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- [ ] Internet
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- [x] Report

B. Document Number: DOE/RL-2010-105 Revision 0

C. Title: Annual Status Report (FY 2010): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site

D. Internet Address:

E. Required Information (MANDATORY)

1. Is document potentially Classified? (•) No ( ) Yes
   DE McKenney [signature]
   Manager Required (Print and Sign)
   If Yes: ADC Required (Print and Sign) (•) No ( ) Yes Classified
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3. Export Controlled Information (•) No ( ) Yes OUO Exemption No. 3
4. UCNI (•) No ( ) Yes
5. Applied Technology (•) No ( ) Yes
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9. Release Level? (•) Public ( ) Limited

F. Complete for a Journal Article

1. Title of Journal

G. Complete for a Presentation

1. Title for Conference or Meeting
2. Group Sponsoring
3. Date of Conference
4. City/State
5. Will Information be Published in Proceedings? ( ) No ( ) Yes
6. Will Material be Handed Out? ( ) No ( ) Yes

H. Information Owner/Author/Requestor: WE Nichols [signature] (Print and Sign)

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Approval by Direct Report to President (Speech/Articles Only) (Print and Sign)

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Information Clearance Approval

APPROVED FOR RELEASE — OFFICIAL DOCUMENT — KA — Date 01/11/2011

83pgs

A-6001-401 (REV 2)

CHPRC ADMINISTRATIVE DOCUMENT PROCESSING AND APPROVAL

DOCUMENT TITLE:	**OWNING ORGANIZATION/FACILITY:**
Annual Status Report (FY 2010): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site	CHPRC/EP&SP
Document Number: DOE/RL-2010-105	**Revision/Change Number:** 0

DOCUMENT TYPE *(Check Applicable)* [ ] Plan [X] Report [ ] Study [ ] Description Document [ ] Other

DOCUMENT ACTION *(Check One)* [X] New [ ] Revision [ ] Cancellation

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DOCUMENT CONTROL

Is the document intended to be controlled within the Hanford Document Control System (HDCS)? [X] Yes [ ] No

Does document contain scientific and technical information intended for public use? [X] Yes [ ] No

Does document contain controlled-use information [ ] Yes [X] No

("yes" requires information clearance review in accordance with PRC-PRO-IRM-184)

DOCUMENT REVISION SUMMARY

NOTE: Provide a brief description or summary of the changes for the document listed.

REVIEWERS — **Others**

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APPROVAL SIGNATURES

		RELEASE / ISSUE
Author: [signature]	11 JAN 2011 Date	JAN 11 2011 DATE: HANFORD RELEASE STA: 14 ID: 16
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Name: (print)	Date	

DOE/RL-2010-105
Revision 0

Annual Status Report (Fiscal Year 2010): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site

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

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

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DOE/RL-2010-105
Revision 0

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Date Published
January 2011

Prepared for the U.S. Department of Energy
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P.O. Box 550
Richland, Washington 99352

Release Approval   Date

Printed in the United States of America

Executive Summary

In accordance with the U.S. Department of Energy (DOE) requirements in DOE O 435.1 Chg 1,[1] *Radioactive Waste Management*, and implemented by DOE/RL-2000-29,[2] *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington*, the DOE Richland Operations Office (DOE-RL), also known as RL, has prepared this annual status report for fiscal year (FY) 2010 of PNNL-11800,[3] *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, hereafter referred to as the Composite Analysis. The main emphasis of DOE/RL-2000-29 is to identify additional data and information to enhance the Composite Analysis and the subsequent PNNL-11800 Addendum 1,[4] *Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, hereafter referred to as the Addendum, and to address secondary issues identified during the review of the Composite Analysis.

This document identifies additional data and information to be considered for purposes of an eventural update to the Hanford Site Composite Analysis.

Preliminary statements and conclusions contained herein do not take into consideration the site-wide cumulative groundwater modeling analyses present in the Tank Closure and Waste Management Environmental Impact Statement, and are not intended to foreclose reaching different conclusions in future uipdates of the Composite Analysis.

Until the final Tank Closure and Waste Management Environmental Impact Statement is completed and issued, preparation of an updated Hanford Site Composite Analysis is deferred.

As required by DOE/RL-2000-29, an annual evaluation of new information and data developed by a number of onsite programs during FY 2010 was completed and is summarized in this annual status report. This included the following work performed in FY 2010 that is considered pertinent to the Composite Analysis:

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[1] DOE O 435.1 Chg 1, 2001, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/current-directives/435.1-BOrder-c1/view.

[2] DOE/RL-2000-29, 2003, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington*, Rev. 2, U.S. Department of Energy Richland Operations Office, Richland, Washington.

[3] 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. Available at: http://www.osti.gov/energycitations/servlets/purl/594543-mUGcOH/webviewable/594543.pdf.

[4] PNNL-11800, 2001, *Addendum to Composite Analysis for Low Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, Addendum 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.pnl.gov/main/publications/external/technical_reports/pnnl-11800-adden-1.pdf.

- Groundwater flow and contamination monitoring
- Solid waste burial performance assessment (PA)
- Remediation science and technology program
- Integrated Disposal Facility PA and related research
- *Resource Conservation and Recovery Act of 1976*[5] (RCRA) corrective action programs
- Waste Management Area C PA
- Central Plateau remediation activities

This annual evaluation identified no information in any of the above activities that considered results of data collection and analysis from research, field studies, and monitoring that invalidates the continued adequacy of the current version of the Composite Analysis and Addendum as currently approved by the "Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities – Submittal of an Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site, PNNL-11800 Addendum 1," (DOE, 2002),[6]

DOE announced on January 30, 2006 its intent to prepare the Tank Closure and Waste Management Environmental Impact Statement (TC&WM EIS) for the Hanford Site pursuant to the *National Environmental Policy Act of 1969*[7] and its implementing regulations (40 CFR 1500-1508,[8] Chapter V, "Council on Environmental Quality," and 10 CFR 1021,[9] "National Environmental Policy Act Implementing Procedures"). A draft of the TC&WM EIS was released for public review and comment in

[5] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://www.epa.gov/epawaste/inforesources/online/index.htm.

[6] DOE, 2002, "Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities – Submittal of an Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site, PNNL-11800 Addendum 1," (memorandum to R. Schepens, Manager, U.S. Department of Energy, Office of River Protection, and K.A. Klein, Manager, U.S. Department of Energy, Richland Operations Office), from M.W. Frei, U.S. Department of Energy, Office of Environmental Management, Washington, D.C., September.

[7] *National Environmental Policy Act of 1969*, 42 USC 4321, et seq. Available at: http://ceq.hss.doe.gov/Nepa/regs/nepa/nepaeqia.htm.

[8] 40 CFR 1500-1508, Chapter V, "Council on Environmental Quality," Part 1500, "Purpose, Policy, and Mandate," through Part 1508, "Terminology and Index," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_08/40cfrv31_08.html.

[9] 10 CFR 1021, "National Environmental Policy Act Implementing Procedures," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_08/10cfr1021_08.html.

October 2009 (DOE/EIS-0391, *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*).[10] The Hanford Site is deferring any revision of the Composite Analysis until the final TC&WM EIS is issued.

This report generally covers FY 2010 (i.e., October 1, 2009 through September 30, 2010). The format for this report follows requirements in DOE G 435.1-1,[11] *Implementation Guide for Use with DOE M 435.1-1.*

This report is organized into the following chapters:

- Chapter 1 provides an introduction and description of the report organization.
- Chapter 2 discusses the status of Composite Analysis activities.
- Chapter 3 summarizes recent onsite monitoring, research, and development results that are relevant to the current Composite Analysis.
- Chapter 4 summarizes key site changes that could affect the Composite Analysis.

[10] DOE/EIS-0391, *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*, U.S. Department of Energy, Richland, Washington.
Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180376.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180377.
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http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180374.
http://www2.hanford.gov/arpir/?content=findpage&AKey=0912180375

[11] DOE G 435.1-1, 1999, *Implementation Guide for Use with DOE M 435.1-1*, U.S. Department of Energy, Washington, D.C. Available at: https://www.directives.doe.gov/directives/current-directives/435.1-EGuide-1ch1/view.

- Chapter 5 summarizes recommended changes to the Composite Analysis.
- Chapter 6 summarizes planned Composite Analysis revisions.
- Chapter 7 contains the references cited in this report.

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R.D. Hildebrand (DOE-RL) S.P. Luttrell (CHPRC)	Summary of Groundwater Monitoring
R.D. Hildebrand (DOE-RL) M.I. Wood (CHPRC)	Solid Waste Burial Ground Performance Assessments
K.M. Thompson (DOE-RL) S.W. Petersen (CHPRC) N. Bowles (CHPRC) M.D. Freshley (PNNL)	Hanford Site Science and Technology Program
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R.W. Lober (DOE-ORP) S.J. Eberlein (WRPS)	Tank Farm RCRA Corrective Action Program
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M.E. Burandt (DOE-ORP)	Tank Closure and Waste Management Environmental Impact Statement
B.L. Charboneau (DOE-RL) M. Hickey (CHPRC) T.B. Bergman (CHPRC)	Remedial Investigation, Feasibility Study, and Remediation Activities for the Central Plateau Source Operable Units
J.G. Morse (DOE-RL) M.H. Doornbos (CHPRC)	Remedial Investigation, Feasibility Study, and Remediation Activities for the Central Plateau Deep Vadose Zone Operable Unit
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CHPRC = CH2M HILL Plateau Remediation Company
DOE-ORP = U.S. Department of Energy, Office of River Protection
PNNL = Pacific Northwest National Laboratory

Name (Affiliation)	Topic Areas
WCH = Washington Closure Hanford	
WRPS = Washington River Protection Solutions	

Contents

Tables

Figure

Terms

AEA	*Atomic Energy Act of 1954*
ARAR	applicable or relevant and appropriate requirement
BRA	baseline risk assessment
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CHPRC	CH2M HILL Plateau Remediation Company
COC	contaminant of concern
COPC	contaminant of potential concern
CSB	Canister Storage Building
CY	calendar year
DOE	U.S. Department of Energy
DOE-ORP	DOE Office of River Protection (also known as ORP)
DOE-RL	DOE Richland Operations Office (also known as RL)
DQO	data quality objective
DVZTT	deep vadose zone treatability test
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ETF	Effluent Treatment Facility
F&T	fate and transport
FS	feasibility study
FY	fiscal year
HCP EIS	*Hanford Comprehensive Land-Use Plan Environmental Impact Statement*
HHE	human health and the environment
HLW	high-level waste
HRC	hydrogen release compound
IDF	Integrated Disposal Facility

IFRC	Integrated Field Research Challenge
IRA	interim remedial action
ISRM	in situ REDOX manipulation
LAW	low-activity waste
LLW	low-level waste
N/A	not applicable
NEPA	*National Environmental Policy Act of 1969*
NRC	U.S. Nuclear Regulatory Commission
OU	operable unit
PA	performance assessment
PFP	Plutonium Finishing Plant
PNNL	Pacific Northwest National Laboratory
PRB	permeable reactive barrier
PUREX	Plutonium Uranium Extraction (Plant)
RAG	remedial action goal
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	reduction/oxidation
RI	remedial investigation
ROD	record of decision
S&GRP	Soil and Groundwater Remediation Project
SAP	sampling and analysis plan
SNF	spent nuclear fuel
SST	single-shell tank
STOMP	*Subsurface Transport Over Multiple Phases* (software code)
STORM	*Subsurface Transport Over Reactive Multiphases* (software code)
SVE	soil vapor extraction
TC&WM EIS	Tank Closure and Waste Management Environmental Impact Statement
TPA	Tri-Party Agreement
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU	transuranic

UPR	unplanned release
WCH	Washington Closure Hanford
WIPP	Waste Isolation Pilot Plant
WMA	waste management area
WRPS	Washington River Protection Solutions
WTP	Waste Treatment Plant

1 Introduction

As required by the U.S. Department of Energy (DOE) in DOE O 435.1, *Radioactive Waste Management,* and implemented by DOE/RL-2000-29, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeastern Washington*, the DOE Richland Operations Office (DOE-RL), also known as RL, has prepared this annual status report for fiscal year (FY) 2010 of PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, hereafter referred to as the Composite Analysis. The main emphasis of DOE/RL-2000-29 is to identify additional data and information that will enhance the Composite Analysis and the subsequent PNNL-11800 Addendum 1, *Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, hereafter referred to as the Addendum, and to address secondary issues identified during review of the Composite Analysis.

1.1 Composite Analysis Annual Summary Report Requirements

DOE O 435.1 requires that the Hanford Site maintain site performance assessments (PAs) and composite analyses. Requirements for composite analysis maintenance under DOE M 435.1-1 Chg 1, *Radioactive Waste Management Manual*, are the same as those for PA maintenance and are described in Chapter 3 of DOE G 435.1-3, *Maintenance Guide for U.S. Department of Energy Low-Level Waste Disposal Facility Performance Assessments and Composite Analyses*. The current plan for maintaining the Composite Analysis for the Hanford Site is described in DOE/RL-2000-29.

DOE M 435.1-1 requires routine review and revision of PAs and composite analyses. The objective of routine review and revision is to ensure that the PAs and composite analyses are updated appropriately, whenever changes in their bases (assumptions, parameters, etc.) are contemplated or effected, in order to maintain the validity and effectiveness of the controls that are based on the PA and composite analysis. These reviews provide a mechanism for routine assessment of the site plans (e.g., remediation, closure, decommissioning, and land use) developed from the results of a composite analysis. This review process allows potential problems to be identified and managed at an early stage. The revisions ensure cohesive documentation providing a reasonable basis to conclude that DOE requirements for radiological protection of the public and the environment will be met in the future. The composite analysis is a planning tool that allows evaluation of the cumulative effects of all sources of radioactive materials that may interact with those in the low-level waste (LLW) disposal facility. The impact of future activities on the dose to hypothetical future members of the public can be evaluated using the composite analysis, and the results used to develop land use plans, remediation plans, or long term stewardship documents. The annual review of the composite analysis is used to determine whether actual and planned conditions are consistent with those contained in the composite analysis. Revisions and special analyses provide a mechanism for evaluating conditions not originally included in the composite analysis to determine if these said conditions could be accommodated without violating the conclusions of the composite analysis.

The following text is quoted from DOE G 435.1-1 Chg 1, *Implementation Guide for use with DOE M 435.1-1*:

> *IV.P (4) Performance Assessment and Composite Analysis Maintenance.*
> *The performance assessment and composite analysis shall be maintained to evaluate changes that could affect the performance, design, and operating bases for the facility. Performance assessment and composite analysis maintenance shall include the conduct of research, field studies, and monitoring needed to address uncertainties or gaps in existing data. The performance assessment shall be updated to support the final facility closure. Additional iterations of the performance assessment and composite analysis shall be conducted as necessary during the post-closure period.*

Performance assessments and composite analyses shall be reviewed and revised when changes in waste forms or containers, radionuclide inventories, facility design and operations, closure concepts, or the improved understanding of the performance of the waste disposal facility in combination with the features of the site on which it is located alter the conclusions or the conceptual model(s) of the existing performance assessment or composite analysis.

The statements also appear in DOE M 435.1-1 and constitute the requirements for maintaining a PA or composite analysis. Further guidance is found in DOE G 435.1-3. The documents that have been prepared to maintain the Composite Analysis are listed in Table 1-1.

1.2 Composite Analysis Annual Status Report Content

The format for this report follows requirements established by DOE G 435.1-1. This report covers FY 2010 (i.e., October 1, 2009 through September 30, 2010). Chapter 2 provides a status of Composite Analysis activities. Chapter 3 summarizes recent onsite monitoring and research and development results that are relevant to the current Composite Analysis, and Chapter 4 summarizes key site changes that could affect the Composite Analysis. Chapter 5 summarizes recommended changes to the initial Composite Analysis, and Chapter 6 summarizes planned Composite Analysis revisions.

Table 1-1. Maintenance Documents for the Composite Analysis and Addendum

Reporting Period	Annual Status Report
FY 2001	Hildebrand and Bergeron (2002), *Annual Status Report: Composite Analysis for Low-Level Waste Disposal in the 200 Area of the Hanford Site*
FY 2002	DOE/RL-2003-26, Rev. 0, *Annual Status Report: Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*
FY 2003	DOE/RL-2004-12, Rev. 0, *Annual Status Report (FY 2003): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*
FY 2004	DOE/RL-2005-58, Rev. 0, *2004 Annual Status Report for the Composite Analysis of Low-Level Disposal in the Central Plateau at the Hanford Site*
FY 2005	DOE/RL-2006-28, Rev. 0, *Annual Status Report (FY 2005): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*
FY 2006, 2007	DOE/RL-2008-43, Draft, *Annual Status Report (FY 2007): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*
FY 2008	DOE/RL-2009-82, Rev. 1, *Annual Status Report (FY 2008): Composite Analysis of Low-level Waste Disposal in the Central Plateau at the Hanford Site*
FY 2009	DOE/RL-2009-132, Rev. 0, *Annual Status Report (FY 2009): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*
FY 2010	DOE/RL-2010-105 (this report), *Annual Status Report (FY 2010): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*

2 Status of Composite Analysis Activities

On January 30, 2006, DOE announced its intent to prepare a new environmental impact statement (EIS) for the Hanford Site. The Tank Closure and Waste Management Environmental Impact Statement (TC&WM EIS), DOE/EIS-0391, *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*, will provide a single integrated analysis of groundwater for most waste types managed at the Hanford Site. Additionally, the scope of 69 FR 50178, "Notice of Intent to Prepare an Environmental Impact Statement for the Decommissioning of the Fast Flux Test Facility at the Hanford Site, Richland, Washington," was merged into the scope of the TC&WM EIS to integrate currently foreseeable activities related to waste management and cleanup at the Hanford Site. Any revision to the Composite Analysis is being deferred until the final TC&WM EIS has been issued. Consequently, there is no need to revise the maintenance plan for the Composite Analysis (DOE/RL-2000-29) until after the TC&WM EIS has been issued.

