Special Wastes."

WAC 173-303-077, "Requirements for Universal Waste."

WAC 173-303-120, "Recycled, Reclaimed, and Recovered Wastes."

WAC 173-303-140, "Land Disposal Restrictions."

WAC 173-303-170, "Requirements for Generators of Dangerous Waste."

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Appendix B

Waste Management Plan for the 200 West Pump and Treat

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Terms

ARAR	applicable or relevant and appropriate requirement
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DOE	U.S. Department of Energy
DOT	Department of Transportation
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ETF	Effluent Treatment Facility
GAC	granular activated carbon
ID	identification
IDW	investigation-derived waste
MSU	modular storage unit
MSW	miscellaneous solid waste
NA	not assigned
O&M	operations and maintenance
OU	operable unit
P&T	pump and treat
ROD	Record of Decision
WMP	waste management plan

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B1 Purpose

This waste management plan (WMP) establishes the requirements for the management and disposal of investigation-derived waste (IDW) and remediation waste associated with operation of the 200 West pump and treat (P&T).

The 200 West P&T was constructed to capture and treat contaminated groundwater in the 200-ZP-1 and 200-UP-1 Operable Units (OUs), as required in the *Record of Decision, Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington* (September 2008) (EPA et al., 2008); and the *Record of Decision for Interim Remedial Action, Hanford 200 Area Superfund Site, 200-UP-1 Operable Unit* (September 2012) (EPA et al., 2012), respectively. The 200 West P&T also treats condensate from soil vapor extraction operations in the 200-PW-1 OU in accordance with the *Record of Decision, Hanford 200 Area Superfund Site, 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units* (EPA et al., 2011).

The 200 West P&T pumps groundwater from a network of extraction wells and then treats the contaminated groundwater to reduce the mass of carbon tetrachloride, total chromium (trivalent and hexavalent), nitrate, trichloroethene, iodine-129, technetium-99, uranium (future), and other constituents within the 200-ZP-1 and 200-UP-1 OUs. Treated water, cleaned to the levels specified by the Records of Decision (RODs) for the 200-ZP-1 and 200-UP-1 OUs, is injected into the aquifer through a network of injection wells. Waste generated by these remedial activities is managed in accordance with substantive portions of the applicable or relevant and appropriate requirements (ARARs), as identified in the 200-ZP-1 and 200-UP-1 OU RODs.

This WMP includes the requirements for the management and disposal of IDW generated from the installation, monitoring, sampling, maintenance, and decommissioning of wells at the 200-ZP-1 OU in accordance with the *Hanford Site Strategy for Management of Investigation Derived Waste* (DOE/RL-2011-41).

Tables B-1 and B-2 provide the well numbers, and Figures B-1 and B-2 illustrate the locations of the wells in the 200 West Area. If additional wells are identified to support groundwater monitoring or remediation activities, this WMP will be updated accordingly.

B2 Waste Generation Activities and Projected Waste Streams

The following activities are expected to generate waste subject to the requirements of this WMP:

- Construction, modification, and operations and maintenance (O&M) of the 200 West P&T
- Installation, development, testing, monitoring, sampling, O&M, and decommissioning of groundwater monitoring, extraction, and injection wells
- Subsurface characterization activities, including water-level and other in situ groundwater or vadose zone measurements
- Aquifer testing and geophysical logging
- Treatability studies
- Decontamination of equipment, tools, and material
- Process sampling and analysis of samples

Table B-1. 200 West Area Groundwater Wells

299-W10-1	299-W15-763	299-W6-6
299-W10-14	299-W15-765	299-W7-3
299-W10-27	299-W15-83	699-30-66
299-W10-30	299-W15-94	699-32-62
299-W10-31	299-W18-1	699-32-72A
299-W10-33	299-W18-15	699-33-75
299-W10-4	299-W18-16	699-34-61
299-W11-13	299-W18-21	699-35-66A
299-W11-18	299-W18-22	699-35-78A
299-W11-33Q	299-W18-40	699-36-61A
299-W11-37	299-W19-105	699-36-66B
299-W11-43	299-W19-107	699-36-70A
299-W11-45	299-W19-18	699-36-70B
299-W11-47	299-W19-34A	699-37-66
299-W11-48	299-W19-34B	699-38-61
299-W11-87	299-W19-36	699-38-65
299-W11-88	299-W19-4	699-38-68A
299-W12-1	299-W19-41	699-38-70B
299-W13-1	299-W19-47	699-38-70C
299-W14-11	299-W19-48	699-40-62
299-W14-13	299-W19-49	699-40-65
299-W14-14	299-W19-6	699-43-69
299-W14-71	299-W21-2	699-44-64
299-W14-72	299-W22-24	699-45-69A
299-W15-11	299-W22-47	699-45-69C
299-W15-152	299-W22-72	699-47-60
299-W15-17	299-W22-86	699-48-71
299-W15-33	299-W22-87	699-50-74
299-W15-37	299-W22-88	699-51-63

Table B-1. 200 West Area Groundwater Wells

299-W15-42	299-W23-19
299-W15-46	299-W23-4
299-W15-49	299-W26-13
299-W15-50	299-W27-2
299-W15-7	299-W6-3

Table B-2. 200 West P&T Wells

Well Code	Well ID	Well Number
Extraction Wells		
YE-1	C7017	299-W15-225
YE-2	C7018	299-W14-20
YE-3	C7021	299-W14-73
YE-4	C7024	299-W14-74
YE-5	C7027	299-W12-2
YE-6	C7020	299-W11-50
YE-7	C7022	299-W11-90
YE-8	C7754	299-W11-96
YE-9	C7577	299-W17-3
YE-10	C7576	299-W17-2
YE-11	C8718	299-W19-111
YE-12	C7019	299-W11-49
YE-13	C8719	299-W11-97
YE-14	C8720	299-W6-15
YE-15	C7494	299-W14-21
YE-16	C7025	299-W11-92
YE-17	C8721	299-W5-1
YE-18	C7028	299-W12-3
YE-19	C7029	299-W12-4
YE-20	C7030	299-W14-22
YE-21	C8095	299-W22-90

Table B-2. 200 West P&T Wells

Well Code	Well ID	Well Number
YE-22	C8096	299-W22-91
YE-23	C8097	299-W22-92
Injection Wells		
YJ-1	C8064	299-W6-13
YJ-2	C8065	299-W6-14
YJ-3	C8066	299-W10-36
YJ-4	C7573	299-W10-35
YJ-5	C7574	299-W15-226
YJ-6	C7575	299-W15-227
YJ-7	C8716	299-W15-228
YJ-8	NA	NA
YJ-9	C8786	699-49-69
YJ-10	C8717	699-45-67B
YJ-11	C7578	699-45-67
YJ-12	C8068	699-44-67
YJ-13	C7579	699-43-67
YJ-14	C8069	699-42-67
YJ-15	C8070	699-40-67
YJ-16	NA	NA
YJ-17	C8386	699-43-67B
YJ-18	B2409	299-W15-29
YJ-19	B2747	299-W18-36
YJ-20	B2756	299-W18-37
YJ-21	B2757	299-W18-38
YJ-22	B2758	299-W18-39
YJ-23	C8067	699-46-68

ID = identification
NA = not assigned

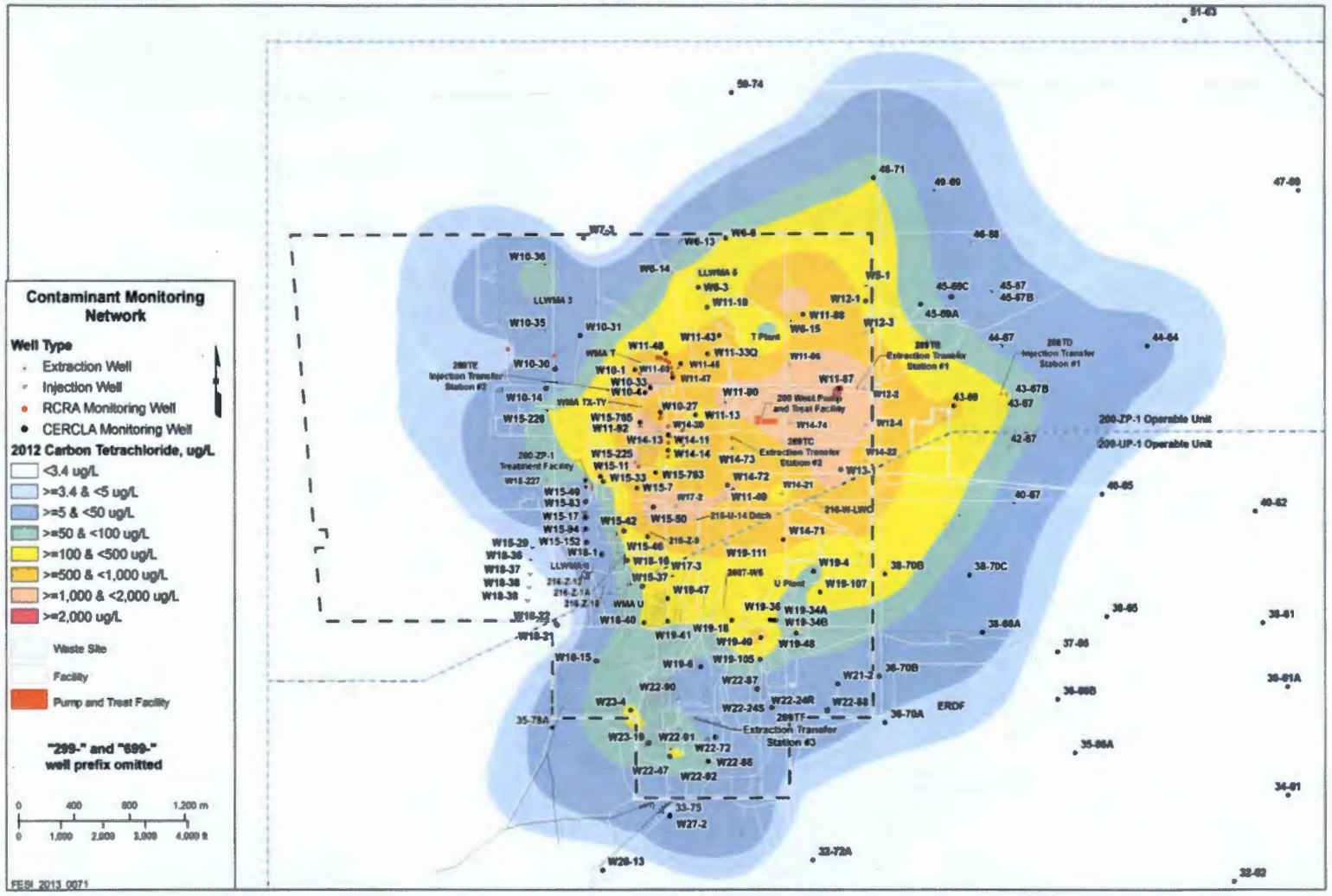

Figure B-1. 200 West Groundwater Well Locations

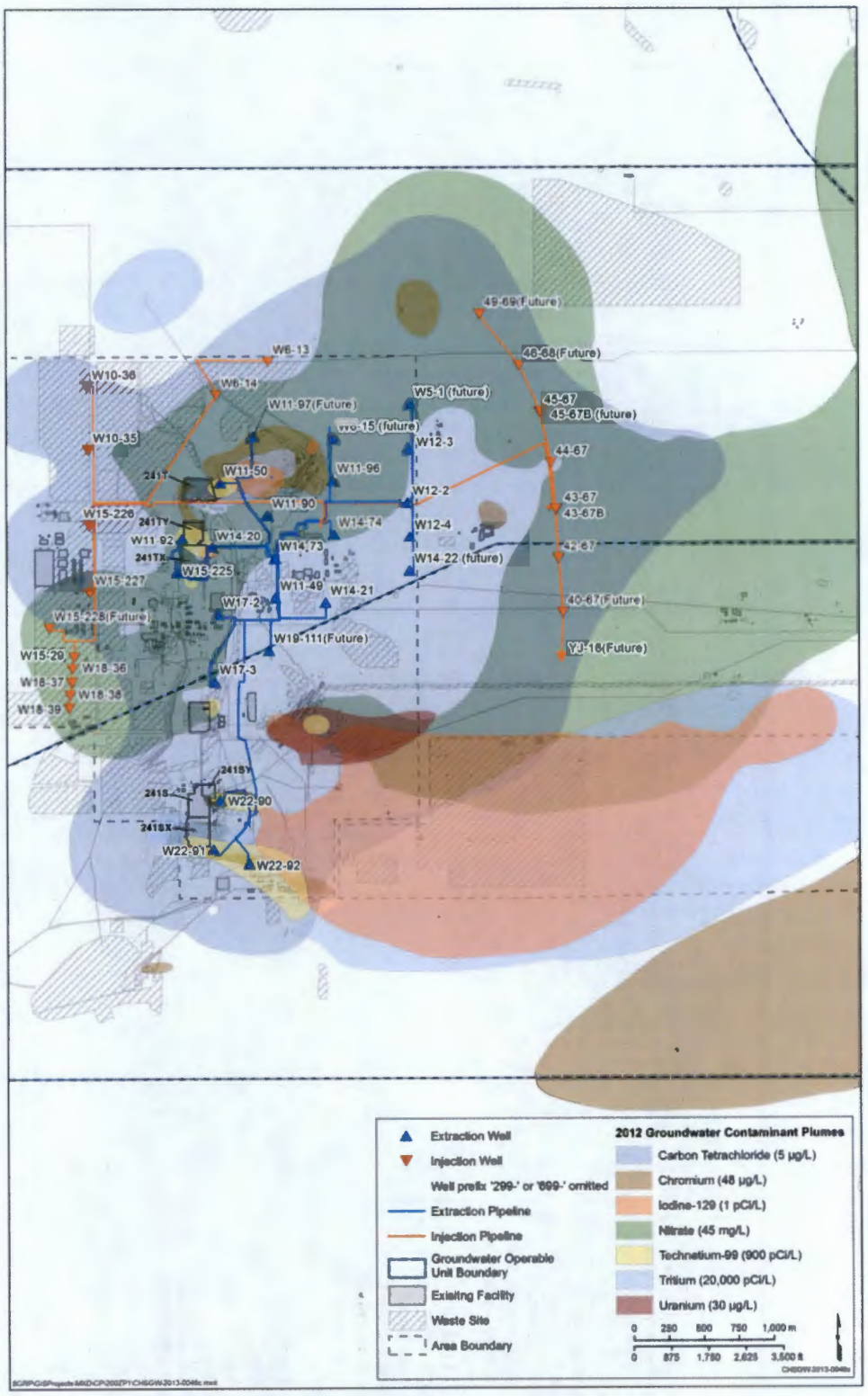

Figure B-2. 200 West P&T Well Locations and Contaminant Plumes

The following waste streams are generated from the investigation and remediation activities described above:

- Loaded and spent granular activated carbon (GAC), resin, sludge, and filter elements (loaded GAC has reached its sorption capacity, is in good physical condition, and is able to be regenerated; spent GAC has reached its sorption capacity and is no longer capable of being regenerated)
- Biosolids
- Off-specification in-process groundwater
- Drill cuttings (vadose and saturated zone soil)
- Miscellaneous solid waste (MSW) (e.g., paper, wipes, personal protective equipment, cloth, tools, syringes, pumps, metal, glass, and plastic)
- Decommissioning debris (e.g., concrete, wood, rebar, metal/plastic pipe and screens, wire, bentonite, sand, gravel, equipment, pumps, and tanks)
- Replaced treatment system components (e.g., air stripper tower packing, vessels, valves, and piping)
- Equipment and construction materials (e.g., well casing, drill strings, drive barrels, construction equipment and material, sampling equipment, and wooden pallets)
- Spent or expired chemicals/reagents and used oil
- Unplanned releases and associated cleanup material
- Liquids include, but are not limited to, the following:
  - Purgewater generated during well installation, development, testing, sampling, monitoring, maintenance, decommissioning, and decanting of saturated zone soil and water drained from GAC and resins
  - Condensate from soil vapor extraction systems
  - Algae treatment fluid
  - Decontamination fluid
  - Liquid from sample analysis and screening
  - Liquid from unplanned release
- Sampling-related waste from any field laboratory (if used) testing, as well as other Hanford Site laboratory 200-ZP-1 OU sample returns
- Treatability test waste in support of the remedial action and P&T process

B3 Waste Management Requirement

The 200-ZP-1 and 200-UP-1 OU IDW and remediation waste will be managed in accordance with this WMP and substantive compliance with the ARARs, as identified in the 200-ZP-1 and 200-UP-1 OU RODs. Every effort will be made to minimize waste generated from investigation and remediation activities.

B3.1 Waste Generation

All waste generated from 200 West P&T drilling activities will be managed in accordance with project procedures and/or waste planning documents.

B3.2 Waste Packaging and Labeling

Waste packaging and labeling are performed in accordance with a Waste Packaging and Labeling Instruction Sheet, or as directed by the waste management specialist.

Packaging and labeling during storage and transportation will meet the substantive requirements of WAC 173-303 ("Dangerous Waste Regulations") and WAC 173-304 ("Minimum Functional Standards for Solid Waste Handling"), as identified in the RODs as being applicable, or relevant and appropriate. For onsite waste shipments, non-Department of Transportation (DOT) packaging may be used if the container will provide an equivalent degree of safety and approval documents are in place. Materials requiring collection will be placed in containers appropriate for the material and the receiving facility. DOT-approved drums may be used for some materials (e.g., drill cuttings); however, packaging and containment for large or irregular waste or large volume waste (e.g., GAC and resin) may require containers other than drums. The packaging and containment may include, but is not limited to, plastic wrap, 4 ft by 4 ft by 8 ft boxes, Environmental Restoration Disposal Facility (ERDF) roll-on/roll-off containers, and GAC canisters.

Waste generated from groundwater monitoring activities (e.g., well sampling, well maintenance, well decommissioning, and geophysical logging) will be bagged, taped, and labeled with the well number and the date the waste was generated. The bagged material will be transported in a protective manner (i.e., containment of the material is maintained) while proceeding from well to well in the OU. Waste bags will be placed in appropriate containers and stored at the established OU storage location or other approved consolidated storage location, or may also be disposed directly to ERDF without storage, as directed by the waste management specialist.

Containers will be labeled and marked appropriately to match the waste designation established for each waste stream. The containers will be sealed and shipped to the identified disposal facility or storage area.

B3.3 Waste Storage

Segregation and staging of waste containers/packages will be performed in accordance with the Waste Packaging and Labeling Instruction Sheet, or as directed by the waste management specialist. The amount of waste stored at the storage area should be kept to a minimum. Full containers should be prepared for disposal as quickly as economically feasible. Designated dangerous waste will be stored in defined storage areas. Designated dangerous waste and waste awaiting sampling, or pending analysis in defined storage areas, will be inspected weekly. Nondangerous waste storage areas will be inspected monthly or at the frequency directed by Soil and Groundwater Remediation Project operations.

Remediation waste (e.g., resin, sludge, spent GAC, bag filters, and MSW) destined for disposal, and loaded GAC for offsite regeneration or disposal, may be stored on the pad within the 200 West P&T boundary for up to one year or longer, with DOE and EPA concurrence (Figure B-3).

Figure B-3. 200 West P&T Waste Storage Location

The IDW waste (e.g., drill cuttings) may be accumulated near the point of generation while awaiting analytical laboratory test results. IDW may also be accumulated at the 200-ZP-1/200-PW-1/200-UP-1 consolidated *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) waste storage area (Figure B-4). If IDW must be stored for longer than 6 months after designation, concurrence from the lead regulatory agency will be obtained on storage, treatment, and disposal options of the waste along with the disposition schedule.

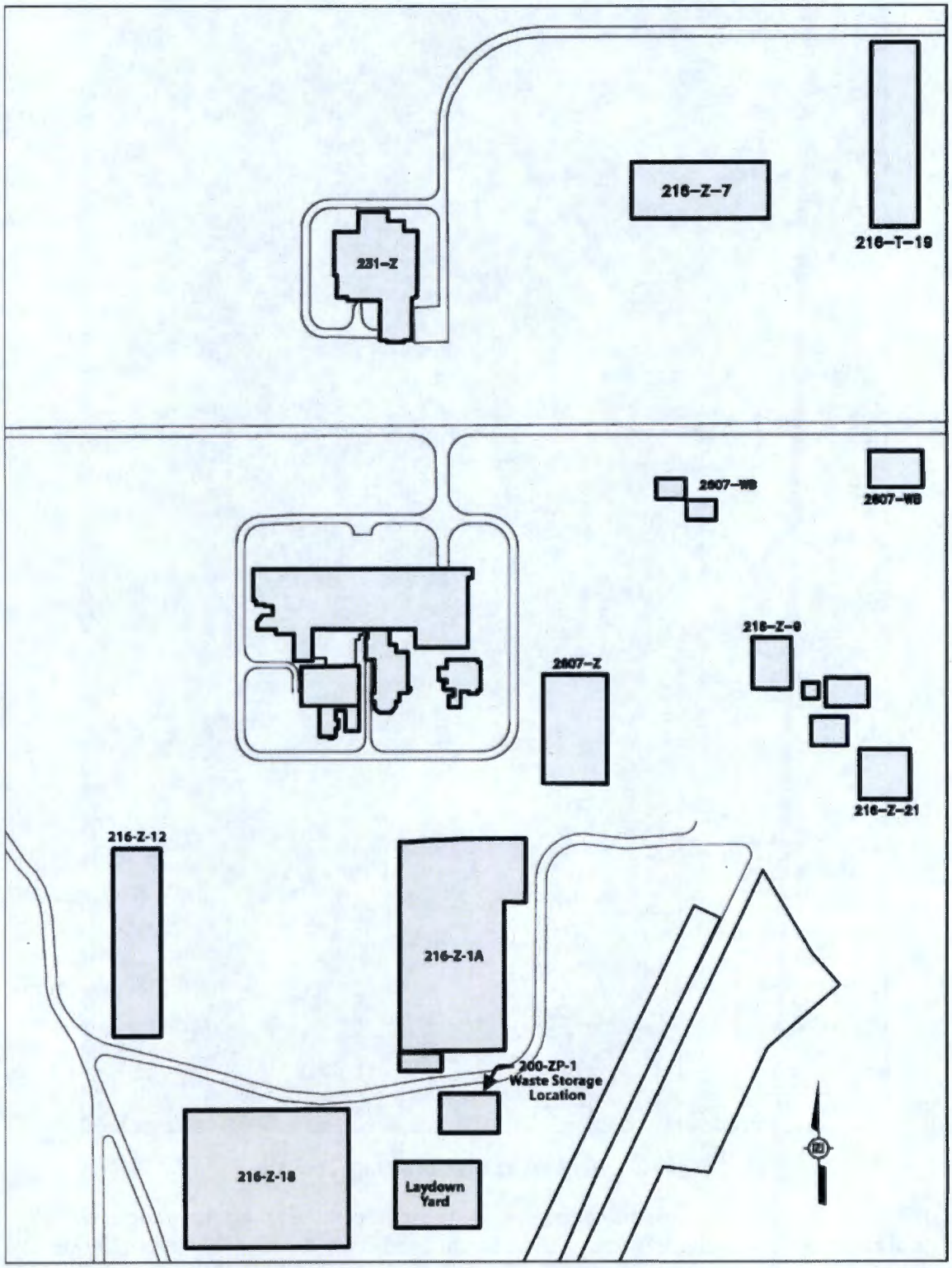

Figure B-4. 200-ZP-1 OU Waste Storage Location

Radioactive waste will be managed separately from nonradioactive waste. The containers bearing radioactive waste will be sealed, labeled, and shipped to the appropriate identified disposal facility in accordance with the criteria established for the respective material.

B3.4 Waste Designation

Waste will be designated in accordance with WAC 173-303-070(3) using process knowledge, historical analytical data, and laboratory analyses. According to CCN 081034 ("Application of Listed Waste Codes to Secondary Solid Wastes Related to Well Construction, Maintenance, and Sampling"), groundwater associated with the 200-ZP-1 and 200-UP-1 OUs carries the following listed waste codes:

- F001: carbon tetrachloride and 1,1,1 trichloroethane
- F002: methylene chloride
- F003: acetone and methyl isobutyl ketone
- F004: cresols and cresylic acid (o-cresols and p-cresols)
- F005: methyl ethyl ketone

Therefore, IDW and remediation waste that come into contact with 200-ZP-1 and 200-UP-1 OU contaminated groundwater will also carry F001 through F005 listed waste codes.

B3.5 Waste Disposal

IDW and remediation waste generated at the 200-ZP-1 and 200-UP-1 Groundwater OUs may be disposed at ERDF if the waste meets the facility's waste acceptance criteria, as defined in *Environmental Restoration Disposal Facility Waste Acceptance Criteria* (WCH-191) and *Supplemental Waste Acceptance Criteria for Bulk Shipments to the Environmental Restoration Disposal Facility* (0000X-DC-W0001). Waste that does not meet ERDF waste acceptance criteria will be evaluated for additional treatment at an onsite or offsite facility. If additional treatment is deemed necessary, treatment options will be evaluated based on the characteristics of the waste and the concentration reduction requirements. If treatment options are not available, the waste may be managed within the Hanford Site Solid Waste Operations Complex (e.g., Central Waste Complex), as authorized by the U.S. Environmental Protection Agency (EPA). Although not identified as being applicable, or relevant and appropriate, a favorable offsite determination will be requested in accordance with 40 CFR 300.440 ("National Oil and Hazardous Substances Pollution Contingency Plan," "Procedures for Planning and Implementing Off-Site Response Actions") prior to shipment of waste to the Central Waste Complex.

B3.6 Records

Completed waste inventory documentation will be used to initiate waste tracking in the Solid Waste Information Tracking System. All records will be managed in accordance with applicable records management processes.

B4 Stream-Specific Waste Management Requirement

Specific waste management guidance for each projected waste stream is provided in the following subsections.

B4.1 Loaded and Spent Granular Activated Carbon

Loaded GAC may be sent offsite for regeneration at an EPA-approved facility (e.g., Siemens Water Technologies in Parker, Arizona) and may be re-used in the treatment system in accordance with

40 CFR 300.440. The GAC sent offsite must meet the authorized limit requirements listed in 09-SED-0003, "Contract No. DE-AC06-08RL14788 – Request for Approval of Use of Authorized Limits for Regeneration of Ion Exchange Resin and Granular Activated Carbon," Attachment 2, "Authorized Limits Approved for Use by CHPRC for Off-Site Shipment and Regeneration of Granular Activated Carbon from the 200-ZP-1 and 200-PW-1 Pump and Treat Operations," as summarized below.

The transfer of the GAC canisters to the offsite regeneration facility constitutes a release from U.S. Department of Energy (DOE) control. Therefore, before the GAC is sent to the regeneration facility, the potential for residual radioactive contamination on the GAC and demonstration of compliance with the requirements of DOE O 458.1, *Radiation Protection of the Public and the Environment*, must be assessed. For any potential residual radioactive contamination, DOE O 458.1 requires that radiological release criteria (i.e., authorized limits) be developed and submitted to the applicable DOE field office. The following authorized limits have been established low enough to ensure that the public dose limit of 100 mrem/yr is not approached. If any radionuclide listed in Table B-3 is detected at an activity greater than the authorized limit shown in Table B-3, then each canister or drum must be reanalyzed separately for that radionuclide to ensure that the authorized limit is not exceeded for the radionuclide in question.

If the loaded GAC canisters and drums cannot meet the authorized limits listed in Table B-3, the GAC canisters may be disposed at ERDF if they meet the facility's waste acceptance criteria. GAC waste that does not meet ERDF waste acceptance criteria will be evaluated for additional treatment at an onsite or offsite facility. If treatment options are not available, the waste may be managed within the Hanford Site Solid Waste Operations Complex. Spent GAC will be similarly evaluated for ERDF disposal and additional treatment if necessary.

Table B-3. Authorized Limits for Offsite Transfer of 200 West P&T GAC

Radionuclide	Authorized Limit (pCi/g)
Americium-241	29
Carbon-14	3,000
Cesium-137	80
Cobalt-60	21
Europium-152	40
Europium-154	40
Europium-155	700
Iodine-129	50
Neptunium-237	50
Nickel-63	100
Plutonium-231	10
Plutonium-238	26
Plutonium-239	24
Plutonium-240	24
Protactinium-231	10

Table B-3. Authorized Limits for Offsite Transfer of 200 West P&T GAC

Radionuclide	Authorized Limit (pCi/g)
Selenium-79	2,000
Strontium-90	100
Technetium-99	500
Thorium-232 + progeny	6
Tritium	300,000
Uranium-234	100
Uranium-235	100
Uranium-238 + short lived progeny	100

B4.2 Filter Elements

The 200 West P&T has bag filters and other filter elements. Fine particles present in the groundwater collect on the bag filters located in filter housings. The bag filters are removed from the filter housings and replaced as needed to maintain system efficiency. The bag filters are dewatered and transferred into appropriate containers for onsite shipment to the ERDF. Water from the filter removal process will be reintroduced to the influent side of the P&T system.

B4.3 Drill Cuttings

Drill cuttings are considered to be IDW and are managed in accordance with DOE/RL-2011-41 and with requirements in this WMP. Due to the amount of data from the very large number of wells and samples obtained in the vadose zone and saturated zone in the 200 West Area, acceptable generator knowledge may be used to determine if drill cuttings will be contaminated and whether the drill cuttings need to be sampled prior to waste disposition. Drill cuttings from the vadose zone and saturated zone will be segregated. Vadose zone drill cuttings suspected to be contaminated will be containerized. Vadose zone drill cuttings that are not suspected to be contaminated based on generator knowledge may be stockpiled on plastic or placed in containers near the point of generation. All saturated zone drill cuttings will be containerized.

As described in procedure GRP-EE-02-14.5, *Returning Vadose Zone Drill Cuttings/Soils to the Environment*, vadose zone drill cuttings that are not designated as dangerous waste in accordance with WAC 173-303, are below the cleanup standards of WAC 173-340-740 ("Model Toxics Control Act–Cleanup," "Unrestricted Land Use Soil Cleanup Standards"). Vadose zone drill cuttings meeting Method B cleanup standards have been determined to be low risk for radiological contamination and have been released from a radiological perspective may be returned to the environment.

Vadose zone drill cuttings that do not meet the return-to-environment criteria will be disposed at ERDF if the facility's waste acceptance criteria are met. If the acceptance criteria cannot be met, the material will be evaluated for additional treatment at an onsite or offsite facility. If treatment options are not available, the waste may be managed within the Hanford Site Solid Waste Operations Complex.

Saturated zone drill cuttings will be placed in containers near the point of generation. Contained drilling slurries (e.g., decanted water) will be safely removed from the containers (i.e., suctioned, ladled, or drained), and free liquids greater than 1 percent remaining in the container will be reduced by evaporation and/or stabilized by the addition of sorbent material prior to disposal. Removed drilling slurries will be managed as purgewater.

Drill cuttings may also be sampled in accordance with project-specific sampling and analysis plans.

B4.4 Liquids

Various liquid wastes are generated from the O&M for well-related activities (as described in Section B2) and for 200 West P&T and soil vapor extraction operations.

B4.4.1 Purgewater

Purgewater generated from investigation and remediation activities within the 200-ZP-1, 200-UP-1, and 200-PW-1 OUs will be managed in accordance with DOE/RL-2011-41 and *Investigation Derived Waste Purgewater Management Work Plan* (DOE/RL-2009-80). Purgewater associated with installation, development, testing, monitoring, sampling, and maintenance, as well as any water decanted from saturated drill cuttings, is generally collected in a purgewater truck at the time of generation and transported to the purgewater modular storage units (MSUs) or the Effluent Treatment Facility (ETF). In instances where this does not occur (e.g., during drilling activities), the purgewater is stored near the point of generation until drilling and well development activities are complete.

Contaminated groundwater/liquids undergoing treatment (in process) at the 200 West P&T that are off-specification may be returned to the influent side of the treatment facility or may be sent to the MSUs or ETF, as needed. Small volumes of liquid that have been stabilized may also be disposed at ERDF if the facility's waste acceptance criteria can be met. Liquid waste that cannot be pre-treated to meet ERDF waste acceptance criteria will be evaluated for additional treatment at an onsite or offsite facility. If treatment options are not available, the waste may be managed within the Hanford Site Solid Waste Operations Complex.

