SGW-34011
Revision 0

Data Quality Objectives Summary Report Supporting the 200-PO-1 Groundwater Operable Unit

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

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

FLUOR®
P.O. Box 1000
Richland, Washington

SGW-34011
Revision 0

Data Quality Objectives Summary Report Supporting the 200-PO-1 Groundwater Operable Unit

G. D. Cummins
Fluor Hanford, Inc.

Date Published
September 2007

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

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

FLUOR®
P.O. Box 1000
Richland, Washington

J. D. Aardal 09/18/2007
Release Approval Date

Approved for Public Release;
Further Dissemination Unlimited

This page intentionally left blank.

CONTENTS

APPENDICES

FIGURES

TABLES

This page intentionally left blank.

TERMS

AA	alternative action
AAMSR	aggregate area management study report
ACL	alternate concentration limit
AEA	alpha energy analysis
AEA	*Atomic Energy Act of 1954*
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
CAS	Chemical Abstracts Service
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CHI	CH2M HILL Hanford, Inc.
CLARC	cleanup levels and risk calculations
CMS	corrective measures study
COPC	contaminant of potential concern
CPP	CERCLA past practice
CRDL	contract-required detection limit
CSM	conceptual site model
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
DOE	U.S. Department of Energy
DQO	data quality objective
DR	decision rule
DS	decision statement
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FS	feasibility study
FH	Fluor Hanford
FY	fiscal year
GPC	gas proportional counting
HAB	Hanford Advisory Board
HCP	*Final Hanford Comprehensive Land-Use Plan - Environmental Impact Statement* (DOE/EIS-0222-F)
HEIS	*Hanford Environmental Information System* database
IC	ion chromatography
ICP	inductively coupled plasma
IDF	Integrated Disposal Facility
IRIS	*Integrated Risk Information System* database
K_d	distribution coefficient
LSC	liquid scintillation counting
MCL	maximum contaminant level
mg	milligram
N/A	not applicable

NCP	"National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300)
NEPA	*National Environmental Policy Act of 1969*
NPL	"National Priorities List" (40 CFR 300, Appendix B)
NPT	Nez Perce Tribe
NRDWL	Nonradioactive Dangerous Waste Landfill
NTU	nephelometric turbidity unit
OR	Oregon State Department of Ecology
ORP	U.S. Department of Energy, Office of River Protection
OU	operable unit
PCB	polychlorinated biphenyl
pCi	picocuries
PNNL	Pacific Northwest National Laboratory
PRG	preliminary remediation goal
PSQ	principal study question
PUREX	Plutonium-Uranium Extraction (Plant or process)
RCRA	*Resource Conservation and Recovery Act of 1976*
RFI	RCRA facility investigation
RFI/CMS	RCRA facility investigation/corrective measures study
RI/FS	remedial investigation/feasibility study
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision
RPP	RCRA past practice
RQL	required quantitation limit
SAP	sampling and analysis plan
SST	single-shell tank
STOMP	Subsurface Transport Over Multiple Phases (code)
SVOC	semivolatile organic compound
TCE	trichloroethylene
TEDF	Treated Effluent Disposal Facility
TOC	total organic compound
Tri-Parties	U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989)
TSD	treatment, storage, and/or disposal (unit)
μg	microgram
VOC	volatile organic compound
WAC	*Washington Administrative Code*
WMA	Waste Management Area
YIN	Yakama Indian Nation

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If you know	*Multiply by*	*To get*	*If you know*	*Multiply by*	*To get*
Length			**Length**		
inches	25.40	millimeters	millimeters	0.0394	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles (statute)	1.609	kilometers	kilometers	0.621	miles (statute)
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.0929	sq. meters	sq. meters	10.764	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.591	sq. kilometers	sq. kilometers	0.386	sq. miles
acres	0.405	hectares	hectares	2.471	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.349	grams	grams	0.0353	ounces (avoir)
pounds	0.454	kilograms	kilograms	2.205	pounds (avoir)
tons (short)	0.907	ton (metric)	ton (metric)	1.102	tons (short)
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.034	ounces (U.S., liquid)
tablespoons	15	milliliters	liters	2.113	pints
ounces (U.S., liquid)	29.573	milliliters	liters	1.057	quarts (U.S., liquid)
cups	0.24	liters	liters	0.264	gallons (U.S., liquid)
pints	0.473	liters	cubic meters	35.315	cubic feet
quarts (U.S., liquid)	0.946	liters	cubic meters	1.308	cubic yards
gallons (U.S., liquid)	3.785	liters			
cubic feet	0.0283	cubic meters			
cubic yards	0.764	cubic meters			
Temperature			**Temperature**		
Fahrenheit	(°F-32)*5/9	Centigrade	Centigrade	(°C*9/5)+32	Fahrenheit
Radioactivity			**Radioactivity**		
picocurie	37	millibecquerel	millibecquerel	0.027	picocurie

This page intentionally left blank.

1.0 STEP 1 – STATE THE PROBLEM

The purpose of this data quality objective (DQO) process is to identify and evaluate the data needs to support the remedial investigation/feasibility study (RI/FS) process for the 200-PO-1 Groundwater Operable Unit (200-PO-1 Groundwater OU). This DQO defines and evaluates the data needs to define the nature and extent of contamination in support of the risk assessment, evaluation of remedial action alternatives, and long-term monitoring of completed remedial actions.

The RI/FS process for the 200-PO-1 Groundwater OU complies with the scoping requirements contained in 40 CFR 300.430(a)(iii)(F), "Remedial Investigation/Feasibility Study and Selection of Remedy." The feasibility study (FS) will evaluate three alternatives to fulfill the requirements of identifying likely response scenarios.

The first alternative discussed in the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300) (NCP) is that the U.S. Environmental Protection Agency (EPA) "expects to return usable ground waters to their beneficial uses wherever practicable" (emphasis added) (40 CFR 300.430(a)(iii)(F)). The NCP goes on to state that "[w]hen restoration of ground water to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated ground water, and evaluate further risk reduction."

The second alternative is considered if it is determined that it is not technically practicable to "return usable ground waters to their beneficial uses wherever practicable." Then alternate concentration limits (ACL) will be established. The EPA has considered the appropriate use of ACLs; the following text is an excerpt from EPA 2005, "Use of Alternate Concentration Limits (ACLs) in Superfund Cleanups," OSWER 9200.4-39:

> *Section 121(d)(2)(B)(ii) also addresses ACLs and limitations concerning their use, as follows:*
>
> *(ii) For the purposes of this section, a process for establishing alternate concentration limits to those otherwise applicable for hazardous constituents in groundwater under subparagraph (A) may not be used to establish applicable standards under this paragraph if the process assumes a point of human exposure beyond the boundary of the facility, as defined at the conclusion of the remedial investigation and feasibility study, except where-*
>
>> *(I) there are known and projected points of entry of such groundwater into surface water; and*
>>
>> *(II) on the basis of measurements or projections, there is or will be no statistically significant increase of such constituents from such groundwater in such surface water at the point of entry or at any point where there is reason to believe accumulation of constituents may occur downstream; and*
>>
>> *(III) the remedial action includes enforceable measures that will preclude human exposure to the contaminated groundwater at any point between the facility boundary*

and all known and projected points of entry of such groundwater into surface water then the assumed point of human exposure may be at such known and projected points of entry.

The third alternative is based on item (II) above. If it is determined that it is not technically practicable to achieve ACLs everywhere within the plume boundary, then one or more conditional points of compliance will be established. For example, points of compliance could be at the boundary of individual waste area groups (groupings of proximate waste sites), and going next to the plume boundary. These alternatives are listed in order of descending preference. Section 1.1 provides a preliminary list of remedial action alternatives that may be evaluated in the FS.

The remedial action includes enforceable measures that will preclude human exposure to the contaminated groundwater at any point between the facility boundary and all known and projected points of entry of such groundwater into surface water. Then the assumed point of human exposure may be at such known and projected points of entry.

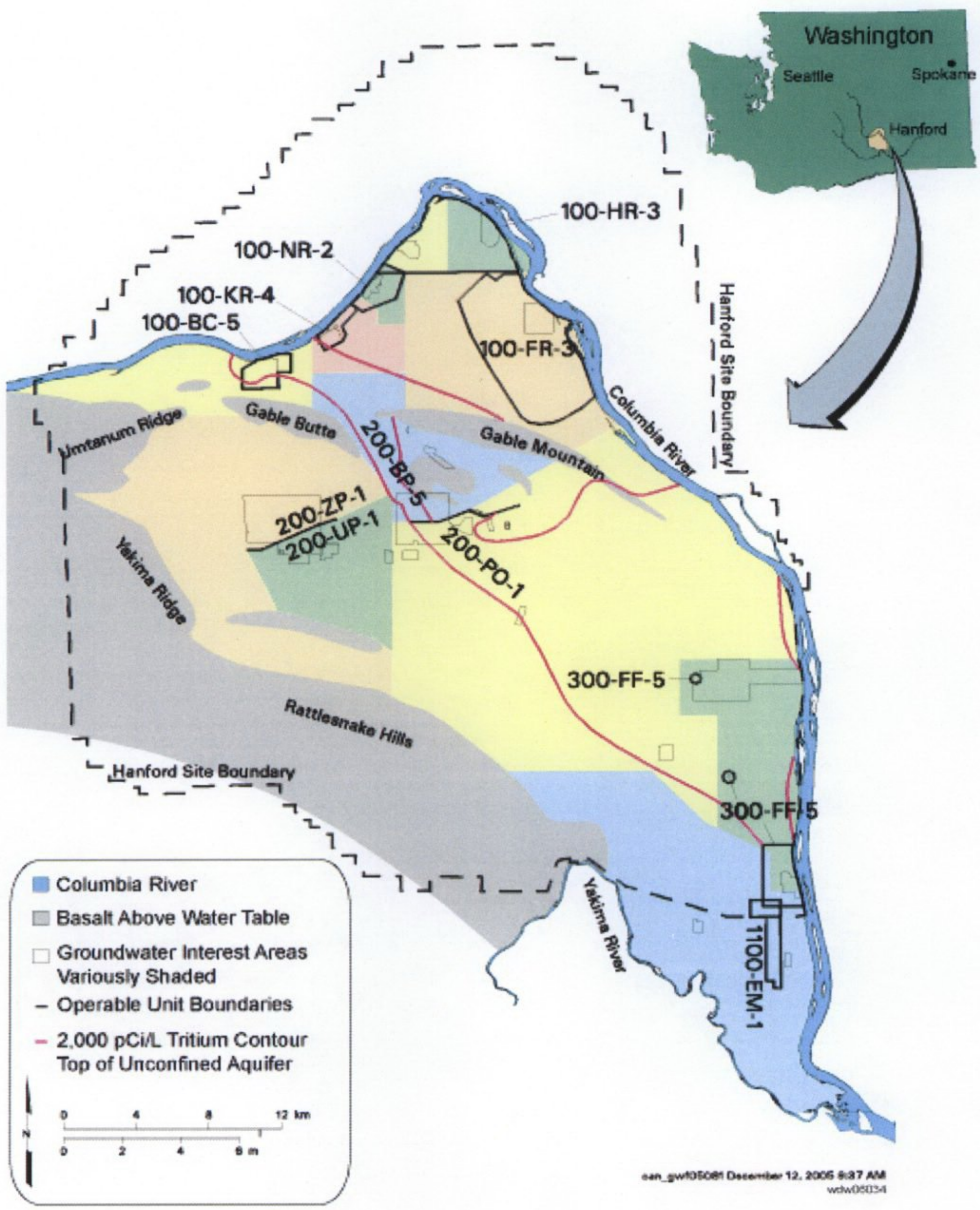
The final DQO report is the foundation for preparing a new RI/FS Work Plan and the characterization Sampling and Analysis Plan (SAP) (DOE/RL-2007-30, *Sampling and Analysis Plan for Characterizing the 200-PO-1 Groundwater Operable Unit*) (Characterization SAP). A Monitoring SAP (DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*) is being implemented for the 200-PO-1 Groundwater OU. Related studies for the 200-PO-1 Groundwater OU are listed in Table 1-3 in Section 1.4, and include DOE/RL-95-100, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit*; DOE/RL-96-66, *RCRA Facility Corrective Measures Study for the 200-PO-1 Operable Unit*; DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study Report*; and DOE/RL-92-04, *PUREX Plant Source Aggregate Area Management Study Report* (PUREX AAMSR). The current understanding of groundwater quality in the 200-PO-1 Groundwater OU is included in PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006.* Figure 1-1 illustrates the location of the 200-PO-1 Groundwater OU and other OUs at the Hanford Site.

1.1 PROJECT OBJECTIVES

The primary objective of this groundwater DQO is to define the data needed to support implementation of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) RI/FS process for the 200-PO-1 Groundwater OU including development of a work plan and RI for determining the nature and extent of contamination, an FS for evaluating remedial action alternatives, and a long-term performance monitoring program for the 200-PO-1 Groundwater OU. Remedial-action alternatives are not fully evaluated. The possible remedial action alternatives are as follows:

- No action (as required by the NCP)
- Institutional controls (current action) and monitored natural attenuation (current action)

Figure 1-1. Location of the 200-PO-1 Groundwater Operable Unit at the Hanford Site.



- Groundwater pump-and-treat (using onsite treatment system)
- Containment – hydraulic or physical barriers
- In situ treatment – permeable reactive barriers, etc.
- In situ anaerobic bioremediation.

Another objective of this DQO is to develop a sampling design that will either confirm or reject the conceptual site model (CSM). This DQO summary report provides the sampling requirements, analyses to be performed, detection limit requirements, and other analytical performance requirements (e.g., precision and accuracy) for additional data collection that supports the DQO objectives.

1.2 PROJECT ASSUMPTIONS

Table 1-1 lists the assumptions under which this DQO report has been prepared. These assumptions were developed and agreed to by the DQO Team that is described in Section 1.6. The DQO Team included representatives of the Washington Sate Department of Ecology (Ecology); U.S. Department of Energy (DOE), Richland Operations Office (RL); DOE, Office of River Protection (ORP), EPA; Fluor Hanford, Inc.; and Pacific Northwest National Laboratory (PNNL). The project assumptions and global issues were discussed in a series of meetings beginning in fiscal year (FY) 2005. The resulting design from this DQO is provided in the Characterization SAP.

Table 1-1. Project Assumptions. (2 Pages)

No.	Assumption
1	COPCs are constituents that define existing, emerging, and anticipated groundwater contaminant plumes within the currently defined boundaries of the 200-PO-1 Groundwater OU. Analysis of groundwater samples will include measurement of COPCs and of additional parameters needed to establish local geochemical conditions. Information obtained from activities being undertaken at the Plutonium-Uranium Extraction Plant, WMA A-AX, BC Cribs, and US Ecology are within the area of interest and will be a part of the data gap evaluation for the 200-PO-1 Groundwater OU RI/FS.
2	The BC Cribs and Trenches and US Ecology are outside the currently defined 200-PO-1 Groundwater OU, but will be evaluated for potential contaminant source threat in the future. Information from decision documents and reports for these areas is incorporated by reference for this DQO summary report.
3	WMA A-AX is within the currently defined 200-PO-1 Groundwater OU and is being analyzed as part of the Tank Farm Closure and Waste Management environmental impact statement and single-shell tank performance assessment. Available information will be incorporated by reference. The Tank Farm environmental impact statement groundwater modeling activity is assumed to be completed in 2008 before modeling activities for the 200-PO-1 Groundwater OU will be completed.
4	An intent of this DQO process is to maximize the use of data obtained from existing and planned monitoring wells, but new wells and deepening of existing wells are not precluded.
5	Information obtained from activities in adjacent groundwater 200-PO-1 Groundwater OUs will be included but not duplicated. For example, the potential for flow to the southeast into the 200-PO-1 Groundwater OU will be evaluated in the 200-BP-5 Groundwater OU RI/FS process.

Table 1-1. Project Assumptions. (2 Pages)

No.	Assumption
6	Because of the complexity of the groundwater remedy decision framework the 200-PO-1 Groundwater OU, a phased approach will be employed for documenting groundwater remedy decisions in accordance with EPA guidance (EPA 540-R-98-031, Appendix B). This approach is used at sites with very complex groundwater contamination problems where it may be difficult to determine whether required cleanup levels are achievable at the time a remedy selection decision must be made.
7	This DQO summary report addresses CERCLA, RCRA past-practice groundwater monitoring, and AEA-based surveillance monitoring requirements in the 200-PO-1 Groundwater OU. RCRA treatment, storage, and/or disposal unit groundwater-monitoring changes may be considered if necessary to support 200-PO-1 Groundwater OU characterization.
8	For this DQO summary report, it is assumed that groundwater data resulting from sampling and analysis at all RCRA, RCRA past practice, CERCLA, and Site-wide (AEA) monitoring wells will be used to support the development of DQO decision statements applicable to the 200-PO-1 Groundwater OU.
9	Because of the benefit to CERCLA monitoring, investigation-derived waste associated with other groundwater investigations may be handled as CERCLA waste.
10	No presumptions are being made regarding adequacy of the existing monitoring well network as presented in DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*. Monitoring well network design modifications will be presented in revisions to DOE/RL-2003-04, which will be reviewed annually and updated as needed.
11	It is assumed that responsibility for vadose-zone characterization (which includes evaluation of potential for impact to groundwater) and remediation remains with the individual waste site 200-PO-1 Groundwater OU project, and that waste site and 200-PO-1 Groundwater OU lead personnel will integrate data needs such that the 200-PO-1 Groundwater OU data needs are met. This includes the current supplemental vadose-zone investigation activity.
12	Past activities in groundwater contaminant modeling have yielded results of limited utility. Continued development of transport parameters and corroboration of modeled results are required.
13	Double-shell tanks will continue to operate to facilitate tank waste retrieval and ultimate closure of WMA A-AX.

AEA = *Atomic Energy Act of 1954*.
CERCLA = *Comprehensive Environmental Response, Compensation and Liability Act of 1980.*
COPC = contaminant of potential concern.
DQO = data quality objective.
OU = operable unit.
RCRA = *Resource Conservation and Recovery Act of 1976*.
RI/FS = remedial investigation/feasibility study.
WMA = Waste Management Area.

1.3 PROJECT ISSUES

Interviews with regulators, stakeholders, and technical experts identified important global and technical issues regarding the design of an adequate monitoring network, continued characterization, contaminant transport modeling, and the evaluation of remedial alternative actions.

1.3.1 Global Issues

Table 1-2 represents a summary of the issues identified during the DQO interviews, and is intended as a guide when considering the decisions presented later in this report. The list of global issues and issue resolutions are presented as revised and approved by the DQO Team and DQO key decision makers described in Section 1.6.

Table 1-2. 200-PO-1 Groundwater Operable Unit Issues and Resolutions. (5 Pages)

No.	Predecisional Draft Interview Issues and Proposed Resolutions
1	***It should be assumed that the BC Cribs and the US Ecology landfill are inside the 200-PO-1 Groundwater OU. (Ecology)*** BC Cribs is part of the 200-BC-1 Waste Sites OU and is outside the 200-PO-1 Groundwater OU boundary as currently defined in the Tri-Party Agreement. The US Ecology landfill is currently located within the 200-UP-1 Groundwater OU geographic interest area and outside of the currently defined 200-PO-1 Groundwater OU boundary decision scope. Although these are not officially part of the 200-PO-1 Groundwater OU, site information will be included in the DQO report as appropriate. A clarification of the 200-PO-1 Groundwater OU boundary and the DQO study area is defined in Chapter 4.0 of this DQO summary report. (DOE)
2	***The hydraulic divide between the 200-PO-1 and 200-BP-5 Groundwater OUs is becoming progressively indistinct as water levels decline. This complicates local-scale contaminant transport predictions and blurs the relationship between respective source OUs and groundwater OUs. Combining the 200-PO-1 and 200-BP-5 Groundwater OUs into one groundwater OU should be considered. (Ecology and OR)*** DOE will complete separate RI/FS document activities as agreed to in Tri-Party Agreement milestones, although 200-PO-1 and 200-BP-5 Groundwater OU activities will be coordinated and discussed in both reports. Any critical data gaps will be integrated between projects. (DOE)
3	***Tritium, I-129, and nitrate are the three main COPCs identified in the 200-PO-1 RFI/CMS documentation prepared from 1995-1997. (Ecology)*** The 200-PO-1 Groundwater OU COPC list will be reevaluated as part of the DQO, the RI/FS Work Plan activity, and the RI/FS activity to reflect more recent data.
4	***Ecology has reviewed borehole data for RCRA wells in WMA A-AX and noted organic vapor analysis at 3.6 – 3.8 ppm organics at 300 ft below ground surface; therefore, it is expected that analysis of volatile organic compounds by the volatile organic analysis method will be included in the sampling analysis plan for the monitoring well network in the 200-PO-1 RI/FS Work Plan. (Ecology) Ecology has sampled trichloroethylene and chloroform above CLARC groundwater values in US Ecology downgradient groundwater wells. This information should be considered in preparation of RI/FS Work Plan-associated sampling and analysis plans NRDWL VOCs. (Ecology)*** Data provided by Ecology for the US Ecology site will be considered in evaluating additional data needs for the 200-PO-1 Groundwater OU. A revised monitoring well network sampling and analysis plan is planned for the 200-PO-1 RI/FS Work Plan (DOE/RL-2007-31, Draft A), due September 30, 2007.

Table 1-2. 200-PO-1 Groundwater Operable Unit Issues and Resolutions. (5 Pages)

No.	Predecisional Draft Interview Issues and Proposed Resolutions
5	***Ecology requests a revision of the conceptual model to take clastic dikes into account.*** Clastic dikes have been studied and documented in clastic injection dikes of the Pasco Basin and Vicinity (BHI-01103) and this information will be incorporated into the RI/FS documentation where applicable.
6	***The 200-PO-1 Groundwater OU is currently a RCRA past practice OU. (EPA)*** Ecology will remain the Lead Regulatory Agency as agreed upon in the Tri-Party Agreement and has agreed that a combined RI/FS report will satisfy the requirements for an RFI/CMS. The DOE will prepare a 200-PO-1 CERCLA RI/FS Work Plan by September 30, 2007, in accordance with Milestone M-013-10A. (DOE).
7	***The A-AX Tank Farm is in the 200-PO-1 Groundwater OU. The C Tank Farm is in the 200-BP-5 Groundwater OU, and effort should not be duplicated for the 200-PO-1 Groundwater OU RI/FS activity. (DOE)*** A duplicate investigation of the C Tank Farm will not be conducted as part of the 200-PO-1 RI/FS; however, the 200-BP-5 Groundwater OU characterization of the C Tank Farm will be referenced and considered as appropriate in the 200-PO-1 Groundwater OU DQO report.
8	***Boundaries of the 200-PO-1 Groundwater OU are unclear and need clarification. (NPT)*** An updated clarification of the 200-PO-1 Groundwater OU boundary and DQO study area of interest, is addressed in Step 4 of the DQO process and is presented in this DQO summary report (DOE).
9	***What steps will DOE take to ensure integration with others in the Central Plateau and River Corridor regarding RCRA/CERCLA, source terms, deep vadose zone, groundwater plumes, solid waste environmental impact statement, natural resource damage assessment, and ecological risk assessment? (OR)*** RCRA and NEPA decision documents and decisions will be incorporated as appropriate into the CERCLA RI/FS documentation prepared for the 200-PO-1 Groundwater OU. Information from source site and model group source terms, deep vadose and RI/FS information (e.g., COPCs) will be included in the 200-PO-1 RI/FS process as data are made available. (DOE)
10	***Define the various end states envisioned for this OU. Describe how the desired end state will be substantially redefined and how might data from the RI/FS process influence that decision. (OR)*** End states for this OU will be evaluated and discussed in the RI/FS Work Plan. Existing published information on end states will be considered and redefined as needed in RI documentation depending on aquifer vulnerability information gathered.
11	***Describe how all COPCs will be addressed in the project. Define what is known and what more needs to be known regarding inventories and mobility of radioactive and other chemicals in groundwater. Key COPCs are tritium, iodine, cobalt, uranium, carbon and carbon tetrachloride. What are the COPCs? (OR)*** COPCs will be evaluated beginning with the use of existing COPC lists from work plans from source sites overlying the 200-PO-1 Groundwater OU to develop a groundwater COPC list and then conducting a screening process as conducted for the 200-UP-1 and 200-ZP-1 Groundwater OU COPC lists.

Table 1-2. 200-PO-1 Groundwater Operable Unit Issues and Resolutions. (5 Pages)

No.	Predecisional Draft Interview Issues and Proposed Resolutions
12	***Evaluate the need to sample for volatile organic compounds in groundwater and include neptunium and Sr-90 at the PUREX cribs.*** The volatile organic compounds will be evaluated in conjunction with COPCs beginning with the use of existing COPC lists from work plans from source sites overlying the 200-PO-1 Groundwater OU to develop a groundwater COPC list and then conducting a screening process as conducted for the 200-UP-1 and 200-ZP-1 Groundwater OU COPC lists.
13	***What is the source of uranium in 699-37-47A? Cobalt-60 and Cs-137 have been detected using borehole geophysics near the water table (NPT). The nitrate plume extent on the plume map (PNNL-15070, Hanford Site Groundwater Monitoring for Fiscal Year 2004) differs in flow direction than I-129 and the inconsistency needs to be resolved.*** Any anomalies that are occurring within the 200-PO-1 Groundwater OU will be evaluated as part of the DQO process to determine data gaps.
14	***Groundwater data are totally inadequate to characterize aquifer contamination. (CTUIR) Need to assess preferential flow paths and include in groundwater models. (OR) The preferred flow paths in groundwater need identification. (NPT)*** Any anomalies that are occurring within the 200-PO-1 Groundwater OU will be evaluated as part of the DQO process to determine data gaps.
15	***Please describe the kinds of data needed to lead to good decision making that will be protective of human health and the environment. (OR) How are temporal data factored in the sample design? (OR) How many samples will be needed to achieve the necessary level of uncertainty? Describe the hypothesis being tested and how that influences sample design. (OR)*** A table containing the information type and use collected for the 200-PO-1 DQO process originally was provided in DOE/RL-95-100, Appendix B, Table B1-2 RFI CMS, and will be reevaluated as part of the RI/FS process. The kind of data that are necessary for the risk assessment will be based on this DQO process.
16	***In the three major potential source areas of PUREX cribs, WMA A-AX, and BC Cribs, there has not been an adequate job of borehole or surface geophysics to characterize the areas for selected remedies. (CTUIR)*** The source area investigations for PUREX cribs, WMA A-AX, and BC Cribs are not within the scope of this DQO process but are being addressed in the waste site OU RI/FS process. Existing information (e.g., OU work plans and feasibility studies) have been reviewed as part of the 200-PO-1 COPC list in this DQO process and is incorporated by reference because they are within the geographic area of interest.
17	***There is a great need for more site characterization at the PUREX cribs. The conceptual model is too simple. Future characterization needs to be handled better than what has been done to date. Geophysics is presently being done, but more is needed. (YIN)*** Any anomalies that are occurring within the 200-PO-1 Groundwater OU will be evaluated as part of the DQO process to determine data gaps.
18	***Much of the Reach does not have enough monitoring (aquifer tubes). More money is needed for tube work. (YIN) Additional characterization and monitoring of the OU/Columbia River boundary is needed.*** Any anomalies that are occurring within the 200-PO-1 Groundwater OU will be evaluated as part of the DQO process to determine data gaps to satisfy the baseline risk assessment.

Table 1-2. 200-PO-1 Groundwater Operable Unit Issues and Resolutions. (5 Pages)

No.	Predecisional Draft Interview Issues and Proposed Resolutions
19	***How will contaminants move in the future and how is the baseline defined? (OR) Discuss how much uncertainty is acceptable for model forecasts. (OR) How will differences between model forecasts and observed data be resolved? (OR) If there is extensive capping of source areas, how will that affect flow paths and volumes through the vadose zone into the groundwater. (OR)*** Modeling of surface remedial actions and their affect on flow paths in the vadose zone are being addressed in waste site and tank farm OU RI/FS activities. Existing information that was collected for the 200-PO-1 RFI/CMS activity and any additional data that have been developed since will be assessed to determine the need for additional modeling forecasts based on acceptable uncertainty as determined in this 200-PO-1 DQO process.
20	***The inventory of contaminants in the vadose zone needs to be well-defined.*** The inventories in the vadose zone are being defined in the source site OU RI/FS process. A review of contaminant contributions from the overlying waste sites to the groundwater OU is being conducted as part of this DQO process.
21	***The effect of remedial action alternatives on the mobility of contaminants in the vadose zone or at the surface needs to be well-defined.*** The effect of remedial action alternatives on the mobility of contaminants in the vadose zone will be addressed in the source site OU investigations. The vadose zone source OUs will consider the effect of their remedial alternatives on groundwater as part of their feasibility studies. The result of the vadose zone mobility evaluations and remedial alternatives from the source OUs will be considered in the 200-PO-1 RI/FS.
22	***Major preferential groundwater flow paths from sources to the Columbia River need to be identified and sampling frequency addressed. Surface geophysical methods may be useful for identifying geologic strata and structure variations that affect groundwater preferred flow paths.*** The need for additional data requirements to address geologic variations and preferential flow paths will be addressed in this DQO process.
23	***Sensitivity analysis should be done for groundwater model input parameters, particularly with respect to spatial variations in hydraulic parameters, factors affecting contaminant retardation, vadose flux, and variations that may be caused by future changes in land use or water management.*** The need for additional analysis for groundwater model input parameters to address spatial variations in hydraulic parameters will be addressed in this DQO process.
24	***Begin groundwater remediation even if we do not have adequate understanding of the vadose zone sources. The remedial actions can be refined as additional information is obtained.*** Areas of contamination for where there are remedial treatment technologies available will be evaluated for additional data needs in this DQO process. The RI/FS process will result in evaluation of both near- and long-term remedial alternatives. The CERCLA process allows a regulatory path for both near- and long-term remedial actions. These will be considered in the RI/FS process.
25	***200-PO-1 Groundwater OU monitoring plans and reports are published in numerous reports by treatment, storage, and/or disposal and OU monitoring activities. Consolidated monitoring documents for the 200-PO-1 Groundwater OU are needed to simplify data review for the RI/FS process. (Ecology)*** Any anomalies that are occurring within the 200-PO-1 Groundwater OU will be evaluated as part of the DQO process to determine data gaps.

Table 1-2. 200-PO-1 Groundwater Operable Unit Issues and Resolutions. (5 Pages)

No.	Predecisional Draft Interview Issues and Proposed Resolutions

BHI-01103, *Clastic Injection Dikes of the Pasco Basin and Vicinity*.
Ecology, 2005, *Cleanup Levels & Risk Calculations (CLARC)* database.
DOE/RL-2007-31, *Remedial Investigation/Feasibility Study Work Plan for the 200-PO-1 Groundwater Operable Unit*.
DOE/RL-95-100, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit*.
Tri-Party Agreement, *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989).

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*.
CLARC = cleanup levels and risk calculations.
COPC = contaminant of potential concern.
CTUIR = Confederated Tribes of the Umatilla Indian Reservation.
DOE = U. S. Department of Energy.
DQO = data quality objective.
Ecology = Washington State Department of Ecology.
EPA = U.S. Environmental Protection Agency.
NEPA = *National Environmental Policy Act of 1969*.
NPT = Nez Perce Tribe.
OR = Oregon State Department of Ecology.
OU = operable unit.
RFI/CMS = RCRA facility investigation/corrective measures study.
RI/FS = remedial investigation/feasibility study.
Tri-Party Agreement = *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989).
YIN = Yakima Indian Nation.

1.3.2 Task Specific Issues and Resolutions

The DQO team members agreed that this DQO should identify all required data needs to support a defensible groundwater remedial decision. The output should be specific in terms of COPCs, the spatial resolution for describing the site, and specific areas of the 200-PO-1 Groundwater OU to which a fate and transport model might be applied. The schedule for availability of specific data is an important consideration.

As the Soil & Groundwater Remediation Project develops plans to remediate the 200-PO-1 Groundwater OU vadose zone, it will be important to remain cognizant of the end state of each waste site and potential impacts on the unconfined aquifer. It is pertinent that the Soil & Groundwater Remediation Project closely coordinates with the River Corridor Contractor, the Tank Waste Remediation Contractor, and PNNL technical resources (e.g., Hanford Science and Technology Program).

Groundwater-monitoring decisions and remedial actions for COPCs that may reach groundwater will be made largely on the basis of the expected concentrations in groundwater through time. The long-term behavior of specific COPCs in the vadose zone and groundwater of the 200 Area is uncertain. This uncertainty may be decreased by obtaining additional information regarding the contaminant plume, three-dimensional distribution, specific matrix attributes in the vadose and the saturated zones, and hydraulic conditions in the unconfined and confined aquifers.

1.4 EXISTING REFERENCES

Table 1-3 lists the principal references consulted during the preparation of this report. Each entry is accompanied by a brief summary of the pertinent information provided by the reference.

Table 1-3. Existing References. (4 Pages)

Reference	Summary
CP-15329, *Data Quality Objectives Summary Report for Establishing a RCRA/CERCLA/ AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network*	Includes historical operations information for wastes sites in the 200-PO-1 Groundwater OU, as well as a detailed consideration of COPCs.
DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study Report*	Presents an extensive compilation of 200 East Area waste sites and inventories of chemical and radiological waste for individual sites, including an analysis of which sites are likely to have contributed to groundwater contamination.
DOE/RL-92-04, *PUREX Plant Source Aggregate Area Management Study Report*	Presents an extensive compilation of the Plutonium-Uranium Extraction Plant Area waste sites and inventories of chemical and radiological waste for individual sites, including an analysis of which sites are likely to have contributed to groundwater contamination.
DOE/RL-95-100, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit*	Summarizes the RCRA site monitoring in the 200-PO-1 Groundwater OU, the extent of groundwater contamination, and the hydrogeology and geology of the 200-PO-1 Groundwater OU.
DOE/RL-96-66, *RCRA Facility Corrective Measures Study for the 200-PO-1 Operable Unit*	Following on DOE/RL-95-100, this 1997 study presents the results of groundwater contaminant transport modeling and risk assessment, and examines remedial alternatives.
DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*	Describes the existing monitor well network, including aquifer tubes along the Columbia River shore, and presents the sampling schedule.
DOE/RL-2005-01, *Initial Single-Shell Tank System Performance Assessment for the Hanford Site*	Presents an initial analysis of the long-term impacts of residual wastes assumed to remain after retrieval of tank wastes and closure of the single-shell tank farms at the Hanford Site.
DOE/EIS-0189, *Final Environmental Impact Statement for the Tank Waste Remediation System, Hanford Site, Richland, Washington*	Presents an analysis of the impacts and risk of tank waste remediation alternatives. Includes site history, waste volumes, and modeled groundwater contamination migration over time for each alternative.
DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*	Presents an analysis of the impacts of Hanford Site operations and presents alternatives for Hanford Site land use. Includes site history and presents groundwater contamination migration projections at the Hanford Site for tritium, iodine, chromium, strontium. EPA et al., 1999, *Record of Decision: Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, was issued for the preferred land use alternative.
PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*	Provides a refined conceptual model of the hydrogeologic framework of the 200 East Area and vicinity, and addresses probable preferential flowpaths from the 200 East Area to the Columbia River.

Table 1-3. Existing References. (4 Pages)

Reference	Summary
PNNL-14049, *Data Quality Objectives Summary Report – Designing a Groundwater Monitoring Network for the 200-BP-5 and 200-PO-1 Operable Units*	Provides an operational history for 200-PO-1 Groundwater OU wastes sites, a discussion of COPCs, and a decision matrix in accordance with the DQO process.
PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*	Summarizes the results of groundwater sampling and analysis in the 200-PO-1 Groundwater OU for fiscal year 2006, with particular emphasis on the major contaminant plumes. Includes groundwater elevations.
Stoller Log Data Reports	Present geophysical logs showing the vertical extent of vadose zone radiological contamination at various waste sites in the 200 East Area, including sites in the 200-PW-2, 200-PW-3, 200-MW-1, and 200-CS-1.
Existing References from the Waste Site Source Units	
Reference	**Summary**
DOE/RL-99-66, *Steam Condensate/Cooling Water Waste Group Operable Units RI/FS Work Plan; Includes: 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units*	Data are presented for 200-SC-1 OU sites as well as for 200-CW-2, 200-CW-4, and 200-CW-5.
DOE/RL-99-07, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan*	Data are presented on COPCs from 200-CW-1.
DOE/RL 2001, *200-PW-2 Uranium Rich Process Waste Group Operable Unit RI/FS Work Plan and Process Waste RCRA TSD Unit Sampling Plan*	Data are presented on COPCs within 200-PW-2 and 200-PW-4.
DOE/RL-2001-01, *Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit RI/FS Work Plan, Includes: 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*	Data are presented on COPCs within 200-PW-1, 200-PW-3, and 200-PW-6.
DOE/RL-2001-66, *Chemical Laboratory Waste Group Operable Units RI/FS Work Plan, Includes: 200-LW-1 and 200-LW-2 Operable Units*	Data are presented on COPCs within both 200-LW-1 and 200-LW-2.
DOE/RL-2005-61, *Remedial Investigation Report for the 200-LW-1 (300 Area Chemical Laboratory Waste Group) and 200-LW-2 (200 Area Chemical Laboratory Waste Group) Operable Units*	Data are presented on COPCs for 216-S-20 and 216-Z-7 Cribs.
DOE/RL-2005-62, *Remedial Investigation Report for the 200-MW-1 Miscellaneous Waste Group Operable Unit*	Data are presented on 200-MW-1 COPCs.
D&D-27257, *Data Quality Objectives Summary Report for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit*	COPCs are presented for the 200-SW-2 OU.

Table 1-3. Existing References. (4 Pages)

Reference	Summary
D&D-28283, *Sampling and Analysis Instruction for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit*	Data are presented for Bin 3A and Bin 3B waste sites in the 200-SW-2 OU.
DOE/RL-2005-73, *Phase I Sampling and Analysis Plan for the 200-IS-1 and 200-ST-1 Operable Units*	Data are presented for 200-IS-1 and 200-ST-1.
DOE/RL-2004-39, *200-UR-1 Unplanned Release Waste Group Operable Unit Remedial Investigation/Feasibility Study Work Plan and Engineering Evaluation/Cost Analysis*	Data are presented on 200-UR-1 COPCs.
DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Site*	Data are presented on COPCs within the BC Cribs for the 216-B-26 Trench, 216-B-46 Crib, and 216-B-58 Trench.
DOE/RL-2002-11, *300-FF-5 Operable Unit Sampling and Analysis Plan*	Data are presented for 618-10 and 618-11 Burial Grounds within the 300-FF-5 OU.
DOE/RL-95-73, *Operation and Maintenance Plan for the 300-FF-5 Operable Unit*	Data are presented for 618-10 and 618-11 Burial Grounds within the 300-FF-5 OU.
RPP-14430, *Subsurface Conditions Description of the C and A-AX Waste Management Area*	Data are presented on COPCs related to the A-AX Tank Farm.
WMP-25924, *Data Quality Objectives Summary Report for the Installation of One Groundwater Well in the 300-FF-5 Operable Unit*	Data are presented for 618-10 and 618-11 Burial Grounds within the 300-FF-5 OU.
Existing References Outside the 200-PO-1 Groundwater OU Boundary	
US Ecology 2006, *Annual Environmental Monitoring Report for Calendar Year 2005*	Includes a compliance summary and list of contaminants for the US Ecology waste disposal facility and annual groundwater-monitoring results.
DOE/RL-92-05, *B Plant Source Aggregate Area Management Study Report*	Presents historic and background information.
DOE/RL-92-18, *Semiworks Plant Source Aggregate Area Management Study Report*	Presents a compilation of the 200 East Semiworks Source Area and inventories of chemical and radiological waste for individual sites, including an analysis of which sites are likely to have contributed to groundwater contamination are presented in this document.
WMP-28945, *Data Quality Objectives Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study Process*	Presents data from the 200-BP-5 Groundwater OU.

Table 1-3. Existing References. (4 Pages)

Reference	Summary
WMP-18647, *Historical Site Assessment of the Surface Radioactive Contamination of the BC Controlled Area*	Presents surficial contaminant data from the BC Cribs and Trenches area.

COPC = contaminant of potential concern.
DQO = data quality objective.
OU = operable unit.
RCRA = *Resource Conservation and Recovery Act of 1976.*

1.5 SITE BACKGROUND INFORMATION

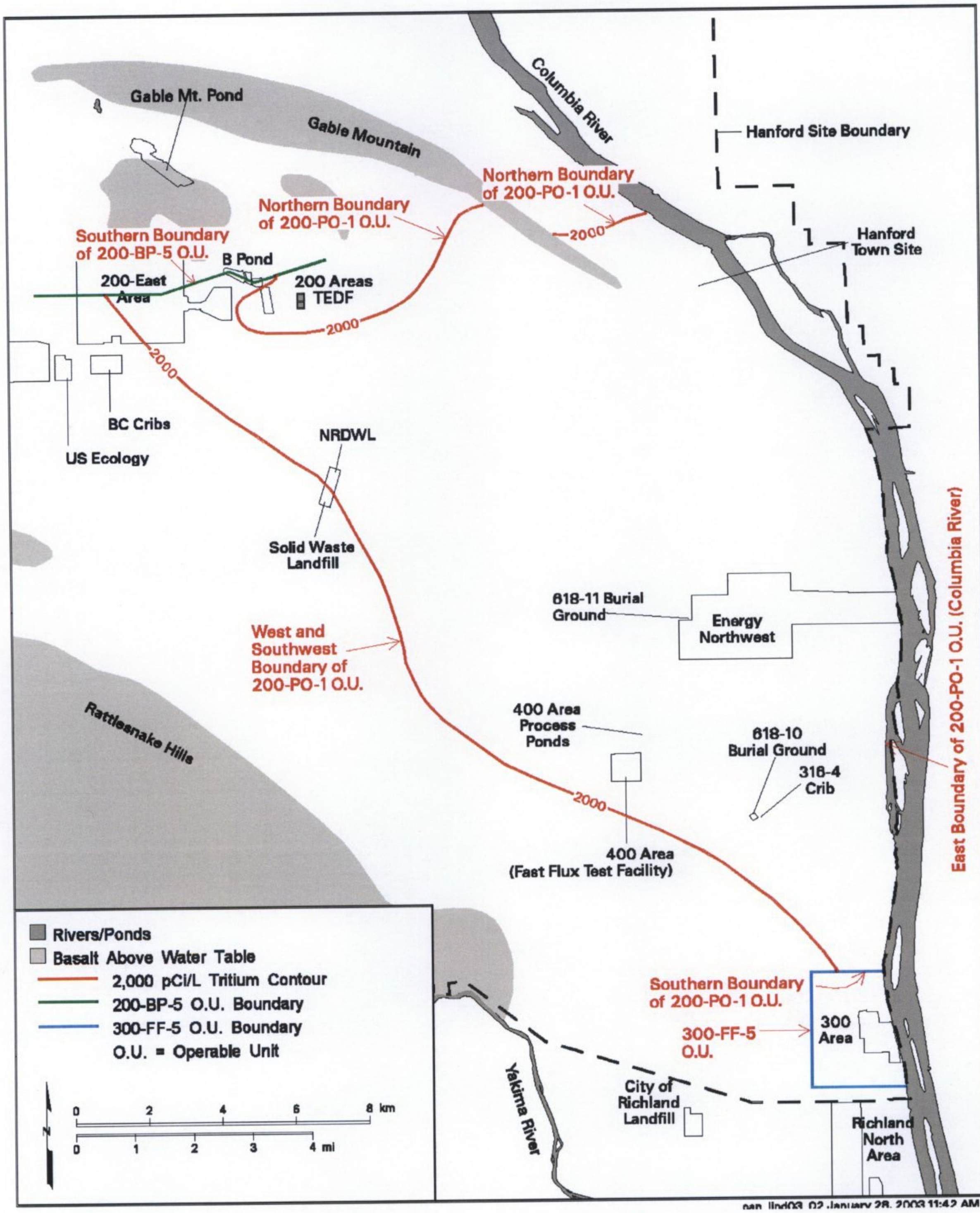
The Hanford Site, established in 1943, originally was designed, built, and operated to produce plutonium for nuclear weapons using production reactors and chemical reprocessing plants. During 1943 and 1944, three reactors (B, D, and F) were constructed on the Hanford Site. In addition, three processing facilities (B, T, and U Plants) were built. After World War II, six more reactors were built (H, DR, C, KW, KE, and N Reactors). Beginning in the 1950s, energy research and development, isotope use, and other activities were added to Hanford Site operations. A gradual shutdown of the Hanford reactors began in 1964. Eight reactors were no longer operating in 1971. The N Reactor operated through 1987 and was placed on cold standby status in October 1989.

1.5.1 200-PO-1 Groundwater Operable Unit Lateral Boundaries

The 200-PO-1 Groundwater OU is located in the 200 East Area of the Hanford Site as shown in Figure 1-1. Two different boundaries are currently used for the 200-PO-1 Groundwater OU. An ongoing investigation will define the boundaries that are applicable for future RI/FS activities. One of the currently applied boundaries is geographically defined; the other boundary includes a 2,000 pCi/L isopleth for a groundwater tritium plume in the southeast portion of the 200-PO-1 Groundwater OU. The associated tritium groundwater plume extends eastward and southward from potential contaminant sources in the southern portion of the 200 East Area. Other boundaries of the 200-PO-1 Groundwater OU are the Columbia River to the east, the 300-FF-5 OU to the south, and the 200-BP-5 Groundwater OU to the north.

The 200-PO-1 Groundwater OU is the largest groundwater OU associated with the Hanford Site, (Figure 1-2). The 200-PO-1 Groundwater OU encompasses the southern part of the 200 East Area and comprises a large triangle-shaped section of the Hanford Site, extending to the Hanford Town Site to the east and the 300-FF-5 OU to the southeast. The 200-PO-1 Groundwater OU is defined in part by the 2000 pCi/L contours of the tritium plume that extends from the 200 East Area to the Columbia River. A more detailed description of the 200-PO-1 Groundwater OU boundary is provided in Section 4.2.

Figure 1-2. 200-PO-1 Groundwater Operable Unit Boundaries.



For this report, the 200-PO-1 Groundwater OU is divided into three geographic areas of concern. The near-field region represents the source areas within and adjacent to the 200 East Area, and the downgradient areas to the Southeast Transect. The far-field region is defined as the area of the 200-PO-1 Groundwater OU including the Southeast Transect to the Columbia River. The River Transect, a subset of the far-field region, and the River Corridor aquifer tubes represent the final area of concern.

1.5.2 Site Background for the 200-PO-1 Operable Unit CERCLA Sites

Numerous sources of liquid waste discharge have existed in the 200 Areas since the inception of activities on the Hanford Site in 1945. Operations in the 200 Areas were related to the chemical separation of plutonium from spent nuclear fuel. Operations in the Plutonium-Uranium Extraction (PUREX) Plant, B Plant, and U Plant resulted in liquid disposal to the soil column in the 200-PO-1 Groundwater OU area, which contaminated the underlying groundwater.

Although the source 200-PO-1 Groundwater OUs are not the focus of this study, it must be noted that source 200-PO-1 Groundwater OUs originally were grouped geographically. In 1996, the source 200-PO-1 Groundwater OUs were regrouped into 23 process 200-PO-1 Groundwater OUs. Thus, the AAMSRs provide background information but not the current 200-PO-1 Groundwater OU grouping. Figure 1-3 presents the location of facilities in the 200-PO-1 Groundwater OU.

1.5.2.1 PUREX Plant Aggregate Area

The PUREX Plant aggregate area contains a variety of facilities that were involved in waste generation, transfer, treatment, storage, and/or disposal (TSD). Radiologically contaminated processing wastes were discharged to the soil column through cribs, trenches, and other facilities. Wastes that were not normally contaminated, but have the potential to contain radionuclides, such as cooling and condensate water, were allowed to infiltrate the ground through ponds and open ditches.

The PUREX Plant was constructed between 1953 and 1955, operating as a chemical separation facility until 1972. This facility was one of the primary sources of waste and is the dominant physical structure within the area. During operation, the PUREX process used tributyl phosphate in normal paraffin hydrocarbon solvent to recover uranium and plutonium from irradiated fuel rods dissolved in nitric acid solutions. Low-level PUREX waste was disposed to liquid waste disposal units such as cribs (e.g., 216-A-36B, 216-A-10, 216-A37-1, and 216-A-45), trenches, and french drains, while the high-level waste was diverted to tank farms. Low-activity waste and other waste were disposed of directly to the soil in 23 cribs, 4 trenches, and 15 french drains. Several unplanned releases are located in the vicinity of the PUREX Plant. More information is available in the PUREX AAMSR (DOE/RL-92-04).