3 Summary of Activities Relevant to the Composite Analysis

This chapter describes the status of Hanford Site activities in FY 2010 relevant to the Composite Analysis, including monitoring, modeling, research and development, and characterization activities. These specific activities are summarized as follows:

- Summary of the groundwater flow conditions and extent of groundwater contamination determined from monitoring
- Results of the solid waste burial ground PA
- Results of the Remediation Science and Technology program
- Results from relevant DOE Office of River Protection (DOE-ORP), also known as ORP, and DOE-RL programs including research activities associated with the Integrated Disposal Facility (IDF) PA, the Tank Farm *Resource Conservation and Recovery Act of 1976* (RCRA) Correction Action and Closure Program, the Waste Management Area (WMA) C PA, and the TC&WM EIS
- Results from remedial investigation (RI)/feasibility study (FS) activities in the Central Plateau areas that include waste site source and groundwater remediation and other activities including the Environmental Remediation Disposal Facility (ERDF)

Consideration of these activities with respect to the Composite Analysis and subsequent Addendum revealed no information that would be expected to, if included in a revised calculation, result in higher dose estimates. Some remedial activities (e.g., pump-and-treat systems) would be qualitatively likely to reduce the projected dose due to removal of contaminant mass from the groundwater pathway, given these activities were not incorporated into the Composite Analysis.

3.1 Summary of Groundwater Flow Conditions and Extent of Contamination

Results discussed below reflect the sampling and analyses completed in 2009 that were reported in DOE/RL-2010-11, *Hanford Site Groundwater Monitoring and Performance Report for 2009 Volumes 1 and 2*, and summarized in DOE/RL-2009-82, *Annual Status Report (FY 2008): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site*. DOE approval of this report constitutes approval of the appropriateness of this monitoring program. This Composite Analysis annual status summarizes the results of for FY 2009, which were analyzed and reported in FY 2010.

The natural pattern of groundwater flow was altered during the Hanford Site's operating years by water table mounds created from the discharge of large volumes of wastewater to the ground. These mounds were present in each reactor area and beneath the 200 Areas. Since effluent disposal decreased significantly in the 1990s, these mounds have dissipated in the reactor areas and have declined considerably in the 200 Areas. Declining water levels from the mounding continue to affect groundwater flow and depth to water.

Solid waste disposal constitutes one of the sources of radioactive waste inventory; estimates of the current inventory and projections of future inventory disposal in the solid waste burial grounds are refined regularly as additional data continue to be collected and reported through maintenance of the solid waste burial ground performance assessment. This updated information is pertinent to the Composite Analysis because of its potential to change the solid waste burial ground inventory evaluated in the Composite Analysis.

Table 3-1 provides a comparison of the areal extent of key radiological contaminant plumes in groundwater at levels above drinking water standards (DWSs) in 2009. Of the radionuclides, tritium and iodine-129 continue to have the largest areas where concentrations exceed DWSs. The largest plumes of these contaminants had their sources in the 200 East Area and extend east and southeast. Extensive tritium and iodine-129 plumes are also present in the 200 West Area.
Technetium-99 concentrations exceed standards in plumes within both the 200 East and 200 West Areas. One uranium plume and one technetium-99 plume have moved northward from the 200 East Area. Technetium-99 plumes are present at each of the single-shell tank (SST) farm WMAs.

Table 3-1. Area of Radionuclide Contaminant Plumes at Levels above Drinking Water Standards

Constituent	Drinking Water Standard	FY 2008 (km^2)*	FY 2009 (km^2)*
Iodine-129	1 pCi/L	65.6	58.8
Strontium-90	8 pCi/L	2.3	1.9
Technetium-99	900 pCi/L	2.4	2.4
Tritium	20,000 pCi/L	127.0	126.5
Uranium	30 µg/L	1.5	1.5

* To obtain mi^2, multiply km^2 by 0.386.

Plumes of uranium (an element that is less mobile than tritium), iodine-129, and technetium-99 are found in groundwater within the 200 East, 200 West, and 300 Areas. Strontium-90 is even less mobile in groundwater, but concentrations of this contaminant exceed standards in the 100 Areas, in the 200 East Area, and beneath the former Gable Mountain Pond. Other radionuclides, including cesium-137, cobalt-60, and isotopes of plutonium that are even less mobile in the subsurface, exceed DWSs in very few wells.

3.2 Integrated Disposal Facility Performance Assessment

DOE approved DOE/ORP-2000-24, *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version*, in 2001 ("Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities – Revision 2" [DOE, 2001]). Continuation of the Hanford Site disposal authorization in "*Review of the Annual Summary of the Hanford Immobilized Low-Activity Waste Preformance Assessment for 2003*" (Frei, 2003) was based in part on RPP-15834, *Integrated Disposal Facility Risk Assessment*. The responsibility for the IDF PA was transferred to DOE-RL. While some planning activities have continued in FY 2010, the IDF PA is currently on hold pending the issue of a final TC&WM EIS and record of decision (ROD). A schedule for completion of the IDF PA is in development and will be dependent on research and DOE M 435.1-1 activities that are the responsibility of DOE-ORP.

3.3 Solid Waste Burial Ground Performance Assessment

In the annual review of the Hanford Site solid waste PA for FY 2010, the projected dose estimates from radionuclide inventories disposed in the active low level burial grounds, from September 26, 1988 through September 30, 2010, were calculated using the dose methodology developed in the original solid waste PA analyses (WHC-SD-WM-TI-730, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*; WHC-EP-0645, *Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds*). These estimates were compared with performance objectives defined in DOE O 435.1 and its companion documents (DOE M 435.1-1; DOE G 435.1-1). The performance objectives are currently satisfied, and operational waste acceptance criteria and waste acceptance practices continue to be sufficient to maintain compliance with performance objectives. In the 2010 PA review for waste disposed between October 1, 2009 and September 30, 2010, dose estimate increases from disposed waste for groundwater contamination scenarios occurred only at the 200 West Area burial grounds and were essentially negligible. A minimal dose increment was observed because LLW and mixed low-level waste disposal is now limited to the double lined mixed waste trenches (Trenches 31 and 34) in the 200 West Area. Both volumes (< 1,000 m^3) and radionuclide inventories (< 0.05 Ci of long-lived mobile radionuclides) in FY 2010 were small compared to the accumulated waste from previous years. Naval reactor compartment waste was also disposed in Trench 94 in the 200 East Area burial grounds. Overall, there are no changes to the conclusions of the PA analyses.

A final set of diffusion half cell experiments were completed to evaluate technetium-99 diffusion into and out of fractured concrete with Hanford formation sand being the source or receptor of the contaminant. The experiments were completed at 4 wt percent moisture, and the concrete sample properties were varied with respect to iron content (0 to 12 percent by weight) and carbonation. The estimated diffusion coefficients ranged between 10^{-10} and 10^{-11} cm^2/s in all cases with diffusion being maximized by carbonation and minimized by the combination of noncarbonation and higher iron content. A summary report is being prepared to compare all half cell data collected over the last several years.

Additional information was also collected to understand the evolution of uranium-bearing precipitates that occurs in concrete dominated chemical environments with continued waste water interactions. Previous experimental work indicates that initial uranium-bearing precipitates that form under grout dominated geochemical conditions (soddyite, becquerelite, uranophane, and autinite) give way to more stable secondary phases. Extended X-ray absorption fine structure spectroscopic analyses of these materials were completed to complement the scanning electron microscopy energy dispersive system data collected previously and confirmed the previous findings. Overall, stable uranium-bearing phases are expected to be present indefinitely in this geochemical environment. A summary report is being prepared to recommend long-term solubility values for uranium in both concrete and soil dominated geochemical environments.

Finally, accelerated grout weathering experiments were initiated using the pressurized unsaturated flow system. In this system, test materials (in this case, grout and sand) are placed in flow through columns, which can establish and maintain unsaturated flow. Flow rates are accelerated to allow the passage of many pore volumes through the column, simulating thousands of years of behavior in a relatively short time. The system is also capable of monitoring and controlling the partial pressure of gases and measuring on a real time basis, mass balance, fluid pH, and conductivity. This information, coupled with standard effluent chemistry analyses and post experimental solids characterization, provides a detailed understanding of weathering effects on soil mineralogy, fluid chemistry, and physical characteristics. In these initial experiments, about 100 pore volumes passed through the flow columns showing rapid reduction in calcium, silica, potassium, and sodium during the first 10 pore volumes followed by relatively constant concentrations thereafter. Rhenium, which was added as an example of a mobile constituent, decreased rapidly in concentration for 10 pore volumes and then continued to decrease at a slower rate thereafter. Solid material characterization will be conducted in the next FY to determine changes in mineralogy.

3.4 Remediation Science and Technology

The Hanford Site uses science and technology investigations to provide new knowledge, data, and tools needed to accomplish the mission of the Soil and Groundwater Remediation Project (S&GRP).

This mission includes investigating technologies to improve characterization and remediation of contaminated soil sites and groundwater and resolving key technical issues that help inform and influence decisions for remediation and closure. To accomplish this, CH2M HILL Plateau Remediation Company (CHPRC) continued to fund the Remediation Science and Technology project in FY 2010. On this project, progress was made on increasing efficiency of groundwater extraction and injection wells, testing sampling techniques to minimize purge water generation, measuring vertical profiles in groundwater wells, determining carbon tetrachloride hydrolysis rates, and refining groundwater recharge measurements. CHPRC also funded treatability testing activities for the soil desiccation technology and reactive gas treatment of uranium. A project funded by the DOE Office of Science made progress on the study of uranium mass transfer to update the conceptual model of the 300 Area.

Plans for a significant increase in groundwater treatment in the Central Plateau, using a new treatment facility that began construction in FY 2010, prompted tests of alternative well development technologies. These tests employed down-hole tools that released high-energy, rapidly pulsating bursts of gas directed toward the well screen and formation. This creates a shock wave and oscillating gas bubbles that help to loosen and remove mineral scale and biological build up from the well screen, gravel pack, and adjacent aquifer, without the use of explosives and minimizing purge water. Tests were performed with two different tools, with one (the Hydropuls® tool) clearly superior to the other. This technology may be used to maintain and enhance extraction and injection volumes to maintain the efficiency of the pump-and-treat system.

Tests of low flow purging were conducted to evaluate this technology as a means of collecting groundwater samples without generating large volumes of purge water. Current groundwater sampling methods generally consist of removing three water column volumes from the well while monitoring groundwater stabilization parameters. When the prescribed volume of groundwater is purged and parameters stabilize to procedural criterion, then sampling is completed. Low flow purging and sampling use an adjustable rate pump to deliver groundwater to the surface to recover samples at low discharge rates (less than 400 ml/min [0.106 gal/min]). Tests were performed in 25 wells, and the results were compared to purged samples to evaluate comparability of the two data sets. These tests will continue into FY 2011, but preliminary data indicate that the low-flow samples are representative of formation water quality and provide the added benefit of minimizing well drawdown and minimizing collection of samples that are exposed to air while reducing purge waste water volumes and the cost of routine groundwater sampling.

To aid in the refinement of conceptual and numeric models, project planning, and remediation optimization, profiling of hydraulic conductivity was tested using Colog's HydroPhysical™ logging technology. This technique emplaces distilled water in a well then logs the temperature and conductivity as the water is displaced under both natural and induced gradients. The data are then analyzed to both horizontal and vertical flow through the well. The tests were performed in eight wells located in diverse hydrogeologic regimes.

In 2004, Lawrence Berkeley National Laboratory began field experiments in the 100-H Area designed to test the effectiveness of a hydrogen release compound (HRC), a slow release glycerol polylactate, for long-term, in situ bioimmobilization of hexavalent chromium (Cr(VI)) in groundwater. The experiment used a combination of hydrogeological, geophysical, geochemical, and microbiological measurements and analyses of water samples and sediments to evaluate the effectiveness and persistence of HRC. The results of this experiment show that a single HRC injection into groundwater stimulates an increase in biomass, a depletion of terminal electron acceptors O_2, NO_3^-, and SO_4^{2-}, and an increase in

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Fe^{2+}, resulting in a significant decrease in soluble Cr(VI). The Cr(VI) concentration remained below the background concentration for more than three years after the HRC injection. In the summer of 2010, more HRC was injected to evaluate the sustainability of Cr(VI) reductive bioimmobilization further under different reduction/oxidation (REDOX) conditions, followed by injection of nitrate to evaluate response of microorganisms to rapid reoxidation. Lawrence Berkeley National Laboratory is also coordinating sampling and analysis efforts in HR-3 with CHPRC to establish a better understanding of the behavior of Cr(VI) in groundwater.

Laboratory measurements continued to help address uncertainties related to the rates of hydrolysis in groundwater for carbon tetrachloride and chloroform. The ongoing study explored the possible effects of contact with minerals and sediment (i.e., heterogeneous hydrolysis) on these rates. Upcoming remediation decisions will rely on an improved conceptual model of the plume as well as mechanistic information concerning the fate and transport (F&T) of carbon tetrachloride and chloroform. A key aspect of these decisions will be to determine the contribution of natural attenuation to stabilize the plume. Of the possible natural attenuation mechanisms, biodegradation is not likely to contribute significantly, and abiotic degradation processes such as hydrolysis and reduction are likely to contribute significantly to natural attenuation. Results to date suggest that heterogeneous hydrolysis rates are higher at groundwater temperatures than would be predicted from the open literature. As previously indicated, hydrolysis rates are significantly enhanced by sorption of carbon tetrachloride to Hanford Site sediments.

Recharge provides the primary driving force for transporting contaminants from the vadose zone to the underlying aquifer system. Quantification of recharge rates is important for assessing contaminant F&T and evaluating remediation alternatives. The recharge activity provided an update of the soil water balance and recharge monitoring performed at the Hanford Site for FY 2009. Recharge rates depend on three main factors (soil, vegetation, and climatic conditions) that are highly variable in both space and time. The results presented in PNNL-19945, *Soil Water Balance and Recharge Monitoring at the Hanford Site – FY 2010 Status Report,* show that temperatures and precipitation did not present an opportunity for enhanced recharge, and normal conditions prevailed.

A treatability test of soil desiccation is underway as part of the deep vadose zone treatability test (DVZTT) plan activities (DOE/RL-2007-56, *Deep Vadose Zone Treatability Test Plan for the Hanford Central Plateau*). Specific activities identified for treatability testing of desiccation included modeling analyses, laboratory analyses, and a field test. Modeling and laboratory elements supporting design of the DVZTT were completed in FY 2010 in support of DOE/RL-2010-04, *Field Test Plan for the Soil Desiccation Pilot Test.*

The DVZTT plan activities also include evaluation of reactive gas approaches for mitigating uranium transport through the vadose zone (DOE/RL-2007-56). Initial laboratory studies identified ammonia gas treatment as most promising for field testing among tested technologies (PNNL-18879, *Remediation of Uranium in the Hanford Vadose Zone Using Gas-Transported Reactants: Laboratory-Scale Experiments*). FY 2010 laboratory efforts focused on providing the design information needed for developing a field test plan (DOE/RL-2010-87, *Field Test Plan for the Uranium Sequestration Pilot Test*). Additional efforts under the DVZTT effort included initial evaluation of soil flushing (PNNL-19938, *Evaluation of Soil Flushing for Application to the Deep Vadose Zone in the Hanford Central Plateau*) and in situ grouting technologies.

DOE-RL also completed DOE/RL-2010-89, *Long-Range Deep Vadose Zone Program Plan*. That document summarizes the state of knowledge about contaminant cleanup challenges facing the deep vadose zone beneath the Central Plateau and identifies investment targets and opportunities. These opportunities were organized into broad categories of controlling processes that establish the linkages between hydrology, geochemistry, and microbiology; predictive modeling and data integration to depict subsurface dynamics, contaminant behavior, and remedial performance; remedial design to protect the underlying aquifer by reducing contaminant flux; and monitoring and characterization. The approach is designed to solve these challenges with input from a broad program, including investments by DOE-RL, DOE Environmental Management, and the DOE Office of Science. A Deep Vadose Zone Applied Field Research Center will provide framework for research investments and link directly to the remediation efforts associated with the 200-DV-1 Deep Vadose Zone Operable Unit (OU) that was also recently formed (Chapter 4.2).