B4.4.2 Water Drained from Granular Activated Carbon and Resin Roll-Off Boxes

During replacement/removal of GAC and ion-exchange resin at the 200 West P&T, water may be drained from the GAC and resin roll-off boxes. Water drained from the GAC and resin roll-off boxes will be reintroduced to the influent side of the 200 West P&T.

B4.4.3 Condensate from Soil Vapor Extraction Operations

Condensate (i.e., knockout water) generated from both active and passive soil vapor extraction operations is processed at the 200 West P&T. In the event that the water cannot be processed at the 200 West P&T, it will be dispositioned to the MSUs or the ETF.

B4.4.4 Algae Removal Liquids

Water generated during algae removal activities may be contained and returned to the influent side of the 200 West P&T, to the MSUs, or to the ETF.

B4.4.5 Decontamination Fluids

Decontamination fluids (i.e., water and/or nonhazardous cleaning solutions) generated from cleaning equipment, tools, and materials will be contained and returned to the influent side of the 200 West P&T or may be dispositioned to the MSUs, ETF (if waste acceptance criteria can be met), or other approved facility. Small volumes (generally less than 208 L [55 gal]) of decontamination fluids may be stabilized

to less than or equal to 1 percent free liquid and disposed at the ERDF if the facility's waste acceptance criteria can be met.

Decontamination of some equipment (e.g., split-spoon samplers) may be conducted at the Waste Sampling and Characterization Facility because decontamination and containment systems are already established at this location. The decontamination waste liquids will be returned to the influent side of the 200 West P&T or dispositioned to the MSUs, the ETF (if waste acceptance criteria can be met), or other approved facility.

B4.4.6 Sample Analysis and Screening Liquids

Unaltered liquid waste (i.e., unused groundwater) generated during sample screening and analysis will be managed as purgewater. Altered samples will be contained and returned to the influent side of the facility for treatment. Altered samples may also be disposed at the MSUs, ETF, ERDF, or other appropriate facility depending on the waste designation. Some liquids may be neutralized and/or stabilized to meet the disposal facility's waste acceptance criteria.

B4.4.7 Liquids from Unplanned Releases

Liquids generated by unplanned releases from the 200 West P&T may be returned to the influent side of the 200 West P&T. If liquids cannot be returned to the treatment facility, they will be managed in accordance with the appropriate containment, storage, and disposal requirements and disposed at the MSUs, ETF, or ERDF. Liquids may be evaporated or stabilized (generally less than 208 L [55 gal]) and stabilized material transported to the ERDF if the facility's waste acceptance criteria can be met.

B4.5 Incidental Solid Waste

Equipment and tools having only incidental nonroutine contact with contaminated groundwater will be air dried to remove volatile organic compounds. After the materials have been dried, the equipment/tools will no longer be considered contaminated with F001 through F005 listed waste in accordance with WAC 173-303-070(2)(c)(ii).

In addition, water washing, spraying, or high-pressure steam cleaning of equipment and tools with or without nonhazardous cleaning solutions meets the alternative treatment standards for hazardous debris identified in Table 1 of 40 CFR 268.45, "Land Disposal Restrictions," "Treatment Standards for Hazardous Debris." These equipment and tools will no longer be considered contaminated with F001 through F005 listed waste, provided that the equipment and tools meet the definition of a clean debris surface. As described in 40 CFR 268.45, a clean debris surface is defined as "...the surface, when viewed without magnification, shall be free of all visible contaminated soil and hazardous waste, except that residual staining from soil and waste consisting of light shadows, light streaks, or minor discolorations; and soil and waste in cracks, crevices, and pits may be present, provided that such staining and waste and soil in cracks, crevices, and pits shall be limited to no more than 5 percent of each square inch of surface area."

B4.6 Miscellaneous Solid Waste

Miscellaneous Solid Waste (MSW) may be generated from construction and O&M activities at the 200 West P&T or from well-related activities. Contaminated and noncontaminated MSW will be segregated and placed in containers that are appropriate for the material, the contaminant, and the disposal facility. MSW contacted with contaminated media may be disposed at the ERDF if the facility's waste acceptance criteria are met. If the waste acceptance criteria cannot be met, the waste will be evaluated for additional treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not

available, the waste may be managed within the Hanford Site Solid Waste Operations Complex. MSW that has not contacted chemically or radiologically contaminated media, and is not a WAC 173-303 dangerous waste, may be disposed at an offsite solid waste landfill or recycled if releasable per PRC-PRO-RP-40026, *Standard Radiological Release Surveys for Material and Equipment*.

B4.7 Decommissioning Debris

Decommissioning debris (e.g., concrete, wood, rebar, metal/plastic pipe and screens, wire, bentonite, sand, gravel, equipment, and pumps) is generated during decommissioning of wells or other equipment. Debris contacted with contaminated media may be disposed at the ERDF if the facility's waste acceptance criteria are met. If ERDF waste acceptance criteria cannot be met, the waste will be evaluated for additional treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not available, the waste may be managed within the Hanford Site Solid Waste Operations Complex. Debris that has not contacted potentially contaminated media, is not a WAC 173-303 dangerous waste, and has been radiologically released per PRC-PRO-RP-40026, may be disposed offsite at a solid waste landfill or at an onsite demolition landfill, or the debris may be recycled, as appropriate.

B4.8 Spent or Expired Chemicals/Reagents and Used Oil

Spent or expired chemicals/reagents that are generated during field sampling and analysis or from 200 West P&T operations will be managed, designated, and disposed as appropriate for the specific chemical or reagent. Used oil generated during operation of the treatment system will be managed by the Hanford Site used oil program administered by the Consolidated Central Recycle Center, or will properly be dispositioned as waste, as appropriate.

Offsite facilities that receive CERCLA-contaminated waste must be approved by EPA in accordance with 40 CFR 300.440. The exceptions are used oil, spent or expired chemical/reagents, and solid waste that has not contacted contaminated media and is recycled or disposed at an offsite solid waste landfill.

B4.9 Sampling-Related Waste

Screening and analysis of solid and liquid samples may be conducted in the field during 200 West P&T operations. Once testing is complete, liquid sample material may be returned to the influent side of the 200 West P&T or properly dispositioned to the MSUs, ETF, or ERDF.

B4.10 Treatability Test Waste

Wastes generated by treatability testing in support of remedial actions and the P&T process will be managed, designated, and disposed at the ETF, ERDF, or other appropriate facility, depending on the waste designation. If waste acceptance criteria cannot be met, the waste will be evaluated for additional treatment at an onsite or offsite facility prior to disposal. If treatment options are not available, the waste may be managed within the Hanford Site Solid Waste Operations Complex.

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Appendix C

Air Monitoring Plan for the 200 West Pump and Treat

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Terms

AMP	air monitoring plan
ARAR	applicable or relevant and appropriate requirement
ASIL	acceptable source impact level
CAS	Chemical Abstracts Service
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COC	contaminant of concern
DOE	U.S. Department of Energy
EDE	effective dose equivalent
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FBR	fluidized bed reactor
GAC	granular activated carbon
gpm	gallons per minute
IX	ion exchange
OU	operable unit
P&T	pump-and-treat
ROD	Record of Decision
scfm	standard cubic feet per minute
SQER	small quality emission rate
TAP	toxic air pollutant

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C1 Introduction

The *Record of Decision, Hanford 200 Area, 200-ZP-1 Superfund Site, Benton County, Washington* (EPA et al., 2008) requires the design, construction, and operation of a new groundwater pump-and-treat (P&T) facility to clean up contaminants of concern (COCs) in the 200 West Area carbon tetrachloride plume. As required by the Record of Decision (ROD), the 200 West P&T captures and treats contaminated groundwater to reduce the mass of COCs (carbon tetrachloride, chromium [total and hexavalent], nitrate, trichloroethene, iodine-129, and technetium-99) specified in the ROD, as well as other constituents. This air monitoring plan (AMP) is needed because groundwater treatment activities may cause emission of *Washington Administrative Code* criteria/toxic compounds (WAC 173-400, "General Regulations for Air Pollution Sources," and WAC 173-460, "Controls for New Sources of Toxic Air Pollutants") to the atmosphere and because there is also a potential for release of radionuclides to the atmosphere. Therefore, substantive requirements from WAC 246-247, "Radiation Protection—Air Emissions," apply so far as abatement controls and emissions monitoring. These activities are being conducted under the authority of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) in the 200-ZP-1 Operable Unit (OU). Other contaminants not specified in the ROD may either be present in extracted groundwater or may be present as byproducts of the treatment processes within the 200 West P&T, including tritium; uranium; 1,1,1-trichloroethane; 1,2-dichloroethane; benzene; acetone; chloroform; dibromochloromethane; dichloromethane; 1,1-dichloroethylene; and vinyl chloride.

The 200 West P&T consists of a radiological processing facility with ion-exchange (IX) columns for removal of technetium-99, iodine-129 (as a particulate), and isotopes of uranium (future). The main treatment facility consists of the following:

- An anaerobic fluidized bed bioreactor (FBR) for removal of nitrate, metals, and carbon tetrachloride
- An aerobic membrane bioreactor for removal of residual carbon substrate, total suspended solids, biomass, and carbon tetrachloride
- A packed bed tower air stripper to remove remaining carbon tetrachloride and other volatile organic compounds

Biomass sludge undergoes thickening prior to disposal as waste. Off-gas from the stripper, FBR, membrane bed reactor, and sludge thickener are comingled and treated by granular activated carbon (GAC) prior to discharge via powered exhaust. The maximum groundwater throughput is approximately 9,464 L/min (2,500 gallons per minute [gpm]), and the associated powered exhaust average flow rate is up to 40,000 standard cubic feet per minute (scfm) for a single stack. The biomass sludge is treated with lime to reduce odors and ammonia, and a scrubber is used to remove ammonia. Extracted groundwater is pumped directly to the radiological processing facility or to the main treatment facility, depending on the contaminants present.

The emission rate for each air toxic compound exceeding de minimis values was compared to its small quantity emission rate (SQER) for the appropriate averaging period. Most were below their respective SQER value. The air pollution dispersion model approved by the U.S. Environmental Protection Agency (EPA), TSCREEN Model Version 95250, was used to calculate the maximum ambient concentrations of toxic air pollutants (TAPs) that are expected to exceed the SQER values following treatment.
The modeled concentrations of the air toxics were compared to the acceptable source impact level (ASIL) for each compound, as specified in WAC 173-460. In each case, the modeled emission value was less than the ASIL for the respective compound.

Calculating Potential-to-Emit Radiological Releases and Doses (DOE/RL-2006-29) was used to calculate the unabated release potential for radiological constituents. Accordingly, the potential emissions would be from a minor source according to WAC 246-247.

Abatement controls and environmental monitoring for air toxic and radiological constituents are described in Section C3 and Section C4.

C2 Air Emissions

Federal and state ambient air quality standards require that pollution control equipment be used to control emissions from new and existing sources. Because the 200 West P&T has the potential to discharge hazardous air pollutants, an evaluation was conducted to estimate the activity of radionuclides and concentration/mass of toxic air pollutants that could potentially be emitted from groundwater treatment operations. The results of this evaluation are presented in the following subsections.

C2.1 Radiological Air Emissions

RCW 70.94, "Public Health and Safety," "Washington Clean Air Act," requires regulation of radioactive air pollutants. WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides," sets standards that are as or more stringent than the federal *Clean Air Act of 1990*, and under the federal implementing regulation 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities."

The EPA partial delegation of the 40 CFR 61 authority to the state of Washington includes all substantive emissions monitoring, abatement, and reporting aspects of the federal regulation. The state standards protect the public by conservatively establishing exposure standards applicable to the maximally exposed (public) individual, be that individual real or hypothetical. To that end, the standards address any member of the public, at the point of maximum annual air concentration, in an unrestricted area where any member of the public may be.

All combined radionuclide airborne emissions from the U.S. Department of Energy (DOE) Hanford Site "facility" are not to exceed amounts that would cause an exposure to any said member of the public of greater than 10 mrem/yr effective dose equivalent (EDE). WAC 246-247 (which adopts the WAC 173-480 standards and the 40 CFR 61, Subpart H standard) requires verification of compliance with the 10 mrem/yr standard and would be applicable or relevant and appropriate to this remedial action.

WAC 246-247 addresses potential radioactive airborne emissions from point sources and from fugitive or diffuse sources by requiring monitoring of such sources. Such monitoring requires physical measurement of the effluent or ambient air and quality assurance measures to ensure the precision, accuracy, and completeness of the environmental measurements. The substantive provisions of WAC 246-247 that require monitoring of radioactive airborne emissions would be applicable or relevant and appropriate to this remedial action.

The above-stated implementing regulations further address control of radioactive airborne emissions where economically and technologically feasible (WAC 246-247-040(3) and -040(4), "Radiation Protection-Air Emissions," "General Standards"). To address the substantive aspect of these requirements, best or reasonably achieved control technology will be addressed by ensuring that applicable emission control technologies (i.e., those successfully operated in similar applications) will be used when economically and technologically feasible (i.e., based on cost/benefit).

C2.2 Criteria/Toxic Air Emissions

Under WAC 173-400 and WAC 173-460, requirements are established for the regulation of TAP emissions. Operation of the new 200 West P&T constitutes a new source of air toxics emissions. Potential criteria/toxic emissions resulting from this remedial action could be gaseous in nature. In accordance with WAC 173-400-040, "General Regulations for Air Pollution Sources," "General Standards for Maximum Emissions," reasonable precautions must be taken to prevent the release of air contaminants associated with point sources and fugitive emissions resulting from excavation, materials handling, or other operations. The use of treatment technologies for emissions of TAPs that would be subject to the substantive applicable requirements of WAC 173-400 and WAC 173-460 is anticipated to be a part of this remedial action. Calculations show that, after application of toxics best available control technology, maximum potential concentrations would be below regulatory thresholds.

Treatment of some waste encountered during this remedial action may be required to meet Environmental Restoration Disposal Facility (ERDF) waste acceptance criteria. In most cases, the type of treatment anticipated would consist of solidification/stabilization techniques such as macroencapsulation or grouting, and WAC 173-460 would not be considered an applicable or relevant and appropriate requirement (ARAR). If more aggressive treatment is required that would result in the emission of regulated air pollutants, the substantive requirements of WAC 173-460-060, "Controls for New Sources of Toxic Air Pollutants," "Control Technology Requirements," would be evaluated to determine applicability.

Treatment byproducts may occur during operations of the 200 West P&T. N-nitrosodimethylamine may be produced in the first hour of operation of a new technetium-99 resin bed at levels expected to be less than the de minimis value over the annual averaging period. Breakdown products of carbon tetrachloride may occur in the FBR. These constituents are already present in the 200-ZP-1 OU groundwater and are included in the evaluation versus de minimis values, small quantity emission rates, and ASILs. Ammonia is anticipated to be generated from the waste sludge at levels requiring lime treatment. Minor amounts of particulates are expected during lime load-in operations.

C2.3 Radiological Airborne Source Information

The radiological COCs for the 200-ZP-1 OU final remedy are technetium-99, iodine-129, and tritium. Isotopes of uranium are added because uranium is present in the adjacent 200-UP-1 Groundwater OU, and it is anticipated that the zone of influence for 200 West P&T operations will eventually extend to the 200-UP-1 OU groundwater plume. Also, future remedial actions in the 200-UP-1 OU are anticipated to include pumping contaminated groundwater from the 200-UP-1 OU and piping it directly to the 200 West P&T. The 200-UP-1 OU interim action P&T system for removal of technetium-99 and uranium (EPA/ROD/R10-97/048, *Interim Remedial Action Record of Decision for the 200-UP-1 Operable Unit, Hanford Site, Benton County, Washington*), wherein pumped groundwater was piped to the 200 East Area Effluent Treatment Facility for treatment and disposal, was discontinued in 2011 due to low flow rates from the extraction wells and because the remedial action objectives were achieved.

DOE/RL-2006-29 is used to calculate the unabated release potential for radiological constituents. As such, Method 1, which is prescribed in 40 CFR 61, Appendix D ("Methods for Estimating Radionuclide Emissions") and in WAC 246-247-030 ("Definitions") is used. Method 1 states, "Multiply the annual possession quantity of each radionuclide by the release fraction for that radionuclide," depending on its physical state. The following release fractions are used:

- 1 for gases
- 10^{-3} (E-03) for liquids or particulate solids
- 10^{-6} (E-06) for solids

A release fraction of 1 is conservatively used for iodine-129 as a gas, although its removal in the treatment system is as a particulate. Tritium is also conservatively considered as a gas for dose calculation. A release fraction of E-03 is used for technetium-99 and for uranium isotopes. Uranium-233 is used to represent all uranium isotopes because its use in dose calculations results in a higher dose. The unabated annual possession quantity for the 200 West P&T is conservatively calculated by applying the maximum design flow for the entire facility to each constituent for a period of one year operating at 24 hr/day, 365 days/yr. The concentrations of the radiological constituents are provided in the integrated mass balance determination (Calculation 382519-CALC-050[1]). Any isotope may be present in the influent. However, the representative isotopes and quantities, which are conservatively used, represent all isotopes potentially present. The technetium-99 IX unit and the main treatment facility are located in series, with the technetium-99 treatment unit at the head end. Depending upon contaminant concentrations, untreated groundwater is piped directly to the technetium-99 treatment unit, or to the main treatment facility. Additional groundwater extraction wells are being installed to optimize removal of contaminants. For instance, extraction wells are being drilled in areas with the highest technetium-99 concentrations. Extracted groundwater from these wells will be piped directly to the technetium-99 treatment unit. The treated effluent from the technetium-99 treatment unit becomes the influent, along with other untreated groundwater, to the main treatment facility. Groundwater treated in the technetium-99 IX unit flows through to the main treatment facility.

- The technetium-99 concentration is obtained by summing the concentration of influent to the technetium-99 IX treatment unit and the concentration of untreated groundwater to the main treatment facility:

$$14{,}700 \text{ pCi/L} + 175 \text{ pCi/L} = 14{,}875 \text{ pCi/L}$$

- The (technetium-99 concentration) x (annual pumpage) = (annual possession quantity):

$$(14{,}875 \text{ pCi/L}) \times (3.7854 \text{ L/gal}) \times (2{,}500 \text{ gpm}) \times (1{,}440 \text{ min/day}) \times (365 \text{ days/yr}) \times (\text{E-12 Ci/pCi}) = 7.40 \text{ E+01 Ci/yr}$$

- The (annual possession quantity) x (release fraction) = (unabated release rate):

$$(7.40 \text{ E+01 Ci/yr}) \times (1\text{E-03}) = 7.4 \text{ E-02 Ci/yr}$$

- The iodine-129 concentration is obtained by summing the concentrations of raw groundwater influent to the technetium-99 IX unit, and untreated groundwater to the main treatment facility:

$$1.3 \text{ pCi/L} + 0.825 \text{ pCi/L} + 0.054 \text{ pCi/L} = 2.18 \text{ pCi/L}$$

- The (iodine-129 concentration) x (annual pumpage) = (annual possession quantity):

$$(2.18 \text{ pCi/L}) \times (3.7854 \text{ L/gal}) \times (2{,}500 \text{ gpm}) \times (1{,}440 \text{ min/day}) \times (365 \text{ days/yr}) \times (\text{E-12 Ci/pCi}) = 1.08 \text{ E-02 Ci/yr}$$

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[1] Calculation 382519-CALC-050, *Integrated Mass Balance Calculation*, Rev. 1, dated February 4, 2010, CH2M HILL, Santa Ana, California.

- The (annual possession quantity) x (release fraction) = (unabated release rate):

  (1.08 E-02Ci/yr) x (1E00) = 1.08 E-02 Ci/yr

- The tritium concentration is obtained from the combined influent to the main treatment facility (9,250pCi/L)

- The (tritium concentration) x (annual pumpage) = (annual possession quantity):

  (9,250 pCi/L) x (3.7854 L/gal) x (2,500 gpm) x (1,440 min/day)
  x (365 days/yr) x (E-12 Ci/pCi) = 4.6 E+01 Ci/yr

- The (annual possession quantity) x (release fraction) = (unabated release rate):

  (4.6 E+01 Ci/yr) x (1E00) = 4.6 E+01 Ci/yr

- The uranium concentration is obtained from summing the concentrations of untreated groundwater influent to the technetium-99 IX unit, and untreated groundwater influent to the main treatment facility:

  570 pCi/L + 3.96 pCi/L + 3.47 pCi/L = 577.43 pCi/L

- The (uranium concentration) x (annual pumpage) = (annual possession quantity):

  (577.43 pCi/L) x (3.7854 L/gal) x (2,500 gpm) x (1,440 min/day)
  x (365 days/yr) x (E-12 Ci/pCi) = 2.87 E00 Ci/yr

- The (annual possession quantity) x (release fraction) = (unabated release rate):

  (2.87 E00 Ci/yr) x (1 E-03) = 2.87 E-03 Ci/yr

- The annual total effective dose equivalent to the maximally exposed individual is conservatively determined by multiplying the unabated release rate for each representative radiological constituent by the highest applicable unit dose conversion factors from DOE/RL-2006-29:

  - Technetium-99: (7.4 E-02 Ci/yr) x (1.8 E-02 mrem/Ci) = 1.33 E-03 mrem/yr
  - Iodine-129: (1.08 E-02 Ci/yr) x (7.62 E-02 mrem/Ci) = 8.21 E-04 mrem/yr
  - Tritium: (4.6 E+01 Ci/yr) x (2.5 E-05 mrem/Ci) = 1.15 E-04 mrem/yr
  - Uranium-233: (2.87 E-03 Ci/yr) x (8.6 mrem/Ci) = 2.47 E-02 mrem/yr

  Total: 2.70 E-02 mrem/yr

Accordingly, the potential emissions would be from a minor source according to WAC 246-247.

C2.4 Criteria/Toxic Airborne Source Information

Compliance with the state air toxic rule was demonstrated according to the requirements of WAC 173-460. The groundwater database was used to identify chemical compounds detected in the 200-ZP-1 OU beyond those already identified as COCs, which are also listed as WAC 173-460 air toxic compounds. Table C-1 lists the constituents that were identified.

Table C-1. Potential Air Toxic Constituents

Constituent	CAS Number	De Minimis Value (lb/averaging period)	SQER Value	Averaging Period
1,1,1-Trichloroethane	71-55-6	6.570	131.0	day
1,1-Dichloroethane	75-34-3	6.000	120.0	year
1,1-Dichloroethylene	75-35-4	1.31	26.3	day
1,2-Dichloroethane	107-06-2	0.369	7.39	year
1,2-Dichloropropane	78-87-5	0.959	19.2	year
1,4-Dichlorobenzene	106-46-7	0.872	17.4	year
2-Napthylamine	91-59-8	0.0188	0.376	year
Ammonia	7664-41-7	0.465	9.31	day
Benzene	71-43 -2	0.331	6.62	year
Beryllium	7440-41-7	0.004	0.08	year
Bromoform	75-25-2	8.720	174,0	year
Cadmium	7440-43-9	0.00228	0.457	year
Carbon disulfide	75-15-0	5.26	105.0	day
Carbon tetrachloride	56-23-5	0.228	4.57	year
Chlorobenzene	108-90-7	6.57	131	day
Chloroform	67-66-3	0.417	8.35	year
Chromium (VI)	18540-29-9	6.4E-05	0.00128	year
Cobalt	7440-48-4	0.000657	0.013	day
Copper	7440-50-8	0.011	0.219	hour
Dibromochloromethane	124-48-1	0.355	7.10	year
Ethylbenzene	100-41-4	3.84	76.8	year
Fluoride	7782-41-4	0.0854	1.71	day
Lead	7439-92-1	10.0	16.0	year
Manganese	7439-96-5	0.000263	0.00526	day
Mercury	7439-97-6	0.000591	0.0118	day
Methyl tertiary butyl ether	1634-04-4	36.90	739.0	year
Methylene chloride	75-09-2	9.59	192.0	year
o-Xylene	95-47-6	1.45	29.0	day
Phenol	108-95-2	1.31	26.3	day
Selenium	7782-49-2	0.131	2.63	day
Styrene	100-42-5	5.91	118.0	day
Toluene	108-88-3	32.90	657.0	day

Table C-1. Potential Air Toxic Constituents

Constituent	CAS Number	De Minimis Value (lb/averaging period)	SQER Value	Averaging Period
Trichloroethene	79-01-6	4.80	95.9	year
Vanadium	7440-62-2	0.00131	0.0263	day
Vinyl chloride	75-01-4	0.123	2.46	year

CAS = Chemical Abstracts Service
SQER = small quantity emission rate

If de minimis and SQER values were exceeded, the constituent was further screened (Calculation 382519-CALC-033[2]; Calculation 382519-CALC-048[3]). The integrated mass balance calculation applies best available control technology for toxics to the remaining constituents (Calculation 382519-CALC-050). After application of the best available control technology for toxics, the value was compared to the SQER for each TAP. If the emissions were lower than the SQER, no further air quality impact analysis was conducted. The comparison of emission rates to the SQERs is presented in Table C-2.

Table C-2. Comparison of Emission Rates to Small Quantity Emission Rates

Pollutant	Daily Emission Rate (lb/day)	Averaging Period	SQER (lb/averaging period)	Emission Rate (lb/averaging period)	Modeling Required
Carbon tetrachloride	7.90E-02	year	4.57	3.03E+01	Yes
Trichloroethene	1.47E-04	year	95.9	5.71E-02	No
1,1,1-TCA	1.08E-03	24 hours	131	1.12E-03	No
1,2-DCA	6.93E-04	year	7.39	2.60E-01	No
Benzene	3.92E-03	year	6.62	1.48E+00	No
Acetone	1.81E-04	N/A	N/A	N/A	No
Chloroform	6.00E-01	year	8.35	2.27E+02	Yes
DBCM	5.69E-04	year	7.1	2.13E-01	No
Methylene chloride	1.11E-01	year	192	41.98E+00	No
1,1-Dichloroethylene	6.36E-04	24 hours	26.3	6.71E-04	No
Vinyl chloride	1.86E-02	year	2.46	7.15E+00	Yes

N/A = not applicable; this pollutant not listed as a toxic air pollutant in WAC 173-460
SQER = small quantity emission rate

[2] Calculation 382519-CALC-033, 2010, *Estimated Influent Concentrations of Constituents of Interest for Mass Balance*, Rev. 4, CH2M HILL, Denver, Colorado.
[3] Calculation 382519-CALC-048, 2010, *Supplemental Mass Balance*, Rev. 1, CH2M HILL, Denver Colorado.

If the expected emissions were above the SQER, ambient air quality modeling was completed (Calculation 382519-CALC-053[4]). Modeling was performed according to the procedures identified in 40 CFR 51, "Requirements for Preparation, Adoption, and Submittal of Implementation Plans," Appendix W, "Guideline on Air Quality Models." WAC 173-460 requires that new stationary sources that have the potential to emit TAPs demonstrate that the TAP emissions would be sufficiently low to protect human health and safety from potential carcinogenic and/or other toxic effects. The EPA-approved model, TSCREEN Model Version 95250, was used to calculate maximum ambient concentrations of TAPs that are expected to exceed the SQER values.

Concentrations from the ambient air quality analysis are compared to the ASIL to demonstrate compliance with WAC 173-460. The model output from the TSCREEN model is the maximum 1-hour concentration at the ambient boundary (nearest distance to State Route 240) in $\mu g/m^3$. Plant emissions are from a single stack.

Recommended EPA persistence factors from *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised* (EPA-454/R-92-019) were applied to the maximum 1-hour concentration at the ambient boundary to estimate the concentrations for the desired averaging period results. The persistence factor is 0.08 for an annual averaging period, which applies to the TAPs modeled.

$$(0.0149\ \mu g/m^3)(0.08) = 0.0012\ \mu g/m^3$$

Table C-3 presents the model results compared to the applicable standards. Model results show no TAPs that would exceed the applicable ASIL.

Table C-3. Comparison of Concentrations to Acceptable Source Impact Level

Pollutant	Maximum 1-Hour Concentration ($\mu g/m^3$)	Annual Average Concentration ($\mu g/m^3$)	Annual Acceptable Source Impact Level ($\mu g/m^3$)
Carbon tetrachloride	0.0149	0.0012	0.0238
Chloroform	0.1120	0.0090	0.0435
Vinyl chloride	0.0035	0.0003	0.0128

Plant emissions were estimated for a single stack. Model results show that carbon tetrachloride, chloroform, and vinyl chloride would not exceed their applicable ASIL.

C3 Emission Controls

Highly efficient IX columns are being used at the 200 West P&T to remove technetium-99 and iodine-129. Purolite[5] A530E resin was selected for technetium-99 removal based on treatability testing conducted in the 200-ZP-1 OU in 2007. Iodine-129 is also expected to be removed by the Purolite A530E resin. Dowex[6] 21K resin was selected for future uranium removal based on its highly successful performance for remediation of uranium contaminated groundwater at DOE's Fernald site in Ohio. Other resins may be used if treatability testing reveals comparable or better performance. An anaerobic FBR is being used to remove nitrate, metals, and carbon tetrachloride. An aerobic membrane bioreactor is being

[4] Calculation 382519-CALC-053, 2010, *Air Emissions Modeling*, Rev. 1, CH2M HILL, Denver, Colorado.

[5] Purolite® is a registered trademark of The Purolite Company, Bala Cynwyd, Pennsylvania.

[6] Dowex® is a registered trademark of the Dow Chemical Company, Midland, Michigan.

used to remove residual carbon substrate, total suspended solids, biomass, and carbon tetrachloride. A packed bed tower air stripper is being used to remove the remaining carbon tetrachloride and other volatile organic compounds. Off-gas from the stripper, FBR, membrane bioreactor, and waste sludge thickener are comingled and treated by GAC prior to discharge via powered exhaust. The biomass sludge is treated with lime to reduce odors and ammonia, and a scrubber is used to remove ammonia. A bag-house (or equivalent) is used to reduce lime particulate.

Tritium, which is bound with the groundwater, is removed with water vapor in a demister located upstream from the GAC treatment unit, and it is comingled with the treated groundwater prior to injection back into the aquifer.

C4 Monitoring

Quarterly sampling will occur for annual determination of compliance with SQERs and ASILs. Grab samples will be collected in each stack. Additional modeling to confirm compliance with ASILs would be completed only if needed and if emissions are higher than previously calculated/modeled.

Periodic confirmatory measurement will be used to confirm low radiological air emissions. This will consist of engineering calculations combined with the Hanford Site Near-Facility Monitoring Program results. The existing near-facility monitoring network will be used. The nearest air monitors are N161, N304, N975, and N987. EPA will be informed if any air sample exceeds 10 percent of the values listed in 40 CFR 61, Appendix E, Table 2, as measured by the Hanford Site near-facility ambient air monitors.

C5 References

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WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-480.

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Appendix D

200 West Pump and Treat Sampling and Analysis Plan

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Terms

AMP	air monitoring plan
CAS	Chemical Abstracts Service
CHPRC	CH2M HILL Plateau Remediation Company
COC	contaminant of concern
DOE	U.S. Department of Energy
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
EB	equipment rinsate blank
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FBR	fluidized bed reactor
FTB	field trip blank
FXR	field transfer blank
GAC	granular activated carbon
gpm	gallons per minute
HEIS	Hanford Environmental Information System
IC	ion chromatography
ICP	inductively coupled plasma
IX	ion exchange
MCL	maximum contaminant level
MDL	method detection limit
N/A	not applicable
O&M	operations and maintenance
OU	operable unit
P&T	pump and treat
PMP	performance monitoring plan
QA	quality assurance
QAPjP	quality assurance project plan

QC	quality control
RCT	radiological control technician
RDL	required detection limit
ROD	Record of Decision
RPD	relative percent difference
SAP	sampling and analysis plan
TDS	total dissolved solids
TOC	total organic carbon
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSS	total suspended solids
VOA	volatile organic analysis
VOC	volatile organic compound
VPGAC	vapor-phase granular activated carbon
WMP	waste management plan

D1 Introduction

This sampling and analysis plan (SAP) has been prepared to support the 200 West pump and treat (P&T) remedial action for the 200-ZP-1 Groundwater Operable Unit (OU). The 200 West P&T is a principal component of the selected remedy presented in the Record of Decision (ROD) for the OU (*Record of Decision, Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington* [EPA et al., 2008]). The system was operational in 2012. This SAP supersedes all previous monitoring plans for the 200 West P&T.