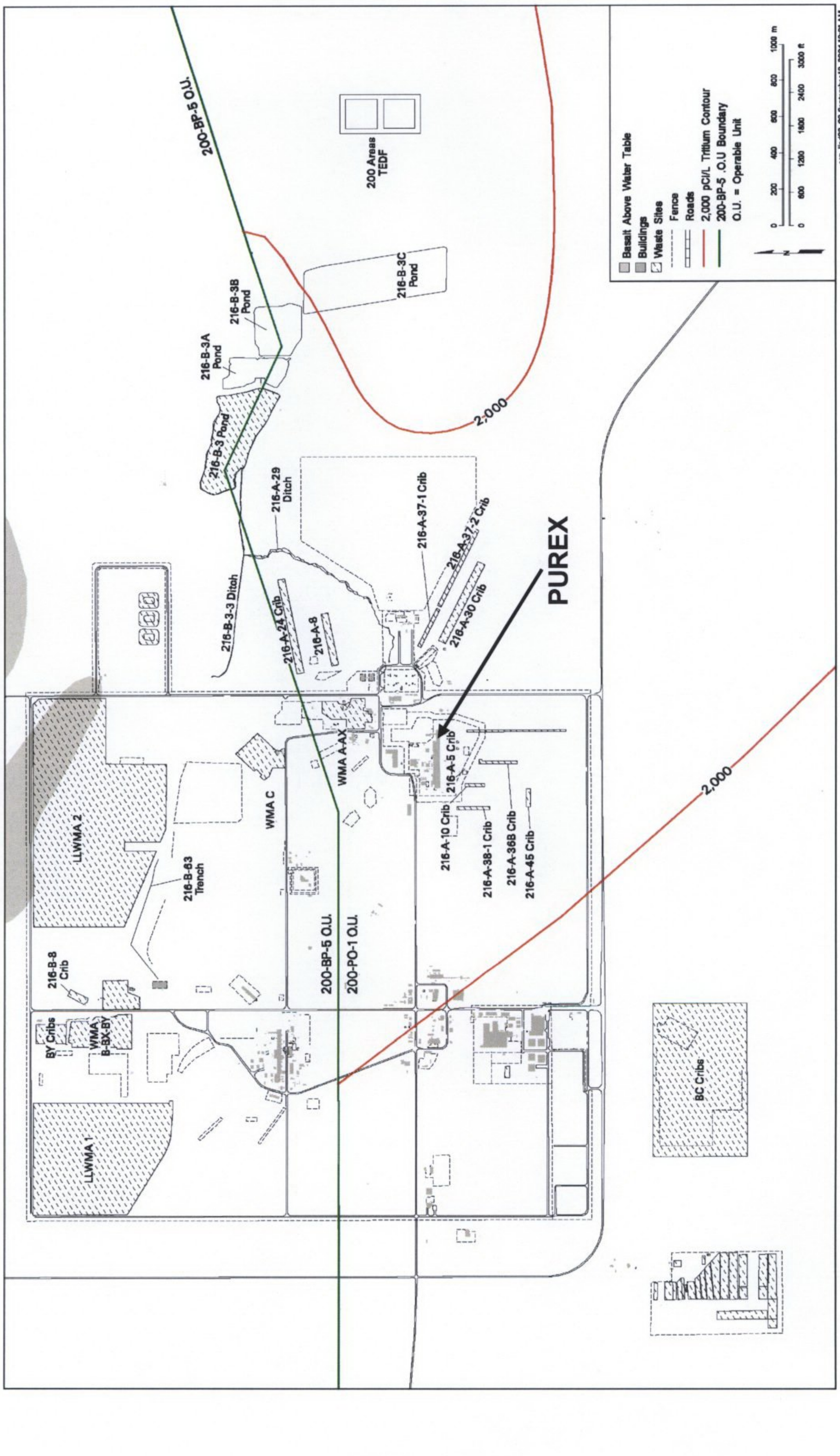


Figure 1-3. 200 East Area Facilities.

1.5.2.2 B Plant Aggregate Area

The B Plant aggregate area contains a large variety of waste disposal and storage facilities. High-level wastes were stored in underground single-shell tanks (SST). Low-level wastes such as cooling and condensate water were allowed to infiltrate the ground through cribs, trenches, reverse wells, and open ponds.

The B Plant used a bismuth phosphate process to extract plutonium from dissolved irradiated fuel rods from 1945 to 1952. From 1968 to 1985, the plant was used to recover cesium and strontium from tank farm waste. Process cooling water and steam condensate from the B Plant were sent to the 216-B-3 Pond system (B Pond). The B Pond system includes the B Pond and three expansion ponds (lobes). The larger volumes of wastewater discharged to the B Pond are known to have affected both the northward and southward groundwater flow regimes in the 200 East Area. Impacts on the 200-PO-1 Groundwater OU from B Plant activities primarily are related to the 216-B-3 Pond system (B Ponds and Ditches). The B Pond began receiving liquid waste in 1945. Three lobes (A, B, and C) were added in the 1980s. Significant groundwater mounding occurred below the B Ponds resulting in alterations in groundwater flow in the 200 East Area. Groundwater mounding has receded since the 216-B-3B Lobe was deactivated in 1985. In 1994, the expansion ponds of the facility were cleaned closed, leaving only the main pond and a portion of the 216-B-3-3 Ditch as the currently regulated facility (PNNL-15479, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*). More information is available in DOE/RL-92-05, *B Plant Source Aggregate Area Management Study Report* (B Plant AAMSR).

1.5.2.3 U Plant Aggregate Area

Wastewater from the U Plant (in the 200 West Area) was transported to the 200 East Area through underground pipelines. The plant used a tributyl phosphate in kerosene diluant process to recover uranium metal from the bismuth phosphate process waste stored in the tank farms. The aqueous portion of the waste stream was neutralized with sodium hydroxide and transferred to the tank farm. Overflow from these tanks was disposed to various cribs in the 200 East Area including the BC Cribs and Trenches. More information is available in DOE/RL-91-52, *U Plant Source Aggregate Area Management Study Report* (U Plant AAMSR).

1.5.3 Site Background for the 200-PO-1 Groundwater Operable Unit RCRA Treatment, Storage, and/or Disposal Units

Included within the 200-PO-1 Groundwater OU are six RCRA TSD units including the PUREX cribs, Waste Management Area (WMA) A-AX (SSTs), 216-A-29 Ditch, Integrated Disposal Facility (IDF), B Pond, and the Nonradioactive Dangerous Waste Landfill (NRDWL). Two other facilities that are not regulated under RCRA but are subject to *Washington Administrative Code* requirements are the 200 Area Treated Effluent Disposal Facility (TEDF) and the Solid Waste Landfill. Figure 1-3 shows the location of most of these facilities.

1.5.3.1 Plutonium-Uranium Extraction Plant Cribs

The PUREX cribs are three RCRA-regulated cribs (216-A-10, 216-A-36B, and 216-A37-1) located south and east of the PUREX Plant (see Figure 1-3). The 216-A-10 and 216-A-36B Cribs are inactive facilities that were used for disposal of liquid waste from PUREX. Waste was directly discharged to the soil column approximately 97 m (318 ft) above the water table. The crib was taken out of service and replaced with the 216-A-45 crib. The 216-A-37-1 Crib is located outside the 200 East Area perimeter fence, just east of the PUREX facility. The waste management unit is a gravel structure with a corrugated, galvanized, perforated pipe located horizontally 2 m (7 ft) below grade. The unit has a vent riser with a concrete base, two gage wells with a concrete support pad, and a membrane barrier between the gravel and the backfill. The crib operated from 1977 to 1989 and received process condensate from the 242-A Evaporator. The RCRA PUREX cribs are located in a region where several groundwater contamination plumes exceed drinking water standards. The similarities in effluent constituents disposed to these cribs, as well as to the 216-A-45 Crib, make determining the contribution of the RCRA PUREX cribs difficult (PNNL-16346).

1.5.3.2 BC Cribs

The BC Cribs are potential sources of contamination (based on Tc-99 disposal inventories), although the limited groundwater monitoring performed to date has not indicated significant groundwater contamination in the area. Other COPCs from the BC Cribs include chromium, Co-60, cyanide, and uranium.

1.5.3.3 Single-Shell Treatment, Storage, and/or Disposal A-AX Tank Farm

The SST TSD A-AX Tank Farm is located in the central portion of the 200 East Area of the Hanford Site north of PUREX. The TSD unit consists of the WMA A-AX SST Farms and ancillary waste systems (transfer piping and diversion boxes).

The A Tank Farm consists of 15 tanks, each with a 3,780,000 L (1 million gal) capacity, that were constructed between 1953 and 1954. These tanks are the largest of all SSTs at the Hanford Site, and received mixtures of organic and inorganic liquids containing radionuclides, solvents, and metals. These wastes contained high levels of fission products and chemical waste (nitrate, chromate, aluminum, and sodium hydroxide). Beginning in 1980, the tanks no longer received waste for disposal. Five of the SSTs in the A-AX Tank Farms are known or suspected to have leaked.

1.5.3.4 216-A-29 Ditch

The 216-A-29 Ditch is a RCRA-regulated unit located to the east of the 200 East Area. This ditch is an inactive facility that was used as an unlined percolation trench that received liquid effluent from the PUREX chemical sewer line, which routed effluent to the B Pond system. Discharges to the trench were approximately 83 to 61.5 m (272 to 202 ft) above the water table depending on location along the ditch. The ditch system received waste from 1955-1991 when discharges were eliminated and rerouted. Waste disposed to the ditch includes sodium hydroxide, sulfuric acid, corrosive waste, and other hazardous wastes (e.g., hydrazine) (DOE/RL-95-100).

1.5.3.5 Integrated Disposal Facility

Construction of IDF began in September 2004 and was completed in April 2006. The DOE submitted a Part B RCRA permit application to Ecology, and it was incorporated into WA7890008967, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8, for the Treatment, Storage, and Disposal of Dangerous Waste*, on April 9, 2006. The IDF operation is scheduled to begin in 2010. The IDF is a RCRA-compliant landfill (with a double-lined trench with leachate collection system) located in the south-central portion of the 200 East Area. Sampling at the IDF well network began in 2005, with the well network consisting of two upgradient wells and six downgradient wells. Groundwater samples are to be analyzed for RCRA indicator parameters including pH, specific conductance, total organic carbon, and total organic halides, and supplemental groundwater constituents including alkalinity, anions, and inductively coupled plasma (ICP) metals (specifically filtered chromium) (DOE/RL-2003-04).

1.5.3.6 216-B-3 Pond

The 216-B-3 Pond (B Pond) is a RCRA-regulated facility located east of the 200 East Area. The pond consists of a main pond, three interconnected lobes (B-3-1, B-3-2, and B-3-3), and three ditches extending east from the 200 East Area fenceline. The main pond began receiving liquid waste in 1945, and expansion lobes were put into service in 1983, 1984, and 1985. The B Pond system received B Plant cooling water, PUREX Plant chemical sewage and steam condensate, 242-A Evaporator cooling water and steam condensate, 283-E Water Treatment Facility filter backwash, and 284-E Powerhouse liquid effluent. The well network includes five wells, one of which is north of the B Pond and is in the 200-BP-5 Groundwater OU. The monitoring plan, including the well network, COPCs, sampling and analysis procedure, and a conceptual model, is described in PNNL-15479.

1.5.3.7 Nonradioactive Dangerous Waste Landfill

This landfill is a RCRA-regulated unit located south and east of the 200 East Area with the Solid Waste Landfill, and is part of the Central Landfill. The NRDWL is an inactive dangerous waste landfill that received nonradioactive dangerous waste from 1975 to 1985, but continued to receive asbestos waste until 1988. Groundwater monitoring has been ongoing since 1986. The well network includes nine wells. The groundwater samples are analyzed for anions, ICP metals, phenols, volatile organic compounds (VOC), and the four RCRA indicator parameters.

1.5.4 Site Background for Washington Administrative Code Permitted Facilities

1.5.4.1 Treated Effluent Disposal Facility

The 200 Area TEDF is located southeast of the B Pond RCRA facility and has received effluent since June 1995. The well network consists of nine wells sampled quarterly for constituents specified in WAC 173-304-490(2)(d), "Minimum Functional Standards for Solid Waste Handling," "Groundwater Monitoring Requirements," "Groundwater Monitoring Requirements," "Sample Constituents," including anions, coliform bacteria, chemical oxygen demand, filtered

ICP metals, pH, specific conductance, temperature, and total organic carbon. In addition, the wells are sampled for site-specific constituents including VOCs and filtered arsenic.

1.5.4.2 Solid Waste Landfill

The Solid Waste Landfill is regulated by Ecology. The well network consists of nine wells sampled quarterly for constituents specified in WAC 173-304-490(2)(d) including anions, coliform bacteria, chemical oxygen demand, filtered ICP metals, pH, specific conductance, temperature, and total organic carbon. In addition, the wells are sampled for site-specific constituents including VOCs and filtered arsenic.

1.5.5 Regulatory Background for the 200-PO-1 Groundwater Operable Unit

In June 1993, a *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et a., 1989) change request (C-93-06) was approved to redesignate the 200 East Area OUs from combined source and groundwater OUs, to groundwater-only OUs. The change was based on recommendations provided in the AAMSRs for the 200 East Area, 200-BP-5 Groundwater OU, and 200-PO-1 Groundwater OU. The AAMSRs supported the decision-making process presented in DOE/RL-91-40, *Hanford Past-Practice Strategy*. The change request designated Ecology as the Lead Regulatory Agency, and stated that groundwater would be addressed as a CERCLA past practice (CPP) unit. Submittal of an RI/FS Work Plan for 200-PO-1 Groundwater OU as a groundwater-only unit was not scheduled as part of this 1993 change request.

Milestone M-013-94-03 (May 1995) provided for the implementation of the 1994 Refocusing Negotiations and modified M-013 milestones for completion of the 200 Area National Priorities List pre-record of decision (ROD). The milestone also established Milestone M-03-10 for submittal of the 200-PO-1 Groundwater OU RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) Work Plan (DOE/RL-96-66) by October 31, 1995; changed the 200-PO-1 Groundwater OU unit category from CERCLA past practice to "RCRA past-practice"; and kept Ecology as the designated Lead Regulatory Agency.

In July 1995, Milestone M-013-95-01 changed milestone M-013-10 to "Submit the 200-PO-1 OU RFI/CMS Work Plan" and added the following three new M-015 milestones, which were completed as scheduled.

- M-015-25, Submit 200-PO-1 Phase I RCRA RFI Report by December 31, 1995
- M-015-25A, Submit 200-PO-1 CMS by July 31, 1996
- M-015-25-B, Submit 200-PO-1 Permit Modification by August 30, 1996.

The following RFI/CMS documents were completed for the new M-015 milestones:

- DOE/RL-95-100, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit*
- DOE/RL-96-59, *200-PO-1 Permit Modification*
- DOE/RL-96-66, *RCRA Facility Corrective Measures Study for the 200-PO-1 Operable Unit*, Draft A.

The following documents also were completed:

- PNNL-14049, *Data Quality Objectives Summary Report – Designing a Groundwater Monitoring Network for the 200-BP-5 and 200-PO-1 Operable Units*
- CP-15329, *Data Quality Objectives Summary Report for Establishing a RCRA/CERCLA/AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network*
- DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit.*

The following are milestone changes agreed upon by the Tri-Parties (DOE, EPA, and Ecology).

- In February 1995, the Hanford Advisory Board endorsed the Hanford Site groundwater remediation strategy (HAB 40, "Hanford Site Wide Ground Water Remediation Strategy" [HAB Advice #40]).
- M-15-02-01 calls for modification of the Tri-Party Agreement Milestone Series M-015 in accordance with the Ecology et al., 2002, *Modify Tri-Party Agreement Milestone Series M-015 in Accordance with the Central Plateau Agreement In Principle, Tri-Party Agreement Change Request, M-015-02-01*, and provides for consolidation of existing Tri-Party Agreement milestones/target dates. Milestone M-015C calls for the completion of all 200 Area non-tank farm pre-ROD site investigations under approved work plan schedules by December 31, 2008.
- M-13-06-01 established six new Tri-Party Agreement M-013 Series Interim Milestone dates for submittal of work plans in support of CERCLA and RCRA processes for 200 Area OUs and established a new M-13-10A milestone for the 200-PO-1 Groundwater OU.
- M-013-10A calls for the submission of the 200-PO-1 Groundwater OU RI/FS Work Plan (DOE/RL-2007-31, *Remedial Investigation/Feasibility Study Work Plan for the 200-PO-1 Groundwater Operable Unit*) to Ecology by September 30, 2007.
- M-15-06-02 calls for the modification of Tri-Party Agreement commitments to complete the RI/FS or RFI/CMS process for all OUs, and extends the 200 Area non-tank farm investigations to December 31, 2011.

This DQO supports the Characterization SAP (DOE/RL-2007-30) and the 200-PO-1 Groundwater OU Work Plan (DOE/RL-2007-31) to fulfill milestone M-013-10A.

1.6 DATA QUALITY OBJECTIVE TEAM MEMBERS AND KEY DECISION MAKERS

Table 1-4 lists DQO team members and key decision makers from the DOE, EPA, and Ecology, identifying their organization and their roles and responsibilities. DQO team members were carefully selected to participate in the seven-step DQO process based on their background and technical expertise to meet specific task objectives.

Table 1-4. Data Quality Objective Team Member and Key Decision Makers.

DQO Team Member		
Name	**Organization**	**Role and Responsibility**
Gloria Cummins	FH S&GRP	200-PO-1 Task Lead
Jon Lindberg	PNNL	200-PO-1 Geologist
Greg Thomas	FH S&GRP	200-BP-5 Task Lead
Susan Narbotovskih	PNNL	A-AX Tank Farm Geologist
Fred Mann	CHI	Tank Farms Geologist
John Roberts	Ecology	Senior Chemist
Beth Rochette	Ecology	Risk Assessor/Chemist
Dib Goswamai	Ecology	Regulatory and Technical Review
Craig Cameron	EPA	EPA Perspective
John Morse	RL	Assistant Manager Central Plateau
Bob Lober	ORP	Tank Farms Programs & Projects
Mitzi Miller	EQM, Inc.	Senior DQO Specialist, Chemist, Senior COPC Advisor
Wanda Elliott	EQM, Inc.	COPC Evaluation
DQO Key Decision Makers		
John Price	Ecology	Final decisions related to the sampling approach
Zelma Maine-Jackson	Ecology	Final decisions related to the sampling approach
Joe Caggiano	Ecology	Final decisions related to the sampling approach
Jeanne Vanni	Ecology	Final decisions related to the sampling approach
Rod Lobos	EPA	Final decisions related to the sampling approach
Doug Hildebrand	RL	Final decisions related to the sampling approach

CHI = CH2M HILL Hanford, Inc.
COPC = contaminant of potential concern.
DQO = data quality objective.
Ecology = Washington State Department of Ecology.
EPA = U.S. Environmental Protection Agency.
FH S&GRP = Fluor Hanford Soil & Groundwater Remediation Project.
ORP = U.S. Department of Energy, Office of River Protection.
PNNL = Pacific Northwest National Laboratory.
RL = U.S. Department of Energy, Richland Operations Office.

1.7 PROJECT BUDGET AND CONTRACT STATUS

Table 1-5 shows the budget for all of the task activities associated with development and implementation of the sampling program, laboratory analyses, data quality assessment, and evaluation and reporting of investigation results and identifies the contract status for activities that need to be subcontracted.

Table 1-5. Task Activity Budget and Contract Status.

Task Activities	Budget	Contract Status
Data quality objective summary report	$37,000	In place
Work plan/sampling and analysis plan	$72,000	In progress
Field sampling implementation	$25,000	In place
Laboratory analyses	$160,000	In place
Data quality assessment	$5,000	Part of remedial investigation/feasibility study
Investigation results evaluation and reporting	$10,000	Part of remedial investigation/feasibility study

1.8 ACTIVITY DATES

Table 1-6 shows the task activities associated with development and implementation of the RI/FS sampling program, laboratory analyses, data quality assessment, and evaluation and reporting of investigation results, along with their dates of activity.

Table 1-6. Task and Activity Dates.

Task Activities	Milestone Dates
Data quality objective summary report	June 30, 2007
Remedial investigation/feasibility study work plan	September 30, 2007 (Milestone M-013-10A)
Phase 1 field investigation activities	October 1, 2007, through December 31, 2008
Laboratory analyses	January 1, 2008, through December 31, 2008
Data quality assessment	October 1, 2008, through April 30, 2009
Phase 2 field investigation activities	January 1, 2009, through December 31, 2009
Laboratory analyses	January 1, 2009, through December 31, 2009
Data quality assessment	October 1, 2009, through April 30, 2010

1.9 CONTAMINANTS OF POTENTIAL CONCERN EVALUATION

The COPC evaluation for the 200-PO-1 Groundwater OU was conducted in two steps. This DQO process references COPCs from existing documentation and from routine monitoring, and presents these contaminants in comprehensive lists. Process history of the source OUs and more than 300,000 results from groundwater analyses were used in the evaluation.

Step 1 examined existing references for any constituents that were known or believed to be used at the facilities within the 200-PO-1 Groundwater OU. Six documents provided the bulk of COPCs and are listed in Section 1.9.1. In addition, various documents provided data on the 200-BP-5 Groundwater OU, Tank Farms, and the BC Cribs and are presented in Appendix A. Each of the historic process documents presents nonradioactive and radioactive constituents. In addition, constituents from routine monitoring were included in the initial list of COPCs. A total of 339 contaminants were identified in Step 1.

The second step in the COPC evaluation included querying the *Hanford Environmental Information System* (HEIS) database and evaluating the analytical data from sampling activities in monitoring wells within the 200-PO-1 Groundwater OU. Data were downloaded for 189 wells within the 200-PO-1 Groundwater OU from November 1, 1988, to November 1, 2006. The HEIS data allowed for an evaluation of the levels of current groundwater contamination and evaluated the concentrations of COPCs as a function of time and location. The resulting data included information on the following types of constituents: metals, non-metals, ions, water quality parameters, polychlorinated biphenyls (PCB), pesticides, radiological, semivolatile organic compounds (SVOC), and VOCs. The results of each constituent were evaluated by comparing individual contaminant results to selected preliminary remediation goals (PRG) that are explained in detail in Appendix E of the 200-PO-1 Groundwater OU Work Plan (DOE/RL-2007-31). Appendix B lists the selected wells and the sampling and analyses to be performed for characterization of the 200-PO-1 Groundwater OU.

1.9.1 Step 1 of Contaminants of Potential Concern Evaluation

All references to documents in this section can be found in Appendix A. Step 1 examined existing references for any constituents that were known or believed to be used within processes at or within the general areas of the 200-PO-1 Groundwater OU. Six documents provided the bulk of COPCs, while 19 others provided ancillary constituents. The majority of the historical information regarding COPCs was located in the following historic process documents:

- DOE/RL-92-04, *PUREX Plant Source Aggregate Area Management Study Report*
- DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study Report*
- DOE/RL-95-100, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit*
- DOE/RL-96-59, *200-PO-1 Permit Modification*
- DOE/RL-96-66, *RCRA Facility Corrective Measures Study for the 200-PO-1 Operable Unit*
- DOE/RL-99-07, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan.*

A total of 25 documents were examined during Phase I. In addition, various documents listed below provide data on the 200-BP-5 Groundwater OU, tank farms, and the BC Cribs. Each of the historic process documents presents nonradioactive and radioactive constituents. In addition, constituents from routine monitoring were included in the initial list of COPCs.

- DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Site*
- WMP-28945, *Data Quality Objectives Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study Process*
- RPP-14430, *Subsurface Conditions Description of the C and A-AX Waste Management Area*
- RPP-23748, *Geology, Hydrology, Geochemistry, and Mineralogy Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site.*

1.9.2 Routinely Monitored Contaminants of Potential Concern

Bands of guard wells, chosen from the existing monitoring network of the 200-PO-1 Groundwater OU, were previously established. These wells were sampled annually (at a minimum) and were used to detect and monitor plumes emanating from primary 200 Area source waste sites in the 200-PO-1 Groundwater OU. Table C-1 of Appendix C presents the analyses to be performed on samples collected from individual wells in the routine groundwater-monitoring well network, and the frequency at which samples will be collected for analytical testing. One band, the Southeast Transect, is located to the south and east of the 200 East Area and detects contamination moving downgradient into the southern and eastern parts of the Hanford Site (PNNL-16346). A second band, the River Transect, is positioned along the Columbia River at the eastern edge of the Hanford Site to monitor contaminant transport to the Columbia River.

For this report, the 200-PO-1 Groundwater OU is divided into three geographic areas of concern. The first area, or near-field region, represents the source areas within and adjacent to the 200 East Area, and the downgradient areas extending to the Southeast Transect. The second area, or far-field region, is defined as the area of the 200-PO-1 Groundwater OU including the Southeast Transect and extending to the Columbia River. The River Transect and River Corridor aquifer tubes, both of which are subsets of the far-field region, represent the final area of concern (see Figure 1-4).

Currently, the far-field groundwater contaminants are tritium, I-129, and nitrate. Concentrations of nitrate that exceed the 45 mg/L drinking water standard as nitrate or 10 mg/L as nitrogen in nitrate, and of I-129 that exceed the minimum required detection level, are within the 2000 pCi/L tritium boundary isopleths (PNNL-16346). Near-field monitoring is associated primarily with TSD facilities, but includes the BC Cribs. Tables D-1 through D-6 of Appendix D present the monitoring constituents in the six RCRA TSD units. The near-field contaminant plumes are generally localized and of limited area. Figure 1-4 presents the near field, far field, Southeast Transect, and River Transect areas of concern.

Figure 1-4. Location of Near Field, Far Field, Southeast Transect, and River Transect Areas of Concern.

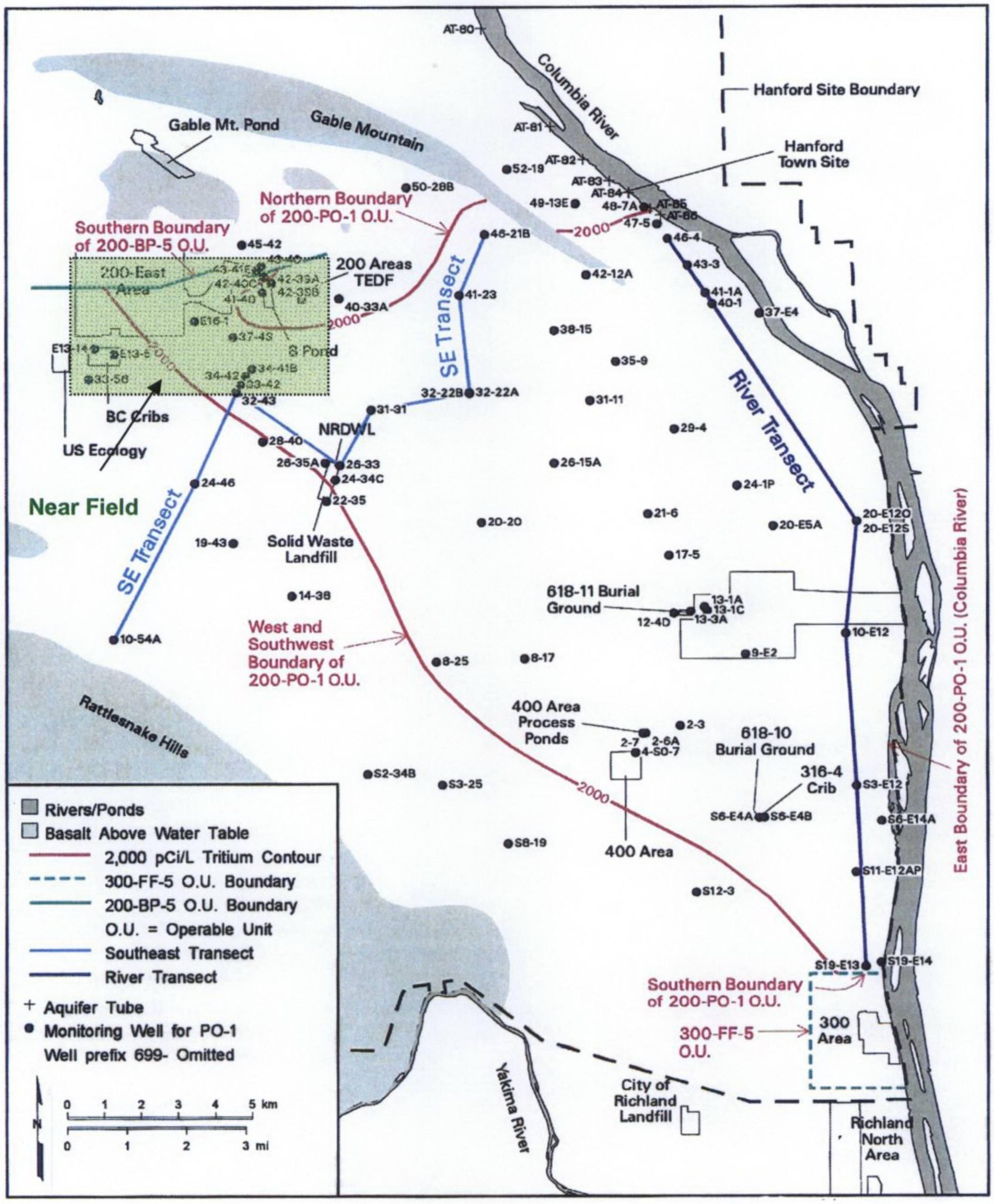


Table 1-7 represents a list of groundwater COPCs generated and the geographic area that they represent for the 200-PO-1 Groundwater OU to fulfill the routine monitoring requirements for the combined RCRA, CERCLA, and *Atomic Energy Act of 1954* groundwater-monitoring network (CP-15329).

Table 1-7. Routinely Monitored Constituents in 200-PO-1 Groundwater Operable Unit. (2 Pages)

Contaminant of Potential Concern	Near-Field Wells[a]	Far-Field Wells[b]	Supplementary Wells[c]
Alkalinity			x
Anions	x	X	x
Arsenic	x	X	x
Chromium	x		
Cyanide		X	x
Gross alpha	x	X	x
Gross beta	x	X	x
Gross gamma		X	x
Hexavalent chromium		X	x
Inductively coupled plasma metals		X	x
Iodine-129	x	X	x
Lead		X	x
Manganese	x		
Mercury		X	x
Metals	x		
Nitrate	x	X	
Phenols			x
Specific conductance	x	X	
Strontium-90	x	X	x
Technetium-99	x	X	x
Temperature	x	X	
Total dissolved solids			x
Total organic carbon		X	x
Total organic halides		X	x
Tritium	x	X	x
Turbidity	x	X	
Uranium		X	x

Table 1-7. Routinely Monitored Constituents in 200-PO-1 Groundwater Operable Unit. (2 Pages)

Contaminant of Potential Concern	Near-Field Wells[a]	Far-Field Wells[b]	Supplementary Wells[c]
Vanadium	x		
Volatile organic analyte		X	x

[a] Routinely sampled analytes and parameters for near-field wells.
[b] Routinely sampled analytes and parameters for far-field wells.
[c] Routinely sampled analytes and parameters for supplementary wells. Supplementary wells are monitored under monitoring plans other than DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*, such as *Resource Conservation and Recovery Act of 1976* and *Washington Administrative Code* permit plans.

Tables 1-8 and 1-9 present the 339 nonradiological and radiological COPCs that were identified in Step 1.

Table 1-8. Initial Comprehensive List of Nonradiological Contaminants of Potential Concern in 200-PO-1 Groundwater Operable Unit. (3 Pages)

Metals	Other Inorganics	Semivolatiles
Aluminum	Ammonia	2,3,4,6-Tetrachlorophenol
Aluminum nitrate monobasic	Ammonium carbonate	2,4-Dichlorophenol
Aluminum nitrate nonahydrate	Ammonium fluoride	2,4-Dichlorophenoxyacetic acid 2,4-D
Antimony	Ammonium ion	2,4-Dimethylphenol
Arsenic	Ammonium nitrate	2,4-Dinitrophenol
Barium	Hydrazine	2,4-dinitrotoluene
Beryllium	Hydrobromic acid	2-methylphenol (o-cresol)
Bismuth	Hydrochloric acid	2-Nitrophenol
Bismuth phosphate	Hydrofluoric acid	Dinoseb 2-sec Butyl-4,6-dinitrophenol
Boron	Hydrogen peroxide	3-Methylphenol
Cadmium	Hydroxylamine hydrochloride	4-methylphenol (p-cresol)
Cadmium nitrate	Hydroxylamine nitrate	Benzo [a] anthracene
Ceric fluoride	Nitric acid	Benzo [a] pyrene
Ceric sulfate	Periodic acid	Benzo[b] fluoranthene
Cerium	Phosphoric acid	Benzo [k] fluoranthene
Chromium	Phosphorus	Bis (2-ethylhexyl) phthalate
Cobalt	Phosphorus pentoxide	Butylated hydroxy toluene
Copper	Sodium bisulfate	Chlorobenzene
Ferric nitrate	Sodium bromate	Chrysene
Ferrocyanide	Sodium carbonate	Dibenzo [a,h] anthracene
Ferrous sulfamate	Sodium dichromate	Dibutyl butyl phosphonate
Ferrous sulfate	Sodium ferrocyanide	Dibutyl phosphate
Gold	Sodium fluoride	Diethylphthalate

Table 1-8. Initial Comprehensive List of Nonradiological Contaminants of Potential Concern in 200-PO-1 Groundwater Operable Unit. (3 Pages)

Hexavalent chromium	Sodium hydroxide	Di-n-Butylphthalate
Iron	Sodium nitrate	Hydroxyacetic acid
Lanthanum	Sodium nitrite	Indeno [1,2,3-cd] pyrene
Lanthanum fluoride	Sodium sulfate	Monobutyl phosphate
Lanthanum hydroxide	Sodium thiosulfate	Naphthylamine
Lanthanum nitrate	Sulfamic acid	n-butyl benzene
Lead	Sulfuric acid	N-Nitrosodiphenylamine
Lead nitrate	Thiocyanate	Polychlorodibenzodioxin
Lithium	**Volatile Organics**	Polychlorodibenzofuran
Magnesium	1,1,1-Trichloroethane	Tetrachlorophenol
Manganese	1,1,2,2-Tetrachloroethane	Thenoyltrifluoroacetone
Mercury	1,1-Dichlorethane	Tributyl phosphate
Mercuric nitrate	1,2-Dichlorobenzene	Trichlorophenol
Metals	**Volatile Organics**	**Semivolatiles**
Molybdenum	1,2-Dichloroethane	Tri-n-dodecylamine
Nickel	1,3-Dichlorobenzene	Tris-2-chloroethyl phosphate
Nickel nitrate	1,4-Dichlorobenzene	**Hydrocarbons**
Potassium	1-Butanol, butyl alcohol	Decane
Potassium fluoride	1-Butynol	Diesel fuel
Potassium hydroxide	2-Butanone	Dodecane
Potassium oxalate	2-Chlorophenol	Hydraulic fluids (greases)
Potassium permanganate	2-Hexanone	Kerosene
Radium	2-Propanol (Isopropyl alcohol)	Lard oil
Selenium	4-Chloro 3-methylphenol	Paint thinner
Selenium tetroxide	4-Methyl-2-Pentanone (Hexone)	Paraffin hydrocarbons NPH
Silicon	Acetone	Shell E-2342 (naphthalene and
Silicon trioxide	Acetonitrile	Soltrol-170 (purified kerosene)
Silver	Benzene	**Pesticides**
Silver nitrate	Bromodichloromethane	2,4,5-TP Silvex
Sodium	Carbon disulfide	4,4'-DDD
Strontium	Carbon tetrachloride	4,4'-DDE
Thallium	Chloroform	4,4'-DDT
Tin	cis-1,2-Dichloroethylene	Aldrin
Titanium	Cyclohexane	Alpha BHC
Tungsten	Cyclohexanone	Delta- BHC
Tungsten tetroxide	Dibromochloromethane	Dieldrin
Uranium	Diethyl ether	Dimethoate
Vanadium	Ethanol	Endosulfan sulfate

Table 1-8. Initial Comprehensive List of Nonradiological Contaminants of Potential Concern in 200-PO-1 Groundwater Operable Unit. (3 Pages)

Zinc	Ethylbenzene	Endrin
Zirconium	Ethylene glycol	Endrin aldehyde
Zirconium oxide	Ethyl cyanide	Heptachlor
Zirconyl phosphate	Formaldehyde	Heptachlor epoxide
Miscellaneous	Hexane	Lindane (Gamma BHC)
Aroclor-1254	Methyl chloride	Methoxychlor
Aroclor-1260	Methylene chloride	Phorate
Polychlorinated biphenyls	Naphthalene	Toxaphene
Sugar	Pentachlorophenol	**Anions**
Complexants	Phenol	Bromide
Citrate	Phenols	Chloride
EDTA	Pyrene	Cyanide
Glycolate (Hydroxyacetic acid)	Tetrachloroethene	Fluoride
HEDTA	Tetrahydrofuran	Hydroxide
Complexants	**Volatile Organics**	**Anions**
Oxalic acid	Toluene	Nitrate
Tartaric acid	trans-1,2-Dichloroethylene	Nitrite
Water Quality Measurements	Trichloroethane	Oxalate
Alkalinity	Trichloroethene	Perchlorate
Coliform bacteria	Trichloromonofluoromethane	Phosphate
pH	Vinyl chloride	Sulfate
Specific conductance	Xylene	Sulfide
Temperature		
Total organic carbon		
Turbidity		

Aroclor is an expired trademark.
Soltrol is a trademark of Chevron Phillips Chemical Company LP, The Woodlands, Texas.

Table 1-9. Initial Comprehensive List of Radiological Contaminants of Potential Concern in 200-PO-1 Groundwater Operable Unit. (2 Pages)

Actinium-225	Gamma scan*	Radium-228
Actinium-227	Gross alpha*	Radon-220
Americium-241	Gross beta*	Radon-222
Americium-242	Iodine-129	Rhodium-106
Americium-242m	Iodine-131	Ruthenium-101
Americium-243	Lead-209	Ruthenium-103
Antimony-125	Lead-210	Ruthenium-106
Antimony-126	Lead-211	Samarium-151
Antimony-126m	Lead-212	Selenium-79

Table 1-9. Initial Comprehensive List of Radiological Contaminants of Potential Concern in 200-PO-1 Groundwater Operable Unit. (2 Pages)

Astatine-217	Lead-214	Strontium-90
Barium-137m	Manganese-54	Technetium-99
Beryllium-7	Neptunium-237	Thallium-207
Bismuth-210	Neptunium-239	Thallium-208
Bismuth-211	Nickel-63	Thorium-227
Bismuth-212	Nickel-64	Thorium-229
Bismuth-213	Palladium-107	Thorium-230
Bismuth-214	Plutonium-238	Thorium-231
Carbon-14	Plutonium-239/240	Thorium 232
Cerium/Praseodymium-144	Plutonium-241	Thorium-233
Cesium-134	Polonium-210	Thorium-234
Cesium-135	Polonium-213	Tin-113
Cesium-137	Polonium-214	Tin-126
Chlorine-36	Polonium-215	Tritium
Cobalt-58	Polonium-218	Uranium-233
Cobalt-60	Potassium-40	Uranium-234
Curium-242	Promethium-147	Uranium-235
Curium-244	Protactinium-231	Uranium-238
Curium-245	Protactinium-233	Yttrium-90
Europium-152	Protactinium-234	Zinc-65
Europium-154	Radium-223	Zirconium-93
Europium-155	Radium-224	Zirconium/Niobium-95
Francium-221	Radium-225	
Francium-223	Radium-226	

*Represents survey parameters.

1.9.3 Step 2 of Contaminants of Potential Concern Evaluation

To examine the levels of current groundwater contamination and evaluate the concentrations of COPCs as a function of time and location, the HEIS database was queried. Contaminant analyses were downloaded for 189 wells within the 200-PO-1 Groundwater OU from November 1, 1988, to November 1, 2006. The resulting data included information on the following types of constituents: metals, non-metals, ions, water-quality parameters, PCBs, pesticides, radiological, SVOCs, and VOCs.

The results for each constituent were evaluated by comparing individual contaminant results (from actual data for existing wells) to a selected PRG. The logic for deriving these limits is explained below. In addition, applicable Hanford Site groundwater background concentrations were compiled from DOE/RL-92-23, *Hanford Site Groundwater Background*. The background values in the report for metals, non-metals, and total alpha/beta were compiled from the evaluation of data and information pertaining to the natural composition of groundwater in the unconfined aquifer system beneath the Hanford Site. Provisional background threshold levels were estimated from the data presented in the report. Background concentrations were available for many of the inorganic and radionuclide constituents, but not for organic constituents. If a background concentration for any COPC was not available, the background was assumed to be zero.

Screening values were extracted for all constituents (when available) from the following sources: the *Cleanup Levels & Risk Calculations* (CLARC) database (Ecology 2005) for carcinogen and non-carcinogen values; primary and secondary MCLs from EPA's National Drinking Water Standards; PRGs defined in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*; and background levels from DOE/RL-92-23. If the background value was higher than any PRG available, the background value was used.

Table E-1 of the 200-PO-1 Groundwater OU Work Plan (DOE/RL-2007-31) lists the COPCs found in the HEIS database, as well as any applicable PRGs, derived from the EPA MCL (40 CFR 141, "National Primary Drinking Water Regulations") or the limit stated in WAC 173-340-720(4), "Ground Water Cleanup Standards," "Method B Cleanup Levels for Potable Ground Water"; any applicable background information also is included. Assumed initial PRGs in Table E-1 were based on the more stringent MCLs and WAC 173-340 values. The MCL levels were obtained from EPA's drinking water standards, as published on EPA's Web site (http://www.epa.gov/ safewater/mcl.html) in August 2003. If MCL data did not exist, WAC 173-340-720(4) carcinogen formula values (preferred) or noncarcinogenic formula values were selected. The WAC 173-340-720(4) data were obtained from the CLARC database (Ecology 2005).

Current MCLs for radionuclides are set at 4 mrem/yr for the sum of the doses from beta particles and photon emitters, and 15 ρCi/L for total alpha particle activity (including Ra-226, but excluding uranium and radon). The MCLs for Sr-90 and tritium are 8 ρCi/L and 20,000 ρCi/L, respectively. The MCL for total uranium is 30 μg/L (40 CFR 141.66, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels for Radionuclides"). The current MCLs for beta emitters specify that the MCLs are to be calculated based on an annual dose equivalent of 4 mrem to the total body or any internal organ. It is further specified (40 CFR 141.66) that the calculation is to be performed on the basis of a 2 L/day (0.5 gal) drinking water intake using the 168-hour data listed in NBS Handbook 69, *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air or Water for Occupational Exposure*. In addition, PRGs defined in DOE/RL-96-17 were used when appropriate and are noted in Appendix E, Table E-1 of the 200-PO-1 Groundwater OU Work Plan (DOE/RL-2007-31).

1.9.4 Contaminant Inclusion/Exclusion Evaluation Process

The logic for inclusion/exclusion of nonradiological and radiological constituents within the Characterization SAP (DOE/RL-2007-30) is presented below. The logic presented does not reflect on constituents in the Monitoring SAP (DOE/RL-2003-04), but only those in the Characterization SAP.

The following logic was initially applied for nonradiological COPCs:

- The compounds/elements/anions listed were examined in the CLARC database (Ecology 2005), the *Integrated Risk Information System* (IRIS) database (maintained by EPA), and the Agency for Toxic Substances and Disease Registry (ATSDR) database. Both carcinogenic and toxic constituents are listed. If any database indicated that the constituent was neither carcinogenic nor toxic, then it was not included as a COPC.

- Parameters that are not specific compounds and provide no specific risk information (e.g., pH or total organic carbon [TOC]) were excluded from the formal CERCLA COPC list. However, in some cases, these analyses will be performed on selected wells to assist in modeling.

- If the constituent has a set PRG from the following, it was included as a COPC: primary or secondary MCL for drinking water specified by Ecology or EPA; cleanup levels for groundwater as determined by the WAC 173-340-720(4) standard formula for noncarcinogenic risks; cleanup levels for groundwater as determined by the WAC 173-340-720(4) standard formula for carcinogenic risks; the groundwater background threshold value, as listed in DOE/RL-92-23, Table 5-9; and the PRGs as defined in DOE/RL-96-17.

For the radiological COPCs, any radionuclide on the list with a half-life of less than 2 years was not included. Similarly, natural short-lived daughter products of other radionuclides in the list (e.g., uranium or radium) were discarded because the daughters are considered in any calculation of dose from the parent isotopes.

For the remaining constituents, the analytical results from all 200-PO-1 Groundwater OU analyses in the HEIS database were compared for all COPCs with PRGs. If any detected result for a constituent exceeded the set PRG, it was retained as a COPC, unless the following occurred:

- The analytical result was flagged with a "P" or "Q" (flags represent that during data validation, the reviewer believed that there was a potential problem with the data or the associated quality control data), and subsequent analyses were consistently below PRGs. The "P" may reflect that the reviewer believed that a problem may have existed with the collection/analysis circumstances that makes the value questionable. The "Q" may reflect that the reviewer found that the associated quality control value was out of limits.

- Subsequent analyses of the well(s) that had exceedances for the particular constituent show results consistently below the PRG.

A total of 596 COPCs were addressed from Steps 1 and 2. Only 235 COPCs had PRGs and were formally evaluated. The results for the 235 constituents were compared against the PRGs. Any result for a constituent that had a detected exceedance above the PRG was included on the candidate list of COPCs. Of the 235 with PRGs, 179 did not have any detects that exceeded

PRGs, and were thus excluded from further consideration. Of the remaining 56 COPCs, 12 were excluded due to questionable analytical results or chemical properties and had subsequent analyses that consistently were below the PRGs. Hydrazine and phosphorus were removed from further consideration. Hydrazine is very reactive in water and should disassociate, and phosphorus is evaluated as phosphate. Table 1-10 shows these 12 constituents and the reasons for exclusion.

Table 1-10. Analytes Excluded.

Reasons for Exclusion	Analytes Excluded
Analytical results were reported as questionable, or suspect based on quality control issues and illogical results.	4,4'-DDT, Aldrin, Dinoseb, Endrin, Lindane, Barium, Beryllium, Silver, Aniline
Only one or few detects exceeded in one or more wells, and subsequent results from the same well or wells show that values are below set preliminary remediation goals.	4,4'-DDT, Aldrin, Dinoseb, Endrin, Lindane, Barium, Beryllium, Silver, 2,4-Dichlorophenol, Aniline
Compound reactive in water, not expected to persist.	Hydrazine
Evaluated as phosphate; see Appendix E, Table E-1.	Phosphorus

Note that the entire database and COPC evaluation details will be published in the forthcoming 200-PO-1 Groundwater OU Work Plan (DOE/RL-2007-31). Because of the size of the information, it is not presented in both the DQO and the Work Plan; however, Appendix E, Table E-1 of this DQO summary report presents the summary details of the COPC inclusion/exclusion process.

1.9.5 Proposed List of Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit

The conclusion of the formal evaluation process culminated in 44 analytes being kept on a list as potential COPCs for the 200-PO-1 Groundwater OU. The 44 COPCs are shown below in Table 1-11.

Table 1-11. Proposed List of Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit. (2 Pages)

Metals	Semivolatile Organic Compounds
Antimony	2,4-Dinitrophenol
Arsenic	Bis (2-ethylhexyl) phthalate
Cadmium	Nitrobenzene[b]
Chromium	Pentachlorophenol
Lead	**Radiological**
Manganese	Gross alpha[c]
Nickel	Iodine-129
Thallium	Neptunium-237[a]
Uranium	Protactinium-231[a]

Table 1-11. Proposed List of Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit. (2 Pages)

Metals	Semivolatile Organic Compounds
Vanadium	Selenium-79[a]
Zinc	Strontium-90
Volatile Organic Compounds	Technetium-99
1,1,2,2-Tetrachloroethane	Tritium
1,2-Dichloroethane	Uranium-234
1,4-Dioxane[b]	Uranium-238
Benzene	**Pesticides**
Bromodichloromethane	Dieldrin
Carbon tetrachloride	Dimethoate
Dibromochloromethane	Heptachlor
Hexane[a]	Heptachlor epoxide
Methylene chloride	**Ions**
Tetrachloroethene	Fluoride
Trichloroethene	Nitrate
Vinyl chloride	Nitrite

[a]Represents constituents listed in historical process documents that have a potential to contribute to dose and have long half lives, or in the case of hexane, regulatory limits set due to U.S. Environmental Protection Agency listing as a possible carcinogen; these contaminants of potential concern have not been analyzed in the 200-PO-1 Groundwater Operable Unit.

