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DOE/RL-2011-108
Revision 1

# Annual Status Report (Fiscal Year 2011): 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

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DOE/RL-2011-108
Revision 1

# Annual Status Report (Fiscal Year 2011): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site

Date Published
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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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***By Shauna E. Adams at 10:02 am, Mar 12, 2012***

Release Approval

Date

# Executive Summary

In accordance with the U.S. Department of Energy (DOE) requirements in DOE O 435.1 Chg 1[1], and as implemented by DOE/RL-2000-29, Rev. 2[2], the DOE Richland Operations Office (DOE-RL) has prepared this annual summary of the composite analysis for fiscal year (FY) 2011 as originally reported in PNNL-11800[3] (henceforth referred to as the Composite Analysis). The main emphasis of DOE/RL-2000-29, Rev. 2 is to identify additional data and information to enhance the Composite Analysis and the subsequent PNNL-11800 Addendum 1[4] (hereinafter referred to as the Addendum), and to address secondary issues identified during the review of the Composite Analysis.

As required by DOE/RL-2000-29, Rev. 2, an annual evaluation of new information and data developed by a number of onsite programs during FY 2011 was completed. This included the following work performed in FY 2011 and that is considered pertinent to the Composite Analysis:

- Information that could change the source terms considered in the Composite Analysis, including:
  - Performance Assessment (PA) development and maintenance activities:

***Composite Analysis and the Tank Closure & Waste Management Environmental Impact Statement***

*This document identifies additional data and information to be considered for purposes of an eventual 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 presented in the Tank Closure and Waste Management Environmental Impact Statement, and are not intended to foreclose reaching different conclusions in future updates of the Composite Analysis.*

*Preparation of an updated Hanford Site Composite Analysis is deferred until the final Tank Closure and Waste Management Environmental Impact Statement is completed and issued.*

[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.

   - 200-East Low-Level Burial Ground (LLBG) PA
   - 200-West LLBG PA
   - Integrated Disposal Facility (IDF) PA
   - Waste Management Area (WMA) C PA
   - Environmental Restoration Disposal Facility (ERDF) PA
   - *Resource Conservation and Recovery Act of 1976*[5] (RCRA) remedial activities
   - *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*[6] (CERCLA) remedial activities
- Monitoring, research, and development results, including:
   - Groundwater flow and contamination monitoring
   - Remediation science and technology programs

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 (PNNL-11800) and Addendum (PNNL-11800 Addendum 1) 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," (Frei, 2002[7]).

On January 30, 2006, DOE announced 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*[8] and its implementing regulations (40 CFR 1500-1508,[9] Chapter V and 10 CFR 1021[10]). A draft of the

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[5] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://www.epa.gov/lawsregs/laws/rcra.html.

[6] *Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq. Available at:* http://epw.senate.gov/cercla.pdf.

[7] Frei, 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, U.S. Department of Energy, Office of River Protection, and K.A. Klein, U.S. Department of Energy, Richland Operations Office) from M.W. Frei, U.S. Department of Energy, Office of Environmental Management, Washington, D.C., July 24.

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

[9] 40 CFR 1500-1508, "Purpose, Policy, and Mandate," through "Terminology and Index," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_08/40cfrv31_08.html.

TC&WM EIS was released for public review and comment in October 2009 (DOE/EIS-0391[11]). The Hanford Site is deferring any revision of the Composite Analysis (PNNL-11800) until the final TC&WM EIS is issued.

This report generally covers FY 2011 (i.e., October 1, 2010 through September 30, 2011). The format for this report follows requirements in DOE G 435.1-1[12].

This report is organized into the following chapters:

- Chapter 1 is an overview of the purpose and content of this report.
- Chapter 2 is an assessment of the continued adequacy of the Composite Analysis (PNNL-11800).
- Chapter 3 is a review of those Hanford Site activities that have the potential to change the source terms evaluated in the Composite Analysis, including PAs, RCRA remedial activities, and CERCLA remedial activities.
- Chapter 4 is a review of recent onsite monitoring, research, and development results that are relevant to the current Composite Analysis.
- Chapter 5 is a review of key site changes that could affect the Composite Analysis.
- Chapter 6 contains recommended changes to relevant Hanford Site programs that could affect the Composite Analysis and recommended changes to the Composite Analysis maintenance program.
- Chapter 7 contains the references cited in this report.

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[10] 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.

[11] 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.

[12] 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.

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| B.L. Charboneau (DOE-RL)<br>T.B. Bergman (CHPRC) | Central Plateau CERCLA Remedial Activities | 3.3 |
| B.L. Charboneau (DOE-RL)<br>R.L. Cathel (CHPRC)<br>P.A. Burke (CHPRC) | Remediation Activities for Central Plateau Source Operable Units | 3.3.1 |
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CHPRC = CH2M HILL Plateau Remediation Company
DOE-ORP = U.S. Department of Energy, Office of River Protection
DOE-RL = U.S. Department of Energy, Richland Operations Office
PNNL = Pacific Northwest National Laboratory
WCH = Washington Closure Hanford
WRPS = Washington River Protection Solutions

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# Contents



# Appendix

# Tables



# Figures

# 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 |
| DAS | disposal authorization statement |
| DOE | U.S. Department of Energy |
| DOE-EM | DOE Office of Environmental Management |
| DOE-ORP | DOE Office of River Protection |
| DOE-RL | DOE Richland Operations Office |
| DVZ-AFRI | Deep Vadose Zone Applied Field Research Initiative |
| DVZTT | deep vadose zone treatability test |
| DWS | drinking water standard |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| ERDF | Environmental Restoration Disposal Facility |
| ETF | Effluent Treatment Facility |
| FBSR | Fluidized Bed Steam Reforming |
| FY | fiscal year |
| HCP EIS | *Hanford Comprehensive Land-Use Plan Environmental Impact Statement* |
| HLW | high-level waste |
| IDF | Integrated Disposal Facility |
| IFRC | Integrated Field Research Challenge |
| ILAW | immobilized low-activity waste |

| | |
|---|---|
| IRA | interim remedial action |
| ISRM | In Situ Redox manipulation |
| LAW | low-activity waste |
| LERF | Liquid Effluent Retention Facility |
| LLBG | low-level burial ground |
| LLW | low-level waste |
| LLWMA | Low-Level Waste Management Area |
| N/A | not applicable |
| NEPA | *National Environmental Policy Act of 1969* |
| NRC | U.S. Nuclear Regulatory Commission |
| OU | operable unit |
| PA | performance assessment |
| PCT | product consistency test |
| PFP | Plutonium Finishing Plant |
| PNNL | Pacific Northwest National Laboratory |
| PUREX | Plutonium Uranium Extraction (Plant) |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| REDOX | reduction/oxidation |
| RI/FS | remedial investigation/feasibility study |
| ROD | record of decision |
| S&GRP | Soil and Groundwater Remediation Project |
| SALDS | State Approved Liquid Disposal Site |
| SNF | spent nuclear fuel |
| SRNL | Savannah River National Laboratory |
| SST | single-shell tank |
| STOMP | *Subsurface Transport Over Multiple Phases* (software code) |
| STORM | *Subsurface Transport Over Reactive Multiphases* (legacy software code) |
| SVE | soil vapor extraction |
| TCLP | Toxicity Characteristic Leaching Parameter |
| 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 |
| WTP | Waste Treatment Plant |
| XMT | X-ray micro-tomography |

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# 1 Overview

As required by the U.S. Department of Energy (DOE) in DOE O 435.1 Chg 1, *Radioactive Waste Management,* and implemented by DOE/RL-2000-29, Rev. 2, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeastern Washington*, the DOE Richland Operations Office (DOE-RL) has prepared this annual status report for fiscal year (FY) 2011 of PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, hereinafter referred to as the Composite Analysis. The main emphasis of DOE/RL-2000-29, Rev. 2 is to identify additional data and information that will enhance the Composite Analysis and the subsequent PNNL-11800, *Addendum to Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, (henceforth 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 1999, *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 (PNNL-11800) for the Hanford Site is described in the maintenance plan (DOE/RL-2000-29, Rev. 2) that was approved in 2004 (Talarico, 2004, "Low-Level Disposal Facility Federal Review Group Review of Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington, April 2003").

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.

DOE G 435.1-1, Ch. 4, *Implementation Guide for Use with DOE M 435.1-1*, states:

> *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 a composite analysis. Further guidance is found in DOE, 1999. Table 1-1 lists the documents prepared to maintain the Composite Analysis (PNNL-11800) since maintenance began.

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

| Reporting Period | Document |
|---|---|
| FY 2000 | DOE/RL-2000-29, Rev. 0, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington* |
| | DOE/RL-2000-29, Rev. 1, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington* |
| 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-2000-29, Rev. 2, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington* |
| | 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: 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 B, *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, Rev. 0, *Annual Status Report (FY 2010): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site* |
| FY 2011 | DOE/RL-2010-108 (this report), *Annual Status Report (FY 2011): Composite Analysis of Low-Level Waste Disposal in the Central Plateau at the Hanford Site* |

FY = Fiscal Year

## 1.2 Composite Analysis Annual Status Report Content

The format for this report follows requirements established by DOE G 435.1-1. The structure of this report is defined in DOE/RL-2000-29, Rev. 2. Chapter 2 provides an assessment of Composite Analysis (PNNL-11800) adequacy in light of the information presented in this report. Chapter 3 summarizes activities during the reporting period that have a potential to reveal information that could change the source terms considered in the Composite Analysis. Chapter 4 summarizes onsite monitoring and research and development results during the reporting period that are relevant to the Composite Analysis. Chapter 5 summarizes key site changes during the reporting period that could affect the Composite Analysis and Chapter 6 summarizes recommended changes to the initial Composite Analysis (PNNL-11880). Chapter 7 contains the list of references cited in this document.

The reporting period for this annual status report is limited to FY 2011 (i.e., October 1, 2010 through September 30, 2011). The scope of this annual status report is limited to reporting on radionuclide contaminants (the only contaminants managed under DOE O 435.1). The scope of this annual status report is also limited geographically to the Hanford Site's Central Plateau (the extent of the sources considered in the Composite Analysis [PNNL-11800]). Exceptions to these scope limitations are made where appropriate. For example, pump-and-treat remedial actions in the Hanford Site's River Corridor have the potential to affect the Composite Analysis (PNNL-11800) because these actions occur in the same unconfined aquifer as the Central Plateau and downgradient. Thus, groundwater flow simulated in the Composite Analysis (PNNL-11800) included this region; therefore, this information is also included. Similarly, if remedial actions for nonradionuclide contaminants provide additional information or insight into the nature and extent of radionuclide contamination, this is also reported, owing to the potential to impact the Composite Analysis (PNNL-11800) basis. Finally, some information, such as from the Hanford Site groundwater monitoring program, is reported on a calendar year (CY) basis and, although published late in FY 2011, it was reported for CY 2010 and is the most current information available.

# 2 Assessment of Composite Analysis Adequacy

Based on this annual evaluation of new information obtained from a review of PAs, remedial actions, and operations (Chapter 3), from a review of the data collected and analyzed from research, field studies, and monitoring developed by Hanford Site programs (Chapter 4), and from other changes (Chapter 5), no new information was identified that would invalidate the continued adequacy of the Composite Analysis (PNNL-11800), and the subsequent Addendum, as approved (Frei, 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").

The disposal authorization statement (DAS) (Scott, 2001, "Disposal Authorization for the Hanford Site Low-Level Waste Disposal Facilities – Revision 2") conditions on the Hanford Site Composite Analysis have all previously been met through the Addendum (PNNL-11800, Addendum 1) and through prior maintenance activities.

DOE announced on January 30, 2006 its intent to prepare a new Tank Closure and Waste Management Environmental Impact Statement (TC&WM EIS) for the Hanford Site pursuant to the *National Environmental Policy Act of 1969* (NEPA) and its implementing regulations (40 CFR 1500-1508, Chapter V, "Council on Environmental Quality," and 10 CFR 1021, "National Environmental Policy Act Implementing Procedures"). This EIS will provide 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. 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. The draft of the TC&WM EIS, DOE/EIS-0391, *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*, was published on October 30, 2009, for a 140-day public comment period.

This annual summary identifies additional data and information from FY 2011 to be considered for purposes of an eventual update to the Hanford Site Composite Analysis. Any revision to the Composite Analysis is being deferred until the final TC&WM EIS has been issued. Consequently, the maintenance plan for the Composite Analysis (DOE/RL-2000-29, Rev. 2) will not be revised until after the final TC&WM EIS has been issued.

# 3 Source Terms

The purpose of this section is to identify changes to the sources of radioactive materials considered in the Composite Analysis and subsequent Addendum. These changes could include:

- Deletion of sources considered in the Composite Analysis
- Addition of new sources not considered in the Composite Analysis
- Changes to existing sources (e.g., completion of remedial activities at *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* [CERCLA] sites)
- Availability of new information that reduces uncertainty in characteristics of existing sources

No major changes occurred to Hanford Site radionuclide inventories in FY 2011. There was no deletion of sources considered, nor any addition of new sources not considered, in the Composite Analysis and subsequent Addendum.

Activities in the following categories are reviewed as these activities have the potential to reveal new information that could constitute changes to existing radionuclide sources and/or constitute new information that reduces uncertainty in characteristics of existing radionuclide sources:

- DOE O 435.1 PAs (Section 3.1)
- *Resource Conservation and Recovery Act of 1976* (RCRA) remedial activities (Section 3.2)
- CERCLA remedial activities (Section 3.3)

Consideration of the above 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 activities were qualitatively considered that would be expected to, if included in a revised calculation, result in lower dose estimates. Most notable of these are the CERCLA pump-and-treat systems on the Central Plateau, which are qualitatively evaluated as likely to reduce the projected dose. Such dose reduction would be due to removal of contaminant mass from the groundwater pathway. The Composite Analysis and subsequent Addendum did not account for pump-and-treat systems. Hydraulic perturbations to the unconfined aquifer at the Hanford Site Central Plateau and contaminant mass reduction in groundwater resulting from pump-and treat systems will be considered in a future revision of the Composite Analysis. Another change qualitatively evaluated as likely to reduce the projected dose is the closure of 200-SW-2 Burial Grounds. This dose reduction for this site would be due to the lower realized inventory than was considered in the Composite Analysis and subsequent Addendum resulting from the cessation of the use of the unlined trenches (with the unused portions being withdrawn from the RCRA/dangerous waste permit because they will not be used at this time). The reduction in inventory at this site from this change will also be considered in a future revision of the Composite Analysis.

## 3.1 Performance Assessments

Hanford Site PAs that are currently in maintenance, planning, scoping, or analysis phases are listed along with scope and their FY 2011 status in Table 3-1. Detailed summaries activities associated with each of these PAs are provided in Sections 3.1.1 through 3.1.4.