The 200 West P&T is designed to extract contaminated groundwater from the 200-ZP-1 OU. The extracted groundwater is treated to reduce the concentrations of carbon tetrachloride, trichloroethene, total chromium (trivalent and hexavalent), nitrate, iodine-129, technetium-99, and other constituents. Extracted groundwater, treated to the levels identified in the ROD, is then injected back into the aquifer. The 200 West P&T system will be expanded in the future to treat contaminated groundwater from the adjacent 200-UP-1 Groundwater OU to remove uranium.

The focus of this SAP is the characterization of the untreated groundwater streams entering the treatment facility, the treated groundwater leaving the facility, and the waste streams requiring disposal. Samples will be tested for the contaminants of concern (COCs) specified in the ROD. Atmospheric discharge of volatile organic compounds (VOCs) will also be monitored according to the air monitoring plan (AMP) (included as Appendix C of this operations and maintenance [O&M] plan). This SAP does not include routine sampling, analysis, or related process control measurements on materials and flow streams contained wholly within the treatment facility. Process control measurements are covered under other O&M documents.

The effect of the 200 West P&T on the 200-ZP-1 Groundwater OU is monitored as described in *Performance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action* (DOE/RL-2009-115), and the performance monitoring plan (PMP) for the 200-ZP-1 groundwater OU remedial action ("200 West Pump and Treat Groundwater Sampling and Analysis Plan," which is included as Appendix E of this O&M plan).

The following documents were used to prepare this SAP:

- "Compliance Matrix for the 200 West Pump and Treat" (Appendix A of this O&M plan)
- "Waste Monitoring Plan for the 200 West Pump and Treat" (Appendix B of this O&M plan)
- "Air Monitoring Plan for the 200 West Pump and Treat" (Appendix C of this O&M plan)
- *200 West Area 200-ZP-1 Pump-and-Treat Remedial Design/Remedial Action Work Plan* (DOE/RL-2008-78)
- *Performance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action* (DOE/RL-2009-115; Appendix E of this O&M plan))
- *Record of Decision, Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington* (EPA et al., 2008)
- Design documents (which include descriptions and the engineering design of the P&T process for the 200-ZP-1 OU)

The specific objectives of the SAP are to facilitate the following:

- Provide a schedule for sampling and analysis of 200 West P&T untreated influent water, treated effluent water, and process waste streams to meet the waste management plan (WMP) (Appendix B) and injected water (Appendix E) analytical data requirements
- Supply data needed for periodic evaluation of P&T system performance and process efficiency based on a calculated mass balance
- Monitor atmospheric discharge of VOCs from unit operations and storage tanks within the main treatment facility (Appendix C)

D1.1 Operations

The 200 West P&T currently treats groundwater from 18 extraction wells, and 14 injection wells receive the treated water. Extraction and injection wells will be added in the future as needed. The installed design capacity of the 200 West P&T is 9,464 L/min (2,500 gallons per minute [gpm]) with two parallel treatment trains. The treatment facility's design includes provisions for a third treatment train for a total design capacity of 14,195 L/min (3,750 gpm). The need for additional treatment capacity will be determined based on well field performance for the 200-ZP-1 OU and the amount of groundwater that may be generated as part of the remedy for the 200-UP-1 OU.

D1.2 Description of Unit Operations

The following descriptions of the basic unit operations within the 200 West P&T provide the basis for identifying the waste streams and other sampling points to meet the objectives of this SAP. The descriptions are taken from engineering design documents.

D1.2.1 Uranium Ion Exchange

Groundwater from 200-UP-1 OU will be pre-treated using ion-exchange (IX) resin (future addition) to reduce uranium concentrations. Incoming groundwater will be sent through bag filters to remove fine particulate matter. Filtered water flows to the IX columns containing a resin with a demonstrated ability to reduce uranium concentrations. The IX effluent will flow through bag filters serving as a resin trap to the technetium-99 IX treatment system. The IX resin, once fully loaded, will be disposed.

D1.2.1 Technetium-99 Ion Exchange

Groundwater from extraction wells in the 200-ZP-1 OU and the 200-UP-1 OU (after uranium pre-treatment), which contains technetium-99 activity greater than 900 pCi/L, is pre-treated separately with IX resin to reduce the technetium-99 activity to less than 900 pCi/L.

Influent groundwater will be sent through bag filters to remove fine particulate matter. The filtered water then flows to the IX columns (up to three in series) containing Purolite[1] A530E resin (or similar substitute), which has demonstrated ability to reduce technetium-99 concentrations. The IX effluent will flow through bag filters that serve as a resin trap and then to the main treatment facility for further treatment.

When the IX resin reaches its loading limit, it will be removed from the column. The loaded resin is sluiced with treated water and moved into a carbon tetrachloride stripping tank. In the stripping tank, the resin is submerged in treated water and heated to a temperature of approximately 71°C (160°F). Air is

[1] Purolite® is a registered trademark of The Purolite Company, Bala Cynwyd, Pennsylvania.

then bubbled through the resin to mix the bed and strip off the carbon tetrachloride. The vapor emission is treated with small vapor-phase granular activated carbon (VPGAC) adsorbers. After treatment, the stripping water is pumped to the influent side of the main treatment facility for treatment. The resin is sluiced with treated water to a roll-off container to allow drainage. The drainage is collected and pumped to the bag filters at the end of the technetium-99 IX system. The spent resin is sampled and analyzed to determine if it meets waste acceptance criteria and, if so, is disposed at the Environmental Restoration Disposal Facility (ERDF). Waste resin that does not meet ERDF waste acceptance criteria will be evaluated for additional treatment at an onsite or offsite facility. Appendix B contains additional information on waste handling.

D1.2.2 Main Treatment Facility

Water from the technetium-99 IX treatment system flows to the main treatment facility's equalization tank where it is blended with extracted groundwater from the remainder of the well field. From the equalization tank, the water is sent to the fluidized bed reactor (FBR) for removal of nitrate, VOCs, metals (including chromium), and other contaminants. The FBR is operated under anoxic condition (i.e., no dissolved oxygen) where heterotrophic facultative bacteria reduce nitrate to nitrogen gas (i.e., denitrification). Water is pumped into the bottom of the FBR, creating an upflow pattern to suspend the granular activated carbon (GAC) media to which the microorganisms attach. The FBR is seeded with microbes suited for nitrate removal and carbon tetrachloride degradation.

The effluent from the FBR flows by gravity to covered membrane filtration tanks for removal of residual carbon substrate and total suspended solids, including biomass carryover from the FBR. The membrane tanks have aeration capacity to provide the oxygen needed for the aerobic biological process.

The treated water from the membranes is pumped to a packed bed tower air stripper for removal of the remaining carbon tetrachloride and other VOCs. Off-gas from the stripper, influent equalization tank, FBR(s), membrane tanks, sludge holding tank(s), rotary drum thickeners, and centrifuges is combined and treated by VPGAC.

Solids from the membrane filter tanks are pumped to rotary drums for sludge thickening. The thickened solids are periodically pumped from the sludge holding tank to centrifuges for dewatering.

D1.2.3 Additional Vapor-Phase Granular Activated Carbon Requirements

The VPGAC train that serves the air stripper(s) also receives off-gas from the equalization tank, the FBR(s), membrane tanks, sludge holding tank(s), recycle tank, rotary drum thickeners, stripping tank(s), and centrifuges. The storage tanks in Extraction Transfer Buildings 1, 2 and 3 are fitted with separate VPGAC absorbers.

D1.3 Waste Streams

Table D-1 lists the individual waste streams associated with the unit processes described above, as well as brief descriptions of the principal expected contaminants.

D1.4 Sampling Points

For the purpose of this SAP, sampling points reflect the entry or exit of untreated water, treated water, and wastes from the treatment facilities. The sampling points fall into five general categories, as described in the following subsections. Requirements for characterizing and designating waste streams are addressed in the WMP (Appendix B).

Table D-1. 200 West Pump and Treat Waste Streams

Waste Stream	Contaminants
Uranium Ion-Exchange System (Future)	
Inflow bag filters	Fine mineral particulates
Outflow bag filters	Uranium-bearing resin particles and possible VOCs
Dewatered loaded resin	Uranium and VOCs
Loaded GAC (uranium system stripping tank)	Carbon tetrachloride and trichloroethene
Technetium-99 Ion-Exchange System	
Inflow bag filters	Fine mineral particulates
Outflow bag filters	Technetium-99-bearing resin particles and possible VOCs
Dewatered loaded resin	Technetium-99, possible VOCs, and traces of iodine-129 and uranium
Loaded GAC (technetium-99 system stripping tank)	Carbon tetrachloride and trichloroethene
Fluidized Bed Reactor/Aeration Filters	
Dewatered sludge	Carbon (GAC), biomass, and inorganic particulates
Air Stripper	
Loaded GAC	Carbon tetrachloride and trichloroethene
Extraction Transfer Building Storage Tanks	
Loaded GAC	Carbon tetrachloride and trichloroethene

GAC = granular activated carbon
OU = operable unit
VOC = volatile organic compound

D1.4.1 Well Field Extraction and Injection Streams

Well field operations include untreated groundwater from extraction wells and treated groundwater injected into the aquifer. Incoming flow from the extraction wells to the treatment facilities occurs as three separate flow streams, while the outgoing flow of treated water returned to the aquifer is considered a single flow stream. Specific sampling points to the treatment facilities include the following:

- Well field inflow from extraction wells
  - Inflow to uranium pre-treatment IX system from the 200-UP-1 OU wells (future)
  - Inflow to the technetium-99 pre-treatment IX system directly from wells not requiring uranium pre-treatment and wells requiring uranium pre-treatment (future)
  - Balance of well field inflow (requiring no uranium or technetium-99 pre-treatment)
- Treated water directed to injection wells

D1.4.2 Air Emissions Stacks

The VPGAC trains remove VOCs from the air. Air emission stacks from each VPGAC train discharge directly to the atmosphere. The performance of the VPGAC trains must be verified by monitoring carbon tetrachloride, trichloroethene, and other VOC contaminants potentially present as described in the AMP (Appendix C). The discharge stacks include the following:

- Main VPGAC stack from air stripper and other plant sources (as described earlier)
- Extraction Transfer Buildings 1, 2, and 3 holding tank VPGAC stacks

D1.4.3 Process Waste Streams

Waste streams destined for disposal at the ERDF are batch sampled and characterized for waste designation prior to disposal:

- Loaded uranium IX resin (future)
- Loaded technetium-99 IX resin
- FBR/aeration filter sludge

The loaded GAC with carbon tetrachloride, trichloroethene, etc., from the main VPGAC train is sampled and analyzed (Section D3.5) and then shipped to an offsite regeneration facility.

D1.4.4 Miscellaneous Waste

Bag filters used to prevent particulates from the well field inflow from entering the IX columns are handled as miscellaneous waste. Bag filters used as resin traps are handled similarly on the assumption that the trapped mass of resin is minimal.

D1.5 Untreated Water Quality

Initial COC concentration estimates for the untreated groundwater entering the treatment facilities are presented in Table D-2. This information is based on historical groundwater sampling and analysis from selected monitoring wells in the 200-ZP-1 and 200-UP-1 OUs.

D1.6 Treated Water Quality

The 200 West P&T is designed to meet or exceed the requirements of the ROD (EPA et al., 2008) for the treated (effluent) water injected back into the aquifer. The treated water quality standards, shown in Table D-3 and specified in the ROD, reflect federal and state drinking water maximum contaminant levels and state groundwater cleanup standards (where more stringent that the maximum contaminant levels) that are the applicable or relevant and appropriate requirements for the selected remedy (EPA et al., 2008). The design treatment goals in Table D-3 are more conservative than the ROD cleanup levels to provide operational margins during periods of stressed or transient operation.

Table D-2. Estimated Influent Water Quality to Unit Processes

Analyte	Uranium Pre-Treatment	Technetium-99 Pre-Treatment	Main Treatment Facility
COCs[a]			
Carbon tetrachloride	365 µg/L	491 µg/L	661 µg/L
Trichloroethene	3.6 µg/L	3.2 µg/L	4.1 µg/L
Chromium (total)	8.3 µg/L	159 µg/L	47 µg/L
Hexavalent chromium	8.3 µg/L	161 µg/L	47 µg/L
Nitrate as nitrogen	320 mg/L	69 mg/L	40 mg/L
Radionuclide COCs[a]			
Iodine-129	1.3 pCi/L	0.86 pCi/L	0.27 pCi/L
Technetium-99	9,050 pCi/L	14,700 pCi/L	273 pCi/L
Tritium	6,480 pCi/L	23,800 pCi/L	9,250 pCi/L
Other Constituents[b]			
Uranium	570 µg/L	5.9 µg/L	3.6 µg/L
Alkalinity (as $CaCO_3$)	108 mg/L	103 mg/L	110 mg/L
Calcium	276 mg/L	75 mg/L	69 mg/L
Chloride	107 mg/L	18 mg/L	20 mg/L
Chloroform	0.007 mg/L	0.025 mg/L	0.041 mg/L
Fluoride	0.48 mg/L	0.37 mg/L	0.35 mg/L
Iron (dissolved)	0.98 mg/L	0.19 mg/L	0.25 mg/L
Magnesium	89 mg/L	24 mg/L	21 mg/L
Manganese (dissolved)	0.035 mg/L	0.049 mg/L	0.084 mg/L
Potassium	12 mg/L	7 mg/L	5 mg/L
Sodium	43 mg/L	24 mg/L	21 mg/L
Sulfate	73 mg/L	34 mg/L	37 mg/L
Total organic carbon	1.3 mg/L	1.3 mg/L	1.6 mg/L
Total suspended solids	5.0 mg/L	3.0 mg/L	1.9 mg/L
Total dissolved solids	2,150 mg/L	614 mg/L	484 mg/L

Notes: The COCs listed in this table are those identified in the ROD (EPA et al., 2008). The other constituents are identified as those of interest in the PMP. Concentrations are based on estimates included in engineering design documents.

a. Concentrations for COCs represent the expected maxima except for total chromium, which is a 5-year average.

b. Concentrations for other constituents are 5-year averages except for uranium, which represents the expected maximum.

COC = contaminant of concern

PMP = performance monitoring plan

ROD = Record of Decision

Table D-3. Treated Water Quality Requirements and Treatment System Design Goals

Parameter	Where Measured	Treated Water Quality Standards		Acceptance Standard Description	Design Treatment Goal
		Value	Unit		
Carbon tetrachloride*	Pipeline to injection wells	3.4	µg/L	Specified by ROD	2 µg/L
Trichloroethene*	Pipeline to injection wells	1	µg/L	Specified by ROD	0.6 to 1 µg/L
Chromium (total)	Pipeline to injection wells	100	µg/L	Federal MCL	60 to 100 µg/L
Hexavalent chromium	Pipeline to injection wells	48	µg/L	Specified by ROD	29 to 48 µg/L
Nitrate as nitrogen	Pipeline to injection wells	10,000	µg/L	Federal MCL	2,000 µg/L
Iodine–129	Pipeline to injection wells	1	pCi/L	Federal MCL	0.6 to 1 pCi/L
Technetium–99	Pipeline to injection wells	900	pCi/L	Federal MCL	540 pCi/L
Tritium	Pipeline to injection wells	20,000	pCi/L	Federal MCL	12,000 to 20,000 pCi/L

* DOE will clean up contaminants of concern for the 200-ZP-1 Operable Unit subject to WAC 173-340, "Model Toxics Control Act—Cleanup," which includes carbon tetrachloride and trichloroethene, so the excess lifetime cancer risk does not exceed 1×10^{-5} at the conclusion of the remedy.

DOE = U.S. Department of Energy

MCL = maximum contaminant level

ROD = Record of Decision

D1.7 Air Emissions Quality

The treatment facility requires emissions control for off-gases from the equalization tank, air stripper(s), FBR(s), membrane tanks, sludge holding tank(s), recycle tank, rotary drum thickeners, and centrifuges. Preliminary estimates of air emissions toxicity values indicated that the off-gas treatment system would require a minimum capture rate of 94 percent to meet the proposed local air emission limit for carbon tetrachloride. Table D-4 presents the modeled ambient emission levels and acceptable concentration limits for three volatile organics. Additional information is provided in the AMP (Appendix C).

Table D-4. Comparison of Concentrations to Acceptable Source Impact Level

Pollutant	Maximum Ambient Concentration ($\mu g/m^3$)	Acceptable Source Impact Level ($\mu g/m^3$)
Carbon tetrachloride	0.0017	0.0238
Chloroform	0.0127	0.0435
Vinyl chloride	0.0004	0.0128

D1.8 Data Needs

The 200 West P&T is an engineered system designed to remove contaminants from groundwater, to return the treated water to the aquifer, and to segregate and contain the mass of contaminants removed from the water for eventual disposal. For the purposes of this SAP, the data needs may be summarized as the body of measurements required to characterize the mass/volume of influent water and COCs entering the treatment facility, and the treated water and separate waste streams exiting the treatment facility (total effluents). This body of measurements serves to independently evaluate treatment system performance to determine if treatment objectives and quality requirements for water injection are met. Additional characterization to support waste designation may be required in accordance with the WMP (Appendix B).

Some trace constituents in the 200-ZP-1 OU that are not included in Table D-2 may become concentrated in some waste streams (e.g., by sorption onto IX resins or onto the GAC/biomass sludge from the main treatment facility). These other constituents shown in Table D-2 are also considered for waste designation.

D1.9 Sampling Design

The sampling design is systematic and intended to verify reported treatment system performance and compliance with the requirements in the 200-ZP-1 OU ROD (EPA et al., 2008) for treated water quality. The sampling design relies neither on statistical interpretation nor on professional expertise. The measurements are a subset of those measurements needed to operate and control the treatment facility.

D1.10 Reporting Requirements

The sample collection and laboratory analysis results obtained under this SAP are reported in periodic briefings and in the performance monitoring reports, as described in the O&M plan.

D2 Quality Assurance Project Plan

The quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including planning, implementation, and assessment of sampling, field measurements, and laboratory analysis. This QAPjP complies with the requirements of the following:

- 10 CFR 830, Subpart A, "Quality Assurance Requirements"
- DOE O 414.1D, *Quality Assurance*
- *Hanford Analytical Services Quality Assurance Requirements Documents* (DOE/RL-96-68)

- *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA/240/B-01/003)

Sections 6.5 and 7.8 of the *Hanford Federal Facility Agreement and Consent Order Action Plan* (Tri-Party Agreement Action Plan) (Ecology et al., 1989b) require the quality assurance (QA)/quality control (QC) and sampling and analysis activities to specify the QA requirements for treatment, storage, and disposal units, as well as for past-practice processes. Therefore, this QAPjP follows the QA elements of EPA/240/B-01/003. This QAPjP demonstrates conformance to Part B requirements of *Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs* (ANSI/ASQC E4-2004).

In addition to the requirements cited above, *Intergovernmental Data Quality Task Force, Uniform Federal Policy for Quality Assurance Project Plans, Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs, Part 1: UFP-QAPP Manual* (EPA-505-B-04-900A) was also used as a resource for identification of QAPjP elements. EPA-505-B-04-900A is not imposed through the Tri-Party Agreement Action Plan (Ecology et al., 1989b); however, it is a valuable resource and provides comprehensive information on the treatment of quality elements that should be addressed in a SAP. It was also designed to be compatible with EPA/240/B-01/003, which forms the basis for this QAPjP.

This QAPjP is divided into the following four sections that describe the quality requirements and controls applicable to this investigation:

- Section D2.1, Project Management
- Section D2.2, Data Generation and Acquisition
- Section D2.3, Assessment and Oversight
- Section D2.4, Data Validation and Usability

D2.1 Project Management

CH2M HILL Plateau Remediation Company (CHPRC), the contractor, or its approved subcontractor is responsible for planning, coordinating, sampling, preparing, packaging, and shipping samples to the laboratory. The project organization (in regard to sampling and characterization) is described in the main text (Chapter 2) of the O&M plan.

D2.1.1 Problem Definition/Background

Sampling under this SAP will be confined to monitoring the 200 West P&T and to characterizing the associated waste streams.

D2.1.2 Project/Task Description

Field sampling (i.e., internal to the P&T system) will not be conducted under this SAP. All sampling will occur within the engineered system for the purpose of operation and compliance monitoring.

D2.1.3 Quality Objectives and Criteria

The QA objective of this plan is to develop implementation guidance providing data of known and appropriate quality. Data quality indicators (DQIs) describe data quality by evaluation against identified data quality objectives (DQOs) and the work activities identified in this SAP. The applicable QC guidelines, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method. The principal DQIs are precision, bias or accuracy, representativeness, comparability, completeness, and sensitivity. These DQIs are defined for the

purposes of this document in Table D-5. The DQIs will be evaluated during the data quality assessment (DQA) process (Section D2.4.3).

Quality objectives and project-specific measurement requirements are presented in Table D-6 for untreated and treated water.

D2.1.4 Special Training/Certification

A graded approach is used to ensure that workers receive a level of training commensurate with their responsibilities and that complies with applicable U.S. Department of Energy (DOE) orders and government regulations. The field work supervisor, in coordination with the CHPRC project manager, will ensure that special training requirements for field personnel are met.

Typical training requirements or qualifications have been instituted by the contractor's management team to meet training requirements imposed by the contract, regulations, DOE orders, DOE contractor requirement documents, American National Standards Institute/American Society of Mechanical Engineers, and the *Washington Administrative Code*. For example, the environmental, safety, and health training program provides workers with the knowledge and skills necessary to safely execute assigned duties. Field personnel typically have completed the following training before starting field work:

- Occupational Safety and Health Administration 40-Hour Hazardous Waste Worker Training and supervised 24-hour hazardous waste site experience
- 8-Hour Hazardous Waste Worker Refresher Training
- CHPRC General Employee Training
- Radiological Worker Training (as required)

Project-specific safety training, intended specifically for the project and the day's activities, is provided, and includes the following:

- Training requirements or qualifications needed by sampling personnel will be in accordance with QA requirements.
- Samplers are required to have training and/or experience in the type of sampling being performed in the field.
- Qualification requirements for radiological control technicians (RCTs) are established by the Radiation Protection Program. The RCTs assigned to these activities will be qualified through the prescribed training program and will undergo ongoing training and qualification activities.

Table D-5. Data Quality Indicators

Data Quality Indicators	Definition	Example Determination Methodologies	Project-Specific Information*	Corrective Actions
Precision	The measure of agreement among repeated measurements of the same property under identical or substantially similar conditions; calculated as either the range or as the standard deviation. May also be expressed as a percentage of the mean of the measurements such as relative range, relative percent difference, or relative standard deviation (coefficient of variation).	Use the same analytical instrument to make repeated analyses on the same sample. Use the same method to make repeated measurements of the same sample within a single laboratory, or have two or more laboratories analyze identical samples using the same method. Split a sample in the field and submit both for sample handling, preservation and storage, and analytical measurements. Collect, process, and analyze co-located samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	**Field precision:** At randomly selected locations, duplicate samples will be taken one per 20 samples per media. **Laboratory precision:** Analysis of laboratory duplicate or matrix spike duplicate. Note if any of the samples or analyses are more or less critical than the others in determining follow-up actions.	If duplicate data do not meet objectives: • Evaluate apparent cause (e.g., sample heterogeneity) • Request reanalysis or re-measurement • Qualify the data before use
Accuracy	A measure of the overall agreement of a measurement to a known value; includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations.	Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (i.e., a spiked sample); usually expressed either as percent recovery or as a percent bias.	Laboratory accuracy determination based on matrix spikes and matrix spike duplicates. Note if any of the samples or analyses are more or less critical than the others in determining follow-up actions.	If recovery does not meet objectives: • Qualify the data before use • Request reanalysis or re-measurement

Table D-5. Data Quality Indicators

Data Quality Indicators	Definition	Example Determination Methodologies	Project-Specific Information*	Corrective Actions
Representativeness	A qualitative term to express "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" (ANSI/ASQC E4-2004).	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.	Samples will be collected as described in the sampling design. Judgment sampling ensures that areas most likely to be contaminated (based on current information) will be evaluated. Random sampling is based on ensuring that all members of the population are equally likely to be chosen and allows probability statements to be made about the quality of estimates derived from the data. Note if any of the samples or analyses are more or less critical than the others in determining follow-up actions.	If results are not representative of the system sampled: • Identify the source of the non-representation • Reject the data, or, if data are otherwise usable, qualify the data for limited use and define the portion of the system that the data represent • Redefine sampling and measurement requirements and protocols • Resample and reanalyze
Comparability	A qualitative term expressing the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made.	Compare sample collection and handling methods, sample preparation and analytical procedures, holding times, stability issues, and quality assurance protocols.	Sampling personnel will use the same sampling protocols. Samples will be submitted to the same laboratories when possible (based on laboratory contracts) for analysis using the same methods, thus data results will be comparable. Note if any of the samples or analyses are more or less critical than the others in determining follow-up actions.	If data are not comparable to other data sets: • Identify appropriate changes to data collection and/or analysis methods • Identify quantifiable bias, if applicable • Qualify the data, as appropriate • Resample and/or reanalyze if needed • Revise sampling/analysis protocols to ensure future comparability

Table D-5. Data Quality Indicators

Data Quality Indicators	Definition	Example Determination Methodologies	Project-Specific Information*	Corrective Actions
Completeness	A measure of the amount of valid data needed to be obtained from a measurement system.	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).	The percent complete will be determined during data validation. Note if any of the samples or analyses are more or less critical than the others in determining follow-up actions.	If data set does not meet completeness objective: • Identify appropriate changes to data collection and/or analysis methods • Identify quantifiable bias, if applicable • Qualify the data, as appropriate. • Resample and/or reanalyze if needed • Revise sampling/analysis protocols to ensure future comparability
Sensitivity	The capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest.	Determine the minimum concentration or attribute to be measured by a method (method detection limit), by an instrument (instrument detection limit), or by a laboratory (quantitation limit). The practical quantitation limit is the lowest level that can be routinely quantified and reported by a laboratory.	Ensure that sensitivity, as measured detection limits, is appropriate for the action levels. Note if any of the samples or analyses are more or less critical than the others in determining follow-up actions.	If sensitivity does not meet objectives: • Request reanalysis or re-measurement • Qualify/reject the data before use

Note: ANSI/ASCQ E4-2004, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use.*

* Field sampling requirements are noted. Laboratories will follow contract requirements for use and interpretation of laboratory control samples.

Table D-6. Analytical Performance Requirements for Untreated and Treated Water

CAS No.	Analyte	Method	RDL – Water	Precision	Accuracy
		COCs			
56-23-5	Carbon tetrachloride	Aromatic and halogenated VOA – 8260	2 µg/L	≤20%	80-120%
79-01-6	Trichloroethene		1 µg/L	≤20%	80-120%
14797-55-8	Nitrate	Anions by IC – 300.0	250 µg/L	≤20%	80-120%
18540-29-9	Hexavalent chromium	Chromium (hex) – 7196	10 µg/L	≤20%	80-120%
7440-47-3	Chromium (total)	ICP metals – 6010, 6020, or 200.8	10 µg/L	≤20%	80-120%
15046-84-1	Iodine-129	Iodine-129, low level	1 pCi/L	≤20%	80-120%
14133-76-7	Technetium-99	Technetium-99	15 pCi/L	≤20%	80-120%
10028-17-8	Tritium	Tritium (H-3)	400 pCi/l	≤20%	80-120%

CAS = Chemical Abstracts Service
COC = contaminant of concern
IC = ion chromatography
ICP = inductively coupled plasma
N/A = not applicable
RDL = required detection limit
VOA = volatile organic analysis

In addition, pre-job briefings will be performed to evaluate an activity and associated hazards by considering many factors, including the following:

- Objective of the activities
- Individual tasks to be performed
- Hazards associated with the planned tasks
- Controls applied to mitigate the hazards
- Environment in which the job will be performed
- Facility where the job will be performed
- Equipment and material required
- Safety procedures applicable to the job
- Training requirements for individuals assigned to perform the work
- Level of management control
- Proximity of emergency contacts

Training records are maintained for each employee in an electronic training records database. The contractor's training organization maintains the training records system. The field work supervisor or groundwater OU project manager confirms that an individual employee's training is appropriate and up-to-date prior to the employee performing any field work.

D2.1.5 Documents and Records

The groundwater OU project manager is responsible for ensuring that the current version of the SAP is being used and for providing any updates to field personnel. Version control is maintained by the administrative document control process. Significant changes to the SAP will be reviewed and approved by DOE and the lead regulatory agency prior to implementation. Table D-7 defines the types of changes that may be made to the sampling design and the documentation requirements.

Table D-7. Change Control for Sampling Projects

Type of Change	Action	Documentation
Temporarily adding constituents, locations, or increasing sampling frequency	Project management approval; notify regulatory agency point of contact, if appropriate	Project's schedule tracking system
Permanently adding constituents, locations, or increasing sampling frequency	Revise SAP; obtain regulatory approval; distribute plan	Letter report documenting changes or revised plan

SAP = sampling and analysis plan

The field work supervisor or buyer's technical representative is responsible for ensuring that field instructions are maintained and aligned with any revisions or approved changes to the SAP. The field work supervisor or buyer's technical representative will ensure that deviations from the SAP or problems encountered in the field are documented appropriately (e.g., in the field logbook or on nonconformance report forms) in accordance with internal corrective action procedures.

The groundwater OU project manager, field work supervisor, or designee is responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities.

Logbooks are required for field activities. 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. Logbooks will be signed by the field manager, supervisor, scientist/engineer, or other responsible individual. 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.

The project manager is responsible for ensuring that a project file is properly maintained. The project file will contain the records or references to their storage locations. The following will be included in the project file, as appropriate:

- Field logbooks or operational records
- Data forms
- Chain-of-custody forms
- Sample receipt records
- Inspection or assessment reports and corrective action reports
- Interim progress reports
- Final reports

- Laboratory data packages
- Verification and validation reports

The laboratory is responsible for maintaining, and having available upon request, the following:

- Analytical logbooks
- Raw data and QC sample records
- Standard reference material and/or proficiency test sample data
- Instrument calibration information

Records may be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes to ensure the accuracy and retrievability of stored records. Records required by the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989a) will be managed in accordance with the requirements therein.

D2.2 Data Generation and Acquisition

The following subsections address data generation and acquisition to ensure that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

D2.2.1 Sampling Process Design

The sampling design is systematic, where samples are taken at regular, specified intervals from specific locations at the treatment facility. No statistical analysis is needed for these samples, which are taken to monitor and/or confirm that the system is functioning correctly.

D2.2.2 Sampling Methods

Sampling is described in Section D3.5, and specific information includes the following:

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

D2.2.3 Sample Handling and Custody

A sampling and data tracking database is used to track the samples from the point of collection through the laboratory analysis process. Samplers should note any anomalies with a sample (e.g., sample appears unusual, sample is sludge, etc.) to prevent laboratory batching across similar matrices. If anomalies are found, the sampler should write "DO NOT BATCH" on the chain-of-custody form and inform the Sample Management and Reporting organization.

Laboratory analytical results are entered and maintained in the Hanford Environmental Information System (HEIS) database. The HEIS sample numbers are issued to the sampling organization for the project. Each chemical, radiological, and physical properties sample is identified and labeled with a unique HEIS sample number.

Specific sample handling information is provided in Section D3.7 and includes the following:

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

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

D2.2.4 Analytical Methods

Information on analytical methods is provided in Table D-6. These analytical methods are controlled in accordance with the laboratory's QA plan and the requirements of this QAPjP. Sample Management and Reporting participates in overseeing offsite analytical laboratories to qualify them for performing Hanford Site analytical work.

If the laboratory uses a nonstandard or unapproved method, then the laboratory must provide method validation data to confirm that the method is adequate for the intended use of the data. This includes information such as determination of detection limits, quantitation limits, typical recoveries, and analytical precision and bias. Deviations from the analytical methods noted in Table D-6 must be approved by the Sample Management and Reporting organization in consultation with the project manager.

Laboratories providing analytical services in support of this SAP will have a corrective action program in place that addresses analytical system failures and documents the effectiveness of any corrective actions. Issues that may affect analytical results are to be resolved by the Sample Management and Reporting organization in coordination with the project manager.

D2.2.5 Quality Control

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability. Field QC sampling includes the collection of field trip blank (FTB), field transfer blank (FXR), and field duplicate samples. Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table D-8.