[b]Represents constituents not listed in historical process documents, but are found in the 200-PO-1 Groundwater Operable Unit.

[c]Represents survey parameters.

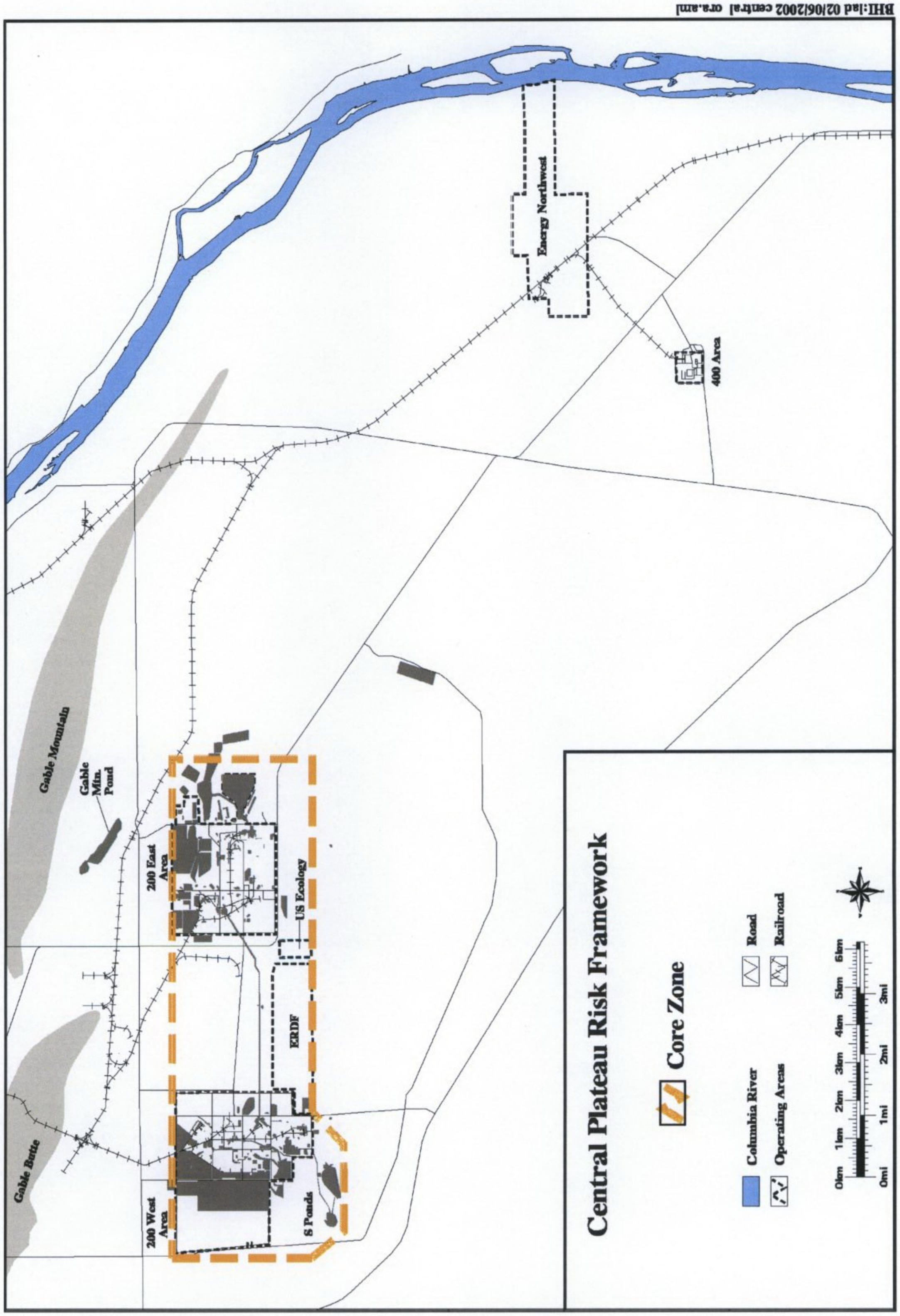
1.10 CURRENT AND POTENTIAL FUTURE LAND USE

To identify appropriate cleanup objectives, the future land use of a site must be considered. Current and future land uses of the 200 Areas and the Central Plateau are discussed below.

1.10.1 Current Land Use

All current land-use activities associated with the 200 Areas and Central Plateau are industrial in nature. The DOE-selected land use for the 200 Areas, documented through DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (HCP), is industrial for areas located within the industrial (exclusive) use boundary and conservation (mining) for sites located outside of the industrial (exclusive) use boundary as shown in Figure 1-5.

Figure 1-5. Core Zone Boundary.



The conservation (mining) land use would enable the extraction of valuable near-surface geologic resources to support implementation of remedial actions (i.e., surface barriers) at some locations on the Hanford Site after obtaining *National Environmental Policy Act of 1969* (NEPA), RCRA, or CERCLA approval to protect NEPA-sensitive resources (e.g., biologic, geologic, historic, or cultural). In addition, the HCP indicates that a notice of deed restriction would be placed in those areas where vadose zone contamination remained in place, according to a CERCLA ROD or RCRA closure permit, foreclosing the mining option. The Hanford Site has no metal ore reserves; therefore, the term mining is not used in the traditional sense and was not intended by the HCP. The HCP anticipates mining only for materials needed to build surface barriers as part of remedial actions and that mining would be precluded from contaminated areas. The conservation (mining) land use would afford protection of natural resources; however, other compatible uses (e.g., recreation or nonintrusive environmental research activities) also would be allowed, provided that these activities are consistent with the purpose of the conservation land-use designation. Conservation would require active management practices to enhance or maintain the existing resources and to minimize or eliminate undesirable or non-native species.

The HCP EIS ROD (64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)") identifies conservation (mining) as reserved for the management and protection of archeological, cultural, ecological, and natural resources. Limited and managed mining (e.g., quarrying for sand, gravel, basalt, and topsoil for governmental purposes only) could occur as a special use (i.e., a permit would be required) within appropriate areas. Limited public access would be consistent with resource conservation. This ROD also indicates that mining would be restricted from contaminated areas.

According to the HCP, industrial (exclusive) land use would preserve DOE control of the continuing remediation activities and would use the existing compatible infrastructure required to support activities such as dangerous waste, radioactive waste, and mixed-waste TSD facilities. The cleanup criteria for these sites must be consistent with either land use or PRGs, based on HAB 132, "Exposure Scenarios Task Force on the 200 Area" (HAB 2002). This application of the Core Zone boundary is defined in the Tri-Parties response (Klein et al., 2002, "Consensus Advice #132: Exposure Scenarios Task Force on the 200 Area") to HAB Advice #132 (HAB 2002). Figure 1-5 presents the Core Zone and anticipated land use.

1.10.2 Anticipated Future Land Use

The reasonably anticipated future land use for the industrial (exclusive) use zone (shown in Figure 1-5) is continued industrial (exclusive) activities. Eventually, portions of this area may be used for non-DOE-related industrial uses. The DOE worked for several years with cooperating agencies and stakeholders, including 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, to define land-use goals and develop future land-use plans for the Hanford Site. The results were reported in Drummond, 1992, *The Future for Hanford: Uses and Cleanup, The Final Report of the Hanford Future Site Uses Working Group*, and culminated in the HCP and associated ROD (64 FR 61615) issued in 1999.

The HCP was written to address the growing need for a comprehensive, long-term approach to planning and development on the Hanford Site because of DOE's separate missions of environmental restoration, waste management, and science and technology. The HCP 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. In the HCP, the land-use designation for sites inside the industrial (exclusive) area is as follows:

- Industrial (Exclusive Core Zone): areas suitable and desirable for TSD of hazardous, dangerous, radioactive, and nonradioactive wastes, and related activities.

For sites outside the industrial (exclusive) area, the land-use designation is as follows:

- Conservation (Area Outside of Core Zone): an area reserved for the management and protection of archeological, cultural, ecological, and natural resources.

Under the preferred land-use alternative selected in the ROD (64 FR 61615), the area outside of the industrial (exclusive) area of the Central Plateau was designated for other activities. For the sites in the study area, the land use was designated as conservation (mining). This would include restrictions against intrusive human activities but would allow recreational use (e.g., hiking, biking, hunting, and bird watching where a receptor spends only a small fraction of time in actual proximity to the contaminated areas) of the surface areas. Restricted use (e.g., recreation or waste management) means that surface use of the waste sites could occur, but subsurface activities such as excavation, well drilling, and farming would be restricted to preclude contact with or disturbance of contaminated soils. These activities could occur *around* the waste sites, but not *on* the waste sites. Based on the risk framework workshops, groundwater use outside the Core Zone also would be restricted until remediation activities result in meeting groundwater cleanup standards. At that point, unrestricted groundwater use would be assumed. Table 1-12 lists the current and potential future land uses.

Table 1-12. Current and Potential Future Land Use.*

Zone Boundary	Current Land Use	Potential Future Land Use	Applicable to this Data Quality Objective
Near field Inside Core Zone	Industrial (no use of groundwater)	Industrial exclusive	Y
Far field Area Outside the Core Zone	Industrial (no groundwater use) for the next 150 years or other negotiated time	Conservative (mining) reserved for management and protection of archeological, cultural, ecological, and natural resources	Y
River Corridor	Industrial (no groundwater use) for the next 150 years	High- and low-intensity recreation, and conservative (mining) reserved for management and protection of archeological, cultural, ecological, and natural resources	Y

*"Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)."

The HCP indicates that contamination in the groundwater would restrict use. Groundwater beneath the Central Plateau currently is contaminated and is not withdrawn for beneficial uses.

Operations at the Hanford Site are expected to terminate in approximately 2050, and active institutional controls are assumed for approximately another 100 years following the termination of operations. Effective passive institutional controls will be designed to endure to provide protection for at least 500 years, which is the time period stated for the Environmental Restoration Disposal Facility (ERDF) (EPA/ROD/R10-95/100, *Declaration of the Interim Record of Decision for the Environmental Restoration Disposal Facility*). Institutional controls are expected to be maintained until the contamination is no longer hazardous to human health or the environment.

1.11 CONCEPTUAL SITE MODEL

The goal of the DQO process is to develop a sampling design that will either confirm or reject the CSM. The CSM is continuously refined as additional data become available.

When contaminants reach the water table, they generally flow along pathways of least resistance depending on groundwater flow patterns, saturated zone properties, and contaminant properties. This results in a general flow of contaminants in an easterly direction from the 200-PO-1 Groundwater OU (DOE/RL-2003-04) to the Columbia River. The concentration of contaminants in the groundwater at different locations and times is used to estimate risk over the next 1,000 years.

The Monitoring SAP lists waste sites grouped around three major facilities as the primary contributors to groundwater contamination in the 200-PO-1 Groundwater OU: PUREX, B Plant, and the BC Cribs and Trenches Area where U Plant waste was disposed. The PUREX Plant and the BC Cribs and Trenches Area are located in the 200-PO-1 Groundwater OU. The B Plant is located in the 200-BP-5 Groundwater OU on the northern boundary of 200-PO-1 Groundwater OU. Six RCRA TSD units are located in the near-field area of 200-PO-1 Groundwater OU: the PUREX Cribs, WMA A-AX, the 216-A-29 Ditch, 216-B-3 Pond (B Pond), the IDF (a RCRA-compliant landfill that is scheduled to begin receiving waste in FY 2010), and the NRDWL. Two additional waste sites in the 200-PO-1 Groundwater OU that are regulated by the *Washington Administrative Code* are the 200 Area TEDF and the Solid Waste Landfill.

Tritium, nitrate, and I-129 are identified in PNNL-16346 as major groundwater COPC plumes that generally coincide and extend outside the 200 East Area. Tritium, nitrate, and I-129 are the groundwater contaminants for the far-field area and also are present in the near-field area. The tritium groundwater plume is described in PNNL-16346 as primarily associated with the PUREX cribs, and generally attenuating through radioactive decay and dispersion.

Nitrate concentrations have exceeded the drinking water standard of 45 mg/L, or 10 mg/L nitrogen in nitrate near PUREX Cribs, WMA A-AX, and the 400 Area. PNNL-16346 states that the nitrate plume appears to be receding except in three areas: the southern portion near the 300 Area, PUREX cribs, and WMA A-AX.

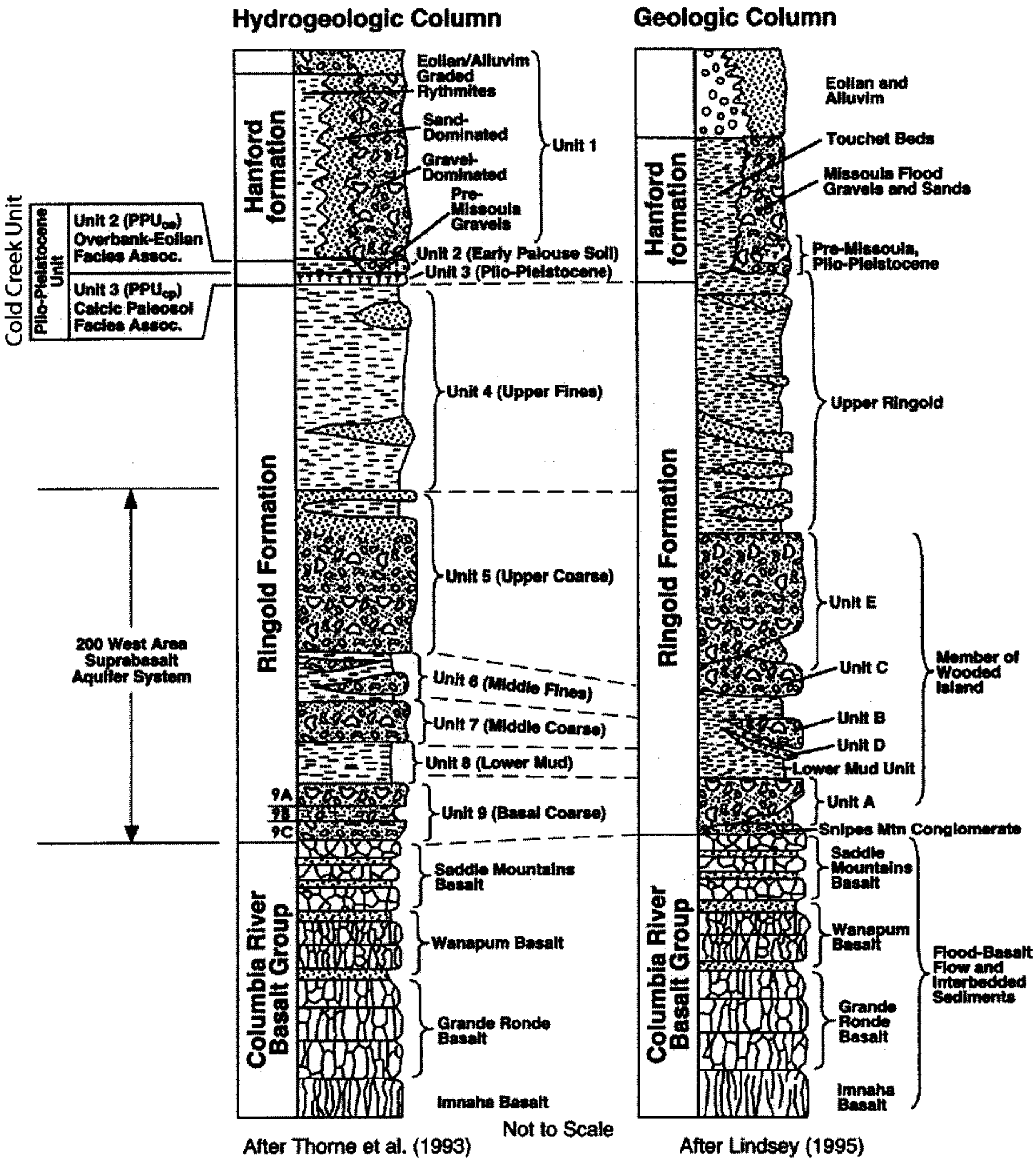
An I-129 groundwater plume extends southeast from the 200 East Area into the 600 Area. PNNL-16346 describes the PUREX cribs as the sources for the I-129 plume. The highest I-129 groundwater concentration in the 200-PO-1 Groundwater OU occurred near the PUREX cribs during FY 2006. An I-129 activity level of 9.1 pCi/L was found in well 299-E17-14 near the 216-A-36B Crib.

PNNL-16346 describes three far-field (i.e., tritium, nitrate, and I-129) and nine near-field groundwater contaminants (i.e., Sr-90, Tc-99, arsenic, chromium, manganese, vanadium, Co-60, cyanide, and uranium). The following groundwater contaminant information is available in PNNL-16346.

- Iodine-129 was not detected during FY 2006 in the few wells that are completed in the deep unconfined aquifer or the confined aquifers.
- Tritium was detected in only one deep well (a water supply well in the 400 Area that is screened in the unconfined aquifer). Tritium was not detected in the basalt-confined aquifer.
- A localized area of Sr-90 groundwater contamination occurs near the 216-A-36B Crib. The low mobility of Sr-90 in groundwater is the primary factor for limiting its extent.
- Technetium-99 groundwater contamination is associated with WMA A-AX and indirectly, through gross beta measurements, with the PUREX cribs.
- Arsenic and manganese were identified in groundwater samples from wells near the PUREX cribs during FY 2006. The current manganese concentrations are less than the 50 μg/L secondary drinking water standard. Both the Monitoring SAP (DOE/RL-2003-04) and PNNL-16346 mention that manganese concentrations detected near the PUREX cribs could result from corrosion of carbon-steel casing in older monitoring wells.
- Chromium, Co-60, cyanide, and uranium are COPCs at the BC Cribs and Trenches Area. The only groundwater contaminant that was detected above background levels in the BC Cribs and Trenches Area in FY 2006 was chromium in well 299-E13-14. A chromium plume is migrating into the BC Cribs and Trenches Area from the west and southwest, and might be impacting wells where chromium was detected.
- The highest vanadium concentrations in the 200-PO-1 Groundwater OU were found at PUREX cribs, the 216-A-29 Ditch, and the B Pond.

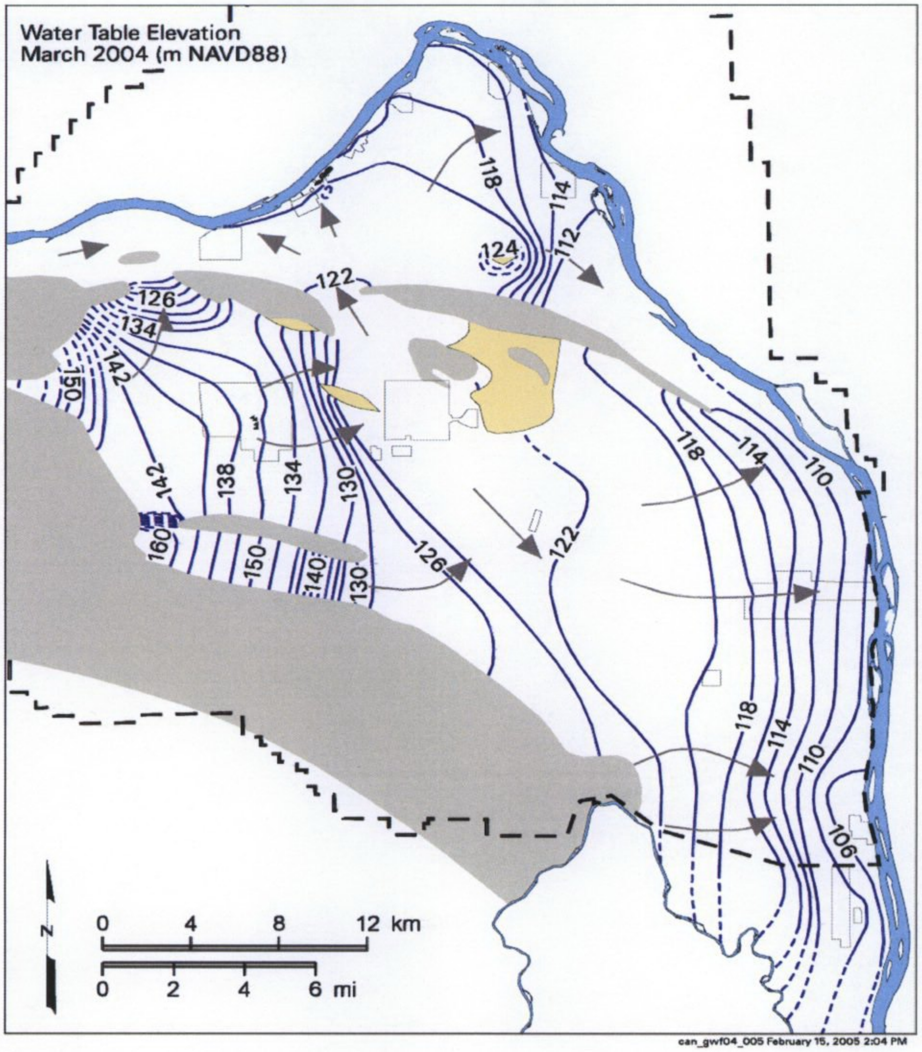
A conceptual model for the hydrogeology of the 200-PO-1 Groundwater OU is described in PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*. The PNNL study concluded that two aquifers exist within the suprabasalt sediments of the 200 East Area. The upper Hanford unconfined aquifer occurs in the sediments of unit 1 of the Hanford formation and unit 5 (i.e., unit E) of the Ringold Formation and is presented in Figure 1-6.

Figure 1-6. Hydrostratigraphic and Geologic Columns in the Hanford Site (PNNL-12261).



After Bjornstad et al. (2002)

Figure 1-7. Groundwater Flow at the Hanford Site.



An underlying confined aquifer was noted where Unit 9 (Units 9A, 9B, 9C) is separated from the unconfined aquifer by the Unit 8 aquiclude (Figure 1-6). The resulting fluvial sand and gravel aquifer is referred to as the Ringold Formation confined aquifer. Groundwater flow in the Ringold Formation confined aquifer appears to converge from the west, south, and east in the 200 East Area according to PNNL-16346. It is postulated that groundwater was forced into the Ringold Formation confined aquifer from the Hanford unconfined aquifer under the B Pond when mounding occurred during effluent disposal.

PNNL-12261 also describes the deeper confined aquifer in the Columbia River Basalt Group underlying the Ringold Formation. The upper basalt-confined aquifer occurs within fractured basalt and interbeds of the Upper Saddle Mountains Basalt that directly underlies the Ringold Formation confined aquifer. Groundwater generally flows from west to east within the upper basalt-confined aquifer. Vertical gradients are upward at most Hanford locations, but are downward near the B Pond.

The 200-PO-1 Groundwater OU hydrogeology is further described in the Monitoring SAP. The Monitoring SAP briefly describes the same three aquifers that are detailed in PNNL-12261. A large paleo-flood channel filled with Hanford sediments trends northwest-southeast across the 200 East Area. The paleo-flood channel cuts through the Ringold lower mud unit in the 200-PO-1 Groundwater OU, resulting in direct contact of the Hanford and lower Ringold sand and gravel sediments. The upper unconfined aquifer merges with the lower semi-confined aquifer in the vicinity of the paleo-flood channel.

Another prominent structural feature in the 200-PO-1 Groundwater OU is the May Junction Fault, which is located east of the B Pond and TEDF. The fault might provide a vertical preferential flow path for groundwater to move from the Ringold confined aquifer into the Hanford unconfined aquifer (PNNL-12261, Section 4.2.3).

Artificial groundwater recharge from effluent disposal at the B Pond, PUREX, and other waste sites generated local mounds in the water table and generally elevated the water table throughout the 200 East Area. The groundwater mound under the B Pond caused an estimated additional 10 m (35 ft) of hydraulic head. The resulting downward gradient and radial flow pattern reversed groundwater flow in the 200 East Area to a western direction away from the Columbia River. The B Pond is located where the Hanford unconfined aquifer and the Ringold confined aquifer are connected. The downward gradient that was generated during disposal operations could have forced contaminants into the Ringold confined aquifer. Alternatively, the relatively impermeable Ringold lower mud unit (unit 8) could have diverted groundwater flow and contaminants laterally and down dip to the east and southeast through an umbrella effect (Section 4.2.1, PNNL-12261). The artificial recharge at the B Pond and TEDF are illustrated in Figure 1-8. Effluent disposal and the associated artificial groundwater recharge at the B Pond ceased in 1997.

Sufficient effluent volumes were disposed at PUREX and other waste sites to result in additional artificial groundwater recharge. The effluent volumes disposed of at PUREX were lower than at the B Pond, but the associated contaminants generally were more concentrated. A conceptual model for the migration of contaminants from the PUREX cribs to groundwater is shown in Figure 1-9. Enhancements to the conceptual models for the 200-PO-1 Groundwater OU waste sites are expected as additional geophysical and other data are collected.

Table 1-13 presents a tabular depiction of the CSM that applies to the 200-PO-1 Groundwater OU. The descriptions of the CSM identify contaminant sources, release mechanisms, migration pathways, potential receptors, and exposure scenarios for the COPCs.

1.12 STATEMENT OF THE PROBLEM

The problem addressed by this DQO process is to ensure that adequate data are available to support the RI/FS process for the 200-PO-1 Groundwater OU, including risk modeling and prediction of alternative remedial actions, judging the effectiveness of interim remedial actions, and long-term CERCLA monitoring.

Figure 1-8. A Conceptual Model of the Lithological Units and Artificial Groundwater Recharge at B Pond and Treated Effluent Disposal Facility.

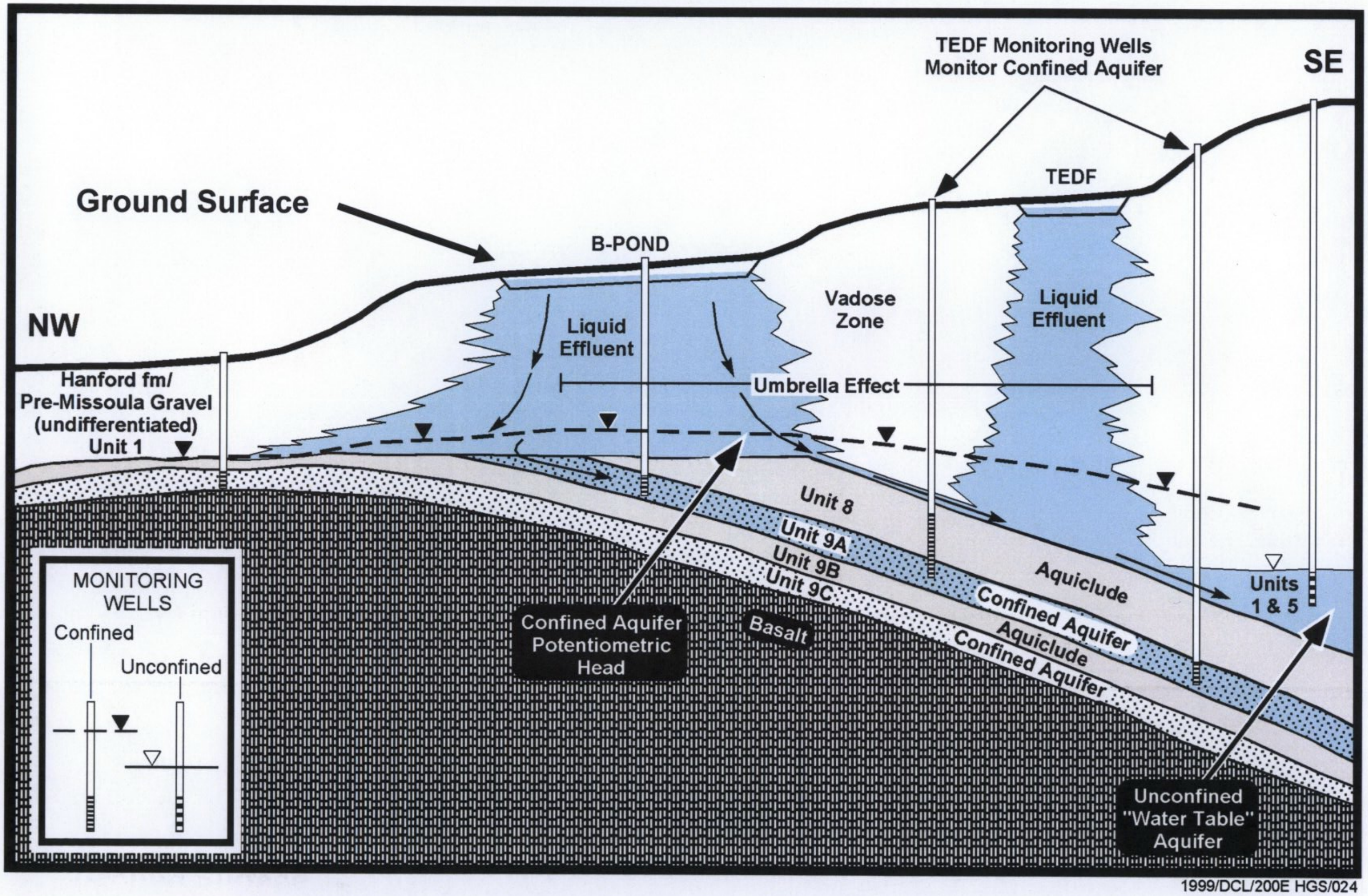


Figure 1-9. A Conceptual Site Model for the PUREX Cribs and BC Cribs and Trenches Area.

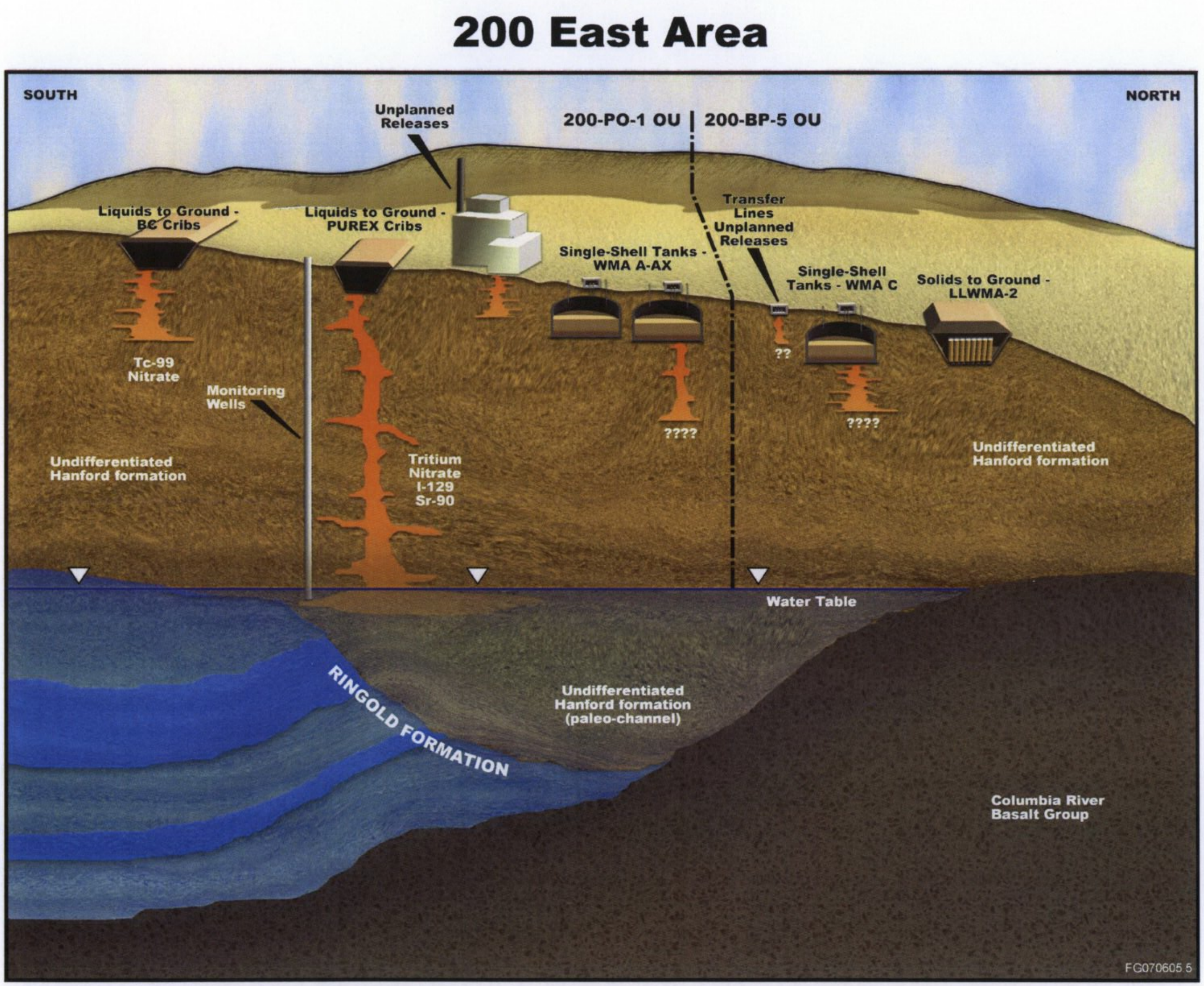


Table 1-13. Tabular Depiction of the 200-PO-1 Groundwater Operable Unit Conceptual Site Model for Groundwater Contamination.

Media	COPCs	Identified Source	Release Mechanism	Migration Pathways	Potential Receptors
Conceptual site model: Downward migration of COPCs from cribs, ponds, ditches, and spills through the underlying soil column to groundwater. Initially, COPCs were carried by large quantities of water, which exceeded the sorptive capacity of the soil. Natural recharge from precipitation, runoff, and future spills are the currently available mechanisms to continue movement to groundwater.					
Nonradiological and Radiological COPCs					
Groundwater	Nonradio-logical COPCs and radiological are presented in Appendix E, Tables E-1 and E-2, respectively	Liquid process wastes from plutonium and uranium separation carried out at U Plant, B Plant, and PUREX and potential leaks from tank farms.	Waste liquids were released to the vadose zone through cribs, trenches, and ponds. Other sources include previous U Plant, B Plant, and PUREX Plant effluents, and tank farm leaks.	1. These waste liquids percolating through cribs, ditches, ponds, or other liquid waste sites were the primary migration pathway transporting this COPC to the groundwater. 2. Natural recharge generally is the current driver and will continue in the future. Future potential remediation activities such as RCRA coverings on contaminated sites may decrease the recharge rate. 3. Downgradient groundwater flow may carry some COPCs to the river. Transport in the saturated zone will be affected by retardation (sorption, radioactive decay) and vertical migration of the COPCs.	• Industrial activities for humans • Human and ecological for COPCs that reach the Columbia River
Exposure Scenario: Current exposure for humans and ecological receptors on the Central Plateau does not exist because groundwater is not in use. Current exposure scenarios for humans and ecological receptors exposed to groundwater entering the Columbia River will be consistent with that used for the River Corridor risk modeling. Future exposure scenarios in the Central Plateau will be based on limited ingestion of the groundwater by humans and ecological receptors or by exposure to volatiles through inhalation. The future use exposure scenarios will be consistent with the 200-ZP-1 Operable Unit for the Central Plateau and consistent with the River Corridor for the usage along the shore of the Columbia River.					

COPC = contaminant of potential concern.
PUREX = Plutonium-Uranium Extraction (Plant or process).
RCRA = *Resource Conservation and Recovery Act of 1976.*

This page intentionally left blank.

2.0 STEP 2 – IDENTIFY THE DECISIONS

The purpose of DQO Step 2 is to define the principal study questions (PSQ) that address the problem statements presented in DQO Step 1, to list alternative actions (AA) that may be pursued to resolve the questions, and to formulate for each PSQ a decision statement (DS) that expresses the choice between alternative actions. Table 2-1 presents the task-specific PSQs, AAs, and resulting DSs. The table also provides a qualitative assessment of the probable severity of the consequences of choosing an AA that is ultimately incorrect. The severity is expressed as low, moderate, or severe in terms of risk and cost.

Table 2-1. Principal Study Questions and Decision Statements. (4 Pages)

No.	Alternative Actions	Consequences of Wrong Choice	Severity
PSQ 1 – Are additional data needed to evaluate and select a preferred remedial action alternative for a specific plume?			
1-1	No action; use existing data to choose remedial action alternative.	The wrong remedial action alternative may be costly and/or ineffective.	Low to Moderate
1-2	Yes – obtain additional data through treatability tests or other means.	If no additional data were needed, then the cost of obtaining the data and the cost of delaying the project would be wasted.	Low to Moderate
DS 1 – Determine if additional data are needed to choose between remedial action alternatives for a specific plume or if no action is required. If additional data are needed, determine the type of data needed.			
PSQ 2 – Are additional data needed to determine the horizontal and vertical distribution of the COPCs in the unconfined aquifer?			
2-1	No action (existing data are adequate).	If additional data are necessary and not collected, then specific COPCs may not be remediated properly.	Moderate to Severe
2-2	Obtain additional data.	Unnecessary cost of obtaining redundant data.	Moderate to Severe
DS 2 – Determine if additional characterization data (e.g., geophysical, discrete sampling etc.) are needed to define the three-dimensional distribution of COPCs within the unconfined aquifer or if no action is required.			
PSQ 3 – Are subsurface contaminant flow barriers and pathways present within the aquifer?			
3-1	No action (existing data are adequate).	If additional data are necessary and not collected, then specific COPCs may not be remediated properly.	Moderate to Severe
3-2	Obtain additional data.	Unnecessary cost of obtaining redundant data.	Moderate to Severe
DS 3 – Determine if there are possible subsurface contaminant flow barriers and pathways, including those that may be associated with declining water levels.			

Table 2-1. Principal Study Questions and Decision Statements. (4 Pages)

No.	Alternative Actions	Consequences of Wrong Choice	Severity
PSQ 4 – Does the current monitoring well network adequately delineate the vertical and horizontal extent of contaminants in the plumes?			
4-1	No action (use existing network).	Existing well locations may be inadequate for evaluating modeling results or contaminant distribution.	Moderate to Severe
4-2	Select a new monitoring network from existing wells.	Unnecessary cost of establishing new network, preparing documentation, and probable additional sampling and analysis.	Low to Moderate
4-3	Install new wells (or deepen existing wells) to supplement existing or new network.	Unnecessary cost of drilling (or deepening) wells, preparing supporting documentation, and additional sampling and analysis.	Moderate to Severe
DS 4 – Determine if and where additional or alternate monitoring points are needed to adequately define the three-dimensional extent of contaminants in the plumes.			
PSQ 5 – Is additional modeling needed to redefine the current hydrogeologic conceptual model in order to make a phased remedial decision for specific contaminants?			
5-1	No action (use available models).	If additional modeling is necessary and not conducted, then specific COPCs may not be remediated properly.	Moderate to Severe
5-2	Obtain additional data.	Unnecessary and very expensive cost of obtaining excessive modeling data.	Moderate to Severe
DS 5 – Determine if additional data are needed to support modeling and redefinition of the conceptual model in order to make a phased remedial decision, or if no action is required.			
PSQ 6 – Are sufficient data available to determine the future potential contribution to groundwater from waste sites, including tank farms?			
6-1	No action (use existing data).	If additional data are necessary and not collected, then specific COPCs may not be remediated properly.	Moderate to Severe
6-2	Obtain additional data.	Unnecessary cost of obtaining redundant data.	Moderate to Severe
DS 6 – Determine if additional data are needed to determine the future potential contribution to groundwater from waste sites (including tank farms) or if no action is required. If additional data are needed, determine the type of data needed.			
PSQ 7 – Does sufficient information exist to define 200-PO-1 Groundwater OU area end states or are additional data needed to redefine end states in the RI/FS process?			
7-1	No action (use existing end states data).	If additional end states are necessary and not collected, then the correct remedial action may be overlooked or not selected.	Moderate to Severe
7-2	Obtain additional end states data.	Unnecessary cost of obtaining data that will not affect the remedial decision.	Moderate to Severe
DS 7 – Determine if additional data are needed to determine the need to redefine end states or if no action is required. If additional data are needed, determine the type of data needed.			

Table 2-1. Principal Study Questions and Decision Statements. (4 Pages)

No.	Alternative Actions	Consequences of Wrong Choice	Severity
PSQ 8 – Does the current monitoring well network provide adequate information to prepare groundwater table contour maps and to infer direction of flow?			
8-1	No action (use existing network).	Significant uncertainty in hydraulic gradients and inferred flow directions.	Low to Moderate
8-2	Select a new monitoring network from existing wells.	Unnecessary cost of establishing new network, preparing documentation, and probable additional field measurements.	Low to Moderate
8-3	Install new wells (or deepen existing wells) to supplement existing or new network.	Unnecessary cost of drilling (or deepening) wells, preparing supporting documentation, and additional field measurements.	Moderate to Severe
8-4	Use alternative methods to determine flow directions.	Unnecessary cost of conducting field investigations.	Moderate
DS 8 – Determine if and where additional resolution of the water table is needed to prepare reliable groundwater table contour maps. Consider alternative means for mapping flow where the groundwater gradient is shallow or flat.			
PSQ 9 – Do the locations of the wells and the current groundwater sampling frequencies provide adequate data for tracking plume movement?			
9-1	No action (use current sampling frequency).	Possible delayed detection of an emerging plume.	Low
9-2	Increase sampling frequency.	Unnecessary cost of additional sampling and analysis.	Low to Moderate
DS 9 – Determine if the locations of the wells and the sampling frequencies are adequate for tracking plume movement or if no action is required.			
PSQ 10 – Is the sampling density for hydraulic parameters and geologic features and structures adequate to identify principal preferential flowpaths?			
10-1	No action.	Possible bias in modeling groundwater flow and contaminant transport.	Low to Moderate
10-2	Install new wells (or deepen existing wells) to supplement hydraulic and geologic data.	Unnecessary cost of drilling and testing.	Moderate to Severe
DS 10 – Determine if risk assessment based on long-term contaminant transport modeling would significantly benefit from more accurate knowledge of preferential flowpaths; if so, consider alternate means (e.g., geophysical testing) to guide or to substitute for additional drilling and testing. Otherwise, no action is required.			
PSQ 11 – Are the sampling frequency and suite of measured COPCs at individual source sites adequate to ensure timely warning of emerging threats to groundwater quality?			
11-1	No action.	Delayed detection of groundwater contaminant(s).	Moderate
11-2	Increase the number of COPCs measured at selected source sites.	Cost of additional laboratory analysis.	Low to Moderate
DS 11 – Determine if the sampling frequency and suite of measured COPCs at individual source sites are adequate to ensure timely warning of emerging contaminant plumes.			

Table 2-1. Principal Study Questions and Decision Statements. (4 Pages)

No.	Alternative Actions	Consequences of Wrong Choice	Severity
PSQ 12 – Are sufficient data available to determine the potential risk to aquatic ecology from 200-PO-1 Groundwater OU COPCs?			
12-1	No action.	If additional data are necessary and not collected then specific COPCs may not be remediated properly.	Moderate
12-2	Obtain additional data.	Unnecessary cost of additional sampling and analysis.	Low to Moderate
DS 12 – Determine if additional data are needed to evaluate potential risk to aquatic ecology from COPCs associated with the 200-PO-1 Groundwater OU. If additional data are needed, determine the type of data needed.			

COPC = contaminant of potential concern.
DS = decision statement.
PSQ = principal study question.

3.0 STEP 3 – IDENTIFY INPUTS TO THE DECISION

The purpose of DQO Step 3 is to identify the type of data needed to resolve the DS identified in DQO Step 2. This chapter describes the kinds and sources of data needed to resolve each of the DSs presented in Chapter 2.0. The data already may exist or may be derived from computing or surveying sampling and analysis methods. Analytical performance requirements also are provided in this step for new data.

3.1 CONCEPTUAL MODEL DATA INPUT NEEDS

The CMS (DOE/RL-96-66) for the 200-PO-1 Groundwater OU presented the results of groundwater flow and solute transport modeling. The modeling employed a three-dimensional finite element code (VAM3DCG) capable of simultaneously handling both flow and solute transport simulations. The conceptual hydrogeologic framework of the model included a horizontal grid covering 971.2 km^2 (375 mi^2) of the Hanford Site. The modeled domain included the Ringold Formation and the pre-Missoula/Hanford formation, with the individual model elements of the vertical grid sized to represent the local thickness of each formation. Similarly, elements within the three-dimensional grid were assigned hydraulic and contaminant transport properties representing local conditions (e.g., hydraulic conductivity, dispersivity, effective porosity, distribution coefficient).

According to this model, communication with underlying basalt aquifers was considered to be negligible, and areas where basalt outcrops or lies above the water table were assigned zero hydraulic conductivity (e.g., Rattlesnake Mountain, Gable Mountain, Gable Butte, Umtanum Ridge).

Dry Creek and Cold Creek units were assumed to represent constant flux recharge. Additional recharge from ponds, ditches, and cribs associated with Hanford Site operations was based on historical records. Recharge from precipitation or runoff was considered negligible. The Columbia River and the Yakima River were considered to be constant head boundaries, with discharge to the Columbia River. The computer model was calibrated using historical data collected during the period from 1979 to 1994. A computer simulation based on the calibrated model was initiated using a starting time of January 1995. Predictions for 10, 20, 50, 100, and 200 years into the future were generated to simulate changes to the water table and tritium plume concentrations (all tritium concentrations were decay-corrected). Actual water-table contours and tritium concentrations presented in PNNL-16346 may be compared to the modeled 10-year predictions.

3.1.1 Saturated Zone Properties

A set of specific parameters for groundwater modeling is not yet identified for the 200-PO-1 Groundwater OU. The potential modeling parameters in this section are based on those that were developed for other groundwater OUs at the Hanford Site. Parameters such as distribution coefficient (K_d), hydraulic conductivity, particle size, and cation-exchange capacity are useful for modeling contaminant movement and evaluating remedial alternatives. Additional saturated zone modeling data will be obtained from new wells that are planned in the 200-PO-1 Groundwater OU. Depth-discrete groundwater data will be collected from new boreholes as they are drilled or during well installation (e.g., well development and aquifer testing). The depth-discrete data will also be useful for selecting screen intervals for new wells.

3.1.2 Saturated Zone Sediment Parameters

Specific modeling input parameters that were considered for the 200-ZP-1 Groundwater OU are listed in Table 3-1. The geotechnical (i.e., physical), hydraulic, and geochemical parameters are included in CP-16151, *Data Quality Objectives Summary Report Supporting the 200-ZP-1 Operable Unit Remedial Investigation/Feasibility Study Process*. Specific modeling requirements and the relative importance of each input will be considered before establishing a final set of modeling parameters for the 200-PO-1 Groundwater OU.

Table 3-1. Potential Saturated Zone Properties. (2 Pages)

Property	Parameter	Method	CRDL	Precision Required	Accuracy Required
		Aquifer Sediments			
Geotechnical	Particle-size distribution (by dry sieve, wet sieve, and hydrometer methods)	ASTM D422	N/A	N/A	N/A
	Borehole geophysics (neutron probe, natural gamma, spectral gamma, and gamma-gamma density[b])	[a]	N/A	N/A	N/A
	Mineralogy	X-ray diffraction	N/A	N/A	N/A
	Lithology	Geologist description	N/A	N/A	N/A
	Effective porosity	Field and laboratory measurement			
	Bulk density	ASTM D2937	N/A	N/A	N/A
	Total porosity	[a]	N/A	N/A	N/A
Geochemical	Major cations (e.g., sodium and calcium)	ASTM D4327	N/A	N/A	N/A
	Cation exchange capacity	Routson et al., 1973	N/A	N/A	N/A
	Calcium carbonate content	ASTM D4373	N/A	N/A	N/A
	Total organic carbon	415.1[c]	N/A	±25%	±25%
	K_d	ASTM D3987	N/A	N/A	N/A
	Tentatively identified compound	415.1M[c]	25,000 µg C/kg sample	±25%	±25%
	pH	9045[d]	0.1 pH unit	±0.1 pH unit	±0.1 pH unit

Table 3-1. Potential Saturated Zone Properties. (2 Pages)

Property	Parameter	Method	CRDL	Precision Required	Accuracy Required
Groundwater					
Hydraulic	Hydraulic gradient	Field measurement	N/A	N/A	N/A
	Slug test, slug interference test, constant rate discharge test, or tracer test	Field test	N/A	N/A	N/A
	Water production flow rate	Well development	N/A	N/A	N/A
	Water-level changes (drawdown)	Well development	N/A	N/A	N/A
	Groundwater pumping performance	Well development	N/A	N/A	N/A
	Dispersivity[f]	Field tracer measurement	N/A	N/A	N/A
Geochemical	Major cations (e.g., sodium and calcium)	ASTM D4327	N/A	N/A	N/A
	K_d (e.g., carbon tetrachloride)	ASTM D3987	N/A	N/A	N/A
	Specific conductivity	Field screening	N/A	N/A	N/A
	Total organic carbon	415.1[c]	1,000 μg/L	±25%	±25%
	Tentatively identified compound	415.1M[c]	1,000 μg/L	±25%	±25%
	pH	9045[d]	0.1 pH unit	±0.1 pH unit	±0.1 pH unit
	Temperature	Field screening	N/A	± 1°C	1°C
	Alkalinity	310.1[c] or 310.2[c]	10 mg/L as CO_3	±20%	±25%
	Dissolved oxygen	Field screening	N/A	0.1 mg/L	±1%
	Turbidity	Field screening	<5 NTU	N/A[e]	N/A[e]

[a]Method will be defined by technical support prior to implementation.
[b]If gamma-gamma density probe is not available at the time of logging, proceed running only natural and neutron-induced capture gamma-ray spectroscopy.
[c]Method from EPA/600/4-79/020, *Methods of Chemical Analysis of Water and Wastes.*
[d]Method from SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-B.*
[e]Requirements are "Yes/No" above or below 5 NTU; precision and accuracy do not apply.
[f]Depending on the model grid size, dispersivity may not be needed.