**Table 3-1. Hanford Site Performance Assessments in Maintenance, Planning, Scoping, and/or Analysis Phases and FY 2011 Status**

| Performance Assessment | Scope | FY 2011 Status |
|---|---|---|
| Low-Level Burial Grounds | The Low-Level Burial Grounds in the 200 East and the 200 West Areas; these burial grounds are operational and small limited quantities of waste. | Maintenance Phase |
| Integrated Disposal Facility | This disposal facility is planned for use in future disposal of tank waste from the Waste Treatment Plant. | Maintenance Phase (for existing 2001 PA)<br>Planning Phase (preparing for a revised PA) |
| Environmental Restoration Disposal Facility | This facility is operational and receives wastes from CERCLA remedial activities. | Maintenance Phase<br>Analysis Phase (PA revision is in development; planning and scoping phases complete) |
| Waste Management Area C | Waste Management Area C; this PA is under development to support eventual closure of this Single-Shell Tank facility. | Analysis Phase (PA is in development; scoping phase is nearly complete) |

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
FY = Fiscal Year
PA = Performance Assessment

### 3.1.1 Low-Level Burial Ground Performance Assessments

In the annual review of the Hanford Site Low-Level Burial Ground (LLBG) PAs for FY 2011 (DOE/RL-2011-110, *Annual Review of the 200 West and 200 East Performance Assessments* (*FY 2011*]), the projected dose estimates from radionuclide inventories disposed in the active LLBGs (at locations shown in Figure 3-1) from September 26, 1988 through September 30, 2011 were calculated using the dose estimate methodology developed in the original PAs (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. Operational waste acceptance criteria (HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*) and waste acceptance practices continue to be sufficient to maintain compliance with performance objectives.

***Low-Level Burial Ground Performance Assessments (LLBG PAs) relevance to the Composite Analysis***

*Solid waste disposal constitutes one of the sources of radioactive waste inventory; the current estimated inventory disposed and projections of future inventory disposal in the LLBGs are refined regularly as additional data continue to be collected and reported through maintenance of the LLBG PAs. This updated information is pertinent to the Composite Analysis because of its potential to change the LLBG inventory evaluated in the Composite Analysis.*

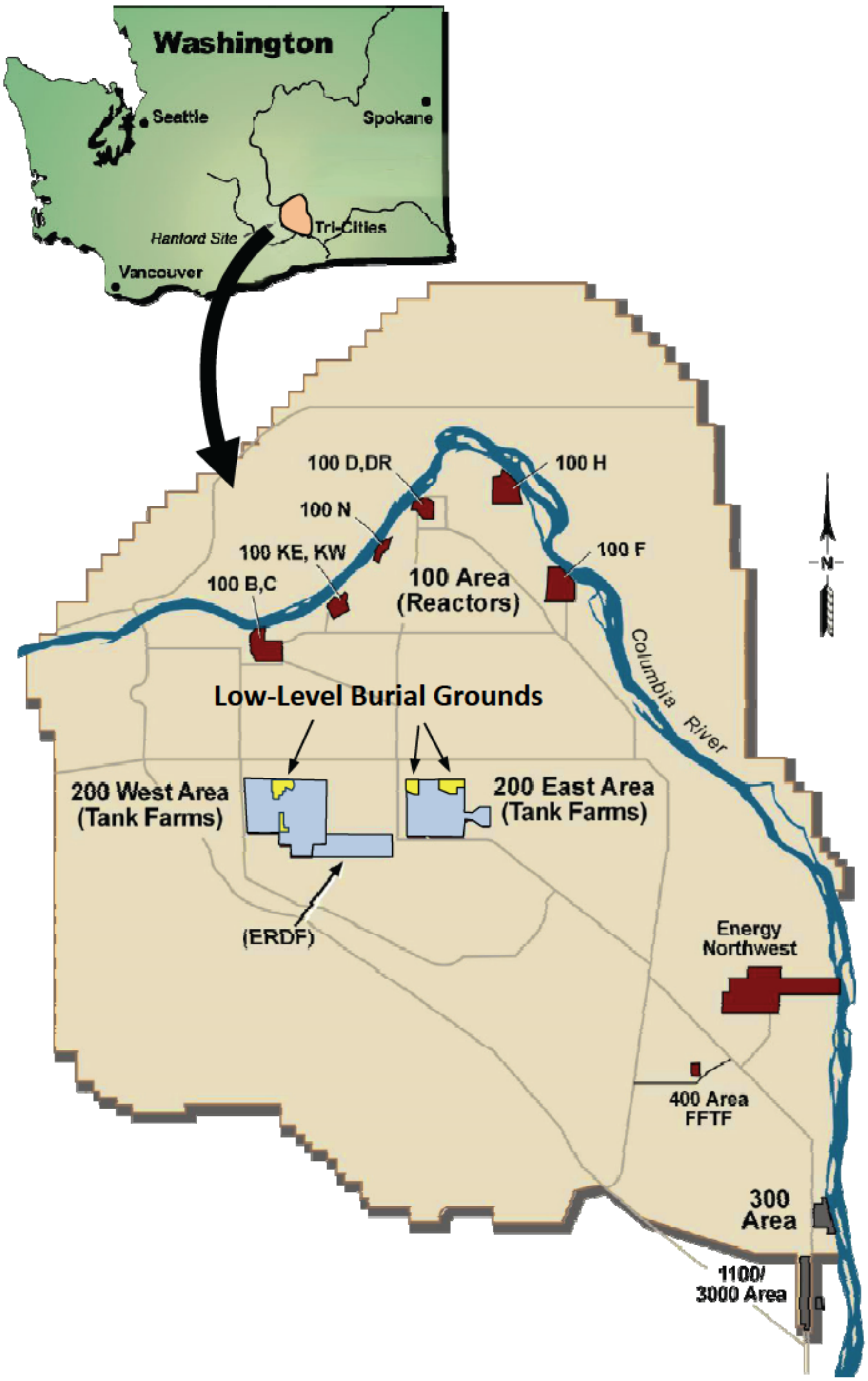



**Figure 3-1. Location of Low-Level Burial Grounds (LLBGs)**

Dose estimate increases from disposed waste for groundwater contamination scenarios occurred only at the 200 West Area LLBGs and were essentially negligible (DOE/RL-2011-110). A minimal dose increment was observed because LLW and mixed LLW disposal are 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 (< 0.2 Ci of long-lived mobile radionuclides) in FY 2011 were small compared to the accumulated waste from previous years. No additional naval reactor compartments were disposed in Trench 94 (located in the 200 East Area LLBGs) during FY 2011. Overall, there are no changes to the conclusions of the PA analyses for the LLBGs.

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 (PNNL-20683, *Diffusion and Leaching Behavior of Radionuclides in Category 3 Waste Encasement Concrete and Soil Fill Material – Summary Report*). The experiments were completed at 4 weight 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 was prepared to compare all half-cell data collected over the last several years.

In addition to the half-cell experiments, three concrete monoliths were buried in sediment at 4 percent and 7 percent moisture content for up to six years. These monoliths were subjected to X-ray microtomography (XMT) analysis and digital microscopy in an effort to evaluate the extent of carbonation of concrete under simulated vadose zone conditions. Carbonation was observed to a depth of 400 μm for the samples weathered for six years. No carbonation was observed in a sample that was weathered for only three years.

Additional information was also collected to understand the evolution of uranium-bearing precipitates that occur in concrete-dominated chemical environments with continued waste water interactions (PNNL-20726, *Summary of Uranium Solubility Studies in Concrete Waste Forms and Vadose Zone Environments*). Previous experimental work indicated that initial uranium-bearing precipitates that formed 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. It 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 150 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. The results of effluent concentration data and image analysis by XMT indicate the concrete coupons have remained largely nonreactive for more than two years.

### 3.1.2 Integrated Disposal Facility Performance Assessment

Figure 3-2 shows the location of the Integrated Disposal Facility (IDF). In 2001, DOE approved DOE/ORP-2000-24, *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version* (Scott, 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*. This PA is maintained in accordance with DOE/ORP-2000-01, *Maintenance Plan for the Hanford Integrated Disposal Facility Performance Assessment*.

***Integrated Disposal Facility Performance Assessment (IDF PA) relevance to the Composite Analysis***

*Planned waste disposal at the IDF constitutes one of the major sources of radioactive waste inventory at the Hanford Site. Estimates of future inventory disposal of glass and secondary waste forms from the Waste Treatment Plant and tank farms that are considered in the IDF PA must be incorporated into the Composite Analysis.*

The first construction phase of IDF was completed on April 28, 2006 and included the installation of the cell liners and leachate collection tanks. The IDF is now in a pre-active life mode and will not receive treated tank waste for several years. In view of these circumstances, the RCRA Permit for the IDF has been modified to recognize that the facility will not be receiving waste in the near future. A subsequent modification of the RCRA Permit transferred responsibility for the IDF from DOE-ORP to DOE-RL in FY 2009.

Some planning activities have continued during FY 2011, but the IDF PA remains on hold pending the issue of the final TC&WM EIS and associated 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 the DOE Office of River Protection (DOE-ORP).

Plans for the revised IDF PA envision a scoping process to begin in FY 2012. This scoping process will build on the experience and knowledge gained from a similar scoping process undertaken for the Hanford Single-Shell Tank System Waste Management Area (WMA) C PA (refer to Section 3.1.3) that was largely completed in FY 2011 but has not been funded for FY 2012. The following must be in place before IDF PA calculations will commence: (1) the revised IDF PA scoping process, (2) a ROD for the final TC&WM EIS, and (3) delivery by DOE-ORP of the necessary data packages and computer simulation codes relevant to the IDF PA to DOE-RL for reactive transport calculations. With current assumptions regarding these prerequisites, the current schedule calls for completion of the revised IDF PA in the first quarter of FY 2015.

With respect to monitoring, DOE/RL-2011-01, *Hanford Site Groundwater Monitoring and Performance Report for 2010*, indicated that there were a total of seven wells in the IDF water level network and semiannual samplings had occurred through CY 2010. The report further stated that in CY 2011 sampling would be reduced to annually for each well in the network to maintain the baseline prior to operational status. The groundwater flow direction has been changing since the network was initially planned and the current network is no longer considered adequate. A revised monitoring network has been provided in a plan that is undergoing review by the Washington State Department of Ecology (Ecology). The average groundwater flow direction is to the east at 80 degrees (± 17 degrees).

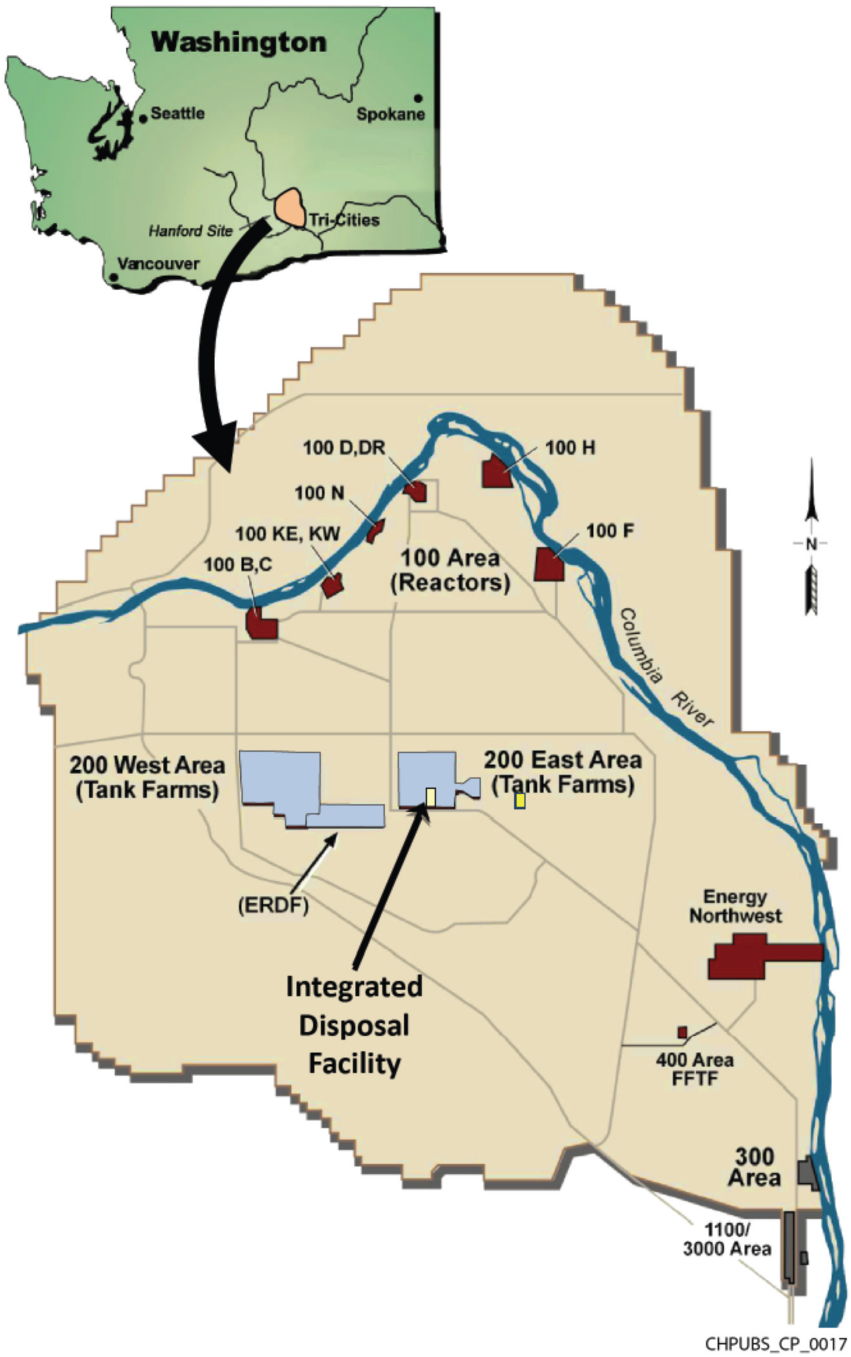



**Figure 3-2. Location of Integrated Disposal Facility (IDF)**

#### *3.1.2.1 Glass Dissolution Rate Research*

Washington River Protection Solutions (WRPS) has conducted the immobilized low-activity waste (ILAW) glass testing program. This includes experimentation and modeling to provide the technical basis for estimating radionuclide releases from the glass waste form to support future IDF PAs. The program is being conducted as part of the IDF PA maintenance plan (DOE/ORP-2000-01), which is intended to allow for IDF PA revisions to reflect new scientific information that reduces the technical uncertainty associated with critical aspects of the IDF PA. The emphasis in FY 2011 was on transitioning from the use of the Subsurface Transport Over Reactive Multi-phases (STORM) (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*) to instead using the Subsurface Transport Over Multiple Phases (STOMP) computer code for near-field calculations (PNNL-11216, *STOMP: Subsurface Transport Over Multiple Phases Application Guide;* PNNL-12030, 2000, *STOMP: Subsurface Transport Over Multiple Phases Version 2.0: Theory Guide*; PNNL-15782, *STOMP: Subsurface Transport Over Multiple Phases Version 4.0: User's Guide*). The STORM code was used in previous PAs, but is not qualified for use under current DOE requirements for safety software. In contrast, the STOMP code (including STOMP-W-R, the water-reactive transport operational mode of STOMP) has been validated as safety software per DOE O 414.1D, *Quality Assurance*, through a rigorous testing program.