Uranium mass transfer is being investigated in the 300 Area for the Integrated Field Research Challenge (IFRC) project funded by the DOE Office of Science. During FY 2010, field experiments continued to characterize the site and uranium behavior. These experiments included a second passive experiment to monitor uranium mobilization within a "smear zone" that coincides with historic water table rise and fall resulting in uranium deposition in vadose zone sediments. The peak in river flow was achieved during the third week in June 2010, and the runoff profile was markedly different from previous years. This experiment has some common elements to the one performed last year, but it is supported by three new shallow wells that specifically monitor the fluctuating water table region yielding a significantly more robust data set. Additionally, packers were placed in the central low conductivity zone of all fully screened wells to mitigate vertical flows, and periodic electromagnetic borehole flow meter measurements were taken in all wells to evaluate packer effectiveness at different river elevations. An elaborate three-salt tracer experiment was performed in the upper high conductivity zone to trace the movement of uranium released from the vadose zone. Initial results of this year's experiment validate the occurrence of a significant uranium recharge event during spring high water. Additionally, the results of the multi-solute transport experiment suggest the presence of a low hydraulic conductivity anomaly in the region of high vadose zone recharge of uranium to groundwater. Results from that experiment are currently being compiled and evaluated. Progress at the IFRC is reported quarterly through the project Web site (http://ifchanford.pnl.gov/documents/).

Efforts to reduce the flux of strontium-90 to the Columbia River from past-practice liquid waste disposal sites have been underway since the early 1990s in the 100-N Area at the Hanford Site. Following an evaluation of potential strontium-90 treatment technologies and their applicability under 100-N hydrogeologic conditions, DOE, the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology) agreed that the long-term strategy for groundwater remediation at the 100-N Area should include apatite sequestration as the primary treatment technology. This agreement was based on results from an evaluation of remedial alternatives that identified the apatite permeable reactive barrier (PRB) technology as the approach showing the greatest promise for reducing strontium-90 flux to the Columbia River at a reasonable cost. As a result, aqueous injection (i.e., the introduction of apatite-forming chemicals into the subsurface through standard injection wells) was selected as the preferred technology for treatability testing. The generalized approach for developing an in situ remedial technology for the sequestration of strontium-90 in groundwater through the formation of calcium-phosphate mineral phases (i.e., apatite) was initially documented in DOE/RL-2005-96, *Strontium-90 Treatability Test Plan for 100-NR-2 Groundwater Operable Unit*. Previous activities completed in support of this technology development included laboratory scale studies (PNNL-16891, *Hanford 100-N Area Apatite Emplacement: Laboratory Results of Ca-Citrate-PO4 Solution Injection and Sr-90 Immobilization in 100-N Sediments*), two pilot scale field tests (PNNL-17429, *Interim Report: 100-NR-2 Apatite Treatability Test: Low-Concentration Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization*), initial installation of a 91 m (300 ft) long PRB using a low concentration formulation (PNNL-17429) followed by sediment core sampling (PNNL-18303, *Sequestration of Sr-90 Subsurface Contamination in the Hanford 100-N Area by Surface Infiltration of a Ca-Citrate-Phosphate Solution*), and additional high concentration injections conducted in 2008 over the existing 91.4 m (300 ft) PRB under Addendum 1 to DOE/RL-2005-96.

During FY 2010, a preliminary evaluation based on sediment core samples collected in November 2009, more than a year after the high concentration injections, was presented in PNNL-19524, *Hanford 100-N Area In Situ Apatite and Phosphate Emplacement by Groundwater and Jet Injection: Geochemical and Physical Core Analysis*. The results indicate that the phosphate precipitation was relatively uniform up to 4.8 m (15.7 ft) from the injection well studied. The sediment cores indicated an average treatment of 100 percent of the targeted apatite content within the Hanford formation and 50 percent treatment within the Ringold Formation. Additionally, performance monitoring of the 91.4 m (300 ft) PRB demonstrated that groundwater strontium-90 concentrations decreased by 90 percent in the existing barrier as a result of previous injections as reported in PNNL-SA-70033, *100-NR-2 Apatite Treatability Test FY09 Status: High Concentration Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization*, and in PNNL-19572, *100-NR-2 Apatite Treatability Test: High-Concentration Calcium-Citrate-Phosphate Solution Injection for In Situ Strontium-90 Immobilization.*

Treatability testing of jet injection technology for delivery of phosphate, pre-formed apatite, and phosphate combined with pre-formed apatite was also conducted during FY 2010 under Addendum 3 to DOE/RL-2005-96. The injections were conducted upgradient of the existing apatite PRB within the moderate strontium-90 plume. The solutions were injected into the vadose zone and unconfined aquifer. Results indicate that jet injection is a viable technology for emplacement of phosphate and pre-formed apatite in the vadose zone, with injected chemicals meeting the injection target goal within 1.2 m (4 ft) of the injection point. The results of the jet injection demonstration were documented in PNNL-19524 and SGW-47062, *Treatability Test Report for Field-Scale Apatite Jet Injection Demonstration for the 100-NR-2 Operable Unit.*

Based on the information and experience gained from performance of this work, two additional studies were developed to aid in the optimization of these technologies for full-scale implementation. The first study is for an additional 183 m (600 ft) expansion of the PRB through well injections under the FY 2010 approved DOE/RL-2010-29, *Design Optimization Study for Apatite Permeable Reactive Barrier Extension for the 100-NR-2 Operable Unit.* The second proposed study is for additional jet injection testing of apatite PRB installation in the vadose zone over the existing 91.4 m (300 ft) barrier, as described in SGW-47062. A primary goal of the implementation of these technologies is to meet the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989), also known as the Tri-Party Agreement (TPA), Milestone M-016-110-T03 for reducing strontium-90 flux to the Columbia River to 8 pCi/L by 2016. Reduction of stronium-90 flux will be achieved through sequestration of strontium-90 in the PRB. As discussed earlier, the groundwater strontium-90 concentrations decreased by 90 percent in the existing barrier as a result of previous injections. With time, strontium-90 concentrations are expected to decrease further as more strontium-90 is incorporated into the apatite structure. These technologies will be optimized for implementation as an interim remedial action (IRA) under the amended interim ROD.

3.5 Office of River Protection Activities Relevant to the Composite Analysis

ORP technical activities include the following projects (discussed in this chapter) pertinent to the Composite Analysis:

- RCRA corrective action program
- WMA C PA
- TC&WM EIS
- Dissolution of glass waste forms for IDF PA
- Secondary waste form testing

3.5.1 RCRA Corrective Action Program

The Tank Farm Vadose Zone Project, a component of DOE's overall RCRA corrective action program, conducted field efforts in WMAs C, TX-TY, S-SX, and B-BX-BY during FY 2010. The direct push technique using a hydraulic hammer was used to obtain 56 samples at 7 locations in WMA C, 15 samples at 5 locations in WMA S-SX, and 21 samples at 7 locations in WMA B-BX-BY. Samples were undergoing laboratory analysis at the end of FY 2010. During decommissioning of direct push probe holes, deep buried electrodes were installed at 19 sites in WMAs C, B-BX-BY, and S-SX to measure soil resistivity, which is useful in defining soil contamination extent. Deep electrode strings at each site included between 2 and 10 electrodes. In WMA C, the pushes were located at sites defined in the WMA C Work Plan (RPP-PLN-39114, *Phase 2 RCRA Facility Investigation/Corrective Measures Study Work Plan for Waste Management Area C*), in support of a corrective measures study. In WMAs B-BX-BY and S-SX, the pushes were directed at characterizing the extent of subsurface contamination in support of design of potential interim surface barriers. Based on the characterization results, a design was initiated for one or more interim surface barriers in WMA S-SX. The interim surface barrier that had been designed in FY 2009 at WMA TX-TY was constructed, covering all of the TY tanks.

Applications of geophysical exploration techniques were made in WMAs C and S-SX. Continued evaluation of surface to deep electrode resistivity measurements was performed in WMA C (RPP-RPT-47486, *Surface Geophysical Exploration of UPR-200-E-86 Near the C Tank Farm*). This effort revealed less extensive soil resistivity anomalies than observed previously near UPR-200-E-81. Several methods were used to construct and install deep electrode strings, and the different electrode configurations were evaluated in a region of WMA S-SX. Evaluation of the deep buried electrode performance was documented to support optimizing future installation methods. Electrodes performed most effectively when installed at moisture subsurface layers and when given time to equilibrate with the surrounding area.

Monitoring continues for the demonstration interim surface barrier in WMA T that was completed in FY 2008 to reduce the infiltration of precipitation through the surface overlying the vadose zone plume resulting from the Tank 241-T-106 release that occurred in 1973. In RPP-RPT-47123, *Interim Surface Barrier Evaluation Report*, the monitoring results to date are documented, and recommendations regarding future barriers are made.

Testing of potential new technologies for vadose zone characterization was also pursued in FY 2010. Laboratory testing of a beta detection probe shows promise for use in conjunction with the direct push unit for screening soil for possible technetium-99 contamination (RPP-RPT-47372, *FY-10 Further Evaluation of an In-Situ Technetium-99 Detector for Use in Subsurface Vadose Zone Application*). Field testing of a prototype time domain electromagnetic system was performed to look for soil anomalies that may represent historic leaks from buried pipelines (RPP-RPT-47303, *Detecting Historical Pipeline Leaks Using Surface Based Geophysical Methods*). The results from this approach were compared to electrical resistivity methods. The electromagnetic method looks encouraging, and further testing near WMA C is planned.

3.5.2 Waste Management Area C Performance Assessment

In FY 2009, a scoping process was initiated to develop the risk assessments and PAs required for the closure of WMA C. A series of working sessions is being held with regulators and stakeholders to solicit input and obtain a common understanding concerning the scope, methods, and data to be used in the planned risk and PAs. In addition to DOE-ORP and Ecology staff and contractors, working session members include representatives from the EPA, the U.S. Nuclear Regulatory Commission (NRC), interested Tribal nations, other stakeholders groups, DOE-RL personnel and their contractors involved with groundwater/vadose zone or composite analyses efforts, and members of the interested public.

NRC staff involvement in the working sessions is a technical resource to assess whether required waste determinations by DOE for waste incidental to reprocessing are based on sound technical assumptions, analyses, and conclusions relative to applicable incidental waste criteria.

The scoping process continued throughout FY 2010. Working sessions were held for the following topics with the corresponding data packages or white papers developed in FY 2010:

- Soil Inventory—revised data package RPP-RPT-42294, *Hanford Waste Management Area C Soil Contamination Inventory Estimates*
- Engineered Systems No. 1 (including waste residuals, surface cap and recharge)—revised data package RPP-RPT-44042, *Recharge and Waste Release within Engineered System in Waste Management Area C*
- Features, Events and Processes—RPP-RPT-44137, *Process for Identification of Features, Events and Processes (FEPs) Applicable to the Waste Management Area C Performance Assessment*
- Natural Systems—revised data package RPP-RPT-46088, *Flow and Transport in the Natural System at Waste Management Area C*
- Engineered Systems No. 2 (including tank structural components)—data package RPP-RPT-46879, *Corrosion and Structural Degradation within Engineered System in Waste Management Area C*
- Exposure Scenarios—RPP-RPT-47479, *Exposure Scenarios for the Waste Management Area C Performance Assessment*

It is anticipated that modeling will begin in FY 2011, based on inputs received in the scoping process.

3.5.3 Tank Closure and Waste Management Environmental Impact Statement

The draft TC&WM EIS was published on October 30, 2009, for a 140-day public comment period and provides a single integrated analysis of groundwater at Hanford for waste types previously addressed in the Hanford solid waste EIS and the originally planned tank closure EIS. In addition, DOE is including the scope of the previously announced 69 FR 50178 in the TC&WM EIS to provide an integrated presentation of currently foreseeable activities related to waste management and cleanup at the Hanford Site.

3.5.4 Dissolution of Immobilized Low-Activity Waste Glasses for the IDF Performance Assessment

The work conducted in FY 2010 focused on laboratory testing to support incorporation of the Subsurface Transport Over Reactive Multiphases (STORM) code (PNNL-14783, *Subsurface Transport Over Reactive Multiphases (STORM): A Parallel, Coupled, Nonisothermal Multiphase Flow, Reactive Transport, and Porous Medium Alteration Simulator, Version 3.0 User's Guide*) capabilities into the Subsurface Transport Over Multiple Phases (STOMP) code (PNNL-15782, *STOMP: Subsurface Transport Over Multiple Phases Version 4.0: User's Guide*; PNNL-12030, *STOMP: Subsurface Transport Over Multiple Phases Version 2.0: Theory Guide*; PNNL-11216, *STOMP Subsurface Transport Over Multiple Phases Application Guide*). This experimental program is being conducted as part of the IDF PA maintenance plan (DOE/ORP-2000-01, *Maintenance Plan for the Hanford Immobilized Low-Activity Tank Waste Performance Assessment*) that allows for IDF PA revisions to reflect new scientific information that reduces the technical uncertainty associated with critical aspects of the IDF PA.

The laboratory scale experiments (single pass flow through, pressurized unsaturated flow, and product consistency tests) are being used to develop kinetic rate law parameters and determine the type of alteration products that form as the glass corrodes over time. The experimental data collected from the above tests are being incorporated into the STOMP code as a means for predicting glass performance in the IDF. These experiments and data provide the defense in depth needed to predict, with a high level of confidence, long-term glass behavior and provide credible estimates of radionuclide release from the Near Field environment.

As part of the FY 2010 work, the Field Lysimeter Test Facility has been dismantled, and all samples have been collected and archived. These samples are being maintained for help in the model conversion.

3.5.5 Secondary Waste Form Testing

The low-activity waste (LAW) at the Hanford Site will be vitrified in a joule heated ceramic melter to produce a stable product for disposal. A portion of the technetium, an important radioactive component in the Hanford tank waste, can be volatilized in the melter and end up in the secondary liquid waste. This secondary liquid waste will be solidified at the Effluent Treatment Facility (ETF).

High retention of contaminants of concern (COCs) in the solidified waste is desirable in order to minimize the impact on the IDF PA. Potential areas to explore in improving COC retention in the solidified LAW secondary waste include changes to waste form composition, chemistry, and process conditions. The potential impact on other COCs needs to be determined.

The scope of this task is divided into two phases. In the first phase, which was completed in FY 2010, the contractor performed a literature search of previous work pertaining to the Waste Treatment Plant (WTP) secondary liquid waste and secondary solid wastes (PNNL-19122, *Review of Potential Candidate Stabilization Technologies for Liquid and Solid Secondary Waste Streams*). The contractor also conducted a preliminary screening of waste forms in the first phase for solidification of liquid secondary wastes from the WTP LAW vitrification facility leading up to a workshop to determine whether waste form improvements justify continuation to the second phase (PNNL-19505, *Secondary Waste Form Screening Test Results—Cast Stone and Alkali Alumino-Silicate Geopolymer*).

In phase two, the contractor will focus on waste form development, development and validation of test methods to characterize waste form performance, characterization of waste form performance to support risk assessments and PAs, and process testing to support process design and operation.

3.6 Richland Operations Office Remedial Activities Relevant to the Composite Analysis

Remediation actions are pertinent to the Composite Analysis because these actions result in the planned redistributions of radioactive inventory in time, location, and waste form. Updated knowledge and information acquired in the conduct of remedial actions have the potential to change the analysis evaluated in the Composite Analysis and are reviewed here to assess any such impact.

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3.6.1 Central Plateau Remediation

The Central Plateau consists of ~195 km^2 (~75 mi^2) near the middle of the Hanford Site. Most activities are concentrated in two main processing areas: the 200 East Area and 200 West Area. The Central Plateau contains excess facilities formerly used in the plutonium production process including five large chemical processing facilities, commonly known as canyons, and the Plutonium Finishing Plant (PFP), as well as individual waste sites including both buried solid waste and contaminated soil.

In FY 2010, DOE, EPA, and Ecology negotiated TPA change packages based on a Central Plateau cleanup completion strategy (for details on this strategy and adoption by the Tri-Party agencies, refer to Chapter 4.2). This strategy calls for the cleanup to be organized into the following three major components:

- The Inner Area, where the final footprint area of the Hanford Site will be dedicated to waste management and containment of residual contamination
- The Outer Area, which contains the balance of the Central Plateau
- Groundwater, which is comprised of contaminant plumes underlying the Central Plateau and originating from waste sites on the Central Plateau

The TPA changes also included restructuring the OUs used to manage *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) cleanup decisions. The new OUs are described in Section 3.6.1.

Several operating waste disposal facilities in the Inner Area will continue to receive waste from Hanford Site cleanup activities and from limited offsite sources. ERDF was constructed for disposal of waste generated during cleanup of the Hanford Site. Additional cells will be constructed in ERDF, as needed, to implement cleanup decisions. LLW or radioactive mixed waste that is generated from Hanford Site activities may also be disposed in the low-level burial grounds or mixed waste trenches as appropriate. A future IDF is in the RCRA permitting process for disposal of some waste generated from radioactive liquid waste tank cleanup and potentially from other Hanford Site activities.

Cleanup actions have already been initiated for some areas of the Central Plateau. The 221-U Processing Facility (U Plant) is one of five massive processing facilities at the Hanford Site. The building, commonly called a "canyon," was built during World War II to extract plutonium from fuel rods irradiated in the Hanford Site's production reactors, it was used for training and equipment work and was later converted to recover uranium from waste generated at the other canyon facilities. A ROD for the Canyon Disposition Initiative at U Plant (*Record of Decision 221-U Facility [Canyon Disposition Initiative] Hanford Site, Washington* [EPA et al., 2005]), issued in October 2005, determined that the U Plant canyon would be disposed in place with a suitable surface barrier to prevent infiltration of water and/or intrusion by human or ecological receptors. Existing contaminated equipment from the canyon deck (a near ground level portion of this facility) will be placed in the canyon process cells (a below-ground level portion of this facility) and grouted in place. The upper part of the canyon building will be demolished to approximately the level of the canyon deck. Debris from this partial demolition will be placed on or adjacent to the canyon deck and then filled with grout to minimize voids. The partially demolished building and debris will be covered with a surface barrier. Final decisions for the remaining canyons and the storage tunnels located at the Plutonium Uranium Extraction (PUREX) Plant will be made as part of the upcoming CERCLA and RCRA cleanup decisions.