D2.2.5.1 Field Quality Control Samples

Field QC samples are collected to evaluate the potential for cross-contamination, and to provide information pertinent to field sampling variability and laboratory performance. Field blanks are typically prepared using high-purity reagent water. The QC samples and the required frequency for collection are described in this subsection.

Table D-8. Project Quality Control Sampling Summary

Quality Control Sample Type	Purpose	Frequency
Field Quality Control		
Trip blank	Assess contamination from containers or transportation	One per 20 samples per media sampled. Volatile organic compound analyses only.
Field transfer blank	Assess contamination from sampling site	One per day when volatile organics are sampled per media sampled. Volatile organic compound analyses only.
Field duplicates	Estimate precision, including sampling and analytical variability	One per batch*; 20 samples maximum of each media sampled. Field duplicates are replicates of the samples taken at the time of sampling and associated analyses.
Equipment rinsate	Verify adequacy of sampling equipment decontamination	**Water and solids:** Minimum of one per 20 locations. If disposable equipment is used, then an equipment rinsate blank is not required. Volatile organic compound analyses only.
Laboratory Quality Control*		
Method blank	Assess response of an entire laboratory analytical system	One of each media sampled, up to a maximum of 20.
Matrix spike	Identify analytical (preparation + analysis) bias; possible matrix effect on the analytical method used	One of each media sampled, up to a maximum of 20.
Matrix duplicate or matrix spike duplicate	Estimate analytical bias and precision	One of each media sampled, up to a maximum of 20.
Laboratory control samples	Assess method accuracy	One per batch*, 20 samples maximum or as identified by the method guidance per media sampled.
Surrogates	Estimate recovery/yield	As identified by the method guidance.

* Batching across projects is allowed for similar matrices (e.g., Hanford Site groundwater).

- **Field trip blank (FTB):** FTBs are prepared by the sampling team prior to traveling to the sampling site. The preserved bottle set is either for volatile organic analysis (VOA) only or identical to the set that will be collected in the field. It is filled with reagent water or silica sand, as appropriate to the primary sample media. The bottles are sealed and will be transported, unopened, to the field in the same storage containers used for samples collected the same day. FTBs are typically analyzed for the same VOC constituents as the samples from the associated sampling event. FTBs are used to evaluate potential contamination of the samples attributable to the sample bottles, preservative, handling, storage, and transportation.

- **Field transfer blanks (FXR):** FXRs are preserved VOA sample bottles filled at the sample collection site with reagent water or silica sand (as appropriate to the primary sample media), transported to the field. The samples will be prepared during sampling to evaluate potential contamination attributable to field conditions. After collection, FXR bottles will be sealed and placed in the same storage containers with the samples collected the same day for the associated sampling event. The FXR samples will be analyzed for VOCs only.

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

- **Field duplicates:** Field duplicates are independent samples collected as close as possible to the same time and from the same location as the parent sample. Field duplicates are separate samples collected from the same source, placed in separate sample containers, and analyzed independently. Field duplicates should be collected from an area expected to have some contamination so valid comparisons between the samples can be made (i.e., some constituents will be greater than detection limit).

  Solid matrix field duplicate samples will be collected and homogenized before dividing into two separate samples in the field. VOA soil duplicates will be sampled as co-located samples (described below). Field duplicates will be stored and transported together and will be analyzed for the same constituents. The field duplicate samples will be used to determine precision for both sampling and laboratory measurements.

  Co-located samples are two samples collected as close as possible to the same time and location which are not homogenized. This sampling protocol is used when homogenizing samples for split or duplicate samples could impact the quality of data.

  Results of field duplicates must have precision within 20 percent, as measured by relative percent difference (RPD). Only field duplicates with at least one result greater than five times the MDL or minimum detectable activity will be evaluated. Evaluation of the results can provide an indication of intra-laboratory variability. Large RPDs can be an indication of potential laboratory performance problems and may be investigated.

- **Equipment rinsate blank (EB):** EBs are samples in which high-purity reagent water is passed through the sample collection tool or place in contact with the sampling surfaces of the equipment; the water is collected and transferred into appropriate containers. EB samples need only be collected from equipment that undergoes decontamination and is used for repeated sample collection. The EB sample bottles are placed in the same storage containers with the samples from the associated sampling event. The EB samples are analyzed for the same constituents as the samples from the associated sampling event and are used to evaluate the effectiveness of the cleaning process to ensure samples are not cross-contaminated from previous sampling events or between locations.

  High-purity water is Type II American Society for Testing and Materials organic-free water if samples for VOC inorganic and radionuclides analysis are being collected that day, or is certified deionized water if samples for only inorganic and radionuclide constituents are being collected. For EB type samples, laboratory results greater than twice the MDL may indicate the presence of cross-contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the threshold is five times the MDL. For

radiological analytical data, blank results are flagged if they are greater than two times the total minimum detectable activity.

D2.2.5.2 Laboratory Quality Control Samples

The laboratory QC samples (e.g., method blanks, laboratory control sample/blank spike, and matrix spike) are defined for the three-digit U.S. Environmental Protection Agency (EPA) methods (EPA/600/4-79/20, *Methods for Chemical Analysis of Water and Wastes*) and for the four-digit EPA methods (SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*), and will be run at the frequency specified in the respective reference unless superseded by agreement.

The QC checks outside of control limits will be reflected in the data validation process and during the DQA, if performed (described in Section D2.4).

D2.2.5.3 Quality Control Requirements

Table D-8 includes the field QC requirements for sampling. If VOC samples are not collected, then a FXR is not required. Field blanks are not required when transferring samples to the field gas chromatograph for analysis.

Field duplicates must agree within 20 percent, as measured by the RPD, to be acceptable. Only those field duplicates with at least one result greater than five times the appropriate detection limit are evaluated. Field duplicate results not satisfying evaluation criteria will be qualified and flagged in the HEIS database, as appropriate.

For chemical analyses, the control limits for laboratory duplicate samples, matrix spike samples, matrix spike duplicate samples, surrogate recoveries, and laboratory control samples are typically derived from historical data at the laboratories in accordance with SW-846. Typical control limits are within 20 percent of the expected values, although the limits may vary considerably depending upon the method and analyte. For radiological analyses, the control limits for laboratory QC samples are specified in the laboratory contract.

Holding time is the elapsed time 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 analytical method, as specified for three-digit EPA methods (EPA/600/4-79/020) or for the four-digit EPA methods (SW-846).

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The contract laboratories participate in national studies such as the EPA-sanctioned Water Pollution and Water Supply Performance Evaluation studies. The CHPRC Soil and Groundwater Remediation Project periodically audits the analytical laboratories to identify, resolve, and prevent quality problems. Audit results are used to improve performance. Summaries of audit results and performance evaluation studies are presented in the annual groundwater monitoring report.

Failure of QC will be determined and evaluated during data validation and DQA processes. Data will be qualified, and flagged in the HEIS database, as appropriate.

D2.2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Equipment used for collection, measurement, and testing will meet applicable standards (e.g., American Society for Testing and Materials) or will have been evaluated as acceptable and valid in accordance with the procedures, requirements, and specifications. The field work supervisor, field technical representative, or equivalent will ensure that the data generated from instructions using a software system are backed up

and/or downloaded on a regular basis. Software configuration will be acceptance tested prior to use in the field.

Measurement and testing equipment used in the field or laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures to ensure minimization of measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory and onsite organization's QA plan or operating procedures, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with the three-digit EPA methods (EPA/600/4-79/020) and four-digit EPA methods (SW-846), or with auditable DOE Hanford Site and contractual requirements. Consumables, supplies, and reagents will be reviewed per SW-846 requirements and will be appropriate for their use.

D2.2.7 Instrument/Equipment Calibration and Frequency

Specific field equipment calibration information is provided in Section D3.4. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory's QA plan.

D2.2.8 Inspection/Acceptance of Supplies and Consumables

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

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

D2.2.9 Data Management

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

Laboratory errors are reported to the Sample Management and Reporting organization on a routine basis. For reported laboratory errors, a sample issue resolution form will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish their resolution with the project manager. The sample issue resolution forms become a permanent part of the analytical data package for future reference and for records management.

Planning for sample collection and analysis will be in accordance with the programmatic requirements governing fixed laboratory sample collection activities, as discussed in the sampling procedures. In the event that specific procedures do not exist for a particular work evolution, or if it is determined that additional guidance is needed to complete certain tasks is needed, a work package will be developed to adequately control the activities, as appropriate. Examples of sampling procedure requirements include activities associated with the following:

- Chain of custody/sample analysis requests
- Project and sample identification for sampling services
- Control of certificates of analysis
- Logbooks
- Checklists
- Sample packaging and shipping

Approved work control packages and procedures will be used to document field activities, including radiological and nonradiological measurements, when this SAP is implemented. Field activities will be recorded in the field logbook.

D2.3 Assessment and Oversight

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

D2.3.1 Assessments and Response Actions

Contractor management, Regulatory Compliance, QA, and/or Health and Safety organizations may conduct random surveillances and assessments to verify compliance with the requirements outlined in this SAP, project work packages, the project quality management plan, procedures, and regulatory requirements. The project manager will determine whether a DQA will be performed for the activities identified in this SAP. The DQA process, if performed, is discussed in Section D2.4. The results of the DQA will be provided to the project manager. No other planned assessments have been identified.

If circumstances arise in the field dictating the need for additional assessment activities, then additional assessments would be performed. Deficiencies identified by these assessments will be reported in accordance with existing programmatic requirements. The project's line management chain coordinates the corrective actions/deficiencies in accordance with the contractor QA program, the corrective action management program, and associated procedures implementing these programs.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratories' QA plans. The contractor oversees offsite analytical laboratories and qualifies the laboratories for performing Hanford Site analytical work.

D2.3.2 Reports to Management

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

A DQA report will be prepared to determine whether the type, quality, and quantity of collected data met the quality objectives described in this SAP.

D2.4 Data Validation and Usability

The elements in data validation and usability address the QA activities occurring after the data collection phase of the project is completed. Implementation of these elements determines whether the data conform to the specified criteria, thus satisfying the project objectives.

D2.4.1 Data Review, Verification, and Validation

The criteria for verification include, but are not limited to, review for completeness (i.e., samples were analyzed as requested), use of the correct analytical method/procedure, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Laboratory personnel may perform data verification.

Data validation will be performed to ensure that the data quality goals established during the planning phase have been achieved. Data validation will be in accordance with internal procedures. The criteria for data validation are based on a graded approach. The primary contractor has defined five levels of validation (Levels A through E). Level A is the lowest level and is the same as verification. Level E is a 100 percent review of all data (e.g., calibration data, calculations of representative samples from the data set, etc.).

Data validation will be performed to contractor Level C. Level C validation consists of a review of the QC data and specifically requires verification of deliverables, requested versus reported analytes, and qualification of the results based on evaluation of analytical holding times, method blank results, matrix spike/matrix spike duplicate results, surrogate recoveries, and duplicate sample results. Level C data validation will be performed on at least 5 percent of the data by matrix and analyte group. "Analyte group" refers to categories such as radionuclides, volatile organic compounds, semivolatile organics, metals, and anions. The goal is to cover the various analyte groups and matrices during the data validation process.

Relative to analytical data in sample media, physical data and/or field screening results are of lesser importance in making inferences regarding risk. Physical data and field QA/QC results will be reviewed to ensure that physical property data and/or field screening results are usable.

D2.4.2 Verification and Validation Methods

Validation activities will be based on EPA functional guidelines. Data validation may be performed by the Sample Management and Reporting organization and/or by a party independent of both the data collector and the data user. Data validation qualifiers must be compatible with the HEIS database.

When outliers or questionable results are identified, additional data validation will be performed. The additional validation will be performed for up to 5 percent of the statistical outliers and/or questionable data. The additional validation will begin with Level C and may increase to Levels D and E, as needed, to ensure that the data are usable. Note that Level C validation is a review of the QC data, while Level D and Level E include review of calibration data and calculations of representative samples from the data set. Data validation results will be documented in data validation reports. An example of questionable data is a positive detection greater than the practical quantitation limit or reporting limit in soil from a site that should not have exhibited contamination. Similarly, results less than background would not be expected and could trigger a validation inquiry. The determination of data usability will be conducted and documented in a DQA report.

Data validation results will be documented in data validation reports which will be included in the project file.

D2.4.3 Reconciliation with User Requirements

The DQA process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine whether quantitative data are of the correct type and are of adequate quality and quantity

to meet the project requirements. The results of the DQA will be used in interpreting the data and determining if the objectives of this activity have been met.

D2.4.4 Corrective Actions

The responses to data quality defects identified through the DQA process will vary and may be data-or measurement-specific. Some pre-identified corrective actions are included in Section D2.1.4.

D3 Field Sampling Plan

The previous sections presented an overall description of the 200 West P&T facility design, the COCs, and project performance and quality requirements. This section provides additional detail regarding the schedule and performance of onsite activities.

D3.1 Site Background and Objectives

A description of the treatment system was provided as site background information in Section D1. In addition, waste streams, sampling points, and COCs were presented in Tables D-1 through D-4. Specific objectives of sampling plan presented here are to establish a sampling schedule, target analytes for individual sampling points, and procedural requirements for conducting and documenting field activities.

D3.2 Documentation of Field Activities

Logbooks or data forms are required for onsite activities. Requirements for the logbook are provided in Section D2.1.6. Data forms may be used to collect specific information; however, the data forms must follow the same requirements as those for logbooks presented below, and the data forms must be referenced in the logbooks. The following is a summary of information to be recorded in logbooks:

- Purpose of activity
- Day, date, time, and weather conditions, as appropriate
- Names, titles, and organizations of personnel present
- Deviations from the QAPjP or procedures
- All site activities, including field tests
- Materials quality documentation (e.g., certifications)
- Details of samples collected (e.g., preparation, splits, duplicates, matrix spikes, and blanks)
- Location and types of samples
- Chain-of-custody details and variances relating to chain-of-custody
- Field measurements
- Field calibrations and surveys and equipment identification numbers as applicable
- Equipment decontaminated, number of decontaminations, and variations to any decontamination procedures

- Equipment failures or breakdowns and descriptions of any corrective actions
- Telephone calls relating to field activities

D3.3 Sampling Design

The sampling design presented in this SAP is systematic. Samples associated with this SAP will be collected on a routine basis and at specified locations during treatment system operations.

D3.4 Calibration of Equipment

Field water quality parameters including pH, specific conductance, temperature, turbidity, dissolved oxygen, and oxidation-reduction potential will be measured and recorded when the untreated and treated water samples are collected (Sections D3.5.1 and D3.5.2). Portable air monitoring equipment (e.g., photoionization detector) may also be used during GAC changeout or during stack emissions sampling. The sampling lead is responsible for ensuring that portable equipment is calibrated appropriately. Field water quality instruments are calibrated in accordance with the manufacturer's operating instructions, internal work requirements and processes, and/or work packages that provide direction for equipment calibration or verification of accuracy by analytical methods. The results from instrument calibration activities are recorded in logbooks and/or work packages; either hardcopy or electronic versions will be maintained.

Calibrations must be performed as follows:

- Before initial use (start of project)
- At the frequency recommended by the manufacturer or procedure, or as required by regulations
- Upon failure to meet specified QC criteria

Instrument, calibration, and QA checks will be performed in accordance with the following:

- Calibration of radiological field instruments on the Hanford Site is performed by Pacific Northwest National Laboratory, as specified in its program documentation.
- Daily calibration checks are performed and documented for each instrument used to characterize the media being evaluated. These checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data. Measurement times will be sufficient to establish detection efficiency and resolution.

D3.5 Sample Location and Frequency

The physical locations for sampling untreated and treated water streams, air emissions, sludge, and loaded GAC and resin are expected to occur within the treatment system building or transfer buildings.

D3.5.1 Well Field Extraction and Injection Streams

Sampling of the extraction well field is currently performed quarterly. Target analytes are those COCs shown in Table D-2. At the time of collection, field parameters (including pH, specific conductance, temperature, turbidity, dissolved oxygen, and oxidation-reduction potential) are also measured and recorded.

The treated water stream sent to the injection well field is sampled monthly for the COCs listed in Table D-3. Depending on treatment system performance and untreated water characteristics, constituents may be added to or deleted from the analyte list with DOE and EPA concurrence.

D3.5.2 Air Emission Stacks

A gas sample of air emitted from each VPGAC stack will be collected quarterly and submitted for analysis of the VOCs listed in Table D-4. Field air monitoring using a photoionization detector may be performed and the measurements recorded during air emissions sampling.

D3.5.3 Process Waste Streams

D3.5.3.1 Loaded Granular Activated Carbon

Loaded GAC is batch sampled. The actual sampling schedule depends on the rate at which individual canisters become loaded and must be exchanged. Measurement of VOCs (per Table D-4) is performed to determine if the canisters may be shipped offsite. Assuming release for offsite shipping, the canisters will be shipped offsite for regeneration.

D3.5.3.2 Loaded Ion-Exchange Resin

Loaded IX resin is batch sampled. The actual sampling schedule depends on the loading rate and resin capacity. Analytes include the COCs from Table D-3. During startup or at major changes to well field operations, additional characterization for waste designation may be needed and will be determined on a case-by-case basis.

D3.5.3.3 Dewatered Sludge

The dewatered sludge from the aeration filters is batch sampled. Initially, the analytes are the COCs (except tritium), as shown in Table D-3. During startup or at major changes to well field operations, additional characterization for waste designation may be needed and will be determined on a case-by-case basis.

These sampling requirements are summarized in Tables D-9 and D-10.

Table D-9. Water and Air Sampling Requirements

Sampling Point	Analyses	Reference
Water Quality Analysis		
Untreated water to uranium IX system	COCs	Table D-2
Untreated water to technetium-99 IX system	COCs	Table D-2
Balance of well field inflow	COCs	Table D-2
Treated water	COCs	Tables D-2 and D-3
Air Quality Monitoring		
Main VPGAC stack	VOCs at VPGAC stacks	Table D-4
Extraction transfer buildings		

COC = contaminant of concern
IX = ion exchange
VOC = volatile organic compound
VPGAC = vapor-phase granular activated carbon

Table D-10. Waste Stream Batch Sampling and Analysis Requirements

Waste Type	Initial Waste Profile	Routine Batch Analysis
Loaded uranium IX resin	Table D-3 COCs and COPCs from DQO	COCs (except tritium)
Loaded technetium-99 IX resin	Table D-3 COCs and COPCs from DQO	COCs (except tritium)
Dewatered aeration filter sludge	Table D-3 COCs and COPCs from DQO	COCs (except tritium)
Loaded granular activated carbon	Table D-4 COCs and COPCs from DQO	VOCs from Table 1-4

COC = contaminant of concern
COPC = contaminant of potential concern
DQO = data quality objective (project-specific report as required by the waste management plan [Appendix B])
IX = ion exchange
VOC = volatile organic compound

D3.6 Sampling Methods

Ports for sampling untreated and treated water flow streams are specified and marked in the pre-treatment and main treatment facilities. Access to and operation of sample ports and valves will be controlled by plant operating procedures. Methods for practical collection of samples of resins, sludge, and loaded GAC will depend upon the physical characteristics of plant apparatus and will be included in the facility's operating procedures.

D3.6.1 Corrective Actions

The project lead, sampling lead, or designee must document deviations from procedures or other issues regarding sample collection, chain-of-custody, target analytes, contaminants of potential concern, sample transport, or other noncompliance. As appropriate, such deviations or issues will be documented in the field logbook or on nonconformance report forms in accordance with corrective action procedures.
The project lead, sampling lead, or designee will be responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to sampling activities.

D3.6.2 Decontamination of Sampling Equipment

Equipment used during sampling of resins, sludge, or loaded GAC will be decontaminated in accordance with the facility operating procedure. To prevent contamination of the samples, care should be taken to use clean or dedicated equipment for each 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 equipment or sample containers by setting the equipment/sample container on or near potential contamination sources
- Handling bottles or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling events

D3.6.3 Radiological Screening

Radiological screening of waste samples will be performed by the RCT or other qualified personnel. The RCT will record field measurements.

The following information will be disseminated to personnel performing work in support of this SAP:

- Instructions will be provided to RCTs on the methods required to measure sample activity and media for gamma, alpha, and/or beta emissions, as appropriate.
- Information regarding the Geiger-Müller, portable alpha meter, dual phosphors beta/gamma, and sodium iodide portable instruments will include a physical description of the instruments, radiation and energy response characteristics, calibration/maintenance and performance testing descriptions, and the application/operation of the instrument. These instruments are commonly used on the Hanford Site for obtaining measurements of removable surface contamination and direct measurements of total surface contamination.
- Information on the characteristics associated with the hand-held probes to be used in the performance of direct radiological measurements will include a physical description of the probe, the radiation and energy response characteristics, calibration/maintenance and performance testing descriptions, and the application/operation of the instrument. The hand-held probe is an alpha detection instrument commonly used on the Hanford Site for measuring removable surface contamination and direct measurements of the total surface contamination.

D3.7 Sample Handling

Level I EPA pre-cleaned sample containers will be used for waste and water samples collected for chemical analysis. Container materials, minimum volume or weight of samples, sample preservation, and holding times are summarized in Table D-11.

D3.7.1 Container Labeling

The sample location, depth, and corresponding HEIS numbers are documented in the sampler's field logbook. A custody seal (e.g., evidence tape) is affixed to each sample container and/or the sample collection package in such a way as to detect potential tampering.

Each sample container will be labeled with the following information on firmly affixed water-resistant labels:

- HEIS number
- Sample collection date and time
- Analysis required
- Preservation method (if applicable)
- Sampling authorization form number

In addition to the above information, sample records must include the following:

- Analysis required
- Source of sample
- Matrix
- Field data (e.g., pH, radiological readings, etc.)

Table D-11. Analytical Methods, Sample Containers, Preservation, and Holding Times

Analytical Method	Container and Amount of Sample*	Preservative	Holding Time
Aromatic and halogenated VOA – 8260	G; 40 mL VOA vial (water) 125 mL jar (solid)	Cool to ≤4°C	14 days
Chromium (hex) - 7196	P, G; 400 mL (water) 100 g (solid)	Cool to ≤4°C	24 hours (water) 30 days until extraction (solid)
ICP metals – 6010, 6020, or 200.8	P, G; 1 L (water) 200 g (solid)	HNO_3 to pH <2 (water) None (solid)	6 months
Radionuclides	P, G	HNO_3 to pH <2 (water) None (solid)	6 months

* Sample containers include glass (G) and plastic (P).

ICP = inductively-coupled plasma

VOA = volatile organic analysis

Except for VOA samples, a custody seal will be affixed to the lid of each sample container. The custody seal will be inscribed with the sampler's initials and the date. Custody seals are not applied directly to VOA bottles because of a potential for affecting analytical results. Custody seals and any other required labels/documentation can be fixed to the exterior of a plastic bag holding vials in such a manner to detect potential tampering.

D3.7.2 Sample Custody

Sample custody is maintained in accordance with existing CHPRC procedures to ensure the maintenance of sample integrity throughout the analytical process. Chain-of-custody procedures are followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. A chain-of-custody record is initiated in the field at the time of sampling and accompanies each set of samples shipped to any laboratory. Shipping requirements will determine how sample shipping containers are prepared for shipment. The analysis requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility changes for the custody of the sample, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and will transmit the copy to the Sample Management and Reporting organization within 48 hours of shipping.

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

- Project name
- Signature of sampler
- Unique sample number
- Date and time of collection
- Matrix
- Preservatives

- Signatures of individual involved in sample transfer
- Requested analyses or reference thereto

D3.7.3 Sample Transport

Sample transportation will be in compliance with the applicable regulations for packaging, marking, labeling, and shipping hazardous materials, hazardous substances, and hazardous waste mandated by the U.S. Department of Transportation (49 CFR, "Transportation," Chapter I, "Pipeline and Hazardous Materials Safety Administration, Department of Transportation"; and 49 CFR 171 through 49 CFR 177) in association with the International Air Transportation Authority, DOE requirements, and applicable program-specific implementing procedures.

D3.8 Waste Management

All waste (including unexpected waste) generated by sampling activities will be managed in accordance with the WMP (Appendix B). Pursuant to 40 CFR 300.440 ("National Oil and Hazardous Substances Pollution Contingency Plan," "Procedures for Planning and Implementing Off-Site Response Actions"), approval from the DOE Richland Operations Office project manager is required before returning unused samples or waste from offsite laboratories. Laboratories located on the Hanford Site (e.g., 222-S analytical laboratories or the Waste Sampling and Characterization Facility) are outside the "areal extent of contamination" and are therefore considered "offsite" (EH-231-020/0194, *The Off-Site Rule*). Authority is granted per the signature on this SAP that unused samples and associated laboratory waste for the analysis will be disposed in accordance with the laboratory contract and agreements for return to the project site.

D4 Health and Safety

Sampling operations will be performed in accordance with health and safety requirements and appropriate CHPRC Soil and Groundwater Remediation Project requirements. Additionally, work control documents will be prepared to provide further control of site operations. Safety documentation will include an activity hazard analysis and, as applicable, radiological work permits. The sampling procedures and associated activities will implement as low as reasonably achievable practices to minimize the radiation exposure to the sampling team, consistent with the requirements defined in 10 CFR 835, "Occupational Radiation Protection."

D5 References

10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title10-vol4/pdf/CFR-2010-title10-vol4-part830.pdf.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title10-vol4/pdf/CFR-2010-title10-vol4-part835.pdf.

40 CFR 300.440, "National Oil and Hazardous Substances Pollution Contingency Plan," "Procedures for Planning and Implementing Off-Site Response Actions," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2011-title40-vol28/pdf/CFR-2011-title40-vol28-sec300-440.pdf.

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Appendix E

200 West Pump and Treat Performance Monitoring Sampling and Analysis Plan

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Terms

amsl	above mean sea level
ASTM	American Society for Testing and Materials
CAS	Chemical Abstracts Service
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CHPRC	CH2M HILL Plateau Remediation Company
COC	contaminant of concern
DOE	U.S. Department of Energy
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
DS	decision statement
EB	equipment rinsate blank
EPA	U.S. Environmental Protection Agency
FTB	field trip blank
FXR	field transfer blank
gpm	gallons per minute
HEIS	Hanford Environmental Information System
IC	institutional control
IDW	investigation-derived waste
MCL	maximum contaminant level
MNA	monitored natural attenuation
MTCA	*Model Toxics Control Act*
N/A	not applicable
NTU	nephelometric turbidity unit
O&M	operations and maintenance
OU	operable unit
P&T	pump-and-treat
PMP	performance monitoring plan
QA	quality assurance

QAPjP	quality assurance project plan
QC	quality control
RCT	radiological control technician
ROD	Record of Decision
SAP	sampling and analysis plan
TBD	to be determined
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
VOA	volatile organic analysis
VOC	volatile organic compound

E1 Introduction

This groundwater performance monitoring sampling and analysis plan (SAP) describes field monitoring activities associated with implementation of the selected remedy for the 200-ZP-1 Groundwater Operable Unit (OU) as presented in the *Record of Decision, Hanford 200 Area 200-ZP-1 Superfund Site, Benton County, Washington* (EPA et al., 2008). The objective for the groundwater SAP is to describe the methods used to collect the data necessary to assess performance of the 200-ZP-1 OU remedial action, specifically the 200 West pump and treat (P&T), monitored natural attenuation (MNA), and flow-path control elements of the selected remedy.

This groundwater SAP was prepared using the recommendations presented in the *Performance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action* (PMP) (DOE/RL-2009-115). This SAP is the controlling document for performance monitoring for the 200 West P&T and complements the 200 West P&T treatment facility SAP, which is included as Appendix D of this operations and maintenance (O&M) plan. The treatment facility SAP (Appendix D) provides guidance for activities associated with the sampling and analysis of the treatment system's untreated and treated groundwater, and the air and solid waste streams.

E1.1 Operable Unit Description

The 200-ZP-1 Groundwater OU includes several groundwater contaminant plumes that span an area approximately 13 km^2 (5 mi^2) beneath the Hanford Site's 200 West Area (Figure E-1). The 200 Area, which includes the 200 East and 200 West Areas, contains permanent waste management facilities and former reprocessing facilities associated with plutonium concentration and recovery operations at Z Plant and plutonium separation operations at T Plant.

E1.1.1 Physical Setting

The 200 Areas are located on a broad, relatively flat plain that constitutes a local topographic high, commonly referred to as the Central Plateau. The 200-ZP-1 OU underlies the northern portion of the 200 West Area, located at the western end of the Central Plateau. The 200 West Area lies about 8 km (5 mi) south of the Columbia River and 11 km (7 mi) from the nearest Hanford Site boundary.

The geology underlying the 200 West Area is comprised of, in descending order, the Hanford formation, the Cold Creek unit, the Ringold Formation, and the Columbia River Basalt Group. The Hanford formation, Cold Creek unit, and Ringold Formation vadose zone and aquifer sediments are approximately 169 m (555 ft) thick and are comprised of gravel, sand, and silt mixtures (Figures E-2, E-3, and E-4).

The uppermost aquifer in the 200-ZP-1 OU is an unconfined aquifer that occurs in the Ringold Formation. Groundwater in the unconfined aquifer flows from areas where the water table is higher (west of the Hanford Site) to areas where it is lower (the Columbia River). The water table depth in the 200 West Area varies from about 50 m (164 ft) in the southwest corner near the former 216-U-1 Pond to greater than 100 m (328 ft) to the north.

Groundwater flows predominantly east beneath the Central Plateau from the 200 West Area to the 200 East Area (Figure E-5) at velocities typically ranging from 0.0001 to 0.5 m/d (0.00033 to 1.64 ft/d) in the vicinity of the 200-ZP-1 OU. Historical effluent discharges in the 200 West Area altered the groundwater flow regime, especially around the 216-U-10 Pond. Seepage from this pond raised the water table elevation, which in turn temporarily deflected groundwater flow to the north. As the discharges ceased, the water table declined, and the easterly groundwater flow pattern was restored.