In FY 2011, a STOMP simulation was developed that incorporates the geochemical reaction network needed to model the weathering of the glass. The reaction network includes the kinetic reactions, equilibrium reactions, mineral species, and aqueous species used previously in the STORM sensitivity analysis base case. A one-dimensional, high-temperature simulation was used for the initial STOMP modeling framework development. This one-dimensional model was successfully benchmarked against the previous STORM model. The modifications must now be incorporated into the parallel-processing mode ("eSTOMP") for the more complex modeling required for the PA work. Work will continue to qualify the eSTOMP code to current DOE quality assurance requirements for safety software.

The laboratory scale experiments (single-pass flow-through, pressurized unsaturated flow, and product consistency tests [PCTs]) are being used to develop kinetic rate law parameters and to determine the type of alteration products that form as the glass corrodes over time.

As input, the STOMP code needs a series of reaction networks leading to the secondary phases that form during the weathering of the ILAW glasses. Geochemical modeling is being conducted to determine the reaction network. PCT data for 128 glasses were used in the geochemical modeling effort. For a majority of these glasses, a secondary-phase reaction network previously developed for an ILAW glass produced good model fits for the major glass components. There were some exceptions and alternative secondary-phase reaction networks were proposed for these cases (PNNL-20781, *Integrated Disposal Facility Glass Testing FY 2011 Summary Report*).

#### 3.1.2.2 Supplemental Immobilization Waste Forms Research

WRPS performed work in FY 2011 to generate data to support selection of a potential alternate waste form for supplemental immobilization of Hanford low-activity waste (LAW). This work ultimately supports Tri-Party Agreement (TPA; Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*) Milestone M62-40, which calls for a one-time "Hanford Tank Waste Supplemental Treatment Technologies Report" to include waste form performance data (compared against the performance of borosilicate glass) for the treatment technologies being considered. Technologies being considered in addition to borosilicate glass include Bulk Vitrification, Fluidized Bed Steam Reforming (FBSR), and Cast Stone. In late FY 2010, DOE recognized that the FBSR waste form had the least amount of waste form performance data available of the technologies being considered, and initiated a program to evaluate the technology with samples of actual Hanford LAW. Two Hanford LAW samples and one Savannah River Site LAW sample, chemically shimmed to match a Hanford 68 Tank blend simulant, were tested in a bench scale reformer at Savannah River National Laboratory (SRNL).

The granular product produced from the SRNL bench scale tests was shown to have the same mineralogy as material made from simulants at pilot and engineering scales. Granular and monolith versions of the FBSR product were subjected to short-term performance testing via the Product Consistency Test and Toxicity Characteristic Leaching Procedure. Longer term performance tests, i.e., Single-Pass Flow-Through and Pressurized Unsaturated Flow, were initiated on products produced from simulants, real waste, and pure phase minerals. These tests are being conducted to develop kinetic rate law parameters (and to confirm results from previous tests) and to determine the type of alteration products that form as the waste form corrodes over time. The data from these tests will be used with the STOMP code to predict waste form performance in the IDF. These experiments and data provide the defense-in-depth needed to predict, with a high level of confidence, long-term waste form behavior. Testing of the FBSR product will continue in FY 2012.

#### *3.1.2.3 Secondary Liquid Waste Form Testing Research*

The LAW at Hanford will be vitrified in a joule-heated ceramic melter to produce a stable product for disposal. Technetium is an important radioactive component in the Hanford tank waste because of its high mobility in the environment and high dose conversion factors for this radionuclide. A portion of technetium can be volatilized in the melter (and thus not be incorporated into the glass waste form) and, following cooling and condensation, 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 (COC) 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 liquid waste include changes to waste form composition, chemistry, and process conditions. The impact on other COCs needs to be determined.

The scope of this testing task is divided into three phases. In the first phase, the contractor performed a literature search of previous work pertaining to Waste Treatment Plant (WTP) secondary liquid waste and on secondary solid wastes. This literature survey highlighted three viable low-temperature solidification processes (Cast Stone, Ceramicrete, and DuraLith) and the fluidized bed steam reforming process as potential waste forms for solidifying the WTP secondary liquid waste. In the second part of Phase 1, preliminary screening tests were performed on the low-temperature waste forms. These screening tests were used as a measure to see if the waste forms were viable for retaining the COC. The screening test results and literature survey were presented at a workshop to a panel of experts. These experts reviewed the data and literature information available to justify carrying the waste forms forward into Phase 2 testing.

Phase 2 was a multi-faceted approach to waste form testing, which included performing screening tests on the monolithed fluidized bed steam reforming product and optimization testing on the three low-temperature immobilization waste forms. Optimized waste form formulations were used for performing waste acceptance testing on test samples of Ceramicrete, DuraLith, and Cast Stone to determine the Toxicity Characteristic Leaching Parameter (TCLP), compressive strength, presence of free liquids, as well as iodine-129 and technetium-99 leach indices. These tests are all part of the acceptance criteria for disposal at the IDF. They provide short-term leach data that can be used to understand long-term waste performance. Also, engineering scale demonstration tests were performed on Ceramicrete and DuraLith to assess challenges associated with larger scale production, as these waste forms had previously been limited to laboratory scale test samples.

The other part of Phase 2 testing focused on radionuclide retention studies and data package preparation. The radionuclide tests were aimed at determining how each waste form holds on to or encapsulates the waste, and how and at what rate the degradation process of the waste form released the COC. The radionuclide retention tests were at a very preliminary level and will have to be evaluated further as long-term testing progresses. The contractor also put together data packages on the four waste forms studied throughout Phases 1 and 2. These data packages consolidated a large amount of data, optimized formulations, radionuclide test results, leachability data, high-level process descriptions, scale tests, and waste form attributes into one report for each waste form. The data packages will be used to support a waste form selection.

The data from Phase 2 were presented to the same expert panel that was convened in Phase 1. The panel provided their assessment of the waste forms and recommendations for follow-on Phase 3 testing and development work.

### 3.1.3 Waste Management Area C Performance Assessment

WMA C includes the C Tank Farm and ancillary equipment and is located in the eastern portion of the 200 East Area. 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 U.S. Environmental Protection Agency (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 phase continued throughout FY 2010 and FY 2011. Working sessions were held for the following topics with the corresponding data packages or white papers developed in FY 2011:

- Numerical Approach Working Session: RPP-RPT-48490, *Technical Approach and Scope for Flow and Contaminant Transport Analysis in the Initial Performance Assessment of Waste Management Area C*
- Ecological Risk Working Session: RPP-RPT-49425, *Ecological Risk Assessment Approach for Hanford Waste Management Area C*
- White Paper Inventory Overview: RPP-RPT-50619, *Overview of Inventory Calculations at Hanford*

Modeling activities were not started in FY 2011 because initiation of the analysis (modeling) phase for the WMA C PA is deferred until the final TC&WM EIS is issued.

***Environmental Restoration Disposal Facility (ERDF) relevance to the Composite Analysis***

*Similar to the Low-level Burial Grounds, disposal of solid waste at ERDF constitutes one of the sources of radioactive waste inventory; because this facility is in active use the current estimated inventory disposed is adjusted annually to reflect waste received. This updated information is pertinent to the Composite Analysis because of its potential to change the ERDF inventory evaluated in the Composite Analysis.*

*Information on the current inventory and operations is reported in Section 3.3.3.1.*

### 3.1.4 Environmental Restoration Disposal Facility Performance Assessment

The Environmental Restoration Disposal Facility (ERDF) was constructed in 1996 to receive waste generated by the remediation of CERCLA sites at the Hanford Site and began operations in July 1996. Figure 3-3 shows the location of the ERDF. The ERDF is an active, operating disposal facility. This section reviews PA activities in FY 2011; Section 3.3.3.1 provides information about FY 2011 disposal operations for ERDF.

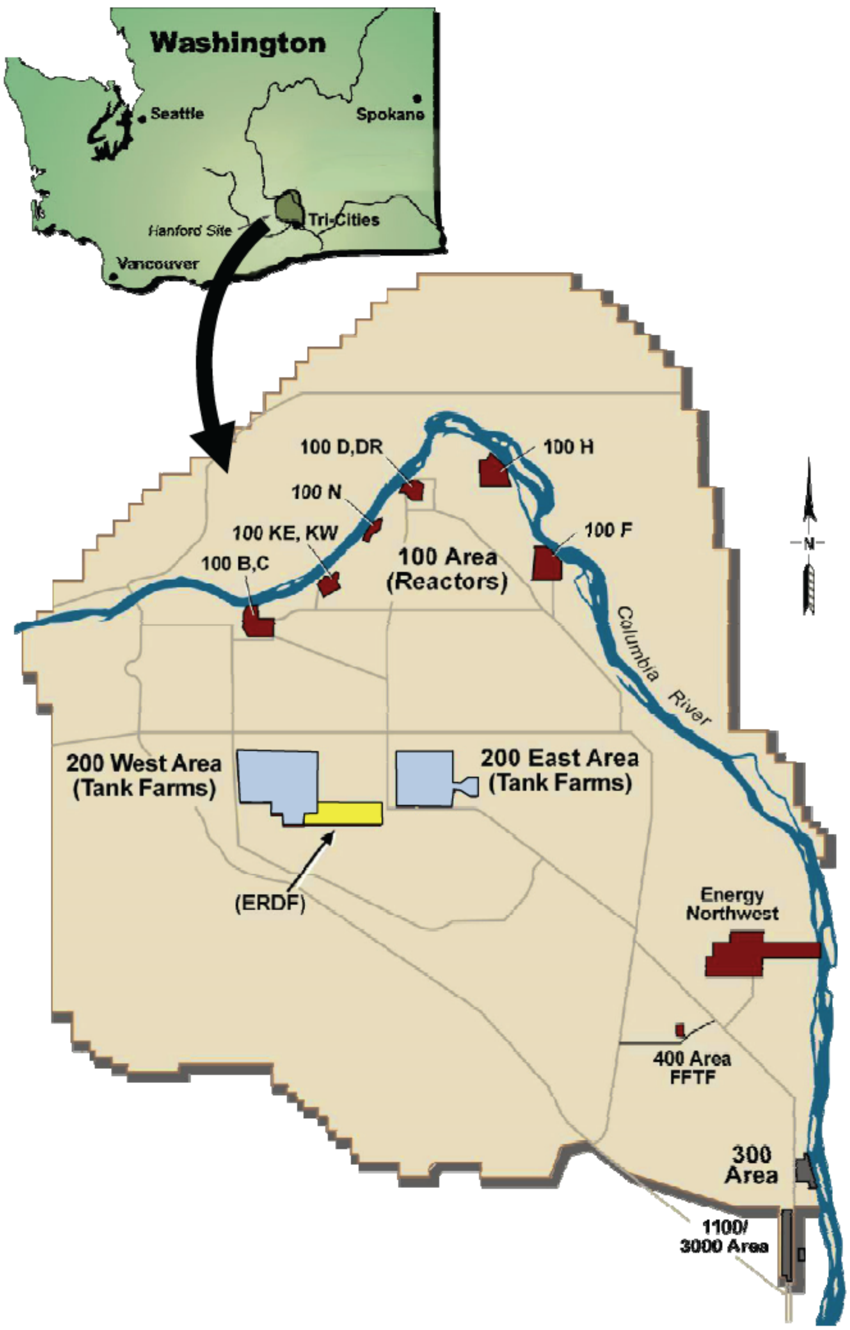



Figure 3-3. Location of the Environmental Restoration Disposal Facility (ERDF)

Authorization to operate the ERDF was granted by EPA in 1995 with EPA/ROD/R10-95/100, *Declaration of the Interim Record of Decision for the Environmental Restoration Disposal Facility*, and by DOE with a DAS (Scott, 2001) per DOE O 5820.2A, *Radioactive Waste Management*. The primary technical analyses supporting approval to operate have been the remedial investigation/feasibility study (RI/FS) completed in 1994 (DOE/RL-93-99, *Remedial Investigation and Feasibility Study Report for the Environmental Restoration Disposal Facility*) for the ROD and a preliminary PA analysis (BHI-00169, *Environmental Restoration Disposal Facility Performance Assessment*) to address DOE O 5820.2A requirements. A crosswalk analysis was completed to show that DOE O 5820.2A facility performance requirements would be satisfied (Dronen, 1996, "Environmental Restoration Disposal Facility CERCLA/DOE Order 5820.2a Roadmap"). That is, DOE determined that the RI/FS and the preliminary PA analysis adequately evaluated the ability of the facility to satisfy specific performance objectives in DOE O 5820.2A and showed a reasonable expectation that these objectives would be met. A second crosswalk was completed to demonstrate compliance with DOE O 435.1 (DOE, 2000) that resulted in issuance of a Disposal Authorization (DA), which was issued on June 18, 2001 (Scott, 2001).

Since the completion of the preliminary PA analysis, two factors have led DOE to decide to update the PA analysis and complete the formal review process per DOE O 435.1, which is the successor to DOE O 5820.2A. First, the ERDF has accepted additional radioactive waste at higher inventory levels than originally foreseen (although still within the limits provided in the preliminary PA analysis), and second, new information has been developed at the Hanford Site that identifies large conservatisms in the initial analysis. The updated PA analysis is intended to provide a more realistic evaluation of facility performance and to optimize the capability of the ERDF to complete its mission of disposing CERCLA remediation waste for the remainder of the Hanford Site cleanup activities.

In FY 2011, a work plan (WCH-426, *Work Plan for the Revision of a Performance Assessment Analysis for the Environmental Restoration Disposal Facility*) was prepared and approved (Einan, 2011, "Approval of the Work Plan for the Revision of a Performance Assessment Analysis for the Environmental Restoration Disposal Facility, WCH-426, Revision 0, October 2010"), and a modeling approach was developed for the ERDF PA. Subsequent to the issue of the work plan, efforts were undertaken to align the modeling approach with that of the TC&WM EIS to maintain an integrated modeling methodology. The work plan will be revised in FY 2012 to incorporate applicable TC&WM EIS methodology and tools into the modeling approach.

## 3.2 Central Plateau RCRA Remedial Activities

The RCRA corrective action program directed by DOE-ORP is pertinent to the Composite Analysis because these actions result in the planned redistributions of radioactive inventory considered in the Composite Analysis in time, location, and waste form.

The Tank Farm Vadose Zone Project, a component of DOE's overall RCRA corrective action program, conducted field efforts in WMAs C, S-SX, and B-BX-BY during FY 2011. The direct push technique using a hydraulic hammer was used to obtain 24 samples at three locations in WMA C, 21 samples at seven locations in WMA S-SX, and 15 samples at five locations in WMA B-BX-BY. Samples were

***Relevance of RCRA and CERCLA Remedial Activities 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.*

undergoing laboratory analysis at the end of FY 2011. During decommissioning of direct push probe holes, deep buried electrodes were installed at 16 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, *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 the design of potential interim surface barriers. A design for two interim barriers, covering much of SX Tank Farm, was completed. The design was approved by Ecology. Barrier monitoring plans for each barrier were also developed and approved.