Disposition of remaining facilities, including PFP facilities, is being addressed with a combination of *National Environmental Policy Act of 1969*, CERCLA, and RCRA processes. Radioactive or other hazardous substances are removed and treated, if necessary, and packaged for disposal in approved disposal facilities. Debris and rubble from the demolition process are disposed at ERDF or offsite in solid waste landfills, as appropriate. Limited volumes of transuranic (TRU) wastes generated during the demolition process are packaged for disposal at the Waste Isolation Pilot Plant (WIPP). The RCRA closure requirements are integrated into the process where necessary. Potential sub-surface contaminants will be addressed in a manner consistent with the waste site remedial alternatives discussed below.

Approximately 15,000 m^3 (~20,000 yd^3) of suspect TRU waste were placed in retrievable storage trenches in four low-level burial grounds starting in 1970. The waste is being retrieved from the trenches and characterized to determine if it is TRU or LLW. Two additional waste sites located outside the 200 Areas (618-10 and 618-11 Burial Grounds) contain ~10,000 m^3 (~13,000 yd^3) of suspect TRU waste. The low-level fraction will be treated and disposed onsite, and the TRU fraction will be shipped to WIPP.

The following extensive and significant inventory of radionuclides exists in other forms that require disposition:

- Approximately 2,000 cesium and strontium capsules are stored underwater at the Waste Encapsulation Storage Facility. These are classified as high-level waste (HLW) and are to be disposed at a HLW geologic repository.
- Pacific Northwest National Laboratory produced 34 borosilicate glass filled canisters for the Federal Republic of Germany. These "German logs" were isotopic heat sources for a repository testing program in Germany and are designated non-hazardous, remote-handled TRU waste. The canisters are stored at the Central Waste Complex in the 200 West Area pending decisions on final disposition.
- Spent nuclear fuel (SNF) is stored in multi-canister overpacks at the Canister Storage Building (CSB) in the 200 East Area. Examples include material from the K Basin, N Reactor, and Shippingport Pressurized Water Reactor Core 2 blanket fuel assemblies. The 200 Area Interim Storage Area, located adjacent to the CSB, is used to store other non-defense SNF in above-ground dry cask storage containers, including material from the Fast Flux Test Facility, Neutron Radiography Facility, and TRIGA (a class of small nuclear reactor) Light Water Reactor SNF. The CSB/Interim Storage Area is designed for interim storage until a suitable long-term repository is established.

The Central Plateau includes more than 800 soil waste sites consisting of cribs, ponds, ditches, trenches, landfills, pipelines, diversions boxes, unplanned releases (UPRs), and other types of sites used for liquid or solid waste disposal. Remedial actions or interim removal actions have been initiated for some of the soil waste sites located in the Outer Area. Sites in the 200 North Area are being remediated in accordance with EPA/541/R-99/039, 1999, *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6 and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington (100 Area Remaining Sites)*, issued in 1999. Interim action is ongoing in the southern part of the Outer Area to remove surface contamination and reduce the footprint of areas requiring radiological control.

Remediation of the remaining Central Plateau soil waste sites will be completed in accordance with CERCLA and RCRA corrective action requirements. CERCLA guidance requires that a range of alternatives be evaluated, including the following:

1. No action
2. Removal of contaminants as the primary remedy
3. Containment as the predominant remedy
4. Treatment of the contaminants to reduce their toxicity, mobility, or volume as the primary remedy

The remedial alternatives evaluations conducted for the Central Plateau OUs will consider these alternatives, as well as one more alternative, that employs a combination of those key features.

Alternatives that involve removal will include treatment, where appropriate, and disposal in an approved disposal facility such as ERDF. Containment remedies may involve maintaining or enhancing existing soil covers, capping with suitable engineered surface barrier, or other containment remedies. Treatment-based remedies may involve monitored natural attenuation to allow radioactive materials to decay, immobilization, or other forms of treatment. Surface barriers will be designed to limit the infiltration of water and, thereby, slow the movement of contaminants currently in the vadose zone into the underlying groundwater. Barriers will also be designed to prevent intrusion by plants and animals so that the underlying contamination is not dispersed.

All alternatives are expected to result in the need for institutional controls as long as the hazards are present to maintain environmental monitoring and surface barriers, to limit access to authorized users, and to prevent unapproved excavation and inadvertent intrusion. DOE has committed to retain the Central Plateau, as well as other areas of the Hanford Site, under federal control for the foreseeable future.

3.6.1.1 Source Operable Units

The CHPRC S&GRP implements the RI/FS process for several source OUs in the Central Plateau. Since the inception of CERCLA programs on the Central Plateau, the configuration of the waste site OUs have been modified as needed to support the RI/FS process. In 2010, DOE, EPA, and Ecology agreed to restructure the OUs to promote consistency in decision making and to facilitate a geographic approach to cleanup implementation. Some existing OUs were retained, while others were absorbed into new geographic-based OUs. The status of OUs prior to the restructure is reported in Table 3-2 for comparison to past reports, while the resulting OUs from the restructuring are listed in Table 3-3.

The decision process for the new OUs will incorporate data and analyses previously conducted for the predecessor OUs, as appropriate. New or revised TPA milestones were negotiated for the RI/FS process in FY 2010. The OUs listed in Table 3-2 are subject to completion of the RI/FS process and remediation in accordance with the following major TPA milestones and interim milestones, as negotiated, to track progress:

- M-15-00, *Complete the RI/FS (or RFI/CMS and RI/FS) process for all non-tank farm operable units except for canyon/associated past practice waste site OUs covered in M-85-00.* (Due date December 31, 2016.)
- M-16-00, *Complete remedial actions for all non-tank farm and non-canyon operable units.* (Due date September 30, 2024.)
- M-85-00, *Complete response actions for the canyon facilities/associated past practice waste sites, other Tier 1 Central Plateau facilities not covered by existing milestones, and Tier 2 Central Plateau facilities. This includes B Plant, PUREX, and REDOX canyons and associated past practice waste sites in 200-CB-1, 200-CP-1, and 200-CR-1 OUs. The milestone does not include U Plant or T Plant canyons.* (Due date to be determined in 2012.)

Table 3-2. Status of Central Plateau Source Operable Units in Fiscal Year 2010

Source OU	Scope	Status
200-BC-1	BC Cribs and Trenches	Separated from 200-TW-1/200-TW-2 OUs in 2004. FS (DOE/RL-2004-66, Draft A) for BC Cribs submitted to regulatory agency for review in June 2005. Treatability test plan (DOE/RL-2007-15, Rev. 0) issued and approved by EPA in April 2008, and excavation of the 216-B-26 Trench as part of the test commenced in May 2008 with excavation completed in June 2008 (total of 181 containers of contaminated soil disposed of to ERDF from this site). Preparations began to support use of direct-push borehole equipment to characterize 216-B-14 Crib and 216-B-53A Trench. An Engineering Study report (PNNL-17176) on the effectiveness of barriers was completed. Issued BC Cribs and Trenches Excavation-Based Treatability Test Report (DOE/RL-2009-36, Rev. 0, Re-issue) in March 2010. Draft B FS report and proposed plan due June 2011 (TPA Milestone M-15-51).
200-CS-1	Chemical Sewer Sites	RI/FS Work Plan (DOE/RL-99-44, Rev. 0) approved October 2000. RI Report (DOE/RL-2004-17, Rev. 0) finalized in November 2004. Draft A FS (DOE/RL-2005-63, Draft A), submitted to regulatory agencies for review in March 2006; Draft B (DOE/RL-2005-63, Draft B) submitted in September 2007; final document pending resolution of RCRA/CERCLA integration issues. The Revision 0 versions of the FS (DOE/RL-2005-63, Rev. 0), Proposed Plan (DOE/RL-2005-64, Rev. 0), and TSD Closure Plans (DOE/RL-2006-11, Rev. 0; DOE/RL-2006-12, Rev. 0); DOE/RL-2008-53, Rev. 0) were provided to RL for their review and/or use on September 29, 2008.
200-CW-1	Gable Mountain, B Pond, and Ditches Cooling Water Sites	RI/FS Work Plan (DOE/RL-99-07, Rev. 0) approved December 2000. RI Report (DOE/RL-2000-35) approved March 2001. Draft A FS (DOE/RL-2002-69) submitted to regulatory agencies for review in March 2003. 200-MG-5/200-CW-1 OU SAP (DOE/RL-2006-57, Draft A) was approved by Ecology in January 2008. Supplemental characterization conducted in 2008/2009: direct pushes were made starting in April 2008 including Gable Mountain Pond (216-A-25 Crib), 216-S-16 and 216-S-17 Ponds, 216-U-11 Ditch, and 216-U-10 Pond with slim line geophysical logging. Draft B FS due November 2010 (TPA Milestone M-015-38B).

Table 3-2. Status of Central Plateau Source Operable Units in Fiscal Year 2010

Source OU	Scope	Status
200-CW-5	Z-Ditches	RI/FS Work Plan (DOE/RL-99-66, Draft A) approved in August 2003. RI Report (DOE/RL-2003-11, Draft A) conditionally approved in October 2004. Draft A FS (DOE/RL-2004-24, Draft A, RE-ISSUE) submitted to regulatory agencies for review in October 2004. Separated from 200-CW-2/4 OU and 200-SC-1 OU in 2007 when all remaining 200-CW-2/4 OU waste sites were transferred to other OUs and 200-SC-1 OU became a stand-alone group. FS (DOE/RL-2004-24, Draft B) and Proposed Plan (DOE/RL-2004-26, Draft B) were issued in 2008 (TPA Milestone M-15-40D). FS (DOE/RL-2004-24, Draft C) was submitted to EPA in August 2010.
200-IS-1	Tanks, Lines, Pits, Boxes, Septic Tank, and Drain Fields	RI/FS Work Plan (DOE/RL-2002-14, Rev. 0) finalized in May 2004; Draft B revision (DOE/RL-2002-14, Rev. 1) submitted to regulatory agencies for review in June 2007; approval pending resolution of regulatory agency comments. Investigation activities planned for 2008/2009 began with approval of SAP (DOE/RL-2002-14, Rev.1 Draft B) by Ecology on April 15, 2008. 68 direct pushes and associated logging completed in September 2008.
200-LW-1	Chemical Laboratory Waste Sites	Draft A RI/FS Work Plan (DOE/RL-2001-66) approved in August 2002. Draft A RI Report (DOE/RL-2005-61) submitted to regulatory agencies for review in February 2006. Supplemental characterization being conducted 2008/2010: 216-B-6 Reverse Well direct-push (200-BP-5 Rejection Well) drilling concluded September 16, 2008 (Casing was pushed to refusal at a depth of 65.9 m (216.25 ft) below ground surface. Geophysical logging of the first 50.9 m (167 ft) was completed. Radiological contamination is significantly less than originally thought). ~~Draft A FS due December 2011 (Tri-Party Agreement Milestone M-015-46B).~~ [This milestone was deleted in August 2009.]
200-MG-1/200-MG-2	Model Group I, Small Shallow Waste Sites	OU created by extracting small, shallow sites from other OUs; no further characterization required to support decision making. EPA and Ecology approved TPA Change Requests that changed the milestone definition from completion of FS and Proposed Plans FS Draft A that was due December 2008 (TPA Milestones M-015-49A for 200-MG-1 OU and M-15-49B for 200-MG-2 OU) to completion of an Engineering Evaluation/Corrective Action and Action Memos.

Table 3-2. Status of Central Plateau Source Operable Units in Fiscal Year 2010

Source OU	Scope	Status
200-MW-1	Miscellaneous Waste Sites	Draft A RI/FS Work Plan (DOE/RL-2001-65) approved in July 2002. Draft A RI Report (DOE/RL-2005-62) submitted to regulatory agencies for review in April 2006. Supplemental characterization conducted in 2007/2008; activities in FY 2008 limited to decommissioning of boreholes. Draft A FS (DOE/RL-2008-38) submitted to EPA in February 2010, meeting TPA Milestone M-015-44B.
200-PW-1/3/6	Process Waste Sites	RI/FS Work Plan (DOE/RL-2001-01, Rev. 0, Re-issue) approved in August 2004. Draft A RI Report (DOE/RL-2006-51) submitted to regulatory agencies for review in October 2006. Draft A FS (DOE/RL-2007-27) submitted to regulatory agencies for review in September 2007 (TPA Milestone M-015-45B); on July 21, 2008 DOE directed inclusion of partial remove, treat, and dispose as the preferred remedy for 200-PW-1, and the 200-PW-3/6 OUs are not being revised from the Draft A FS (DOE/RL-2007-27) and Draft A Proposed Plan (DOE/RL-2007-40). FS (DOE/RL-2007-27, Draft B, RE-ISSUE) submitted to EPA April 2009. FS (DOE/RL-2007-27, Draft C) submitted to DOE September 2010.
200-PW-2/4	Process Waste Sites	RI/FS Work Plan (DOE/RL-2000-60, Rev. 1, Re-issue) approved in September 2004. Draft A RI Report (DOE/RL-2004-25, Draft A) submitted to regulatory agencies for review in June 2004. Draft A FS (DOE/RL-2004-85, Draft A) submitted to regulatory agencies for review in May 2006. RL and Ecology signed the SAP (DOE/RL-2007-02-VOLII-ADD5, Rev. 0) and waste control plan (SGW-37320) for the high-risk boreholes at the 216-A-5 Crib and 216-S-1/2 Crib; supplemental characterization is planned in 2009. ~~Draft B FS due in December 2010 (Tri-Party Agreement Milestone M-015-43D).~~ [This milestone cancelled per change package in August 2009].
200-SC-1	Steam Condensate Sites	Separated from 200-CW-5 OU in 2007. The Supplemental Work Plan (DOE/RL-2007-02, Volumes I and II, Rev. 0) was approved by EPA and Ecology and Volume II, 200-SC-1 Field Sampling Plan Addendum (DOE/RL-2007-02-VOL I-ADD 1, Rev. 0) was approved by RL and EPA in December 2007, paving the way to start 200-SC-1 OU field activities. Direct pushes in the 216-B-55 Crib waste site began December 12, 2007, and were followed by direct pushes in the 216-A-30 Crib and 216-S-6 Crib. FS Draft A was due December 2010 (TPA Milestone M-15-40E); this milestone was completed in March 2010.

Table 3-2. Status of Central Plateau Source Operable Units in Fiscal Year 2010

Source OU	Scope	Status
200-SW-1/2	Nonradioactive/ Radioactive Landfills and Dumps	Draft A RI/FS Work Plan (DOE/RL-2004-60) submitted to regulatory agencies for review in December 2004; Draft B (DOE/RL-2004-60) submitted to regulatory agencies for review in September 2007; and Rev. 0 (DOE/RL-2004-60) was issued late in FY 2008 (TPA Milestone M-013-28). Agreement between DOE, Ecology, and Fluor Hanford Inc. was reached in June 2008 for all 265 comments on the RI/FS Work Plan (DOE/RL-2004-60, Draft B) and revision incorporation started.
200-TW-1 200-PW-5	Tank Waste and Process Waste Sites	Separated from 200-TW-2 OU in 2007 at regulatory agency request. RI/FS Work Plan (DOE/RL-2000-38, Rev. 0) approved in May 2001. RI Report (DOE/RL-2002-42, Rev. 0) approved provisionally in March 2004. Draft A FS (DOE/RL-2003-64, Draft A) submitted to regulatory agencies for review in March 2004. Waste Control Plan (SGW-37529) for 200-TW-1/200-PW-5 OUs was approved by DOE and EPA in May 2008. ~~Draft B due in December 2011 under Tri-Party Agreement Milestone M-15-42D.~~ [This milestone was cancelled in August 2009.]
200-TW-2	Tank Waste Sites	Separated from 200-TW-1/200-PW-5 OUs in 2007 at regulatory agency request. RI/FS Work Plan (DOE/RL-2000-38, Draft A) approved in May 2001. RI Report (DOE/RL-2002-42, Draft A) approved provisionally in March 2004. Draft A FS (DOE/RL-2003-64, Draft A, Re-issue) submitted to regulatory agencies for review in March 2004. Site Specific Sampling Plan (SGW-37530) for Waste Sites on the 200-TW-2 OU was approved by DOE in April 2008 and EPA in May 2008. Supplemental characterization is planned in 2011. ~~Draft B due December 2011 under Tri-Party Agreement Milestone M-15-42E.~~ [This milestone was cancelled in August 2009.]
200-UR-1	UPRs (West Lake and BC Control Area)	RI/FS Work Plan (DOE/RL-2004-39, Draft A) finalized in May 2005; Revision 1 to be submitted in 2008. Interim action ongoing in BC Control Area to remove surface contamination. West Lake DQO report (SGW-35643) sent to Ecology and comments received in May 2008. Downposting survey of the eastern chapter of the BC Control Area (RSP-GRP-07-007, Rev. 1) completed in 2008.
200-UW-1	U Plant Waste Sites that are Part of the U-Zone Closure	DOE has adopted a Central Plateau cleanup strategy that combines the 200-UW-1 OU into a new 200-WA-1 OU (Chapter 4.2). Major DQOs have been completed for the most challenging waste sites in the OU.