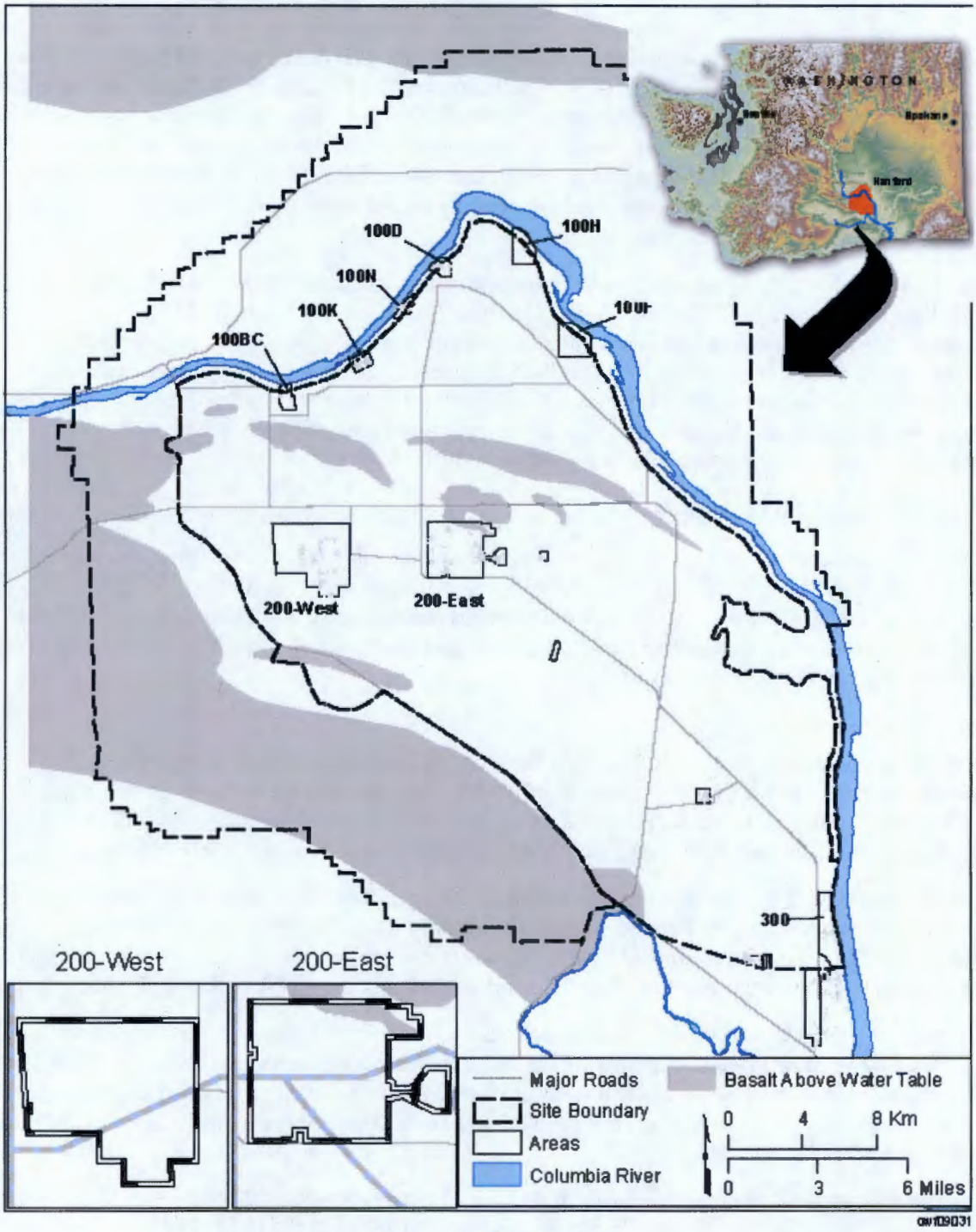


Figure E-1. Site Location

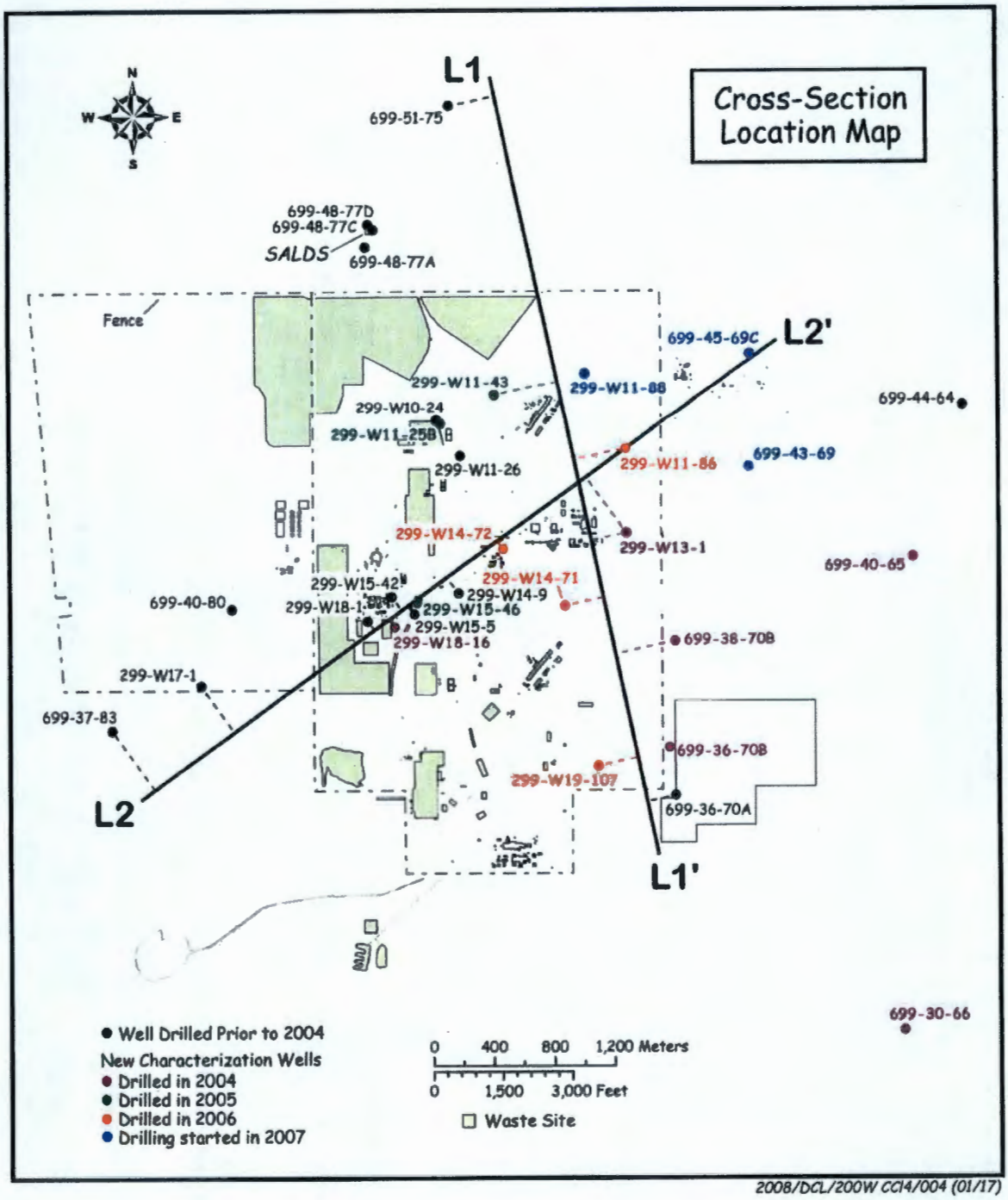


Figure E-2. Location of Geologic Cross Sections

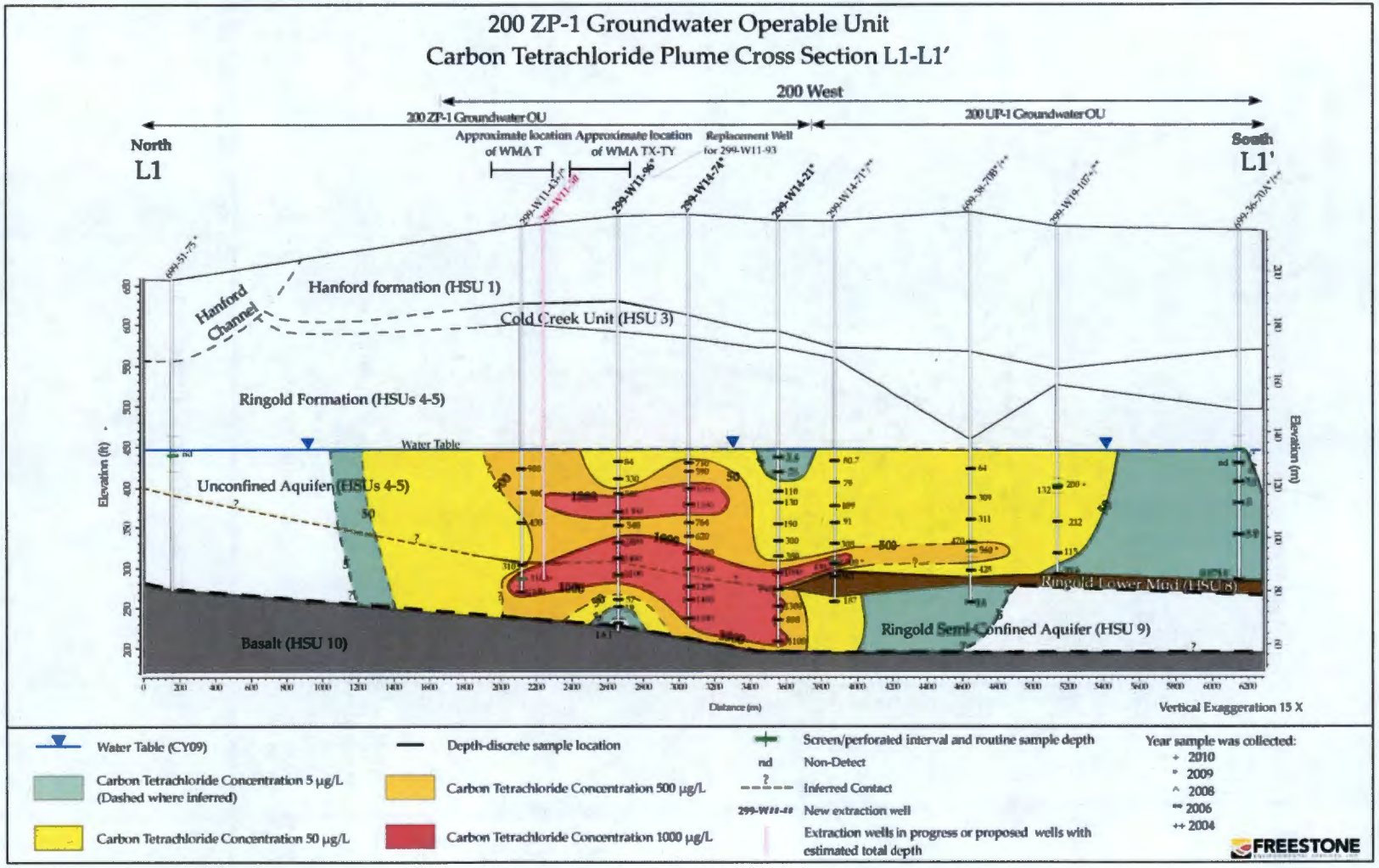
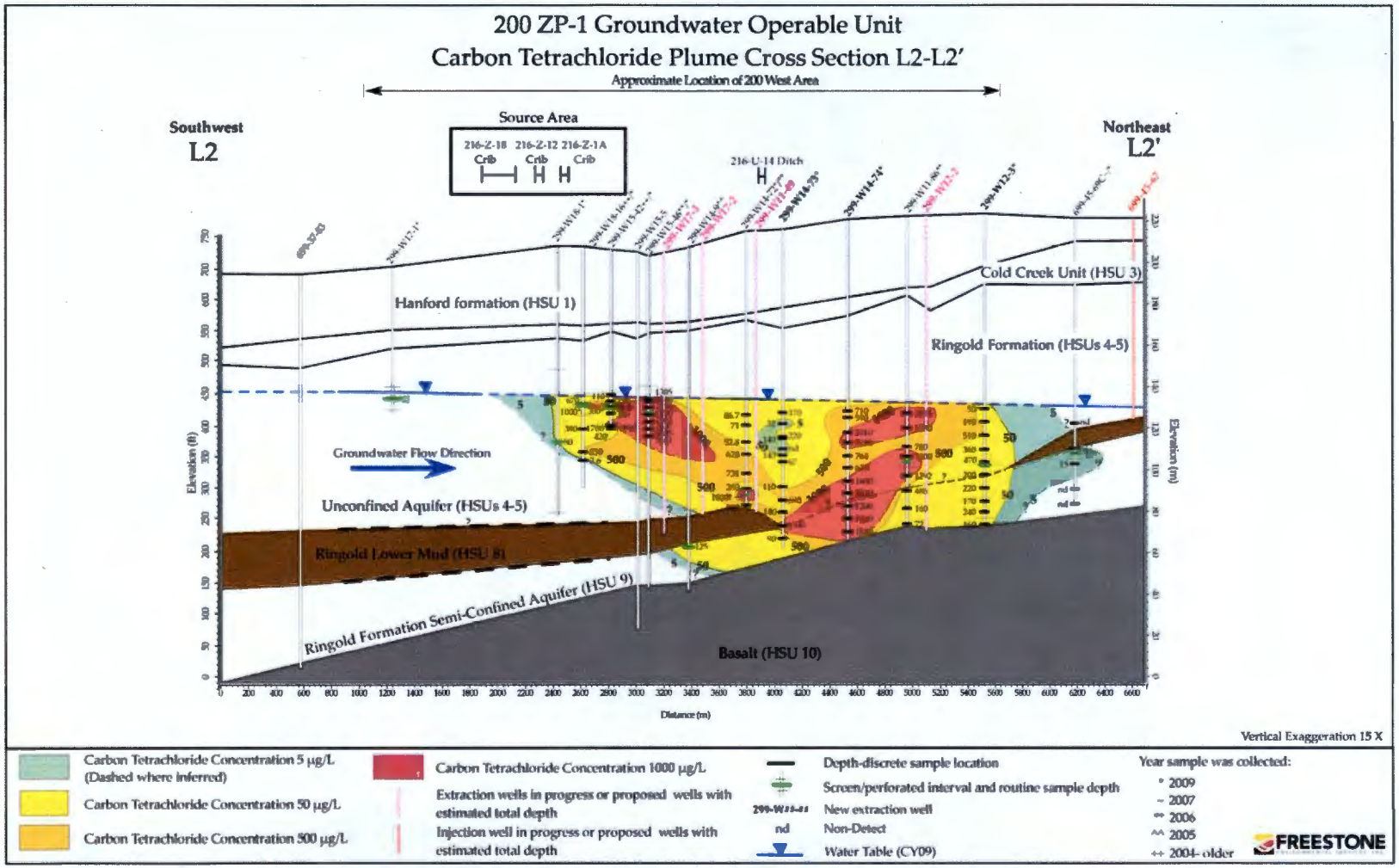


Figure E-3. Geologic Cross Section L1 to L1′ (North to South)



Note: Modified from *Remedial Investigation Report for the 200-ZP-1 Groundwater Operable Unit* (DOE/RL-2006-24).

Figure E-4. Hydrogeologic Cross Section L2 to L2' (Southwest to Northeast)

Figure E-5. Carbon Tetrachloride Plume and 200 West P&T Well Layout

E1.1.2 Nature and Extent of Contaminants

The contaminants of concern (COCs) identified in the Record of Decision (ROD) include carbon tetrachloride, trichloroethene, total chromium (trivalent and hexavalent), nitrate, iodine-129, technetium-99, and tritium. Carbon tetrachloride is the primary COC, with the other COCs (except nitrate) occurring in smaller comingled plumes that lie within the carbon tetrachloride plume boundary. Figures E-3 and E-4 show the vertical distribution of carbon tetrachloride in the 200-ZP-1 OU. The lateral distribution of carbon tetrachloride and extraction and injection well locations are shown on Figure E-5.

E1.2 Remedy Description

The selected remedy for the 200-ZP-1 OU consists of four components: (1) groundwater P&T, (2) MNA, (3) flow-path control, and (4) institutional controls (ICs). The first three components, which are the subject of this SAP, require periodic groundwater monitoring and data evaluation to assess remedy performance and to determine when the remedial action is complete. The fourth component does not require groundwater monitoring and is addressed separately in the *Sitewide Institutional Controls Plan for Hanford CERCLA Response Actions and RCRA Corrective Actions* (DOE/RL-2001-41). Descriptions of the first three components of the selected remedy are presented in the following subsections.

E1.2.1 Pump-and-Treat System

The 200 West P&T remedy component draws groundwater from a network of extraction wells at rates up to 9,464 L/min (2,500 gallons per minute [gpm]). The treatment system includes several unit operations/processes to reduce COC concentrations to the levels specified in the ROD. Treated water is returned to the aquifer through an injection well network.

E1.2.2 Monitored Natural Attenuation

In addition to P&T, natural attenuation processes will help reduce COC concentrations to the cleanup levels specified in the ROD. During the early stages of remedy implementation, the P&T system accounts for a majority of the contaminant mass removal. In the outer regions of the plume, and during the latter stages of P&T system operation, natural attenuation plays an increasingly larger role in reducing COC concentrations. Natural attenuation processes expected to contribute to COC concentration reductions include abiotic degradation, volatilization (for trichloroethene and carbon tetrachloride), dispersion, sorption, and radioactive decay (for tritium). As presented in the ROD, it is estimated that natural attenuation processes will reduce COC concentrations to the ROD cleanup levels within 100 years of final P&T operations. The overarching requirement is to meet the groundwater cleanup levels listed in Table E-1 within 125 years.

E1.2.3 Flow-Path Control

Flow-path control is achieved by injecting treated groundwater into the aquifer to the northeast and east (downgradient) of the groundwater contamination (Figure E-5). Injecting treated water at these locations slows the natural eastward flow of most of the groundwater and, as a result, keeps the COCs within the hydraulic capture zone of the extraction wells. Injection wells installed to the west (upgradient) are used to redirect groundwater flow to the east (toward the extraction wells), minimizing the potential for groundwater in the northern portion of the aquifer to flow northward through Gable Gap toward the Columbia River. Flow-path control also increases the time available for natural attenuation processes to reduce COC concentrations in areas not captured by the extraction wells.

Table E-1. Final Cleanup Levels for 200-ZP-1 OU Groundwater

COC	Units	Initial Estimated Concentration[a]	Final Cleanup Level
Carbon tetrachloride	µg/L	738	3.4[b]
Trichloroethene	µg/L	3.7	1[b]
Chromium (total)	µg/L	Insufficient data	100
Hexavalent chromium	µg/L	27	48
Nitrate-nitrogen	mg/L	35	10
Iodine-129	pCi/L	0.46	1
Technetium-99	pCi/L	8,240	900
Tritium	pCi/L	20,200	20,000

a. From Table 2 (radionuclides) and Table 4 (inorganics) in Calculation 382519-TMEM-003, *200-ZP-1 Basis of Design Memorandum*, Rev. 4, dated August 11, 2009.

b. The DOE will clean up COCs for the 200-ZP-1 Operable Unit subject to the requirements of WAC 173-340, "Model Toxics Control Act-Cleanup" (carbon tetrachloride and trichloroethene), so the excess lifetime cancer risk does not exceed 1×10^{-5} at the conclusion of the remedy.

COC = contaminant of concern

DOE = U.S. Department of Energy

E1.2.4 Groundwater Cleanup Levels

The final cleanup levels for 200-ZP-1 OU groundwater are presented in Table E-1. These cleanup levels were developed using federal drinking water maximum contaminant levels (MCLs); the criteria and equations in *Model Toxics Control Act* (MTCA) (WAC 173-340, "Model Toxics Control Act–Cleanup") Method B cleanup levels for potable groundwater (WAC 173-340-720[4][b][iii][A], WAC 173-340-720[4][b][iii][B], and WAC 173-340-720[7][b]); and the federal standards for radionuclides.

E1.3 Data Quality Objectives

The U.S. Environmental Protection Agency's (EPA) seven-step data quality objective (DQO) process (EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process*) was used to guide development of the selected remedy's groundwater performance monitoring program. This section summarizes the key outputs arising from the DQO process. Additional information on the DQO process is presented in the PMP (DOE/RL-2009-115).

E1.3.1 Statement of the Problem

The first step in the DQO process is to define the problem. In the case of the 200-ZP-1 OU, sufficient monitoring data must be collected and evaluated to optimally operate the groundwater P&T system and to verify that the contaminated groundwater is being remediated to the levels identified in the ROD (EPA et al., 2008).

E1.3.2 Identify the Goals of the Study

The second step of the DQO process identifies the key decisions and/or goals that must be addressed to achieve the final solution to the problem. As stated in the ROD, the selected remedy combines P&T, MNA, flow-path control, and ICs to solve the problem. The performance monitoring goals for the first three of these components are addressed by the PMP (DOE/RL-2009-115). Monitoring data shall be collected over the lifetime of the remedial action to evaluate its performance and optimize its effectiveness. The key questions that the data collection must address, along with alternative actions that may result based on the analysis of the collected data, are presented below as series of decision statements (DSs).

- **DS #1:** Determine if there are any new releases of COCs that could impact the effectiveness of the remedy and necessitate changes to the remedial action and/or the PMP; otherwise, continue with the current remedial action and the PMP.
- **DS #2:** Determine if potentially toxic and/or mobile transformation products are being generated at concentrations large enough to justify their inclusion in the list of COCs with associated cleanup levels; otherwise, continue with the current list of COCs and associated cleanup levels.
- **DS #3:** Determine if changes are occurring in environmental conditions that may reduce the efficacy of the P&T system, natural attenuation processes, and the flow-path control actions, thereby necessitating changes to the remedial action and/or the PMP; otherwise, continue with the current remedial action and the PMP.
- **DS #4:** Determine if the P&T system will remove at least 95 percent of the mass of COCs in 25 years or less, and thereby achieve remedy goals for the P&T phase of the remedy; otherwise, evaluate modifications to the P&T system that could achieve the stated goal for the P&T phase of the remedy.
- **DS #5:** Determine if contamination is expanding downgradient, laterally, or vertically after the P&T component has been turned off, thereby necessitating an evaluation of the predicted success of the remedial action; otherwise, continue with the current remedial action and the PMP.
- **DS #6:** Determine if the current remedy design is predicted to achieve cleanup levels for all COCs within 125 years, and thereby achieve the overall remedial goal; otherwise, evaluate modifications to the remedial action that could achieve the stated goal for the overall remedy.
- **DS #7:** Determine if remediation has been successfully completed and a recommendation can be made for no further action; otherwise, continue with the current remedial action and the PMP or determine if a technical impractability waiver should be invoked.
- **DS #8:** Determine if certain areas of the contaminant plumes are not responding to P&T remediation as expected, and therefore require the evaluation of other technologies for a more focused or "hot spot" remedy; otherwise, no new action is required.
- **DS #9:** Once 95 percent of the mass of COCs had been removed, determine if there is rebound in COC concentrations, which would require the P&T system to be turned back on; otherwise, leave the P&T system off and continue with MNA.

E1.3.3 Identify the Information Inputs and Analytical Approach

Step 3 and Step 5 of the DQO process identify the data and analytical approach necessary to resolve the DSs listed in Section E1.3.2. This information is summarized in Table E-2.

E1.3.4 Define the Boundaries of the Study

In the fourth step of the DQO process, the spatial and temporal features pertinent to the decision-making process are identified. The 200-ZP-1 performance monitoring network must verify that cleanup levels have been achieved in all areas of the groundwater plumes of the OU. Spatially, this covers an area from the western injection well fence to the eastern leading edges of the plumes. Elevations range from the top of the basalt bedrock to the water table interface. The current 200-ZP-1 OU site conceptual model does not include any COC concentrations greater than cleanup levels in the basalt bedrock. Performance monitoring is expected to continue until cleanup levels have been achieved, which is estimated to be 125 years.

E1.3.5 Specify Performance or Acceptance Criteria

The sixth step of the DQO process involves deriving the performance or acceptance criteria that the collected data must achieve in order to minimize the possibility of either making erroneous conclusions or failing to keep uncertainty in estimates within acceptable levels. Typically, the decision rule as a statistical hypothesis test is specified in this section, and the consequences of making incorrect decisions from the test are examined. However, statistical tests of the monitoring data to support the end of this remedial action were not developed as part of the PMP and may not be applicable. Therefore, typically accepted performance criteria for the data to be gathered under this SAP are presented in Table E-3.

E1.3.6 Develop the Plan for Obtaining Data

The seventh step of the DQO process is to develop the sampling and analysis design to generate data needed to address the nine DSs. The design for collecting contaminant concentration, hydraulic, and flow rate monitoring data is presented in the PMP (DOE/RL-2009-115). The monitoring well network is described in Section E1.4 and the designs for the water level, flow rate, COC, and MNA programs are presented in Section E3.

E1.4 Groundwater Monitoring Well Network

The data necessary to address the DSs described in Section E1.3.2 will be collected over the projected 125 year lifetime of the remedial action to evaluate performance, optimize effectiveness, and determine when the remedial action is complete. The selection of the contaminant monitoring well network, sampling frequency, and analytical parameters are discussed in the PMP.

As described in the following subsections, the monitoring program obtains data from a network of monitoring wells that have been evaluated to develop a constituent-specific set of analyses for each well. For each contaminant (excluding carbon tetrachloride and trichloroethene), each well in the PMP list (DOE/RL-2009-115) was evaluated in the context of geographic location relative to the plume in the 200-ZP-1 and the data trends relative to the cleanup level (this evaluation included data collected as part of the PMP efforts as well as data from as far back as 1990). For volatile organic compounds (VOCs) such as carbon tetrachloride and trichloroethene, the well monitoring well network extends into the 200-UP-1 in order to track the plume and mass removal to meet the performance metrics provided in the 200-ZP-1 ROD. The contaminant-specific sampling will be augmented by sampling each well for all COCs every 5 years to support the preparation of the CERCLA 5-year review. Sampling of the monitoring well network for all COCs on a 5-year basis will generate sufficient data for quantitative analysis in support of addressing all nine DSs; however, annual sampling from the contaminant-specific well list will provide data for assessing DSs #1, #2, and #5. This includes determining if there are any new releases of COCs, evaluating concentration trends in high-concentration areas of the plumes, and determining if contamination is expanding downgradient, laterally, or vertically.

Table E-2. DQO Step 3 and Step 5 – Information Inputs and Analytical Approach

DS Number	Data Inputs*	Analytical Approach*
DS #1: Determine if there are any new releases of COCs that could impact the effectiveness of the remedy and necessitate changes to the remedial action and/or the PMP.	Groundwater sampling data collected from the contaminant monitoring well network. Hydraulic monitoring data, extraction and injection well flow rate data, and extraction well contaminant sampling data.	Groundwater contaminant sampling data will be evaluated to determine if any new releases of COCs have occurred. Contaminant monitoring well sampling concentration trends will be evaluated, and the sampling data will be used to update the three-dimensional plume shell for each contaminant. If contaminant concentrations in a monitoring well are stable and/or increasing, and there is no known upgradient dissolved-phase contaminant mass to support these stable and/or increasing concentrations, then there may be a new release.
DS #2: Determine if potentially toxic and/or mobile transformation products are being generated at concentrations large enough to justify their inclusion in the list of COCs with associated cleanup levels.	Groundwater sampling data collected from the contaminant monitoring well network.	Groundwater sampling data will be evaluated to determine if potentially toxic and/or mobile transformation products are generated within the OU. This evaluation is typically performed by analyzing concentration changes in the parent COC and the COC degradation products. This analysis applies to COCs that are commonly degraded in the environment, and in the case of the 200-ZP-1 OU, includes carbon tetrachloride, trichloroethene, and nitrate. The rates of decline in the parent compound and the formation of the degradation products will be used to derive degradation rates. The degradation rates will be included in the 200 West Area contaminant transport model and will be used to evaluate whether natural attenuation will achieve cleanup levels within the time period specified in the ROD.
DS #3: Determine if changes are occurring in environmental conditions that may reduce the efficacy of the P&T system, natural attenuation processes, and flow-path control actions, thereby necessitating changes to the remedial action and/or PMP.	Hydraulic monitoring data and groundwater contaminant sampling data.	Groundwater elevation data will be necessary to determine if changes are occurring in environmental conditions that may reduce the efficacy of the P&T system and the flow-path control action. The data should include transient groundwater elevations measured using transducers with data loggers and more long-term, quasi-steady-state data measured during synoptic groundwater elevation surveys. The transient data logger groundwater elevation data may be evaluated to monitor the sustainability of the extraction well field and to optimize pumping possibly by re-balancing upgradient and downgradient injection to ensure that a sustainable remedy is implemented. The more long-term, quasi-steady-state data measured during synoptic groundwater elevation surveys should be used to generate water table maps to evaluate groundwater elevations and their impacts on the monitoring well networks and flow-path control actions. The potentiometric surface of water table elevations will be defined using hydraulic monitoring data to help understand groundwater flow directions in the 200-ZP-1 OU. Groundwater monitoring for key biogeochemical and field parameters will be used to determine if changes occur in environmental conditions that may reduce the efficacy of natural attenuation processes. In order to evaluate remediation by natural attenuation it needs to be determined if contaminant mass is being degraded. The biogeochemical parameters help identify if the appropriate conditions exist in the aquifer to support COC degradation. The monitoring constituents can be used in mass balance calculations to determine if decreases in contaminant and electron acceptor/donor concentrations can be directly correlated to increases in daughter compounds. The simplest way to accomplish this is by mapping of concentration changes in reactants (contaminants, electron acceptors, and donors) or products of the biogeochemical process (e.g., dissolved iron and chloride) that degrade or immobilize the contaminants. These maps can be measured to determine if transformation processes are active at the site. Biodegradation rate constants can be calculated from time-series data of the measured COC concentrations in conjunction with aquifer hydrogeologic parameters such as seepage velocity and dilution.
DS #4: Determine if the P&T system will remove at least 95 percent of the mass of COCs in 25 years or less, and thereby achieve remedy goals for the P&T phase of the remedy.	Groundwater contaminant sampling data, extraction and injection well flow rate data, and extraction well and combined treatment plant influent and effluent contaminant sampling data.	The groundwater contaminant transport model will be used to predict if the P&T system will remove at least 95 percent of the mass of COCs in 25 years or less. This analysis will use the three-dimensional contaminant plume shell for each COC as the starting concentration in the model, and then transporting the contaminant plume forward in time for at least 25 years. Current and future anticipated extraction and injection well flow rates will be needed as input to the model. Using the simulated extraction well contaminant concentrations and flow rates, the contaminant mass removed by each extraction is calculated. The percentage mass removed for each COC will be calculated by summing the simulated mass removed by each extraction well and dividing that by starting mass for each COC. Initial masses are provided in ECF-200ZP1-13-0006 and DOE/RL-2013-14. The combined treatment plant influent and effluent contaminant sampling data, extraction well contaminant sampling data, and extraction well and treatment plant influent flow rate data will be used to calculate the actual contaminant mass removed by the P&T system. Contaminant mass removal can be calculated by multiplying the difference in the treatment plant influent and effluent contaminant concentrations by the influent flow rate and the elapsed time at that concentration and flow rate. However, some COCs may not be detectable at the combined treatment plant influent samples but are detectable in samples collected from one or more of the extraction wells. In this case, a more accurate mass removal can be calculated using the individual extraction well contaminant sampling and flow rate data and summing the mass removed from the individual extraction wells to obtain the total mass removal for the COC.
DS #5: Determine if contamination is expanding downgradient, laterally or vertically after the P&T component has been turned off, thereby necessitating an evaluation of the predicted success of the remedial action.	Groundwater contaminant sampling data collected from the monitoring well network.	Groundwater sampling data will be evaluated to determine if contamination is expanding downgradient, laterally, or vertically after the P&T system has been shut down. The trends in measured concentrations for downgradient monitoring wells will be analyzed to draw conclusions about the expansion and/or migration of the COC plumes. Three-dimensional contaminant plume shells will be updated for each COC using the most current sampling data. Plume volume and contaminant mass statistics can be generated from the plume shells. The contaminant distributions and statistics can be compared to those from the previous plume shell versions to evaluate expansion or contraction of each COC plume. If evaluation of groundwater sampling data indicates that a COC plume may be expanding downgradient and the remedial system is still operating, several courses of action may be taken. Extraction and injection well flow rates and/or production intervals may be adjusted to improve the hydraulic capture of escaping contaminant mass or new extraction wells may be installed to capture escaped contaminant mass that is contributing to downgradient plume expansion.
DS #6: Determine if the current remedy design is predicted to achieve cleanup levels for all COCs within 125 years, and thereby achieve the overall remedial goal.	Groundwater contaminant sampling data, extraction and injection well flow rate data, and extraction well contaminant sampling data.	The groundwater contaminant transport model will be used to predict if the current remedy design will achieve cleanup levels for all COCs within 125 years. This analysis can be accomplished by using the three-dimensional contaminant plume shell for each COC as the starting concentration in the model and transporting the contaminant plume forward in time for at least 125 years. Current and future anticipated extraction and injection well flow rates can be supplied to the model as input. An animation can be made for each COC displaying the contaminant concentrations greater than or equal to the cleanup level as the plume contracts over time. If the simulated contaminant concentrations remain significantly above the cleanup level during the 125-year period, the remedy goal may not be achieved within the desired remedial time frame.

Table E-2. DQO Step 3 and Step 5 – Information Inputs and Analytical Approach

DS Number	Data Inputs*	Analytical Approach*
DS #7: Determine if remediation has been successfully completed and a recommendation can be made for no further action.	Groundwater contaminant sampling data.	Groundwater sampling data will be evaluated to determine if the remediation has been successfully completed. If contaminant concentrations in all monitoring wells, for all COCs, have decreased to below the cleanup levels for at least 5 years, then a recommendation should be made for no further action.
DS #8: Determine if certain areas of the contaminant plumes are not responding to P&T remediation as expected, and therefore require the evaluation of other technologies for a more focused or "hot spot" remedy.	Groundwater contaminant sampling data.	Groundwater sampling data will be evaluated on an annual basis to determine if any areas of the contaminant plumes are not responding to P&T remediation. If one or more areas are identified, options will be evaluated.
DS #9: Once 95 percent of the mass of COCs has been removed, determine if there is rebound in COC concentrations, which would require the P&T to be turned back on.	Groundwater contaminant sampling data.	Groundwater sampling data will be collected and analyzed for each of the COCs to determine if there is a rebound in COC concentrations.