Applications of geophysical exploration techniques were made in WMAs C and B-BX-BY. No discernible subsurface resistivity targets were identified as part of the three-dimensional resistivity characterization of unplanned release (UPR) 82 at WMA C (RPP-RPT-50052, *Surface Geophysical Exploration of UPR-200-E-82 near the C Tank Farm*). Results from the BY West surface geophysical exploration characterization activities (RPP-RPT-49129, *Three-Dimensional Surface Geophysical Exploration of the BY Tank Farm*), in conjunction with the preliminary results from the BY East surface geophysical exploration characterization activities, indicate no resistivity targets below the excavation depth of the tanks, and some small targets in the spaces in between the tanks in the very near surface.

Monitoring continued 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. Monitoring was performed for the interim surface barrier in the TY Tank Farm that was constructed in FY 2010.

Tank leak inventory assessment reports for releases to the soil from tanks and ancillary equipment in the following tank farms were completed in FY 2011:

- B Tank Farm (RPP-RPT-49089, *Hanford B-Farm Leak Inventory Assessments Report*)
- BX Tank Farm (RPP-RPT-47562, *Hanford BX-Farm Leak Assessments Report*)
- BY Tank Farm (RPP-RPT-43704, *Hanford BY-Farm Leak Assessments Report*)
- S Tank Farm (RPP-RPT-48589, *Hanford 241-S Farm Leak Assessment Report*)
- U Tank Farm (RPP-RPT-50097, *Hanford 241-U Farm Leak Inventory Assessment Report*)

The reports noted above recommended reassessing the current integrity classification for many of the single-shell tanks currently assumed to be assumed leakers and some assumed to be sound in these tank farms (HNF-EP-0182, *Waste Tank Summary Report for Month Ending July 31, 2011*). Assessment reports for TX Tank Farm and a reassessment of C Tank Farm leak inventories based on additional data and information collected through field investigations, PAs, and tank leak integrity assessments are in progress.

## 3.3 Central Plateau CERCLA Remedial Activities

CERCLA remedial activities directed by DOE-RL are pertinent to the Composite Analysis because these actions result in the planned redistributions of radioactive inventory considered in the Composite Analysis 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.

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.

The approach for cleanup of the Central Plateau focuses on these 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

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 the 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 U Plant facility (221-U) 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 (EPA et al., 2005, *Record of Decision 221-U Facility [Canyon Disposition Initiative] Hanford Site, Washington*), 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) were size-reduced as necessary and placed in the canyon process cells (a belowground level portion of this facility) and grouted in place during FY 2011. 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.

The disposition of remaining facilities, including PFP facilities, is being addressed with a combination of NEPA, 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 subsurface contaminants will be addressed in a manner consistent with the waste site remedial alternatives discussed in the following paragraphs.

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 Area (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 (PNNL) 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 aboveground 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, UPRs, and other types of sites used for liquid or solid waste disposal. Remedial actions or interim removal actions have been conducted for some of the soil waste sites located in the Outer Area. Sites in the 200 North Area have been remediated in accordance with EPA/ROD/R10-99/039, *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 has been conducted 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 operable units (OUs) will consider these alternatives, as well as an 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.

### 3.3.1 Central Plateau Source Operable Units

The CH2M HILL Plateau Remediation Company (CHPRC) Soil and Groundwater Remediation Project (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 has 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. Table 3-2 lists the restructured Central Plateau source OUs.

The decision process for these OUs will incorporate data and analyses previously conducted for the predecessor OUs, as appropriate. New or revised TPA (Ecology et al., 1989) 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 negotiated major and interim TPA milestones to track progress listed in Table 3-3.

**Table 3-2. Central Plateau Source Operable Units**

| Operable Unit Group | Description | FY 2011 Activity |
|---|---|---|
| | **Inner Area** | |
| 200-PW-1/3/6 and 200-CW-5 | • Plutonium-contaminated soil sites located near the Plutonium Finishing Plant and cesium-contaminated sites near PUREX | • ROD issued September 30, 2011 (EPA, 2011, *Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*). |
| 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<br>• Soil waste sites in the BC Cribs and Trenches | • Draft A of the RI/FS Work Plan developed in FY 2011 to be delivered to the regulatory agencies by December 31, 2011. |
| 200-EA-1 | • 200 East Inner Area sites not included in the 200-SW-2, 200-CB-1, 200-CP-1, and 200-PW-3 OUs | |

**Table 3-2. Central Plateau Source Operable Units**

| Operable Unit Group | Description | FY 2011 Activity |
|---|---|---|
| 200 IS-1 | • Pipelines and diversion boxes in the 200-IS-1 OU | • Draft A of the RI/FS Work Plan for 200-IS-1 developed in FY 2011 to be delivered to the regulatory agencies by December 31, 2011. |
| 200-SW-2 | • Solid Waste Burial Grounds and waste sites in the footprint of the burial grounds | • Draft A of the RI/FS Work Plan developed in FY 2011 to be delivered to the regulatory agencies by December 31, 2011. |
| 200-DV-1 | • Selected soil waste sites in the Inner Area with Deep Vadose Zone contamination | • Developed Sampling and Analysis Plan.<br>• Developed draft conceptual site models for S and T Complex Areas. |
| 200-CB-1 | • B Plant Canyon<br>• Associated waste sites | • DOE/RL-2011-96, Decisional Draft, *Sampling and Analysis Plan for the 200-CB-1 Operable Unit*, delivered to DOE in August 2011.<br>• DOE/RL-2011-32, Decisional Draft, *200-CB-1 (B Plant and Associated Sites) Remedial Investigation/Feasibility Study Work Plan*, delivered to DOE in August 2011. |
| 200-CP-1 | • PUREX Canyon<br>• Associated waste sites | |
| 200-CR-1 | • REDOX Canyon<br>• Associated waste sites | |
| **Outer Area** | | |
| 200-OA-1, 200-CW-1, and 200-CW-3 | • Sites located in the Outer Area | • The 200-CW-1, 200-CW-3 and 200-OA-1 RI/FS Work Plan (DOE/RL-2010-55) and Sampling and Analysis Plan (DOE/RL-2010-119), Draft A have been submitted to DOE-RL.<br>• In the CW-3 OU, 12 waste sites were addressed in late FY 2010 – FY 2011: site evaluation only, confirmatory sampling/no further action, or RTD/verification sampling.<br>• In the MG-1 OU, 24 waste sites were addressed in late FY 2010 through FY 2011: site evaluation only, confirmatory sampling/no further action or RTD/verification sampling. Three additional sites in the MG-1 OU failed confirmatory sampling and require additional work.<br>• Response Action Reports, Remaining |

**Table 3-2. Central Plateau Source Operable Units**

| Operable Unit Group | Description | FY 2011 Activity |
|---|---|---|
| | | Sites Verification Packages and Waste Site Reclassification Forms have been completed (as necessary) to document the actions taken. |

FY = Fiscal Year
OU = Operable Unit
PUREX = Plutonium Uranium Extraction (Plant)
REDOX = Reduction/Oxidation
RI/FS = Remedial Investigation/Feasibility Study
RTD = Remove, Treat, Dispose

**Table 3-3. Central Plateau CERCLA/RCRA Deliverables Planned for FY 2012 through FY 2018**

| TPA Milestone Number | Title | Due Date |
|---|---|---|
| M-091-40L-032 to -059 | Submit Quarterly Burial Ground Sample Results from 4th Quarter FY 2011 to 3rd Quarter FY 2018. | 3½ months from previous quarter |
| M-015-90 | Submit RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) and RI/FS work plan for 200-IS-1 OU to Ecology. | 12/31/2011 (Completed) |
| M-015-91A | Submit RI/FS Work Plan for the 200-WA-1 OU (200West Inner Area) to EPA. | 12/28/2011 (Completed) |
| M-015-93A | Submit revised RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) and RI/FS Work Plan for the 200-SW-2 OU to Ecology. | 12/31/2011 (Draft A Completed) |
| M-085-10A | Submit RI/FS Work Plan for the 200-CB-1 OU (B Plant Canyon/ associated past practice waste sites) to Ecology. | 6/30/2014 |
| M-037-03 | Submit revised closure plans to support TSD closure of two (2) TSD Units: 216-B-3 Main Pond system and 216-S-10 Pond and Ditch. | 4/30/2012 |
| M-015-38B | Submit a revised Feasibility Study Report and revised Proposed Plan(s) for the 200-CW-1, 200-CW-3, and 200-OA-1 OU for Waste Sites in the Outer Area of the Central Plateau to EPA. | 10/30/2014 |
| M-015-92A | Submit a RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) and RI/FS Work Plan for the 200-EA-1 OU (200 East Inner Area) to Ecology. | 6/30/2015 |
| M-015-91B | Submit Feasibility Study Report and Proposed Plan for the 200-WA-1 OU (200-West Inner Area) to EPA. | 12/31/2015 |
| M-037-02 | Submit revised closures plans to support TSD closure of five (5) TSD Units: 207-A South Retention Basin; 216-A-20 Ditch; 216-A-36B Crib; 216-A-37-1 Crib and 216-B-63 Trench. | 6/30/2014 |

**Table 3-3. Central Plateau CERCLA/RCRA Deliverables Planned for FY 2012 through FY 2018**

| TPA Milestone Number | Title | Due Date |
|---|---|---|
| M-015-92B | Submit Corrective Measures Study and Feasibility Study Report(s) and Proposed Plan(s)/Proposed Corrective Action Decision(s) for the 200-EA-1 and 200-IS-1 OUs (Central Plateau 200 East Inner Area) to Ecology. | 12/31/2016 |
| M-085-20A | Submit RI/FS Work Plan for the 200-CP-1 OU (PUREX Canyon/ associated past practice waste sites) to Ecology. | 9/30/2015 |
| M-037-11 | Complete unit-specific closure requirements for two (2) TSD Units: 216-B-3 Main Pond System and 216-S-10 Pond and Ditch. | 9/30/2016 |
| M-015-93B | Submit RCRA Facility Investigation/Corrective Measures Study and RI/FS Report and Proposed Corrective Action Decision/Proposed Plan for the 200-SW-2 OU to Ecology. | 12/31/2016 |
| M-015-00 | Complete the RI/FS (or RI/CMS) process for all non-tank farm OUs except for canyon/associated past-practice waste site OUs covered in M-85-00. A day-for-day slip in submitting the feasibility study report and proposed plan milestone will be given for each day the RI/FS work plan is not approved following six months after submittal. | 12/31/2016 |
| M-085-30A | Submit RI/FS Work Plan for the 200-CR-1 OU (REDOX Canyon /associated past-practice waste sites) to EPA. | 12/31/2017 |
| M-037-10 | Complete unit-specific closure requirements according to the Closure plans for seven TSD Units: 207-A South Retention Basin; 216-A-29 Ditch; 216-A-36B Crib; 216-A-37-1 Crib; 216-B-63 Trench; Hexone Storage and Treatment Facility (276-S-141/142), and 241-CX Tank System (241-CX-70/71/72). | 9/30/2020 |
| M-091-40L | Submit Quarterly Burial Ground Vent/Substrate Sampling Results. | Not Applicable |
| M-085-01 | Submit a change package to formally establish a date for TPA major milestone M-085-00. | 9/30/2012 |
| M-085-50 | Submit revised removal action work plan for the 224B Concentration Facility in accordance with the Action Memorandum for the Non-Time Critical Removal Action for the 224-B Plutonium Concentration Facility (DOE/RL-2004-36). A change package with a completion milestone will accompany the submittal of the work plan. | 12/31/2015 |
| M-085-60 | Complete Engineering Evaluation/Cost Analysis report(s) for all Tier 2 facilities listed in Appendix J. | 3/31/2018 |
| M-085-51 | Submit removal action work plan for the 224T Transuranic Storage and Assay Facility in accordance with the Action Memorandum for the Non-Time-Critical Removal Action for the 224-T Plutonium Concentration Facility (DOE/RL-2004-68). A change package with a completion milestone will accompany the submittal of the work plan. | 12/31/2025 |
| M-085-00 | Complete response actions for the specified canyon facilities and waste sites. | To Be Decided |

**Table 3-3. Central Plateau CERCLA/RCRA Deliverables Planned for FY 2012 through FY 2018**

| TPA Milestone Number | Title | Due Date |
|---|---|---|
| M-016-00 | Complete remedial actions for all non-tank farm and non-canyon OUs. | 9/30/2024 |

| | | | | | |
|---|---|---|---|---|---|
| CERCLA | = | *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* | RCRA | = | *Resource Conservation and Recovery Act of 1980* |
| CMS | = | Corrective Measures Study | RI/FS | = | Remedial Investigation/Feasibility Study |
| EPA | = | U.S. Environmental Protection Agency | RFI | = | RCRA Facility Investigation |
| FY | = | fiscal year | TPA | = | Tri-Party Agreement |
| OU | = | operable unit | TSD | = | treatment, storage, and disposal (unit) |
| PUREX | = | Plutonium Uranium Extraction Plant | | | |

### 3.3.2 Central Plateau Groundwater Operable Units

The DOE is committed to protecting the Columbia River, human health, and the environment from the Hanford Site's contaminated groundwater. As part of this commitment, DOE developed a detailed strategy for the protection, monitoring, and remediation of the Hanford Site's contaminated groundwater (DOE/RL-2002-59, *Hanford Site Groundwater Strategy: Protection, Monitoring, and Remediation*). To further bolster this commitment, DOE created a plan to accelerate groundwater remediation as detailed in DOE/RL-2002-68, *Hanford's Groundwater Management Plan: Accelerated Cleanup and Protection*. The DOE's most recent recommitment to groundwater protection is outlined in DOE/RL-2007-20, *Hanford Integrated Groundwater and Vadose Zone Management Plan*, which outlines the steps for addressing groundwater and vadose zone contamination in conjunction with the above strategy.

The CY 2010 groundwater monitoring results are presented in DOE/RL-2011-01 that was published in August 2011 and is summarized here in reporting on FY 2010 activities that pertain to the Composite Analysis.

During the reporting period, workers sampled 1,311 monitoring wells and 145 shoreline aquifer tubes across the Hanford Site to determine the distribution and movement of contaminants. Many of the wells and aquifer tubes were sampled multiple times during the reporting period, resulting in 4,277 well sample trips. A total of 51,860 analyses were performed for the groundwater program, yielding over 283,000 results during the reporting period. During this time, a total of 2,185 samples of Hanford Site groundwater were analyzed for tritium, 1,625 samples for technetium-99, and 1,475 samples for uranium. These totals include results for routinely sampled groundwater wells, pump-and-treat operational samples, and aquifer tube samples.

Of the radionuclide contaminant plumes present in groundwater at the Hanford Site, tritium and iodine-129 have the largest areas with concentrations above drinking water standards (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.

There were eight pump-and-treat systems that operated at the Hanford Site during FY 2011 under these interim RODs:

- EPA et al., 1995, *Declaration of the Interim Record of Decision for the 200-ZP-1 Operable Unit*

- 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*
- EPA/AMD/R10-00/122, *Interim Remedial Action Record of Decision Amendment for the 100-HR-3 Operable Unit, Hanford Site, Benton County, Washington*

All of these pump-and-treat systems are reviewed in this annual summary report because, regardless of the target constituents for remediation, changes in hydraulic conditions caused by pump-and-treat systems (as well as any radionuclide removal by these systems) represent a point of departure from the site-wide groundwater model used in the Composite Analysis. Notably, the site-wide groundwater model used in the Composite Analysis did not account for pump-and-treat systems. Table 3-4 provides a full summary of all pump-and-treat activities for the Hanford Site in FY 2011.