Table 3-2. Status of Central Plateau Source Operable Units in Fiscal Year 2010

Source OU	Scope	Status

Sources:

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DOE/RL-99-44, 2000, *200-CS-1 Operable Unit RI/FS Work Plan and RCRA TSD Unit Sampling Plan*, Rev. 0.

DOE/RL-99-66, 1999, *200-CW-5 Operable Unit RI/FS Work Plan*, Draft A.

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DOE/RL-2000-38, 2000, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan*, Draft A.

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DOE/RL-2001-01, 2004, *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*, Rev. 0, Re-issue.

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DOE/RL-2002-14, 2003, *Tanks/Lines/Pits/Boxes/Septic Tank and Drain Fields Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan Includes: 200-IS-1 and 200-ST-1 Operable Units*, Rev. 0.

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DOE/RL-2002-69, 2003, *Feasibility Study for the 200-CW-1 and 200-CW-3 Operable Units and the 200 North Area Waste Sites*, Draft A.

DOE/RL-2003-11, 2003, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units*, Draft A.

DOE/RL-2003-64, 2004, *Feasibility Study for the 200-TW-1 Scavenged Waste Group, the 200-TW-2 Tank Waste Group, and the 200-PW-5 Fission-Product Rich Waste Group Operable Units*, Draft A.

DOE/RL-2003-64, 2004, *Feasibility Study for the 200-TW-1 Scavenged Waste Group, the 200-TW-2 Tank Waste Group, and the 200-PW-5 Fission-Product Rich Waste Group Operable Units*, Draft A, Re-issue.

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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, RE-ISSUE.

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Table 3-2. Status of Central Plateau Source Operable Units in Fiscal Year 2010

Source OU	Scope	Status

DOE/RL-2004-60, 2008, *200-SW-1 Nonradioactive Landfills Group Operable Unit and 200-SW-2 Radioactive Landfills Group Operable Unit Remedial Investigation/Feasibility Study Work Plan*, Rev. 0.

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SGW-37529, 2008, *Waste Control Plan for the 200-TW-1/200-PW-5 Operable Units*, Rev. 0.

SGW-37530, 2008, *Waste Control Plan for the 200-TW-2 Operable Unit*, Rev. 0.

Table 3-3. Revised Central Plateau Source Operable Structure

Operable Unit Group	Description	Predecessor Operable Units	
	Inner Area		
200-PW-1/3/6 and 200-CW-5	• Plutonium-contaminated soil sites located near PFP and cesium-contaminated sites near PUREX	No change	
200-WA-1 and 200-BC-1	• Soil waste sites located in the 200 West Inner Area that are not included in the 200-SW-2, 200-CR-1, 200-PW-1/6, 200-CW-5, and 200-IS-1 OUs • Soil waste sites in the BC Cribs and Trenches	• 200-BC-1 • 200-MG-1/2 • 200-PW-2/4 • 200-TW-2 • 200-UW-1	• 200-LW-1/2 • 200-MW-1 • 200-SC-1 • 200-UR-1
200-EA-1 and 200 IS-1*	• 200 East Inner Area that are not included in the 200-SW-2, 200-CB-1, 200-CP-1, and 200-PW-3 OUs • Pipelines and diversion boxes in the 200-IS-1 OU	• 200-CS-1 • 200-LW-2 • 200-MW-1 • 200-SC-1 • 200-UR-1	• 200-IS-1 • 200-MG-1/2 • 200-PW-2/4 • 200-TW-1/2
200-SW-2	• Solid Waste Burial Grounds and waste sites in the footprint of the burial grounds	• 200-CW-1 • 200-SW-2	• 200-MG-1/2
200-DV-1	• Selected soil waste sites in the Inner Area with Deep Vadose Zone contamination	• 200-TW-1/2	• 200-PW-5
200-CB-1	• B Plant Canyon • Associated waste sites	• 200-IS-1 • 200-MW-1 • 200-UR-1	• 200-MG-1/2 • 200-PW-2
200-CP-1	• PUREX Canyon • Associated waste sites	• 200-IS-1	• 200-MG-1/2
200-CR-1	• REDOX Canyon • Associated waste sites	• 200-IS-1	• 200-MG-1
	Outer Area		
200-OA-1, 200-CW-1, and 200-CW-3	• Sites located in the Outer Area	• 200-CS-1 • 200-CW-3 • 200-MG-1/2 • 200-SW-2 • 200-UW-1	• 200-CW-1 • 200-IS-1 • 200-MW-1 • 200-UR-1

* Some sites currently assigned to the 200-IS-1 OU may be reassigned to OUs based on their geographic location, pending the outcome of discussions among the three parties taking place in FY 2011.

3.6.1.2 Groundwater Operable Units

The FY 2009 groundwater monitoring results are presented in DOE/RL-2010-11, which was published in August 2010 (considered here in summarizing FY 2010 activities). During FY 2009, 922 monitoring wells and 326 shoreline aquifer tubes were sampled to determine the distribution and movement of contaminants. Many of the wells and aquifer tubes were sampled multiple times during the year. A total of 18,899 samples were analyzed. A total of 4,746 samples of groundwater were analyzed for total chromium (with a nearly equal amount of hexavalent chromium analyses); 3,024 samples were analyzed for nitrate; and 2,029 samples were analyzed for tritium. Other constituents frequently analyzed included technetium-99 (1,502 samples), uranium (1,495 samples), and carbon tetrachloride (1,427 samples). These totals include results for routinely sampled groundwater wells, pump-and-treat operational samples, and aquifer tube samples.

DOE has developed a cleanup strategy and plan for addressing contaminated groundwater beneath the Central Plateau. Of the groundwater contaminant plumes, tritium and iodine-129 have the largest areas with concentrations above DWSs. The most expansive of these plumes have sources in the 200 East Area and extend east and southeast towards the Columbia River. Less expansive plumes of tritium, uranium, iodine-129, and technetium-99 are present under the 200 West Area. Nitrate is the most widespread chemical contaminant in Hanford Site groundwater, with some plumes originating from 200 Areas and some from offsite industrial and agricultural sources. Carbon tetrachloride is the most widespread organic contaminant on the Hanford Site, forming a large plume beneath the 200 West Area. Other organic contaminants include chloroform (in the 200 West Area) and trichloroethene. Finally, in portions of the 200 West Area (200-UP-1), chromium is found at levels above the 100 μg/L DWS as well.

There were seven pump-and-treat systems that operated at the Hanford Site during FY 2010 under interim RODs (*Declaration of the Interim Record of Decision for the 200-ZP-1 Operable Unit* [EPA et al., 1995]; EPA/ROD/R10-96/134, *Record of Decision for the 100-HR-3 And 100-KR-4 Operable Units Interim Remedial Actions, Hanford Site, Benton County, Washington*; EPA/ROD/R10-97/048, *Interim Remedial Action Record of Decision for the 200-UP-1 Operable Unit, Hanford Site, Benton County, Washington*; and EPA/AMD/R10-00/122, *Interim Remedial Action Record of Decision Amendment for the 100-HR-3 Operable Unit, Hanford Site, Benton County, Washington*).

Three of these pump-and-treat systems are located in the 200 West Area; four other pump-and-treat systems and one barrier system are located at sites along the Columbia River (see Table 3-4 for operation and contaminant recovery information).

The seven pump-and-treat systems include the following:

- The 200-UP-1 pump-and-treat system is removing the primary COCs of uranium and technetium-99 and secondary contaminants carbon tetrachloride and nitrate. Groundwater from the two active 200-UP-1 Groundwater OU extraction wells is transported by pipeline to the ETF for treatment.
- The main 200-ZP-1 pump-and-treat system is a standalone treatment system removing primarily carbon tetrachloride, but also chloroform and trichloroethene. In FY 2010, 15 injection and/or extraction wells were completed in support of constructing the 200 West Area groundwater pump-and-treat system.
- A second 200-ZP-1 Groundwater OU pump-and-treat system continued to operate at WMA T (T Tank Farm). Groundwater from the two active extraction wells is transported by pipeline to the ETF for treatment and removal of technetium-99 and other contaminants.

- The 100-KW pump-and-treat system was started in January 2007 to remediate a recently discovered chromium plume associated with the KW Reactor.
- The 100-DR-5 pump-and-treat system in the 100-D Area was activated in July 2004 and uses ion exchange technology to treat hexavalent chromium from the 100-D Area groundwater that is not controlled by the 100-HR-3 pump-and-treat system.
- An in situ reduction and oxidation manipulation barrier system was installed in the 100-D Area in phases from FY 2000 through FY 2002 to control movement of hexavalent chromium.
- The 100-NR-2 groundwater OU system was removing strontium-90 from groundwater at the 100-N Area. This system was placed in cold standby while an alternate treatment technology test (apatite sequestration) was completed. Since completion of the test, additional chapters of the apatite barrier have been built, extending the initial 91.4 m (300 ft) length to 274.3 m (900 ft). The total barrier will eventually be 762 m (2,500 ft) in length.

A full summary of all pump-and-treat activities for the Hanford Site through FY 2010 is provided in Table 3-4. Note that this table provides information on areas nominally outside the scope of the Composite Analysis (100 and 300 Areas) but, because groundwater pump-and-treat has at least the potential to influence the unconfined flow system to some degree, these actions are included for completeness. To the degree that these pump-and-treat systems alter the site-wide flow system modeled in the Composite Analysis, which did not include pump-and-treat processes, these systems can influence the results of the Composite Analysis. These influences reviewed here are not yet considered to have significant impact on the Composite Analysis saturated zone simulations for pump-and-treat operations to date, but it is qualitatively expected that the impact, if any, would be to reduce the projected dose due to the removal of contaminant mass from the groundwater pathway. Continued operation of pump-and-treat processes, presuming more remedial actions will be adopted through CERCLA activities, can be expected to constitute a need for an updated Composite Analysis that incorporates representation of these processes.

Table 3-4. Status of Groundwater Remediation in Fiscal Year 2010

Area	Remedial Action Site	Startup Date	Progress from Startup to September 2008
100-K	100-KR-4 Pump-and-Treat	1997	Three CERCLA interim action ion exchange pump-and-treat systems operated in the 100-KR-4 OU. The original KR-4 treatment system (around the 116-K-2 Trench) began operation in 1997. Decreased chromium to river; 317 million L of groundwater treated, and 7.8 kg of hexavalent chromium removed.
	100-KX Pump-and-Treat	2008	The new KX pump-and-treat system began operation in 2009 to treat groundwater contaminated by the 116-K-2 Trench. Decreased chromium to the river; 719 million L of groundwater was treated, and about 40 kg of hexavalent chromium was removed.
	100-KW Pump-and-Treat	2007	The KW pump-and-treat system was expanded to a treatment capacity of 757 L/min with the addition of a second four-vessel treatment train with a capacity of 379 L/min. The expanded treatment system began operation in 2009. The KW system currently consists of seven extraction wells and three injection wells.

Table 3-4. Status of Groundwater Remediation in Fiscal Year 2010

Area	Remedial Action Site	Startup Date	Progress from Startup to September 2008
			Decreased chromium to the river; 298 million L of groundwater were treated, and 49.3 kg of hexavalent chromium were removed.
100-N	100-NR-2 Pump-and-Treat (Inactive) In Situ Treatment Barrier	1995	Diverts strontium-90 from river; 1.8 Ci removed. Extraction ceased in March 2006. Injected apatite-forming chemicals to create an in situ treatment barrier, which is being expanded from the current 300 ft (91 m) to 900 ft (274 m). When completed, the total system will measure 2,500 ft (762 m).
100-D 100-H	100-HR-3 Pump-and-Treat	1997	The 100-HR-3 pump-and-treat system was the first system in the 100-D Area and extracted water from both the 100-D and 100-H Areas. Construction of a pump-and-treat system expansion has now started. The new 100-HR-3 facility will expand the treatment capacity in the 100-D Area and the southwest area of the Horn area to 2,271 L/min (referred to as the DX facility), while a new facility will expand the treatment capacity in the 100-H Area and the northeast area of the Horn area to 2,650 L/min (referred to as the HX facility) and will be optimized to improve remedial efficiency. The expanded process facility is now under construction. Seventy new extraction and injection wells are being drilled in the area. The 100-HR-3 pump-and-treat system extracted 177 million L of groundwater from the 100-D and 100-H Areas. The system removed 15.9 kg of hexavalent chromium, bringing the total removal to 362 kg since 1997, in addition to the 30 kg removed by a pilot scale system in the early 1990s.
	100-DR-5 Pump-and-Treat	2004	This second pump-and-treat system (DR-5) in the 100-D Area for remediation of chromium contamination began operating at the end of July 2004 to treat increasing hexavalent chromium concentrations in the 100-D Area wells southwest of the original system. The system was modified in 2005 to increase the rate of remediation and widen the capture zone. The extracted water is treated in the 100-D Area at the DR-5 treatment facility, using a metal anion exchange system with onsite regeneration, and the treated groundwater is then injected. The DR-5 pump-and-treat system removed 44.2 kg of hexavalent chromium (a total of 251.3 kg since 2004). This involved pumping and treating 49 million L of water.
	100-HR-3 ISRM Barrier	1999	The REDOX treatment zone is 680 m (2,231 ft) long (aligned parallel to the Columbia River) and 100 m (328 ft) to 200 m (656 ft) inland. The treatment zone was designed to reduce the concentration of hexavalent chromium in groundwater to less than 20 μg/L at seven compliance wells located between the treatment zone and

Table 3-4. Status of Groundwater Remediation in Fiscal Year 2010

Area	Remedial Action Site	Startup Date	Progress from Startup to September 2008
			the river. This system decreases chromium concentrations down gradient of the barrier. The hexavalent chromium concentrations were all below the 20 μg/L remedial action goal in the southernmost compliance wells, with a maximum measurement of 19 μg/L. The compliance monitoring wells downgradient (north) of the ISRM barrier generally contained higher concentrations of hexavalent chromium in the northeast portion of the barrier. The most northeastern well had levels of hexavalent chromium up to 95.8 μg/L, with the highest value recorded representing a 25 percent increase from prior levels. Other wells near the northern end of the barrier had hexavalent chromium levels ranging from 515 to 783 μg/L. Concentrations remained variable downgradient from the central portion of the barrier, ranging from 106 to 265 μg/L.
100-B/C	Monitoring (Soil Waste Sites)	N/A	Monitoring contamination has continued while waste site remedial actions are conducted. No groundwater remediation activities are currently being performed.
100-FR-3	Monitoring (Soil Waste Sites)	N/A	Monitoring contamination has continued. Most waste sites have been excavated and backfilled. No groundwater remediation activities are currently being performed.
200 West	200-ZP-1 Pump-and-Treat	1994	The main 200-ZP-1 pump-and-treat system removes carbon tetrachloride, chloroform, and trichloroethene. The baseline groundwater plume is centered south and east of the PFP. The total amount of carbon tetrachloride removed was 544 kg (extracting 730 L/min of groundwater), which is a 15.2 percent increase in mass removal in comparison to 462 kg removed in the prior year. The extraction system produced 462 million L of groundwater, which is a 34.2 percent increase in comparison to the 304 million L of water treated the previous year. The total volume of groundwater pumped since startup in 1994 is 4.45 billion L.
200 West	241-T Tank Farm Technetium-99 Test System	2007	An interim pump-and-treat system treats technetium-99 contamination, specifically to the east of and within WMA T. The IRA pump-and-treat system currently consists of two extraction wells (299-W11-45 and 299-W11-46) that dispose of the extracted groundwater via a direct discharge line connection to ETF. The average pumping rates this year were 152 L/min (40 gal/min). For the year, the total mass removed was as follows: nitrate at 33,993 kg, technetium-99 at 22.7 g (0.38 Ci), uranium at 13.2 g, and carbon tetrachloride at 95.9 kg.
200 West	Soil Vapor Extraction	1992	SVE was initiated in the 200 West Area in 1992 to remove carbon tetrachloride contamination from the

Table 3-4. Status of Groundwater Remediation in Fiscal Year 2010

Area	Remedial Action Site	Startup Date	Progress from Startup to September 2008
			vadose zone in the vicinity of the 216-Z-9 Trench, the 216-Z-1A Tile Field, and the 216-Z-18 Crib. Since 1992, SVE has operated as an interim action pending a final ROD for the 200-PW-1 OU. This year, two new 14.2 m^3/min (500 ft^3/min) SVE systems were installed and operated. One system operated at the combined 216-Z-1A/216-Z-18 Well Field, and one system operated at the 216-Z-9 Well Field. The two SVE systems extracted 177 kg (390 lb) of carbon tetrachloride, and approximately 5 kg (11 lb) of carbon tetrachloride were removed from the passive SVE in FY 2009. A total of 79,600 kg (175,488 lb) have been removed to date.
200 West	200-UP-1 Pump-and-Treat	1994	The 200-UP-1 pump-and-treat system is intended to reduce uranium and technetium-99 concentrations within the groundwater plume from the 216-U-1/2 Cribs. The primary COCs for the system are uranium and technetium-99, and the co-contaminants are carbon tetrachloride and nitrate. The extracted groundwater from wells (299-W19-36 and 299-W19-43) is transported by pipeline to the Liquid Effluent Retention Facility and is then processed at the ETF. The system removed 2.98 kg of uranium, 0.0025 kg (0.042 Ci) of technetium-99, 2.58 kg of carbon tetrachloride, and 6,044 kg of nitrate from the aquifer. Since startup, a total of 220 kg of uranium, 0.126 kg (2.14 Ci) of technetium-99, 40 kg of carbon tetrachloride, and 47,585 kg of nitrate have been removed.
Waste Management Area S-SX	Well 299-W23-19 Extended Purging	2003	To perform some remediation of the technetium-99, the practice of extended purging during sampling at Well 299-W23-19 was agreed to by DOE and Ecology and began in 2003. The well purging is continued after samples are collected until a minimum of 3,785 L (1,000 gal) of water is removed. A total of 0.12 g (0.002 Ci) of technetium-99 was recovered this year. Since the start of this treatment in 2003, 0.50 g (0.008 Ci) of technetium-99 has been recovered.
300	300-FF-5, Natural Attenuation	N/A	Average trichloroethene concentrations are below target level in wells, but above target level in characterization samples; uranium concentrations are above target level. Uranium mobility is being evaluated at a test location.
1100-EM-1	Natural Attenuation	N/A	Average trichloroethene concentrations have been below the action level since 2001. Remediation goals have been met. 1100-EM-1 has been delisted from the NPL. The portion of this former OU that lies south of Horn Rapids Road was turned over to the Port of Benton.