ASTM D422-63 (2002)e1, *Standard Test Method for Particle-Size Analysis of Soils.*
ASTM D2937, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.*
ASTM D3987-06, *Standard Test Method for Shake Extraction of Solid Waste with Water.*
ASTM D4327-03, *Standard Test Method for Anions in Water by Chemically Suppressed Ion Chromatography.*
ASTM D4373-02, *Standard Test Method for Rapid Determination of Carbonate Content of Soils.*
Routson, R. C., R. W. Wildung, and R. J. Serne, "A Column Cation-Exchange-Capacity Procedure for Low-Exchange Capacity Sands."

ASTM = American Society for Testing and Materials.
CRDL = contract-required detection limit.
K_d = distribution coefficient.
N/A = not applicable.
NTU = nephelometric turbidity unit.

Eight potential geotechnical parameters for saturated sediments are listed in Table 3-1: particle-size distribution, geophysical borehole surveys, mineralogy, bulk density, lithology, effective porosity, total porosity, and bulk density. Seven geochemical parameters are listed in Table 3-1: major cations (i.e., sodium and calcium), cation exchange capacity, calcium carbonate content, K_d for carbon tetrachloride, TOC, total inorganic carbon, and pH.

3.1.3 Groundwater Parameters

Table 3-1 lists six hydraulic and 10 geochemical parameters that are applicable to groundwater samples. If new wells are drilled in the 200-PO-1 Groundwater OU, some of these data could be obtained from depth-discrete groundwater samples during drilling. The following six hydraulic parameters for groundwater modeling and/or evaluation of remedial alternatives are included: hydraulic gradient, hydraulic conductivity measured during slug tests, groundwater production rates, water-level drawdown, groundwater pumping performance during well development, and longitudinal and transverse dispersivity. Multiple depth intervals may be tested to provide an indication of the vertical distribution of hydraulic properties. The following 10 geochemical parameters also are potential inputs for groundwater modeling and/or remedial alternatives evaluation: major cations (i.e., sodium and calcium), K_d, specific conductance, TOC, total inorganic carbon, pH, temperature, alkalinity, dissolved oxygen, and turbidity.

3.1.4 Physical, Geological, Hydraulic, and Geochemical Properties

Consideration of the CSM, discussed above in Section 1.11, and discussions with the PNNL and Fluor Hanford staff members on the DQO team led to the listing of a number of properties of the saturated zone that are needed to support the accurate modeling of contaminant plumes. All of the properties listed below are properties of the soil water matrix through which contaminants may move. Although many such measurements have been obtained for the saturated zone in the 200 East Area, increased specificity may be needed as the models are required to address individual waste sites and wells near the source. Waste site and plume-specific measurements of the properties will allow refinement of model predictions with regard to horizontal and vertical migration of the contaminants in the saturated zone. The properties that were identified were split into the following three major categories:

1. Physical/geologic properties (e.g. ,particle size, calcium carbonate content).
2. Hydraulic and transport properties (e.g., bulk density, total porosity, and effective porosity).
3. Geochemical properties (e.g., cation exchange capacity, partition coefficient).

Within each of the three categories, numerous measurements help to define the specific parameters of the saturated zone. Table 3-1 lists those parameters that may be chosen for measurement in the saturated zone, and applicable performance requirements.

3.2 INFORMATION REQUIRED TO RESOLVE DECISION STATEMENTS

Table 3-2 specifies information required to resolve the DSs identified in Table 2-1 and identifies whether data already exist. For the data identified as existing, the source references for the data have been provided with a qualitative assessment as to whether or not the data are of sufficient quality and quantity to resolve the corresponding DS.

3.3 BASIS FOR SETTING THE ACTION LEVEL OR PRELIMINARY REMEDIATION GOAL

In context of terms within the DQO, the target action level is a threshold value that provides the criterion for choosing among some of the AAs defined by the DSs. In the regulatory framework for CERCLA, the term for action level for remediation decisions is PRG. The term used in this document is PRG. Not all of the DS AAs are resolved by comparing specific data to specific PRGs. A number of the programmatic DSs rely on professional judgment to select a path forward. Table 3-3 lists potential action limits for individual COPCs in groundwater. For those DSs that will be determined by comparison to specific analytical results, Table 3-3 identifies the basis for establishing the action level for each of the COPCs. The PRG is the lowest of the MCL and WAC 173-340, "Model Toxics Control Act – Cleanup," limits, except when background is higher, then background is selected. PRGs or action levels for some contaminants may be less than the required quantitation limits (RQL). If the PRG is less than the RQL, the RQL will be chosen. Future revisions to WAC 173-340 will review the RQLs to determine if they should be lowered as a result of improved analytical technology. The final numerical value for the action level will be established in the FS and ROD.

3.4 COMPUTATIONAL METHODS

An integrated modeling system is required that is capable of predicting the movement of contaminants from the vadose zone to the groundwater, and subsequently on to the Columbia River to calculate cleanup levels and predict contaminant migration rates in the vadose zone and groundwater. For DSs that can be compared directly to analytical data, calculations will be performed that relate the measured concentration of the COPCs in a sample to the concentration of the COPCs in the matrix of interest. Most of the comparisons will be made from the analytical sample results obtained from groundwater samples from specific wells over a period (months to years). The mean, upper 95 percent confidence limit, or other statistical estimate of the mean may be used in certain circumstances. The mean may be used in either of the following instances.

- Multiple samples are obtained from a single well over a timeframe that is considered short with regard to the rate of plume movement.
- Samples are from a group of wells that are considered to be in an area of constant plume concentration.

Table 3-2. Required Information and Reference Sources. (3 Pages)

DS No.	Variable	Required Data	Do Data Exist?	Source Reference	Sufficient Quality?	Additional Information Required?*
1	Remedial action alternatives and capabilities/requirements of each.	Concentration of COPCs as a function of time, location. Spatial extent for any COPCs that reach or may reach the groundwater. Geotechnical properties of unconfined aquifer (e.g., hydraulic conductivity, porosity, transmissivity), K_d values, groundwater gradient, mixing depth.	Y	DOE/RL-95-100 DOE/RL-2007-31 HEIS database PNNL-11800 PNNL-14027 PNNL-16346	Y	Y
2	Vertical and lateral extent in unconfined aquifer of COPCs identified in Section 1.9.	Concentration of COPCs as a function of vertical and lateral location in the groundwater plume.	Y	CP-15329 HEIS database PNNL-11800 PNNL-14027	Y	Y
3	Vertical and lateral extent of subsurface flow barriers and pathways in unconfined aquifer.	Vertical and lateral locations in the unconfined aquifer.	Y	CP-15329 PNNL-11800 PNNL-12261 PNNL-14027	Y	Y
4	Data needed to evaluate three-dimensional plumes.	Levels of current groundwater contamination. Modeling predictions to verify modeling for future expectations. Concentration of COPCs as a function of time, location. Spatial extent for any COPCs that reach or may reach the groundwater.	Y	HEIS database PNNL-11800 PNNL-14027 PNNL-16346	Y	Y
5	COPCs at appropriate times and spatial boundaries.	Concentration of COPCs as a function of time, location. Spatial extent for any COPCs that reach or may reach the groundwater. End-use scenarios. Fate and transport models defined.	Y	DOE/RL-2005-01 HEIS database PNNL-11800 PNNL-14027 PNNL-14049	Y	Y
6	COPCs at appropriate times and spatial boundaries under agreed upon end-use scenarios.	Concentration of COPCs as a function of time, location. Spatial extent for any COPCs that reach or may reach the groundwater. End-use scenarios.	Y	DOE/RL-2005-01 HEIS database PNNL-11800 PNNL-14027 PNNL-14049	Y	Y

Table 3-2. Required Information and Reference Sources. (3 Pages)

DS No.	Variable	Required Data	Do Data Exist?	Source Reference	Sufficient Quality?	Additional Information Required?*
7	Wells required to monitor whether remedial action objectives have been met.	Concentration of COPCs in groundwater in near field and along the Columbia River.	Y	CP-15329 HEIS database PNNL-16346	Y	Y
8	Fate and transport modeling input parameters.	Geotechnical properties of unconfined aquifer (e.g., hydraulic conductivity, porosity, transmissivity), K_d values, groundwater gradient, mixing depth.	Y	CP-15329 PNNL-11800 PNNL-12261 PNNL-14027	Y	Y
9	COPC concentrations over time.	Concentration of COPCs as a function of time, location. Spatial extent for any COPCs that reach or may reach the groundwater. End-use scenarios.	Y	DOE/RL-2005-01 HEIS database PNNL-11800 PNNL-14027 PNNL-14049	Y	Y
10	Hydraulic parameters, geological lithology and features.	Geotechnical properties of unconfined aquifer (e.g., hydraulic conductivity, porosity, transmissivity), K_d values, groundwater gradient, mixing depth.	Y	CP-15329 PNNL-11800 PNNL-12261 PNNL-14027	Y	Y
11	COPC concentrations from wells near sources (near-field wells).	Concentration of COPCs as a function of time, location. Spatial extent for any COPCs that reach or may reach the groundwater. End-use scenarios.	Y	DOE/RL-2005-01 HEIS database PNNL-11800 PNNL-14027 PNNL-14049	Y	Y
12	COPCs identified in Section 1.9.	Identification of COPCs currently or potentially in the unconfined aquifer. River Corridor risk scenarios for ecological receptors.	Y	DOE/RL-92-04 DOE/RL-92-19 DOE/RL-95-100 DOE/RL-99-07 DOE/RL-99-66 HEIS database PNNL-16346	Y	Y

Table 3-2. Required Information and Reference Sources. (3 Pages)

DS No.	Variable	Required Data	Do Data Exist?	Source Reference	Sufficient Quality?	Additional Information Required?*

*Although the data available generally are of sufficient quality for use in resolving the corresponding DS, the quantity or type of data generally is not sufficient; therefore, additional data are needed.

CP-15329, *Data Quality Objectives Summary Report for Establishing a RCRA/CERCLA/AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network.*
DOE/RL-92-04, *PUREX Plant Source Aggregate Area Management Study Report.*
DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study Report.*
DOE/RL-95-100, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit.*
DOE/RL-99-07, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan.*
DOE/RL-99-66, *Steam Condensate/Cooling Water Waste Group Operable Units RI/FS Work Plan; Includes: 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units.*
DOE/RL-2005-01, *Initial Single-Shell Tank System Performance Assessment for the Hanford Site.*
DOE/RL-2007-31, *Remedial Investigation/Feasibility Study Work Plan for the 200-PO-1 Groundwater Operable Unit.*
Hanford Environmental Information System database.
PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site.*
PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington.*
PNNL-14027, *An Initial Assessment of Hanford Impact Performed with the System Assessment Capability.*
PNNL-14049, *Data Quality Objectives Summary Report – Designing a Groundwater Monitoring Network for the 200-BP-5 and 200-PO-1 Operable Units.*
PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006.*

COPC = contaminant of potential concern.
DS = decision statement.
HEIS = *Hanford Environmental Information System* database.
K_d = distribution coefficient.

Table 3-3. Preliminary Remediation Goals and Basis for Groundwater Contaminants of Potential Concern. (3 Pages)

Constituent	Primary MCL[a]	Secondary MCL[a]	Required Quantitation Limit	Groundwater WAC 173-340-720(4) Noncarcinogen[b]	Groundwater WAC 173-340-720(4) Carcinogen[b]	Background in Hanford Site Groundwater[c]	PRGs[d]	Units
1,1,2,2-Tetrachloroethane			5.00		0.22		0.22[i]	µg/L
1,2-Dichloroethane	5.00		1.50	160.00	0.48		0.48[i]	µg/L
1,4-Dioxane			10.00		4.00		4.00[i]	µg/L
2,4-Dinitrophenol			25.00	32.00			32.00	µg/L
Antimony	6.00		6.00	6.40			6.00[i]	µg/L
Arsenic	10.00		6.00	4.80	0.06	10.00	10[g]	µg/L
Benzene	5.00		1.50	32.00	0.80		0.80[i]	µg/L
Bis(2-ethylhexyl) phthalate	6.00		10.00	320.00	6.30		6.00[i]	µg/L
Bromodichloro-methane	80.00		5.00	160.00	0.71		0.71[i]	µg/L
Cadmium	5.00		2.00	8.00		<10	10[g]	µg/L
Carbon tetrachloride	5.00		1.50	5.60	0.34		0.34[i]	µg/L
Chromium	100.00		10.00			<30	100.00	µg/L
Dibromochloro-methane	80.00		5.00	160.00	0.52		0.52[i]	µg/L
Dieldrin			0.1	0.80	0.0055		0.0055[i]	µg/L
Dimethoate			20.00	3.20			3.20[i]	µg/L
Fluoride	4000.00	2000.00	500.00	960.00		775.00	960.00	µg/L
Gross alpha[h]	15.00		3.00			5.79	15.00	pCi/L
Heptachlor	0.40		0.05	8.00	0.019		0.019[i]	µg/L
Heptachlor epoxide	0.20		0.05	0.10	0.0048		0.0048[i]	µg/L
Hexane (n-hexane)			5.00	480.00			480.00	µg/L
Iodine-129	1.00		1.00				1.00[i]	pCi/L
Lead	15.00		5.00			<5	15.00	µg/L

Table 3-3. Preliminary Remediation Goals and Basis for Groundwater Contaminants of Potential Concern. (3 Pages)

Constituent	Primary MCL[a]	Secondary MCL[a]	Required Quantitation Limit	Groundwater WAC 173-340-720(4) Noncarcinogen[b]	Groundwater WAC 173-340-720(4) Carcinogen[b]	Background in Hanford Site Groundwater[c]	PRGs[d]	Units
Manganese			5.00	2200.00		163.50	2200.00	µg/L
Methylene chloride	5.00		1.00	480.00	5.80		5.00	µg/L
Neptunium-237	15.00		1.00				15.00	pCi/L
Nickel			40.00	320.00		<30	320.00	µg/L
Nitrate as NO_3	44300.00		75.00			12400.00	44300.00	µg/L
Nitrite as NO_2	3290.00		75.00				3290.00	µg/L
Nitrobenzene			10.00	4.00			4.00[i]	µg/L
Pentachlorophenol	1.00		10.00	480.00	0.73		0.73[i]	µg/L
Protactinium-231			1.00				--[e, i]	pCi/L
Selenium-79			30.00				--[e, i]	pCi/L
Strontium-90			2.00				8.00[f]	pCi/L
Technetium-99			15.00				900[f]	pCi/L
Tetrachloroethene	5.00		1.00	80.00	0.08		0.081[i]	µg/L
Thallium	2.00		0.50	1.10			1.10[i]	µg/L
Trichloroethene	5.00		2.00	2.40	0.11		0.11[i]	µg/L
Tritium	20000.00		400.00				20000.00	pCi/L
Uranium	30.00		0.10			3.43	30.00	µg/L
Uranium-234			1.00				20[f]	pCi/L
Uranium-238			1.00				20[f]	pCi/L
Vanadium			25.00	110.00		15.00	110.00	µg/L

Table 3-3. Preliminary Remediation Goals and Basis for Groundwater Contaminants of Potential Concern. (3 Pages)

Constituent	Primary MCL[a]	Secondary MCL[a]	Required Quantitation Limit	Groundwater WAC 173-340-720(4) Noncarcinogen[b]	Groundwater WAC 173-340-720(4) Carcinogen[b]	Background in Hanford Site Groundwater[c]	PRGs[d]	Units
Vinyl chloride	2.00		5.00	24.00	0.029		0.029[i]	µg/L
Zinc		5000.00	10.00	4800.00		673.00	4800.00	µg/L

[a]Primary and secondary MCLs are taken from the U.S. Environmental Protection Agency's Office of Groundwater and Drinking Water Web site at http://www.epa.gov/safewater/contaminants/index.html .
[b]WAC 173-340 values for non-carcinogens and carcinogens are from the CLARC database (Ecology 2005).
[c]Background values are from DOE/RL-92-23.
[d]The PRG is the lowest of the MCL and WAC 173-340 limits, except when background is higher, then background is selected. If the RQL is larger than the PRG, the RQL will be chosen.
[e]A calculation has not been yet performed to establish a target action level (pCi/L) from the drinking water regulatory requirement of 4 mrem/yr for these COPCs.
[f]Values are defined in DOE/RL-96-17 and are based on the 4 mrem/yr dose.
[g]Background values for these analytes were chosen as PRGs based on natural background being higher than other action limits.
[h]Represents a survey parameter.
[i]These values have the RQL>PRG, or the RQL is equal to the PRG. When this occurs, the RQL will become the PRG based on WAC 173-340-707.

DOE/RL-92-23, *Hanford Site Groundwater Background.*
DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area.*
Ecology, 2005, *Cleanup Levels & Risk Calculations (CLARC)* database, available on the Internet at https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx .
WAC 173-340, "Model Toxics Control Act -- Cleanup."
WAC 173-340-707, "Model Toxics Control Act -- Cleanup," "Analytical Considerations."
WAC 173-340-720(4), "Ground Water Cleanup Standards," "Method B Cleanup Levels for Potable Ground Water."

MCL = maximum contaminant level.
PRG = preliminary remediation goal.
RQL = required quantitation limit.

Several of the DSs in this DQO summary report require the application of professional judgment regarding the adequacy of current information to predict future movement of the COPCs from the vadose zone into the groundwater. Decisions will be based on computational methods that will be documented, selected, and agreed upon as the project moves on to the FS phase.

3.5 ANALYTICAL PERFORMANCE REQUIREMENTS

Table 3-4 lists analytical performance requirements for individual COPCs in groundwater samples. The table shows contractually required minimum detection limits as well as the maximum allowable concentrations of regulated constituents.

Table 3-4. Performance Requirements for Groundwater Analysis. (3 Pages)

Constituent	CAS No.	PRG[a]	Analytical Method[b]	Required Quantitation Limit	Precision	Accuracy
Radionuclides (pCi/L)						
Gross alpha[c]	12587-46-1	15	Alpha/beta GPC	3	±30%[d]	70 – 130%[d]
Iodine-129	15046-84-1	1[b]	I-129 liquid scint. (low level)	1		
Neptunium-237	13994-20-2	15	Neptunium-237 - AEA	1		
Protactinium-231	14331-85-2	-- [b]	Protactinium-231 - AEA	1		
Selenium-79	15758-45-9	-- [b]	LSC	30		
Strontium-90	10098-97-2	8	Gas proportional counting	2		
Technetium-99	14133-76-7	900	Tc-99 liquid scint. or GPC	15		
Tritium	10028-17-8	20,000	H-3 liquid scint. (mid-level)	400		
Uranium-234	13966-29-5	20	Isotopic uranium - AEA	1		
Uranium-238	U-238					
Inorganics – Metals (µg/L)						
Antimony	7440-36-0	6[b]	6010 B/200.8	6	±30%[e]	70 – 130%[e]
Arsenic	7440-38-2	10	Trace ICP	6		
Cadmium	7440-43-9	10	6010 B/200.8	2		
Chromium	7440-47-3	100	6010 B/200.8	10		
Lead	7439-92-1	15	6010 B/200.8	5		
Manganese	7439-96-5	2200	6010 B/200.8	5		
Nickel	7440-02-0	320	6010 B/200.8	40		
Thallium	7440-28-0	1.1	Trace ICP	0.5		
Uranium (total)	7440-61-1	30	6020 B/ 200.8/kinetic phosphorescence	0.1		
Vanadium	7440-62-2	110	6010 B/200.8	25		
Zinc	7440-66-6	4800	6010 B/200.8	10		

Table 3-4. Performance Requirements for Groundwater Analysis. (3 Pages)

Constituent	CAS No.	PRG[a]	Analytical Method[d]	Required Quantitation Limit	Precision	Accuracy
Inorganics – Non-Metals (µg/L)						
Fluoride	16984-48-8	960	Anions by IC – 300.0	500		
Nitrate as NO_3	14797-55-8	44,300	Anions by IC – 300.0	75	±30%[e]	70 – 130%[e]
Nitrite as NO_2	14797-65-0	3,290	Anions by IC – 300.0	75		
Volatile Organics (µg/L)						
1,1,2,2-Tetrachloroethane	79-34-5	0.22[b]	Volatile organics – 8260 B	5		
1,2-Dichloroethane	107-06-2	0.48[b]	Volatile organics – 8260 B	1.5		
Benzene	71-43-2	0.8[b]	Volatile organics – 8260 B	1.5		
Bromodichloromethane	75-27-4	0.71[b]	Volatile organics – 8260 B	5		
Carbon tetrachloride	56-23-5	0.34[b]	Volatile organics – 8260 B	1.5		
Dibromochloromethane	124-48-1	0.52[b]	Volatile organics – 8260 B	5	±30%[f]	50 – 150%[f]
Hexane	110-54-3	480	Volatile organics – 8260 B	5		
Methylene chloride	75-09-2	5[b]	Volatile organics – 8260 B	5		
Tetrachloroethylene	127-18-4	0.081[b]	Volatile organics – 8260 B	1		
Trichloroethylene (TCE)	79-01-6	0.11[b]	Volatile organics – 8260 B	2		
Vinyl chloride	75-01-4	0.029[b]	Volatile organics – 8260 B	10		
Semivolatile Organics (µg/L)						
1,4-Dioxane	123-91-1	4[b]	Semivolatile organics – 8270 C	10		
2,4-Dinitrophenol	51-28-5	32	Semivolatile organics – 8270 C	25	±30%[f]	50 – 150%[f]
Bis (2-ethylhexyl) phthalate	117-81-7	6[b]	Semivolatile organics – 8270 C	10		
Nitrobenzene	98-95-3	4[b]	Semivolatile organics – 8270 C	10	±30%[f]	50 – 150%[f]
Pentachlorophenol	87-86-5	0.73[b]	Semivolatile organics – 8270 C	10		
Pesticides (µg/L)						
Dieldrin	60-57-1	0.0055[b]	Pesticides – 8081 C	0.1		
Dimethoate	60-51-5	3.2[b]	Semivolatile –8270 C	20	±30%	50 – 150%
Heptachlor	76-44-8	0.019[b]	Pesticides –8081 C	0.05		
Heptachlor epoxide	1024-57-3	0.0048[b]	Pesticides –8081 C	0.05		

[a]The PRG is the lowest of the MCL and WAC 173-340 limits, except when background is higher, then background is selected.
[b]These values have the RQL>PRG, or the RQL is equal to the PRG. When this occurs, the RQL will become the PRG based on WAC 173-340-707.
[c]Represents a survey parameter.

Table 3-4. Performance Requirements for Groundwater Analysis. (3 Pages)

Constituent	CAS No	PRG[a]	Analytical Method[g]	Required Quantitation Limit	Precision	Accuracy

[d]Accuracy criteria for associated batch laboratory control sample percent recoveries for radionuclides. With the exception of gamma energy analysis, additional analysis-specific evaluations also performed for matrix spikes, tracers, and carriers, as appropriate to the method. Precision criteria for batch laboratory replicate sample analyses.

[e]Accuracy criteria for associated batch matrix spike percent recoveries for inorganics. Evaluation based on statistical control of laboratory control samples also performed. Precision criteria for batch laboratory replicate matrix spike sample analyses or replicate sample analyses.

[f]Accuracy criteria are the minimum for associated batch laboratory control sample percent recoveries for organics. Laboratories must meet statistically based control if more stringent. Additional analyte-specific evaluations also performed for matrix spikes and surrogates as appropriate to the method. Precision criteria for batch laboratory replicate matrix spike sample analyses.

[g]Four-digit EPA Methods are found in SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-B*; EPA Method 200.8 is found in EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*; EPA Method 300.0 is found in EPA/600/4-79/020, *Methods of Chemical Analysis of Water and Wastes.*

WAC 173-340, "Model Toxics Control Act -- Cleanup."
WAC 173-340-707, "Analytical Considerations."

AEA = alpha energy analysis.
CAS = Chemical Abstracts Service.
GPC = gas proportional counting.
IC = ion chromatography.
ICP = inductively coupled plasma.
LSC = liquid scintillation counting.
MCL = maximum contaminant level.
PRG = preliminary remediation goal.
RQL = required quantitation limit.

4.0 STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

The purpose of DQO Step 4 is to define the target population of interest, define the spatial and temporal boundaries that apply to each DS, define the scale of decision making, and identify any practical constraints associated with sample/data collection. This chapter presents the DSs that originally were shown in Table 2-1.

4.1 POPULATION OF INTEREST

Before defining the spatial and temporal boundaries of the site under investigation, it is first necessary to clearly define the populations of interest that apply for each DS (Table 2-1). The intent of Table 4-1 is to clearly define the attributes that make up each population of interest by stating them in a way that makes the focus of the study unambiguous.

Table 4-1. Characteristics that Define the Population of Interest.

DS No.	Population of Interest	Approximate Sample Size	Total Number of Potential Samples Within the Population
1, 2, 4, 5, 7, 8, 9, 10, 11, 12	All analyte results within the aquifers, geochemical data, and physical property data required to evaluate remedial action alternatives for specific plumes. Data required to define three-dimensional distribution of COPCs within the unconfined aquifer.	19 L	Infinite
3	Data required to evaluate subsurface contaminant flow paths and impact of declining water levels.	(a)	
5	Fate and transport data input to models such as MODFLOW or STOMP.	(b)	
6	All analyte results within the aquifers, geochemical data, and physical property data required to evaluate the future potential contribution to groundwater from waste sites also discussed in this document as near-field boundary (including tank farms).	19 L	Infinite
7, 10	Risk scenarios, fate and transport data, and remedial alternatives.	19 L	Infinite
11	Evaluate COPC data from the near field and compare it to far-field results and fate and transport modeling results.	19 L	Infinite
12	Evaluate data from the River Transect. See Chapter 7.0 of this document and compare to ecological screening levels.	19 L	Infinite

[a]Does not apply because geophysical data samples the entire area.
[b]Does not apply because modeling includes analytical data discussed above and the various physical parameters.

COPC = contaminant of potential concern.
DS = decision statement.
STOMP = Subsurface Transport Over Multiple Phases (code).

4.2 GEOGRAPHIC AND PLUME BOUNDARIES

Figure 4-1 illustrates the geographic and plume perimeters of the 200-PO-1 Groundwater OU, which generally are triangular in shape, representing the tritium plume that extends from the 200 East Area to the Columbia River. The western boundary is the 2000 pCi/L isopleth of tritium (one-tenth of the primary drinking water standard) on the western flank of the plume, extending from the boundary of the 300 Area on the south to the boundary between the 200-PO-1 Groundwater OU and 200-BP-5 Groundwater OU on the north. The northern boundary is the 2000 pCi/L tritium isopleth on the northern flank of the plume, extending from the Columbia River to the 200-PO-1 Groundwater OU/200-BP-5 Groundwater OU boundary, then along the boundary to the 2000 pCi/L tritium isopleth of the western flank. The eastern boundary of the 200-PO-1 Groundwater OU is the Columbia River, south to the 300 Area. The southern boundary is represented by the northern border of the 300 Area from the river to the western 2000 pCi/L tritium isopleth.

For this report, the 200-PO-1 Groundwater OU is divided into three geographic areas of concern. The first area, or near-field region, represents the source areas within and adjacent to the 200 East Area, and the downgradient areas to the Southeast Transect. The second area, or far-field region, is defined as the area of the 200-PO-1 Groundwater OU including the Southeast Transect extending to the Columbia River. The River Transect, a subset of the far-field region, and the River Corridor aquifer tubes represent the final area of concern.

Table 4-2 presents the geographic boundaries that pertain to each DS from Table 2-1. DSs 1–12 from Table 2-1 encompass the entire groundwater beneath the 200-PO-1 Groundwater OU. DSs 6 and 11 encompass the groundwater beneath the near-field zone only, while DSs 1, 2, 3, 4, 5, 7, 8, 9, and 10 reflect the far field zone. DS 12 reflects decisions involving the groundwater along the River Transect and River Corridor zones.

4.3 VERTICAL BOUNDARIES

The vertical extents of the 200-PO-1 Groundwater OU for the purposes of this DQO summary report are the suprabasalt sediments of the Hanford and Ringold formations. In addition, this DQO specifically includes continued monitoring of the upper basalt confined aquifers for detecting future contamination within the geographic boundaries of the 200-PO-1 Groundwater OU.

4.4 STRATA CHARACTERISTICS IN 200-PO-1 GROUNDWATER OPERABLE UNIT

The unconfined aquifer within the 200-PO-1 Groundwater OU occurs within the Hanford formation and/or underlying Ringold Formation. Groundwater flow in the unconfined aquifer is generally southeast and east toward the Columbia River. Confined or semi-confined aquifer conditions occur locally below the Ringold lower mud unit and within the Columbia River Basalts (DOE/RL-2003-04).

Figure 4-1. Location Map of 200-PO-1 Groundwater Operable Unit as Defined by the 1995 Tritium Plume Extent.

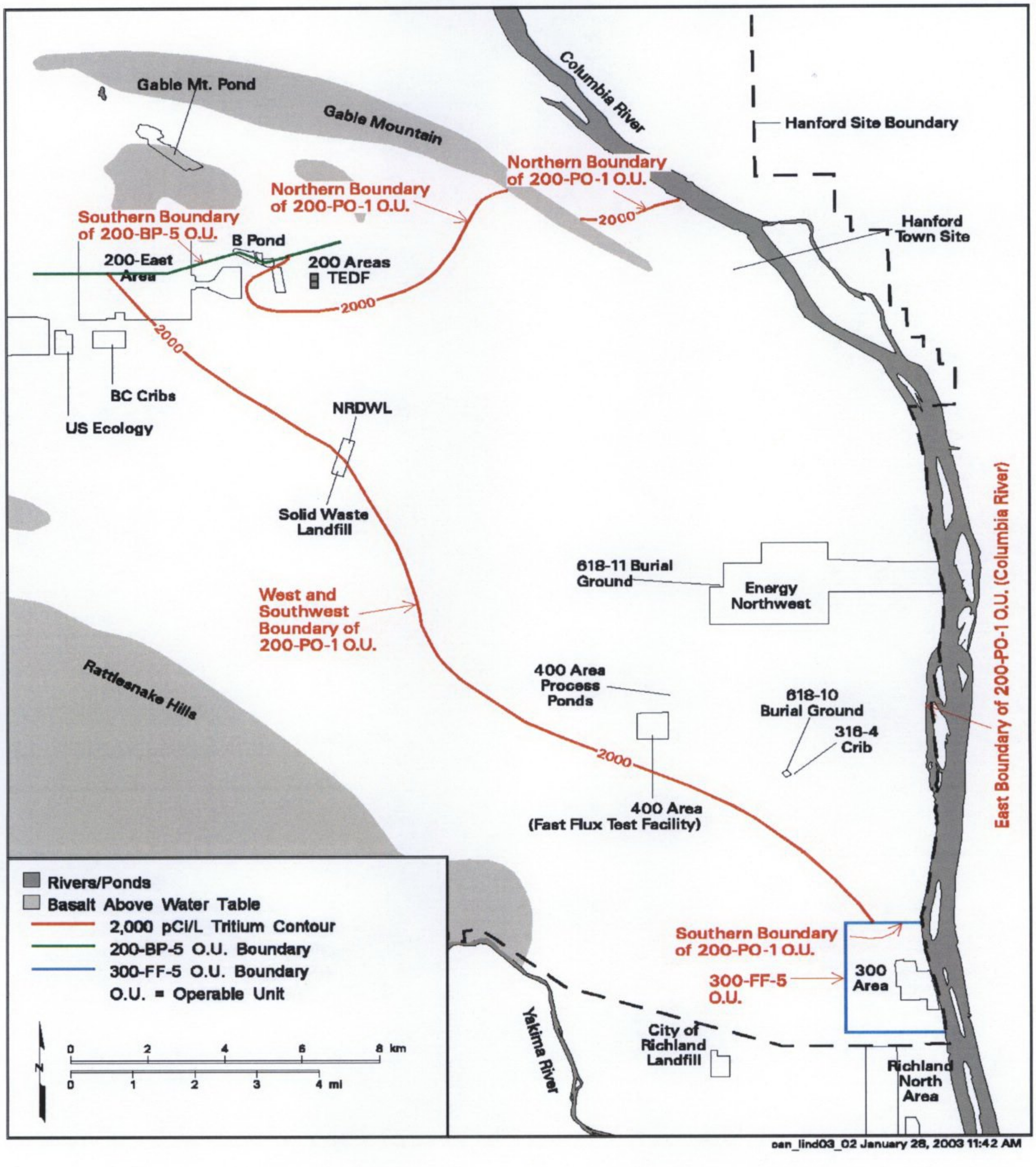


Table 4-2. Geographic Boundaries of the Investigation.

Decision Statement No.	Geographic Boundaries of the Investigation
1-12	Groundwater that lies beneath the perimeter of the 200-PO-1 Groundwater OU.
6, 11	Groundwater that lies beneath the near-field zone within the 200-PO-1 Groundwater OU.
1, 2, 3, 4, 5, 7, 8, 9, 10	Groundwater that lies beneath the far-field zone within the 200-PO-1 Groundwater OU.
12	Groundwater that lies beneath the River Transect line and adjacent to the river.

The direction of groundwater flow and hydraulic gradient are customarily inferred from hydraulic head measurements, and the rate of groundwater mass transport is calculated from inferred gradient and measured hydraulic conductivity. Such inferences and calculations are reliably accurate only for a homogeneous, isotropic aquifer, which is not descriptive of the 200-PO-1 Groundwater OU unconfined aquifer. Further, measurements of hydraulic conductivity at the Hanford Site generally are made using single-well stress tests, which effectively interrogate the aquifer only in the immediate vicinity of the test well. Finally, as seen in Figure 4-2, over much of 200-PO-1 Groundwater OU, hydraulic gradients are extremely shallow thereby adding considerable uncertainty to the inferred gradients. Figure 4-2 also shows those areas where basalt is above the water table and therefore serves to constrain groundwater flow.

In general, the Hanford formation and Ringold Formation are distinguished based on sediment characteristics (e.g., texture, color, lithology and competency) as observed during geologic logging. Specific units within these formations also are easily identified using standard borehole geophysical techniques. Figure 4-3 is a simplified cross section illustrating the suprabasalt stratigraphy approximately along the axis of the principal lobe of the far-field tritium plume, which approaches the Columbia River north of the Energy Northwest power plant. Figure 4-3 shows that the suprabasalt sediments thin significantly toward the east, which is consistent with the increased hydraulic gradient near the river.

PNNL's extensive Well Log Library was used to prepare structure maps showing the elevation of the top of each hydrostratigraphic unit and four cross sections as visual representations of the subsurface hydrogeology and hydrostratigraphy (Figure 4-4). Two of the four structural cross sections, Lines 2 and 1, are represented schematically in Figures 4-5 and 4-6, respectively. These cross sections are oriented roughly perpendicular to the regional structural trends and depositional axes of the geologic units. It is intended that these visual aids help illustrate the revised interpretation of the lateral and vertical extent and variability of the principal hydrogeologic unit within the geologic framework and their relationship to groundwater movement through the area.

Figure 4-2. Hanford Site Water Table Elevations for April 2006 (PNNL-16346).

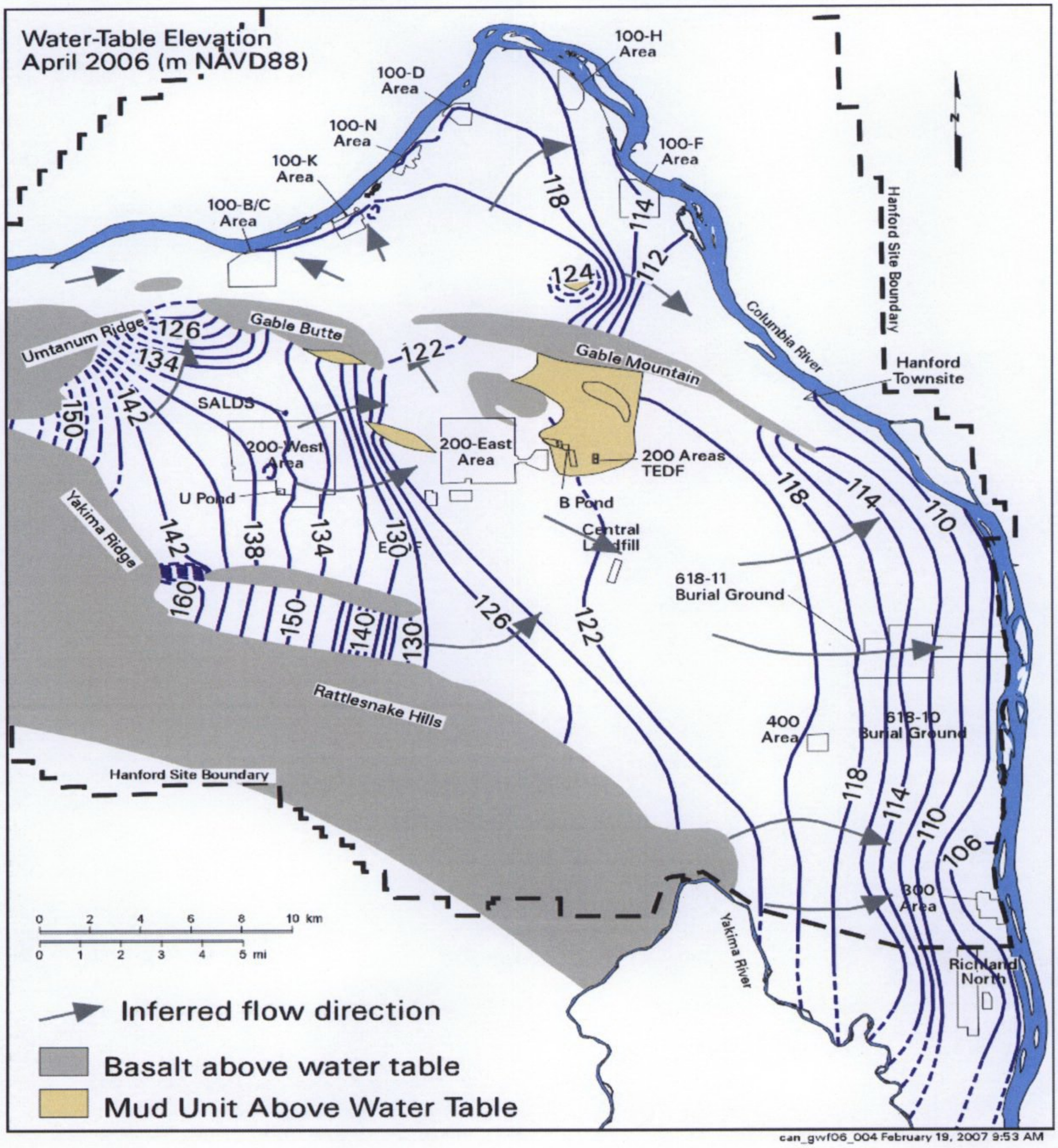
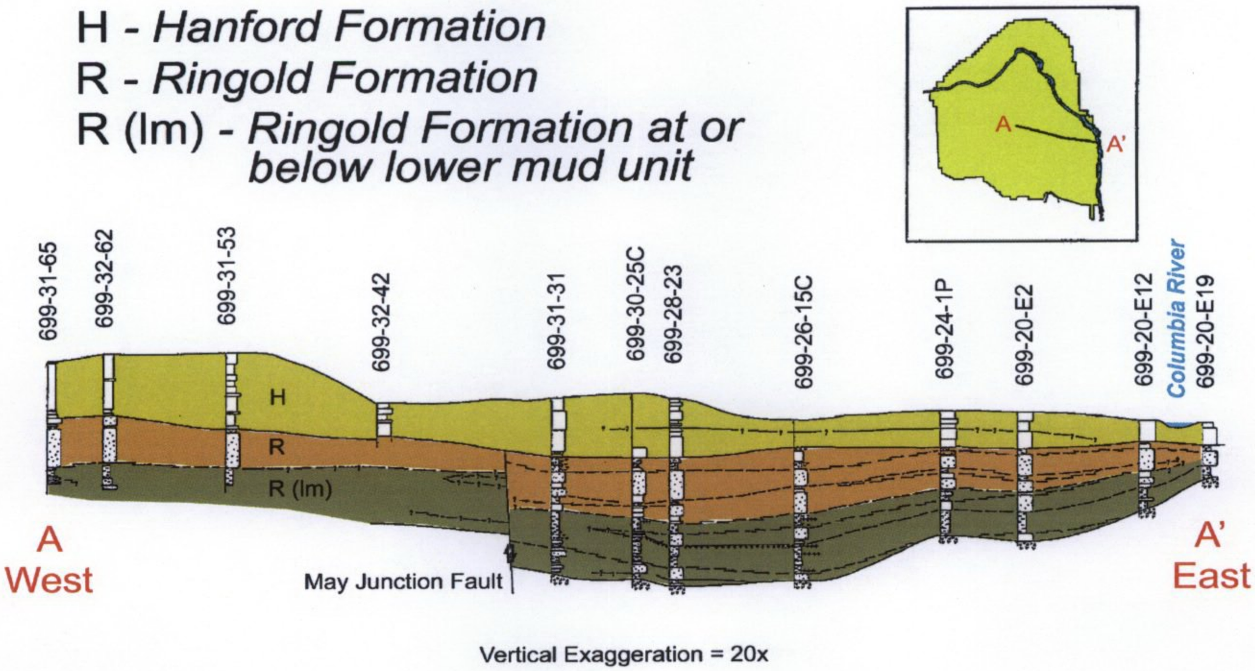


Figure 4-3. Geologic Cross Section of the Suprabasalt Sediments of the 200-PO-1 Groundwater Operable Unit from the 200 Areas to the Columbia River.

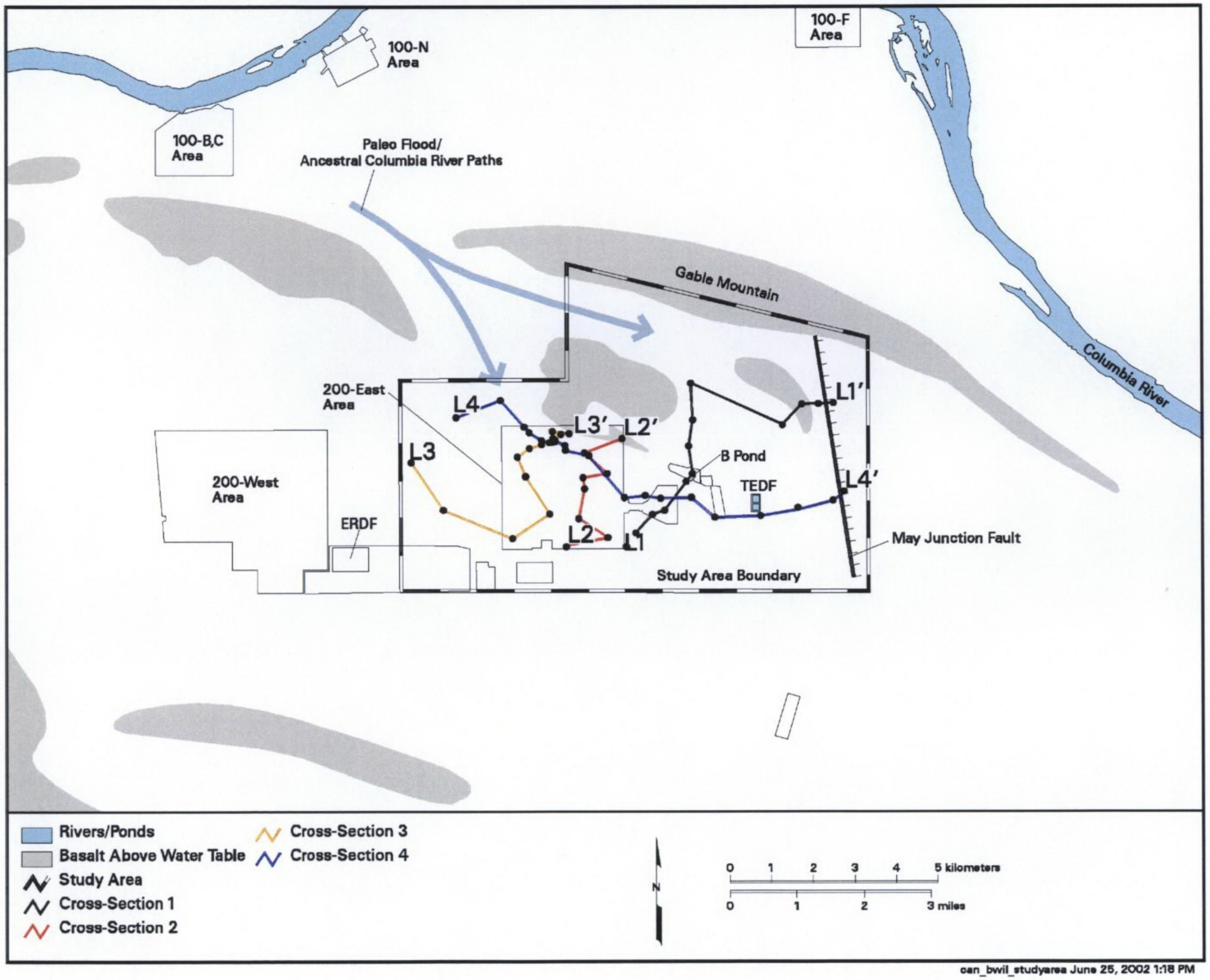


The suprabasalt aquifer is believed to comprise two aquifers: an upper unconfined aquifer, and a lower confined aquifer (Ringold units 9A/C). Throughout most of the Hanford Site, groundwater in the uppermost unconfined aquifer is isolated from groundwater in the confined Ringold aquifer system by the Ringold lower mud unit (unit 8). However, an erosional window exists along the margins of the buried paleo-channel, and the confined Ringold aquifer system is in direct contact with unit 1 of the uppermost unconfined aquifer (see Figures 4-5 and 4-6). Because the hydraulic conductivity of the channel fill is generally much higher than for Unit 9, and because an upward gradient exists in this region, groundwater from the confined Ringold aquifer system likely discharges into the highly transmissive channel-fill sediments where it mixes with groundwater of the uppermost unconfined aquifer. However, there is a lack of groundwater data (i.e., no wells) in the confined Ringold aquifer to the west and southwest of the 200 East Area where contamination from the 200 West Area may enter the study area (PNNL-12261).

4.4.1 Near-Field Stratigraphy

Line 2 (Figure 4-5) is a north-to-south oriented structural cross section across the eastern 200 East Area that underlies part of the near-field zone. This line is perpendicular to the suspected erosional channel that cut through and removed the Ringold lower mud unit (unit 8) and older Ringold sediments near the crest of the basalt anticline (north end).

Figure 4-4. Four Cross-Sectional Lines Presenting Visuals of the Subsurface Hydrogeology and Hydrostratigraphy Across a Portion of the 200 East Area (PNNL-12261).