The radionuclide activity removed to date by pump-and-treat systems reviewed here are not yet considered to have a significant impact on the Composite Analysis saturated zone simulations for pump-and-treat operations to date. It is qualitatively inferred that the impact of including such activity removal would be to reduce the projected radiological dose estimate due to the removal of contaminant mass from the groundwater pathway. Continued operation of pump-and-treat processes, presuming that more remedial actions will be adopted through CERCLA activities, can be expected to eventually constitute a need for an updated Composite Analysis that will account for this process.

**Table 3-4. Status of Groundwater Remediation in FY 2011**

| Area | Remedial Action Site | Active Dates | Purpose and Progress on Major Contaminant through December 2010 |
|---|---|---|---|
| 100-K | KR4 Pump-and-Treat | 1997 to present | Decreases chromium mass release to Columbia River; 354.7 kg removed. System is being expanded. |
| | KW Pump-and-Treat | 2007 to present | Decreases chromium mass release to Columbia River; 137.4 kg removed. System is being expanded. |
| | KX Pump-and-Treat | 2009 to present | Decreases chromium mass release to Columbia River; 83.7 kg removed. System was completed and brought online. |
| 100-N | 100-NR-2 Pump-and-Treat (Inactive) | 1995 to 2006 | 1.8 Ci of strontium-90 removed. |
| | Apatite Barrier | 2006 to present | In Situ Treatment Barrier. |
| 100-D & 100-H | 100-HR-3 Pump-and-Treat | 1997 to present | Decreases chromium to Columbia River; 392.9 kg removed. |
| | 100-DR-5 Pump-and-Treat | 2004 to present | Decreases chromium to Columbia River; 326.2 kg removed. |
| | 100-HR-3 *in situ* REDOX manipulation (ISRM) Barrier | 1999 to present | Decreases chromium concentrations downgradient of barrier. Showing breakthrough; amendments being tested. |

**Table 3-4. Status of Groundwater Remediation in FY 2011**

| Area | Remedial Action Site | Active Dates | Purpose and Progress on Major Contaminant through December 2010 |
|---|---|---|---|
| | 100-D DX System | January 2011 to present | Testing of the DX system was completed in December 2010; 18.4 kg removed. |
| | 100-H HX System | Startup October 2011 | Testing is planned to be completed in September 2011; in preparation for October 2011 operation. |
| 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 to present | Prevents high-concentration portion of carbon tetrachloride plume from spreading; 12,647 kg removed. System is being expanded to implement final ROD. |
| | Soil Vapor Extraction (SVE) | 1992 to present | Reduces carbon tetrachloride movement to groundwater; 79,751 kg removed from vadose zone. |
| | WMA T Tank Farm Technetium-99 Test System | 2007 to present | Removes technetium-99 from the aquifer; 63.6 g (1.08 Ci) removed. |
| | 200-UP-1 (U Plant) Pump-and-Treat | 1994 to 2005; 2007 to present | Removes technetium-99 and uranium from the aquifer; 127.6 g of technetium-99 (2. 17 Ci) and 220.3 kg of uranium removed. |
| | S-SX Tanks Farms Well 299-W23-19 extended purging | 2003 to present | Removes some technetium-99 from the aquifer; 0.57 g (0.01 Ci) removed. |
| 300 | 300-FF-5, Monitoring and institutional controls on groundwater ruse (interim action, 300-FF-5) | 1996 to present | Uranium concentrations remain above the target value, with contamination level relatively constant and or gradually decreasing.<br>*Cis*−1,2-dichloroethene concentrations remain above target value at one well, with constant trend. Trichloroethene concentrations are below the target value in the unconfined aquifer, but well above it in finer grained subinterval. Nitrate concentrations exceed target levels in the southern portion of the 300 Area. Uranium and nitrate remain elevated above target levels in samples from shoreline aquifer tubes. |

**Table 3-4. Status of Groundwater Remediation in FY 2011**

| Area | Remedial Action Site | Active Dates | Purpose and Progress on Major Contaminant through December 2010 |
|---|---|---|---|
| | 618-11 Burial Ground: Monitoring and institutional controls on groundwater use (interim action, 300−FF−5) | 2000 to present | Tritium concentrations remained highly elevated above the target value during 2010. |
| | 618-10 Burial Ground: Monitoring and institutional controls on groundwater use (interim action, 300−FF−5) | 2000 to present | Uranium and organic compounds continued to be monitored, but were at concentrations lower than the target values during 2010. |
| 1100 | 1100-EM-1 Natural Attenuation | 1996 to present | Trichloroethene concentrations below 5 µg/L since 2001. |

ISRM = In-Situ Redox Manipulation
N/A = Not Available
REDOX = Reduction-Oxidation
ROD = Record of Decision

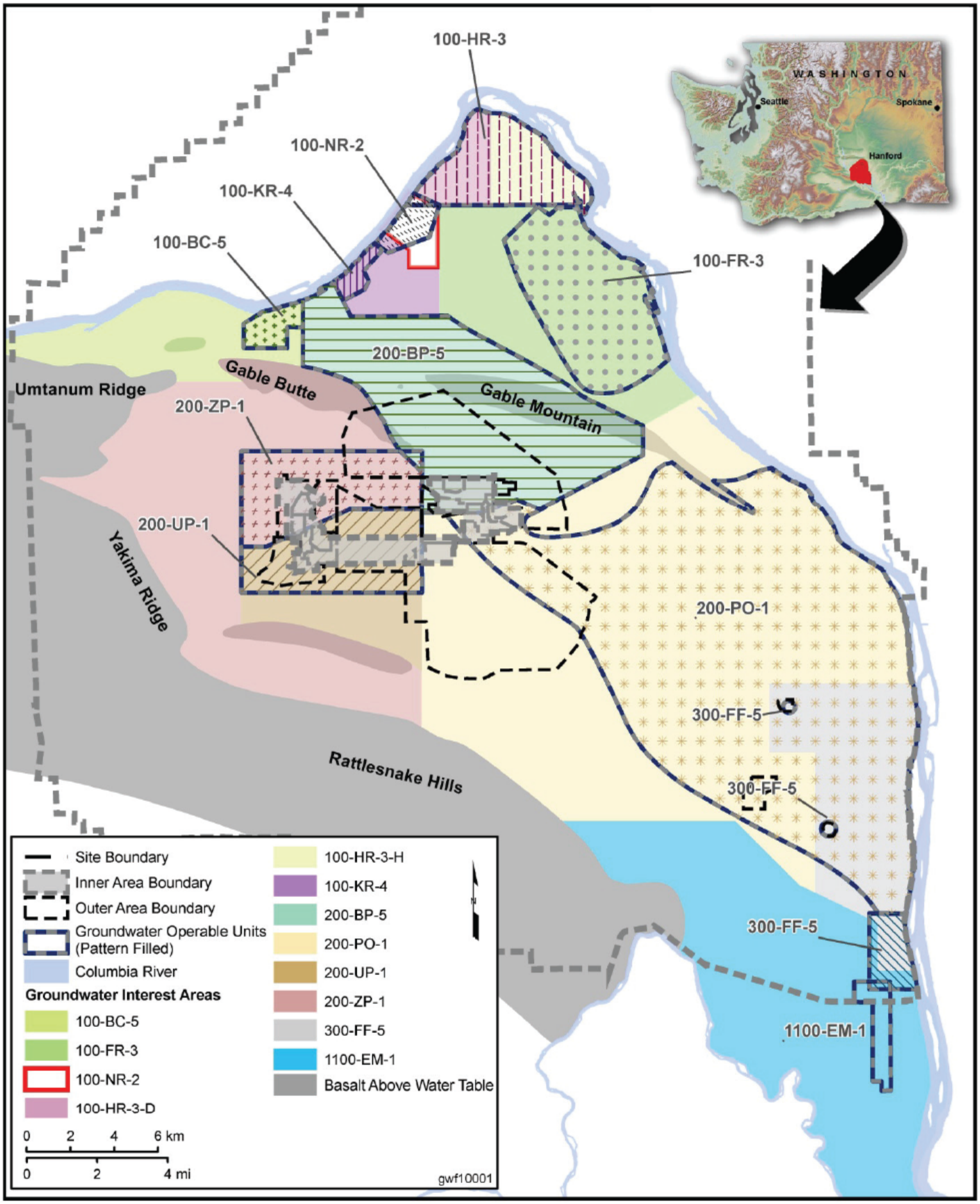
Within the Central Plateau, there are four groundwater OUs (200-UP-1, 200-ZP-1, 200-BP-5, and 200-PO-1). Activities at all four are pertinent to the Composite Analysis. Figure 3-4 shows the location and boundaries of these four groundwater OUs (as well as other groundwater OUs in the river corridor not pertinent to the Composite Analysis). Any activities in the four groundwater OUs within the Central Plateau that provides new information on radionuclide constituents relevant to the Composite Analysis are discussed in the following text with respect to each groundwater OU. Remedial actions directed at nonradioactive contaminants are also discussed wherever it was found that these actions could potentially influence the characterization, extent, or remediation of radioactive constituents and, thereby, become relevant to the Composite Analysis.

#### 3.3.2.1 200-BP-5 Groundwater Operable Unit

The 200−BP−5 Groundwater OU includes groundwater beneath the northern 200 East Area and the region to the northwest to the Columbia River where mobile contaminants, including tritium and technetium-99, have historically and continue to move northward between Gable Mountain and Gable Butte. Decreasing water levels over more than two decades and a nearly flat groundwater table lead to little change in the contaminant plume configuration during FY 2011 in the 200-BP-5 OU. Most of the groundwater contamination in the OU is concentrated beneath the facilities in the north-central/northwest portion of the 200 East Area known as the B Complex (e.g., WMA B-BX-BY and adjacent waste sites).

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

- DOE/RL-2001-49, *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*




Source: DOE/RL-2011-01, *Hanford Site Groundwater Monitoring Report for 2010.*

**Figure 3-4. Groundwater OUs and Groundwater Interest Areas on the Hanford Site**

During CY 2010, DOE continued work the 200-BP-5 OU RI/FS. The primary CERCLA accomplishments for the reporting period were:

- Successful sampling and analyses of all but three wells specified in DOE/RL-2001-49
- Completion of a full suite of chemical and physical property analyses for three RI wells: three new monitoring wells and three vadose zone boreholes were installed in the 100-F Area in CY 2010
- Completion of TPA Milestone M-015-082 through submittal of DOE/RL-2010-74, Draft A, *Treatability Test Plan for the 200-BP-5 Groundwater Operable Unit*
- Preparation of the RI draft report for the 200-BP-5 Groundwater OU
- Completion of SGW-44071, *Data Quality Assessment Report for the 200-BP-5 Groundwater Operable Unit: October 2004 through September 2009 Groundwater Data*

Six TSD units in the 200-BP-5 OU are monitored under RCRA in coordination with CERCLA and *Atomic Energy Act of 1954* (AEA) requirements. These TSD units are the Low-Level Waste Management Area 1 (LLWMA-1), Low-Level Waste Management Area 2 (LLWMA-2), WMA B-BX-BY, WMA C, Liquid Effluent Retention Facility (LERF), and 216-B-63 Trench. Results from the groundwater monitoring program for the 200-BP-5 Groundwater OU in FY 2010 are presented in detail in DOE/RL-2011-01.

Review of FY 2010 CERCLA investigations and CERCLA monitoring activities reported in DOE/RL-2011-01 and evaluated in FY 2011 did not reveal any new information associated with this Groundwater OU with the potential to significantly alter the conclusions of the Composite Analysis presented in PNNL-11800 and Addendum 1.

#### 3.3.2.2 200-PO-1 Groundwater Operable Unit

The 200-PO-1 OU encompasses the southern portion of the 200 East Area and a large region to the east and southeast as far as the Columbia River where groundwater is contaminated with tritium and iodine-129. Concentrations of tritium continued to decline as the groundwater plume attenuates naturally due to radioactive decay and dispersion. The iodine-129 plume above the 1 pCi/L isopleths has changed very little, but the maximum concentrations have declined significantly as a result of dispersion; the mass of contamination remains the same; thus, the volume of contaminated groundwater has increased. Other radionuclide contaminants include strontium-90, technetium-99, and uranium, but these contaminants are limited to smaller areas near their respective sources.

During CY 2010, routine monitoring continued under DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*. The radionuclide COCs listed in the sampling and analysis plan include iodine-129, strontium-90, technetium-99, tritium, and uranium.

The 200-PO-1 Groundwater OU encompasses six RCRA units including the PUREX cribs (also called the RCRA PUREX cribs), the WMA A-AX (Single-shell tanks, or 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. Results from the groundwater monitoring program for the 200-PO-1 Groundwater OU in FY 2010 are presented in detail in DOE/RL-2011-01.

The primary document developed for the 200-PO-1 Groundwater OU in FY 2010 was 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 Baseline Risk Assessment (BRA) that compares detected contaminant concentrations to applicable or relevant and appropriate requirements (ARARs) and identifies contaminants of potential concern (COPCs)
- Computational analysis of groundwater contaminant fate and transport for future impacts
- Determination of whether OU conditions present a basis for remedial action

Review of FY 2010 CERCLA investigations and CERCLA monitoring activities reported in DOE/RL-2011-01 and evaluated in FY 2011 did not reveal any new information associated with this Groundwater OU with the potential to significantly alter the conclusions of the Composite Analysis presented in PNNL-11800 and Addendum 1.

#### *3.3.2.3 200-UP-1 Groundwater Operable Unit*

The 200−UP−1 OU underlies the southern portion of the 200 West Area and adjacent areas to the east and south. The primary radionuclide contaminants forming extensive plumes within the OU are technetium-99, uranium, tritium, and iodine-129. Another radionuclide contaminant identified in the groundwater at concentrations above its DWS was strontium-90. During CY 2010, the DOE began groundwater monitoring under the RI/FS work plan for the 200-UP-1 OU.

Accomplishments related to CERCLA actions during the reporting period included the following:

- Release and initiation of work from the draft RI/FS report and proposed plan report, meeting TPA Milestone M-015-17A
- The release of Revision 3 of DOE/RL-97-36, *200-UP-1 Groundwater Remedial Design/Remedial Action Work Plan*, implemented changes made to the interim action ROD by the EPA et al., 2009a, *Explanation of Significant Differences for the Interim Action Record of Decision for the 200-UP-1 Groundwater Operable Unit Hanford Site Benton County, Washington*, that was issued in 2009. The decision lowered the uranium remedial action goal to 300 µg/L.

The 200-UP-1 OU includes one CERCLA interim action pump-and-treat system (at U-Plant), three TSD units monitored under RCRA (WMA S-SX, WMA U, 216-S-10 Pond and Ditch), and one CERCLA disposal site (ERDF). Results from the groundwater monitoring program for the 200-UP-1 Groundwater OU in FY 2010 are presented in detail in DOE/RL-2011-01.