Within the Central Plateau, there are four groundwater OUs (200-UP-1, 200-ZP-1, 200-BP-5, and 200-PO-1). Activities at all four are pertinent to the Composite Analysis. The location and boundaries of these four groundwater OUs (as well as other groundwater OUs in the river corridor not pertinent to the Composite Analysis) are shown in Figure 3-1. Any activities in the four groundwater OUs within the Central Plateau that provide new information on radionuclide constituents relevant to the Composite Analysis in these four groundwater OUs are discussed in the following four subchapters. Remedial actions directed at nonradioactive contaminants are also discussed because these actions could potentially influence the characterization, extent, or remediation of radioactive constituents and, thereby, become relevant to the Composite Analysis.

200-UP-1 Groundwater Operable Unit. For FY 2010, the following primary actions were undertaken with respect to the 200-UP-1 Groundwater OU:

- The IRA pump-and-treat system near U Plant (in the 216-U-17 Crib area) continued to operate.
- The 200-UP-1 RI/FS Report (DOE/RL-2009-122, *Remedial Investigation/Feasibility Study for the 200-UP-1 Groundwater Operable Unit)* and the related Proposed Plan (DOE/RL-2010-05, *Proposed Plan to Amend the 200-ZP-1 Groundwater Operable Unit Record of Decision to Include the Remedial Actions for the 200-UP-1 Groundwater Operable Unit*) were completed and submitted to EPA and Ecology.

The sampling and analysis plan (SAP) for FY 2010 within the 200-UP-1 Groundwater OU was incorporated into the RI/FS Work Plan for the 200-UP-1 Groundwater OU (DOE/RL-92-76, *Remedial Investigation/Feasibility Study Work Plan for the 200-UP-1 Groundwater Operable Unit, Hanford Site*).

A summary of the FY 2010 efforts follows:

- **Interim Action Pump-and-Treat System Operations**
  - During system operation, groundwater was pumped from two extraction wells and discharged to the ETF for removal of groundwater COCs, including uranium, technetium-99, carbon tetrachloride, and nitrate.
  - During FY 2010, uranium concentrations at groundwater Wells 299-W19-18 and 299-W19-37 that surround the original baseline uranium plume exceeded the current 300 μg/L remedial action goal (RAG) established by EPA/ROD/R10-97/048. These extraction wells were operated sporadically during FY 2010 because of rehabilitation activities and scheduled ETF process and maintenance activities. A total volume of 3.67×10^6 L (969,511 gal) of groundwater was discharged to the ETF. An estimated 0.718 kg (1.58 lb) of uranium and 1.3 g (0.003 lb) of technetium-99 were removed. More than 8.87×10^8 L (2.34×10^8 gal) has been treated since startup of remediation activities in FY 1994. A total of 212 kg (467 lb) of uranium and 2.16 Ci (127 g) of technetium-99 have been removed from the effluent during treatment.
  - Prior to operation of this pump-and-treat system, the baseline plume was estimated to contain a total mass of 2.72 Ci (160 g) of technetium-99 and 130 kg (286 lb) of uranium (DOE/RL-97-36, *200-UP-1 Groundwater Remedial Design/Remedial Action Work Plan*). Thus, about 78 percent of the original technetium-99 mass has been recovered, while more uranium has been recovered than was originally estimated to be present. The additional mass of uranium is attributed to ongoing vadose zone contributions.

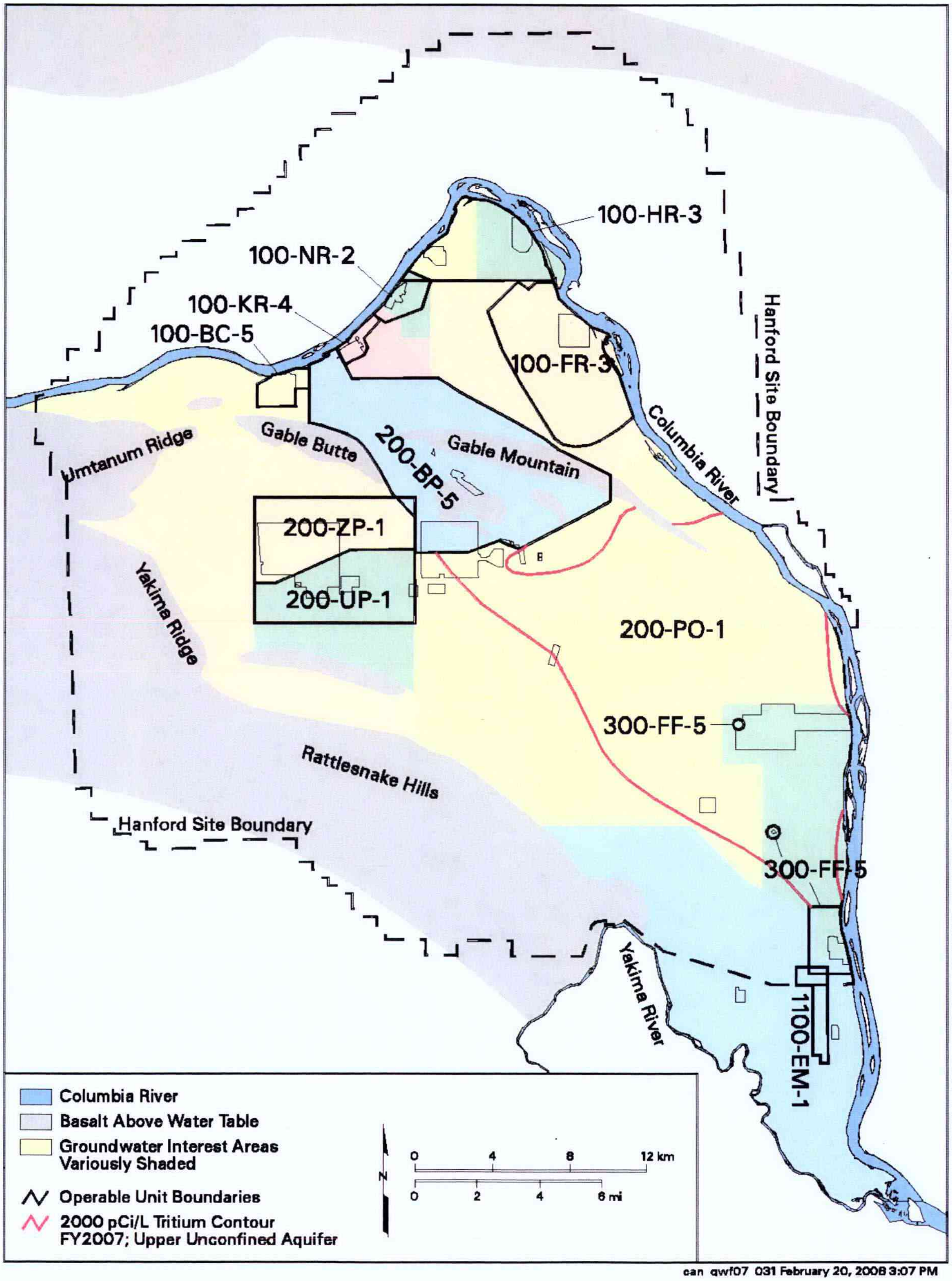

Figure 3-1. Groundwater Operable Units and Groundwater Interest Areas on the Hanford Site

- **200-UP-1 Groundwater OU RI/FS and Proposed Plan**
  - During FY 2010, an RI/FS (DOE/RL-2009-122) was issued in support of the final remedy. Additionally, the related Proposed Plan (DOE/RL-2010-05,) was issued simultaneously with the RI/FS. These documents were both presented to EPA and Ecology as Draft A. The Proposed Plan calls for the remedial actions associated with the preferred alternative to be addressed through an amendment to the 200-ZP-1 Groundwater OU ROD.
- **Monitoring Well Sampling**
  - Forty-six wells were scheduled for sampling during FY 2010. The primary COCs for this work were technetium-99 and uranium.
  - Uranium concentrations associated with the U Plant IRA exceeded the current RAG (300 µg/L) for several of the baseline plume monitoring wells. The maximum quarterly sampling result was observed at extraction well 299-W19-43 (380 µg/L). Uranium trends remained stable or decreased at all wells.
  - Technetium-99 concentrations were substantially below the 9,000 pCi/L RAG for the U Plant IRA for most monitoring and extraction wells with the exception of Well 299-W22-83. Concentrations have increased in this monitoring well from a 228 pCi/L in October 2001 to 18,000 pCi/L in June 2010.
  - In addition to the technetium-99 at the U Plant IRA, technetium-99 concentrations occur above the DWS (900 pCi/L) in two other regions of the 200-UP-1 Groundwater OU: WMA S-SX and WMA U.
  - At WMA S-SX, a technetium-99 plume originates from the southwestern corner of the WMA, and another plume originates from the northern portion. The highest technetium-99 concentrations within this OU occur in the southern plume (located inside the SX Tank Farm). Concentrations in this well have exhibited a generally increasing trend. The southern plume from WMA S-SX represents a growing contamination issue because the plume is increasing in areal extent, and concentrations are increasing in many of the downgradient wells. At far downgradient wells, the technetium-99 concentration has increased beyond ten times the DWS for this COC. The northern plume at WMA S-SX originates from the S Tank Farm. Concentrations began increasing in this plume during FY 2007 and have continued to increase. Future remediation of both the northern and southern plumes from WMA S-SX is being addressed by the 200-UP-1 Groundwater OU CERCLA activities.
  - Technetium-99 concentrations in the downgradient wells at WMA U are elevated compared to concentrations in the upgradient well. This indicates that the U Tank Farm may be a source of technetium-99 contamination (PNNL-13282, *Groundwater Quality Assessment for Waste Management Area U: First Determination*); however, concentrations are very low compared to WMA S-SX. The DWS for this COC was exceeded in several wells.
- **Summary of Groundwater OU Activities**
  - Within the 200-UP-1 Groundwater OU, technetium-99, tritium, and iodine-129 are the radiological contaminants of greatest significance in groundwater and form extensive plumes within the region. Groundwater plumes of tritium and iodine-129 that originated from ponds and cribs are dispersing naturally, whereas plumes originating from the tank farms are generally growing in areal extent and exhibit increasing concentrations.

- FY 2009 activities in the 200-UP-1 Groundwater OU are summarized in DOE/RL-2010-11. Review of these FY 2009 activities (e.g., CERCLA investigations and CERCLA monitoring) in FY 2010 did not reveal any new information associated with this OU that has potential to alter the conclusions of the Composite Analysis presented in PNNL-11800 and Addendum 1.

200-ZP-1 Groundwater Operable Unit. During FY 2010, within the 200-ZP-1 Groundwater OU, interim actions continued to be implemented for remediation of carbon tetrachloride, chloroform, and trichloroethene in the vicinity of the 216-Z Liquid Waste Disposal Units (comprised primary of cribs and trenches). The final remedy for the 200-ZP-1 Groundwater OU is being constructed now and will remediate carbon tetrachloride as well as seven other COCs throughout the vertical extent of the aquifer in accordance with the *Record of Decision Hanford 200 Area 200-ZP-1 Operable Unit Superfund Site Benton County, Washington* (EPA et al., 2008), signed in September 2008.

The final selected remedy for the 200-ZP-1 Groundwater OU includes the following four components:

- An extensive groundwater pump-and-treat system will be used to capture and treat contaminated groundwater throughout this groundwater OU to reduce the mass of carbon tetrachloride and seven other COCs by a minimum of 95 percent in about 25 years.
- Natural attenuation processes will be used to reduce COC concentrations to below cleanup levels after active pumping has removed the majority of COC concentration. The total time to remedial completion is estimated to be about 150 years (for active pumping plus monitored natural attenuation).
- Flow path control will be achieved by injecting treated groundwater into the aquifer upgradient and downgradient of the source area to restrain COCs to remain within the capture zone of the pump-and-treat system.
- ICs will be used to restrict groundwater use in the 200-ZP-1 Groundwater OU until cleanup levels are achieved.

In addition to the interim remediation pump-and-treat facility, work on the 200 West Area pump-and-treat facility and infrastructure proceeded during FY 2010. Activities include completion of design and balance of plant review for DOE and start of plant construction (TPA Milestone M-016-123). Fifteen injection and extraction wells were installed during FY 2010 that will support the 200 West Area pump-and-treat facility. During field operations, geochemical samples were collected at discrete vertical intervals as drilling progressed through the saturated interval.

Additional reports related to this groundwater OU that were completed and submitted for regulatory approval during FY 2010 include the following:

- DOE/RL-2009-38, *Description of Modeling Analysis in Support of the 200-ZP-1 Remedial Design/Remedial Action Work Plan*
- DOE/RL-2009-115, *Performance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action*
- DOE/RL-2009-124, *200 West Area Pump-and-Treat Facility Operations and Maintenance Plan*
- DOE/RL-2010-13, *200 West Area Groundwater Pump-and-Treat Remedial Design Report*
- DOE/RL-2010-72, *Sampling and Analysis Plan for Eight Remediation Wells in the 200-ZP-1 Operable Unit in FY 2011*

- SGW-42736, *Geohydrologic Data Package in Support of 200-ZP-1 Modeling*

Carbon tetrachloride mass was reduced in the area of highest concentrations through pumping and treating more than 485 million L (128 million gal) from 14 groundwater extraction wells in FY 2010. Approximately 574.3 kg (1,264 lb) of carbon tetrachloride were removed in FY 2010. A total of 4.9×10^9 L (1.3×10^9 gal) of water has been processed, and 12,410.4 kg (27,352 lb) of carbon tetrachloride have been removed since startup in March 1994.

A pump-and-treat test system began operation as an IRA to treat technetium-99 contamination to the east of and within WMA T in September 2007. This IRA was implemented as part of the general remedial guidance for this Hanford Site groundwater OU based on EPA/ROD/R10-95/114, *Declaration of the Interim Record of Decision for the 200-ZP-1 Operable Unit*, and the data quality objectives (DQOs) process per WMP-28389, *T-Area Technetium-99 Data Quality Objectives Summary Report.*

The pump-and-treat test system currently consists of two extraction wells that dispose of the extracted groundwater to the ETF. These extraction wells operated with intermittent stoppages in FY 2010 because of pump problems and scheduled ETF process and maintenance activities.

A total volume of 13.18×10^6 L (3.5×10^6 gal) of groundwater was discharged to the ETF, and a total mass of 0.168 Ci (9.9 g) of technetium-99 was removed in FY 2010.

- **Summary of Groundwater OU Activities.** The primary radiological COC in the 200-ZP-1 Groundwater OU continues to be technetium-99. Remedial actions at this OU have focused on pump-and-treat operations to capture and contain the high concentration region of this plume, as well as the carbon tetrachloride plume.

  Two separate pump-and-treat systems are currently in operation in this groundwater OU:

  1. The pump-and-treat network that addresses carbon tetrachloride contamination has been active since 1995 and currently consists of 14 extraction wells and 5 injection wells. The primary sources of carbon tetrachloride are from cribs and trenches south of WMA TX-TY, with the main plume located along the western edge of that WMA. This IRA continued to remove carbon tetrachloride from the highest concentration area west of WMA TX-TY during 2010. Fewer monitoring wells exceeded the high concentration limit (2,000 μg/L) during FY 2010 than was observed in FY 2009. However, the maximum extent of the carbon tetrachloride plume (at the 5 μg/L DWS) expanded slightly to the east though the concentrations continue to decline as the source is contained and the carbon tetrachloride is subject to dispersion and decay. Remediation of carbon tetrachloride influent at the treatment facility continued to perform at near 100 percent removal efficiency. Effluent concentration from the treatment facility to the reinjection wells is consistently below the 5 μg/L DWS.

  2. The pump-and-treat network that addresses technetium-99 contamination has been in service since 2007 and consists of two extractions wells located east of WMA T. Monitoring and PA of the pump-and-treat network for the 200-ZP-1 Groundwater OU are subject to regulation in accordance with RCRA and CERCLA. Observation of technetium-99 concentration in wells near the high concentration core, east of WMA T, shows declines in all wells during FY 2010. Technetium-99 concentration remains constant at downgradient well 299-W11-7, northeast of the pumping wells that are beyond the pump-and-treat capture zone. Other wells located downgradient from the source zone also show a general decline in technetium-99. Technetium-99 plumes adjacent to WMA TX-TY are subject to capture by the 200-ZP-1 interim pump-and-treat system. Most monitoring wells show stable to decreasing trends for technetium-99 during the period.