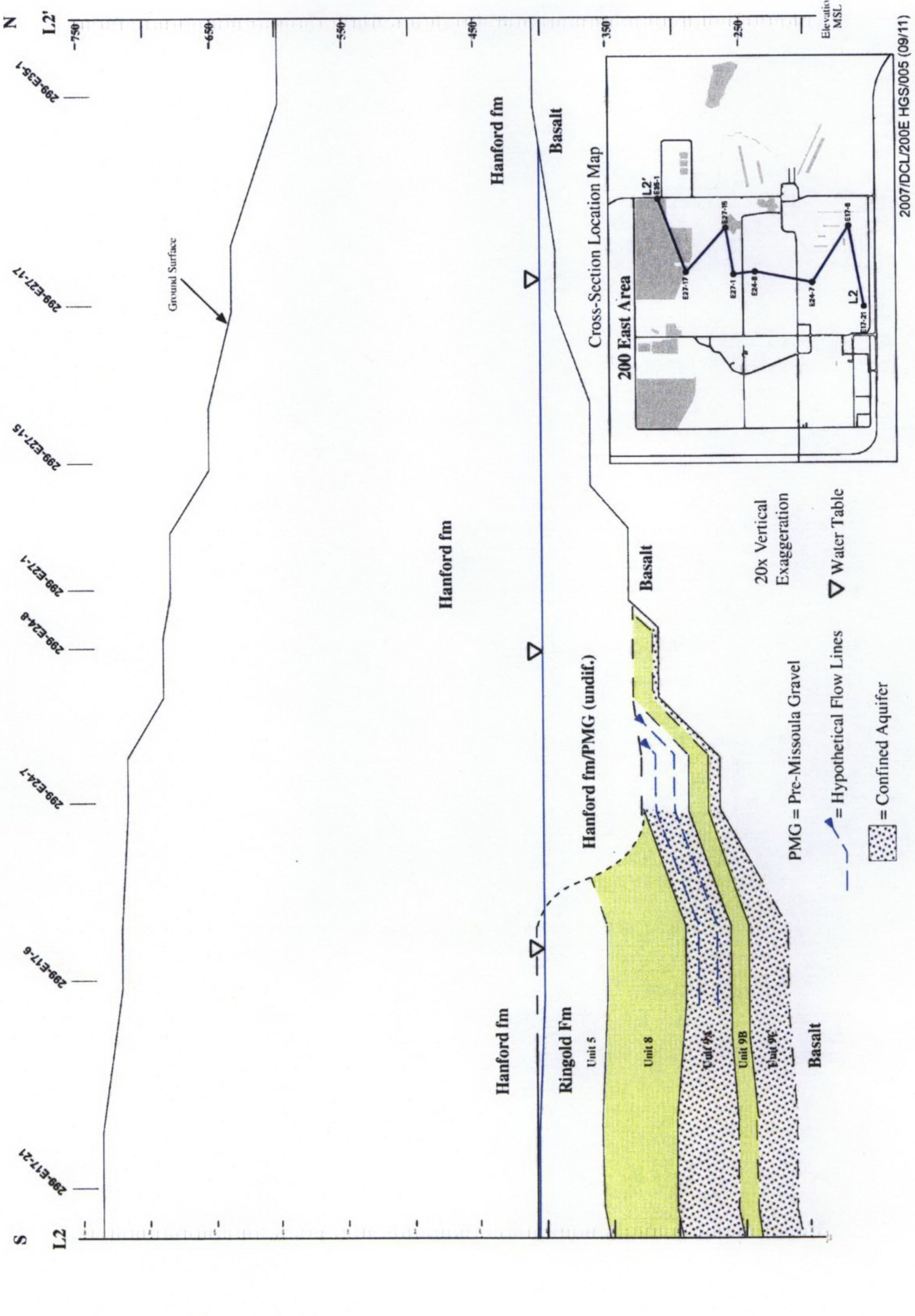
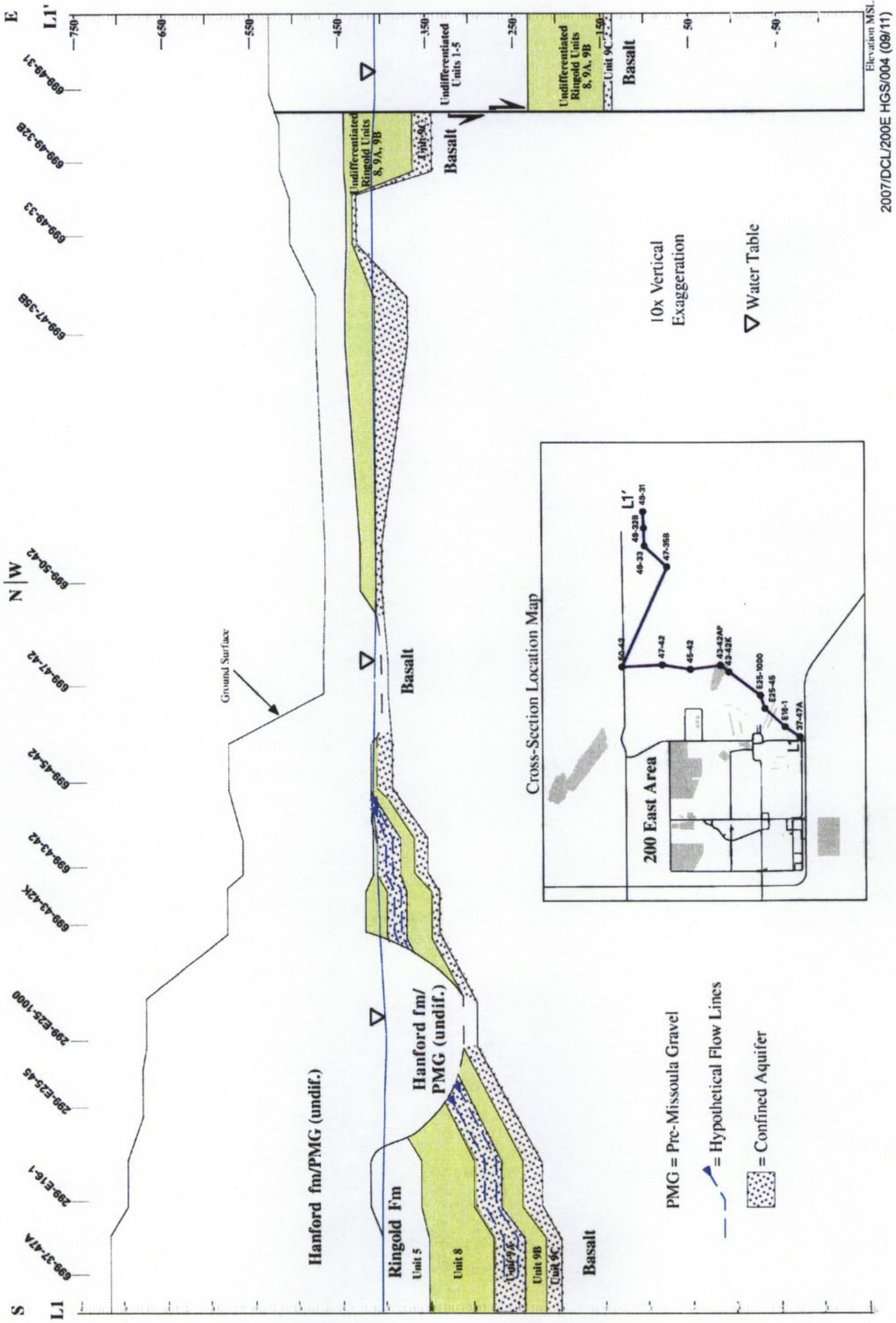


Figure 4-5. Line 2 Near-Field Cross Section (PNNL-12261).

Figure 4-6. Line 1 Far-Field Cross Section (PNNL-12261).



4.4.2 Far-Field Stratigraphy

Line 1 (Figure 4-6) illustrates the hydrostratigraphy roughly perpendicular to the ancestral Columbia River and Pleistocene flood paths and subsequent channel development, and crosses the far-field zone. Salient hydrostratigraphic features include the relative stratigraphic position and thickness of the confining lower mud unit (unit 8), with respect to the basalt structure; the continuity of unit 8 up onto the structure (only minor depositional thinning); and the isolated areas where unit 8, and portions of Ringold units 9A/C and 9B are abruptly absent or have been removed. The thickness and relative position (vertical separation) of the units is maintained up onto the structure on both sides of the channel scour, which suggests the erosional removal of the units rather than depositional thinning (PNNL-12261).

4.4.3 River Transect and River Corridor

Estimating the rate of mass transport of contaminants through the far-field zone (600 Area) to the Columbia River is of importance for assessing environmental risk to the river. The River Transect wells are of particular interest because they effectively establish a cross section or vertical "curtain" through which the waste constituents must pass to reach the river, and because the saturated interval of the suprabasalt sediments is relatively thin compared to most of the 200-PO-1 Groundwater OU.

The River Transect wells lie within the area of thinner suprabasalt sediments and steeper hydraulic gradient. The shallower basement and relatively unambiguous gradients indicate that the River Transect may represent the most useful area within the 200-PO-1 Groundwater OU for initial application of a combined program of geophysical testing, single-well tracer testing, depth-discrete groundwater sampling, and supplementary hydraulic stress testing.

The River Corridor aquifer tubes will determine concentrations of near-shore sediment pore water. The samples are intended to show the concentrations of the Hanford Site groundwater contaminants discharging to the Columbia River via the unconfined aquifer. The purpose of the measurements is to provide data for assessing ecological risk to near-shore biota.

4.5 STRATA WITH HOMOGENEOUS CHARACTERISTICS

The textural and mineralogical properties of the strata also influence hydraulic and mass transport characteristics that are important for contaminant transport modeling.

Aquifer identification (i.e., unconfined vs. confined) is principally based on the physical characteristics of the bounding strata. Appendix F presents alternative characterization methods that may be used to supplement investigative measurements routinely used for Hanford Site aquifers. Hydraulic head measurements also are useful in differentiating between aquifers and for identifying aquifer communication. Table 4-3 presents strata with homogenous characteristics and the DSs that apply.

Table 4-3. Strata with Homogeneous Characteristics.

DS No.	Strata	Homogeneous Characteristics Logic
6, 11	The unconfined and confined aquifers within the near-field underlying source sites within the 200-PO-1 Groundwater Operable Unit	Semi-homogeneous for specific plume COPCs dissolved in the groundwater. Generally higher in concentration than the far-field, River Transect, or River Corridor.
1, 2, 3, 4, 5, 7, 8, 9, 10	The unconfined and confined aquifers within the far- field underlying the 200-PO-1 Groundwater Operable Unit	Semi-homogeneous for specific plume COPCs dissolved in the groundwater. Generally lower in concentration than groundwater than inside the near-field zone. Also potentially subject to different remedial action objectives.
12	The unconfined aquifer underlying the River Transect and River Corridor	Semi-homogeneous for specific plume COPCs dissolved in the groundwater. Generally lower in concentration than groundwater than inside the near-field zone. Also potentially subject to different remedial action objectives.

COPC = contaminant of potential concern.
DS = decision statement.

4.6 TEMPORAL BOUNDARIES

Table 4-4 identifies temporal boundaries that may apply to each DS. The temporal boundary refers to the timeframe over which the data collected will apply to the DSs and shows the optimum time to collect the samples. For analyses such as VOC, samples should not be collected during extremely high temperatures or extreme wind conditions because these conditions will increase the rate of volatilization, which could affect the analytical results.

Table 4-4. Temporal Boundaries of the Investigation.

DS No.	Timeframe (Years)	When to Collect Data
2, 3, 4, 6, 8, 9, 10,11, 12	0-3	During the drilling of new groundwater-monitoring wells and data collection.
1, 5, 7	1-3	Before choosing remedial action alternative and completion of record of decision revision.

DS = decision statement.

Three main areas of consideration comprise the temporal boundaries of the project. The first reflects the period of time needed to consider the DSs, to choose one of the alternative actions for each DS, and to incorporate the results into a Characterization SAP (DOE/RL-2007-30). The second consideration is the likely duration, in years, of the scale of monitoring reflected by the Characterization SAP. The final consideration addresses the timing of sampling within each annual period. Table 4-5 identifies the temporal factors that correspond to the activities that are proposed.

Table 4-5. Temporal Boundaries of the Investigation Related to the Proposed Activities.

DS No.	Activity	Temporal Factors
4, 6, 8, 10	Drill or deepen wells; design and initiate any planned field and laboratory testing programs.	1 to 3 years from completion of DQO.
2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	Groundwater sampling and analysis.	Nominally annual to semiannually, but sampling frequency may be adjusted for individual locations. Supplementary sampling (e.g., from RCRA TSD monitoring) is nominally quarterly to annually. There are no general constraints on groundwater sampling other than frequency.
2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	Water level measurements.	Nominally annual to semiannually, but measurement frequency may be adjusted for individual locations. Measurements from supplementary wells (e.g., from RCRA TSD monitoring) is nominally quarterly to annually. Water-level measurements are best performed during periods relatively free of barometric pressure or storm effects (e.g., June – August). For wells near the Columbia River, river stage (and bank storage) should be considered.
1, 5, 7,	Duration of monitoring program.	It is expected that the monitoring program will continue through at least 2018, which is the Tri-Party Agreement (Ecology et al., 1989) target date for completion of remedial action (DOE/RL-99-66). In the event that institutional controls are chosen over remediation, it is expected that monitoring will continue through at least 2118.

DOE/RL-99-66, *Steam Condensate/Cooling Water Waste Group Operable Units RI/FS Work Plan; Includes: 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units.*
Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order.*

DQO = data quality objective.
DS = decision statement.
RCRA = *Resource Conservation and Recovery Act of 1976.*
TSD = treatment, storage, and/or disposal.

4.7 SCALE OF DECISION MAKING

In Table 4-6, the scale of decision making has been defined for each DS. The scale of decision making is defined by joining the population of interest and the geographic and temporal boundaries of the area under investigation. For this DQO, the scale of decision making has been maintained in fairly global terms. As discussed in recent EPA DQO guidance (EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4), the scale of decision making may be based on widely different project needs. It is expected that as the cleanup of the site progresses, more specific and different decision making scales will be developed. The following paragraph summarizes recent EPA guidance (EPA/240/B-06/001).

> *The scale of decision making is the smallest area or volume of the media, or the shortest time frame associated with the contamination problem of the site for which the planning team wishes to control decision errors. The goal of this activity is to define subsets of*

media about which the planning team will be able to make independent decisions that satisfy the decision error constraints specified in Step 6. The scale may range from the entire geographic boundaries of the site to the smallest area that can be remediated with a given technology. The scale of decision making is sometimes called a decision unit. The scale of decision making may be based on:

(1) Risk

(2) Technological Considerations

(3) Temporal Considerations

(4) Financial

(5) Other considerations

A temporal scale of decision making is based on exposure from constituents in media that change over time. For example, in order to regulate water quality, it would be useful to set a scale of decision making that reduces the time between sampling events. Using this scale, the planning team could minimize the potential adverse effects in case the water quality changed between sampling events.

For this DQO, the scale of the decision includes a temporal component. The decisions made are expected to apply to the groundwater conditions for 1,000 years.

Table 4-6. Scale of Decision Making. (3 Pages)

DS No.	Population of Interest	Geographic Boundaries	Temporal Boundary		Scale of Decision
			Time-frame	When to Collect Data	
1	Data required to evaluate specific chosen remedial action alternatives.	Near field, far field, and along river within the 200-PO-1 Groundwater OU.	See Table 4-4	See Table 4-4	A specific groundwater contaminant plume within the geographic boundaries over next 3 years.
2	Characterization data required to determine horizontal and vertical COPC distribution within the unconfined aquifer.	Near field, far field, and along river within the 200-PO-1 Groundwater OU.	See Table 4-4	See Table 4-4	Groundwater within the geographic boundaries over next 2 years.
3	Data required to evaluate subsurface contaminant flow paths and impact of declining water levels.	Near field, far field, and along river within the 200-PO-1 Groundwater OU.	See Table 4-4	See Table 4-4	Groundwater within the geographic boundaries over next 2 years.

Table 4-6. Scale of Decision Making. (3 Pages)

DS No.	Population of Interest	Geographic Boundaries	Temporal Boundary		Scale of Decision
			Time-frame	When to Collect Data	
4	Data required to evaluate alternate monitoring points to adequately define the three-dimensional extent of the contaminants in the plumes.	Near field, far field, and along river within the 200-PO-1 Groundwater OU.	See Table 4-4	See Table 4-4	Groundwater within the geographic boundaries over next 2 years.
5	Data required to support modeling and redefinition of the current hydrogeologic conceptual model in order to make a phased remedial decision.	Near field, far field, and along river within the 200-PO-1 Groundwater OU.	See Table 4-4	See Table 4-4	Groundwater within the geographic boundaries over next 2 years.
6	Data required to evaluate the future potential contribution to groundwater from waste sites (including tank farms).	Near field within the 200-PO-1 Groundwater OU.	See Table 4-4	See Table 4-4	Groundwater within the geographic boundaries over next 2 years.
7	Data required to evaluate the need to redefine end states.	Near field, far field, and along river within the 200-PO-1 Groundwater OU.	See Table 4-4	See Table 4-4	Groundwater within the geographic boundaries over next 2 years.
8	Data required to prepare reliable groundwater table contour maps and for mapping flow where the groundwater gradient is shallow or flat.	Near field, far field, and along river within the 200-PO-1 Groundwater OU.	See Table 4-4	See Table 4-4	Groundwater within the geographic boundaries over next 2 years.
9	Data required to evaluate whether the locations of wells and sampling frequency for tracking plume movement are adequate.	Near field, far field, and along river within the 200-PO-1 Groundwater OU.	See Table 4-4	See Table 4-4	Groundwater within the geographic boundaries over next 2 years.
10	Data required to evaluate benefits of more accurate preferential flow path knowledge to risk assessment based on long-term contaminant transport modeling.	Near field, far field, and along river within the 200-PO-1 Groundwater OU.	See Table 4-4	See Table 4-4	Groundwater within the geographic boundaries over next 2 years.

Table 4-6. Scale of Decision Making. (3 Pages)

DS No.	Population of Interest	Geographic Boundaries	Temporal Boundary		Scale of Decision
			Time-frame	When to Collect Data	
11	Data required to evaluate adequacy of sampling frequency and suite of COPCs at source sites would ensure timely warning of emerging threats.	Near field within the 200-PO-1 Groundwater OU.	See Table 4-4	See Table 4-4	Groundwater within the geographic boundaries over next 2 years.
12	Data required to evaluate potential risk to aquatic ecology from COPCs associated with the 200-PO-1 Groundwater OU.	Along the River Transect and adjacent to the river within the 200-PO-1 Groundwater OU.	See Table 4-4	See Table 4-4	Groundwater within the geographic boundaries over next 2 years.

OU = operable unit.
DS = decision statement.
COPC = contaminant of potential concern.

4.8 PRACTICAL CONSTRAINTS

Potential practical constraints that could interfere with the implementation of the sampling program outlined in Chapter 7.0 are as follows.

- Monitoring wells identified for sampling could go dry due to declining water table.
- Access to one or more groundwater-monitoring wells could be temporarily impeded due to security issues, radiological controls, or wildfire.
- Scheduling constraints on sampling could affect when data are collected.
- Well maintenance or pump problems could impede collection of some samples.
- Budgetary issues could require renegotiations of the SAP and affect installation of new wells.
- Sample shipping or laboratory problems can affect holding times and completeness of sample analysis.

This page intentionally left blank.

5.0 STEP 5 – DEVELOP A DECISION RULE

The purpose of Step 5 is to develop a decision rule (DR) for each DS in the form of an "if…then…" statement that incorporates the parameter of interest, the scale of decision making, the action level, and the AAs that would result from the resolution of the decision. Note that the scale of decision making and AAs were identified earlier in DQO Steps 4 and 2, respectively.

5.1 INPUTS TO DEVELOP DECISION RULES

Table 5-1 is a reiteration of the DSs developed in DQO Step 2 (Table 2-1) and specific COPC action levels, or PRGs (Table 3-4). This information will be used to develop the DRs in Section 5.2.

Table 5-1. Decision Statements.

DS No.	Decision Statements
1	Determine if additional data are needed to choose between remedial action alternatives for a specific plume or if no action is required. If additional data are needed, determine the type of data needed.
2	Determine if additional characterization data (e.g., geophysical, discrete sampling) are needed to define the three-dimensional distribution of COPCs within the unconfined aquifer or if no action is required.
3	Determine if there are possible subsurface contaminant flow barriers and pathways. Including those that may be associated with declining water levels.
4	Determine if and where additional or alternate monitoring points are needed to adequately define the three-dimensional extent of contaminants in the plumes.
5	Determine if additional data are needed to support modeling and redefinition of the conceptual model in order to make a phased remedial decision, or if no action is required.
6	Determine if additional data are needed to determine the future potential contribution to groundwater from waste sites (including tank farms) or if no action is required. If additional data are needed, determine the type of data needed.
7	Determine if additional data are needed to determine the need to redefine end states or if no action is required. If additional data are needed, determine the type of data needed.
8	Determine if and where additional resolution of the water table is needed to prepare reliable groundwater table contour maps. Consider alternative means for mapping flow where the groundwater gradient is shallow or flat.
9	Determine if the locations of the wells and the sampling frequencies are adequate for tracking plume movement, or if no action is required.
10	Determine if risk assessment based on long-term contaminant transport modeling would significantly benefit from more accurate knowledge of preferential flowpaths; if so, consider alternate means (e.g., geophysical testing) to guide or to substitute for additional drilling and testing; otherwise, no action is required.
11	Determine if the sampling frequency and suite of measured COPCs at individual source sites are adequate to ensure timely warning of emerging contaminant plumes.
12	Determine if additional data are needed to evaluate potential risk to aquatic ecology from COPCs associated with the 200-PO-1 Groundwater Operable Unit. If additional data are needed, determine the type of data needed.

COPC = contaminant of potential concern.
DS = decision statement.

5.2 DECISION RULES

A DR is an "if...then..." statement that incorporates the parameter of interest, the unit of decision making, the action level, and the action(s) that would result from resolution of the decision. Table 5-2 presents DRs in tabular form that corresponds to each of the DSs identified in Table 5-1. Several of the DSs require professional judgment to evaluate data from widely differing sources and quality. In some cases, the data for a specific DR are not currently available. As discussed in Chapter 2.0, the PSQs do not necessarily relate to a single sample statistic. In many cases, there is no sample statistic that relates directly to the question that must be answered. As a result of these considerations, the DRs are more complicated than a simple comparison of a single analyte to a specific regulatory action level, or PRG.

Table 5-2. Decision Rules for Each Decision Statement. (2 Pages)

DR No.	Population Parameter	Sample Statistic	Variable		Unit or Scale of Decision Making	Relationship	Action Level	AA No. 1	Relationship	AA No. 2
			Attribute	Unit of Measure						
1	If additional data are required to choose a final remedial action alternative.	As determined by representative values.	Of the COPCs concentration and/or strata characteristics in µg/L or pCi/L or other appropriate units.		For a specific groundwater COPC plume within the geographic boundaries[a] over the next 1–3 years.	Are not available for comparison.	The operational requirements of the final remedial action alternatives.	Obtain additional data through treatability tests or other means as appropriate.	or	Choose remedial action alternative.
2	If characterization data (geophysical, etc.) define three-dimensional distribution of COPCs.	As estimated by spatially defined analytical results in the groundwater.	Of the COPCs concentration and/or strata characteristics in the appropriate units.		For groundwater within the geographic boundaries[a] over the next 0–3 years.	Are adequately known.[b]	Based on professional judgment of DOE, regulators, and contractor staff.	Gather no more data.	or	Gather additional data.
3	If Saturated Zone Model input.	As estimated by representative values.	Of the modeling input parameters measured in appropriate units.		For the soil and groundwater within the geographic boundaries[a] over the next 0–3 years.	Are adequately known.[b]	Based on professional judgment of DOE, regulators, and contractor staff.	Gather no more data.	or	Gather additional data.
4	If the total number of groundwater wells defines the horizontal and vertical distribution of COPCs in groundwater.	As estimated by spatially defined analytical results in the groundwater.	Of the COPCs in appropriate units.		For the groundwater within the geographic boundaries[a] over the next 0–3 years.	Are adequately known.[b]	Based on professional judgment of DOE, regulators, and contractor staff.	Gather no more data.	or	Gather additional data.
5	If additional data are required to make a phased remedial decision.	As determined by representative values.	Of the COPCs concentration and/or strata characteristics in the appropriate units.		For a specific groundwater COPC plume within the geographic boundaries[a] over the next 1–3 years.	Are not available for comparison.[b]	The operational requirements of the final remedial action alternatives.	Obtain additional data through treatability tests or other means as appropriate.	or	Choose remedial action.
6	If additional data are needed to evaluate future risk level in groundwater.	As estimated by measurement or modeling and approved risk assessment procedures.	Of the COPCs in pCi/L or µg/L.		For the groundwater within the geographic boundaries[a] over the next 0–3 years.	Is >.	The preliminary remediation goals.	Monitor and/or remediate.	or	Conduct only long-term monitoring.
7	If additional data are needed to redefine end states.	As estimated by analytical measurements.	Of the COPCs in pCi/L or µg/L.		For specific groundwater COPC plume within the geographic boundaries over the next 3+ years.	Are >.	The established remedial action objectives.	Continue to implement remedial alternative.	or	Cease remediation.
8	If additional data are needed to provide adequate groundwater table contour resolution.	As estimated by representative values.	Of the modeling input parameters measured in appropriate units.		For the groundwater within the geographic boundaries[a] over the next 0–3 years.	Are adequately known.[b]	Based on professional judgment of DOE, regulators, and contractor staff.	Gather no more data.	or	Gather additional data.
9	If well location and sampling frequencies are adequate.	As determined by the existing well network.	In the 200-PO-1 Groundwater OU.		For a specific groundwater contaminant plume within the geographic boundaries over the next 0–3 years.	Are ≥.	Minimum required by PNNL's geostatistical model.	Use existing wells to monitor remedial action.	or	Install additional monitoring wells and increase sampling frequency.
10	If transport modeling is supported by accurate knowledge of flow paths.	As estimated by representative values.	Of the modeling input parameters measured in appropriate units.		For the soil and groundwater within the geographic boundaries[a] over the next 0–3 years.	Are adequately known.[b]	Based on professional judgment of DOE, regulators, and contractor staff.	Gather no more data.	or	Gather additional data.

Table 5-2. Decision Rules for Each Decision Statement. (2 Pages)

DR No.	Population Parameter	Sample Statistic	Variable		Unit or Scale of Decision Making	Relationship	Action Level	AA No. 1	Relationship	AA No. 2
			Attribute	Unit of Measure						
11	If COPCs measured at source sites ensure timely warning of emerging threats.	As estimated by measurement or modeling and approved risk assessment procedures.	Of the COPCs in pCi/L or μg/L.		For the groundwater within the geographic boundaries[a] over the next 0–3 years.	Are >.	The preliminary remediation goals.	Increase sampling frequency, monitor and/or remediate.	or	Conduct only long-term monitoring.
12	If additional data are needed to evaluate potential risks to aquatic ecology.	As estimated by representative values from historical analytical and process data or through modeling source terms.	Of the COPCs estimated in pCi/L or other appropriate units.		In the groundwater within the geographic boundaries[a] over the next 0–3 years.	Are reliably known.[b]	Based on professional judgment of DOE, regulators, and contractor staff.	Gather no more data.	or	Gather additional data.

[a]Geographic boundaries are defined in Table 4-2 and consist of the near field, far field, and River Corridor zone groundwater OUs (Figure 1-2) that lie within the 200-PO-1 OU.
[b]These decisions require consideration of multiple inputs and professional judgment. There is no quantitative measurement level for a statistical comparison.

AA = alternative action.
DR = decision rule.
COPC = contaminant of potential concern.
OU = operable unit.
DOE = U.S. Department of Energy.
PNNL = Pacific Northwest National Laboratory.

6.0 STEP 6 – SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

Because analytical data only can estimate the true condition of the site under investigation, decisions made based on measurement data potentially could be in error (i.e., decision error). For this reason, the primary objective of DQO Step 6 is to determine if any DSs require a statistically based sample design. For this DQO, a number of programmatic DSs are formulated. These DSs result in several DRs that require professional judgment to assess the data for adequacy and determine what data are missing.

A total of 189 monitoring wells are routinely sampled within the 200-PO-1 Groundwater OU. New well locations that are proposed in Step 7 of this DQO are based on professional judgment to better define the COPCs from near-field waste sites, and to obtain more information along the Columbia River for risk assessment. The existing and proposed well locations are not statistically based. The locations are derived from COPC information published in annual groundwater-monitoring reports such as PNNL-16346, and characterization requirements for the baseline risk assessment and FS. SAPs for the proposed wells are described in the Characterization SAP (DOE/RL-2007-30).

Because all of the DSs for this DQO do not require traditional statistical calculations, tables defining the null hypothesis, alpha and beta error, and width of the gray region are excluded. The determination of whether additional wells are needed to adequately monitor remedial action will be based on geostatistical models. A statistical design for determining the success or failure of remedial action will not be part of this DQO. Table 6-1 connects the DSs from Table 2-1 to the sampling design basis. Chapter 7.0 of this document provides details of the sampling design and additional logic on the well locations.

Table 6-1. Statistical Versus Non-Statistical Sampling Design.

DS No.*	Time-Frame (Years)	Resampling Access (Accessible/Inaccessible)	Proposed Sampling Design Basis (Statistical/Non-Statistical)
1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12	0-3	Accessible	Non-statistical—Decisions will be based on analytical results over a period of time and/or through professional judgment.
7	3+	Accessible	To be done when final remedial action is chosen.

*See Table 2-1 for the exact meaning of each DS.

DR = decision statement.

This page intentionally left blank.

7.0 STEP 7 – OPTIMIZE THE DESIGN FOR OBTAINING DATA

The purpose of this step of the DQO process is to design a data collection program that makes best use of available resources while satisfying project objectives.

As discussed in Chapter 6.0, the population parameters shown in Table 6-1 are not amenable to statistical sampling. The 200-PO-1 Groundwater OU monitoring network design and future data collection will be based on using historical data and professional judgment.

Initial decisions will relate to sampling frequency and the configuration of the monitoring well network in order to support preparation of a Characterization SAP.

The purpose of this section is to define the sampling and analysis design to obtain the data identified in previous sections. Section 7.2 focuses on the design for obtaining different types of data from the existing monitoring well network, including current and proposed wells.

7.1 GEOGRAPHIC SCALE

In Chapter 4.0, it was suggested that the DRs be addressed on three geographic scales for near-field wells, far-field wells, and the River Transect and River Corridor wells. The three geographic scales represent three semi-independent studies. The focus and principal considerations for each of the geographic scales are discussed below.

7.1.1 Near-Field Wells

The near-field wells are those in the vicinity of the contaminant source areas as well as those downgradient to, and extending toward, the Southeast Transect wells. For purposes of this DQO, the main function of the near-field wells is to provide timely detection and characterization of emerging contaminant plumes.

An emerging plume may not intercept wells adjacent to a source area (e.g., RCRA TSD wells). As an emerging plume disperses laterally, downgradient wells may intercept it. Transport modeling will include longitudinal and lateral downgradient dispersion. The spacing of wells from source areas to the Southeast Transect wells could be evaluated with respect to dispersive broadening of plumes.

Finally, decisions regarding modification of the near-field monitoring network would benefit from additional understanding of preferential flowpaths. Surface geophysical methods (see Appendix F) could be considered as a means for elucidating geologic structure.

7.1.2 Far-Field Wells

Far-field wells include the Southeast Transect wells extending to the Columbia River. Contaminant and water-level data from these wells, and modeled predictions of future contaminant concentrations, provide two main benefits. First, present and future contaminant concentrations are the basis for making decisions regarding land use, long-term institutional controls, and remedial actions. Second, the models provide a means for predicting transport of contaminants into the Columbia River.

7.1.3 River Transect Wells and River Corridor Aquifer Tubes

The series of wells comprising the River Transect form a curtain, across which contaminants must flow before discharge to the river. This curtain extends from the water table to the bottom of the contaminated zone of the groundwater.

Given basic hydraulic information (e.g., hydraulic conductivity and gradient, depth interval) and COPC concentrations, it is possible to estimate mass transport across the River Transect curtain in the vicinity of a transect well. Several factors affect the estimate:

- Accuracy of the method used for measuring hydraulic conductivity
- Accuracy of gradient measurement
- Variation of COPC concentrations with depth
- Variation of hydraulic conductivity with depth.

Also, the sampling point density along the River Transect varies widely, so the area represented by any one well also varies widely. Finally, depth-discrete data typically are lacking for many well sites at the Hanford Site.

Adequacy of characterization of the River Transect may be the single most important facet of the project, because it offers the most direct method for estimating transport of contaminants from the 200-PO-1 Groundwater OU to the Columbia River and for independently corroborating results from the computer transport model.

The River Corridor aquifer tubes provide a last spatial detection for waste constituents that are migrating from the 200-PO-1 Groundwater OU to the Columbia River and that may affect the river biota.

7.2 MONITORING WELL CHARACTERIZATION AND SAMPLING DESIGN

A two-phased approach is planned to complete RI activities for the 200-PO-1 Groundwater OU (Table 7-1). This is to be incorporated with any geophysical and geotechnical information that already has been established.

Table 7-1. Summary of Phase I and Phase II Characterization Activities.

Characterization activities	All wells and frequencies shown in DOE/RL-2007-31, Appendix A, Tables A3-1 and A3-2	
Routine monitoring activities	All wells and frequencies shown in DOE/RL-2007-31, Appendix B, Tables 2-1 and 2-2	
Phase I		
Opportunistic Wells[b]	Area	Well Identification[a]
	PUREX	A-2
		A-5
		A-30
	BC Cribs	A
		C
		E
Planned aquifer tubes	River Corridor	10 sets of 3
Phase II		
	Area	Well Identification[a]
Opportunistic wells[b]	PUREX	A-7
Planned wells[c]	To be decided	A
		B
		C
		D

[a]Preliminary well identification is presented. Once wells are physically established, formal well names will be given.
[b]Opportunistic wells are wells that operable units outside of the 200-PO-1 Groundwater Operable Unit are proposing to drill. These wells offer an opportunity for supplemental data gathering.
[c]Planned wells are those that may be drilled in the 200-PO-1 Groundwater Operable Unit, but locations will depend on the data evaluation from Phase I.

DOE/RL-2007-31, *Remedial Investigation/Feasibility Study Work Plan for the 200-PO-1 Groundwater Operable Unit.*

PUREX = Plutonium-Uranium Extraction (Plant or process).

According to EPA/540/G-89/004, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*, OSWER 9355.3-01, the RI process serves as a mechanism for collecting data to characterize site conditions, determine the nature of the waste, and assess risk to human health and the environment. The FS continues to serve as the mechanism for the development, screening, and detailed evaluation of alternative remedial actions. Data collected in the RI influence the development of remedial alternatives in the FS. The various phases of the RI/FS process provide an iterative approach to data collection. Two concepts are essential to the phased RI/FS approach.

First, data generally should be collected in several stages, with initial data-collection activities usually limited to developing a general understanding of the site. Field sampling should be phased, so that the results of the initial sampling activities can be used to refine plans developed during scoping to better focus subsequent sampling activities. As a basic understanding of site characteristics is achieved, subsequent data collection activities focus on filling identified gaps in the understanding of site characteristics and gathering information necessary to evaluate remedial alternatives.

Second, this phased sampling approach encourages identification of key data needs as early in the process as possible to ensure that data collection is always directed toward providing information relevant to selection of a remedial action. In this way, the overall site characterization activity can be continually scoped to minimize the collection of unnecessary data and maximize data quality.

7.2.1 Well and Analyte Selection for Phase I and Phase II Characterization and Assessment in the 200-PO-1 Groundwater Operable Unit

Sections 7.2.2 through 7.2.3 explain details of the summary information that is provided in the following paragraphs. A total of 107 wells are selected for assessment in the 200-PO-1 Groundwater OU. These wells will enhance the lateral and depth discrete groundwater data that is necessary to determine the nature and extent of contamination in the aquifer. It is proposed that ten aquifer tubes be drilled in Phase I along the River Corridor. An aquifer tube consists of a set of three tubes emplaced at different depths vertically in one well casing. Each tube will be sampled for the 44 COPCs listed in Table 3-3.

In addition, six wells, three from the PUREX Area (A-2, A-5, and A-30) and three from the BC Cribs and Trenches Area (A, C, and E) will be opportunistically sampled in Phase I. One well (A-7) proposed for drilling in FY 2009 adjacent to the 216-A-7 Crib also will be opportunistically sampled in Phase II. Opportunistic wells are wells that are being drilled in other OUs, including waste sites that 200-PO-1 Groundwater OU task leads will collect samples from to acquire supplemental data.

Four wells (A, B, C, and D) will be installed within the 200-PO-1 Groundwater OU during Phase II. The specific locations of these four new wells are to be determined through the Phase I data collection activities.

The remaining 86 wells are existing wells that are to be added for assessment with the analytes and frequency of sampling shown in Appendix B, Figures B-1 and B-2.

The analytes chosen in Phase I and Phase II for analyses consist of two categories: routine monitoring analytes, and a list of 44 analytes. The routine monitoring analytes are constituents that are routinely monitored within 200-PO-1 Groundwater OU, and can be found in Appendix C, Tables C-1 and C-2. The list of 44 analytes presented in Table 3-3 consists of constituents that were designated as COPCs from the evaluation process presented in the above sections.

7.2.2 Phase I Near Field

Characterization of the 200-PO-1 Groundwater OU will be conducted in two phases. Table 7-1 presents the characterization and routine summaries of Phase I and Phase II activities. The primary objectives for Phase I are to collect data on groundwater contaminants, acquire geophysical data to estimate vertical and lateral extent of contamination, and to refine or confirm preferred contaminant pathways. In addition, a detailed evaluation of existing monitoring data will be conducted to assess data needs to determine preliminary fate and transport of analytes in 200-PO-1 Groundwater OU.

Groundwater and geophysical data will be acquired during Phase I. Data will be gathered in order to provide information on depth of contaminants in the aquifer, provide information on stratigraphy, define the extent of chromium plume, assess flow direction and hole deviations, and determine depth-to-water measurements. Within Phase I, the use of existing transducer equipment in a few chosen near-field wells also will be considered.

Groundwater grab samples will be collected from seven new opportunistic waste-site borings in 200-PO-1 Groundwater OU that intercept the water table. Opportunistic wells allow integration with other OUs. Samples will be collected from boreholes and analyzed for the 44 COPCs that are being drilled in other OUs. The purpose of these samples is to better define the nature and extent of contamination and contaminant movement deep in the aquifer. The geophysical data acquired will provide information helpful for future fate and transport modeling and help locate preferential pathways for contaminant movement.

7.2.2.1 PUREX

A vadose zone well within the PUREX Area (299-E24-23) was drilled adjacent to the 216-A-4 Crib (see Figure 7-1). This well was deepened to 14 m (46 ft) below top of groundwater and was sampled for the full 44 COPCs (see Table 3-3). Sediments were sampled for geochemical and geotechnical parameters required for modeling and remedial evaluation. This well assesses whether the COPCs have moved deep in an area known for high contamination.

Three wells (A-2, A-5, and A-30) are scheduled to be drilled in the 216-A-2, 216-A-5, and 216-A-30 Crib areas, respectively (Figures 7-1 and 7-2) during Phase I. These wells will be opportunistically sampled for the constituents presented in Appendix B, Figures B-1 and B-2. The plan is to extend these wells to basalt and sample for the full 44 COPCs semiannually. The sediments also will be sampled for geochemical and geotechnical parameters required for modeling and remedial evaluation. These wells will help assess whether COPCs have moved deep in the aquifer in a known area of high contamination.

The results of the data from these wells coupled with the results from the electrical resistivity characterization being conducted will assist in characterization of the area surrounding the 216-A-36B and 216-A-37-1 Cribs.

This page intentionally left blank.

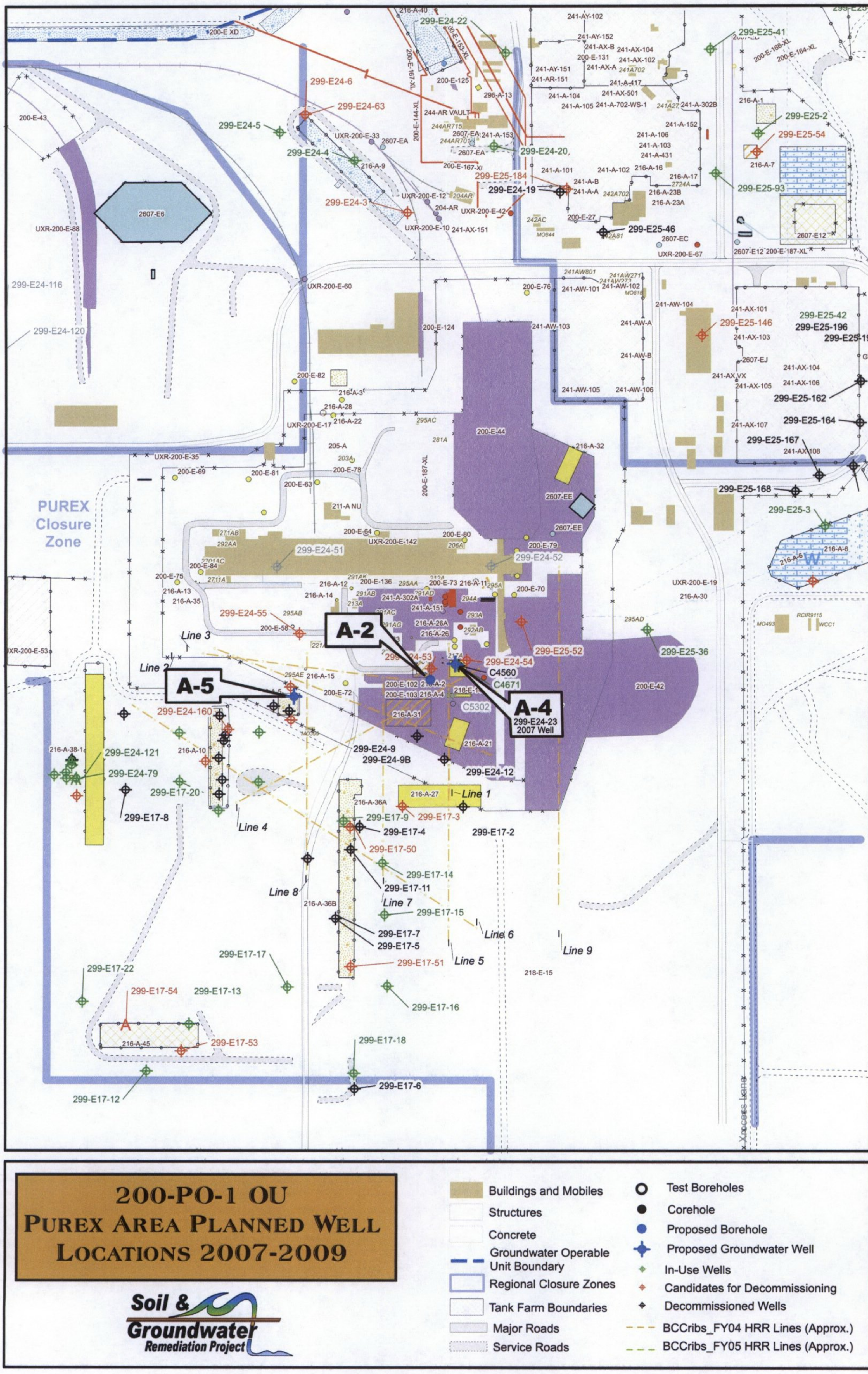
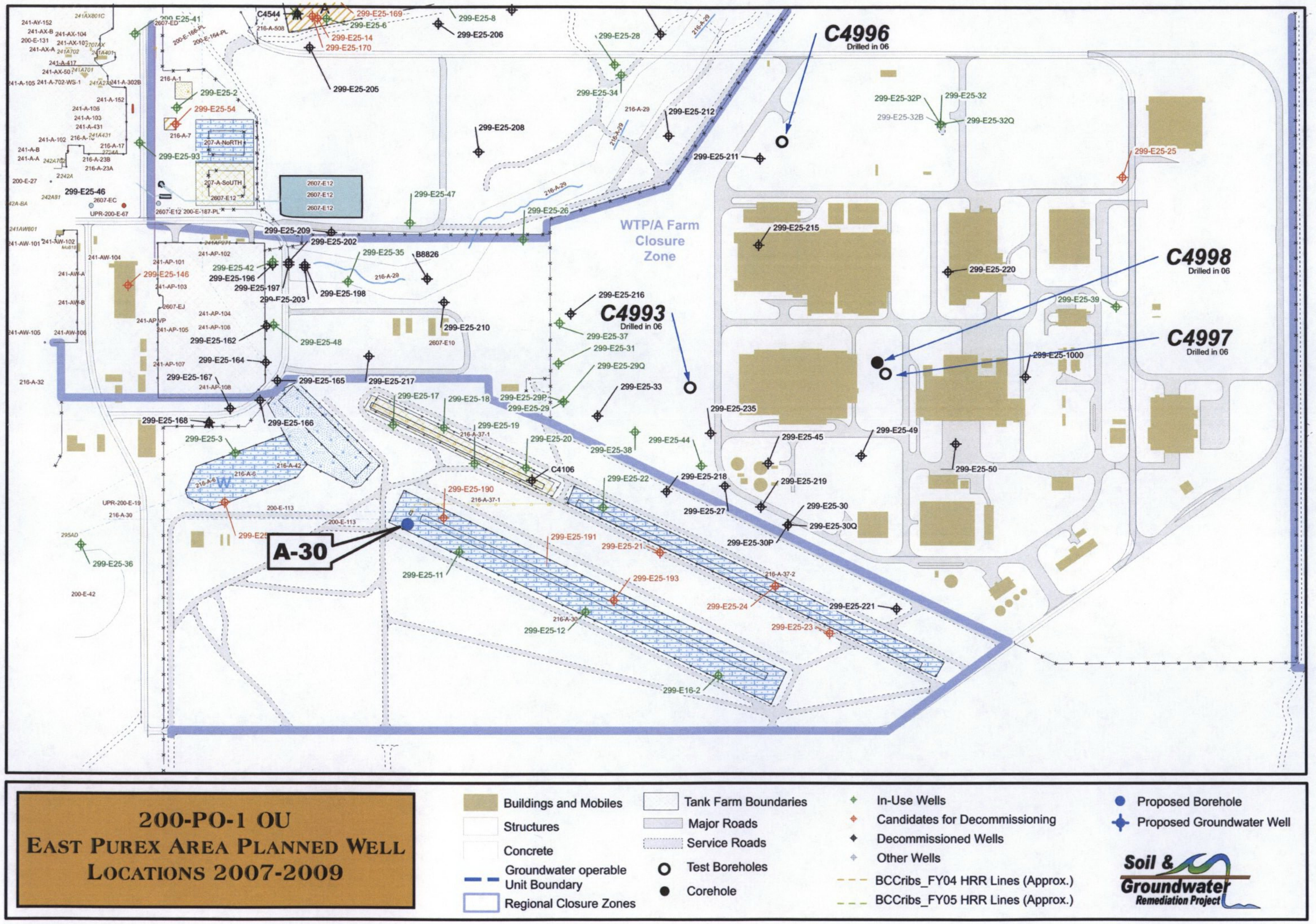


Figure 7-1. Location of Wells (A-2, A-4, and A-5) in the PUREX Area to be Opportunistically Sampled for 200-PO-1 Groundwater Operable Unit Analytes.

Figure 7-2. Location of Well A-30 in the PUREX Area to be Opportunistically Sampled for 200-PO-1 Groundwater Operable Unit Analytes.



All wells chosen for sampling within the PUREX area will have alkalinity and ammonium (RCRA constituents) added to the COPCs as noted on well tables provided in Appendix B, Figures B-1 and B-2.

7.2.2.2 BC Cribs and Trenches

A previous assessment of the capability of the BC Cribs and Trenches wells determined that the wells chosen are accessible and producing water. Twelve wells in the area will be sampled once using the routine SAP constituents. If any constituent exceedances are exhibited, the well will be sampled once more. The analytical results will be reviewed from new borings where groundwater samples are collected to determine whether added groundwater wells are needed and to assess whether any contamination has reached groundwater. Three planned borings in the BC Crib and Trenches Area (A, C, and E) shown in Figure 7-3 will be opportunistically sampled for the full 44 analytes listed in Table 3-3. Additional borings B, D, C4732, and C4733 also are shown in Figure 7-2. These are proposed by the BC Crib Waste Site OU, and are outside the scope of this DQO summary report.