* A detailed explanation of the data inputs included in this table is provided in the *Performance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action* (DOE/RL-2009-115).

COC = contaminant of concern
DS = decision statement
OU = operable unit
P&T = pump-and-treat
ROD = Record of Decision

Table E-3. DQO Step 6 – Typical Acceptance and Performance Criteria

Required Data	Acceptance/Performance Criteria
Groundwater level (depth-to-water, top of casing, northing and easting coordinates, well screen top and bottom elevations)	Depth to water should be specified to the nearest 0.61 cm (0.02 ft). Top of casing should be specified to the nearest 0.03 m (0.1 ft). Northing and easting should be specified to the nearest 0.03 to 1.5 m (0.1 to 5 ft). Well screen top and bottom should be specified to the nearest 0.03 m (0.10 ft) ±1.5 m (5 ft).
Pumping rates	Pumping rates should be measured on a semicontinuous basis using inline flow meters accurate to 5 percent of the flow rate.
Contaminant concentrations	Precision ≤20 percent. Analytical method must be able to provide data equal to or less than the cleanup levels.
Biogeochemical parameters	Precision ≤20 percent. Errors in the measurement of these parameters have little impact on any significant decisions regarding natural attenuation processes.
Groundwater field parameters	Precision ≤20 percent. Errors in the field measurement of these parameters have little impact on any significant decisions regarding natural attenuation processes.

Therefore, while the P&T system is operating, the list of plume/constituent specific analyses will be evaluated on an annual basis to determine if analyses will be added or dropped for the well. These changes will be presented in an amended version of the PMP (DOE/RL-2009-115). Further vertical sampling will be performed to support the assessment of the remedy against the RAOs.

E1.4.1 Existing Monitoring Wells

The monitoring well network will change over time as remedy components reduce COC concentrations and the plumes contract. Some areas within the aquifer will be cleaned up more quickly and many of the shallow monitoring wells may go dry in areas farthest removed from the injection wells. Therefore, while the P&T system is operating, the contaminant monitoring well networks will be evaluated on an annual basis to determine if monitoring wells will be dropped from the network, or if other wells should be added to the network. These changes will be presented in an amended version of this SAP (DOE/RL-2009-124, Appendix E).

E1.4.2 New Monitoring Wells

The PMP (DOE/RL-2009-115) identifies several areas where existing monitoring well coverage may be inadequate to evaluate remedial action effectiveness. To address potential gaps in the monitoring well network, new monitoring wells may be installed (Table E-4). New wells will be installed using procedures similar to those described in *Sampling and Analysis Plan for Eighteen Remedial Action Wells in the 200-ZP-1 Groundwater Operable Unit* (DOE/RL-2010-72).

Table E-4. Proposed New Monitoring Wells

Well Priority	Well Name	Easting (m)	Northing (m)	Estimated Mid-Screen Elevation (m amsl)
1	MW7B	568900	135945	120
	MW7A	568900	135945	100
2	MW1A	568369	137743	90
	MW1B	568369	137743	110
3	MW3A	567578	136476	73
	MW3B	567578	136476	92
	MW3C	567578	136476	112
4	MW5A	567374	135941	70
	MW5B	567374	135941	110
5	MW2	567591	137577	111
6	MW4A	566638	136251	80
	MW4B	566638	136251	100
7	MW6A	566941	135175	80
	MW6B	566941	135175	106
8	MW8A	568670	136810	98
	MW8B	568670	136810	120

amsl = above mean sea level

E2 Quality Assurance Project Plan

The quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including planning, implementation, and assessment of sampling, field measurements, and laboratory analysis. The QAPjP complies with the requirements of the following:

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

Sections 6.5 and 7.8 of the *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al., 1989b) require that the quality assurance (QA), quality control (QC), and sampling and analysis activities specify the QA requirements for treatment, storage, and disposal units, as well as for past-practice processes. The organization of this QAPjP is patterned after the QA elements of

EPA/240/B-01. The QAPjP demonstrates conformance to Part B requirements of the *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use* (ANSI/ASQ E4-2004).

The QAPjP is divided into the following four sections (designated in EPA/240/B-01/003 by a, b, c, and d), which describe the quality requirements and controls applicable to the work described herein:

- **Project Management (Section E2.1):** This section addresses project management, including project history, objectives, and roles and responsibilities of the participants. These elements ensure that the project has a defined goal, that the participants understand the goal, and that the approach to be used and the planning outputs are documented.
- **Data Generation and Acquisition (Section E2.2):** This section addresses all aspects of project design and implementation. Implementation of these elements ensures that appropriate methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are employed and properly documented.
- **Assessment and Oversight (Section E2.3):** This section addresses the activities for assessing project implementation effectiveness and the associated QA and QC activities. The purpose for the assessment activity is to ensure that the QAPjP is implemented as described.
- **Data Validation and Usability (Section E2.4):** This section addresses the QA activities that occur after the data collection or generation phase of the project is completed. Implementation of these elements ensures that the data conform to the specified criteria, thus achieving the project objectives.

E2.1 Project Management

The contractor, CH2M HILL Plateau Remediation Company (CHPRC), and its subcontractors are responsible for the planning, preparation, coordination, sampling, packaging, and shipment of all samples collected under this SAP (Appendix E of this O&M plan) to the laboratory. The project organization, in regard to sampling and characterization, is described in the main text of this O&M plan.

E2.1.1 Problem Definition/Background

Sufficient monitoring data must be collected to ensure 200-ZP-1 OU remedy effectiveness, verify that contaminated groundwater is restored to a level that supports future use as a potential domestic drinking water supply, and verify that the Columbia River and its ecological resources are protected from degradation and unacceptable impact potentially associated with 200 ZP-1 OU COC migration.

E2.1.2 Project/Task Description

The field activities described in this SAP include measurement and sampling of groundwater. Radiological field measurements will also be performed to screen samples from selected monitoring wells following collection. Sampling requirements for investigation-derived waste (IDW) disposal determinations are addressed in the waste management plan (Appendix B of this O&M plan).

E2.1.3 Quality Objectives and Criteria

The QA objective of this plan is to develop implementation guidance that will provide data of known and appropriate quality. Data quality is assessed by data quality indicators (DQIs), by evaluation against identified DQOs and the work activities identified in this SAP (Appendix E of this O&M plan). The applicable QC guidelines, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method. The principal DQIs are precision, bias or accuracy, representativeness, comparability, completeness, and sensitivity. These DQIs

are defined for the purposes of this document in Table E-5. The DQIs are evaluated during the data quality assessment (DQA) process described further in Section E2.4.3. The quality objectives and criteria for groundwater measurement data are presented in Table E-6.

E2.1.4 Special Training Requirements/Certification

A graded approach is used to ensure that workers receive a level of training that is commensurate with their responsibilities and that complies with applicable U.S. Department of Energy (DOE) orders and government regulations. The field work supervisor, in coordination with the CHPRC project manager, will ensure that all field personnel meet all special training requirements. Typical training requirements or qualifications have been instituted by the CHPRC management team to meet training requirements imposed by the contract, regulations, DOE orders, DOE contractor requirement documents, the American National Standards Institute/American Society of Mechanical Engineers, and the *Washington Administrative Code*.

For example, the environmental, safety and health training program provides workers with the knowledge and skills necessary to safely execute assigned duties. Field personnel typically complete the following training before starting work:

- Occupational Safety and Health Administration 40-Hour Hazardous Waste Worker Training and supervised 24-hour hazardous waste site experience
- 8-Hour Hazardous Waste Worker Refresher Training
- Hanford general employee radiation training
- Hanford general employee training
- Radiological worker training (as required)

Project-specific safety training, geared specifically to the project and the day's activity, will be provided. Project-specific training may include the following:

- Training requirements or qualifications needed by sampling personnel in accordance with QA requirements.
- Samplers are required to have training and/or experience in the type of sampling that is being performed in the field.

Qualification requirements for radiological control technicians (RCTs) are established by the Radiation Protection Program. The RCTs assigned to these activities will be qualified through the prescribed training program and will undergo ongoing training and qualification activities.

Table E-5. Data Quality Indicators

DQI	Definition	Example Determination Methodologies	Project-Specific Information*	Corrective Actions
Precision	A measure of agreement among repeated measurements of the same property under identical, or substantially similar, conditions; calculated as either the range or as the standard deviation. May also be expressed as a percentage of the mean of the measurements, such as relative range, relative percent difference, or relative standard deviation (coefficient of variation).	Use the same analytical instrument to make repeated analyses on the same sample. Use the same method to make repeated measurements of the same sample within a single laboratory or have two or more laboratories analyze identical samples with the same method. Split a sample in the field and submit both for sample handling, preservation and storage, and analytical measurements. Collect, process, and analyze collocated samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	**Field precision:** At one randomly selected location duplicate samples will be taken. **Laboratory precision:** Analysis of laboratory duplicate or matrix spike duplicate sample.	If duplicate data do not meet objective: • Evaluate apparent cause (e.g., sample heterogeneity) • Request reanalysis or re-measurement • Qualify the data before use.
Accuracy	A measure of the overall agreement of a measurement to a known value; includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations.	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); usually expressed either as percent recovery or as a percent bias.	Laboratory accuracy determination based on matrix spikes and matrix spike duplicates. Note if any of the samples or analyses are more or less critical than the others in determining follow-up actions.	If recovery does not meet objective: • Qualify the data before use • Request reanalysis or re-measurement
Representativeness	A qualitative term that 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" (ANSI/ASQ E4-2004).	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.	Samples will be collected as described in the sampling design. Judgmental sampling ensures that areas most likely to be contaminated, based on current information, will be evaluated. Random sampling is based on ensuring all members of the group are equally likely to be chosen and allows probability statements to be made about the quality of estimates derived from the data.	If results are not representative of the system sampled: • Identify the source of the nonrepresentation • Reject the data, or, if data are otherwise usable, qualify the data for limited use and define the portion of the system that the data represent • Redefine sampling and measurement requirements and protocols • Resample and reanalyze.
Comparability	A qualitative term that expresses the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made.	Compare sample collection and handling methods, sample preparation and analytical procedures, holding times, stability issues, and QA protocols.	All sampling personnel will use the same sampling protocols. Samples will be submitted to the same laboratories when possible (based on laboratory contracts) for analysis by the same methods, thus data results will be comparable.	If data are not comparable to other data sets: • Identify appropriate changes to data collection and/or analysis methods • Identify quantifiable bias, if applicable • Qualify the data as appropriate • Resample and/or reanalyze if needed • Revise sampling/analysis protocols to ensure future comparability
Completeness	A measure of the amount of valid data needed to be obtained from a measurement program.	Compare number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (DQO performance/ acceptance criteria).	The percent complete will be determined during data validation.	If data set does not meet completeness objective: • Identify appropriate changes to data collection and/or analysis methods • Identify quantifiable bias, if applicable • Qualify the data as appropriate • Resample and/or reanalyze if needed • Revise sampling/analysis protocols to ensure future comparability
Sensitivity	The capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest.	Determine the minimum concentration or attribute that can be measured by a method (method detection limit), by an instrument (instrument detection limit), or by a laboratory (quantitation limit). The practical quantitation limit is the lowest level that can be routinely quantified and reported by a laboratory.	Ensure that sensitivity, as measured by detection limits, is appropriate for the action levels.	If sensitivity does not meet objective: • Request reanalysis or re-measurement • Qualify/reject the data before use

Note: ANSI/ASQ E4-2004, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use.*

DQO = data quality objective

QA = quality assurance

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Table E-6. Groundwater Analytical Performance Requirements

CAS No.	Analyte	Survey or Analytical Method	Units	Action Level	Target Detection Limit	Precision Required (%)	Accuracy Required (%)
56-23-5	Carbon tetrachloride (COC)	SW-846, Method 8260	µg/L	3.4	2	≤20%	80-120%
67-66-3	Chloroform (TP)	SW-846, Method 8260	µg/L	7.17	5	≤20%	80-120%
75-09-2	Dichloromethane (TP)	SW-846, Method 8260	µg/L	5	5	≤20%	80-120%
74-87-3	Chloromethane (TP)	SW-846, Method 8260	µg/L	NA	5	≤20%	80-120%
79-01-6	Trichloroethene (COC)	SW-846, Method 8260	µg/L	1	1	≤20%	80-120%
156-59-2	cis-1,2-Dichloroethene (TP)	SW-846, Method 8260	µg/L	70	5	≤20%	80-120%
75-01-4	Vinyl chloride (TP)	SW-846, Method 8260	µg/L	2	1	≤20%	80-120%
7440-47-3	Chromium – total (COC)	SW-846, SW6010/6020 or EPA 200.8	µg/L	100	10	≤20%	80-120%
18540-29-9	Hexavalent chromium (COC)	Method 7196	µg/L	48	10	≤20%	80-120%
14697-55-8	Nitrate–N (COC)	SW-846, EPA 300.0	mg/L	10	0.25	≤20%	80-120%
14797-65-0	Nitrite–N (TP)	EPA 300.0	mg/L	1	0.1	≤20%	80-120%
15046-84-1	Iodine-129 (COC)	Low-energy photon spectroscopy	pCi/L	1	1	≤20%	80-120%
14133-76-7	Technetium-99 (COC)	Liquid scintillation	pCi/L	900	15	≤20%	80-120%

Table E-6. Groundwater Analytical Performance Requirements

CAS No.	Analyte	Survey or Analytical Method	Units	Action Level	Target Detection Limit	Precision Required (%)	Accuracy Required (%)
10028-17-8	Tritium (COC)	Liquid scintillation	pCi/L	20,000	400	≤20%	80-120%
7440-61-1	Uranium (from 200-UP-1 OU)	SW-846, SW6010/6020 or EPA 200.8	µg/L	30	1	≤20%	80-120%
N/A	Total organic carbon (NAP)	EPA 415.1	µg/L	N/A	1	≤20%	80-120%
N/A	Total dissolved solids	EPA 160.1	mg/L	500	1	≤20%	80-120%
14808-79-9	Sulfate (NAP)	EPA 300.0A	mg/L	250	4	≤20%	80-120%
12597-04-50	Sulfide (NAP)	EPA 9215	mg/L	N/A	0.1	≤20%	80-120%
7439-89-6	Iron (NAP)	SW-846, SW6010/6020	µg/L	300	10	≤20%	80-120%
7439-96-5	Manganese (NAP)	SW-846, SW6010/6020	µg/L	50	10	≤20%	80-120%
N/A	Alkalinity (NAP)	EPA 310.1	mg/L	N/A	1	≤20%	80-120%
16887-00-6	Chloride	EPA 300.0	mg/L	250	1,000	≤20%	80-120%
Field Measured Water Quality Parameters							
N/A	Temperature	Hach HQ40d (or equivalent)	°C	N/A	0.0 to 80.0	N/A	±0.3
N/A	pH	Hach HQ40d (or equivalent)	Standard units	6.5-8.5	0.0 to 14.0	N/A	±0.1 of the buffer solution

Table E-6. Groundwater Analytical Performance Requirements

CAS No.	Analyte	Survey or Analytical Method	Units	Action Level	Target Detection Limit	Precision Required (%)	Accuracy Required (%)
N/A	Dissolved oxygen	Hach HQ40d (or equivalent)	mg/L	N/A	0.1 to 20.0	N/A	±0.1 for 0.1 to 8.0, ≤0.2 for >8.0
N/A	Specific conductance	Hach HQ40d (or equivalent)	µS/cm	N/A	0.01 to 200.0	N/A	±0.5% of reading
N/A	Turbidity	Hach 2100P turbidimeter HW40D (or equivalent)	NTU	N/A	0 to 1000	N/A	±2% for 0 to 499, ≤3 for 500 to 1,000
N/A	Reduction-oxidation potential	*USGS National Manual for the Collection of Water-Quality Data* (USGS, 1997)	mV	N/A	-500 to 500	N/A	±1.0

CAS = Chemical Abstracts Service
COC = contaminant of concern
EPA = U.S. Environmental Protection Agency
TP = transformation product
N/A = not applicable
NAP = natural attenuation evaluation parameter
NTU = nephelometric turbidity unit
OU = operable unit

In addition, pre-job briefings will be performed to evaluate an activity and its hazards by considering the following factors:

- Objective of the activities
- Individual tasks to be performed
- Hazards associated with the planned tasks
- Controls applied to mitigate the hazards
- Environment in which the job will be performed
- Facility where the job will be performed
- Equipment and material required
- Safety procedures applicable to the job
- Training requirements for individuals assigned to perform the work
- Level of management control
- Proximity of emergency contacts

Training records are maintained for each individual in an electronic training record database. The contractor training organization maintains the training records system. Line management will be used to confirm that employee training is appropriate and up-to-date prior to performing any field work.

E2.1.5 Documents and Records

The 200-ZP-1 groundwater OU project manager is responsible for distributing copies of the SAP and any addendums to field sampling personnel. Version control is maintained by the administrative document control process. Significant changes to the SAP (Appendix E of this O&M plan) will be reviewed and approved by DOE and EPA prior to implementation. Table E-7 defines the types of changes that may be made to the sampling design and the appropriate documentation requirements.

The field work supervisor is responsible for ensuring that field instructions are maintained, up-to-date, and aligned with any revisions to the SAP (Appendix E of this O&M plan). The field work supervisor ensures that all deviations from the SAP or problems encountered in the field are documented appropriately (e.g., in the field logbook or on nonconformance report forms) in accordance with internal corrective action procedures.

Table E-7. Change Control for Sampling Projects

Type of Change	Action	Documentation
Temporarily (≤1 event) adding/deleting constituents, locations, or increasing/decreasing sampling frequency.	Project management approval; notify regulatory agency point of contact, if appropriate	Project's schedule tracking system
Permanently (>1 event or year) adding/deleting constituents, locations, or increasing/decreasing sampling frequency.	Revise SAP; obtain DOE and EPA approval; distribute plan	Letter report documenting changes or revised plan

SAP = sample and analysis plan

The 200-ZP-1 groundwater OU project manager, field work supervisor, or designee will be responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities.

Logbooks are required for field activities. The logbook must be identified with a unique project name and number. Individuals responsible for logbooks shall be identified in the front of the notebook, and only authorized persons may make entries in logbooks. Logbooks will be signed by the field manager, supervisor or other assigned field personnel. Logbooks shall have the following characteristics:

- Permanently bound
- Waterproof
- Ruled with sequentially numbered pages

Pages shall not be removed from logbooks for any reason. Entries shall be made in indelible ink. Corrections shall be made by marking through the erroneous data with a single line, entering the correct data, and initialing and dating the change.

The project manager is responsible for ensuring that a project file is properly maintained. The project file will include the following items, as appropriate:

- Field logbooks or operational records
- Data forms
- Global positioning system data
- Chain-of-custody forms
- Sample receipt records
- Inspection or assessment reports and corrective action reports
- Interim progress reports
- Final reports (laboratory data packages and validation reports)

The project file will contain the records or references to their storage locations.

The laboratory is responsible for maintaining, and having available upon request, the following information:

- Analytical logbooks
- Raw data and QC sample records
- Standard reference material and/or proficiency test sample data
- Instrument calibration information

Records may be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989a) will be managed in accordance the requirements therein.

E2.2 Data Generation and Acquisition

The following subsections address data generation and acquisition to ensure that project methods for sampling, measurement and analysis, data collection and generation, data handling, and QC activities are appropriate and documented.

E2.2.1 Sampling Process Design

The sample design presented in Section E3 of this SAP uses a judgmental sampling approach based on an existing monitoring well grid. The field team will note in the daily field sampling log any instance where samples cannot be collected at the designated location because of field conditions. These events will be discussed in the follow-up *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) documentation (e.g., periodic briefings and performance monitoring report).

E2.2.2 Sampling Methods

Sampling methods are described in Section E3 and are based on previously approved operating procedures developed for similar field characterization activities conducted at the Hanford Site.

E2.2.3 Sample Handling and Custody

A sample and data tracking database is used to track the samples from the point of collection through the laboratory analysis process. Laboratory analytical results are entered and maintained in the Hanford Environmental Information System (HEIS) database. The HEIS sample numbers are issued to the sampling organization for the project. Each chemical, radiological, and physical property sample is identified and labeled with a unique HEIS sample number.

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

E2.2.4 Analytical Methods

Information on the analytical methods to be used under this SAP are provided in Table E-6. These analytical methods are controlled in accordance with the laboratory's QA plan and the requirements of this QAPjP. CHPRC participates in oversight of offsite analytical laboratories to qualify the laboratories for performing Hanford Site analytical work. If the laboratory uses a nonstandard or unapproved method, then the laboratory must provide method validation data to confirm that the method is adequate for the intended use of the data. This includes information such as determination of detection limits, quantitation limits, typical recoveries, and analytical precision and bias. Deviations from the analytical methods noted in Table E-6 must be approved by Sample Management and Reporting in consultation with the 200-ZP-1 groundwater OU project manager.

Laboratories providing analytical services in support of this SAP will have a corrective action program in place that addresses analytical system failures and documents the effectiveness of any corrective actions. Issues that may affect analytical results are to be resolved by Sample Management and Reporting in coordination with the 200-ZP-1 groundwater OU project manager.

E2.2.5 Quality Control

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field replicates (duplicates), trip or field blanks, and equipment blanks. Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC sampling frequency is summarized in Table E-8, and the sample types are described further in the following subsections.

Table E-8. Project QC Sampling Summary

QC Sample Type	Purpose	Frequency
Field QC		
Field duplicates	Estimate precision, including sampling and analytical variability	Minimum of one sample for each sample media type or 1 per 20 sample locations, whichever is greater.
Equipment rinsate blank (EB)	Verify adequacy of sampling equipment decontamination	Solids: Minimum of 1 per 20 locations. Water: Minimum of 1 per 20 locations. If disposable equipment is used, then an equipment rinsate blank is not required.
Field trip blank (FTB)	Assess contamination from containers or transportation	1 per 20 well trips.
Field transfer blank (FXR)	Assess contamination from sampling site	One per day when volatile organics are sampled.
Laboratory QC		
Method blank	Assess response of an entire laboratory analytical system	One per batch,* 20 samples maximum, of each matrix type or as required by laboratory contract.
Matrix spike	Identify analytical (preparation and analysis) Bias; possible matrix effect on the analytical method used	One per batch,* 20 samples maximum, of each matrix type or as required by laboratory contract.
Matrix duplicate or matrix spike duplicate	Estimate analytical bias and precision	One per batch,* 20 samples maximum, of each matrix type or as required by laboratory contract.
Laboratory control samples	Assess method accuracy	One per batch,* 20 samples maximum, of each matrix type or as required by laboratory contract.
Surrogates	Estimate recovery/yield	As required by laboratory contract.

* Batching across projects is allowed for similar matrices.

QC = quality control

E2.2.5.1 Field Quality Control Samples

Field QC samples for this SAP includes equipment rinsate blanks, field duplicates, field trip blank (FTB), and field transfer blank (FXR).

- **Field duplicates:** Field duplicates are two samples that are collected as close as possible to the same time and same location and are intended to be identical. Field duplicates are collected from an area with some contamination so valid comparisons between the samples can be made. Field duplicates are collected by filling similar analyte containers from the same sampling tool, are stored and transported

together, and are analyzed for the same constituents. The field duplicates are used to determine precision for both sampling and laboratory measurements.

Field duplicate results must have precision within 20 percent as measured by the relative percent difference. Only field duplicates with at least one result greater than five times the method detection limit or minimum detectable activity are evaluated.

- **Equipment rinsate blank (EB):** The EBs are samples in which high-purity reagent water is passed through the sample collection tool or put in contact with the sampling surfaces of the equipment and the water collected and transferred into the appropriate containers. EB samples need only be collected from equipment that undergoes decontamination and is used for repeated sample collection.

  The EB sample bottles are placed in the same storage containers with the samples from the associated sampling event. The EB samples are analyzed for the same constituents as the samples from the associated sampling event. The EBs are used to evaluate the effectiveness of the cleaning process to ensure samples are not cross-contaminated from previous sampling events or between locations.

  High-purity water is Type II American Society for Testing and Materials organic-free water if samples for VOCs, inorganic and radionuclides analysis are being collected that day, or certified deionized water if samples for only inorganic and radionuclide constituents are being collected. For EB type samples, laboratory results greater than twice the method detection limit may indicate the presence of cross-contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the threshold is five times the method detection limit. For radiological analytical data, blank results are flagged if they are greater than two times the total minimum detectable activity.

- **Field trip blank (FTB):** FTBs are prepared by the sampling team prior to traveling to the sampling site. The preserved bottle set is either for volatile organic analysis (VOA) only or identical to the set that will be collected in the field and is filled with high-purity reagent water. The bottles are sealed and transported, unopened, to the field in the same storage containers used for samples collected that day. Collected FTBs are analyzed for the same constituents as the samples. FTBs are used to evaluate potential contamination of the samples due to the sample bottles, preservative, handling, storage and transportation.

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

E2.2.5.2 Laboratory Quality Control

Laboratory QC samples (e.g., method blanks, laboratory control sample/blank spike, and matrix spike) are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition*; *Final Update IV-B*, and will be run at the frequency specified in that reference unless superseded by agreement. The QC checks outside of control limits will be identified in the data validation process and during the DQA (as described in Section E2.4). Laboratory QC samples include method blanks, matrix spike/matrix spike duplicate, control and surrogates.

- **Method blanks:** Method blanks are used to assess the response of an entire laboratory analytical system. One sample is routinely processed per batch (20 samples maximum) by the laboratory for each matrix type, or as required by laboratory contract or project-specific requirements.

- **Matrix spike and matrix spike duplicate:** These samples identify analytical (preparation and analysis) bias; possible matrix effect on the analytical method used. These are one sample per batch, 20 samples maximum, of each matrix type or as required by laboratory contract. These types of samples require that triple the normal volume of sample be collected in the field. The need for these sample types will be defined on the sample authorization form.
- **Laboratory control samples:** Laboratory control samples are used to assess method accuracy. One sample is routinely processed per batch (20 samples maximum) by the laboratory for each matrix type, or as required by laboratory contract, or project specific requirements.
- **Surrogates:** Surrogates are used to estimate recovery/yield. Frequency is specified by laboratory contract.

For chemical analyses, the acceptance criteria for laboratory duplicates, matrix spikes, matrix spike duplicates, surrogates, and laboratory control samples are generally derived from historical data at the laboratories in accordance with SW-846. Typical acceptance limits are within 20 percent of the expected values, although the limits may vary considerably with the method and analyte. For radiological analyses, the acceptance limits for laboratory QC samples are specified in the laboratory contract.

Holding time is the elapsed time period between sample collection and analysis. Exceeding required holding times could result in changes in constituent concentrations due to volatilization, decomposition, decay or other physical-chemical alterations. Recommended holding times depend on the analytical method, as specified in SW-846 or *Methods of Chemical Analysis of Water and Wastes* (EPA/600/4-79/020). Holding times are specified in laboratory contracts. Data associated with exceeded holding times are flagged with an "H" in the HEIS database.

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

Failure of QC will be determined and evaluated during data validation and DQA process. Data will be qualified as appropriate.

E2.2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Equipment used for collection, measurement, and testing, will meet the applicable standards (e.g., American Society for Testing and Materials) or have been evaluated as acceptable and valid in accordance with the procedures, requirements, and specifications. The field work supervisor, field technical representative, or equivalent will ensure that the data generated from instructions using a software system are backed up and/or downloaded on a regular basis. Any software configuration will be acceptance tested prior to use in the field.

Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures to ensure minimization of measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory's and the onsite organization's QA plan or operating procedures, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with

SW-846 or with auditable DOE Hanford Site and contractual requirements. Consumables, supplies, and reagents will be reviewed per SW-846 requirements and will be appropriate for their use.

E2.2.7 Instrument/Equipment Calibration and Frequency

Specific field equipment calibration information is provided in Section E3.4 of this SAP. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory QA plan.

E2.2.8 Inspection/Acceptance of Supplies and Consumables

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

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

E2.2.8.1 Nondirect Measurements

Nondirect measurements include data obtained from sources such as computer databases, programs, literature files, and historical databases. Nondirect measurements (historical data) will not be evaluated in conjunction with the acquisition of new data. It is assumed that all historical data have been evaluated and deemed usable for the remedial action project.

E2.2.9 Data Management

The Sample Management and Reporting organization, in coordination with the CHPRC project manager, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with the applicable programmatic requirements governing data management procedures. Electronic data access, when appropriate, will be via a database (e.g., HEIS or a project-specific database). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b).

Planning for sample collection and analysis will be in accordance with the programmatic requirements governing fixed laboratory sample collection activities, as discussed in the sample team's procedures. In the event that specific procedures do not exist for a particular work evolution, or if it is determined that additional guidance to complete certain tasks is needed, a work package will be developed to adequately control the activities, as appropriate. Examples of the sample team's requirements include activities associated with the following:

- Chain of custody/sample analysis requests
- Project and sample identification for sampling services
- Control of certificates of analysis
- Logbooks
- Checklists
- Sample packaging and shipping

Approved work control packages and procedures will be used to document field activities, including radiological measurements, when this SAP is implemented. All field activities will be recorded in the field logbook. Examples of the types of documentation for field radiological data include the following:

- Instructions regarding the minimum requirements for documenting radiological controls information in accordance with 10 CFR 835, "Occupational Radiation Protection."
- Instructions for managing the identification, creation, review, approval, storage, transfer, and retrieval of primary contractor radiological records.
- The minimum standards and practices necessary for preparing, performing, and retaining radiological-related records.
- The indoctrination of personnel on the development and implementation of sample plans.
- The requirements associated with preparing and transporting regulated material.
- Daily reports of radiological surveys and measurements collected during conduct of field investigation activities. Data will be cross-referenced between laboratory analytical data and radiation measurements to facilitate interpreting the investigation results.
- Daily reports of radiological surveys and measurements collected during conduct of field investigation activities. Data will be cross-referenced between laboratory analytical data and radiation measurements to facilitate interpreting the investigation results.

Laboratory errors are reported to Sample Management and Reporting on a routine basis. For reported laboratory errors, a sample disposition record will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish their resolution with the project manager. The sample disposition records become a permanent part of the analytical data package for future reference and for records management.

E2.3 Assessment and Oversight

This section describes the methods to be used for assessing the effectiveness of project implementation and associated QA and QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

E2.3.1 Assessments and Response Actions

CHPRC management, regulatory compliance, quality and/or health and safety representatives may conduct random surveillance and assessments to verify compliance with the requirements outlined in this SAP, project work packages, the project quality management plan, procedures, and regulatory requirements. The CHPRC project manager will determine if a DQA will be performed for the activities identified in this SAP. The results of the DQA will be provided to the CHPRC project manager.

If circumstances arise in the field that would dictate the need for additional assessment activities (as determined by the CHPRC project manager or field work supervisor), the additional assessments would be performed and recorded. Deficiencies identified by these assessments will be reported in accordance with existing programmatic requirements. CHPRC management representatives shall coordinate the corrective actions/deficiencies in accordance with the CHPRC QA program, the corrective action management program, and associated procedures that implant these programs.

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

E2.3.2 Reports to Management

Reports to management on data quality issues will be made if and when these issues are identified. Issues reported by the laboratories are communicated to Sample Management and Reporting and are documented in a sample disposition record. This process is used to document analytical or sample issues and to establish resolution with the CHPRC project manager.

Depending on the type, significance, and visibility of the project, a DQA report may be prepared to determine if the type, quality, and quantity of the collected data met the quality objectives described in this SAP.

E2.4 Data Validation and Usability

This section describes the QA activities that occur after the data collection phase of the project is completed. Implementation of these elements determines whether the data conform to the specified acceptance criteria.

E2.4.1 Data Review, Verification, and Validation

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

Data validation will be performed to ensure that the data quality goals established during the planning phase have been achieved. As recommended in EPA guidance (*Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses* [Bleyler, 1988a]; *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses* [Bleyler, 1988b]), the criteria for data validation are based on a graded approach. Based on contract requirements, five levels of validation, Levels A through E, have been defined. Level A is the lowest level and is the same as verification. Level E is a 100 percent review of all data (e.g., calibration data; calculations of representative samples from the data set).