FY 2009 activities in the 200-ZP-1 Groundwater OU are summarized in DOE/RL-2010-11. Review of these FY 2009 activities in FY 2010 (CERCLA investigations and monitoring) did not reveal any new information associated with this OU that has potential to alter the conclusions of the Composite Analysis presented in PNNL-11800 and Addendum 1.

200-BP-5 Groundwater Operable Unit. The following two documents direct CERCLA activities in the 200-BP-5 Groundwater OU:

- DOE/RL-2001-49, Rev. 1, *Groundwater Sampling and Analysis Plan for the 200-BP-5 Operable Unit*
- DOE/RL-2007-18, *Remedial Investigation/Feasibility Study Work Plan for the 200-BP-5 Groundwater Operable Unit*

The following activities in the 200-BP-5 Groundwater OU are discussed in the context of the two driving documents:

1. SAP Activities
   - The SAP was revised in 2004 (DOE/RL-2001-49, Rev. 1) to integrate *Atomic Energy Act of 1954* (AEA) monitoring and make minor modifications in the monitoring network. CERCLA monitoring data are used to define the extent of groundwater contamination in the 200-BP-5 Groundwater OU. Each year, new contours are created for each COC identified in DOE/RL-2001-49, Rev. 1. The certainty of the plume construction is also assessed each year to determine the effectiveness of the CERCLA and AEA monitoring program. The assessment determines if the selected analytical methods, sampling frequencies, and monitoring well locations are appropriate. In addition, the new contours are compared each year with previous contours to interpret groundwater flow and track concentration trends near contaminant sources. This document also supports the RCRA program and provides the direction for the integrated use of RCRA analytical data.
   - The SAP was revised again in 2010 (DOE/RL-2001-49, Rev. 2) following installation of the RI wells. Data obtained from these new RI wells, along with data from the existing monitoring network, enabled development of an improved understanding of several potential contaminant sources as well as the groundwater flow direction across the central portion of the 200 East Area. The groundwater flow direction in this low-gradient area has been uncertain for several years because of differences in the groundwater elevations and the apparent groundwater divide in the gap between Gable Mountain and Gable Butte that made use of conventional three point analyses less valuable. The flow regime was better defined in 2010 using groundwater chemistry analysis and was confirmed using contaminant plume configurations and an improved understanding of waste site impacts to the groundwater. The groundwater chemistry comparisons also provided an additional technical means for defining the plume configurations.
2. RI/FS Work Plan Activities
   - The 200-BP-5 RI/FS Work Plan (DOE/RL-2007-18) was derived through the DQOs process (WMP-28945, *Data Quality Objectives Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study Process*), which established the need for 15 additional wells to resolve future impacts to groundwater, improve the understanding of contaminant nature and extent within the aquifer, and refine the groundwater flow direction.

- Three RI wells (denoted as "K," "L," and "M") identified in DOE/RL-2007-18 and WMP-28945 were drilled and installed in FY 2010. These wells are located near the following facilities: 216-B-12 Crib just west of B Plant, 216-B-6 injection well just south of B Plant, and 216-C-1 Crib near Semi Works. A borehole summary report was completed (SGW-46869, *Borehole Summary Report for the Three 200-BP-5 Wells, "K," "L," and "M" Fiscal Year 2010*) that provides the details of the well completion, the sample collection process, and the geologic interpretations. All of the analytical data derived from samples collected both in the vadose zone and groundwater were verified, validated, and entered into the Hanford Environmental Information System database.

- The vadose zone and initial groundwater sample results indicate that these sites are not currently impacting groundwater. However, results from the "M" well (299-E28-30) indicate that contamination from the 216-B-12 Crib, or from other source(s) to the south, is responsible for a highly contaminated groundwater plume in this area. The most significant groundwater contaminants in this plume are nitrate (828 mg/L) and tritium (94,000 pCi/L). These elevated concentrations are associated with groundwater samples that were collected approximately 7.6 m (25 ft) below the water table in the sediment horizon defined as Ringold unit A.

- The hydraulic conductivity of this sediment horizon (Ringold unit A) is defined in PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*, as 0.0013 ft/day. A range for the horizontal hydraulic conductivity of this unit, from a minimum of 0.00051 m/d to a maximum of 4.24 m/d, reflects the uncertainty in hydraulic conductivity in this sediment horizon (PNNL-14753, *Groundwater Data Package for Hanford Assessments*). Proximal well data show significant nitrate and tritium concentrations in the 1970s and 1980s, indicating that this contamination plume is aged and contains residual contaminants caught in this low permeability sediment. The vertical extent of elevated contamination in this sediment horizon is from approximately 12.2 to 15.2 m (40 to 50 ft). The horizontal extent is uncertain and will be verified through implementation of the 2011 revised groundwater SAP (DOE/RL-2001-49, Rev. 2).

- Four major reports were drafted in 2010 for the 200-BP-5 Groundwater OU RI/FS. Two of the reports were associated with a treatability test near WMA B/BX/BY (SGW-44329, *200-BP-5 OU Data Quality Objective Summary Report*, and DOE/RL-2010-74, *Treatability Test Plan for the 200-BP-5 Groundwater Operable Unit*). These reports defined the boundary, location, data, infrastructure, and approach required to complete the treatability test. Submittal of the treatability test plan to the EPA in September 2010 completed TPA Milestone M-015-082. The third report was initiated in 2010 (DOE/RL-2009-127, *Remedial Investigation Report for the 200-BP-5 Groundwater Operable Unit*). This draft report is in development and will undergo DOE review before its release to EPA, which is planned for early in calendar year (CY) 2011. The final report initiated and completed this year was SGW-44071, *Data Quality Assessment Report for the 200-BP-5 Groundwater Operable Unit: November 2004 through November 2009 Groundwater Data*. This report evaluated 10,926 groundwater samples over the past five years to determine whether the data was of sufficient quality to support the baseline risk assessment (BRA) and selection of remedial alternatives. The conclusion of the report was that the data were of the proper type, quality, and quantity for use as part of the RI/FS study process.

- **Summary of Groundwater OU Activities.** FY 2009 activities in the 200-BP-5 Groundwater OU are summarized in DOE/RL-2010-11, which was published in August 2010.

The information derived from routine sampling in FY 2009, in addition to samples from newly installed RI wells, provided evidence to support identification of the source of the uranium plume and the flow direction in the 200-BP-5 Groundwater OU. In addition, sampling data collected beneath the BY Cribs have been used to clarify the contaminants associated with the BY Cribs. New RI wells 299-E33-50 and 299-E33-340 have been used to refine estimates of the extent of contamination within the basalt confined aquifer. Information gained from the three new RI wells north of the 200 East Area has been used to clarify understanding of the transport pathways across the subsurface basalt anticline ridge.

Overall, observed contaminant concentration/activity increases were associated mainly with WMA B-BX-BY, WMA C, the BY Cribs, and possibly other past practice liquid effluent waste sites near WMA B-BX-BY. Although new peak concentrations were reported in some of these areas, the extent of contaminant migration is minimal due to either the low hydraulic gradient in this area, the flow reversal observed throughout the northwest portion of the 200 East Area, and/or the low mobility of the contaminant.

In summary, review of FY 2009 CERCLA investigations and CERCLA monitoring activities reported in DOE/RL-2010-11 and evaluated in FY 2010 for did not reveal any new information associated with this Groundwater OU with the potential to alter the conclusions of the Composite Analysis presented in PNNL-11800 and Addendum 1.

200-PO-1 Groundwater Operable Unit. The 200-PO-1 Groundwater OU encompasses the south portion of the 200 East Area and a large portion of the Hanford Site extending east to the Columbia River to the east and southeast to the 300-FF-5 Groundwater OU. Under current conditions, the Near Field area contaminants of potential concern (COPCs) include iodine-129, technetium-99, tritium, nitrate, strontium-90, trichloroethene, and uranium. COPCs for the Far Field area include iodine-129, tritium, nitrate, trichloroethene, carbon tetrachloride, and tetrachloroethene. In the river area of this groundwater OU, only tritium and nitrate are COPCs under current conditions.

The primary monitoring objective within the 200-PO-1 Groundwater OU is to meet the groundwater monitoring requirements for the CERCLA, RCRA, the *Washington Administrative Code*, and AEA as directed in DOE Orders. The long-term goals for CERCLA are to implement risk based remedial actions and verify that cleanup objectives and goals have been met.

The 200-PO-1 Groundwater OU encompasses six RCRA units including the PUREX cribs (also called the RCRA PUREX cribs), the WMA A AX (SSTs), the 216-A-29 Ditch, the IDF, the 216-B-3 Pond, and the Nonradioactive Dangerous Waste Landfill. 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 and the Solid Waste Landfill.

The primary document developed for the 200-PO-1 Groundwater OU in FY 2010 was *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit* (DOE/RL-2009-85, *Remedial Investigation Report for the 200-PO-1 Groundwater Operable Unit*). This RI report for the 200-PO-1 Groundwater OU was completed (Draft A) and submitted to the regulators in May 2010. This report included data reduction and analysis that addresses the following topics:

- Assessment of data quality for data collected during the RI
- Evaluation of the RI work plan scope of work for completeness
- Development of the hydrogeologic conceptual site model of the groundwater OU
- Assessment of the nature and extent of groundwater contamination

- Preparation of a BRA that compares detected contaminant concentrations to applicable or relevant and appropriate requirements (ARARs) and identifies COPCs
- Computational analysis of groundwater contaminant F&T for future impacts
- Determination of whether OU conditions present a basis for remedial action

Results from the groundwater monitoring program for the 200-PO-1 Groundwater OU in FY 2009 are presented in DOE/RL-2010-11.

3.6.1.3 Deep Vadose Zone Operable Unit

Chapter 4.2 discusses the development of major changes in the TPA milestones that govern cleanup of the 194.25 km^2 (75 mi^2) area of the Central Plateau in FY 2010. Among the changes in this agreement is the creation of a new OU for sites with deep vadose zone contamination, 200-DV-1, with new milestones to identify technologies for characterization, treatment, and monitoring of contamination in the deep vadose zone. Work on this new OU will commence in FY 2011.

3.6.1.4 Other Central Plateau Remediation Activities

Other remediation activities on the Central Plateau, aside from source and groundwater OU activities, are presented in this chapter. For FY 2010, ERDF represents the only activity in this category.

Status of the Environmental Restoration Disposal Facility. Washington Closure Hanford (WCH) operates ERDF to dispose of Hanford Site low-level radioactive, hazardous, or dangerous, and low-level mixed waste generated during waste site closures and remediation activities from other Hanford contractors as authorized by CERCLA. The requirements associated with the facility are identified in EPA/ROD/R10-95/100, *Declaration of the Interim Record of Decision for the Environmental Restoration Disposal Facility,* including amendments (EPA/AMD/R10-97/101, *Record of Decision Amendment: U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site – 200 Area Benton County, Washington*; EPA/AMD/R10-99/038, *Record of Decision Amendment: U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site 200 Area Benton County, Washington*; EPA/AMD/R10-02/030, *Record of Decision Amendment: U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site 200 Area Benton County, Washington, Amended Record of Decision, Decision Summary and Responsiveness Summary*; EPA et al., 2007, *U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site-200 Area Benton County, Washington, Amended Record of Decision, Decision Summary and Responsiveness Summary*).

- **Leachate Monitoring.** ERDF began operating in July 1996. Situated between the 200 East and 200 West Areas, the facility operates eight cells covering 30.0 hectares (74.1 acres). Construction of super cells 9 and 10 (super cells are twice the size of regular cells) is in progress and will be completed in first or second quarter of FY 2011. Each cell is double lined to collect leachate resulting from water added as a dust suppressant and from precipitation. The liner is sloped to a sump in each cell and the leachate pumped from the sump to holding tanks. From there, the leachate is pumped to the ETF for treatment.

  Additionally, ERDF leachate is sampled for constituents identified in the 1999 ERDF ROD amendment, EPA/AMD/R10-99/038, and WCH-173, *Environmental Restoration Disposal Facility Leachate Sampling and Analysis Plan*. The 2002 ERDF ROD amendment, EPA/AMD/R10-02/030, delisted the leachate and identified the necessary sampling frequency. Leachate samples are obtained directly from the holding tanks. The constituents detected in the ERDF leachate samples are then compared with the groundwater monitoring analyte list to determine whether additional analytes should be added to the Groundwater Performance Assessment Project. The target analytes for groundwater monitoring are consistent with the leachate monitoring program. Furthermore, the leachate data are evaluated for trends. Based on the groundwater sampling and leachate data, no impact to groundwater has occurred from ERDF operations because of the double lined leachate collection system and other design features. Although technetium-99 and uranium have slightly increased in the leachate over time, it represents no impact to groundwater. The groundwater sampling data indicate that no uranium or technetium-99 values in the groundwater samples are out of historical trends. WCH produces an annual report summarizing the leachate and groundwater monitoring data and providing conclusions and recommendations as appropriate. The most recent report is WCH-399, *Groundwater and Leachate Monitoring and Sampling at the Environmental Restoration Disposal Facility, Calendar Year (CY) 2009.*

- **Current Inventory Estimates.** ERDF received and disposed of record quantities of waste during FY 2010 and is poised to exceed those quantities in FY 2011. In terms of radionuclide inventory, Table 3-5 lists the annual inventory of key radionuclides placed in ERDF for CY 2005 through CY 2009. Table 3-6 presents detail on FY 2010 and the totals since inception of ERDF through September 30, 2010. In 1996, Bechtel Hanford, Inc. estimated that fewer than 500 Ci were disposed to ERDF. Table 3-5 shows that after over 14 years of operations, more than 103,831 Ci have been disposed at ERDF since inception of operations on July 1, 1996. The data source for this summary is the monthly inventory disposal report from the WCH Waste Management Information System. The annual activity count increased every year between CY 2006 and CY 2009. The rate of inventory accumulation dropped slightly between FY 2009 and FY 2010. This slight decrease may be due to the increased proportion of nonradiological and very low-radiological content waste being shipped to ERDF in heavy dump trucks and super dump trucks. The ERDF waste acceptance criteria were revised in 2009 (WCH-191, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*). Another revision to the waste acceptance criteria is anticipated in late CY 2010. The basis for the changing the ERDF waste acceptance criteria total curie guidelines for carbon-14 and total uranium is analyzed in WCH-191. The analysis was performed because additional current and potential sources of carbon-14 and uranium bearing waste have been identified with ongoing remediation of CERCLA sites at Hanford that must be remediated. The analysis increased the limits by reviewing the underlying assumptions for the initial inventory limit estimates and adjusting them in light of subsequent relevant information that has been collected at the Hanford Site and elsewhere. These include extensive recharge measurements taken at a field scale prototype barrier built in the 200 East Area, sorption data and field observations for both uranium and carbon-14 which indicate that they are slightly sorptive (as opposed to zero sorption in the initial analysis), and transport field scale experiments of carbon-14 transport through the vadose zone at the Idaho National Engineering Laboratory site. Table 3-6 reflects the changes to WCH-191, including modification of some of the existing radionuclide limits as well as the addition of new radionuclides to the list.

The ERDF inventory estimate is considered to be very conservative. The ERDF inventories are derived from the ERDF waste acceptance system, which is operated to ensure that no waste above the established limits (based on the ERDF waste acceptance criteria and safety analysis) enters ERDF. The waste acceptance achieves this by biasing every element of the process, such as profiles and onsite waste tracking forms (the ERDF manifest), to the highest possible levels before comparison with the established limits. The net effect of this bias is to inflate the ERDF inventory artificially. A comparison of the ERDF inventory for waste from the N Cribs with the waste generator's records showed that the ERDF inventory was higher by a factor of three. The factor for inventories from other waste sites may be higher. While this bias does not allow for a precise knowledge of the actual inventory, it does provide excellent assurance that inventory limits are not being exceeded. Because of this deliberate bias, it is inappropriate to expect that the ERDF inventories listed here will match best estimate inventories prepared for other purposes.