7.2.2.3 Phase I Far-Field Tasks

Far-field is defined as the areas concerning TEDF, B Ponds, NRDWL, Solid Waste Landfill, 400 Area wells, Southeast Transect wells, and the River Transect and River Corridor wells. These wells will be used to collected data on groundwater contaminants, acquire geophysical data to estimate vertical and lateral extent of contamination, and refine or confirm preferred contaminant pathways.

7.2.2.4 River Transect Wells

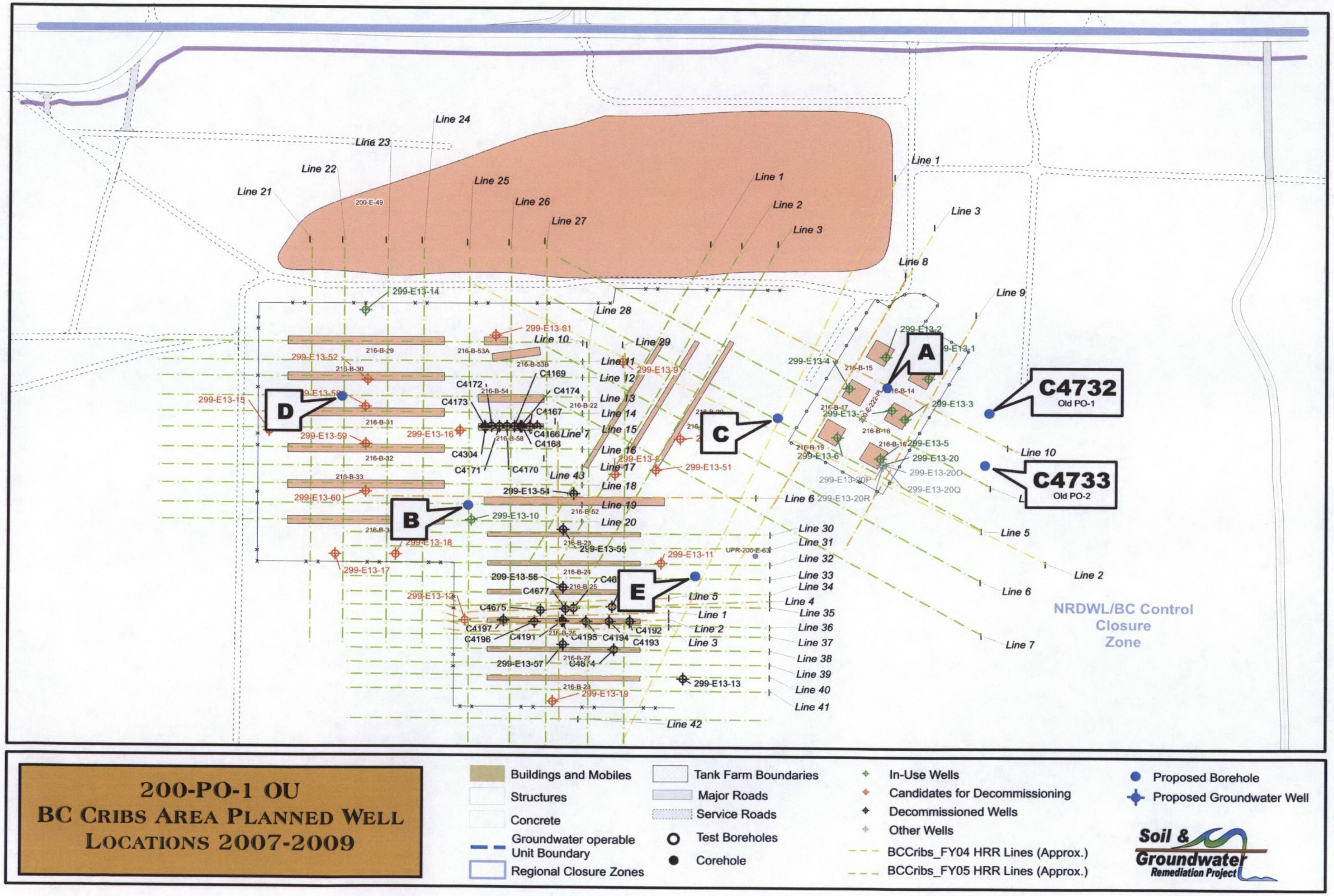
Five existing River Transect wells were chosen for sampling and analysis. These wells will have all 44 COPCs analyzed annually. These analyses will determine the extent of contamination for the purposes of risk assessment along the river.

7.2.2.5 Southeast Transect Wells

Nine existing wells were chosen along the Southeast Transect. These wells will have all 44 COPCs analyzed annually.

This page intentionally left blank.

Figure 7-3. Location of BC Crib Wells (A, C, and E) to be Opportunistically Sampled for 200-PO-1 Groundwater Operable Unit Analytes.



7.2.2.6 Aquifer Tubes

Ten aquifer tube stations (each station is three vertical tubes) will be installed and sampled along the river (Figure 7-4). Each set of three will be vertically placed within the upper, middle, and lower aquifer. The purpose of these new aquifer tubes is to acquire contaminant data within a geographic area that has not been acquired thus far and is needed for risk assessment, especially for an ecological risk assessment. Coordinates of each set will be taken and markers placed within substrate for ease of relocating. More tubes may be added in Phase II if the information from the geophysical characterization suggests so.

7.2.2.7 Candidate Wells

Forty-three candidates for decommissioning wells were selected to be evaluated for sampling utility. Any wells that are open and reasonably deep will be at a minimum logged. If the candidate well is open and has water, the well will be logged and a grab sample will be taken before decommissioning. If it is determined that the utility of each well on the list is available for sampling, then each well will be sampled once for the 44 constituents listed in Table 3-3. If any constituent exhibits exceedances, the well will be sampled once more. In addition, if the wells are capable of being sampled, gradient and head data could be collected using a gyroscope to quantify water-table data. It should be noted that the candidate for decommissioning wells that have been chosen for sampling may change as data become available on sampling utility (e.g., water availability and physical access) and as other wells are placed on the candidate list.

7.2.2.8 NRDWL

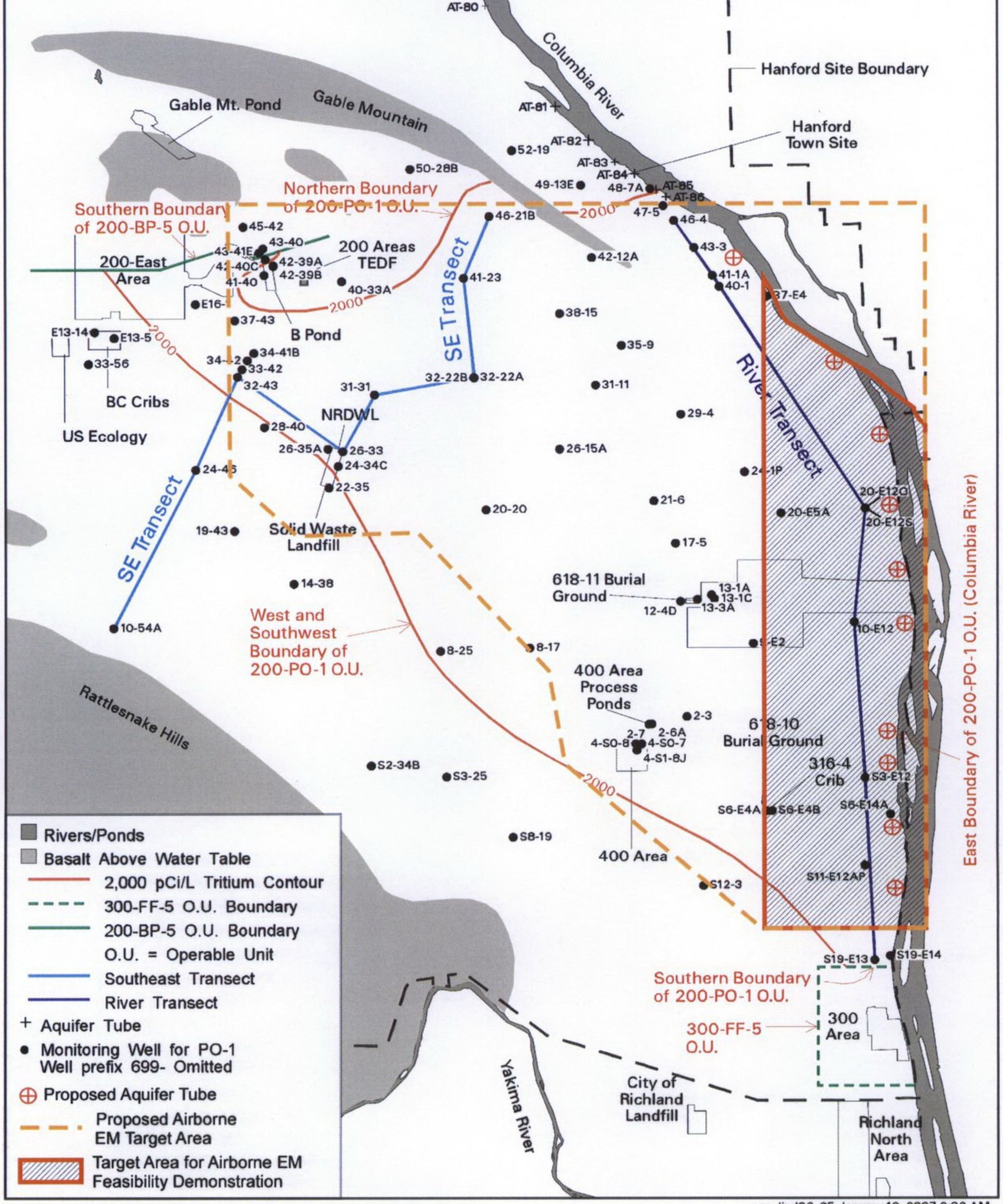
Samples will be collected to evaluate geophysical results to determine preferential pathways. Data from RCRA wells will be evaluated.

7.2.3 Phase II

Phase II objectives are to evaluate Phase I results, including collecting and evaluating additional data as they come in, to accomplish Phase I objectives and to conduct a baseline risk assessment.

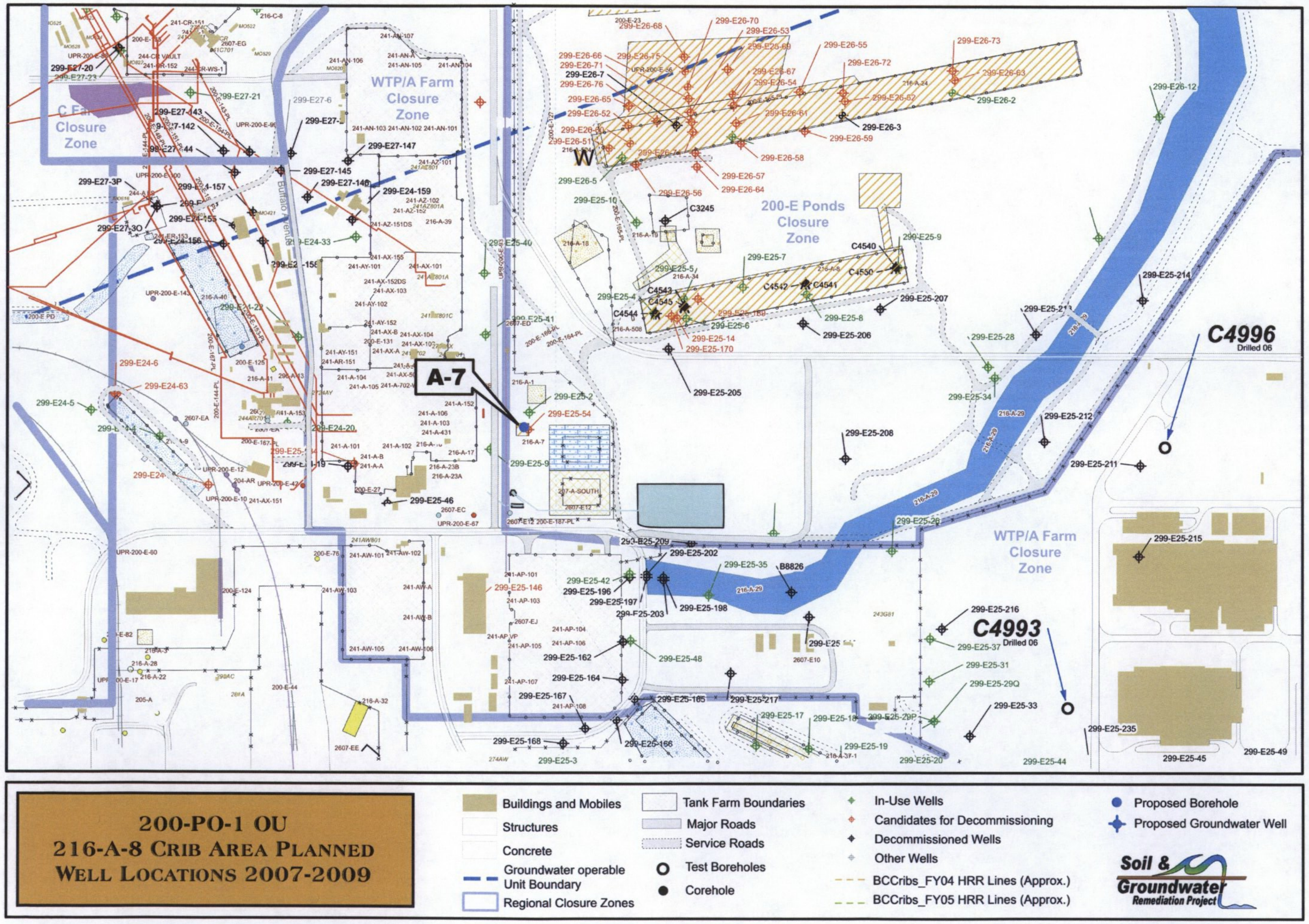
An opportunistic well (A-7) within the 216-A-7 Crib area has been selected for analysis in Phase II (see Figure 7-5). Up to four new wells will be installed in the 200-PO-1 Groundwater OU during Phase II.

Figure 7-4. Aquifer Tube Locations.



can_lind06_05 January 10, 2007 9:32 AM

Figure 7-5. Location of PUREX Well (A-7) Adjacent to 216-A-7 Crib to be Opportunistically Sampled for 200-PO-1 Analytes.



7.3 200-PO-1 GROUNDWATER OPERABLE UNIT ROUTINE MONITORING WELL NETWORK

Table C-1 of Appendix C presents the analyses to be performed on samples collected from individual wells in the modified groundwater-monitoring well network, and the frequency at which samples will be collected for analytical testing. Twenty-eight of the existing routine monitoring wells will be sampled annually for the 44 COPCs.

Newly installed wells and replacement wells are to be sampled semiannually during the first year after installation. Annual sampling is proposed for perimeter wells with stable concentrations for several years. The sampling frequency may be decreased for wells with stable COPC concentrations. If irregular or increasing trends appear, the sampling frequency may be increased.

7.3.1 Additional Contaminant of Potential Concern Monitoring Strategy

COPCs beyond those presently analyzed in the current well-monitoring network were identified in Chapter 1.0. The implementation strategy to obtain information regarding these additional COPCs is to sample specific wells in high-concentration areas of the plumes and/or at wells immediately downgradient from selected waste sites. The results of the initial sampling will be evaluated and if the COPCs are detected above MCLs, a subsequent sampling plan will be developed. If new COPCs are not detected, appropriate wells could be sampled at 5-year intervals thereafter depending on professional judgment. Figures B-1 and B-2 in Appendix B present the wells chosen for sampling. These wells will be analyzed for all of the COPCs according to the methods shown in Table 3-4.

7.3.2 Supplemental Data

The data resulting from the implementation of this DQO may be supplemented by information from other groundwater investigations. This supplemental information includes, but is not limited to, the following:

- Sampling and analysis activities required to monitor sites under RCRA
- Water level, pH, temperature, and conductivity measurements
- Hydrologic testing
- Dense, nonaqueous-phase liquid investigations
- Quality assurance activities (e.g., Washington State Department of Health co-sampling)
- Possible research activities.

These supplemental data may be used to help refine the CSM and to provide information on contaminant movement through the vadose zone. Wells providing supplemental information for the 200-PO-1 Groundwater OU network and the primary sampling purpose for each of these wells are presented in Appendix B.

7.3.3 Modeling Input Parameters

The modeling input parameters that were identified in Table 3-1 will be evaluated on selected wells within the 200-PO-1 Groundwater OU. Well A-7 is proposed for drilling in Phase II. The well is proposed for deepening, depth-discrete sampling, and analysis for the 44 COPCs. Deep wells will extend to approximately the top of the Ringold lower mud unit, a depth of 37 to 61 m (120 to 200 ft) below the top of the water table. The wells will be sampled at approximately 9 m (30-ft) intervals. Final depth will be determined on a well by well basis with DOE concurrence. Wells will be completed to screen the upper portion of the aquifer unless higher concentrations of contaminants are found at a deeper interval. In the latter case, RL will be consulted on the interval to be screened. The data from these wells will allow more accurate modeling of plume movement and knowledge of the extent of vertical COPC distribution.

7.3.4 Sampling Design for Hanford Site Science and Technology Research and Support

PNNL Science and Technology and Fluor Hanford staff are evaluating the need for samples to support science and technology. The groundwater project is anticipating a need for the samples described below in the contaminated groundwater plume.

A study of geochemical process involved in the contaminant plume saturated zone would require as many as five 2 to 5 kg (4.4- to 11-lb) soil samples obtained from the near source, middle, and distal regions of the contaminated groundwater plume. These samples would be collected during the drilling of proposed wells A-4, A-30, and A-5 (refer to Appendix B).

This distribution of samples would allow determination of the following:

- Retardation processes and absorbed/dissolved contaminant inventories in groundwater.
- The kinetics of solid-liquid redistribution phenomena controlling migration and influencing potential remediation efficiency.

A combination of microscopic contaminant characterization with advanced radiochemical, microscopic, and analytical techniques, and kinetic studies of desorption/dissolution rate will provide information necessary to assess the long-term behavior of contaminants in the vadose zone and contaminated groundwater at the 200-PO-1 Groundwater OU.

8.0 REFERENCES

40 CFR 141, "National Primary Drinking Water Regulations," Title 40, *Code of Federal Regulations*, Part 141.

40 CFR 141.66, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels for Radionuclides," Title 40, *Code of Federal Regulations*, Part 141.66.

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Title 40, *Code of Federal Regulations*, Part 300.

40 CFR 430, "Remedial Investigation/Feasibility Study and Selection of Remedy," Title 40, *Code of Federal Regulations*, Part 430.

64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)," *Federal Register*, Vol. 64, No. 218, pp. 61615-61625, November 12, 1999. Available on the Internet at http://www.epa.gov/EPA-IMPACT/1999/November/Day-12/i29325.htm .

Agency for Toxic Substances and Disease Registry (ATSDR) database, at http://www.atsdr.cdc.gov/mrls.html .

Atomic Energy Act of 1954, 42 USC 2011, et seq.

BHI-01103, 1999, *Clastic Injection Dikes of the Pasco Basin and Vicinity*, Bechtel Hanford, Inc., Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.

CP-15329, 2003, *Data Quality Objectives Summary Report for Establishing a RCRA/CERCLA/AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

CP-16151, 2003, *Data Quality Objectives Summary Report Supporting the 200-ZP-1 Operable Unit Remedial Investigation/Feasibility Study Process*, Fluor Hanford, Inc., Richland, Washington.

D&D-27257, 2006, *Data Quality Objectives Summary Report for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit*, Rev. 0 Reissue, Fluor Hanford, Inc., Richland, Washington.

D&D-28283, 2006, *Sampling and Analysis Instruction for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit*, Rev. 0 Reissue, Fluor Hanford, Inc., Richland, Washington.

DOE/EIS-0189, 1996, *Final Environmental Impact Statement for the Tank Waste Remediation System, Hanford Site, Richland, Washington*, U.S. Department of Energy, Washington, D.C.

DOE/EIS-0222-F, 1999, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, U.S. Department of Energy, Washington, D.C.

DOE/ORP-2005-01, 2006, *Initial Single-Shell Tank System Performance Assessment for the Hanford Site*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-91-40, 1991, *Hanford Past-Practice Strategy*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-91-52, 1992, *U Plant Source Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-92-04, 1993, *PUREX Plant Source Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-92-05, 1993, *B Plant Source Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-92-18, 1993, *Semiworks Plant Source Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-92-19, 1993, *200 East Groundwater Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-92-23, 1992, *Hanford Site Groundwater Background*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-95-73, 2002, *Operation and Maintenance Plan for the 300-FF-5 Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-95-100, 1997, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-96-17, 2002, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-96-59, 1996, *200-PO-1 Permit Modification*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-96-66, 1997, *RCRA Facility Corrective Measures Study for the 200-PO-1 Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-99-07, 2000, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-99-66, 2004, Steam Condensate/Cooling Water Waste Group Operable Units RI/FS Work Plan; Includes: 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2000-60, 2004, *Uranium-Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan; Includes 200-PW-2 and 200-PW-4 Operable Units*, Rev. 1, Reissue, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2001-01, 2004, *Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit RI/FS Work Plan, Includes: 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*, Rev. 0, Reissue, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2001-66, 2002, *Chemical Laboratory Waste Group Operable Units RI/FS Work Plan, Includes: 200-LW-1 and 200-LW-2 Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2002-11, 2002, *300-FF-5 Operable Unit Sampling and Analysis Plan*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2003-04, 2005, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-39, 2004, *200-UR-1 Unplanned Release Waste Group Operable Unit Remedial Investigation/Feasibility Study Work Plan and Engineering Evaluation/Cost Analysis*, Rev. 0, Reissue, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-66, 2005, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2005-61, 2006, *Remedial Investigation Report for the 200-LW-1 (300 Area Chemical Laboratory Waste Group) and 200-LW-2 (200 Area Chemical Laboratory Waste Group) Operable Units*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland Washington.

DOE/RL-2005-62, 2006, *Remedial Investigation Report for the 200-MW-1 Miscellaneous Waste Group Operable Unit*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2005-73, 2005, *Phase I Sampling and Analysis Plan for the 200-IS-1 and 200-ST-1 Operable Units*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2007-30, pending, *Sampling and Analysis Plan for Characterizing the 200-PO-1 Groundwater Operable Unit*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2007-31, pending, *Remedial Investigation/Feasibility Study Work Plan for the 200-PO-1 Groundwater Operable Unit*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, 2005, *Cleanup Levels & Risk Calculations (CLARC)* database, available on the Internet at https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx

Ecology, EPA, and DOE, 2002, *Modify Tri-Party Agreement Milestone Series M-015 in Accordance with the Central Plateau Agreement In Principle, Tri-Party Agreement Change Request, M-015-02-01,* Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Drummond, M. E., 1992, *The Future for Hanford: Uses and Cleanup, The Final Report of the Hanford Future Site Uses Working Group*, Richland, Washington.

Ecology, 2005, *Cleanup Levels & Risk Calculations (CLARC)* database. Available on the Internet at https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx .

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington, as amended.

EPA, *Integrated Risk Information System* (IRIS) database, a database available through the EPA National Center for Environmental Assessment (NCEA), U.S. Environmental Protection Agency, Washington, D.C. Available on the Internet at http://www.epa.gov/iris/index.html .

EPA, 2005, "Use of Alternate Concentration Limits (ACLs) in Superfund Cleanups," Memorandum, OSWER 9200.4-39, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. Available on the Internet at http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/aclmemo.pdf .

EPA/240/B-06/001, 2006, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C.

EPA/540/G-89/004, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*, OSWER 9355.3-01, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA/600/R-94/111, 1994, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*, U.S. Environmental Protection Agency, Washington, D.C.

EPA/600/4-79/020, 1983, *Methods of Chemical Analysis of Water and Wastes*, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio.

EPA/ROD/R10-95/100, 1995, *Declaration of the Interim Record of Decision for the Environmental Restoration Disposal Facility*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available on the Internet at http://www.epa.gov/superfund/sites/rods/fulltext/r1095100.pdf .

HAB 40, 1995, "Hanford Site Wide Ground Water Remediation Strategy (HAB Advice #40)," (letter to C. Clarke, U.S. Environmental Protection Agency; M. Riveland, Washington State Department of Ecology; J. Wagoner, U.S. Department of Energy, Richland Operations Office, from M. B. Reeves), Hanford Advisory Board Consensus Advice #40, Richland, Washington, February 2.

HAB 132, 2002, "Exposure Scenarios Task Force on the 200 Area," (letter to K. Klein, H. Boston, J. Iani, and T. Fitzsimmons from T. Martin), Hanford Advisory Board Consensus Advice #132, Richland, Washington, June 7.

Hanford Environmental Information System, Hanford Site database.

Klein, K. A., D. R. Einan, and M. A Wilson, 2002, "Consensus Advice #132: Exposure Scenarios Task Force on the 200 Area," (letter to Mr. Todd Martin, Hanford Advisory Board, from Keith A. Klein, U.S. Department of Energy; David R. Einan, U.S. Environmental Protection Agency; and Michael A. Wilson, State of Washington, Department of Ecology, 02-HAB-0006), Richland, Washington, July 11.

NAVD88, 1988, *North American Vertical Datum of 1988*, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland.

NBS Handbook 69, 1963, *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air or Water for Occupational Exposure*, U.S. National Bureau of Standards, Washington, D.C.

PNNL-11800, 1998, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-12261, 2001, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-14027, 2002, *An Initial Assessment of Hanford Impact Performed with the System Assessment Capability*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-14049, 2002, *Data Quality Objectives Summary Report – Designing a Groundwater Monitoring Network for the 200-BP-5 and 200-PO-1 Operable Units*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-15070, 2005, *Hanford Site Groundwater Monitoring for Fiscal Year 2004*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-15479, 2005, *Groundwater Monitoring Plan for the Hanford Site 216-B-3 Pond RCRA Facility*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-16346, 2007, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*, Pacific Northwest National Laboratory, Richland, Washington.

Resource Conservation and Recovery Act of 1976, 42 U. S. C. 6901 et seq.

RPP-14430, 2003, *Subsurface Conditions Description of the C and A-AX Waste Management Area*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

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

Stoller Log Data Reports, Reports for Individual Wells Available from Hanford 200 Areas Vadose Zone Characterization Project, U.S. Department of Energy, Grand Junction Office, Grand Junction, Colorado.

SW-846, 2005, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-B*, as amended, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available on the Internet at www.epa.gov/SW-846/main.htm .

US Ecology, 2006, *Annual Environmental Monitoring Report for Calendar Year 2005*, US Ecology, Inc., Richland, Washington.

WA7890008967, 2004, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8, for the Treatment, Storage, and Disposal of Dangerous Waste,* Washington State Department of Ecology, Richland, Washington, as amended.

WAC 173-304-490(2)d, "Minimum Functional Standards for Solid Waste Handling," "Groundwater Monitoring Requirements," "Groundwater Monitoring Requirements," "Sample Constituents," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340, "Model Toxics Control Act -- Cleanup," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-707, "Model Toxics Control Act -- Cleanup," "Analytical Considerations," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-720(4), "Ground Water Cleanup Standards," "Method B Cleanup Levels for Potable Ground Water," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WMP-18647, 2004, *Historical Site Assessment of the Surface Radioactive Contamination of the BC Controlled Area*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

WMP-25924, 2005, *Data Quality Objectives Summary Report for the Installation of One Groundwater Well in the 300-FF-5 Operable Unit*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

WMP-28945, 2007, *Data Quality Objectives Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study Process*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

This page intentionally left blank.

APPENDIX A

BIBLIOGRAPHY OF EXAMINED DOCUMENTS

This page intentionally left blank.

APPENDIX A

BIBLIOGRAPHY OF EXAMINED DOCUMENTS

CP-15329, 2003, *Data Quality Objectives Summary Report for Establishing a RCRA/CERCLA/AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

D&D-28283, 2006, *Sampling and Analysis Instruction for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit*, Rev. 0 Reissue, Fluor Hanford, Inc., Richland, Washington.

DOE/RL-92-04, 1993, *PUREX Plant Source Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-92-17, 1993, *200 North Aggregate Area Source AAMS Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-92-19, 1993, *200 East Groundwater Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-95-100, 1996, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-96-59, 1996, *200-PO-1 Permit Modification*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-96-66, 1997, *RCRA Facility Corrective Measure Study for the 200-PO-1 Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-98-28, 1999, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-99-07, 2000, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2000-60, 2004, *Uranium-Rich/General Process Condensate and Process Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan; Includes 200-PW-2 and 200-PW-4 Operable Units*, Rev. 1, Reissue, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2001-01, 2004, *Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit RI/FS Work Plan, Includes: 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*, Rev. 0, Reissue, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2001-66, 2002, *Chemical Laboratory Waste Group Operable Units RI/FS Work Plan, Includes: 200-LW-1 and 200-LW-2 Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2002-11, 2002, *300-FF-5 Operable Unit Sampling and Analysis Plan*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-17, 2004, *Remedial Investigation Report for the 200-CS-1 Chemical Sewer Group Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-18, 2004, *Waste Control Plan for the 200-PO-1 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-24, 2004, *Feasibility Study for the 200-CW-5 (U Pond/Z Ditches Cooling Water Waste Group), 200-CW-2 (S Pond and Ditches Cooling Water Waste Group), 200-CW-4 (T Pond and Ditches Cooling Water Waste Group), and 200-SC-1 (Steam Condensate Waste Group) Operable Units*, Draft A, Reissue, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-39, 2004, *200-UR-1 Unplanned Release Waste Group Operable Unit Remedial Investigation/Feasibility Study Work Plan and Engineering Evaluation/Cost Analysis*, Rev. 0, Reissue, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-66, 2005, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-69, 2005, *Proposed Plan for the BC Cribs and Trenches Area Waste Sites*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington

DOE/RL-2005-73, *Tanks/Lines/Pits/Boxes/Septic Tank and Drain Fields RI/FS Work Plan and RCRA TSD Unit Sampling; Includes 200-IS-1 and 200-ST-1 Operable Units*, Decisional Draft, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2006-50, 2007, *200-UR-1 Unplanned Release Waste Group Operable Unit Sampling and Analysis Plan*, Rev. 0 REISSUE, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

PNNL-14049, 2002, *Data Quality Objectives Summary Report – Designing a Groundwater Monitoring Network for the 200-BP-5 and 200-PO-1 Operable Units*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-15127, 2005, *Contaminants of Potential Concern in the 300-FF-5 Operable Unit: Expanded Annual Groundwater Report for Fiscal Year 2004*, Pacific Northwest National Laboratory, Richland, Washington.

RPP-14430, 2003, *Subsurface Conditions Description of the C and A-AX Waste Management Area*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

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

WHC-SD-EN-TI-019, 1992, *Hydrogeologic Model for the 200-East Groundwater Aggregate Area*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WMP-28945, 2007, *Data Quality Objectives Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study Process*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

This page intentionally left blank.

APPENDIX B

WELL SELECTION FOR CHARACTERIZATION SAMPLING AND ANALYSIS PLAN

This page intentionally left blank.

Figure B-1. Sampling and Analysis for Wells in the 200-PO-1 Groundwater Operable Unit.

			Metals											VOCs & SVOCs																Radiological										Pesticides				Anions			Supporting Parameters							Supporting Constituents											
Geographic Area	200-PO-1 Well Identification	Sampling Frequency	Antimony	Arsenic	Cadmium	Chromium	Lead	Manganese	Nickel	Thallium	Uranium	Vanadium	Zinc	1,1,2,2-Tetrachloroethane	1,2-Dichloroethane	1,4-Dioxane	Benzene	Bromodichloromethane	Carbon tetrachloride	Dibromochloromethane	Hexane	Methylene chloride	Tetrachloroethene	Trichloroethene	Vinyl chloride	2,4-Dinitrophenol	Bis (2-ethylhexyl) phthalate	Nitrobenzene	Pentachlorophenol	Gross alpha	I-129	Np-237	Pa-231	Se-79	Sr-90	Tc-99	Tritium	U-234	U-238	Dieldrin	Dimethoate	Heptachlor	Heptachlor epoxide	Fluoride	Nitrate	Nitrite	Specific conductance	Temperature	Turbidity	DO	Alkalinity	pH	Water level	Ammonium	Hexavalent chromium	Cyanide	Co-60	Total Organic Carbon	Mercury	Anions (a)	Gross beta	Gamma	Total Organic Halides	Metals (b)	VOCs (c)
BC Crib	299-E13-11	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-12	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-14	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-16	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-17	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-10	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-19	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-4	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-5	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-6	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-8	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
BC Crib	299-E13-9	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
Near Field Basalt Confined Aquifer- Annual	299-E16-1	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
PUREX shallow unconfined- Annual	299-E17-14	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					X			X											
IDF RCRA site well	299-E17-21	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
	299-E24-3	Single Sample		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
PUREX Area	299-E24-23	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Down gradient WTP A-AX and A-29 Ditch	299-E25-25	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
	299-E25-39	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
A-AX Tank Farm	299-E25-93	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
400 Area screened lower than adjacent wells	499-S1-8J	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
River transect TUC	699-10-E12	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-10-54A	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Far field Basalt Confined aquifer	699-13-1C	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
River transect	699-20-E12O	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Far field Basalt Confined aquifer	699-24-1P	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-24-46	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect LPU	699-25-33A	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-26-33	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-31-31	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-32-22A	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Far field Basalt Confined aquifer	699-32-22B	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-32-43	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
BC Cribs	699-33-56	Annually		X		X	X	X			X	X											X	X	X					X	X				X	X	X								X		X	X	X				X			X	X	X	X	X	X	X	X	X	X
River trenches TUC	699-41-1A	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-41-23	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Far field Basalt Confined aquifer	699-42-40C	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Southeast transect UUC	699-45-21B	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
River transect TUC	699-46-4	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Far field Basalt Confined aquifer	699-S11-E12AP	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
River transect TUC	699-S19-E13	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Far field Basalt Confined aquifer close to LIGO	699-S2-34B	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
River transect TUC	699-S3-E12	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
Opportunistic well PUREX Area	A-30	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
Opportunistic well PUREX Area	A-6	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
Opportunistic well PUREX Area	A-2	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
Opportunistic WMA A-AX Tank Farm Well	A-7	Unknown	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
Opportunistic BC Crib Area	A	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
Opportunistic BC Crib Area	C	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
Opportunistic BC Crib Area	E	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
New Well - TBD	A	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
New Well - TBD	B	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
New Well - TBD	C	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
New Well - TBD	D	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
Aquifer tubes (new) along river corridor																																																																		
1	AT-1U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-1M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-1L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
2	AT-2U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-2M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-2L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
3	AT-3U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-3M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-3L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
4	AT-4U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-4M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-4L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
5	AT-5U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-5M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-5L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
6	AT-6U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-6M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-6L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
7	AT-7U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-7M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-7L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
8	AT-8U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-8M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-8L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
9	AT-9U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-9M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-9L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
10	AT-10U	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-10M	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										
	AT-10L	Annually	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X										

(a) Anions include but are not limited to nitrate.
(b) Metals include but are not limited to chromium, manganese, and vanadium.
(c) VOCs - Analytes include but not limited to trichloroethene, 1,1-dichloroethene, 1,2-dichloroethene, tetrachloroethene, and vinyl chloride.
IDF = Integrated Disposal Facility
LIGO=Laser Interferometer Gravitational-Wave Observatory
LPU- lower permeability unit
RT- river transect
SET- south-east transect
TBD= to be decided
TUC= top of the unconfined aquifer
UUC= upper unconfined aquifer

Figure B-2. Sampling and Analysis for Candidate Wells in the 200-PO-1 Groundwater Operable Unit.

DRAFT DRAFT DRAFT

Candidate for Decommissioning Wells

Well Depths	Candidate Wells ID (a)	Sampling Frequency	Metals											VOCs & SVOCs															
			Antimony	Arsenic	Cadmium	Chromium	Lead	Manganese	Nickel	Thallium	Uranium	Vanadium	Zinc	1,1,2,2-Tetrachloroethane	1,2-Dichloroethane	1,4-Dioxane	Benzene	Bromodichloromethane	Carbon tetrachloride	Dibromochloromethane	Hexane	Methylene chloride	Tetrachloroethene	Trichloroethene	Vinyl chloride	2,4-Dinitrophenol	Bis (2-ethylhexyl) phthalate	Nitrobenzene	Pentachlorophenol
Unknown depth	299-E24-6	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Unknown depth	299-E25-21	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Unknown depth	299-E25-23	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Unknown depth	299-E25-24	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Unknown depth	699-10-30B	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Greater than 500 feet in depth	699-13-26	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Unknown depth	699-17-24	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Greater than 500 feet in depth	699-18-21	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
300-399 feet in depth	699-18-25A	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Greater than 500 feet in depth	699-19-23	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Unknown depth	699-20-E8	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Greater than 500 feet in depth	699-23-33	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Greater than 500 feet in depth	699-25-20	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Greater than 500 feet in depth	699-31-17	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Greater than 500 feet in depth	699-31-8	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
100-199 feet in depth	699-32-18	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Greater than 500 feet in depth	699-33-14	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Greater than 500 feet in depth	699-35-16	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
100-199 feet in depth	699-35-19B	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Greater than 500 feet in depth	699-36-17	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
100-199 feet in depth	699-37-E1	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Greater than 500 feet in depth	699-38-19	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Greater than 500 feet in depth	699-39-23	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Unknown depth	699-40-28	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
100-199 feet in depth	699-41-25	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
400-499 feet in depth	699-42-21	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
400-499 feet in depth	699-43-18	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-S6-E4C	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-S5-E16A	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-S5-E16B	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-S6-E4J	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-10-3A	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-12-1B	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-16-E3A	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-7-6	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-4-E16	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-13-E14	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-2-E14	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-15-E13	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-11-E10	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-S6-E14A	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-S5-16B	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	699-S6-E16B	Single Sample	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Candidate Wells ID (a)	Radiological										Pesticides				Anions			Supporting Parameters							Supporting Constituents											
	Gross alpha	I-129	Np-237	Pa-231	Se-79	Sr-90	Tc-99	Tritium	U-234	U-238	Dieldrin	Dimethoate	Heptachlor	Heptachlor epoxide	Fluoride	Nitrate	Nitrite	Specific conductance	Temperature	Turbidity	DO	Alkalinity	pH	Water level	Ammonium	Hexavalent chromium	Cyanide	Co-60	Total Organic Carbon	Mercury	Anions (b)	Gross beta	Gamma	Total Organic Halides	Metals (c)	VOCs (d)
299-E24-6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							X												
299-E25-21	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
299-E25-23	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
299-E25-24	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-10-30B	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-13-26	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-17-24	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-18-21	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-18-25A	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-19-23	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-20-E8	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-23-33	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-25-20	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-31-17	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-31-8	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-32-18	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-33-14	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-35-16	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-35-19B	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-36-17	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-37-E1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-38-19	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-39-23	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-40-28	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-41-25	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-42-21	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-43-18	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-S6-E4C	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-S5-E16A	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-S5-E16B	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-S6-E4J	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-10-3A	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-12-1B	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-16-E3A	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-7-6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-4-E16	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-13-E14	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-2-E14	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-15-E13	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-11-E10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-S6-E14A	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-S5-16B	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			
699-S6-E16B	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																			

(a) All wells that are candidates for decommissioning (CD) will be checked for sampling utility prior to decommissioning. If water is available a single grab sample will be taken prior to decommissioning. Wells can be added or removed from this list depending on the utility of sampling and the availibility of water.

(b) Anions include but are not limited to nitrate.

(c) Metals include but are not limited to chromium, manganese, and vanadium.

(d) VOCs - Analytes include but not limited to trichloroethene, 1 1-dichloroethene, 1,2-dichloroethene, tetrachloroethene, and vinyl chloride

APPENDIX C

ROUTINE SAMPLING AND ANALYSIS SCHEDULE

This page intentionally left blank.

Table C-1. Routine Monitoring Sampling and Analysis Schedule for 200-PO-1 Groundwater Operable Unit Near-Field Wells. (3 Pages)

Well ID	Well Number	Co-Sample	Comments	WAC Compliant	Contaminants of Concern							Supporting Constituents							
					Arsenic	Chromium, Manganese, and Vanadium (filtered)	Iodine-129	Nitrate	Strontium-90	Technetium-99	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Gross Beta	Metals[c]	Water Level[a]
A5878	299-E16-2			N/1960	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4730	299-E17-12			N/1986	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4731	299-E17-13			N/1986	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4732	299-E17-14	RCRA-PUREX		C	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4734	299-E17-16	RCRA-PUREX		C	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4736	299-E17-18	RCRA-PUREX		C	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4737	299-E17-19	RCRA-PUREX		C	A	A	A	A	A		A	A	A	A	A	A	A	A	A
C3827	299-E17-23	IDF		C	T	T	T	T			T	T	T	T	T	T	T	T	T
C3926	299-E17-25	IDF		C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4743	299-E18-1	IDF		C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4747	299-E23-1			N/1948	T	T	T	T			T	T	T	T	T	T	T	T	T
A4753	299-E24-18	RCRA-PUREX		C	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4756	299-E24-20	RCRA-A-AX		C	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
A5899	299-E24-5			N/1956	T	T	T	T			T	T	T	T	T	T	T	T	T
A6031	299-E25-17	RCRA-PUREX		N/1976	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4764	299-E25-18			N/1976	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4765	299-E25-19	RCRA-PUREX		N/1976	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4767	299-E25-20			N/1976	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A6032	299-E25-22			N/1983	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4773	299-E25-28	RCRA-A-29	Deep unconfined	N/1986	T	T	T	T			T	T	T	T	T	T	T	T	T
A4774	299-E25-29P		Piezometer	Y/1987	T	T	T	T			T	T	T	T	T	T	T	T	T
A4775	299-E25-29Q		Piezometer	Y/1987	T	T	T	T			T	T	T	T	T	T	T	T	T

Table C-1. Routine Monitoring Sampling and Analysis Schedule for 200-PO-1 Groundwater Operable Unit Near-Field Wells. (3 Pages)

Well ID	Well Number	Co-Sample	Comments	WAC Compliant	Contaminants of Concern							Supporting Constituents							
					Arsenic	Chromium, Manganese, and Vanadium (filtered)	Iodine-129	Nitrate	Strontium-90	Technetium-99	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Gross Beta	Metals[c]	Water Level[d]
A6024	299-E25-3			N/1954	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4779	299-E25-32P	RCRA-A-29	Piezometer	C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4780	299-E25-32Q		Piezometer	C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4782	299-E25-34	RCRA-A-29		C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4783	299-E25-35	RCRA-A-29		C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4784	299-E25-36			C	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4785	299-E25-37			C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4790	299-E25-41	RCRA-A-AX		C	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
A4791	299-E25-42	RCRA-A-AX		C	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
A4792	299-E25-43			C	T	T	T	T			T	T	T	T	T	T	T	T	T
A5448	299-E25-44			C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4794	299-E25-47			C	T	T	T	T			T	T	T	T	T	T	T	T	T
A4796	299-E25-6			N/1956	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A4804	299-E26-4			N/1958	A	A	A	A	A		A	A	A	A	A	A	A	A	A
B2822	699-37-47A	RCRA-PUREX		C	A	A	A	A	A		A	A	A	A	A	A	A	A	A
A5150	699-39-39			N/1970	T	T	T	T			T	T	T	T	T	T	T	T	T
A5170	699-42-41			C	T	T	T	T			T	T	T	T	T	T	T	T	T
A5171	699-42-42B	RCRA-B Pond	Confined Ringold	C	T	T	T	T			T	T	T	T	T	T	T	T	T
A5179	699-43-43			C	T	T	T	T			T	T	T	T	T	T	T	T	T

Table C-1. Routine Monitoring Sampling and Analysis Schedule for 200-PO-1 Groundwater Operable Unit Near-Field Wells. (3 Pages)

Well ID	Well Number	Co-Sample	Comments	WAC Compliant	Contaminants of Concern							Supporting Constituents							
					Arsenic	Chromium, Manganese, and Vanadium (filtered)	Iodine-129	Nitrate	Strontium-90	Technetium-99	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Gross Beta	Metals[c]	Water Level[a]
A5180	699-43-45	RCRA-A-29, B Pond		C	T	T	T	T			T	T	T	T	T	T	T	T	T
A5185	699-44-39B	RCRA-B Pond	C	T	T	T	T			T	T	T	T	T	T	T	T	T	

[a]Field measurement.
[b]Anions - Analytes include but not limited to nitrate.
[c]Metals - Analytes include but not limited to chromium, manganese, and vanadium.
A = To be sampled annually.
C = Well construction is compliant with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," resource protection requirements.
N = Well construction is not compliant with WAC 173-160 resource protection requirements.
T = To be sampled triennially (next scheduled in fiscal year 2007).