DOE/RL-2011-26, *Calendar Year 2010 Annual Summary Report for the 200-ZP-1 and 200-UP-1 Operable Unit Pump-and-Treat Operations*, provides additional detail on remedial actions in CY 2010. Review of FY 2010 CERCLA investigations monitoring and remedial activities in FY 2011 did not reveal any new information associated with this OU that has the potential to significantly alter the conclusions of the Composite Analysis and Addendum (PNNL-11800).

#### *3.3.2.4 200-ZP-1 Groundwater Operable Unit*

The 200-ZP-1 OU encompasses the northern and central portions of the 200 West Area and adjacent areas to the north and east. Groundwater monitoring continued under DOE/RL-2002-17*, Sampling and Analysis Plan for the 200-ZP-1 Groundwater Monitoring Well Network*. Groundwater at this OU is monitored to assess interim pump-and-treat performance and to track existing contaminant plumes. Other activities are conducted for facility-specific monitoring.

The primary COC for the 200-ZP-1 OU, carbon tetrachloride, is not a radionuclide. The list of other contaminants of interest does include radionuclides, namely tritium, iodine-129, and technetium-99.

During the reporting period, CERCLA accomplishments included issuance of DOE/RL-2009-115, *Performance Monitoring Plan for the 200-ZP-1 Groundwater Operable Unit Remedial Action*. That document serves to guide groundwater monitoring data collection activities associated with 200-ZP-1 OU remedial action.

The 200-ZP-1 groundwater interest area contains two CERCLA interim action pump-and-treat systems for groundwater, one soil vapor remediation system for the vadose zone, four TSD units (LLWMA-3, LLWMA-4, WMA T, and WMA TX-TY) monitored under RCRA (in coordination with CERCLA and AEA), and one state-permitted unit (the State Approved Liquid Disposal Site, or SALDS). Results from the groundwater monitoring program for the 200-ZP-1 Groundwater OU in FY 2010 are presented in detail in DOE/RL-2011-01.

Since 1994, DOE has operated an interim action pump-and-treat system to prevent carbon tetrachloride in the upper portion of the aquifer from spreading. The system is limiting movement of the shallow, high-concentration portion of the plume but does not address contamination deeper in the aquifer and at the periphery of the plume. In CY 2010, the system removed more than 700 kilograms of carbon tetrachloride from 5.7 million liters of groundwater. In 2009, under the ROD for final remediation (EPA et al., 2008, *Record of Decision Hanford 200 Area 200-ZP-1 Superfund Site Benton County, Washington*), the DOE began construction of an expanded pump-and-treat system to address groundwater contamination relating to all of the COCs.

A second pump-and-treat test system began operation in September 2007 as part of a designed interim remediation activity to treat technetium-99 contamination downgradient of the WMA T. During CY 2010, the total volume treated was 52.2 million liters, allowing for removal of 16.35 grams (0.278 curies) of technetium-99, 27.86 kilograms of carbon tetrachloride, 6.25 kilograms of chromium, 245 grams of trichloroethene, and 22,959 kilograms of nitrate from the aquifer.

Soil vapor extraction (SVE) is also used to remove carbon tetrachloride from the vadose zone in the 200-ZP-1 OU. A new system came online at the 216-Z-18 and 216-Z-1A well field in CY 2010. During CY 2010, both the new and existing vapor extraction systems removed a total of 193 kilograms of carbon tetrachloride from the vadose zone.

DOE/RL-2011-26 provides these additional pertinent details on the pump-and-treat remedial actions for CY 2010. FY 2010 activities in the 200-ZP-1 Groundwater OU are summarized in DOE/RL-2011-01. Review of these FY 2010 activities in FY 2011 (CERCLA investigations and monitoring) did not reveal any new information associated with this OU that was considered to have potential to alter the conclusions of the Composite Analysis and Addendum 1 (PNNL-11800).

### 3.3.3 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 2011, ERDF represents the only activity in this category.

#### *3.3.3.1 Environmental Restoration Disposal Facility Operations*

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. Details on the preparation of a revised PA for ERDF are reported in Section 3.1.4; this section provides a review of ERDF operations during FY 2011.

ERDF began operating in July 1996. Situated between the 200 East and 200 West Areas, the facility presently operates ten cells covering approximately 42.5 hectares (105 acres). Construction of super cells 9 and 10 (super cells are twice the size of regular cells) was completed in the second and third quarters of FY 2011, respectively. The configuration of the ERDF cells is shown in map view in Figure 3-5 and in a photograph in Figure 3-6.

The requirements associated with the facility are identified in the following ROD and amendments:

- EPA/ROD/R10-95/100, *Record of Decision for the USDOE Hanford Environmental Restoration Disposal Facility, Hanford Site, Benton County, Washington*
- 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*
- 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*
- EPA et al., 2009b, *U.S. Department of Energy Environmental Restoration Disposal Facility Hanford Site 200 Area Benton County, Washington, Amended Record of Decision and Explanation of Significant Differences*

***Leachate Monitoring***
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.

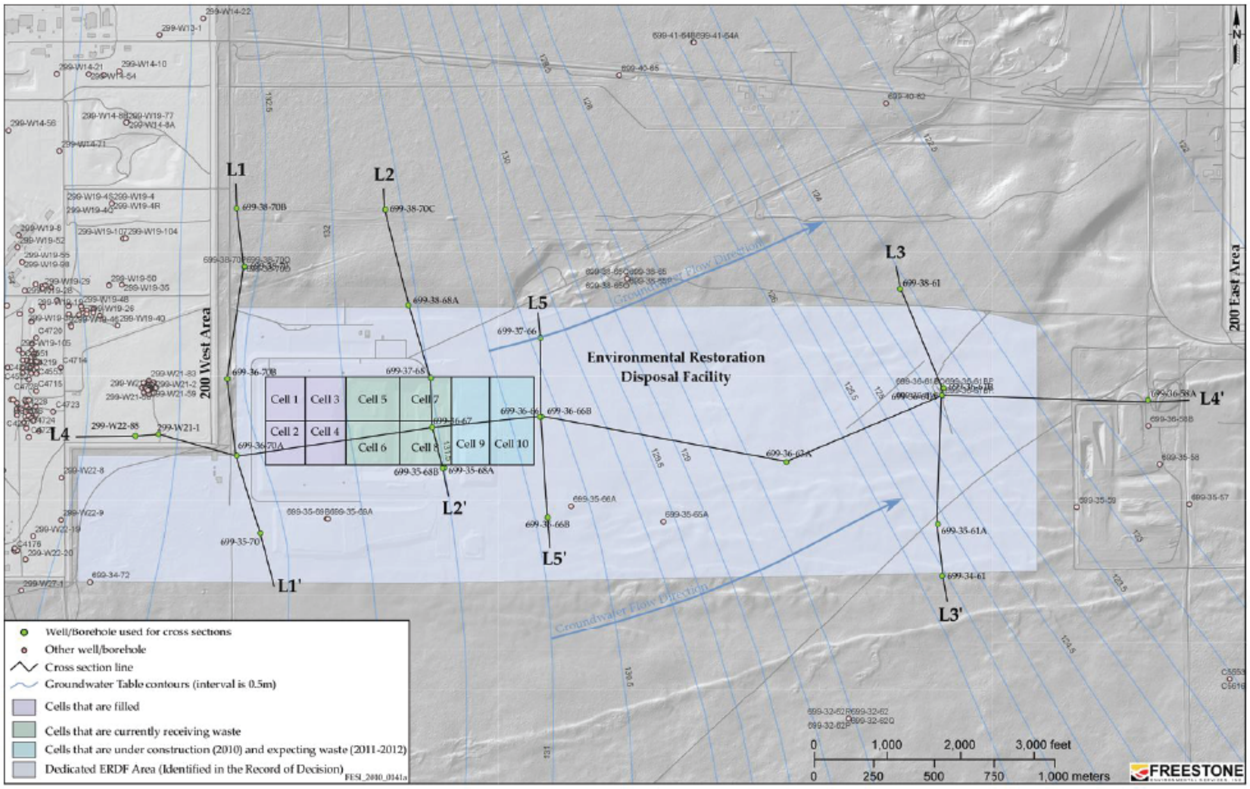



**Figure 3-5. Configuration of Disposal Cells in the Environmental Restoration Disposal Facility**

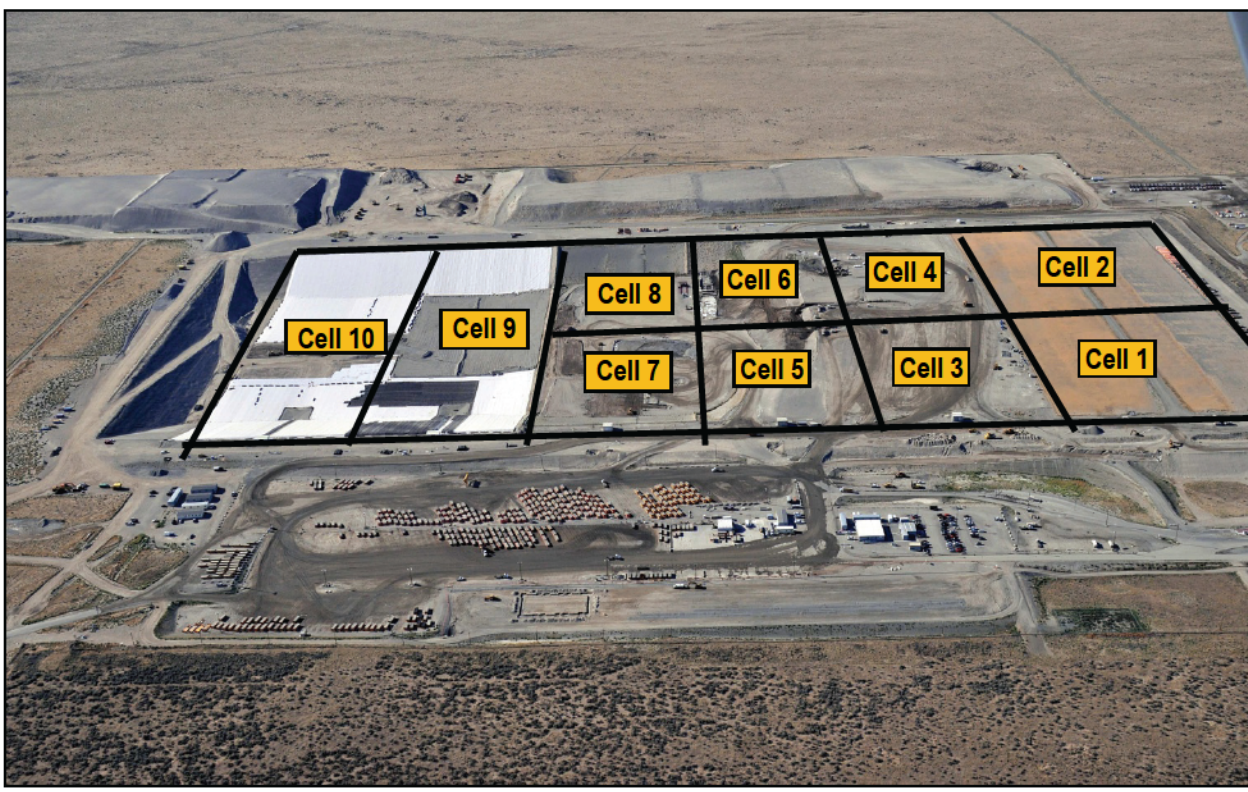



**Figure 3-6. Photograph of the Environmental Restoration Disposal Facility with Indication of Disposal Cells**

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, the increase presents 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-455, *Groundwater and Leachate Monitoring and Sampling at the Environmental Restoration Disposal Facility, Calendar Year (CY) 2010*.

***Current Inventory Estimates.*** ERDF received and disposed of record quantities of waste during FY 2011. In terms of radionuclide inventory, Appendix A provides the annual inventory of key radionuclides placed in ERDF for CY 2006 through CY 2010 (Table A-1). Appendix A also provides detail of FY 2011 and the totals since inception of ERDF through September 30, 2011 (Table A-2). In 1996, Bechtel Hanford, Inc. estimated that fewer than 500 Ci were disposed to ERDF. After over 15 years of operations, more than 125,192 Ci have been disposed at ERDF since inception of operations on July 1, 1996 (Table A-1 in Appendix A). 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 and increased again in FY 2011. The ERDF waste acceptance criteria were revised in 2009 (WCH-191, Rev. 1, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*) and again in November 2010 (WCH-191, Rev. 2, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*). The basis for the changing the ERDF waste acceptance criteria total curie guidelines for carbon-14 and total uranium is analyzed in WCH-191, Rev. 2. 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 the Hanford Site 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. Appendix A, Table A-2 reflects the changes to WCH-191, Rev. 2, including modification of some of the existing radionuclide limits as well as the addition of new radionuclides to the list.

A DOE O 435.1 PA is being developed for ERDF (see Section 3.1.4) with completion projected in 2013. The draft inventory data package developed for that PA indicates that the ERDF inventory estimate is 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. 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.

# 4 Monitoring and Research and Development Results

This chapter describes the status of Hanford Site monitoring and research and development activities in FY 2011 relevant to the Composite Analysis. Included is a summary of the groundwater flow conditions and extent of groundwater radionuclide contamination determined from monitoring as well as results of the Remediation Science and Technology program.

Consideration of monitoring and research and development 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.

## 4.1 Summary of Groundwater Flow Conditions and Extent of Contamination

Due to the reporting cycle for the groundwater monitoring program, results discussed below reflect the sampling and analyses completed in 2010 that were reported in FY 2011 in DOE/RL-2011-01. DOE approval of this report constitutes approval of the appropriateness of this monitoring program.

The natural pattern of groundwater flow was altered during the Hanford Site's operating years by water table mounds created by the discharge of large volumes of wastewater to the ground. These mounds were present in each reactor area and beneath the 200 Area. Since effluent disposal decreased significantly in the 1990s, these mounds have dissipated in the reactor areas and have declined considerably in the 200 Area. Declining water levels from the mounding continue to affect groundwater flow and depth to water. Figure 4-1 shows the water table in FY 2010.