Table 3-5. Summary of Environmental Restoration Disposal Facility Annual Radionuclide Inventory Calendar Years 2005 through 2008 and Fiscal Year 2009

Radionuclide	CY 2005 (Ci)	CY 2006 (Ci)	CY 2007[a] (Ci)	CY 2008[a] (Ci)	FY 2009 (Ci)[b]
Ac-227			0.000	0.000	0.000
Ag-108m			40.172	50.416	31.455
Am-241	24.687	14.339	4.572	4.135	315.438
Am-242m			0.000	0.000	0.048
Am-243	0.000	0.000	0.000	0.000	0.028
Ba-133			0.165	0.491	0.482
Be-7			0.000	0.000	0.000
C-14[c]	0.104	3.644	0.101	0.031	0.881
C-14A[c]	329.812	439.190	391.457	36.975	273.530
Ca-41			36.404	31.692	95.453
Cd-113m			3.796	0.312	0.009
Ce-144			0.000	1.006	2.811
Cf-249			0.000	0.000	0.000
Cm-242				0.000	0.001
Cm-243			0.019	0.004	0.093
Cm-244			0.005	0.001	0.136
Cm-245			0.126	0.066	0.709
Cm-246			0.000	0.000	0.000
Cm-247			0.000	0.000	0.000
Cm-248			0.000	0.000	0.000
Co-58			0.000	0.000	0.000
Co-60	0.000	0.000	0.001	0.000	0.000
Cs-134	839.458	1,398.213	2,246.674	2,255.345	384.510
Cs-135	0.966	0.059	0.036	0.016	8.515
Cs-137			0.000	0.000	0.104
Eu-152	1,521.190	1,527.564	419.671	443.805	7,071.143
Eu-154					0.000
Eu-155	29.167	38.542	67.245	123.326	216.721
Fe-55	19.226	22.409	34.599	50.429	159.676

Table 3-5. Summary of Environmental Restoration Disposal Facility Annual Radionuclide Inventory Calendar Years 2005 through 2008 and Fiscal Year 2009

Radionuclide	CY 2005 (Ci)	CY 2006 (Ci)	CY 2007[a] (Ci)	CY 2008[a] (Ci)	FY 2009 (Ci)[b]
Fe-59	2.401	1.729	0.336	5.889	78.588
H-3			0.000	13.025	11.037
I-129			0.000	0.000	0.001
K-40	337.964	748.913	1,326.269	259.057	989.696
Kr-85			0.000	0.015	0.002
Mn-54			0.586	13.200	21.140
Mo-93			0.030	0.000	0.163
Na-22			0.000	0.085	0.009
Nb-93m			0.673	0.332	0.075
Nb-94	0.000	0.000	0.000	0.000	0.000
Nb-94A			1.564	0.393	4.419
Ni-59	0.000	2.206	1.203	1.358	1.731
Ni-59A			0.422	0.153	0.032
Ni-63			14.538	8.437	30.059
Ni-63A			490.889	66.260	10.874
Np-237	252.520	40.460	76.224	12,743.879	2,408.458
Pa-231	583.523	1,536.107	6,865.657	3,368.755	1,057.055
Pb-210	0.002	0.006	0.003	0.094	0.021
Pd-107			0.000	0.000	0.000
Pm-147			0.000	0.000	0.000
Pu-238			0.000	0.000	0.017
Pu-239			0.063	0.163	123.569
Pu-240	4.992	1.785	0.422	0.234	12.793
Pu-241	26.263	12.666	4.582	1.082	66.639
Pu-242	10.428	4.440	1.586	0.392	39.387
Pu-244	437.187	88.556	20.980	12.543	1,095.561
Ra-226	0.003	0.000	0.000	0.030	0.021
Ra-228			0.000	0.000	0.001
Ru-103	0.002	0.134	0.145	0.349	0.074

Table 3-5. Summary of Environmental Restoration Disposal Facility Annual Radionuclide Inventory Calendar Years 2005 through 2008 and Fiscal Year 2009

Radionuclide	CY 2005 (Ci)	CY 2006 (Ci)	CY 2007[a] (Ci)	CY 2008[a] (Ci)	FY 2009 (Ci)[b]
Ru-106	0.004	0.005	0.053	0.098	0.075
Sb-125					0.000
Se-79			0.000	0.000	0.000
Sm-151			0.003	0.015	0.001
Sn-113			0.028	2.094	49.572
Sn-121m			0.000	13.656	21.415
Sn-126			0.175	2.962	238.061
Sr-90			0.000	0.000	0.000
Tc-99			0.000	0.000	18.120
Th-228			0.000	0.126	0.081
Th-230	909.442	1,179.237	906.339	293.669	5,239.872
Th-232	0.681	7.813	3.471	0.250	3.271
Th-234	0.202	0.042	0.312	0.300	0.050
U-232					0.000
U-233/234			0.000	0.001	0.001
U-235	0.014	0.026	0.056	0.473	0.112
U-236			0.000	0.000	0.000
U-238					0.000
Zn-65			0.000	0.000	0.001
Zr-93	6.245	17.762	0.695	11.022	4.339
Total Activity	**1.169**	**7.380**	**0.068**	**1.085**	**1.014**

a. Expanded inventory tracking began in 2007.

b. Reporting changed from CY to FY basis beginning in FY 2009; thus, three months (October, November, and December 2008) are double reported (values are summed in both CY 2008 and FY 2009).

c. C-14 and C-14A inventories have been adjusted per CCN 088793, *White Paper on Environmental Restoration Disposal Facility Inventory and Waste Acceptance Practices.*

Ac = actinium	Co = cobalt	Na = sodium	Sb = antimony
Ag = silver	Cs = cesium	Nb = niobium	Se = selenium
Am = americium	Eu = europium	Ni = nickel	Sm = samarium
Ba = barium	Fe = iron	Np = neptunium	Sn = tin
Be = beryllium	H = hydrogen	Pa = protectinium	Sr = strontium
C = carbon	I = iodine	Pb = lead	Tc = technetium

Table 3-5. Summary of Environmental Restoration Disposal Facility Annual Radionuclide Inventory Calendar Years 2005 through 2008 and Fiscal Year 2009

Radionuclide	CY 2005 (Ci)	CY 2006 (Ci)	CY 2007[a] (Ci)	CY 2008[a] (Ci)	FY 2009 (Ci)[b]
Ca = calcium	K = potassium		Pm = promethium	Th = thorium	
Cd = cadmium	Kr = krypton		Pu = plutonium	U = uranium	
Ce = cerium	Mn = manganese		Ra = radium	Zn = zinc	
Cf = californium	Mo = molybdenum		Ru = ruthenium	Zr = zirconium	
Cm = curium					

Table 3-6. Summary of Environmental Restoration Disposal Facility Radionuclide Inventory Fiscal Year 2010 and Total Since Inception

Radionuclide	ERDF Waste Acceptance Criteria (Ci/m^3)	FY 2010[a] (Ci)	FY 2010[a] (Ci/m^3)	Inception through September 2010 (Ci)	Inception through September 2010 (Ci/m^3)
Ac-227	7.60E+04	4.08E-07	5.89E-13	6.09E-06	1.37E-12
Ag-108m	N/A	2.92E+02	4.21E-04	4.07E+02	9.13E-05
Am-241	5.40E-02	1.47E+02	2.12E-04	5.03E+02	1.13E-04
Am-242m	4.00E-01	6.45E-03	9.31E-09	5.00E-02	1.12E-08
Am-243	5.60E-02	4.09E-03	5.90E-09	1.78E-01	3.98E-08
Ba-133	N/A	4.51E+00	6.51E-06	5.54E+00	1.24E-06
Be-7	N/A	0.00E+00	0.00E+00	9.18E-06	2.06E-12
C-14[b]	5.10E+00	4.93E+00	7.11E-06	3.98E+01	8.93E-06
C-14 Activated Metal[b]	5.10E+01	2.76E+02	3.99E-04	1.55E+03	3.47E-04
C-14 Insoluble	N/A	2.81E+02	4.06E-04	4.44E+02	9.95E-05
Ca-41	N/A	6.99E-04	1.01E-09	4.12E+00	9.23E-07
Cd-113m	N/A	2.39E-01	3.44E-07	3.94E+00	8.83E-07
Ce-144	N/A	3.96E-03	5.71E-09	4.26E-03	9.55E-10
Cf-249	N/A	0.00E+00	0.00E+00	8.91E-04	2.00E-10
Cm-242	3.20E+01	3.33E-02	4.81E-08	1.16E-01	2.59E-08
Cm-243	8.60E+01	6.91E-02	9.97E-08	1.45E-01	3.25E-08
Cm-244	3.90E+01	8.14E-01	1.17E-06	1.41E+00	3.17E-07
Cm-245	5.60E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-246	1.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 3-6. Summary of Environmental Restoration Disposal Facility Radionuclide Inventory Fiscal Year 2010 and Total Since Inception

Radionuclide	ERDF Waste Acceptance Criteria (Ci/m^3)	FY 2010[a] (Ci)	FY 2010[a] (Ci/m^3)	Inception through September 2010 (Ci)	Inception through September 2010 (Ci/m^3)
Cm-247	3.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cm-248	2.70E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Co-58	N/A	3.23E-04	4.66E-10	7.86E-01	1.76E-07
Co-60	N/A	1.09E+03	1.57E-03	1.05E+04	2.35E-03
Cs-134	N/A	4.04E-01	5.82E-07	2.19E+01	4.91E-06
Cs-135	8.80E+00	3.75E-03	5.41E-09	1.05E-01	2.34E-08
Cs-137	3.20E+01	3.13E+03	4.51E-03	1.67E+04	3.75E-03
Eu-150	1.70E+02	0.00E+00	0.00E+00	1.98E-04	4.44E-11
Eu-152	2.10E+07	6.62E+02	9.54E-04	6.56E+03	1.47E-03
Eu-154	N/A	2.30E+02	3.31E-04	2.07E+03	4.65E-04
Eu-155	N/A	2.29E+01	3.30E-05	2.44E+02	5.46E-05
Fe-55	N/A	1.33E+01	1.92E-05	2.87E+01	6.44E-06
Fe-59	N/A	8.69E-04	1.25E-09	8.73E-04	1.96E-10
H-3	N/A	3.10E+03	4.47E-03	9.56E+03	2.14E-03
I-129	8.00E-02	2.16E-03	3.11E-09	1.89E-02	4.24E-09
K-40	1.20E-03	2.42E+01	3.48E-05	4.98E+01	1.12E-05
Kr-85	N/A	0.00E+00	0.00E+00	1.93E-01	4.33E-08
Mn-54	N/A	1.54E-02	2.22E-08	1.09E-01	2.45E-08
Mo-93	5.10E+01	2.36E-01	3.40E-07	1.31E+00	2.95E-07
Na-22	N/A	9.71E-06	1.40E-11	1.02E+01	2.29E-06
Nb-93m	N/A	3.74E+00	5.39E-06	6.62E+00	1.48E-06
Nb-94	1.20E-02	9.78E-04	1.41E-09	6.54E+00	1.47E-06
Nb-94A	1.20E-01	1.57E-02	2.27E-08	6.23E-01	1.40E-07
Ni-59	2.10E+02	9.87E+01	1.42E-04	1.28E+02	2.87E-05
Ni-59A	2.20E+02	1.14E+01	1.64E-05	5.79E+02	1.30E-04
Ni-63	7.00E+02	1.81E+03	2.61E-03	1.91E+04	4.28E-03
Ni-63A	7.00E+03	1.06E+03	1.53E-03	1.45E+04	3.26E-03

Table 3-6. Summary of Environmental Restoration Disposal Facility Radionuclide Inventory Fiscal Year 2010 and Total Since Inception

Radionuclide	ERDF Waste Acceptance Criteria (Ci/m³)	FY 2010[a] (Ci)	FY 2010[a] (Ci/m³)	Inception through September 2010 (Ci)	Inception through September 2010 (Ci/m³)
Np-237	1.50E-03	9.63E-02	1.39E-07	4.30E-01	9.65E-08
Pa-231	7.40E-03	3.95E-07	5.70E-13	7.35E-07	1.65E-13
Pb-210	5.10E+05	8.88E-05	1.28E-10	1.04E-04	2.33E-11
Pd-107	8.20E+02	7.73E-04	1.11E-09	1.73E-02	3.88E-09
Pm-147	N/A	7.52E+00	1.08E-05	1.25E+02	2.81E-05
Pu-238	1.50E+00	8.38E+00	1.21E-05	4.21E+01	9.44E-06
Pu-239	2.90E-02	3.94E+01	5.68E-05	2.44E+02	5.48E-05
Pu-240	2.90E-02	3.18E+01	4.58E-05	1.18E+02	2.64E-05
Pu-241	5.60E+00	2.43E+03	3.51E-03	6.50E+03	1.46E-03
Pu-242	1.10E-01	4.94E-01	7.13E-07	6.58E-01	1.48E-07
Pu-244	3.20E-02	8.44E-04	1.22E-09	8.44E-04	1.89E-10
Ra-226	1.40E-04	1.16E-01	1.67E-07	8.94E-01	2.00E-07
Ra-228	2.20E-04	1.16E-01	1.67E-07	3.61E-01	8.09E-08
Re-187	N/A	9.60E-08	1.38E-13	9.60E-08	2.15E-14
Ru-103	N/A	2.22E-03	3.19E-09	2.22E-03	4.97E-10
Ru-106	N/A	1.94E-02	2.80E-08	3.72E-02	8.35E-09
Sb-125	N/A	6.84E+00	9.86E-06	5.19E+01	1.16E-05
Se-79	2.70E+01	8.23E-03	1.19E-08	3.51E+01	7.87E-06
Sm-151	5.30E+04	4.16E+01	6.00E-05	2.70E+02	6.07E-05
Sn-113	N/A	1.38E-03	1.99E-09	1.38E-03	3.09E-10
Sn-121m	5.60E+03	1.49E+01	2.15E-05	1.81E+01	4.06E-06
Sn-126	8.40E-03	2.44E-02	3.52E-08	2.22E-01	4.97E-08
Sr-90	7.00E+03	1.91E+03	2.75E-03	1.29E+04	2.90E-03
Tc-99	1.30E+00	4.07E+00	5.87E-06	8.43E+01	1.89E-05
Th-228	1.20E-04	1.08E-01	1.55E-07	1.36E+00	3.06E-07
Th-229	2.50E-02	9.80E-09	1.41E-14	1.07E-06	2.40E-13
Th-230	3.80E-02	4.82E-05	6.95E-11	1.66E-03	3.73E-10

Table 3-6. Summary of Environmental Restoration Disposal Facility Radionuclide Inventory Fiscal Year 2010 and Total Since Inception

Radionuclide	ERDF Waste Acceptance Criteria (Ci/m^3)	FY 2010[a] (Ci)	FY 2010[a] (Ci/m^3)	Inception through September 2010 (Ci)	Inception through September 2010 (Ci/m^3)
Th-232	5.80E-03	1.50E-01	2.16E-07	1.12E+00	2.51E-07
Th-234	N/A	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ti-44	N/A	2.52E-05	3.63E-11	2.52E-05	5.64E-12
U-232	1.20E+00	8.09E-05	1.17E-10	7.44E-04	1.67E-10
U-233/234	7.40E-02	8.73E+00	1.26E-05	9.52E+01	2.14E-05
U-235	2.70E-03	9.88E-01	1.42E-06	2.79E+01	6.25E-06
Total		**16,786.02**		**103,831.444**	

a. Weight of waste received in FY 2010 = 1,588,017 U.S. tons; total received since inception = 10,210,240 U.S. tons. Volume of waste received in FY 2010 = 693,457 m^3 (907,008 yd^3); total received since inception = 4,458,620 m^3 (5,831,655 yd^3).

b. C-14 and C-14A inventories have been adjusted per CCN 088793, *White Paper on Environmental Restoration Disposal Facility Inventory and Waste Acceptance Practices.*

Ac = actinium
Ag = silver
Am = americium
Ba = barium
Be = beryllium
C = carbon
Ca = calcium
Cd = cadmium
Ce = cerium
Cf = californium
Cm = curium
Co = cobalt
Cs = cesium
Eu = europium
Fe = iron
H = hydrogen
I = iodine
K = potassium
Kr = krypton
Mn = manganese
Mo = molybdenum
Na = sodium
Nb = niobium
Ni = nickel
Np = neptunium
Pa = protectinium
Pb = lead
Pm = promethium
Pu = plutonium
Ra = radium
Ru = ruthenium
Sb = antimony
Se = selenium
Sm = samarium
Sn = tin
Sr = strontium
Tc = technetium
Th = thorium
U = uranium
Zn = zinc
Zr = zirconium

4 Summary of Changes

This chapter summarizes key site changes that could affect the Composite Analysis.

4.1 Changes in Hanford Site Inventories for Major Programs

No major changes have occurred to Hanford Site inventories in FY 2010.

4.2 Land Use Issues

DOE/RL-2009-81, *Central Plateau Cleanup Completion Strategy*, was issued in March 2010. This strategy is the result of thousands of hours of work involving DOE input from the Tribal Nations, the public, and stakeholders. DOE, EPA, and Ecology negotiated TPA change packages based on the strategy. The Tri-Party agencies completed seven months of negotiations in April 2010. This strategy document lays out the approach DOE intends to use to clean up nearly 194.25 km^2 (75 mi^2) of the Central Plateau near the center of the Hanford Site. Land use is one of the foundational elements in the CERCLA and DOE strategy. The strategy calls for cleanup decisions to be organized into the following three major components:

- **Inner Area.** The final footprint area of the Hanford Site that will be dedicated to waste management and containment of residual contamination
- **Outer Area.** All of the Central Plateau beyond the boundary of the Inner Area
- **Groundwater.** Contaminant plumes underlying the Central Plateau and originating from waste sites on the Central Plateau

5 Recommended Changes

Based on this annual evaluation of new information and the data collected and analyzed from research, field studies, and monitoring developed by a number of Hanford Site programs, no information was identified that would invalidate the continued adequacy of the current version of the Composite Analysis (PNNL-11800), and the subsequent Addendum 1, as approved (DOE, 2002, "Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities – Submittal of an Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site, PNNL-11800 Addendum 1").

DOE is preparing the TC&WM EIS for the Hanford Site; a draft of this EIS was released for public review and comment in October 2009 (DOE/EIS-0391).

5.1 Status of Composite Analysis Activities

The Hanford Site is deferring any revisions of the Composite Analysis until the final TC&WM EIS and associated ROD are issued; accordingly, no revisions to the Composite Analysis are needed at this time.

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