ID = identification.
IDF = Integrated Disposal Facility.
PUREX = Plutonium-Uranium Extraction (Plant or process).
RCRA = *Resource Conservation and Recovery Act of 1976.*
WAC = *Washington Administrative Code.*

Table C-2. Routine Monitoring Sampling and Analysis Schedule for 200-PO-1 Groundwater Operable Unit Far-Field Wells. (6 Pages)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	WAC Compliant	Contaminants of Concern		Supporting Constituents																				
					I-129	Nitrate	Tritium	Specific conductance(a)	Temperature(a)	Turbidity(a)	Gross Alpha	Anions(b)	Arsenic	Gross Beta	Hexavalent Chromium	Cyanide	Gamma(c)	Hg and Pb	ICP Metals (filtered)(d)	Sr-90	Tc-99	Total Organic Carbon	Total Organic Halides	Uranium	Volatile Organic Analyte(e)	Other Constituents	Water Level(a)
BC Cribs																											
A4726	299-E13-14			N/1956		A	A	A	A	A	A	A		A		A	A		A	A	A			A			A
A5853	299-E13-5			N/1955		A	A	A	A	A	A	A		A		A	A		A	A	A			A			A
	Proposed well		To be drilled in FY 2005			A	A	A	A	A	A	A		A		A	A		A	A	A			A			A
	Proposed well		To be drilled in FY 2005			A	A	A	A	A	A	A		A		A	A		A	A	A			A			A
A5849	299-E13-1		Sample once before decommissioning	N/1955		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5851	299-E13-3		Sample once before decommissioning	N/1955		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5852	299-E13-4		Sample once before decommissioning	N/1955		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5854	299-E13-6		Sample once before decommissioning	N/1955		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5855	299-E13-7		Sample once before decommissioning	N/1956		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5856	299-E13-8		Sample once before decommissioning	N/1956		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5857	299-E13-9		Sample once before decommissioning	N/1956		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5858	299-E13-11		Sample once before decommissioning	N/1956		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A4725	299-E13-12		Sample once before decommissioning	N/1956		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5861	299-E13-16		Sample once before decommissioning	N/1957		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5862	299-E13-17		Sample once before decommissioning	N/1957		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
A5863	299-E13-18		Sample once before decommissioning	N/1957		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1

Table C-2. Routine Monitoring Sampling and Analysis Schedule for 200-PO-1 Groundwater Operable Unit Far-Field Wells. (6 Pages)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	WAC Compliant	Contaminants of Concern			Supporting Constituents																			
					I-129	Nitrate	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Arsenic	Gross Beta	Hexavalent Chromium	Cyanide	Gamma[c]	Hg and Pb	ICP Metals (filtered)[d]	Sr-90	Tc-99	Total Organic Carbon	Total Organic Halides	Uranium	Volatile Organic Analyte[e]	Other Constituents	Water Level[a]
A5864	299-E13-19		Sample once before decommissioning	N/1957		1	1	1	1	1	1	1		1		1	1		1	1	1			1			1
Southeast Transect																											
A5063	699-10-54A			N/1950		A	A	A	A	A	A	A		A			A		A	A					A		A
A8457	699-24-46			N/1958	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A5101	699-26-33			C	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A5123	699-31-31			N/1956	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A5126	699-32-22A			N/1971	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A5127	699-32-43			N/1968	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A5159	699-41-23			N/1948	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A5197	699-46-21B			N/1955	A	A	A	A	A	A	A	A		A			A		A	A					A		A
River Transect																											
A5065	699-10-E12			N/1962		A	A	A	A	A	A	A		A			A		A	A					A		A
A9613	699-20-E12O			N/1961	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A8646	699-41-1A			N/1979	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A8726	699-46-4			N/1979	A	A	A	A	A	A	A	A		A			A		A	A					A		A
A5374	699-S3-E12			N/1960		A	A	A	A	A	A	A		A			A		A	A					A		A
A5370	699-S19-E13			N/1971		A	A	A	A	A	A	A		A			A		A	A					A		A
Basalt Confined Aquifer																											
A4727	299-E16-1[f]		Elephant Mt interflow[g]	N/1961	T	T	T	T	T	T	T	T		T					T								T
A8262	699-13-1C[f]		Elephant Mt interflow & Rattlesnake Ridge interbed[g]	N/1978		T	T	T	T	T	T	T		T					T								T
A8453	699-24-1P[f]		Rattlesnake Ridge interbed & Pomona basalt[g]	N/1966		T	T	T	T	T	T	T		T					T								T

Table C-2. Routine Monitoring Sampling and Analysis Schedule for 200-PO-1 Groundwater Operable Unit Far-Field Wells. (6 Pages)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	WAC Compliant	Contaminants of Concern			Supporting Constituents																			
					I-129	Nitrate	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Arsenic	Gross Beta	Hexavalent Chromium	Cyanide	Gamma[c]	Hg and Pb	ICP Metals (filtered)[d]	Sr-90	Tc-99	Total Organic Carbon	Total Organic Halides	Uranium	Volatile Organic Analyte[e]	Other Constituents	Water Level[a]
A8512	699-32-22B[f]		Rattlesnake Ridge interbed[g]	C	T	T	T	T	T	T	T	T		T					T								T
A5169	699-42-40C[f]		Rattlesnake Ridge interbed[g]	N/1982	T	T	T	T	T	T	T	T		T					T								T
A9778	699-S11-E12AP		Levey interbed[h]	N/1962		T	T	T	T	T	T	T		T					T								T
Far-Field General																											
A8098	499-S0-7	400 Area		N/1972		T	T	T	T	T		T															T
A8252	699-12-4D			N/1982	T	T	T	T	T	T		T															T
A8260	699-13-1A			N/1973	T	T	T	T	T	T		T															T
B2540	699-13-3A	300-FF-5		Y/1995		T	T	T	T	T		T															T
A5068	699-14-38			N/1958		T	T	T	T	T		T															T
A5073	699-17-5			N/1950	T	T	T	T	T	T		T															T
A5075	699-19-43			N1950	T	T	T	T	T	T		T															T
A5080	699-20-20			N/1948	T	T	T	T	T	T		T															T
A9617	699-20-E12S		Deep unconfined[g]	N/1962		T	T	T	T	T		T															T
A8428	699-20-E5A			N/1976		T	T	T	T	T		T															T
A8438	699-21-6			N/1979	T	T	T	T	T	T		T															T
A5078	699-2-3			N/1950	T	T	T	T	T	T		T															T
A8443	699-22-35			C	T	T	T	T	T	T		T															T
A5092	699-24-34C	SWL		C	T	T	T	T	T	T		T															T
A5100	699-26-15A			N/1958	T	T	T	T	T	T		T															T
A5101	699-26-33	RCRA-NRDWL		C		T	T	T	T	T		T															T
A5103	699-26-35A	RCRA-NRDWL, SWL		C	T	T	T	T	T	T		T															T
B8077	699-2-6A			C		T	T	T	T	T		T															T
A8122	699-2-7			N/1978		T	T	T	T	T		T															T

Table C-2. Routine Monitoring Sampling and Analysis Schedule for 200-PO-1 Groundwater Operable Unit Far-Field Wells. (6 Pages)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	WAC Compliant	Contaminants of Concern			Supporting Constituents																			
					I-129	Nitrate	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Arsenic	Gross Beta	Hexavalent Chromium	Cyanide	Gamma[c]	Hg and Pb	ICP Metals (filtered)[d]	Sr-90	Tc-99	Total Organic Carbon	Total Organic Halides	Uranium	Volatile Organic Analyte[e]	Other Constituents	Water Level[a]
A5110	699-28-40			N/1956	T	T	T	T	T	T		T															T
A8490	699-29-4			N/1979	T	T	T	T	T	T		T															T
A8503	699-31-11			N/1980	T	T	T	T	T	T		T															T
A5132	699-33-42			N/1968	T	T	T	T	T	T		T															T
A5133	699-33-56			N/1958		T	T	T	T	T		T															T
A5135	699-34-41B			N/1970	T	T	T	T	T	T		T															T
A5136	699-34-42			N/1970	T	T	T	T	T	T		T															T
A5142	699-35-9			N/1950	T	T	T	T	T	T		T															T
A5146	699-37-43			N/1955	T	T	T	T	T	T		T															T
A8588	699-37-E4			N/1982	T	T	T	T	T	T		T															T
A8594	699-38-15			N/1979	T	T	T	T	T	T		T															T
A5152	699-40-1			N/1961	T	T	T	T	T	T		T															T
A5153	699-40-33A			N/1949	T	T	T	T	T	T		T															T
A5161	699-41-40		Confined Ringold[g]	C	T	T	T	T	T	T		T															T
A5163	699-42-12A			N/1957	T	T	T	T	T	T		T															T
A5165	699-42-39A			C	T	T	T	T	T	T		T															T
A5166	699-42-39B		Confined Ringold[g]	C	T	T	T	T	T	T		T															T
A8677	699-43-3			N/1979	T	T	T	T	T	T		T															T
A5173	699-43-40			C	T	T	T	T	T	T		T															T
A5174	699-43-41E		Confined Ringold[g]	C	T	T	T	T	T	T		T															T
A5195	699-45-42			N/1948	T	T	T	T	T	T		T															T
A8744	699-47-5			N/1979	T	T	T	T	T	T		T															T
A5213	699-48-7A			N/1943		T	T	T	T	T		T															T

Table C-2. Routine Monitoring Sampling and Analysis Schedule for 200-PO-1 Groundwater Operable Unit Far-Field Wells. (6 Pages)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	WAC Compliant	Contaminants of Concern			Supporting Constituents																			
					I-129	Nitrate	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Arsenic	Gross Beta	Hexavalent Chromium	Cyanide	Gamma[c]	Hg and Pb	ICP Metals (filtered)[d]	Sr-90	Tc-99	Total Organic Carbon	Total Organic Halides	Uranium	Volatile Organic Analyte[e]	Other Constituents	Water Level[a]
A5215	699-49-13E			N/1944	T	T	T	T	T	T		T															T
A5222	699-50-28B			N/1971	T	T	T	T	T	T		T															T
A5233	699-52-19			N/1944		T	T	T	T	T		T															T
A5333	699-8-17			N/1950	T	T	T	T	T	T		T															T
A5334	699-8-25			N/1971	T	T	T	T	T	T		T															T
A5349	699-9-E2			N/1958	T	T	T	T	T	T		T															T
A5366	699-S12-3			N/1950		T	T	T	T	T		T															T
A5421	699-S19-E14			C		T	T	T	T	T		T															T
B8101	699-S2-34B		LIGO	Y/1984	A	A	A	A	A	A		A							A								A
A5373	699-S3-25			N/1971		T	T	T	T	T		T															T
A5405	699-S6-E14A			N/1962		T	T	T	T	T		T															T
A9152	699-S6-E4A	300-FF-5		N/1948		T	T	T	T	T		T															T
A9153	699-S6-E4B	300-FF-5		N/1953		T	T	T	T	T		T															T
A5408	699-S8-19			N/1950		T	T	T	T	T		T															T
Aquifer Sampling Tube Locations (Hanford Town Site)[f]																											
B8391, 2, 3	81-D, M, S		81-Deep, Medium, Shallow		A	A	A				A	A		A	A						A						
B8395, 6	82-M, S		82-Medium, Shallow		A	A	A				A	A		A	A						A						
B8397	83-D		83-Deep		A	A	A				A	A		A	A						A						
B8400, 1, 2	84-D, M, S		84-Deep, Medium, Shallow		A	A	A				A	A		A	A						A						
B8403, 4, 5	85-D, M, S		85-Deep, Medium, Shallow		A	A	A				A	A		A	A						A						

Table C-2. Routine Monitoring Sampling and Analysis Schedule for 200-PO-1 Groundwater Operable Unit Far-Field Wells. (6 Pages)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	WAC Compliant	Contaminants of Concern			Supporting Constituents																			
					I-129	Nitrate	Tritium	Specific conductance[a]	Temperature[a]	Turbidity[a]	Gross Alpha	Anions[b]	Arsenic	Gross Beta	Hexavalent Chromium	Cyanide	Gamma[c]	Hg and Pb	ICP Metals (filtered)[d]	Sr-90	Tc-99	Total Organic Carbon	Total Organic Halides	Uranium	Volatile Organic Analyte[e]	Other Constituents	Water Level[a]
B8406, 7, 8	86-D, M, S		86-Deep, Medium, Shallow		A	A	A				A	A		A	A						A						

[a]Field measurement.
[b]Anions – Analytes include but are not limited to nitrate. For the transect wells, analytes include but not limited to nitrate, sulfate, chloride, nitrite, and fluoride.
[c]Gamma scan – Analytes include are but not limited to Co-60.
[d]Metals – Analytes include but are not limited to chromium, manganese, and vanadium.
[e]Volatile organic analyte – Analytes include but are not limited to trichloroethene, 1,1-dichloroethene, 1,2-dichloroethene, tetrachloroethene, and vinyl chloride.
[f]Triennial sampling next scheduled for FY 2006.
[g]PNNL-13021, *Water-Level Monitoring Plan for the Hanford Groundwater Monitoring Project.*
[h]PNL-10817, 1995, *Hydrochemistry and Hydrogeologic Conditions Within the Hanford Site Upper Basalt Confined Aquifer System.*
[i]Aquifer tube sites may include multiple depths: deep (D), medium (M), and shallow (S). Each aquifer tube will be sampled for field parameters if conditions permit. If specific conductance in at least one tube is >160 μS/cm, samplers will select the tube with the highest specific conductance for laboratory analyses.

C = Well construction is compliant with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," resource protection requirements.
N = Well construction is not compliant with WAC 173-160 resource protection requirements.
1 = One time sampling.
T = To be sampled triennially; next scheduled for FY 2007 except where noted.
A = To be sampled annually.

FY = fiscal year.
ID = identification.
LIGO = Laser Interferometer Gravitational Wave Observatory.
NRDWL = Nonradioactive Dangerous Waste Landfill.
RCRA = *Resource Conservation and Recovery Act of 1976.*
SWL = Solid Waste Landfill.
WAC = *Washington Administrative Code.*

Table C-3. Sampling and Analysis Schedule for Supplementary Wells. (5 Pages)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	Alkalinity	Alpha	Anions[a]	Arsenic	Beta	Hexavalent Chromium	Cyanide	Gamma	Hg and P[b]	I-129	ICP Metals (filtered)[b]	Phenols	Sr-90	Tc-99	Total Dissolved Solids[c]	Total Organic Carbon	Total Organic Halides	Tritium	Uranium	Volatile Organic Analyte	Other Constituents	Water Level[d]
RCRA Treatment, Storage, and Disposal Units																									
PUREX Cribs																									
A4728	299-E17-1			S	S	S	S	S					S	S	S	S					S			S:Amm	S
A4732	299-E17-14	200-PO-1		Q	Q	Q	Q	Q					Q	Q	Q	Q					Q			Q:Amm	Q
A4734	299-E17-16	200-PO-1		S	S	S	S	S					S	S	S	S					S			S:Amm	S
A4736	299-E17-18	200-PO-1		S	S	S	S	S					S	S	S	S					S			S:Amm	S
A4737	299-E17-19	200-PO-1		S	S	S	S	S					S	S	S	S					S			S:Amm	S
A4751	299-E24-16			Q	Q	Q	Q	Q					Q	Q	Q	Q					Q			Q:Amm	Q
A4753	299-E24-18	200-PO-1		S	S	S	S	S					S	S	S	S					S			S:Amm	S
A6031	299-E25-17	200-PO-1		S	S	S	S	S					S	S	S	S					S			S:Amm	S
A4765	299-E25-19	200-PO-1		Q	Q	Q	Q	Q					Q	Q	Q	Q					Q			Q:Amm	Q
A4778	299-E25-31			S	S	S	S	S					S	S	S	S					S			S:Amm	S
B2822	699-37-47A	200-PO-1		S	S	S	S	S					S	S	S	S					S			S:Amm	S
Waste Management Area A-AX																									
A4756	299-E24-20	200-PO-1		S		S		S			A		A	S	A	A	S		S	S	A	A			S
C4123	299-E24-22		Top of confined	S		S		S			A		A	S	A	A	S		S	S	A	A			S
	299-E24-33			S		S		S			A		A	S	A	A	S		S	S	A	A			S
	299-E24-94			S		S		S			A		A	S	A	A	S		S	S	A	A			S
A4766	299-E25-2			S		S		S			A		A	S	A	A	S		S	S	A	A			S
A4789	299-E25-40			S		S		S			A		A	S	A	A	S		S	S	A	A			S
A4790	299-E25-41	200-PO-1		S		S		S			A		A	S	A	A	S		S	S	A	A			S
A4791	299-E25-42	200-PO-1		S		S		S			A		A	S	A	A	S		S	S	A	A			S
C4122	299-E25-93		Top of confined	S		S		S			A		A	S	A	A	S		S	S	A	A			S
C4665	299-E25-94			S		S		S			A		A	S	A	A	S		S	S	A	A			S
A5898	299-E24-4[e]			[e]		[e]		[e]			[e]		[e]	[e]	[e]	[e]	[e]				[e]	[e]			[e]

Table C-3. Sampling and Analysis Schedule for Supplementary Wells. (5 Pages)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	Alkalinity	Alpha	Anions[a]	Arsenic	Beta	Hexavalent Chromium	Cyanide	Gamma	Hg and P[b]	I-129	ICP Metals (filtered)[b]	Phenols	Sr-90	Tc-99	Total Dissolved Solids[c]	Total Organic Carbon	Total Organic Halides	Tritium	Uranium	Volatile Organic Analyte	Other Constituents	Water Level[d]
A4749	299-E24-13[e]			[e]		[e]		[e]			[e]		[e]	[e]	[e]	[e]	[e]				[e]	[e]			[e]
A4750	299-E24-14[e]			[e]		[e]		[e]			[e]		[e]	[e]	[e]	[e]	[e]				[e]	[e]			[e]
A4759	299-E25-1[e]			[e]		[e]		[e]			[e]		[e]	[e]	[e]	[e]	[e]				[e]	[e]			[e]
A4788	299-E25-4[e]			[e]		[e]		[e]			[e]		[e]	[e]	[e]	[e]	[e]				[e]	[e]			[e]
A6025	299-E25-5[e]			[e]		[e]		[e]			[e]		[e]	[e]	[e]	[e]	[e]				[e]	[e]			[e]
A6026	299-E25-7[e]			[e]		[e]		[e]			[e]		[e]	[e]	[e]	[e]	[e]				[e]	[e]			[e]
A6027	299-E25-8[e]			[e]		[e]		[e]			[e]		[e]	[e]	[e]	[e]	[e]				[e]	[e]			[e]
A4797	299-E25-9[e]			[e]		[e]		[e]			[e]		[e]	[e]	[e]	[e]	[e]				[e]	[e]			[e]
A4762	299-E25-13[e]			[e]		[e]		[e]			[e]		[e]	[e]	[e]	[e]	[e]				[e]	[e]			[e]
A6641	299-E26-5[e]			[e]		[e]		[e]			[e]		[e]	[e]	[e]	[e]	[e]				[e]	[e]			[e]
216-A-29 Ditch																									
A4770	299-E25-26			S		S								A	A				S	S					S
A4773	299-E25-28	200-PO-1	Deep unconfined	S		S								A	A				A	A					S
A4779	299-E25-32P	200-PO-1		S		S								A	A				S	S					S
A4782	299-E25-34	200-PO-1		S		S								A	A				S	S					S
A4783	299-E25-35	200-PO-1		S		S								A	A				S	S					S
A4795	299-E25-48			S		S								A	A				S	S					S
A4801	299-E26-12			S		S								A	A				S	S					S
A4802	299-E26-13			S		S								A	A				S	S					S
A5180	699-43-45	200-PO-1		S		S								A	A				S	S					S
216-B-3 Pond																									
A5171	699-42-42B	200-PO-1	Confined Ringold[f]	S	S	A		S				A		A	A				S	S	A			A:Cd	S
B8758	699-43-44			S	S	A		S				A		A	A				S	S	A			A:Cd	S
A5180	699-43-45	200-PO-1		S	S	A		S				A		A	A				S	S	A			A:Cd	S

Table C-3. Sampling and Analysis Schedule for Supplementary Wells. (5 Pages)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	Alkalinity	Alpha	Anions[a]	Arsenic	Beta	Hexavalent Chromium	Cyanide	Gamma	Hg and P[b]	I-129	ICP Metals (filtered)[b]	Phenols	Sr-90	Tc-99	Total Dissolved Solids[c]	Total Organic Carbon	Total Organic Halides	Tritium	Uranium	Volatile Organic Analyte	Other Constituents	Water Level[d]
A5185	699-44-39B	200-PO-1		S	S	A		S				A		A	A				S	S	A			A:Cd	S
Nonradioactive Dangerous Waste Landfill																									
A5094	699-25-33A		Bottom unconfined			S								A	A				S	S			S		S
A5095	699-25-34A					S								A	A				S	S			S		S
A5096	699-25-34B					S								A	A				S	S			S		S
A5419	699-25-34D					S								A	A				S	S			S		S
A5101	699-26-33	200-PO-1				S								A	A				S	S			S		S
A5102	699-26-34A					S								A	A				S	S			S		S
A5420	699-26-34B					S								A	A				S	S			S		S
A5103	699-26-35A	200-PO-1				Q	Q							Q	A				Q	S			Q	Q:Amm, COD, Col	Q
A5104	699-26-35C		Bottom unconfined			S								A	A				S	S			S		S
IDF																									
B8500	299-E17-21			A	A	A		A						A	A				S	S			A	A:Amm	S
C3826	299-E17-22			A	A	A		A						A	A				S	S			A	A:Amm	S
C3827	299-E17-23	200-PO-1		A	A	A		A						A	A				S	S			A	A:Amm	S
C3926	299-E17-25	200-PO-1		A	A	A		A						A	A				S	S			A	A:Amm	S
A4743	299-E18-1	200-PO-1		A	A	A		A						A	A				S	S			A	A:Amm	S
C3177	299-E24-21			A	A	A		A						A	A				S	S			A	A:Amm	S
	Proposed well		TBD 12/04																						
	Proposed well		TBD 12/04																						
***Washington Administrative Code* Sites**																									
Solid Waste Landfill																									
A8443	699-22-35	200-PO-1				Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A5087	699-23-34A					Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A8450	699-23-34B					Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A5089	699-24-33					Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A5090	699-24-34A					Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q

Table C-3. Sampling and Analysis Schedule for Supplementary Wells. (5 Pages)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	Alkalinity	Alpha	Anions[a]	Arsenic	Beta	Hexavalent Chromium	Cyanide	Gamma	Hg and P[b]	I-129	ICP Metals (filtered)[b]	Phenols	Sr-90	Tc-99	Total Dissolved Solids[c]	Total Organic Carbon	Total Organic Halides	Tritium	Uranium	Volatile Organic Analyte	Other Constituents	Water Level[d]
A5091	699-24-34B					Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A5092	699-24-34C	200-PO-1				Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A5093	699-24-35					Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
A5103	699-26-35A	200-PO-1				Q	Q							Q					Q				Q	Q:Amm, COD, Col	Q
200 Area Treated Effluent Disposal Facility																									
A5154	699-40-36			Q	Q	Q	Q	Q	Q			Q		Q				Q			A			Q: Cd	Q
A5160	699-41-35			Q	Q	Q	Q	Q	Q			Q		Q				Q			A			Q: Cd	Q
A5164	699-42-37			Q	Q	Q	Q	Q	Q			Q		Q				Q			A			Q: Cd	Q
CERCLA (300-FF-5)																									
618-10 Burial Grounds and 316-4 Crib																									
A9152	699-S6-E4A	200-PO-1		S	S	S		S			S			S							S	S	S	S:SVOA	S
A9153	699-S6-E4B	200-PO-1		S	A			A			A										S	A			S
A5406	699-S6-E4D			S	A			A			A										S	A			S
A9155	699-S6-E4E			A																					A
C4072	699-S6-E4K			S	S	S		S			S			S							S	S	S	S:SVOA, pH	S
C4073	699-S6-E4L			S	S	S		S			S			S							S	S	S	S:SVOA, pH	S
618-11 Burial Grounds																									
C3253	699-12-2C			S	Q	S		Q			Q		S	A							Q	Q	A		Q
C3256	699-13-0A			S	Q	S		Q			Q		S	A							Q	Q	A		Q
C3798	699-13-1E			S	Q	S		Q			Q		S	A							Q	Q	A		Q
C3254	699-13-2D			S	Q	S		Q			Q		S	A							Q	Q	A		Q
B2540	699-13-3A	200-PO-1		S	Q	S		Q			Q		S	A							Q	Q	A		Q

Table C-3. Sampling and Analysis Schedule for Supplementary Wells. (5 Pages)

Well ID	Well or Aquifer Tube Name	Co-Sample	Comments	Alkalinity	Alpha	Anions[a]	Arsenic	Beta	Hexavalent Chromium	Cyanide	Gamma	Hg and P[b]	I-129	ICP Metals (filtered)[b]	Phenols	Sr-90	Tc-99	Total Dissolved Solids[c]	Total Organic Carbon	Total Organic Halides	Tritium	Uranium	Volatile Organic Analyte	Other Constituents	Water Level[d]
Miscellaneous Units																									
400 Area Water Supply Wells																									
A8098	499-S0-7	200-PO-1		A	A		A					A	A							Q			A:Amm	Q	
A8099	499-S0-8				A	A		A					A	A							Q				Q
A8114	499-S1-8J		Drinking water well; deeper aquifer (unit unknown)		A	A		A			A		A	A		A	A				Q	A	A	A:Amm, Uiso	Q

[a]Anions – Analytes include but not limited to nitrate.
[b]Metals – Analytes include but not limited to chromium, manganese, and vanadium.
[c]Optional constituent.
[d]Field measurement.
[e]NOTE: Waste Management Area A-AX wells will be sampled and evaluated for possible continued use to monitor cribs and to provide a monitoring location between Waste Management Area A-AX and Waste Management Area C.
[f]PNNL-13021, *Water-Level Monitoring Plan for the Hanford Groundwater Monitoring Project*.
A = To be sampled annually.
S = To be sampled semiannually.
Q = To be sampled quarterly.

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
ICP = inductively coupled plasma.
ID = identification.
PUREX = Plutonium-Uranium Extraction (Plant or process).
SVOA = semivolatile organic analyte.

APPENDIX D

200-PO-1 GROUNDWATER OPERABLE UNIT RCRA TSD UNITS

This page intentionally left blank.

APPENDIX D

200-PO-1 GROUNDWATER OPERABLE UNIT RCRA TSD UNITS

There are currently six individually monitored *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage and disposal (TSD) units located within the 200-PO-1 Groundwater Operable Unit (OU) including the Plutonium-Uranium Extraction (PUREX) cribs, Waste Management Area A-AX (single-shell tanks), 216-A-29 Ditch, 216-B-3 Pond, Integrated Disposal Facility, and the Nonradioactive Dangerous Waste Landfill.

The six units are managed under the Hanford Groundwater Monitoring Project. The purpose of the RCRA groundwater monitoring is to detect new or existing contamination to groundwater from these facilities; to provide input to the corrective action process, if necessary, pursuant to WAC 173-303-646, "Dangerous Waste Regulations"; and to support closure of the RCRA-regulated TSD units. Issues relating to potential contamination of other media (e.g., sediments and air) are not within the scope of this data quality objectives summary report. The identification of specific contaminants of potential concern in groundwater is not necessarily applicable for all TSD units monitored under RCRA. Facilities monitored under interim-status indicator evaluation are required to follow a prescribed list of contaminant indicators and groundwater quality parameters to determine if contamination has occurred. These required constituents form a base monitoring list for all regulated TSD units monitored under interim-status. It should be noted that radionuclides are exempt from RCRA regulations; however, selected radionuclides are monitored to meet requirements of the *Atomic Energy Act of 1954*. Radionuclides also may be used to assist in determining the source and migration of RCRA-regulated contaminants.

One of the RCRA TSDs (PUREX Cribs) located in the 200 East Area has impacted the quality of groundwater and is currently monitored in accordance with RCRA groundwater quality assessment requirements of 40 CFR 265.93, "Interim Status for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities." In accordance with RCRA assessment regulations, the groundwater quality assessment plans are prepared to evaluate the rate and extent of migration of dangerous wastes and dangerous waste constituents in groundwater from the facility. Tables D-1 through D-6 present monitoring constituents in the six RCRA units.

Table D-1. Monitoring Constituents for Treatment, Storage, and Disposal Unit A-AX.

RCRA Contamination Indicator Parameters	**RCRA Site-Specific Parameters***	
pH Specific conductance (field) Total organic carbon Total organic halides	Alkalinity Anions ICP metals (filtered)	Phenols Turbidiity Uranium
CERCLA/AEA Parameters		
Iodine-129 Tritium	Strontium-90 Technetium-99	

*Constituent list varies by well.
Source: Adapted from PNNL-15315, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area A-AX at the Hanford Site.*
AEA = *Atomic Energy Act of 1954.*
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
ICP = inductively coupled plasma.
RCRA = *Resource Conservation and Recovery Act of 1976.*

Table D-2. Monitoring Constituents for 216-B-3 Pond.

RCRA Contamination Indicator Parameters	**RCRA Site-Specific Parameters***	
pH Specific conductance (field) Total organic carbon Total organic halides	Anions ICP metals (filtered, unfiltered)	Phenols Turbidiity
CERCLA/AEA Parameters		
Gross alpha Gross beta Tritium	Iodine-129 Arsenic	

*Constituent list varies by well.
Source: Adapted from WHC-SD-EN-AP-013, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond.*
AEA = *Atomic Energy Act of 1954.*
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
ICP = inductively coupled plasma.
RCRA = *Resource Conservation and Recovery Act of 1976.*

Table D-3. Monitoring Constituents for 216-A-29 Ditch.

RCRA Contamination Indicator Parameters	**RCRA Site-Specific Parameters***	
pH Specific conductance (field) Total organic carbon Total organic halides	Alkalinity Anions ICP metals (filtered)	Phenols Turbidiity

*Constituent list varies by well.
Source: Adapted from PNNL-13047, *Groundwater Monitoring Plan for the 216-A-29 Ditch.*
ICP = inductively coupled plasma.
RCRA = *Resource Conservation and Recovery Act of 1976.*

Table D-4. Monitoring Constituents for PUREX Cribs 216-A-10, 216-A-36B, and 216-A-37-1.

RCRA Contamination Indicator Parameters	RCRA Site-Specific Parameters*	
pH Specific conductance (field)	Anions Ammonium ion Arsenic (filtered) Alkalinity	ICP metals (filtered) Phenols Turbidiity
CERCLA/AEA Parameters		
Gross alpha Tritium	Gross beta Iodine-129 Strontium-90	

*Constituent list varies by well.

Source: Adapted from PNNL-11523, *Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs.*

AEA = *Atomic Energy Act of 1954.*

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*

ICP = inductively coupled plasma.

RCRA = *Resource Conservation and Recovery Act of 1976.*

Table D-5. Monitoring Constituents for the Integrated Disposal Facility.

RCRA Contamination Indicator Parameters	RCRA Site-Specific Parameters*	
pH Specific conductance (field) Total organic carbon Total organic halides	Anions Alkalinity	ICP metals (filtered) Chromium (filtered)

*Constituent list varies by well.

Source: Adapted from DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit.*

ICP = inductively coupled plasma.

RCRA = *Resource Conservation and Recovery Act of 1976.*

Table D-6. Monitoring Constituents for the Nonradioactive Dangerous Waste Landfill.

RCRA Contamination Indicator Parameters	RCRA Site-Specific Parameters*	
pH Specific conductance (field) Total organic carbon	Anions Ammonium ion Alkalinity	ICP metals (filtered) Phenols VOCs

*Constituent list varies by well.

Source: Adapted from DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit.*

ICP = inductively coupled plasma.

RCRA = *Resource Conservation and Recovery Act of 1976.*

VOC = volatile organic carbon.

REFERENCES

40 CFR 265.93, "Interim Status for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Preparation, Evaluation, and Response," Title 40, *Code of Federal Regulations*, Part 265.93.

Atomic Energy Act of 1954, 42 USC 2011, et seq.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.

DOE/RL-2003-04, 2005, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

PNNL-11523, 1997, *Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-13047, 1999, *Groundwater Monitoring Plan for the 216-A-29 Ditch*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-15315, 2006, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area A-AX at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.

WAC 173-303-646, "Dangerous Waste Regulations," "Closure and Post-Closure," "Corrective Action," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WHC-SD-EN-AP-013, 1995, *Interim Status Groundwater Monitoring Plan for the 216-B-3 Pond*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

APPENDIX E

RADIOLOGICAL AND NONRADIOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN WORKSHEETS

This page intentionally left blank.

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU Source COPC[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Unit Where Monitoring is Required[j]
						Nonradiological Constituents				
						Metal COPCs				
Aluminum	x				N	Last analyzed for in 2006; from 1988 to present, 3,453 results from 160 wells; no PRGs; no data in IRIS	x	x	x	
Aluminum nitrate monobasic	x				N	See aluminum and nitrate				
Aluminum nitrate nonahydrate	x				N	See aluminum and nitrate	x			
Antimony					Y	Last analyzed for in 2006; from 1988 to present, 4,255 results from 162 wells: 42 detects and 3912 non-detects exceed PRGs; within the last 10 years 112 wells had more than one exceedance	x	x	x	
Arsenic	x		x	x	Y	Last analyzed for in 2006; from 1988 to present, 2,147 results from 101 wells: 236 detects and 11 non-detects exceed PRGs and background; within the last 10 years 8 wells had more than one exceedance	x	x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Barium	x				N	Last analyzed for in 2006; from 1988 to present, 4,372 results from 169 wells: one detect and zero non-detects exceed PRGs, subsequent results in well with exceedance below limits	x	x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Beryllium	x				N	Last analyzed for in 2006; from 1988 to present, 4,257 results from 162 wells: 6 detects and 41 non-detects exceed PRGs and background; but subsequent sampling in wells with exceeds all below limits	x	x	x	
Bismuth	x				N	Not analyzed for in 200-PO-1 Groundwater OU; not a known carcinogen; no PRGs available	x	x		
Bismuth phosphate	x	x			N	Quantities listed[k]: 130,000 kg in 216-A-8 crib; see bismuth and phosphate				
Boron	x				N	Last analyzed for in 1995; from 1988 to present, 519 results from 92 wells: zero detects and zero non-detects exceed PRGs		x	x	
Cadmium	x				Y	Last analyzed for in 2006; from 1988 to present, 4,415 results from 162 wells: 6 detects and zero non-detects exceed PRGs and background	x	x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Cadmium nitrate	x				N	See cadmium and nitrate	x			
Ceric fluoride	x				N	See cerium and fluoride				

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU Source COPC[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Unit Where Monitoring is Required[j]
Ceric sulfate	x				N	See cerium and sulfate				
Cerium	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no PRGs available; no data in IRIS				
Chromium	x		x	x	Y	Last analyzed for in 2006; from 1988 to present, 4,424 results from 162 wells: 173 detects and zero non-detects exceed PRGs	x	x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Cobalt					N	Last analyzed for in 2006; from 1988 to present, 4,012 results from 160 wells; no PRGs available; no data in IRIS; radioactive component considered under radionuclides		x	x	
Copper	x				N	Last analyzed for in 2006; from 1988 to present, 4,255 results from 162 wells: zero detects and zero non-detects exceed PRGs; not a known human carcinogen (IRIS)	x	x	x	
Ferric nitrate	x				N	See iron and nitrate				
Ferrocyanide	x	x			N	See iron and cyanide		x		
Ferrous sulfamate	x				N	See iron and sulfate	x			
Ferrous sulfate	x				N	See iron and sulfate				
Gold	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no PRG available; no data in IRIS				
Hexavalent chromium				x	N	Last analyzed for in 1997; from 1988 to 1997, 6 results from 6 wells: zero detects and zero non-detects exceed PRGs	x		x	
Iron	x				N	Last analyzed for in 2006; from 1988 to present, 4,342 results from 168 wells; iron poses no risk but may be important for remedial action alternative evaluation		x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Lanthanum	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no toxicity or carcinogen data available in EPA databases; tightly bound to soil		x		
Lanthanum fluoride	x				N	See lanthanum and fluoride				
Lanthanum hydroxide	x				N	See lanthanum and hydroxide				
Lanthanum nitrate	x				N	See lanthanum and nitrate				
Lead	x			x	Y	Last analyzed for in 2006; from 1988 to present, 1,968 results from 109 wells: 13 detects and 17 non-detects exceed PRGs; 2 wells within the last 10 years had exceedances	x	x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 216-B-3 Pond
Lead nitrate	x				N	See lead and nitrate				

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU Source COPC[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Unit Where Monitoring is Required[j]
Lithium					N	Last analyzed for in 1999; from 1988 to 1999, 492 results from 65 wells; no PRGs available; no data in IRIS	x	x	x	
Magnesium	x				N	Last analyzed for in 2006; from 1988 to present, 4,375 results from 169 wells: no PRGs available		x	x	
Manganese	x		x	x	Y	Last analyzed for in 2006; from 1988 to present, 4,298 results from 164 wells: 5 detects and zero non-detects exceed PRGs	x	x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Mercury	x			x	N	Last analyzed for in 2006; from 1988 to present, 1,787 results from 102 wells: zero detects and zero non-detects exceed PRGs	x	x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 216-B-3 Pond
Mercuric nitrate	x				N	See mercury and nitrate				
Molybdenum					N	Last analyzed for in 1999; from 1988 to 1999, 501 results from 66 wells; zero detects and zero non-detects exceed PRGs	x			
Nickel	x				Y	Last analyzed for in 2006; 4,267 results from 162 wells: 4 detects and zero non-detects exceed PRGs; within the last 10 years one well had more than one exceedance	x	x	x	
Nickel nitrate	x				N	See nickel and nitrate				
Potassium	x	x			N	Last analyzed for in 2006; from 1988 to present, 4,359 results from 169 wells; no health risk; radioactive component covered with radioactive constituents		x	x	
Potassium fluoride	x				N	See potassium and fluoride				
Potassium hydroxide	x				N	See potassium and hydroxide	x			
Potassium oxalate	x				N	See potassium and oxalate				
Potassium permanganate	x				N	See potassium and manganese	x			
Radium					N	Last analyzed for in 2005; from 1988 to 2005, 589 results from 72 wells; no PRGs available; will be considered as its radiological part; no data in IRIS			x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 216-B-3 Pond
Selenium	x				N	Last analyzed for in 2006; from 1988 to present, 1,792 results from 101 wells: zero detects and 11 non-detects exceed PRGs; within the last 10 years one well had more than one exceedance, but exceedances were non-detect	x	x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Selenium tetroxide	x				N	See selenium				

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU Source COPC[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Unit Where Monitoring is Required[j]
Silicon	x				N	Last analyzed for in 2006; from 1988 to present, 789 results from 76 wells; no screening data available; no data in IRIS		x	x	
Silicon trioxide	x				N	See silicon				
Silver	x				N	Last analyzed for in 2006; from 1988 to present, 4,277 results from 164 wells: one detect and zero non-detects exceed PRGs; within the last 10 years zero wells had more than one exceedance	x	x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Silver nitrate	x				N	See silver and nitrate				
Sodium	x	x			N	Last analyzed for in 2006; from 1988 to present, 4,359 results from 169 wells; no health risk, radioactive component covered under radioactive constituents		x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Strontium	x				N	Last analyzed for in 2006; from 1988 to present, 2,589 results from 155 wells: zero detects and zero non-detects exceed PRGs; nonradiological component; radioactive component under radioactive constituents; no health risk		x	x	
Thallium					Y	Last analyzed for in 2006; from 1988 to present, 542 results from 76 wells: 19 detects and 494 non-detects exceed PRGs; within the last 10 years 5 wells had more than one exceedance		x	x	
Tin	x				N	Last analyzed for in 2000; from 1988 to 2000, 1970 results from 97 wells: zero detects and zero non-detects exceed PRGs			x	
Titanium					N	Last analyzed for in 2006; from 1988 to present, 740 results from 64 wells: no PRGs available; no data in IRIS		x	x	
Tungsten	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no PRGs available; no data in IRIS			x	
Tungsten tetroxide	x				N	See tungsten				
Uranium	x			x	Y	Last analyzed for in 2006; from 1988 to present, 982 results from 122 wells: 29 detects and zero non-detects exceed PRGs; within the last 10 years 2 wells had more than one exceedance; Also covered under radioactive constituents	x	x	x	A-AX Tank Farm 216-A-10 Crib 2101-M Pond
Vanadium	x		x	x	Y	Last analyzed for in 2006; from 1988 to present, 4,285 results from 163 wells: 10 detects and zero non-detects exceed PRGs	x	x	x	
Zinc	x				Y	Last analyzed for in 2006; from 1988 to present, 4,295 results from 167 wells: 2 detects and zero non-detects exceed PRGs	x	x	x	216-A-36B Crib
Zirconium	x				N	Last analyzed for in 1996; from 1988 to 1996, 525 results from 70 wells; no PRGs available; no known carcinogenic or toxic properties				
Zirconium oxide	x				N	See zirconium				
Zirconyl phosphate	x				N	See zirconium and phosphate				

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU Source COPC[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Unit Where Monitoring is Required[j]
Non-Metal COPCs										
Ammonia					N	Last analyzed for in 2006; from 1988 to present, 693 results from 33 wells; no PRGs available; EPA has not evaluated evidence for carcinogenicity (IRIS)	x	x	x	
Ammonium carbonate	x	x			N	Quantities listed[k]: 400,000 kg in 216-A-21 Crib; considered as ammonium and carbonate		x		
Ammonium fluoride	x				N	See ammonia and fluoride	x			
Ammonium ion					N	Last analyzed for in 1999; from 1988 to 1999, 803 results from 85 wells; no PRGs available; no data in IRIS		x	x	A-AX Tank Farm 216-A-36B Crib 216-A-29 Ditch 216-B-3 Pond
Ammonium nitrate	x	x			N	Quantities listed[k]: 320,000 kg in 216-A-8 crib; see ammonium and nitrate	x	x		
Hydrazine	x				N	Last analyzed for in 2001; from 1988 to 2001, 421 results from 67 wells: 24 detects and 397 non-detects exceed PRGs; within the last 10 years one well had more than one exceedance, but that exceedance was a non-detect	x	x	x	216-A-29 Ditch
Hydrobromic acid	x				N	See bromide				
Hydrochloric acid	x				N	See chloride				
Hydrofluoric acid					N	See fluoride		x		
Hydrogen peroxide	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no screening data available; no data in IRIS				
Hydroxylamine hydrochloride	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no screening data available; no data in IRIS				
Hydroxylamine nitrate	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no screening data available; no data in IRIS	x			
Nitric acid	x	x			N	Not analyzed for in 200-PO-1 Groundwater OU; see nitrate	x	x		
Periodic acid	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no screening data available; no data in IRIS				
Phosphoric acid	x				N	See phosphorus and phosphate				
Phosphorus					N	Last analyzed for in 1996; from 1988 to present one result from one well: one detect and zero non-detects exceeded PRGs		x		
Phosphorus pentoxide	x				N	See phosphorus and phosphate				
Sodium bisulfate	x				N	See sodium and sulfate				
Sodium bromate	x				N	See sodium and bromide				
Sodium carbonate	x				N	See sodium and carbonate	x			
Sodium dichromate	x	x			N	See sodium and chromium		x		
Sodium ferrocyanide	x				N	See sodium, iron, and cyanide				
Sodium fluoride	x				N	See sodium and fluoride				
Sodium hydroxide	x				N	See sodium and hydroxide	x			
Sodium nitrate	x				N	See sodium and nitrate				
Sodium nitrite	x				N	See sodium and nitrite				

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU Source COPC[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Unit Where Monitoring is Required[j]
Sodium sulfate	x				N	See sodium and sulfate				
Sodium thiosulfate	x				N	See sodium, sulfate, and sulfur				
Sulfamic acid	x				N	See sodium, sulfate, and sulfur				
Sulfuric acid	x	x			N	See sulfur and sulfate; quantities listed[k]: 10,000 kg in 216-B-6 Reverse Well	x			
Sulfur	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no screening data available; no data in IRIS				
Thiocyanate					N	See sulfur and cyanide	x			
Volatile Organic COPCs										
1,1,1-Trichloroethane					N	Last analyzed for in 2006; from 1988 to present, 1,502 results from 129 wells: zero detect and zero non-detects exceed PRGs	x	x		
1,1,2,2-Tetrachloroethane					Y	Last analyzed for 2006; from 1988 to present, 240 results from 87 wells: one detect and 237 non-detects exceed PRGs; within the last 10 years 2 wells had more than one exceedance	x		x	
1,1,2-Trichloroethane					N	Last analyzed for in 2006; from 1988 to present, 1,381 results from 120 wells: zero detects and 373 non-detects exceed PRGs; within the last 10 years 3 wells had more than one exceedance, but exceedances were non-detects	x	x		
1,1-Dichloroethane					N	Last analyzed for in 2006; from 1988 to present, 1,430 results from 129 wells: zero detects and zero non-detects exceed PRGs		x	x	
1,2-Dichlorobenzene					N	Last analyzed or in 2006; from 1988 to present, 232 results from 88 wells: zero detects and zero non-detects exceed PRGs	x			
1,2-Dichloroethane					Y	Last analyzed for in 2006; from 1988 to present, 1,410 results from 128 wells: 7 detects and 499 non-detects exceed PRGs; within the last 10 years 3 wells had more than one exceedance	x	x	x	
1,3-Dichlorobenzene					N	Last analyzed for in 2006; from 1988 to present, 232 results from 88 wells; no PRGs available; not a known carcinogen (IRIS)	x			
1,4-Dichlorobenzene					N	Last analyzed for in 2006; from 1988 to present, 1,633 results from 124 wells: zero detects and 584 non-detects exceed PRGs; within the last 10 years 6 wells had more than one exceedance, but exceedances were non-detects			x	
1-Butanol, butyl alcohol					N	Last analyzed for n 2006; from 1988 to present, 531 results from 89 wells: zero detects and 92 non-detects exceed PRGs; within the last 10 years zero wells had more than one exceedance	x	x		
1-Butynol					N	Last analyzed for in 1990; from 1988 to 1990, 63 results from 41 wells; no PRGs available; no data in IRIS			x	216-A-10 Crib
2-Butanone (Methyl ethyl ketone)					N	Last analyzed for in 2006; from 1988 to present, 847 results from 118 wells: zero detects and zero non-detects exceed PRGs	x	x	x	
2-Chlorophenol					N	Last analyzed for in 2006; from 1988 to present, 1,207 results from 92 wells: zero detects and one non-detect exceed PRGs		x		
2-Hexanone					N	Last analyzed for in 2006; from 1988 to present, 127 results from 54 wells; no PRGs available; no data in IRIS	x			

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU Source COPC[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Unit Where Monitoring is Required[j]
2-Propanol (Isopropyl alcohol)	x				N	Last analyzed for in 1995; from 1988 to present, 21 results from 20 wells; no PRGs available; no data found in IRIS	x		x	
4-Methyl-2-Pentanone (hexone)					N	Last analyzed for in 2006; from 1988 to present, 848 results from 118 wells; no PRGs available; health hazard being reviewed by EPA	x	x	x	
4-chloro 3-methylphenol					N	Last analyzed for in 2006; from 1988 to present, 1,205 results from 92 wells; no PRGs available; no data in IRIS		x		
Acetone	x				N	Last analyzed for in 2006; from 1988 to present, 778 results from 110 wells: zero detects and zero non-detects exceed PRG	x	x	x	
Acetonitrile					N	Last analyzed for in 2006; from 1988 to present, 210 results from 75 wells; no PRGs available; not a known human carcinogen (IRIS)	x			
Benzene					Y	Last analyzed for in 2006; from 1988 to present, 1,442 results from 128 wells: 7 detects and 460 non-detects exceed PRGs; within the last 10 years 6 wells had more than one exceedance	x	x	x	
Bromodichloro-methane					Y	Last analyzed for in 2006; from 1988 to present, 204 results from 63 wells: one detect and 128 non-detects exceed PRGs			x	
Carbon disulfide					N	Last analyzed for in 2006; from 1988 to present, 690 results from 107 wells: zero detects and zero non-detects exceed PRGs			x	
Carbon tetrachloride					Y	Last analyzed for in 2006; from 1988 to present, 1,496 results from 128 wells: 85 detects and 693 non-detects exceed PRGs; within the last 10 years 23 wells had more than one exceedance	x	x	x	
Chloroform					N	Last analyzed for in 2006; from 1988 to present, 1,94 results from 129 wells: zero detects and 2 non-detects exceed PRGs; within the last 10 years zero wells had more than one exceedance	x	x	x	
cis-1,2-Dichloroethylene					N	Last analyzed for in 2006; from 1988 to present, 1,012 results from 78 wells: zero detects and zero non-detects exceed PRGs	x	x		
Cyclohexane					N	Not analyzed for in 200-PO-1 Groundwater OU; no screening data available; not a known human carcinogen (IRIS)	x			
Cyclohexanone					N	Not analyzed for in 200-PO-1 Groundwater OU; no data on quantities can be located for this constituent[l]; EPA has not yet evaluated this compound as a human carcinogen (IRIS); No toxicity in data presented; Unplanned releases are generally	x	x		
Dibromochloro-methane					Y	Last analyzed for in 2006; from 1988 to present, 204 results from 63 wells: one detect and 164 non-detects exceed PRGs			x	
Diethyl ether					N	Last analyzed for in 1996; from 1988 to 1996, 20 results from 3 wells: zero detects and 20 non-detects exceed PRGs; within the last 10 years zero wells had more than one exceedance		x		
Ethanol					N	Last analyzed for in 1996; from 1988 to 1996, 92 results from 44 wells; no PRGs available; no data in IRIS	x	x		
Ethylbenzene					N	Last analyzed for in 2006; from 1988 to present, 934 results from 108 wells: ,zero detects and zero non-detects exceed PRGs	x	x		
Ethylene glycol					N	Last analyzed in 1996; from 1988 to 1996, 92 results from 49 wells: zero detects and zero non-detects exceed PRGs	x	x		
Ethyl cyanide					N	Last analyzed for in 2006; from 1988 to present, 636 results from 94 wells; no PRGs available; no data in IRIS		x	x	

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS(a)	200 East Groundwater AAMS(b)	DQO for 200-BP-5 and 200-PO-1 OUs(c)	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA(d)	Retain as COPC for CERCLA Actions(e)	Logic for CERCLA/RCRA Inclusion and Exclusion(f)	Other Sources(g)	200-BP-5 OU Source COPC(h)	RCRA FIR for 200-PO-1 COPCs(i)	RCRA TSD Unit Where Monitoring is Required(j)
Formaldehyde	x				N	Last analyzed for in 1990; from 1988 to 1990, 142 results from 62 wells; zero detects and zero non-detects exceed PRGs				
Hexane					Y	Not analyzed for in 200-PO-1 Groundwater OU; EPA lists as a possible human carcinogen; listed as a 200-UR-1 OU COPC(l).	x			
Methyl chloride (Chloromethane)					N	Last analyzed for in 2006; from 1988 to present, 239 results from 86 wells: zero detects and 218 non-detects exceed PRGs; within the last 10 years 2 wells had more than one exceedance, but exceedances were non-detects	x			
Methylene chloride					Y	Last analyzed for in 2006; from 1988 to present, 1,486 results from 129 wells: 22 detects and 113 non-detects exceed PRGs; within the last 10 years 2 wells had more than one exceedance	x	x	x	
Naphthalene					N	Last analyzed for in 2006; from 1988 to present, 416 results from 97 wells: zero detects and zero non-detects exceed PRGs	x	x		
Pentachlorophenol					Y	Last analyzed for in 2006; from 1988 to present, 1,394 results from 94 wells: 6 detects and 1328 non-detects exceed PRGs; within the last 10 years 54 wells had more than one exceedance		x	x	
Phenol					N	Last analyzed in 2006; from 1988 to present, 1,37 results from 107 wells: zero detects and zero non-detects exceed PRGs	x	x		
Phenols				x	N	Covered by analyzing for separate phenols				A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M-Pond 216-B-3 Pond
2,4,5-Trichlorophenol					N	Last analyzed for in 2006, from 1988 to present, 704 results from 91 wells: zero detects and zero non-detects exceed PRGs				
2,4,6-Trichlorophenol					N	Last analyzed for in 2006; from 1988 to present, 1,149 results from 92 wells: zero detects and 634 non-detects exceed PRGs; within the last 10 years 40 wells had more than one exceedance, but exceedances were non-detects				
2-Cyclohexyl-4,6-dinitrophenol					N	Last analyzed for in 2006; from 1988 to present 57 from 47 wells; no PRGs available; no data in IRIS				
2,6-Dichlorophenol					N	Last analyzed for in 2006; results from 1,143 from 87 wells; no PRGs available; no data in IRIS				
4-Nitrophenol					N	Last analyzed for in 2006; from 1988 to present, 1,148 results from 92 wells; no PRGs available; no data in IRIS for toxicity				
4,6-Dinitro-2-methylphenol					N	Last analyzed for in 2006; from 1988 to present, 1,205 results from 92 wells; no PRGs available; no data in IRIS				
Pyrene					N	Last analyzed for in 2006; from 1988 to present, 205 results from 62 wells: zero detects and zero-non-detects exceed PRGs		x		
Styrene					N	Last analyzed for in 2006; from 1988 to present, 127 results from 54 wells: zero detects and 107 non-detects exceed PRGs; within the last 10 years 2 wells had more than one exceedance, but exceedances were non-detects		x	x	
Tetrachloroethene					Y	Last analyzed for in 2006; from 1988 to present, 1,442 results from 129 wells: 807 detects and 583 non-detects exceed PRGs; within the last 10 years 30 wells had more than one exceedance	x	x	x	