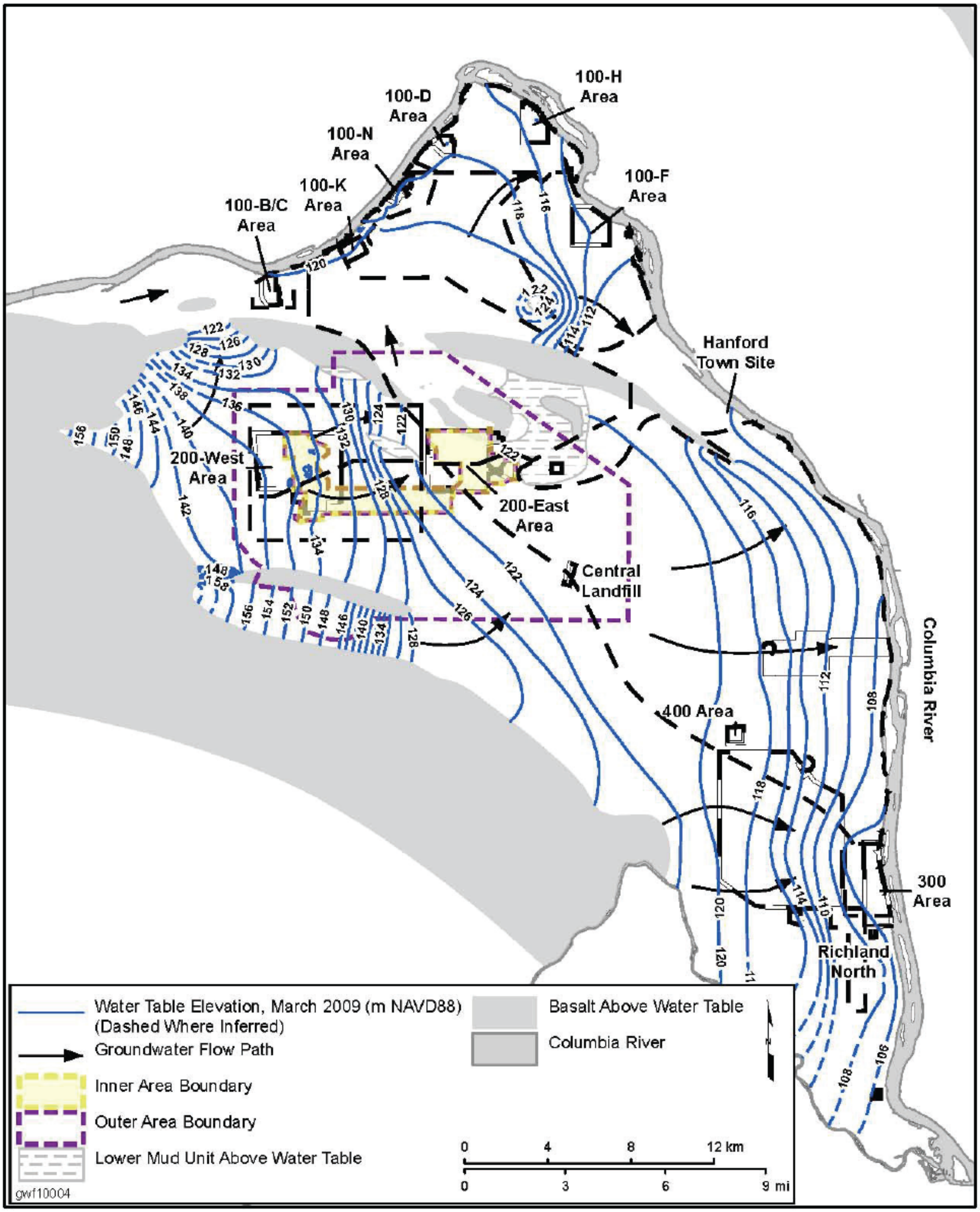
Table 4-1 provides a comparison of the areal extent of key radionuclide contaminant plumes in groundwater at levels above DWSs in 2010. Of the radionuclides, tritium and iodine-129 continue to have the largest areas where concentrations exceed DWSs. The largest plumes of these contaminants had their 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. Figure 4-2 shows the distribution of major contaminant plumes on the Hanford Site at concentrations above DWSs in approximately the upper 10 meters of the unconfined aquifer.

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 SST farm WMAs.

***Relevance of Groundwater Monitoring to the Composite Analysis***

*The groundwater monitoring program provides additional data that serve to validate or revise the modeling basis used in the Composite Analysis. The unconfined aquifer at the Hanford Site was subject to immense liquid discharges during the site's operational phase (1944 to 1989) and is now experiencing a slow decline to pre-Hanford flow conditions. It is also subject to pumping stresses associated with pump-and-treat actions. Historical groundwater data predominately reflect the operational phase; consequently later data continue to support improvement in the predictive capability of groundwater flow models as the system approaches long-term flow conditions.*

*Similarly, monitoring of groundwater contamination provides important data to validate or revise the modeling basis used in the Composite Analysis.*




Source: DOE/RL-2011-01, *Hanford Site Groundwater Monitoring Report for 2010*.

**Figure 4-1. Water Table and Inferred Groundwater Flow Directions in March 2010**

**Table 4-1. Area of Radionuclide Contaminant Plumes at Levels above Drinking Water Standards**

| Radionuclide Contaminant | Drinking Water Standard | Area of Plume at Level Above Drinking Water Standard | |
|---|---|---|---|
| | | Calendar Year 2009 ($km^2$)[a] | Calendar Year 2010 ($km^2$)[a] |
| Iodine-129 | 1 pCi/L | 58.8 | 66.6[b] |
| Strontium-90 | 8 pCi/L | 1.9 | 1.6 |
| Technetium-99 | 900 pCi/L | 2.4 | 2.8[b] |
| Tritium | 20,000 pCi/L | 126.5 | 129.1[b] |
| Uranium | 30 µg/L | 1.5 | 1.4 |

a. To obtain $mi^2$, multiply $km^2$ by 0.386.

b. Increase in plume areas for iodine-129, technetium-99, and tritium are due to revisions in how the plume contours were drawn; DOE/RL-2011-01, *Hanford Site Groundwater Monitoring Report for 2010*, provides a detailed discussion of this difference.

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.

## 4.2 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 CHPRC's 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, CHPRC continued to fund the Remediation Science and Technology project in FY 2011. On this project, CHPRC continued to fund research in to recharge rates, treatability testing activities for the soil desiccation technology in the deep vadose zone, and reactive gas treatment of uranium (as well as other activities not reported here because these lack pertinence to the scope of this annual summary report). A project funded by the DOE Office of Science also made progress on the study of uranium mass transfer to update the conceptual model of the 300 Area. Summaries of those science and technology efforts that pertain to radionuclide migration in the Central Plateau are summarized in the following text.

### 4.2.1 Recharge Rate Research

Recharge provides the primary driving force for transporting contaminants, including radionuclides, from the vadose zone to the underlying aquifer system. Quantification of recharge rates is important for assessing contaminant fate and transport 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 2011. Recharge rates depend on three main factors (soil, vegetation, and climatic conditions) that are highly variable in both space and time. In FY 2011, the average air temperatures were several degrees lower than normal and precipitation was 5 percent lower than normal. The cooler temperatures result in lower evapotranspiration rates, which could lead to higher recharge rates. However, there was not an overall increase in recharge, likely due to the concurrent lower than normal precipitation rate.

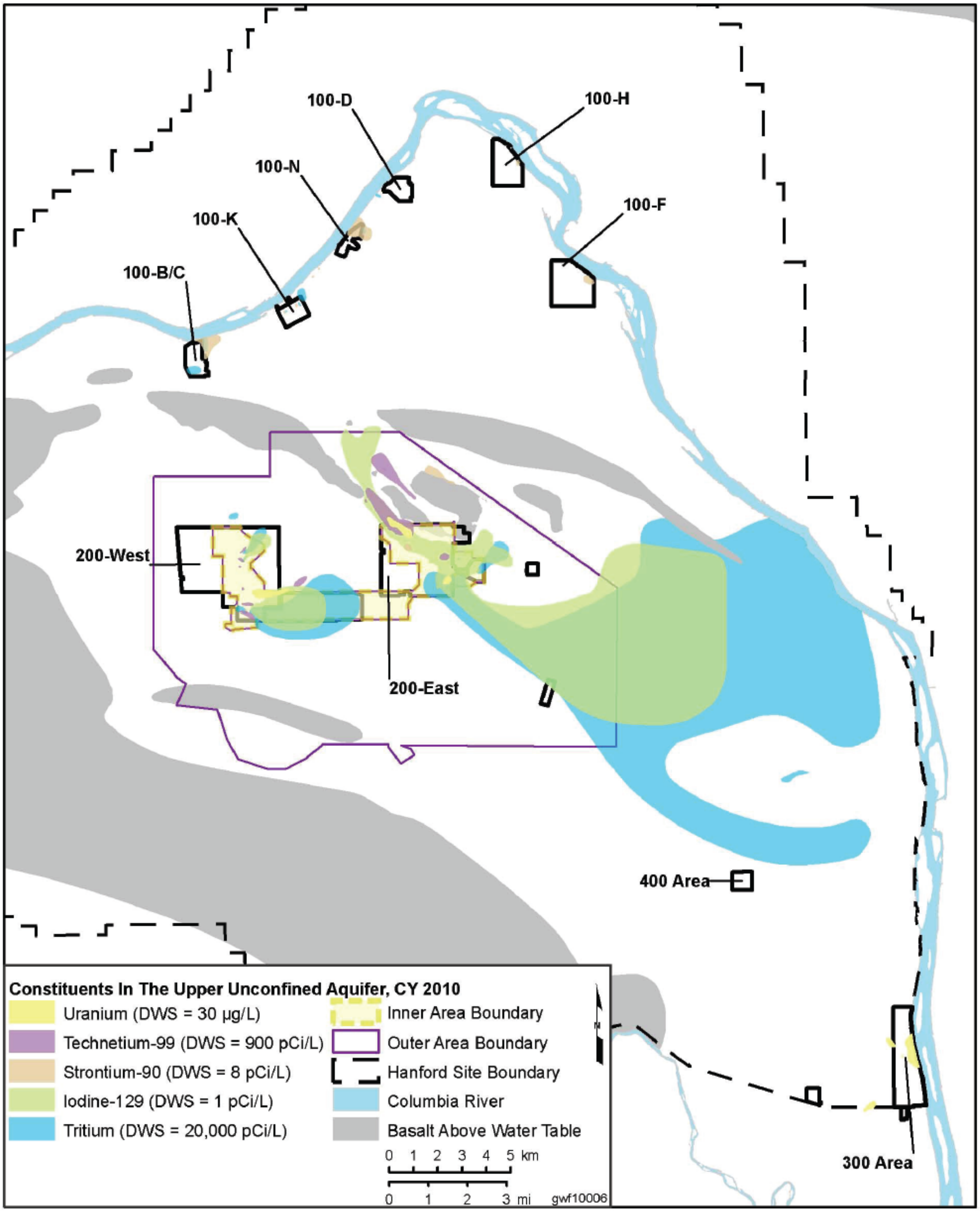



**Figure 4-2. Distribution of Radionuclide Contaminant Plumes on the Hanford Site at Concentrations above Drinking Water Standards in Approximately the Upper 10 meters of the Unconfined Aquifer**

### 4.2.2 Deep Vadose Zone Remediation Research

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. The active portion of the desiccation field test was completed in FY 2011. Monitoring of long-term performance metrics was initiated and will continue in FY 2012. A treatability test report for the desiccation test is due in FY 2012.

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 (PNNL-20004, *Remediation of Uranium in the Hanford Vadose Zone Using Ammonia Gas: FY 2010 Laboratory-Scale Experiments*) 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*).

A Deep Vadose Zone Applied Field Research Initiative (DVZ-AFRI) was established to provide a framework for research investments and link directly to the remediation efforts associated with the 200-DV-1 Deep Vadose Zone OU. The primary objective of the DVZ-AFRI is to provide long-term protection of water resources across the DOE Office of Environmental Management (DOE-EM) complex by developing and applying effective solutions to solve deep vadose zone challenges in characterization, prediction, remediation, and monitoring of hazardous and radioactive contaminants. During the first year of operation, the DVZ-AFRI performed field work in support of the desiccation field treatability test and the vadose zone soil vapor extraction of organics (carbon tetrachloride), conducted work to develop advanced geophysical imaging technologies, continued to develop the technical basis for foam delivery of remediation amendments to the vadose zone, conducted research to quantify the role of geochemical and hydrogeologic heterogeneities on the mass discharge of technetium from the vadose zone to groundwater, and conducted laboratory work on geophysical methods for monitoring uranium remediation using ammonia gas.

### 4.2.3 Integrated Field Research Challenge Uranium Mobility Research

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. The 300 Area is not located on the Central Plateau, but information obtained from this research has the potential to improve understanding of uranium contamination distribution and migration at Central Plateau locations. Thus, it is also reviewed.

During FY 2011, field experiments continued to characterize the site and uranium behavior. These experiments included a third 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. During the experiment, unusually high precipitation in the Columbia River watershed led to unseasonably high water levels in the river. Through isotope monitoring, Columbia River water was observed in the IFRC well field. The data were analyzed with a multi-rate surface complexation model imbedded in the STOMP code to simulate uranium(VI) desorption. The well field was mitigated to prevent vertical flow by backfilling all of the fully-screened wells in the Hanford formation. A uranium desorption experiment was performed in the March through April time frame. In the experiment, low uranium groundwater was injected at a slow rate into the upper portion of the aquifer. Unfortunately, the discharge of the Columbia River impacted performance of the experiment through multiple reversals in groundwater flow direction and advance of the water table into the uranium-enriched periodically rewetted zone. The results of the experiment are being analyzed by the modeling teams for the project. An important finding of the field experiment was that the extent of uranium adsorption was much less than estimated from laboratory studies of intact saturated zone cores. There was no discernible retardation of uranium in the saturated zone. Progress at the IFRC is reported quarterly through the project Web site (http://ifchanford.pnl.gov/documents/).

# 5 Summary of Changes

This chapter summarizes changes affecting the Composite Analysis that have occurred during FY 2011. This includes changes to expected future conditions, such as site land-use plans or remediation plans and also any changes made as a result of special analyses (DOE O 435.1, Section 3.4).

There are at present no outstanding information needs (e.g., data gaps, uncertainties) identified in the Composite Analysis, the subsequent Addendum, or previous annual reviews.

## 5.1 Special Analyses

No special analyses were conducted in FY 2011.

## 5.2 Changes in Site Land Use and Remediation Plans

The draft of DOE/RL-2009-10, *Hanford Site Cleanup Completion Framework*, was issued for public comment in July 2009, closely followed by the issuance of DOE/RL-2009-81, *Central Plateau Cleanup Completion Strategy*, in September 2009. The strategies described in these documents are 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 (Ecology et al., 1989) change packages that utilize elements of the Central Plateau cleanup strategy. These changes were approved in October 2010. These documents describe the approach DOE intends to use to clean up nearly 195 $km^2$ (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 for the Central Plateau 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

These components are consistent with land uses designated for the Central Plateau in DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, the subsequent ROD (64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement [HCP EIS]"), and the 2008 supplemental analysis (DOE/EIS-0222-SA-01, *Supplement Analysis: Hanford Comprehensive Land-Use Plan Environmental Impact Statement*) and subsequent ROD (73 FR 55824, "Amended Record of Decision for the Hanford Comprehensive Land-Use Plan Environmental Impact Statement"). The designated land uses on the Central Plateau are: Industrial-Exclusive for the 50 $km^2$ (20 $mi^2$) at the core of the Central Plateau and Conservation (Mining) in the surrounding 145 $km^2$ (55 $mi^2$).

# 6 Recommended Changes

This chapter advises of planned or contemplated changes in relevant site programs that could affect the Composite Analysis and changes in the Composite Analysis maintenance program.

## 6.1 Monitoring and Research and Development Activities

The current monitoring and research and development activities associated with the Composite Analysis remains adequate: no changes are recommended.