Validation will be performed to Level C. Level C validation is a review of the QC data and specifically requires verification of deliverables, verification of requested versus reported analyses, and qualification of the results based on analytical holding times; method blank results; matrix spike/matrix spike duplicate; surrogate recoveries; duplicates; and analytical method blanks. Level C validation will be performed on at least five percent of the data by matrix and analyte group. Analyte group refers to categories (e.g., VOCs, radionuclides, metals, anions, etc.). The goal is to cover the various analyte groups and matrices during the validation.

Relative to analytical data in sample media, physical data and/or field screening results are of lesser importance. Field QA/QC will be reviewed to ensure that physical property data and/or field screening results are consistent with expectations and are useable.

E2.4.2 Verification and Validation Methods

Validation activities will be based on EPA functional guidelines (Bleyler, 1988a and 1988b). Data validation may be performed by Sample Management and Reporting, and/or by a party independent of both the data collector and the data user. Data qualifiers must be compatible with the HEIS database.

When outliers or questionable results are identified, additional data validation will be performed. The additional validation will be performed for up to five percent of the statistical outliers and/or questionable data. The additional validation will begin with Level C and may increase to Levels D and E as needed to ensure that the data are usable. Note that Level C validation is a review of the QC data, while Levels D and E include review of calibration data and calculations of representative samples from the data set. All data validation will be documented in data validation reports, which will placed in the project file.

E2.4.3 Reconciliation with User Requirements

The DQA process (EPA/240/B-06/002, *Data Quality Assessment: A Reviewer's Guide*; and EPA/240/B-06/003, *Data Quality Assessment: Statistical Methods for Practitioners*) compares completed field sampling activities to those described in the SAP and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the DQOs. The CHPRC project manager is responsible for determining if a DQA is necessary and ensuring that it is performed if required. The results of the DQA will be used in interpreting the data and determining if objectives have been met. The type of DQA performed may vary depending on whether the sample design was statistical. DQA activities typical of a statistical based sample design may include the following:

- **Step 1:** Review DQOs and sampling design. This step requires a comprehensive review of the sampling and analytical requirements outlined in the project-specific DQO summary report and SAP. As appropriate, the following are performed:
  - Verify that the hypothesis or estimate chosen is consistent with the project's objective and meets the project's performance and acceptance criteria
  - Translate study objectives into statistical terms
  - List any deviations from the planned sampling design
  - Determine the potential effect of any deviation
- **Step 2:** Conduct a preliminary data review. Compare the actual QA/QC achieved (e.g., precision, accuracy, and completeness) with the requirements identified in the SAP. Document in the final DQA report any significant deviations. Calculate the basic statistics from the analytical data and include an evaluation of the distribution of the data. As appropriate, determine the following:
  - Central tendency of the data (e.g., mean, median, and mode)
  - Relative standing of individual datum (e.g., percentiles and quantiles)
  - Dispersion of the data (e.g., range, variance, and standard deviation)
  - Association, i.e. relationship between two or more variables, of the data (e.g., correlation coefficients)

  If appropriate, this information can be determined and/or displayed graphically.

- **Step 3:** Select the data analyses. Select the appropriate statistical hypothesis test(s) or graphical data analyses and justify this selection. As appropriate, determine the following:
  - The null hypothesis
  - Alternative hypothesis
  - Statistic test (t-test)
  - Critical value (regulatory threshold)
  - Conclusion
- **Step 4:** Verify the assumptions. Assess the validity of the data analyses (Step 3) by determining if the data support the underlying assumptions necessary for the analyses or if the data set must be modified (e.g., transposed or augmented with additional data) before further analysis. This step is necessary because the validity of the selected method depends on the validity of key assumptions underlying the test. As appropriate, determine the following:
  - Assumptions required for data analyses test (e.g., independent data and approximate normal distribution)
  - If data meet the assumptions

  Assumptions might be determined qualitatively by reviewing the sampling plan, qualitatively inspecting the shape of a histogram, and quantitatively applying an appropriate test for distributions assumptions. If it is determined that one or more of the assumptions is not met, then an alternate plan is needed (selection of a different statistical method or collection of additional data).
- **Step 5:** Draw conclusions from the data. Apply the statistical method selected in Step 3. Clearly document any calculations used. As appropriate, determine the following:
  - If the data reject the null hypothesis
  - If the data fail to reject the null hypothesis
  - Confidence interval (qualitatively or quantitatively)
  - Tolerance interval

E2.4.4 Corrective Actions

The responses to data quality defects identified through the DQA process will vary and may be data- or measurement-specific.

E3 Field Sampling Plan

E3.1 Sampling Objectives

The objective for the field sampling plan portion of this SAP is to identify and clearly describe the sampling and analysis activities necessary to achieve the identified DQOs. The field sampling plan implements the sampling design developed through the PMP (DOE/RL-2009-115) and presents the design using figures and tables to identify sampling locations, the total number of samples to be collected, sampling procedures to be implemented, sample container requirements, and the analyses to be performed.

E3.2 Documentation of Field Activities

Logbooks or data forms are required for all field activities. Water-level measurement and groundwater quality sampling data forms may be used to record field information; however, the forms must follow the same requirements for logbooks and must be referenced in the logbooks.

Information to be recorded in logbooks or data forms shall include the following:

- Purpose of activity
- Day, date, time, and weather conditions
- Names, titles, and organizations of personnel present
- Deviations from the QAPjP or procedures
- All site activities, including field tests
- Materials quality documentation (e.g., certifications)
- Details of samples collected (e.g., preparation, splits, duplicates, matrix spikes, and equipment blanks)
- Location and types of samples
- Chain-of-custody details and variances relating to chain-of-custody
- Field measurements
- Field calibrations and surveys, and equipment identification numbers, as applicable
- Equipment decontaminated, number of decontaminations, and variations to any decontamination procedures
- Equipment failures or breakdowns and descriptions of any corrective actions
- Telephone calls associated with field activities

E3.3 Sampling Design

The sampling design employed in this SAP (Appendix E of this O&M plan) is judgmental and was developed based on the information presented in the PMP (DOE/RL-2009-115). Monitoring well locations and measurement parameters were selected based on knowledge of the feature or condition under investigation, professional judgment, and ROD requirements.

E3.4 Calibration of Field Equipment

The field work supervisor or designee is responsible for ensuring that all field equipment is calibrated appropriately. All onsite environmental instruments are calibrated in accordance with the manufacturer's operating instructions, internal work requirements and processes, and/or work packages that provide direction for equipment calibration or verification of accuracy by analytical methods. The results from all instrument calibration activities are recorded in logbooks and/or work packages; either hardcopy or electronic are acceptable. Calibrations must be performed as follows:

- Prior to initial use of a field analytical measurement system
- At the frequency recommended by the manufacturer or procedure, or as required by regulations
- Upon failure to meet specified QC criteria

Field instrumentation, calibration, and QA checks will be performed in accordance with the following:

- Calibration of radiological field instruments on the Hanford Site is performed under contract by Pacific Northwest National Laboratory, as specified in their program documentation.
- Daily calibration checks will be performed and documented for each instrument used to measure physical/chemical properties. These checks will be made using reference standards that are sufficiently like the matrix under consideration so direct comparison of the data can be made.
- Standards used for calibration will be traceable to a nationally or internationally recognized source or measurement system, if available.

Nonradiological equipment requiring field calibration includes water quality meters (e.g., temperature, specific conductance, reduction-oxidation potential, and dissolved oxygen). Selection of the pH buffers and specific conductance standards shall account for the range of conditions present within 200-ZP-1 OU.

E3.5 Sample Locations and Frequency

The groundwater monitoring well network is comprised of two well groups: monitoring wells for water-level measurements, and monitoring wells for COC and MNA sampling and analysis. Hydraulic monitoring well locations are shown on Figure E-6 ,VOC monitoring well locations are shown in Figure E-7, and contaminant-specific well locations are shown in Figures E-8 through E-13 for contaminant-specific monitoring. General information on each of the hydraulic monitoring wells is provided in Table E-9, and details of the current groundwater monitoring well networks are provided in the PMP (DOE/RL-2009-115). The sampling schedule for all analytes is found in Table E-10.

E3.5.1 Water-Level Measurements

Figure E-6 depicts the current hydraulic monitoring network. Table E-9 lists the current wells with pressure transducers installed. Water-level measurements are collected during each groundwater monitoring event.

Periodic water-level data recorded by the pressure transducers are downloaded on a quarterly to annual basis, depending on the measurement frequency.

Water-level measurements may also be collected during nonroutine events when a significant change in P&T operation occurs, such as during a system-wide shutdown, when a group of wells is temporarily or permanently idle for a period of 7 days or more, or when pumping rates are simultaneously altered at three or more wells for a period of 7 days or more. The CHPRC project manager will have the discretion to determine if a nonroutine water-level measurement event is warranted.

E3.5.2 Groundwater Extraction Well Pumping Rates

Extraction well instantaneous pumping rates and total flow are measured by inline flow meters and the data are saved to an onsite and remote server. The data servers can be queried as needed to obtain daily, weekly, or monthly average flow rates, as well as total monthly flows.

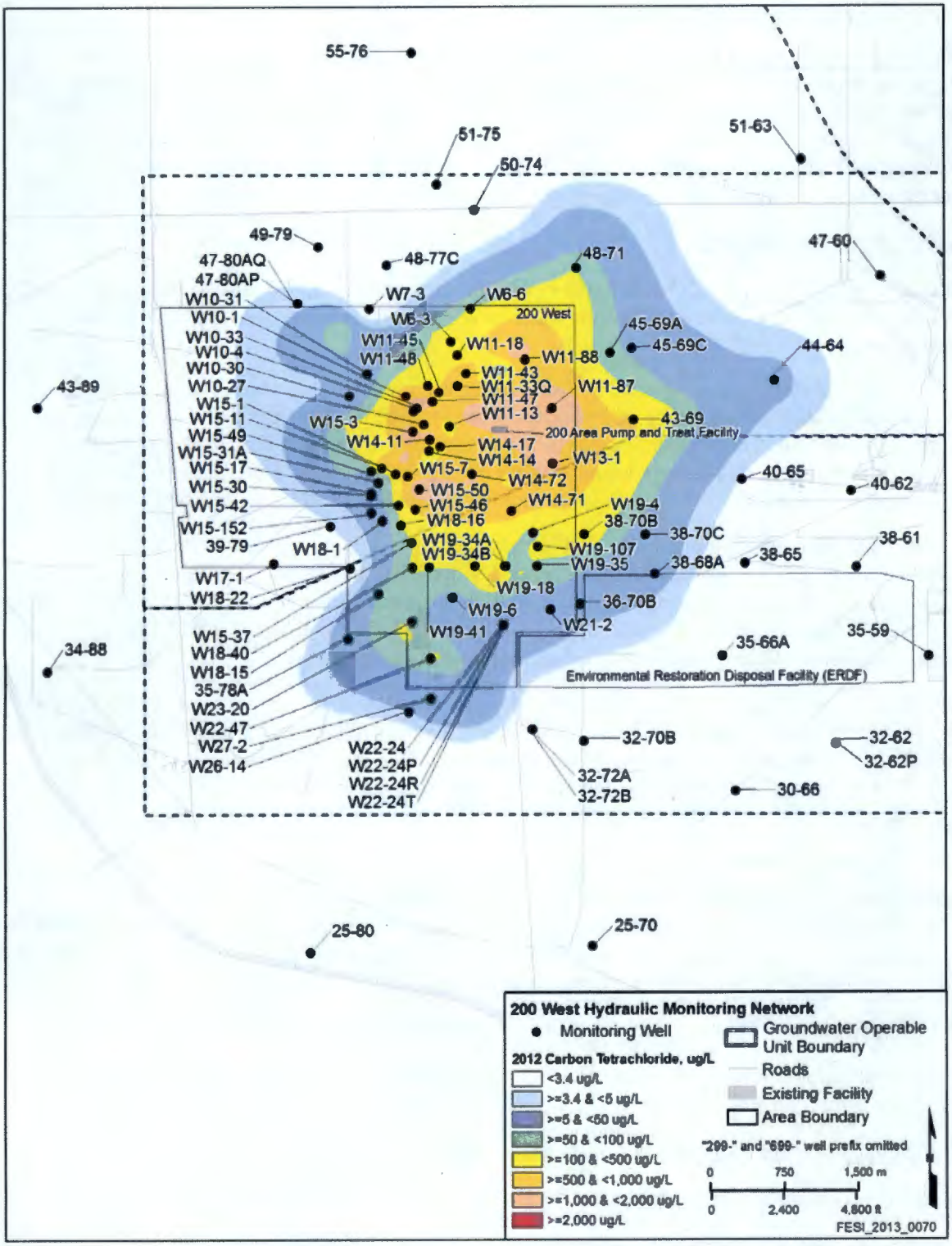

Figure E-6. Water-Level Monitoring Network

E3.5.3 Groundwater Quality Sampling

Groundwater sampling was performed on an annual basis from the contaminant monitoring wells in the 200 West Area beginning in 2011 in accordance with the PMP (DOE/RL-2009-115). Beginning in 2014, a contaminant-specific set of wells (Figures E-7 through E-13) have been identified for annual sampling based on a review of the wells and data trends relative to the plumes published in the *Hanford Site Groundwater Monitoring Report for 2012* (DOE/RL-2013-22). All of the 200-ZP-1 OU wells will be sampled in the year prior to and in preparation for the next CERCLA 5-year review.

E3.6 Sampling Methods

Water-level measurements shall be performed using an electronic meter, and the date, time, and measurement depth shall be recorded on the water-level measurement form or in the logbook (as described in Section E3.2).

Groundwater samples shall be collected by first purging each well per procedure. During the purging process, water quality parameters (e.g., pH, temperature, specific conductance, dissolved oxygen, and reduction-oxidation potential) shall be periodically measured in a flow-through chamber using field instrumentation and the results recorded on the data form or field logbook. Samples are collected after field parameters have stabilized in accordance with the criteria described in the sampling procedure.

Following the purging step, samples for VOC and total organic carbon analysis will be collected first using a bottom-emptying disposable bailer equipped with a VOC draw tube. Samples for inorganic and general water quality parameters may be collected from the pump discharge (if dedicated purge tubing is being used) or from the bailer. Samples for dissolved metals analysis will be collected by field filtering through an inline 0.45-micron filter installed on the pump discharge tubing.

Preliminary sample container bottle and preservation types are shown in Table E-11. The laboratory's letter of instruction will specify the final container types, sample volume, and preservation requirements. The total estimated number of samples to be collected, including field QA samples, is shown in Table E-12. Additional sample volume requirements (matrix spike/matrix spike duplicate) will be specified in the laboratory's letter of instruction.

E3.6.1 Decontamination of Sampling Equipment

Sampling equipment will be decontaminated in accordance with applicable procedures. To prevent contamination of the samples, care will be taken to use clean or dedicated equipment for each sampling activity. Special care will 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 container by setting the equipment/sample container 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
- Field decontamination (e.g., field washing methods) is not rigorous enough or does not use the appropriate equipment (stiff brushes or pressure washer) for the sampling equipment being used

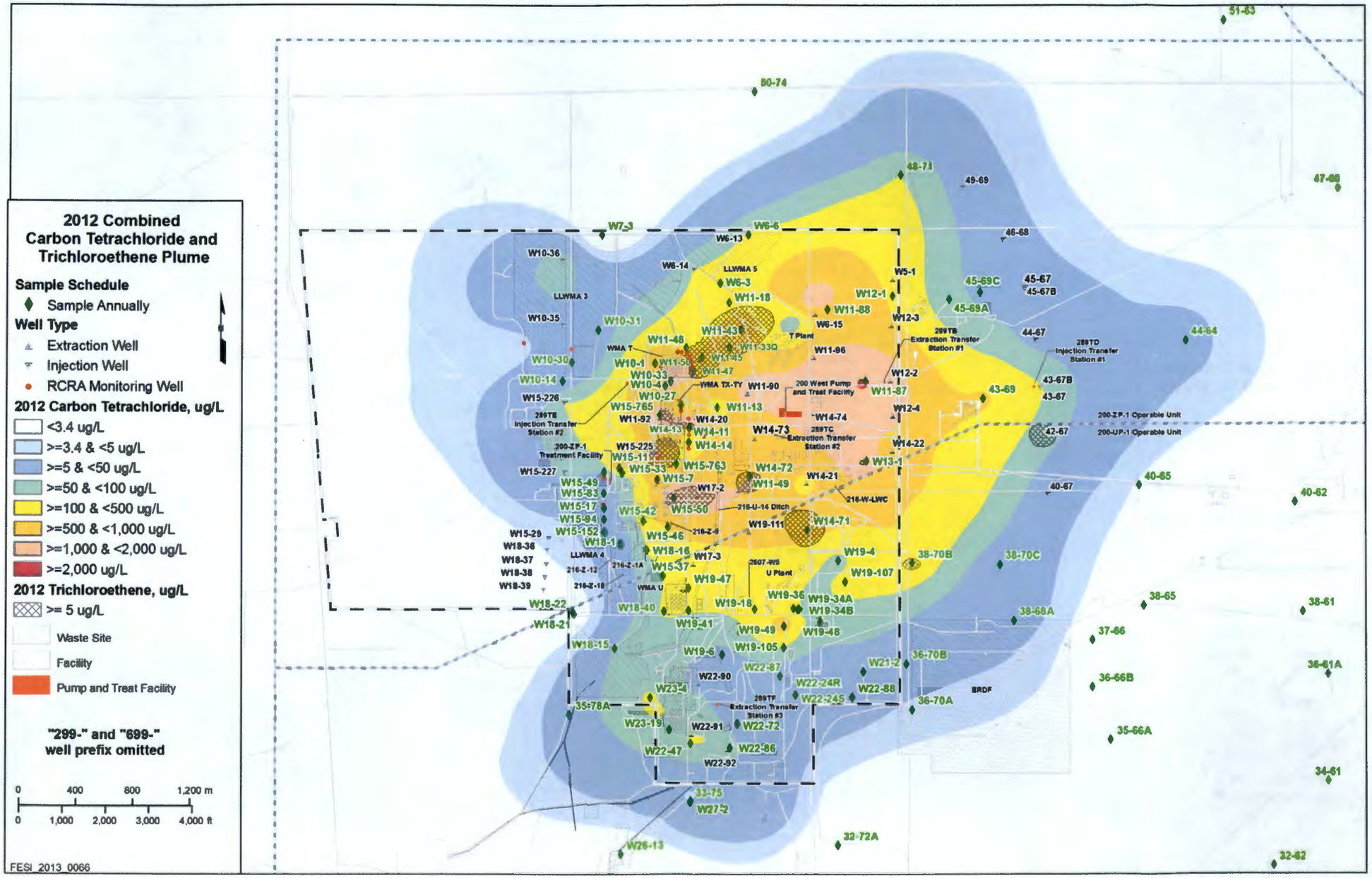

Figure E-7. Contaminant Monitoring Well Network (VOCs)

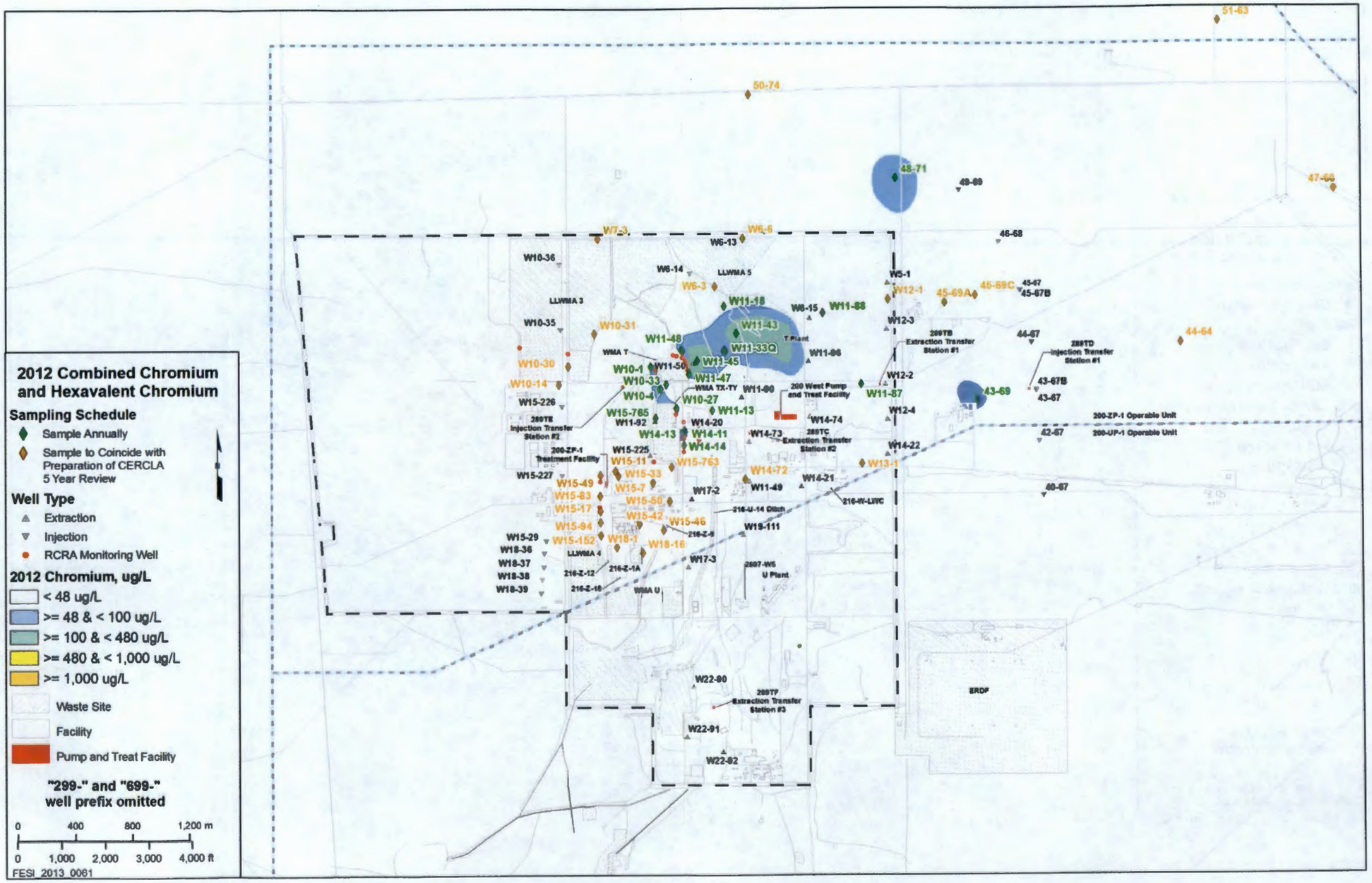

Figure E-8. Contaminant-Specific Monitoring Well Network (Chromium)

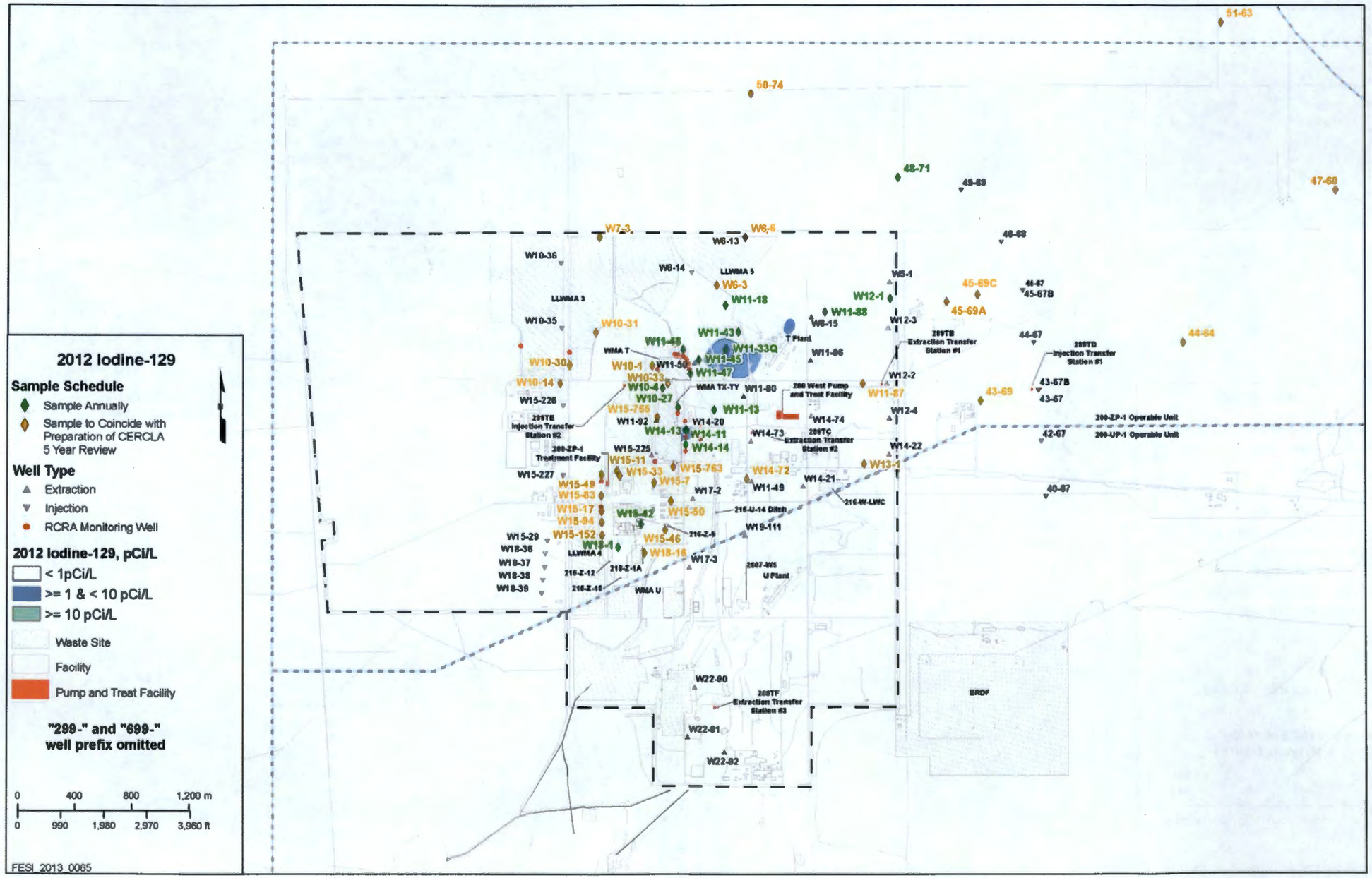

Figure E-9. Contaminant-Specific Monitoring Well Network (Iodine-129)

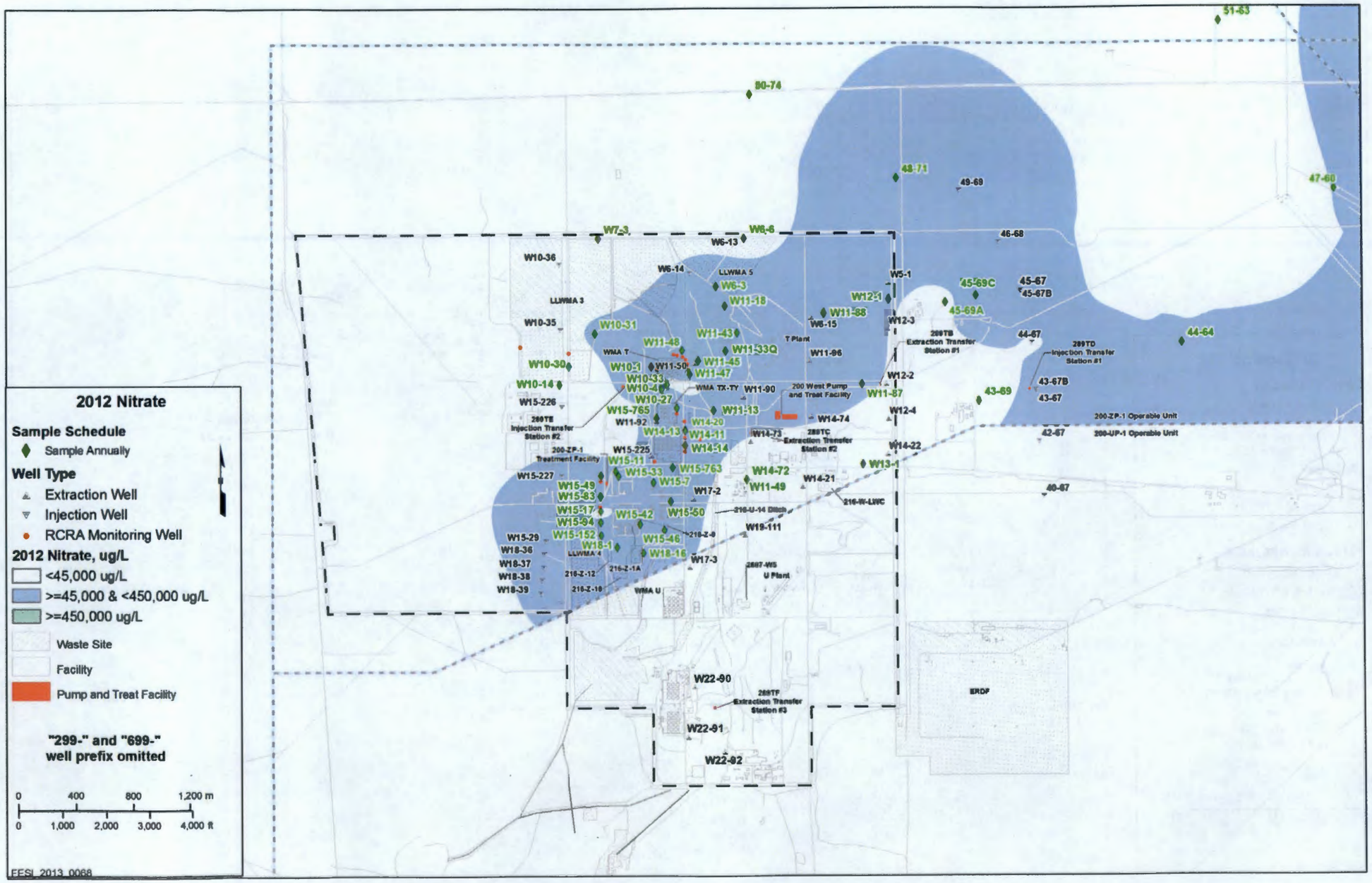

Figure E-10. Contaminant-Specific Well Monitoring Network (Nitrate)

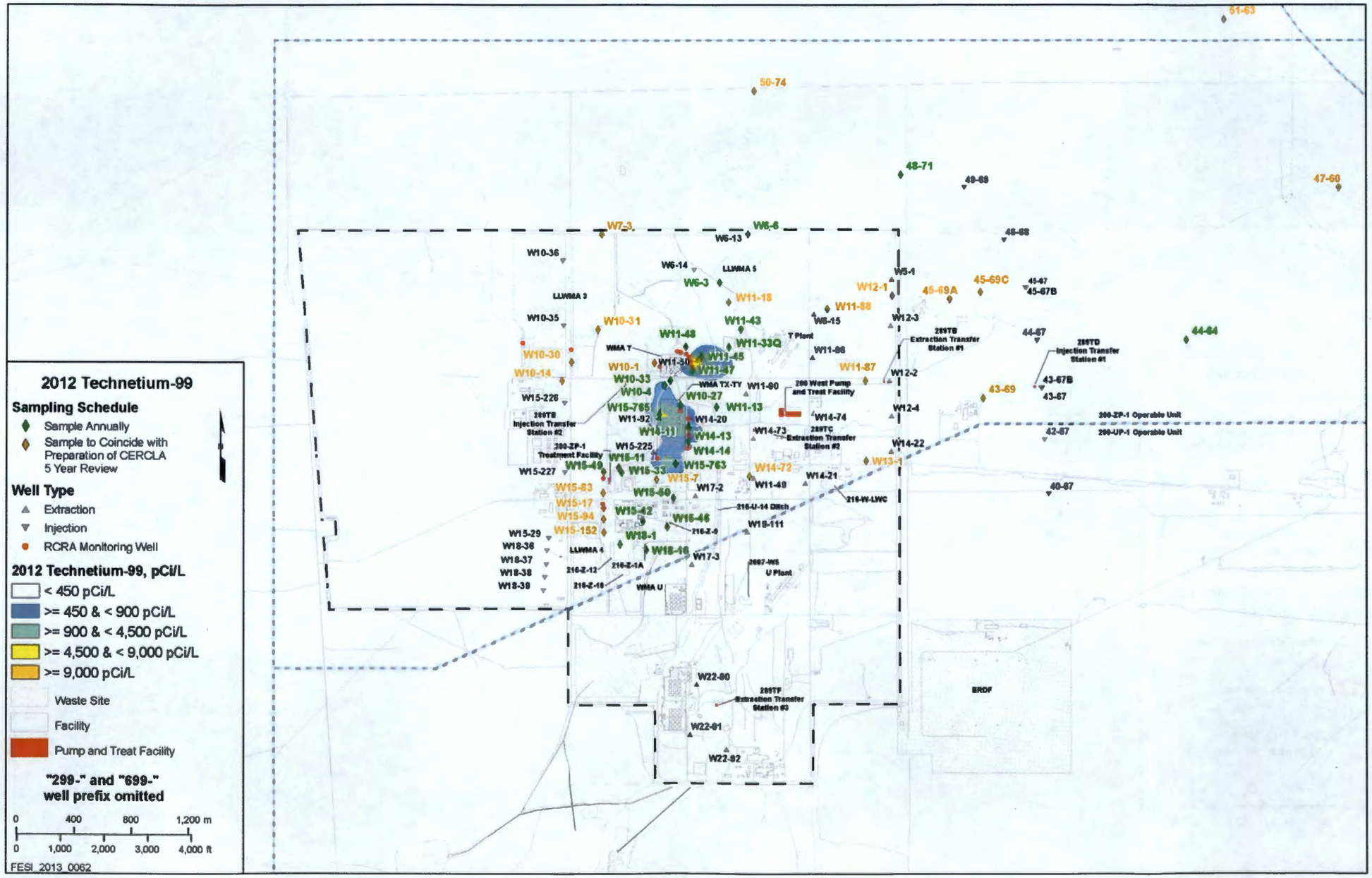

Figure E-11. Contaminant-Specific Monitoring Well Network (Technetium-99)