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU Source COPC[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Unit Where Monitoring is Required[j]
Tetrahydrofuran					N	Last analyzed for in 2006; from 1988 to present, 691 results from 103 wells; no PRGs available; no data in IRIS	x			216-A-10 Crib
Toluene					N	Last analyzed for in 2006; from 1988 to present, 1,444 results from 129 wells: zero detects and zero non-detects exceed PRGs	x	x		
trans-1,2-Dichloroethylene					N	Last analyzed for in 2006; from 1988 to present, 1,299 results from 113 wells: zero detects and zero non-detects exceed PRGs	x	x		
Trichloroethane	x				N	Considered as 1,1,1-Trichlorethane and 1,1,2-Trichloroethane				
Trichloroethene					Y	Last analyzed for in 2006; from 1988 to present, 1,482 results from 129 wells: 746 detects and 659 non-detects exceed PRGs; within the last 10 years 32 wells had more than exceedance	x	x	x	
Trichloromono-fluoromethane					N	Last analyzed for in 2006; from 1988 to present, 221 results from 79 wells: zero detects and zero non-detects exceed PRGs		x	x	
Vinyl chloride					Y	Last analyzed for in 2006; from 1988 to present, 1,372 results from 120 wells: 4 detects and 1368 non-detects exceed PRGs; within the last 10 years 30 wells had more than one exceedance	x			
Xylenes (total)					N	Last analyzed for in 2006; from 1988 to present, 1,252 results from 121 wells: zero detects and zero non-detects exceed PRGs	x	x		
Semivolatile Organics										
2,4-Dichlorophenol					N	Last analyzed for in 2006; from 1988 to present, 1,296 results from 93 wells: one detect and zero non-detects exceed PRGs; within the last 10 years zero wells had more than one exceedance		x		
2,4-Dichlorophenoxyacetic acid; 2,4-D					N	Last analyzed for in 2005; from 1988 to 2005, 629 results from 75 wells: zero detects and zero non-detects exceed PRGs			x	
2,4-Dimethylphenol					N	Last analyzed for in 2006; from 1988 to present, 1,114 results from 88 wells: zero detects and zero non-detect exceed PRGs		x	x	
2,4-Dinitrophenol					Y	Last analyzed for in 2006; from 1988 to present, 1148 results from 92 wells: one detect and 292 non-detects exceed PRGs		x	x	
2,4-dinitrotoluene					N	Last analyzed for in 2006; from 1988 to present, 225 results from 75 wells: zero detects and zero non-detects exceed PRGs	x	x		
2,3,4,6-tetrachlorophenol					N	Last analyzed for in 2006; from 1988 to present ,697 results from 86 wells: zero detects and zero non-detects exceed PRGs		x		
2-methylphenol (o-cresol)					N	Last analyzed for in 2006; from 1988 to present, 830 results from 79 wells: zero detects and zero non-detects exceed PRGs	x			
2-Nitrophenol					N	Last analyzed for in 2006; from 1988 to present, 1,279 results from 86 wells; no PRGs available; no data in IRIS		x	x	
Dinoseb 2-sec Butyl-4,6-dinitrophenol					N	Last analyzed for in 2006; from 1988 to present, 1,518 results from 88 wells: one detect and 84 non-detects exceed PRGs; within the last 10 years one well had more than one exceedance, but exceedance was non-detect. The only detect was from 1995			x	
3-methylphenol					N	Last analyzed for in 2000; from 1988 to 2000, 150 results in 39 wells; zero detects and zero non-detects exceed PRGs		x		

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU Source COPC[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Unit Where Monitoring is Required[j]
4-methylphenol (p-cresol)					N	Last analyzed for in 2006; from 1988 to present, 251 results from 56 wells: zero detects and zero non-detects exceed PRGs	x	x		
Benzo [a] anthracene					N	Last analyzed for in 2006; from 1988 to present, 168 results from 75 wells: zero detects and 168 non-detects exceed PRGs; within the last 10 years 4 wells had more than one exceedance, but exceedances were non-detects	x	x		
Benzo [a] pyrene					N	Last analyzed for in 2006; from 1988 to present, 168 results from 75 wells: zero detects and 168 non-detects exceed PRGs; within the last 10 years 4 wells had more than one exceedance, but exceedances were non-detects	x	x		
Benzo[b] fluoranthene					N	Last analyzed for in 2006; from 1988 to present ,168 results from 75 wells: zero detects and 168 non-detects exceed PRGs; within the last 10 years 4 wells had more than one exceedance, but exceedances were non-detects	x	x		
Benzo [k] fluoranthene					N	Last analyzed for in 2006; from 1988 to present, 148 results from 62 wells: zero detects and 148 non-detects exceed PRGs; within the last 10 years 4 wells had more than one exceedance, but exceedances were non-detects	x			
Bis (2-ethylhexyl) phthalate					Y	Last analyzed for in 2006; from 1988 to present, 384 results from 82 wells: 15 detects and 107 non-detects exceed PRGs		x	x	
Butylated hydroxy toluene					N	Not analyzed for in 200-PO-1 Groundwater OU; no screening data available; no data in IRIS	x	x	x	216-A-36B Crib
Chlorobenzene					N	Last analyzed for in 2006; from 1988 to present, 365 results from 90 wells: zero detects and zero non-detects exceed PRGs	x	x		
Chrysene					N	Last analyzed for in 2006; from 1988 to present, 168 results from 75 wells: zero detects and 168 non-detects exceed PRGs; within the last 10 years 4 wells had more than one exceedance, but exceedances were non-detects	x	x		
Dibenz [a,h] anthracene					N	Last analyzed for in 2006; from 1988 to present, 168 results from 75 wells: zero detects and 168 non-detects exceed PRGs; within the last 10 years 4 wells had more than one exceedance, but exceedances were non-detects	x	x		
Dibutyl butyl phosphonate	x				N	Not analyzed for in 200-PO-1 Groundwater OU; will degrade to phosphate and will be detected as such	x			
Dibutylphosphate					N	Last analyzed for in 1990; from 1988 to 1990, 72 results from 41 wells; no PRG available; no known health hazards or toxicity		x	x	216-A-10 Crib
Diethylphthalate					N	Last analyzed for in 2006; from 1988 to present, 168 results from 75 wells: zero detects and zero non-detects exceed PRGs	x			
Di-n-Butylphthalate					N	Last analyzed for in 2006; from 1988 to present, 169 results from 75 wells: zero detects and zero non-detects exceed PRGs	x			
Hydroxyacetic acid (Glycolate)	x				N	Not analyzed for in Hanford Site groundwater; no toxicity/carcinogenicity data available in EPA databases. Continued radionuclide measurements in groundwater will detect any increased mobility of radionuclides				
Indeno [1,2,3-cd] pyrene					N	Last analyzed for in 2006; from 1988 to present, 168 results from 75 wells: zero detects and 168 non-detects exceed PRGs; within the last 10 years 4 wells had more than one exceedance, but exceedances were non-detects	x	x		
Monobutyl phosphate					N	Last analyzed for in 1990; from 1988 to 1990, 72 results from 41 wells; no PRG available; no data in IRIS			x	216-A-10 Crib

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU Source COPC[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Unit Where Monitoring is Required[j]
Naphthylamine					N	Analyzed for as 1-Naphthylamine and 2-Naphthylamine; found in groundwater	x			
n-butyl benzene					N	Not analyzed for in 200-PO-1 Groundwater OU; no PRGs; no data in IRIS	x	x		
N-Nitrosodiphenylamine					N	Last analyzed for in 2006; from 1988 to present, 148 results from 62 wells: no PRGs available; IRIS lists as a probable human carcinogen			x	
Polychlorinated dibenzo-p-dioxins					N	Last analyzed for in 1993; from 1988 to 1993, 44 results in 41 wells; no PRGs available; no data for this in IRIS			x	
Polychlorinated dibenzofurans					N	Last analyzed for in 1993; from 1988 to 1993, 44 results in 41 wells; no PRGs available; no data for this in IRIS			x	
Tetrachlorophenol					N	Last analyzed for in 1996; from 1988 to 1996, 446 results for 53 wells: zero detects and zero non-detects			x	
Thenoyltri-fluoroacetone	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no PRGs available; no data in IRIS				
Tributyl phosphate	x	x			N	Last analyzed for in 2006; from 1988 to present, 402 results from 94 wells; no PRGs available; quantities listed[k]: 100,000 kg in 216-A-7 Crib and other waste disposal sites; a concern with TBP is that it might carry radionuclides with it as it migrates. Because monitoring for radionuclides exists, there is little reason to look for this further. Degradation of this compound would be detected as phosphate.	x	x		216-A-10 Crib
Trichlorophenol					N	Last analyzed for in 1996; from 1988 to 1996, 446 results from 53 wells: zero detect and zero non-detect exceed PRGs				
Tri-n-dodecylamine	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no PRGs available; no data in IRIS			x	
Tris-2-chloroethyl phosphate					N	Last analyzed for in 2006; from 1988 to present, 180 results from 37 wells: no PRGs available; no data in IRIS			x	
Hydrocarbons										
Decane					N	Last analyzed for in 1996; from 1988 to 1996, 151 results from 28 wells: no PRGs available; no data in IRIS	x	x		
Total petroleum hydrocarbons diesel range, (diesel fuel)					N	Last analyzed for in 2005; from 1988 to 2005, 41 results from 10 wells: no detects above PRGs	x	x		
Dodecane					N	Last analyzed for in 1996; from 1988 to 1996, 151 results from 29 wells: no PRGs available; no data in IRIS	x			
Hydraulic fluids (oil and greases)					N	Last analyzed for in 2005; from 1988 to 2005, 109 results from 6 wells; no detects above PRGs	x			
Kerosene (TPH kerosene range)					N	Last analyzed for in 2001; from 1988 to 2001, 159 results from 79 wells; no detects above PRGs; no data in IRIS	x	x		
Lard oil					N	No toxicity factors	x			
Paint thinner					N	See other organic volatiles and hydrocarbons; no detects for toluene	x			
Paraffin hydrocarbons NPH	x	x			N	see TPH	x			

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS(a)	200 East Groundwater AAMS(b)	DQO for 200-BP-5 and 200-PO-1 OUs(c)	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA(d)	Retain as COPC for CERCLA Actions(e)	Logic for CERCLA/RCRA Inclusion and Exclusion(f)	Other Sources(g)	200-BP-5 OU Source COPC(h)	RCRA FIR for 200-PO-1 COPCs(i)	RCRA TSD Unit Where Monitoring is Required(j)
Shell E-2342 (naphthalene and paraffin)					N	See naphthalene and paraffin NPH	x			
Soltrol-170 (purified kerosene)					N	See kerosene (TPH kerosene range)	x			
Pesticide COPCs										
2,4,5-TP Silvex					N	Last analyzed for in 2005; from 1988 to 2005, 629 results from 75 wells: zero detects and zero non-detects exceed PRGs			x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 216-B-3 Pond
4,4'-DDD					N	Last analyzed for in 2005; from 1988 to 2005, 467 results from 77 wells: zero detects and zero non-detects		x	x	
4,4'-DDE					N	Last analyzed for in 2005; from 1998 to 2005, 467 results from 77 wells: zero detects and zero non-detects exceed PRGs			x	
4,4'-DDT					N	Last analyzed for in 2005; 467 results from 77 wells: 3 detects and zero non-detects exceed PRGs; within last 10 years zero wells had more than one exceedance		x	x	
Aldrin					N	Last analyzed for in 2005; from 1998 to 2005, 467 results from 77 wells: 4 detects and 411 non-detects exceed PRGs; within the last 10 years 3 wells had more than one exceedance, but exceedances are all non-detects. The 4 detects are all prior to 1995.		x	x	
Alpha BHC					N	Last analyzed for in 2005; from 1988 to 2005, 624 results from 78 wells: zero detects and 472 non-detects exceed PRGs; within the last 10 years 2 wells had more than one exceedance, but exceedances were non-detects			x	
Delta- BHC					N	Last analyzed for in 2005; from 1988 to 2005, 624 results from 78 wells: no PRGs available; not a known human carcinogen (IRIS)			x	
Dieldrin					Y	Last analyzed for in 2005; from 1988 to 2005, 467 results from 77 wells: 3 detects and 401 non-detects exceed PRGs		x	x	
Dimethoate					Y	Last analyzed for in 2006; from 1988 to present, 155 results from 62 wells: 3 detects and 73 non-detects exceed PRGs		x	x	
Endosulfan sulfate					N	Last analyzed for in 2005; from 1988 to 2005, 454 results from 72 wells; no PRGs available; no data in IRIS			x	
Endrin					N	last analyzed for in 2005; from 1988 to 2005, 624 results from 78 wells: 3 detects and zero non-detects exceed PRGs; within the last 10 years zero wells exceeded		x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 216-B-3 Pond
Endrin aldehyde					N	Last analyzed for in 2005; from 1988 to 2005, 409 results from 57 wells; no PRGs available; no data in IRIS		x	x	
Heptachlor					Y	Last analyzed for in 2005; from 1988 to 2005, 467 results from 77 wells: 7 detects and 325 non-detects exceed PRGs		x	x	

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU Source COPC[h]	RCRA FIR for 200-PO-1 COPCs[f]	RCRA TSD Unit Where Monitoring is Required[f]
Heptachlor epoxide					Y	Last analyzed for in 2005; from 1988 to 2005, 467 results from 77 wells: 2 detects and 344 non-detects exceed PRGs			x	
Lindane (Gamma BHC)					N	Last analyzed for in 2005; from 1988 to 2005, 624 results from 78 wells: 3 detects and 213 non-detects exceed PRGs; within the last 10 years zero wells had exceedances		x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 216-B-3 Pond
Methoxychlor					N	Last analyzed for in 2005; from 1988 to 2005, 624 results from 78 wells: zero detects and zero non-detects exceed PRGs			x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 216-B-3 Pond
Phorate					N	Last analyzed for in 2006; from 1988 to present, 108 results from 47 wells: zero detects and 26 non-detects exceed PRGs; within the last 10 years one well had more than one exceedance, but exceedance was non-detect		x	x	
Toxaphene					N	Last analyzed for in 2005; from 1988 to 2005, 624 results from 78 wells: zero detects and 624 non-detects exceed PRGs; within the last 10 years 3 wells had more than one exceedance.			x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 216-B-3 Pond
						Complexants				
Citrate	x				N	Not analyzed for in 200-PO-1 Groundwater OU; may increase the mobility of metals and radionuclides. Continued radionuclide measurements in groundwater will detect any increased mobility.				
EDTA	x				N	Chelator, no toxicity data available. May increase mobility of metals and radionuclides. Continued radionuclide measurements in the groundwater will detect any increased mobility of radionuclides. Not analyzed for in Hanford Site groundwater.				
Glycolate (Hydroxyacetic acid)	x				N	No toxicity/carcinogenicity data available in EPA databases. Continued radionuclide measurements in groundwater will detect any increased mobility of radionuclides. Not analyzed for in Hanford Site groundwater.				
HEDTA	x				N	Chelator, no toxicity data available. May increase mobility of metals and radionuclides. Continued radionuclide measurements in the groundwater will detect any increased mobility of radionuclides. Not analyzed for in Hanford Site groundwater.				
Oxalic acid	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no data in IRIS				
Tartaric acid	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no data in IRIS				
						Miscellaneous				
Aroclor-1254					N	Last analyzed for in 2005; from 1988 to 2005, 146 results from 69 wells: zero detects and 115 non-detects exceed PRGs; within the last 10 years zero wells had exceedances	x			
Aroclor-1260					N	Last analyzed for in 2005; from 1988 to 2005, 146 results from 69 wells; no PRGs available; no data in IRIS		x		
Polychlorinated biphenyls (total)					N	Will be considered as separate Aroclors.	x			

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU Source COPC[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Unit Where Monitoring is Required[j]
Sugar	x				N	Not analyzed for in 200-PO-1 Groundwater OU; not a toxin or known carcinogen				
Water-Quality Measurements										
Alkalinity				x	N	General-water quality evaluation parameter; pH will cover general water quality			x	
Coliform bacteria					N	Water quality parameter			x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
pH				x	N	General water-quality evaluation parameter that affects transport in CERCLA risk evaluation. Groundwater not expected to have significantly acidic or alkaline pH.	x		x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Specific conductance				x	N	Provides no definitive information for risk assessment			x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Temperature					N				x	
Total organic carbon				x	N	General water quality evaluation parameter that affects transport in CERCLA risk evaluation			x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Turbidity				x	N	General water quality and assesses whether filtration is successful. Provides no definitive information for risk assessment.			x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Anions										
Bromide					N	Last analyzed for in 2006; from 1988 to present, 1,728 results from 132 wells; no PRGs available; no data in IRIS	x	x		
Carbonate	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no PRGs available; no data in IRIS				

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU Source COPC[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Unit Where Monitoring is Required[j]
Chloride	x				N	Last analyzed for in 2006; from 1988 to present, 3,993 results from 183 wells; no screening data available, no data in IRIS	x	x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Cyanide	x		x	x	N	Last analyzed for in 2006; from 1988 to present, 314 results from 111 wells: zero detects and zero non-detects exceed PRGs. Retained in DQO for 200-PO-1 Groundwater OU and 200-BP-5	x	x	x	
Fluoride	x	x			Y	Last analyzed for in 2006; from 1988 to present, 4,119 results from 183 wells: 163 detects and 10 non-detects exceed PRGs; within the last 10 years 7 wells had more than one exceedance	x	x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Hydroxide	x				N	See alkalinity and pH				
Nitrate		x	x	x	Y	Last analyzed for in 2006; from 1988 to present, 4,400 results from 189 wells: 481 detects and zero non-detects exceed PRGs. Within the last 10 years, 19 wells had more than one exceedance; part of a regional plume.	x	x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Nitrite		x			Y	Last analyzed for in 2006; from 1988 to present, 3,410 results from 182 wells: one detects and zero non-detects exceed PRGs; within the last 10 years one well had more than one exceedance	x	x	x	
Oxalate		x			N	Not analyzed for in 200-PO-1 Groundwater OU; no screening data available, no data in IRIS				
Perchlorate ion					N	Last analyzed for in 1995; from 1988 to 1995, 70 results from 41 wells; zero detects and 70 non-detects exceed PRGs; within the last 10 years zero wells had exceedances			x	
Phosphate		x			N	Last analyzed for in 2006; from 1988 to present, 1,832 results from 139 wells; no PRGs available; quantities listed[k]: 100,000 kg in 216-B-19 Crib and B-33 Trench; degradation product from TBP, DBP, and DDBP.	x	x	x	
Sulfate		x			N	Last analyzed for in 2006; from 1988 to present, 4,059 results from 183 wells; no PRGs available; no data in IRIS	x	x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond

Table E-1. Nonradiological Contaminants of Potential Concern in the 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (16 Pages)

Constituent	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	200-BP-5 OU Source COPC[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Unit Where Monitoring is Required[j]
Sulfide					N	Last analyzed for in 2006; from 1988 to present, 119 results from 66 wells; no PRGs available; no data in IRIS	x	x		

[a]DOE/RL-92-04, *PUREX Source Aggregate Area Management Study Report.*
[b]DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study Report.*
[c]PNNL-14049, *Data Quality Objectives Summary Report- Designing a Groundwater Monitoring Network for the 200-BP-5 and 200-PO-1 Operable Units.*
[d]CP-15329, *Data Quality Objectives Summary Report for Establishing RCRA/CERCLA/AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network.*
[e]COPCs are noted as "Y" or "N." "Y" represents constituents included as COPCs, and "N" represents a constituent that has been removed from the final list of COPCs.
[f]Logic for COPC inclusion or exclusion from final list of COPCs.
[g]Other sources refers to ancillary documents that provided duplicative COPCs; see below:
D&D-28283, *Sampling and Analysis Instruction for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit.*
DOE/RL-99-07, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan.*
DOE/RL-2000-60, *200-PW-2 Uranium Rich Process Waste Group Operable Unit RI/FS Work Plan and Process Waste RCRA TSD Unit Sampling Plan.*
DOE/RL-2001-01, *Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit RI/FS Work Plan: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units.*
DOE/RL-2001-66, *Chemical Laboratory Waste Group Operable Unit RI/FS Work Plan.*
DOE/RL-2002-11, *300-FF-5 Operable Unit Sampling and Analysis Plan.*
DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit.*
DOE/RL-2004-17, *Remedial Investigation Report for the 200-CS-1 Chemical Sewer Group Operable Unit.*
DOE/RL-2004-24, *Feasibility Study for the 200-CW-5 (U Pond/Z Ditches Cooling Water Waste Group), 200-CW-2 (S Pond and Ditches Cooling Water Waste Group), 200-CW-4 (T Pond and Ditches Cooling Water Waste Group), and 200-SC-1 (Steam Condensate Waste Group) Operable Units.*
DOE/RL-2004-39, *200-UR-1 Unplanned Release Waste Group Operable Unit Remedial Investigation/Feasibility Study Work Plan and Engineering Evaluation/Cost Analysis.*
DOE/RL-2004-66, *Feasibility Study for the BC Cribs and Trenches Area Waste Sites Hanford Site, Richland, Washington.*
[h]Half lives from HEAST, EPA Radionuclide Table: Radionuclide Carcinogenicity-Slope Factors. http://www.epa.gov/radiation/heast/.
[i]DOE/RL-95-100, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit.*
[j]RCRA TSD sites for 200-PO-1 Groundwater OU per analyte as presented in DOE/RL-95-100, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit.*
[k]Quantities listed in DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study Report.*
[l]DOE/RL-2004-39, *200-UR-1 Unplanned Release Waste Group Operable Unit Remedial Investigation/Feasibility Study Work Plan and Engineering Evaluation/Cost Analysis.*

Aroclor is an expired trademark.

AAMS = aggregate area management study.
AEA = *Atomic Energy Act of 1954.*
BHC = Lindane.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
COPC = contaminant of potential concern.
DBBP = dibutyl butyl phosphonate.
DBP = dibutyl phosphate.
DQO = data quality objective.
EPA = U.S. Environmental Protection Agency.
FIR = facility investigation report for the 200-PW-1 OU (DOE/RL-95-100; see footnote [i] above).
IRIS = *Integrated Risk Information System.*
NPH = normal paraffin hydrocarbon.
OU = operable unit.
PRG = preliminary remediation goal.
PUREX = Plutonium-Uranium Extraction (Plant or process).
RCRA = *Resource Conservation and Recovery Act of 1976.*
TBP = tributyl phosphate.
TPH = total petroleum hydrocarbon.
TSD = treatment, storage, and/or disposal (unit).

Table E-2. Radiological Contaminants of Potential Concern in 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (6 Pages)

COPCs	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA/RCRA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	COPCs Incorporated from 200-BP-5 OU[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Units Where Monitoring is Required[j]
Actinium-225	x				N	Short half life (10 days)		x		
Actinium-227	x				N	Tightly bound to soil; will decay before reaching groundwater		x		
Americium-241	x	x			N	Last analyzed for in 2000; from 1988 to 2000, 19 results from 18 wells: zero detects and 3 non-detects exceed regulatory limits; tightly bound to soil; highest concentrations released to B pond at 3.96 Ci[k]; will decay before reaching groundwater	x	x		
Americium-242	x				N	Short half life (16 hours)[l]		x		
Americium-242m	x				N	Not analyzed for in 200-PO-1 Groundwater OU; tightly bound to soil, half life (152 years)[l]		x		
Americium-243					N	Not analyzed for in 200-PO-1 Groundwater OU; tightly bound to soil; half life (7,380 years)[l]		x		
Antimony-125					N	Last analyzed in 2006; from 1988 to present, 675 results from 113 wells; no regulatory limits available; short half life (2.77 years)[l]; will not contribute to dose if reached groundwater in 100 to 200 years	x	x		
Antimony-126	x				N	Short half life (12.4 days)[l]; will not contribute to dose if reached groundwater in 100 to 200 years		x		
Antimony-126m					N	Short half life (19.0 minutes)[k(l)]		x		
Astatine-217	x				N	Short half life (0.0323 seconds)[l]				
Barium-137m					N	Short half life (38.9 hours)[l]		x		
Beryllium-7	x				N	Short half life (53.44 days)[l]		x		
Bismuth-210	x				N	Short half life (5.012 days)[l]		x		
Bismuth-211	x				N	Short half life (2.14 minutes)[l]		x		
Bismuth-212					N	Short half life (60.6 minutes)		x		
Bismuth-213	x				N	Short half life (45.65 minutes)[l]		x		
Bismuth-214	x				N	Short half life (19.9 minutes)[l]		x		
Carbon-14	x				N	Last analyzed for in 2000; from 1988 to 2000, 20 results from 7 wells: zero detects and zero non-detects exceed regulatory limits; present in process waste; high mobility; half life (5,730 years)[l]	x	x		
Cerium/ Praseodymium-144	x				N	Short half life (284.3 days)[l]; tightly bound to soil; eliminated in FIR as COPC		x	x	
Cesium-134	x				N	Last analyzed for in 2006; from 1988 to present, 476 results from 89 wells; no regulatory limits available; short half life (2.062 years)[l]	x	x		
Cesium-135					N	Not analyzed for in 200-PO-1 Groundwater OU; bound tightly to soil; half life (2,300,000 years)[l]		x		

Table E-2. Radiological Contaminants of Potential Concern in 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (6 Pages)

COPCs	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA/RCRA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources [g]	COPCs Incorporated from 200-BP-5 OU[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Units Where Monitoring is Required[j]
Cesium-137	x	x			N	Last analyzed for in 2006; from 1988 to present, 1,078 results from 138 wells: zero detect and one non-detect exceed regulatory limits; values highest were in 216-A-36A crib at 847.0 Ci[j]; half life (30 years)[l]	x	x	x	A-AX Tank Farm
Chlorine-36					N	Not analyzed for in 200-PO-1 Groundwater OU; as discussed in PNNL-11800 based on ORIGEN2 runs, the chlorine activity would be about 0.025% of Tc-99 activity. The dose response factor (mrem/yr per pCi/L) would be about 10 times more than Tc-99. Thus any dose would be less than 1% of the Tc-99 dose K_d value of 0 in groundwater [m]; half life (301,000 years)[l]		x		
Cobalt-58	x				N	Short half life (70.8 days)[l]				
Cobalt-60	x	x	x	x	N	Last analyzed for in 2006; from 1988 to present, 1,078 results from 138 wells: zero detects and zero non-detects exceed regulatory limits; high k_d 1200 mL/g; largest quantities were released in 216-A-5 crib at 3.32 Ci[j]; half life (5.27 years)[l]	x	x	x	A-AX Tank Farm
Curium-242	x				N	Short half life (162.8 days)[l]; strongly bound to soil				
Curium-244	x				N	Not analyzed for in 200-PO-1 Groundwater OU; strongly bound to soil, will not reach groundwater; half life (18.1 years)[l]		x		
Curium-245	x				N	Not analyzed for in 200-PO-1 Groundwater OU; strongly bound to soil, will not reach groundwater; half life (8,500 years)[l]		x		
Europium-152	x				N	Last analyzed for in 2006; from 1988 to present, 287 results from 68 wells: zero detects and zero non-detects exceed regulatory limits; half life (13 years)[l]; strongly bound to soil; will decay before reaching groundwater	x	x		
Europium-154	x				N	Last analyzed for in 2006; from 1988 to present, 509 results from 94 wells: zero detects and zero non-detects; half life (8.8 years)[l]; strongly bound to soil; will decay before reaching groundwater	x	x		
Europium-155	x				N	Last analyzed for in 2006; from 1988 to present, 508 results from 93 wells: zero detects and zero non-detects exceed regulatory limits; half life (4.96 years)[l]; strongly bound to soil; will decay before reaching groundwater	x	x		
Francium-221	x				N	Short half life (4.8 minutes)[l]		x		
Francium-223	x				N	Short half life (21.8 minutes)[l]		x		
Gamma scan				x		See individual isotopes			x	A-AX Tank Farm 216-A-10 Crib
Gross alpha		x		x	Y	Last analyzed for in 2006; from 1988 to present, 2,919 results from 170 wells: 34 detects and zero non-detects exceed background; within the last 10 years 3 wells had more than one exceedance; not useful for risk assessment; eliminated in FIR as COPC, but used as a survey parameter.	x		x	A-AX Tank Farm 216-A-10 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond

Table E-2. Radiological Contaminants of Potential Concern in 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (6 Pages)

COPCs	PUREX Plant Source AAMS[(a)]	200 East Groundwater AAMS[(b)]	DQO for 200-BP-5 and 200-PO-1 OUs[(c)]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[(d)]	Retain as COPC for CERCLA/RCRA Actions[(e)]	Logic for CERCLA/RCRA Inclusion and Exclusion[(f)]	Other Sources [(g)]	COPCs Incorporated from 200-BP-5 OU[(h)]	RCRA FIR for 200-PO-1 COPCs[(i)]	RCRA TSD Units Where Monitoring is Required[(j)]
Gross beta		x		x	N	Last analyzed for in 2006; 3,368 results from 178 wells; not useful for risk assessment; but useful as a survey parameter.	x		x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 2101-M Pond 216-B-3 Pond
Iodine-129	x	x	x	x	Y	Last analyzed for in 2006; from 1988 to present, 1,364 results from 166 wells: 629 detects and 56 non-detects exceed regulatory limits; within the last 10 years 47 wells had more than one exceedance; part of a regional plume; potential dose contributor; values 0.107 found in 216-A-10 Crib[j]; FIR retained for analysis in monitoring wells; half life (15,700,000 years)[(l)]	x	x	x	A-AX Tank Farm
Iodine-131					N	Short half life (8 days)[(l)]			x	
Lead-209	x				N	Naturally occurring; short half life (3.253 hours)[(l)]		x		
Lead-210	x				N	Not analyzed for in 200-PO-1 Groundwater OU; naturally occurring, decay product; half life (22.3 years)[k(l)]		x		
Lead-211	x				N	Short half life (36.1 minutes) [(l)]		x		
Lead-212	x				N	Short half life (10.64 hours)[(l)]		x	x	
Lead-214	x				N	Short half life (26.8 minutes)[(l)]		x		
Manganese-54	x				N	Short half life (312.5 days)[(l)]				
Neptunium-237	x				Y	Not analyzed for in 200-PO-1 Groundwater OU; potential high mobility; long-lived alpha emitter; potential dose contributor; half life (2,140,000 years)[(l)]	x	x		
Neptunium-239	x				N	Not analyzed for in 200-PO-1 Groundwater OU; short half life (2.355 days)[(l)]		x		
Nickel-63	x				N	Last analyzed for in 2004; from 1988 to 2004, 13 results from one well; no regulatory limits available; tightly bound to soil, will not contribute to significant dose in 1,000-year period; half life (96 years)[(l)]	x	x		
Nickel-64	x				N	Short half life (2.5 hours)[(l)]				
Palladium-107	x				N	Not analyzed for in 200-PO-1 Groundwater OU; no analytical method for determination; half life (6,500,000 years)[(l)]				
Plutonium-238	x	x			N	Last analyzed for in 2003; from 1988 to 2003, 167 results from 58 wells: zero detects and zero non-detects exceed regulatory limits; tightly bound to soil	x	x	x	A-AX Tank Farm
Plutonium-239/240	x	x			N	Last analyzed for in 2003; 166 results from 57 wells: zero detects and zero non-detects exceed regulatory limits; tightly bound to soil	x	x	x	A-AX Tank Farm
Plutonium-241	x	x			N	Short half life (14.4 years)[(l)]		x	x	A-AX Tank Farm
Polonium-210	x				N	Short half life (138.38 days)[(l)]		x		
Polonium-213	x				N	Short half life (4.2 microseconds)[(l)]				
Polonium-214	x				N	Short half life (164.3 microseconds)[(l)]		x		
Polonium-215	X				N	Short half life (0.00178 seconds)[(l)]		x		
Polonium-218	X				N	Short half life (3.05 minutes)[(l)]		x		

Table E-2. Radiological Contaminants of Potential Concern in 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (6 Pages)

COPCs	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA/RCRA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	COPCs Incorporated from 200-BP-5 OU[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Units Where Monitoring is Required[j]
Potassium-40	X				N	Last analyzed for in 2006; from 1988 to present, 464 results from 77 wells; no regulatory limits; half life (1,280,000,000 years)[l]		x		
Promethium-147	X	x			N	Not analyzed for in 200-PO-1 Groundwater OU; short half life (2.62 years)[l]; values found at 1.99 Ci in 216-A-36B Crib; quantities disposed of numerous cribs		x		
Protactinium-231	X				Y	Not analyzed for in 200-PO-1 Groundwater OU; potentially mobile radionuclide; half life (32,800 years)		x		
Protactinium-233	X				N	Short half life (27 days)[l]				
Protactinium-234					N	Short half life (6.7 hours)[l]		x		
Protactinium-234m	X				N	Short half life (1.17 minutes)[l]		x		
Radium-223	X				N	Short half life (11.4 days)[l]		x		
Radium-224					N	Short half life (3.66 days)[l]		x		
Radium-225	X				N	Short half life (14.8 days)[l]		x		
Radium-226	X				N	Last analyzed for in 2000; from 1988 to 2000, 75 results from 7 wells; naturally occurring; tightly bound to soil	x	x	x	
Radium-228					N	Last analyzed for in 2000; from 1988 to 2000, 59 results from 5 wells; no regulatory limits available; Toxicity data (IRIS) under review with EPA; half life (5.75 years)[l]	x	x		
Radon-220					N	Short half life (55 seconds)[l]		x		
Radon-222					N	Short half life (3.8 days)[l]		x		
Rhodium-106					N	Short half life (30 seconds)[l]		x		
Ruthenium-101					N	Not analyzed for in 200-PO-1 Groundwater OU; stable isotope, not radioactive				
Ruthenium-103	X				N	Short half life (39.2 days)[l]			x	
Ruthenium-106	X	x			N	Short half life (368 days)[l]; tightly bound to soil; values found at 3.17 Ci in 216-A-36B Crib[j]; eliminated in FIR		x	x	
Samarium-151	X				N	Not analyzed for in Hanford Site groundwater; tightly bound to soil; will not reach groundwater in 1,000 years		x		
Selenium-79	X				Y	Not analyzed for in 200-PO-1 Groundwater OU; long half life (65,000 years); potential dose contributor		x		
Strontium-90	X	x	x	x	Y	Last analyzed for in 2006; from 1988 to present, 832 results from 102 wells: 52 detects and 3 non-detects exceed regulatory limits; within the last 10 years 2 wells had more than one exceedance; Part of process history; long half life (29 years)[l]; values found at 978.0 in 216-A-36A Crib[j]; FIR retained for analysis in monitoring wells	x	x	x	A-AX Tank Farm
Technetium-99	X		x	x	Y	Last analyzed for in 2006; from 1988 to present, 735 results from 146 wells: 13 detects and zero non-detects exceed regulatory limits; within the last 10 years 2 wells had more than one exceedance; Part of process history; long half life (214,000 years)[l]; very mobile	x	x	x	
Thallium-207	X				N	Short half life (4.77 minutes)[l]		x		

Table E-2. Radiological Contaminants of Potential Concern in 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (6 Pages)

COPCs	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA/RCRA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	COPCs Incorporated from 200-BP-5 OU[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Units Where Monitoring is Required[j]
Thallium-208	X				N	Short half life (3.07 minutes)[l]				
Thorium-227	X				N	Short half life (18.7 days)[l]		x		
Thorium-229	X				N	Not analyzed for in 200-PO-1 Groundwater OU; tightly bound to soil; will not reach groundwater in 1,000 years; half life (1.91 years)[l]		x		
Thorium-230	X				N	Not analyzed for in 200-PO-1 Groundwater OU; tightly bound to soil; will not reach groundwater in 1,000 years; half life (77,000 years)[l]		x		
Thorium-231	X				N	Short half life (25.5 hours)[l]		x		
Thorium-232					N	Last analyzed for in 1992; from 1988 to 1992, 6 results from 3 wells; no regulatory limits available; no data in IRIS; generally tightly bound to soil; half life (14,100,000,000 years)[l]	x	x		
Thorium-233	X				N	Not analyzed for in Hanford Site groundwater; cannot locate a half life				
Thorium-234	X				N	Short half life (24.1 days)[l]		x		
Tin-113	X	x			N	Not analyzed for in 200-PO-1 Groundwater OU; high k_d >50[m]; half life (115 years)[l]				
Tin-126	X				N	Not analyzed for in 200-PO-1 Groundwater OU; generally tightly bound to soil; half life (100,000 years)[l]				
Tritium	X	x	x	x	Y	Last analyzed for in 2006; from 1988 to present, 4,020 results from 183 wells: 2,085 detects and zero non-detects exceed regulatory limits; within the last 10 years 73 wells had more than one exceedance; part of a regional plume; potential dose contributor; values in 18,500 Ci in 216-A-10 Crib [k]; FIR retained for analysis in monitoring wells	x	x	x	A-AX Tank Farm 216-A-10 Crib 216-A-36B Crib 216-A-29 Ditch 216-B-3 Pond
Uranium-233/234	X				N	Last analyzed for in 1992; one result from one well: zero detect and zero non-detect exceed regulatory limits	x	x	x	A-AX Tank Farm 216-A-10 Crib 2101-M Pond
Uranium-234	X				Y	Last analyzed for in 2006; from 1988 to present, 111 results from 29 wells: 4 detects and zero non-detects exceed regulatory limits; potential dose contributor	x	x	x	A-AX Tank Farm 216-A-10 Crib 2101-M Pond
Uranium-235	X				N	Last analyzed for in 2006; from 1988 to present, 116 results from 29 wells: zero detects and 3 non-detects exceed regulatory limits; within the last 10 years one well had more than one exceedance; potential dose contributor	x	x	x	A-AX Tank Farm 216-A-10 Crib 2101-M Pond
Uranium-238	X	x			Y	Last analyzed for in 2006; from 1988 to present, 116 results from 29 wells: 5 detects and 3 non-detects exceed regulatory limits; within the last 10 years 2 wells had more than one exceedance; potential dose contributor; values found at 13.1 Ci in 216-A-19 Trench[k]	x	x	x	A-AX Tank Farm 216-A-10 Crib 2101-M Pond
Yttrium-90	X				N	Short half life (64.0 hours)[l]		x		
Zinc-65	X				N	Short half life (243.9 days)[l]		x	x	

Table E-2. Radiological Contaminants of Potential Concern in 200-PO-1 Groundwater Operable Unit: Source References and Retention Logic. (6 Pages)

COPCs	PUREX Plant Source AAMS[a]	200 East Groundwater AAMS[b]	DQO for 200-BP-5 and 200-PO-1 OUs[c]	DQO Integrated Groundwater Monitoring Network for RCRA/CERCLA/AEA[d]	Retain as COPC for CERCLA/RCRA Actions[e]	Logic for CERCLA/RCRA Inclusion and Exclusion[f]	Other Sources[g]	COPCs Incorporated from 200-BP-5 OU[h]	RCRA FIR for 200-PO-1 COPCs[i]	RCRA TSD Units Where Monitoring is Required[j]
Zirconium-93	X				N	Not analyzed for in 200-PO-1 Groundwater OU; generally bound tightly to soil; long lived radionuclide (1,530,000 years)[l]		x		
Zirconium/ Niobium-95					N	Short half life (63.9 days)[l]; eliminated in FIR as COPC		x	x	

[a]DOE/RL-92-04, *PUREX Source Aggregate Area Management Study Report.*
[b]DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study Report.*
[c]PNNL-14049, *Data Quality Objectives Summary Report- Designing a Groundwater Monitoring Network for the 200-BP-5 and 200-PO-1 Operable Units.*
[d]CP-15329, *Data Quality Objectives Summary Report for Establishing RCRA/CERCLA/AEA Integrated 200 West and 200 East Area Groundwater Monitoring Network.*
[e]COPCs are noted as "Y" or "N". "Y" represents constituents included as COPCs, and "N" represents a constituent that has been removed from the final list of COPCs
[f]Logic for COPC inclusion or exclusion from final list of COPCs
[g]Other sources refers to ancillary documents that provided duplicative COPCs; see below:
D&D-28283, *Sampling and Analysis Instruction for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit.*
DOE/RL-99-07, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan.*
DOE/RL-2000-60, *200-PW-2 Uranium Rich Process Waste Group Operable Unit RI/FS Work Plan and Process Waste RCRA TSD Unit Sampling Plan.*
DOE/RL-2001-01, *Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit RI/FS Work Plan: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units.*
DOE/RL-2001-66, *Chemical Laboratory Waste Group Operable Unit RI/FS Work Plan.*
DOE/RL-2002-11, *300-FF-5 Operable Unit Sampling and Analysis Plan.*
DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit.*
DOE/RL-2004-17, *Remedial Investigation Report for the 200-CS-1 Chemical Sewer Group Operable Unit.*
DOE/RL-2004-24, *Feasibility Study for the 200-CW-5 (U Pond/Z Ditches Cooling Water Waste Group), 200-CW-2 (S Pond and Ditches Cooling Water Waste Group), 200-CW-4 (T Pond and Ditches Cooling Water Waste Group), and 200-SC-1 (Steam Condensate Waste Group) Operable Units.*
DOE/RL-2004-39, *200-UR-1 Unplanned Release Waste Group Operable Unit Remedial Investigation/Feasibility Study Work Plan and Engineering Evaluation/Cost Analysis.*
DOE/RL-2004-66, *Feasibility Study for the BC Cribs and Trenches Area Waste Sites Hanford Site, Richland, Washington.*
[h]DOE/RL-2006-55, *Sampling and analysis Plan for FY 2006 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study.* COPCs noted here are from 200-BP-1 OU and WMP-28945, *Data Quality Objective Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study Process.*
[i]DOE/RL-95-100, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit.*
[j]RCRA treatment, storage, and disposal sites for 200-PO-1 Groundwater Operable Unit per analyte as presented in DOE/RL-95-100, *RCRA Facility Investigation Report for the 200-PO-1 Operable Unit.*
[k]Quantities listed in DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study Report.*
[l]Half lives from HEAST, EPA Radionuclide Table: Radionuclide Carcinogenicity-Slope Factors. http://www.epa.gov/radiation/heast/.
[m]K_d values from PNNL-11800, *Composite Analysis for Low Level Waste Disposal in the 200 Area Plateau of the Hanford Site.*

PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site.*

AAMS = aggregate area management study.
AEA = alpha energy analysis.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
COPC = contaminant of potential concern.
FIR = facility investigation report for the 200-PW-1 OU (DOE/RL-95-100; see footnote [i] above).
ORIGEN2 = Oak Ridge Isotope GENeration and depletion code.
OU = operable unit.
PUREX = Plutonium-Uranium Extraction (Plant or process).
RCRA = *Resource Conservation and Recovery Act of 1976.*
TSD = treatment, storage, and/or disposal (unit).

APPENDIX F

ALTERNATIVE CHARACTERIZATION METHODS

This page intentionally left blank.

APPENDIX F

ALTERNATIVE CHARACTERIZATION METHODS

Table F-1 summarizes characterization methods that may be used to supplement investigative measurements routinely used for Hanford Site aquifers, and includes references where appropriate.

Supplemental methods can be useful in two main ways, which are (1) as an aid for determining optimum locations for new wells, and (2) as a means for in situ estimation of factors such as effective porosity and contaminant retardation.

Table F-1. Hydrogeologic Field Characterization Methods. (2 Pages)

Method	Capabilities	Limitations
Surface and Borehole Geophysics		
Electrical Resistance Geophysical Method.	Profiles moisture and the distribution of conductive contaminants.	Depth resolution ~0 to 300 ft. Anomalies require review and identification of data artifacts. Most effective at differentiating high moisture zones.
High Resolution Reflection Seismic.	Used to investigate subsurface geologic structure (e.g., faults, stratigraphy).	Depth resolution 100 to 1,000 ft. Acquisition and processing expensive and difficult in glacial deposits, but can offset cost of well drilling. Requires accurate velocity models for interpreting depth to basalt. Does not resolve thin stratigraphic units. Anomalies require review and identification of data artifacts.
Magnetic Resonance Sounding.	Can identify water table and top of basalt.	Data acquisition limited by presence of power lines and metal structures.
Airborne and Ground Electromagnetics (EM) and Ground-Penetrating Radar (GPR).	Useful for measuring thickness of clay layers, delineating basement rock, and for identifying landfills, tanks, pipelines, and other buried structures.	Depth resolution of ground-based EM and GPR is limited to <75 ft. Airborne EM can penetrate up to 600 ft, but requires a line spacing of 1,000 to 1,700 ft for high resolution.
Cross-Borehole Geophysics.	Capable of tracing thin, fine-grained strata between boreholes.	Data resolution is affected by the distance between boreholes. Best results obtained when the well spacing is less than 500 ft.
Borehole Geophysical Logging.	Multiple downhole tool capabilities primarily include measurement of gamma emitting radionuclides and lithologic variability.	Most downhole tools require a minimum casing diameter of 4 to 6 in. Effectiveness of the tools is influenced by well construction and well diameter.
Single-Well Tracer Tests		
Multiple, Simultaneous Point-Dilution Tests.	Uses in situ sensing of a conservative tracer such as bromide to provide a vertical profile of hydraulic conductivity for the screened section of a well. Provides direct estimates of volumetric flow when calibrated for well construction. Can detect and quantify vertical flow in a borehole (Newcomer et al., 1996).	Test duration is dependent upon groundwater flow rate and ranges from a few hours to days. Detailed vertical resolution requires manual measurements.

Table F-1. Hydrogeologic Field Characterization Methods. (2 Pages)

Method	Capabilities	Limitations
Drift and Pumpback Test.	Yields direct estimates of effective porosity and groundwater flow velocity. Primary means for calibrating point-dilution tests to account for well construction (Hall 1993).	Accuracy of test results is dependent upon accurate knowledge of borehole hydraulic conductivity and local gradient.
Radial Injection-Withdrawal.	Direct in situ estimate of contaminant retardation. This type of test can sometimes be performed using innocuous chemical surrogates for hazardous or radioactive contaminants. (Schroth et al., 2001).	Performs best for physically homogeneous aquifer with spatially uniform dispersivity, and for linear equilibrium sorption.
Other Instrumental		
Groundwater Flow Meter.	Downhole instrument uses heat pulse technology to measure groundwater flow as low as 0.1 ft/day, as well as the direction of flow.	Indicated flow must be corrected for well construction. Accuracy of flow direction may depend on the location of the sensor within the cross-section of the borehole.

Hall, S. H., 1993, "Single-Well Tracer Tests in Aquifer Characterization," Ground Water Monitoring and Remediation, v. 13, no. 2, pp. 118-124.

Newcomer, D. R., S. H. Hall, and V. R. Vermuel, 1996, "Use of Improved Hydrologic Testing Methods and Borehole Geophysical Logging for Aquifer Characterization," Ground Water Monitoring and Remediation, v. 16, no. 1, pp. 67-72.

Schroth, M. H., J. D. Istok, and R. Haggerty, 2001, "In Situ Evaluation of Solute Retardation Using Single-Well Push-Pull Tests," *Advance in Water Resources*, v. 24, no. 1, pp. 105-117.

DISTRIBUTION

Onsite

1	U.S. Department of Energy Richland Operations Office	
	DOE Public Reading Room	H2-53
1	Pacific Northwest National Laboratory	
	Hanford Technical Library	P8-55
2	Lockheed Enterprise Solutions and Services	
	Document Clearance	H6-08
	Administrative Record	H6-08

This page intentionally left blank.