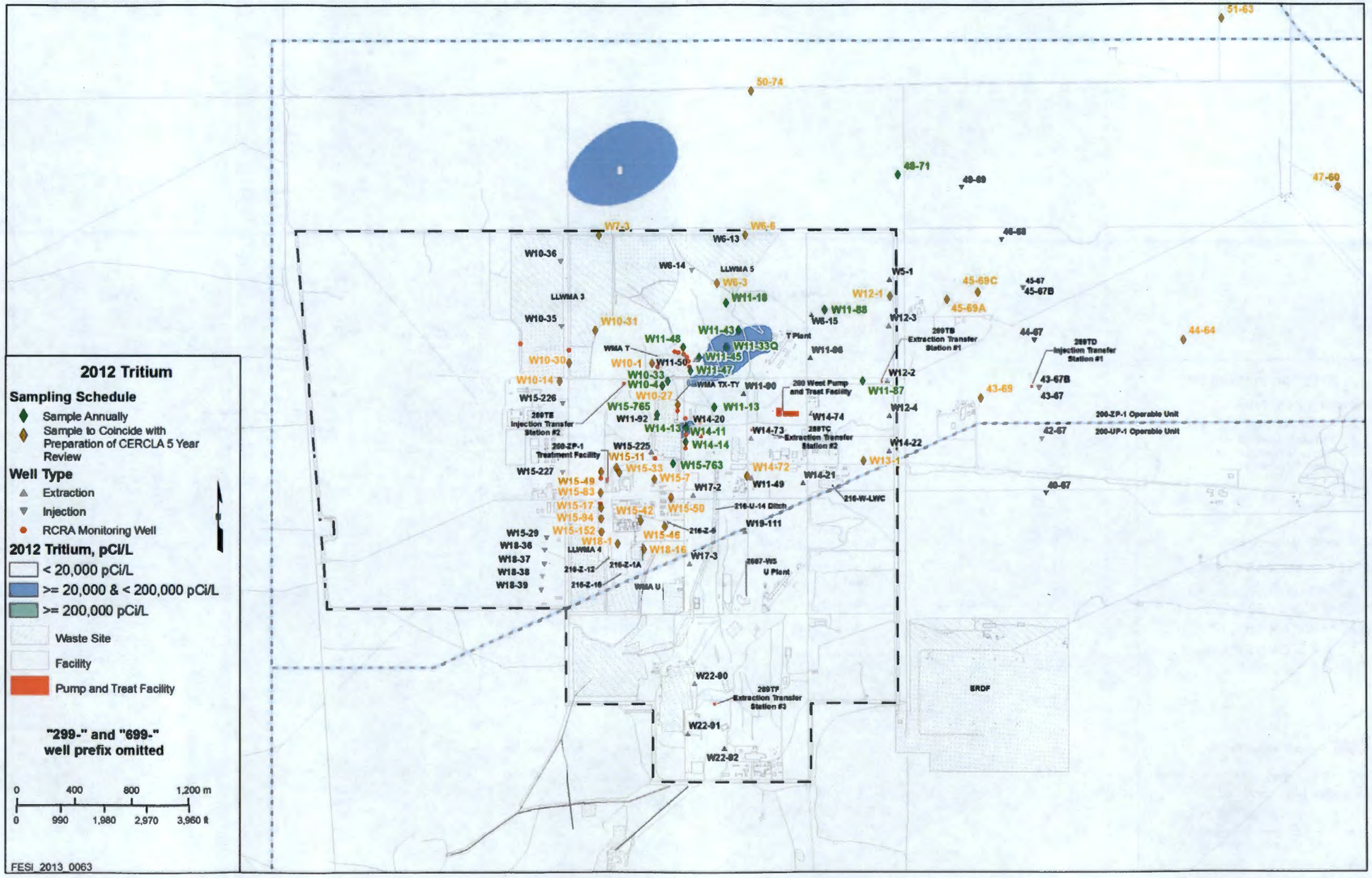

Figure E-12. Contaminant-Specific Monitoring Well Network (Tritium)

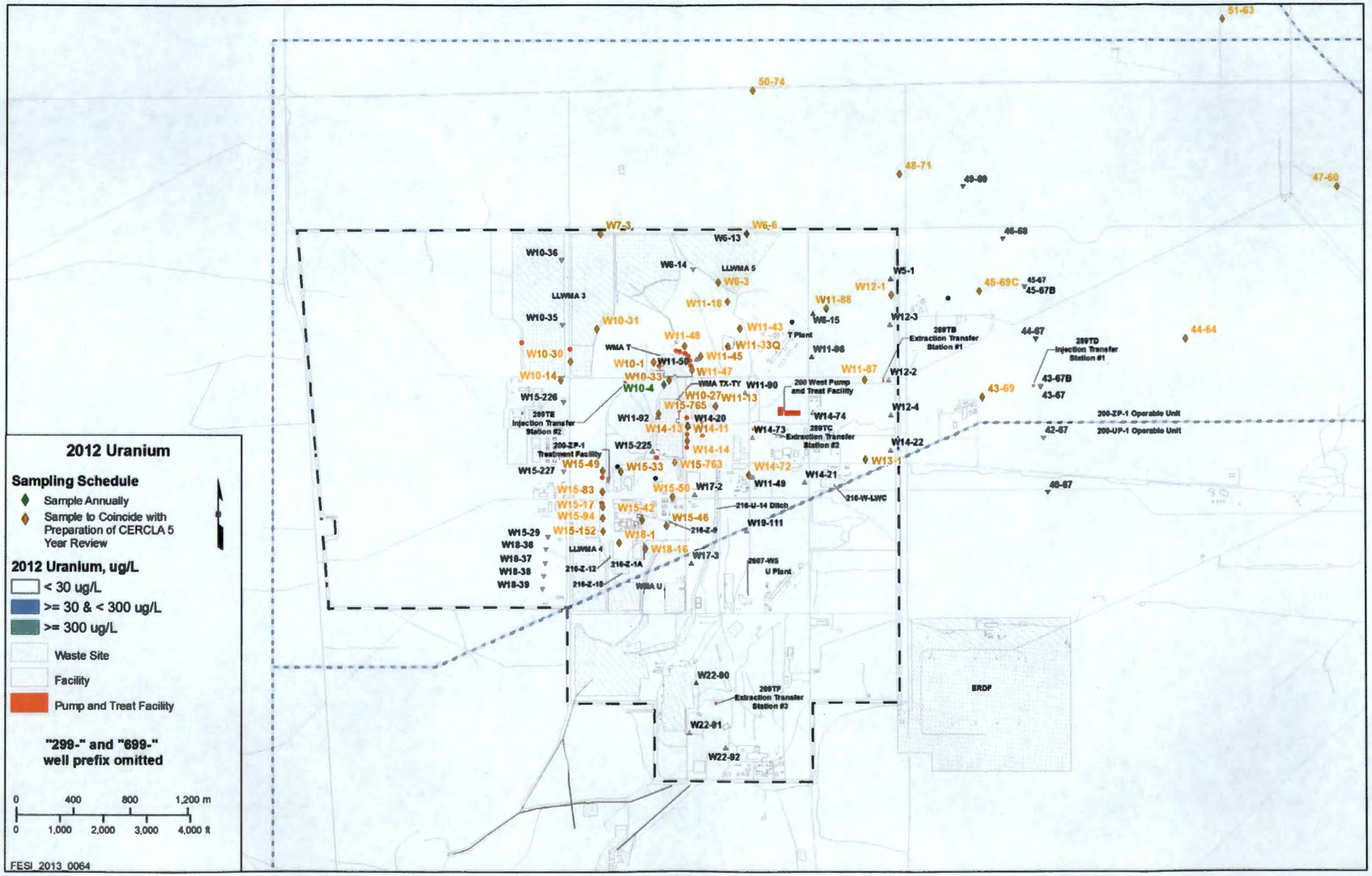

Figure E-13. Contaminant-Specific Well Monitoring Network (Uranium)

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Table E-9. 200 West Area Hydraulic Monitoring Well Network

Well Name	Easting (m)	Northing (m)	Surface Elevation (m)	Depth to Screen Top (m)	Depth to Screen Bottom (m)	Date Drilled	Transducer Equipment	Mid-Screen Elevation (m)
299-W10-1	566663	136735	207.5	57.91	82.3	08/07/47	No	137.4
299-W10-27	566844	136442	205.6	67.36	78.02	03/23/01	No	132.9
299-W10-30	566083	136739	211.6	73.86	84.53	03/14/06	No	132.4
299-W10-31	566266	136968	210.4	73.13	83.82	04/20/06	No	131.9
299-W10-33	566773	136610	206.0	118.87	124.96	06/15/07	No	84.1
299-W10-4	566735	136578	205.5	57.91	74.68	11/10/52	Yes	139.2
299-W11-13	567099	136424	211.9	66.45	143.86	07/31/61	No	106.7
299-W11-18	567182	137161	216.5	69.19	89.916	03/01/67	No	136.9
299-W11-33Q	567185	136844	217.2	74.41	91.17	09/09/94	No	134.4
299-W11-43	567270	136971	217.5	129.44	134.01	05/23/05	Yes	85.8
299-W11-45	566993	136776	213.6	85.73	90.18	09/02/05	No	125.7
299-W11-47	566934	136681	210.4	83.58	92.89	01/06/06	Yes	122.2
299-W11-48	566882	136846	209.7	84.56	112.01	11/29/06	Yes	111.4
299-W11-87	568141	136609	223.6	116.36	120.94	03/01/07	Yes	105.0
299-W11-88	567875	137113	221.9	135.66	147.85	10/03/07	Yes	80.1
299-W13-1	568149	136049	223.5	119.15	129.81	02/10/04	Yes	99.1
299-W14-11	566902	136288	205.1	79.77	82.81	04/26/05	No	123.8
299-W14-14	566898	136181	205.4	66.13	76.81	11/12/98	Yes	134.0
299-W14-17	567007	136218	205.9	67.64	78.32	10/24/00	No	132.9
299-W14-71	567733	135568	219.4	125.17	129.74	07/27/06	Yes	92.0
299-W14-72	567328	135941	216.3	126.18	130.76	08/15/06	Yes	87.9
299-W15-1	566554	135943	207.0	57.91	82.3	05/02/47	No	136.9
299-W15-11	566412	136001	208.3	55.78	90.53	03/08/68	Yes	135.1
299-W15-152	566309	135550	209.9	71.94	82.61	09/15/05	No	132.6
299-W15-17	566307	135719	209.8	128.77	131.82	10/28/87	No	79.5
299-W15-3	566729	136371	205.4	60.96	71.93	09/30/52	No	139.0
299-W15-30	566305	135749	210.2	66.47	78.63	05/05/95	Yes	137.7

Table E-9. 200 West Area Hydraulic Monitoring Well Network

Well Name	Easting (m)	Northing (m)	Surface Elevation (m)	Depth to Screen Top (m)	Depth to Screen Bottom (m)	Date Drilled	Transducer Equipment	Mid-Screen Elevation (m)
299-W15-31A	566377	135856	208.5	64.76	76.93	05/26/95	No	137.7
299-W15-37	566716	135248	203.0	64.74	77.98	05/16/96	No	131.68
299-W15-42	566582	135627	207.4	69.50	84.74	02/26/02	No	130.3
299-W15-46	566752	135587	204.2	63.86	88.23	10/03/03	No	128.2
299-W15-49	566307	135973	209.1	71.86	82.52	11/01/04	No	131.9
299-W15-50	566793	135791	203.2	74.19	84.85	02/28/05	No	123.7
299-W15-7	566676	135920	204.2	55.47	106.68	03/30/66	Yes	123.1
299-W17-1	565311	135039	199.2	58.99	69.67	12/17/03	No	134.9
299-W18-1	566422	135465	209.1	59.44	111.89	01/12/59	No	123.4
299-W18-15	566380	134733	202.2	51.82	74.07	04/25/80	No	139.3
299-W18-16	566605	135426	208.5	71.47	82.13	10/20/04	No	131.8
299-W18-22	566089	134990	204.9	126.94	136.39	09/25/87	No	73.2
299-W18-40	566723	134996	203.4	66.53	77.20	09/28/01	No	131.6
299-W19-107	567998	135206	217.4	94.65	99.22	03/31/06	Yes	120.5
299-W19-18	567361	135012	214.0	67.06	109.12	12/12/85	No	125.90
299-W19-34A	567674	135012	215.1	98.82	103.51	05/18/94	No	113.9
299-W19-34B	567663	135011	215.5	125.46	128.41	12/12/85	No	88.6
299-W19-35	567992	135015	213.6	73.13	82.3	04/20/94	No	135.9
299-W19-4	567950	135351	219.0	77.72	135.03	02/15/60	No	112.3
299-W19-41	566897	135005	206.5	67.07	77.76	09/23/98	No	134.1
299-W19-6	567133	134694	210.3	115.82	125.27	12/13/68	No	89.79
299-W21-2	568124	134574	214.9	79.29	89.96	11/22/04	No	130.2
299-W22-24	567648	134411	212.2	67.06	163.07	09/08/60	No	97.1
299-W22-47	566909	134076	206.3	69.70	80.37	01/19/05	No	131.3
299-W23-20	566718	134446	203.8	65.68	76.35	08/21/00	No	132.8
299-W26-14	566683	133539	205.4	68.08	78.75	04/03/03	No	132.0
299-W27-2	566908	133670	207.4	123.79	126.87	12/18/92	No	82.1

Table E-9. 200 West Area Hydraulic Monitoring Well Network

Well Name	Easting (m)	Northing (m)	Surface Elevation (m)	Depth to Screen Top (m)	Depth to Screen Bottom (m)	Date Drilled	Transducer Equipment	Mid-Screen Elevation (m)
299-W6-3	567118	137299	214.4	124.82	127.95	10/15/91	No	87.9
299-W6-6	567319	137639	217.5	127.58	130.84	10/24/91	No	88.3
299-W7-3	566292	137639	207.2	136.85	145.29	11/23/87	No	66.1
699-25-70	568545	131172	193.0	53.34	134.11	08/31/48	No	99.24
699-25-80	565676	131106	189.0	273.41	370.03	11/30/48	No	-132.7
699-30-66	569991	132739	210.5	117.35	120.4	10/13/04	No	91.6
699-32-62	571010	133216	216.6	83.82	103.63	04/06/60	No	122.9
699-32-62P	571010	133216	216.6	83.82	146.3	04/06/60	No	101.5
699-32-70B	568462	133242	204.2	63.09	100.58	08/09/57	No	122.37
699-32-72A	567943	133363	204.7	65.42	74.56	07/31/57	No	134.7
699-32-72B	567935	133362	205.1	65.41	74.56	05/18/94	No	135.1
699-34-88	563012	133950	194.0	146.0	127.02	12/20/48	No	136.5
699-35-59	571956	134096	222.1	94.48	106.67	10/31/85	No	121.5
699-35-66A	569858	134099	222.5	79.25	98.15	06/13/57	No	133.76
699-35-78A	566064	134271	202.4	54.86	85.04	08/17/50	Yes	132.02
699-36-70B	568428	134626	215.2	80.51	91.17	06/09/04	No	129.4
699-38-61	571219	134997	228.2	101.83	107.92	11/16/93	No	123.3
699-38-65	570090	135040	230.7	152.4	155.45	12/31/59	Yes	76.8
699-38-68A	569180	134932	219.0	81.59	90.74	06/21/94	No	132.8
699-38-70B	568469	135331	222.6	123.96	128.53	02/03/04	No	96.3
699-38-70C	569084	135326	226.7	120.60	125.18	02/17/04	No	103.8
699-39-79	565891	135412	206.5	54.44	73.152	09/07/48	Yes	142.7
699-40-62	571164	135764	228.9	102.11	114.0	01/17/49	No	120.8
699-40-65	570057	135881	231.0	100.0	111.5	02/03/04	Yes	125.3
699-43-69	568967	136488	227.4	121.98	132.64	12/11/07	Yes	100.1
699-43-89	562917	136620	197.7	43.28	60.35	01/16/51	No	145.9
699-44-64	570391	136897	222.2	96.32	134.72	01/31/60	Yes	106.67

Table E-9. 200 West Area Hydraulic Monitoring Well Network

Well Name	Easting (m)	Northing (m)	Surface Elevation (m)	Depth to Screen Top (m)	Depth to Screen Bottom (m)	Date Drilled	Transducer Equipment	Mid-Screen Elevation (m)
699-45-69A	568729	137183	222.1	83.52	111.56	06/22/48	No	124.6
699-45-69C	568947	137234	222.6	111.86	116.43	07/13/07	Yes	108.4
699-47-60	571474	137969	199.6	71.63	84.43	07/20/48	No	121.6
699-47-80AP	565562	137693	218.26	198.12	204.83	11/30/83	No	16.8
699-47-80AQ	565562	137693	218.26	153.31	156.36	11/30/83	No	63.4
699-48-71	568388	138057	210.9	138	156.36	09/26/56	Yes	63.7
699-48-77C	566469	138087	206.6	88.39	94.49	04/01/94	No	115.42
699-49-79	565771	138271	211.1	65.58	80.77	07/03/48	Yes	137.9
699-50-74	567360	138647	201.4	68.07	78.74	07/12/05	No	128.0
699-51-63	570664	139148	175.3	47.85	55.78	11/06/56	No	123.49
699-51-75	566978	138906	196.6	57.91	68.58	10/31/57	No	133.4
699-55-76	566723	140226	178.7	42.98	67.36	01/18/59	No	123.5

E3.6.2 Pre-Shipment Sample Screening

A representative portion of each sample, retained from leftover media, will be shipped to the Waste Sampling and Characterization Facility or other suitable onsite laboratory for total activity analysis. Total radiological activities or other analysis, as required, will be used for sample shipping characterization. Samples that slightly exceed the offsite laboratory criterion may be reduced in volume to reduce total activity and allow for offsite shipment. Onsite and offsite laboratories will be identified before field activities are initiated and will be mutually acceptable to the CHPRC Sample and Data Management organization and the field work supervisor.

E3.7 Sample Handling

Level I EPA pre-cleaned sample containers will be used for samples collected for chemical analysis. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. The radiological engineering organization will measure both the contamination levels and dose rates associated with the sample containers. This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's acceptance criteria. If the dose rate on the outside of a sample jar or the curie content exceeds levels acceptable by an offsite laboratory, the field work supervisor (in consultation with Sample Management and Reporting) can send smaller volumes to the laboratory. Preliminary container types and volumes are identified in Table E-8.

Table E-10. 200-ZP-1 Sampling Schedule

Well Name	Carbon tetrachloride	Chromium (total and hexavalent)	Iodine-129	Nitrate	Technetium-99	Trichloroethene	Tritium	Uranium	Chloroform	Dichloromethane	Chloromethane	cis-1,2-Dichloroethene	Vinyl chloride	Chloride	Nitrite	Total Organic Carbon	Total Dissolved Solids	Sulfate	Sulfide	Iron	Manganese	Alkalinity	Carbonate Content	Temperature	pH	Specific conductance	Turbidity	Dissolved oxygen	Redox potential
299-W10-1	A	A	5	A	5	A	5	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W10-14	A	5	5	A	5	A	5	5	A	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W10-27	A	A	A	A	A	A	5	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W10-30	A	5	5	A	5	A	5	5	A	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W10-31	A	5	5	A	5	A	5	5	A	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W10-33	A	A	5	A	A	A	A	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W10-4	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W11-13	A	A	A	A	A	A	A	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W11-18	A	A	A	A	5	A	A	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W11-33Q	A	A	A	A	A	A	A	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W11-43	A	A	A	A	A	A	A	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W11-45	A	A	A	A	A	A	A	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W11-47	A	A	A	A	A	A	A	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W11-48	A	A	A	A	A	A	A	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W11-87	A	A	5	A	5	A	A	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W11-88	A	A	A	A	5	A	A	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W12-1	A	5	A	A	5	A	5	5	A	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W13-1	A	5	5	A	5	A	5	5	A	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W14-11	A	A	A	A	A	A	A	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W14-13	A	A	A	A	A	A	A	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W14-14	A	A	A	A	A	A	A	5	A	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A

Table E-10. 200-ZP-1 Sampling Schedule

Well Name	Carbon tetrachloride	Chromium (total and hexavalent)	Iodine-129	Nitrate	Technetium-99	Trichloroethene	Tritium	Uranium	Chloroform	Dichloromethane	Chloromethane	cis-1,2-Dichloroethene	Vinyl chloride	Chloride	Nitrite	Total Organic Carbon	Total Dissolved Solids	Sulfate	Sulfide	Iron	Manganese	Alkalinity	Carbonate Content	Temperature	pH	Specific conductance	Turbidity	Dissolved oxygen	Redox potential
299-W14-72	A	5	5	A	5	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W15-11	A	5	5	A	A	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W15-152	A	5	5	A	5	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W15-17	A	5	5	A	5	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W15-33	A	5	5	A	A	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W15-42	A	5	A	A	A	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W15-46	A	5	5	A	A	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W15-49	A	5	5	A	A	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W15-50	A	5	5	A	A	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W15-7	A	5	5	A	5	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W15-763	A	5	5	A	A	A	A	A	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W15-765	A	A	5	A	A	A	A	A	5	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
299-W15-83	A	5	5	A	5	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W15-94	A	5	5	A	5	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W18-1	A	5	A	A	A	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W18-16	A	5	5	A	A	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W6-3	A	5	5	A	A	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W6-6	A	5	5	A	A	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W7-3	A	5	5	A	5	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
699-43-69	A	A	5	A	5	A	5	5	5	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
699-44-64	A	5	5	A	A	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A

Table E-10. 200-ZP-1 Sampling Schedule

Well Name	Carbon tetrachloride	Chromium (total and hexavalent)	Iodine-129	Nitrate	Technetium-99	Trichloroethene	Tritium	Uranium	Chloroform	Dichloromethane	Chloromethane	cis-1,2-Dichloroethene	Vinyl chloride	Chloride	Nitrite	Total Organic Carbon	Total Dissolved Solids	Sulfate	Sulfide	Iron	Manganese	Alkalinity	Carbonate Content	Temperature	pH	Specific conductance	Turbidity	Dissolved oxygen	Redox potential
699-45-69A	A	5	5	A	5	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
699-45-69C	A	5	5	A	5	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
699-47-60	A	5	5	A	5	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
699-48-71	A	A	A	A	A	A	A	A	5	A	A	A	A	A	A	5	5	A	5	A	A	5	5	A	A	A	A	A	A
699-50-74	A	5	5	A	5	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
699-51-63	A	5	5	A	5	A	5	5	5	A	A	A	A	A	A	5	5	A	5	5	5	5	5	A	A	A	A	A	A
299-W14-71	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W15-37	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W18-15	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W18-21	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W18-22	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W18-40	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W19-105	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W19-107	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W19-18	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W19-34A	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W19-34B	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W19-36	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W19-4	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W19-41	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W19-47	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A

Table E-10. 200-ZP-1 Sampling Schedule

Well Name	Carbon tetrachloride	Chromium (total and hexavalent)	Iodine-129	Nitrate	Technetium-99	Trichloroethene	Tritium	Uranium	Chloroform	Dichloromethane	Chloromethane	cis-1,2-Dichloroethene	Vinyl chloride	Chloride	Nitrite	Total Organic Carbon	Total Dissolved Solids	Sulfate	Sulfide	Iron	Manganese	Alkalinity	Carbonate Content	Temperature	pH	Specific conductance	Turbidity	Dissolved oxygen	Redox potential
299-W19-48	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W19-49	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W19-6	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W21-2	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W22-24S	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W22-47	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W22-72	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W22-86	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W22-87	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W22-88	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W23-19	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W23-4	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W26-13	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
299-W27-2	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-30-66	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-32-62	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-32-72A	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-33-75	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-34-61	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-35-66A	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-35-78A	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A

Table E-10. 200-ZP-1 Sampling Schedule

Well Name	Carbon tetrachloride	Chromium (total and hexavalent)	Iodine-129	Nitrate	Technetium-99	Trichloroethene	Tritium	Uranium	Chloroform	Dichloromethane	Chloromethane	cis-1,2-Dichloroethene	Vinyl chloride	Chloride	Nitrite	Total Organic Carbon	Total Dissolved Solids	Sulfate	Sulfide	Iron	Manganese	Alkalinity	Carbonate Content	Temperature	pH	Specific conductance	Turbidity	Dissolved oxygen	Redox potential
699-36-61A	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-36-66B	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-36-70A	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-36-70B	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-37-66	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-38-61	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-38-65	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-38-68A	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-38-70B	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-38-70C	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-40-62	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A
699-40-65	A	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A

A = sample annually
5 = sample every 5 years to coincide with preparation of the next CERCLA 5-year review
- = not sampled

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Table E-11. Sample Preservation, Container, and Holding Times for Groundwater Samples

Analytes[a]	Container		Volume[b]	Chemical Preservation	Packing Requirements	Holding Time
	Number	Type				
VOCs (carbon tetrachloride, chloroform, dibromomethane, chloromethane, trichloroethene, cis-1-2-dichloroethene, vinyl chloride)	4	Glass VOA, septum-lined lid	40 mL	HCL pH <2	Cool 4°C	14 days
Total organic carbon	4	Glass VOA, septum-lined lid	40 mL	HCL pH <2	Cool 4°C	14 days
Total metals (chromium, iron, manganese)	1	Plastic	500 mL	HNO_3 pH <2	Cool 4°C	28 days
Dissolved metals (chromium, iron, and manganese)	1	Plastic	500 mL	HNO_3 pH <2	Cool 4°C	28 days
Hexavalent chromium	1	Plastic	500 mL	4°C	Cool 4°C	24 hours
Iodine-129	1	Plastic	TBD	HNO_3 pH <2	None	N/A
Technetium-99	1	Plastic	TBD	None	None	N/A
Tritium	1	Plastic	TBD	None	None	N/A
Nitrate	1	Plastic	500 mL	None	Cool 4°C	48 hours
Nitrite	1	Plastic	500 mL	None	Cool 4°C	48 hours
Alkalinity	1	Plastic	500 mL	None	Cool 4°C	14 days
Sulfate	1	Plastic	500 mL	None	Cool 4°C	28 days
Sulfide	1	Plastic	TBD	Four drops 2N zinc acetate/100 mL sample; NaOH to pH >9; minimize aeration; store headspace free at ≤6°C	Cool 4°C	7 days
Chloride	1	Plastic	500 mL	None	Cool 4°C	28 days
Total dissolved solids	1	Plastic	500 mL	None	Cool 4°C	7 days
Uranium	1	Glass	500 mL	None	Cool 4°C	14 days

Note: Refer to Section E2 for specific constituents requiring analyses for each media and specified analytical methods.

a. For 4-digit methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

b. Minimum sample size and preservation requirements will be defined on the Sampling Authorization Form.

N/A = not applicable

TBD = to be determined

VOA = volatile organic analysis

VOC = volatile organic compound

Table E-12. Sample Locations, Frequencies, and Sampling Methods

Sampling Event	Sample Matrix	Sample Locations	Number of Samples	Number of QA Samples[a,b]	Sampling Procedure	Current Sampling Frequency
VOC network in 200-UP-1	Groundwater	Figure E-7 and Table E-10	48	Two duplicate Two equipment rinsate blanks Trip blanks – one per day when VOC samples are collected	GRP-FS-04-G-028	Annual
Contaminant network in 200-ZP-1	Groundwater	Figures E-7 to E-13 and Table E-10	49	Three duplicates Three equipment rinsate blanks Trip blanks – one per day when VOC samples are collected	GRP-FS-04-G-028	Annual

a. Final QA sample types and numbers will be specified on the sample authorization form.

b. One blank is required for every 20 samples taken.

QA = quality assurance

VOC = volatile organic compound

E3.7.1 Container Labeling

Sample location, depth, and corresponding HEIS numbers are documented in the sampler's field logbook. Each sample container will be labeled with the following information on firmly affixed, water-resistant labels:

- Sampling authorization form
- HEIS number
- Sample collection date/time
- Analysis required
- Preservation method (if applicable)

In addition to the above information, sample records must include the following:

- Analysis required
- Source of sample
- Matrix (e.g., water, soil, etc.)
- Field data (e.g., pH and radiological readings)

E3.7.2 Sample Custody

Sample custody will be maintained in accordance with CHPRC procedures to ensure the maintenance of sample integrity throughout the analytical process. The custody of samples will be maintained from the time the samples are collected until the ultimate disposal of the samples, as appropriate. A custody seal (e.g., evidence tape) is affixed to each sample container and/or the sample collection package in such a way as to indicate potential tampering. 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. The following information is required on a completed chain-of-custody form:

- Project name
- Signature of sampler
- Unique sample number
- Date and time of collection
- Matrix
- Preservatives
- Signatures of individual involved in sample transfer
- Requested analyses or reference thereto

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. Chain-of-custody will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. Each time the responsibility changes for the custody of the sample, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and will transmit the copy to Sample and Data Management within 48 hours of shipping.

Custody tape (i.e., evidence seals) will be affixed to the lids of each sample jar. The container tape will be inscribed with the sampler's initials and the date. For VOA sample vials, the custody tape is not to be applied directly over the septa because of a potential for affecting analytical results. The tape may be applied in any manner that does not affect analysis. For example, the custody tape may be placed in a single layer directly around the neck of the vial (use caution, as too much tape applied around the neck of vial will cause difficulties in with analytical equipment), or the VOA vials can be placed inside of a plastic bag and the custody seal and any other required labels/documentation can be fixed to exterior of the bag.

E3.7.3 Sample Transportation

Sample transportation will be in compliance with the applicable regulations for packaging, marking, labeling, and shipping hazardous materials, hazardous substances, and hazardous waste that are mandated by the U.S. Department of Transportation (49 CFR 171 through 177) in association with the International Air Transportation Authority, DOE requirements, and applicable program-specific implementing procedures.

E3.8 Investigation-Derived Waste Management Sampling

All IDW sample and analysis will be performed in accordance with the waste management plan (Appendix B of this O&M plan).

E4 Health and Safety

All field operations are performed in accordance with existing CHPRC Soil and Groundwater Remediation Project requirements. In addition, documentation is prepared that further controls site operations. This documentation consists of an activity hazard analysis, a site-specific health and safety plan, and applicable work permits. Work is performed in accordance with these site-specific health and safety plans and applicable work permits. The sampling procedures and associated activities take into consideration exposure-reduction and contamination-control techniques that minimize the sampling team's exposure.

E5 Management of Investigation-Derived Waste

The IDW generated by characterization activities are managed in accordance with the waste management plan (Appendix B of this O&M plan).

E6 References

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