## 6.2 Composite Analysis Maintenance Program

The Hanford Site is deferring any revision 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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# Appendix A

# Environmental Restoration Disposal Facility Inventory

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**Table A-1. Summary of Environmental Restoration Disposal Facility Annual Radionuclide Inventory Calendar Years 2007 and 2008 and Fiscal Years 2009 through 2011**

| Radionuclide | CY 2007 (Ci) | CY 2008 (Ci) | FY 2009 (Ci)[a] | FY 2010 (Ci) | FY 2011 (Ci) |
|---|---|---|---|---|---|
| Ac-227 | 2.35E-06 | 1.60E-09 | 3.33E-06 | 4.08E-07 | 1.19E-04 |
| Ag-108m | 4.02E+01 | 5.04E+01 | 4.98E+01 | 2.92E+02 | 4.36E+02 |
| Am-241 | 4.57E+00 | 4.13E+00 | 2.74E+02 | 1.47E+02 | 1.73E+02 |
| Am-242m | 3.50E-09 | 2.30E-04 | 4.34E-02 | 6.45E-03 | 7.33E-02 |
| Am-243 | 1.61E-04 | 1.87E-04 | 2.45E-02 | 4.09E-03 | 6.36E-02 |
| Ba-133 | 1.65E-01 | 4.91E-01 | 7.62E-01 | 4.51E+00 | 6.74E+00 |
| Be-7 | 0.00E+00 | 2.58E-06 | 6.60E-06 | 0.00E+00 | 0.00E+00 |
| Bi-207 | | | | | 6.79E-06 |
| C-14[b] | 1.01E-01 | 3.06E-02 | 5.35E-01 | 4.93E+00 | 2.69E+02 |
| C-14A[b] | 3.91E+02 | 3.70E+01 | 4.74E+00 | 2.76E+02 | 3.40E+00 |
| C-14 (insoluble) | 3.64E+01 | 3.17E+01 | 1.01E+02 | 2.81E+02 | 3.39E+03 |
| Ca-41 | 3.80E+00 | 3.12E-01 | 3.15E-02 | 6.99E-04 | 9.62E-04 |
| Cd-113m | 4.88E-04 | 1.01E+00 | 2.69E+00 | 2.39E-01 | 1.34E+00 |
| Ce-144 | 6.07E-06 | 2.55E-04 | 3.58E-05 | 3.96E-03 | 1.20E-07 |
| Cf-249 | | 4.63E-06 | 8.91E-04 | 0.00E+00 | 0.00E+00 |
| Cf-252 | | | | | 1.57E-04 |
| Cm-242 | 1.88E-02 | 3.63E-03 | 6.11E-02 | 3.33E-02 | 2.58E+00 |
| Cm-243 | 5.32E-03 | 1.17E-03 | 6.94E-02 | 6.91E-02 | 6.93E-01 |
| Cm-244 | 1.26E-01 | 6.59E-02 | 4.12E-01 | 8.14E-01 | 2.83E+00 |
| Cm-245 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.29E-07 |
| Cm-246 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Cm-247 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Cm-248 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Co-58 | 9.22E-04 | 1.60E-06 | 1.55E-06 | 3.23E-04 | 6.19E-01 |
| Co-60 | 2.25E+03 | 2.26E+03 | 4.00E+02 | 1.09E+03 | 1.04E+03 |
| Cs-134 | 3.63E-02 | 1.56E-02 | 8.14E+00 | 4.04E-01 | 9.30E-01 |
| Cs-135 | 5.40E-09 | 2.22E-04 | 1.01E-01 | 3.75E-03 | 4.27E-01 |
| Cs-137 | 4.20E+02 | 4.44E+02 | 5.91E+03 | 3.13E+03 | 7.64E+03 |

**Table A-1. Summary of Environmental Restoration Disposal Facility Annual Radionuclide Inventory Calendar Years 2007 and 2008 and Fiscal Years 2009 through 2011**

| Radionuclide | CY 2007 (Ci) | CY 2008 (Ci) | FY 2009 (Ci)[a] | FY 2010 (Ci) | FY 2011 (Ci) |
|---|---|---|---|---|---|
| Eu-150 | | | 1.98E-04 | 0.00E+00 | 6.85E-04 |
| Eu-152 | 6.72E+01 | 1.23E+02 | 2.65E+02 | 6.62E+02 | 3.44E+02 |
| Eu-154 | 3.46E+01 | 5.04E+01 | 1.73E+02 | 2.30E+02 | 1.23E+02 |
| Eu-155 | 3.36E-01 | 5.89E+00 | 7.83E+01 | 2.29E+01 | 2.17E+01 |
| Fe-55 | 4.03E-07 | 1.30E+01 | 1.54E+01 | 1.33E+01 | 3.68E+00 |
| Fe-59 | 0.00E+00 | 4.31E-06 | 4.15E-06 | 8.69E-04 | 0.00E+00 |
| H-3 | 1.33E+03 | 2.59E+02 | 8.28E+02 | 3.10E+03 | 2.18E+03 |
| I-129 | 8.10E-06 | 1.49E-02 | 1.89E-03 | 2.16E-03 | 3.63E-02 |
| K-40 | 5.86E-01 | 1.32E+01 | 1.79E+01 | 2.42E+01 | 7.58E+00 |
| Kr-85 | 2.97E-02 | 1.21E-04 | 1.63E-01 | 0.00E+00 | 0.00E+00 |
| Mn-54 | 0.00E+00 | 8.54E-02 | 9.38E-02 | 1.54E-02 | 5.00E-03 |
| Mo-93 | 6.73E-01 | 3.32E-01 | 8.04E-02 | 2.36E-01 | 2.58E-01 |
| Na-22 | 0.00E+00 | 0.00E+00 | 7.48E-07 | 9.71E-06 | 6.91E-04 |
| Nb-93m | 1.56E+00 | 3.93E-01 | 9.42E-01 | 3.74E+00 | 2.86E-01 |
| Nb-94 | 1.20E+00 | 1.36E+00 | 2.50E+00 | 9.78E-04 | 6.53E-02 |
| Nb-94A | 4.22E-01 | 1.53E-01 | 4.47E-02 | 1.57E-02 | 1.78E-02 |
| Ni-59 | 1.45E+01 | 8.44E+00 | 7.32E+00 | 9.87E+01 | 3.88E+01 |
| Ni-59A | 4.91E+02 | 6.63E+01 | 1.36E+01 | 1.14E+01 | 1.36E+01 |
| Ni-63 | 7.62E+01 | 1.27E+04 | 6.98E+03 | 1.81E+03 | 1.09E+02 |
| Ni-63A | 6.87E+03 | 3.37E+03 | 1.30E+03 | 1.06E+03 | 1.23E+03 |
| Np-237 | 3.14E-03 | 9.37E-02 | 1.74E-02 | 9.63E-02 | 1.33E-01 |
| Pa-231 | 0.00E+00 | 0.00E+00 | 3.40E-07 | 3.95E-07 | 1.06E-04 |
| Pb-210 | 0.00E+00 | 0.00E+00 | 1.52E-05 | 8.88E-05 | 2.28E-01 |
| Pb-212 | | | | | 1.78E+01 |
| Pd-107 | 9.96E-06 | 5.97E-05 | 1.65E-02 | 7.73E-04 | 4.33E-03 |
| Pm-147 | 6.33E-02 | 1.63E-01 | 1.18E+02 | 7.52E+00 | 1.32E+01 |
| Po-209 | | | | | 6.85E-04 |
| Pu-238 | 4.22E-01 | 2.34E-01 | 9.37E+00 | 8.38E+00 | 2.36E+01 |

**Table A-1. Summary of Environmental Restoration Disposal Facility Annual Radionuclide Inventory Calendar Years 2007 and 2008 and Fiscal Years 2009 through 2011**

| Radionuclide | CY 2007 (Ci) | CY 2008 (Ci) | FY 2009 (Ci)[a] | FY 2010 (Ci) | FY 2011 (Ci) |
|---|---|---|---|---|---|
| Pu-239 | 4.58E+00 | 1.08E+00 | 5.12E+01 | 3.94E+01 | 9.37E+01 |
| Pu-240 | 1.59E+00 | 3.92E-01 | 2.75E+01 | 3.18E+01 | 6.99E+01 |
| Pu-241 | 2.10E+01 | 1.25E+01 | 9.45E+02 | 2.43E+03 | 1.52E+03 |
| Pu-242 | 9.78E-05 | 2.96E-02 | 1.88E-02 | 4.94E-01 | 7.37E-01 |
| Pu-244 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.44E-04 | 0.00E+00 |
| Ra-226 | 1.45E-01 | 3.49E-01 | 1.33E-01 | 1.16E-01 | 9.84E-01 |
| Ra-228 | 5.26E-02 | 9.83E-02 | 1.02E-01 | 1.16E-01 | 2.06E-01 |
| Ru-103 | | | 0.00E+00 | 9.60E-08 | 6.25E-08 |
| Ru-103 | 0.00E+00 | 0.00E+00 | | 2.22E-03 | 0.00E+00 |
| Ru-106 | 2.79E-03 | 1.49E-02 | 1.28E-02 | 1.94E-02 | 3.06E-07 |
| Sb-125 | 2.83E-02 | 2.09E+00 | 4.40E+01 | 6.84E+00 | 2.13E+01 |
| Se-79 | 9.95E-05 | 1.37E+01 | 2.91E+01 | 8.23E-03 | 3.71E-02 |
| Sm-151 | 1.75E-01 | 2.96E+00 | 2.26E+02 | 4.16E+01 | 5.87E+02 |
| Sn-113 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.38E-03 | 1.00E-03 |
| Sn-121m | 0.00E+00 | 2.02E-04 | 3.20E+00 | 1.49E+01 | 7.68E-02 |
| Sn-126 | 6.79E-06 | 1.26E-01 | 7.12E-02 | 2.44E-02 | 3.55E-02 |
| Sr-90 | 9.06E+02 | 2.94E+02 | 4.50E+03 | 1.91E+03 | 1.92E+03 |
| Tc-99 | 3.47E+00 | 2.50E-01 | 2.96E+00 | 4.07E+00 | 1.60E+01 |
| Th-228 | 3.12E-01 | 3.00E-01 | 8.16E-02 | 1.08E-01 | 1.42E-01 |
| Th-229 | | | 1.06E-06 | 9.80E-09 | 8.04E-04 |
| Th-230 | 1.08E-05 | 5.37E-04 | 1.51E-03 | 4.82E-05 | 2.11E-01 |
| Th-232 | 5.57E-02 | 4.73E-01 | 2.70E-01 | 1.50E-01 | 3.37E-01 |
| Th-234 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Ti-44 | | | | 2.52E-05 | 0.00E+00 |
| U-232 | 1.21E-07 | 5.35E-06 | 6.57E-04 | 8.09E-05 | 2.22E-04 |
| U-233/234 | 6.95E-01 | 1.10E+01 | 5.66E+00 | 8.73E+00 | 2.40E+01 |
| U-235 | 6.77E-02 | 1.09E+00 | 6.93E-01 | 9.88E-01 | 6.87E-01 |
| U-236 | 5.53E-04 | 3.04E-01 | 7.30E-01 | 9.05E-02 | 3.43E-01 |

**Table A-1. Summary of Environmental Restoration Disposal Facility Annual Radionuclide Inventory Calendar Years 2007 and 2008 and Fiscal Years 2009 through 2011**

| Radionuclide | CY 2007 (Ci) | CY 2008 (Ci) | FY 2009 (Ci)[a] | FY 2010 (Ci) | FY 2011 (Ci) |
|---|---|---|---|---|---|
| U-238 | 2.14E+00 | 2.88E+01 | 1.20E+01 | 1.41E+01 | 9.94E+00 |
| Y-90 | | | | 1.96E-04 | 2.47E+00 |
| Zn-65 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.15E-03 | 0.00E+00 |
| Zr-93 | 1.00E-03 | 1.70E+01 | 3.25E+01 | 4.82E+00 | 5.36E-01 |
| **Total Activity** | **1.30E+04** | **1.99E+04** | **2.24E+04** | **1.68E+04** | **2.14E+04** |

a. Reporting changed from calendar year (CY) to fiscal year (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).

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

**Table A-2. Summary of Environmental Restoration Disposal Facility Radionuclide Inventory Fiscal Year 2011 and Total Since Inception**

| | ERDF WAC[a] | FY 2011 | | Inception through FY 2011 | |
|---|---|---|---|---|---|
| Radionuclide | (Ci/m$^3$) | (Ci) | (Ci/m$^3$)[b] | (Ci) | (Ci/m$^3$)[b] |
| Ac-227 | 7.60E+04 | 1.19E-04 | 1.33E-10 | 1.25E-04 | 2.33E-11 |
| Ag-108m | N/A[c] | 4.36E+02 | 4.87E-04 | 8.43E+02 | 1.57E-04 |
| Am-241 | 5.40E-02 | 1.73E+02 | 1.93E-04 | 6.76E+02 | 1.26E-04 |
| Am-242m | 4.00E-01 | 7.33E-02 | 8.19E-08 | 1.23E-01 | 2.30E-08 |
| Am-243 | 5.60E-02 | 6.36E-02 | 7.11E-08 | 2.41E-01 | 4.50E-08 |
| Ba-133 | N/A | 6.74E+00 | 7.53E-06 | 1.23E+01 | 2.29E-06 |
| Be-7 | N/A | 0.00E+00 | 0.00E+00 | 9.18E-06 | 1.71E-12 |
| Bi-207 | 3.60E+02 | 6.79E-06 | 7.59E-12 | 6.79E-06 | 1.27E-12 |
| C-14[d] | 5.10E+00 | 2.69E+02 | 3.01E-04 | 3.09E+02 | 5.78E-05 |
| C-14A[d] | 5.10E+01 | 3.40E+00 | 3.80E-06 | 1.55E+03 | 2.90E-04 |
| C-14 (insoluble) | N/A | 3.39E+03 | 3.78E-03 | 3.83E+03 | 7.15E-04 |
| Ca-41 | N/A | 9.62E-04 | 1.07E-09 | 4.12E+00 | 7.69E-07 |
| Cd-113m | N/A | 1.34E+00 | 1.50E-06 | 5.28E+00 | 9.86E-07 |
| Ce-144 | N/A | 1.20E-07 | 1.34E-13 | 4.26E-03 | 7.95E-10 |
| Cf-249 | N/A | 0.00E+00 | 0.00E+00 | 8.91E-04 | 1.66E-10 |
| Cf-252 | N/A | 1.57E-04 | 1.76E-10 | 8.91E-04 | 1.66E-10 |

**Table A-2. Summary of Environmental Restoration Disposal Facility Radionuclide Inventory Fiscal Year 2011 and Total Since Inception**

| | ERDF WAC[a] | FY 2011 | | Inception through FY 2011 | |
|---|---|---|---|---|---|
| Radionuclide | (Ci/m$^3$) | (Ci) | (Ci/m$^3$)[b] | (Ci) | (Ci/m$^3$)[b] |
| Cm-242 | 3.20E+01 | 2.58E+00 | 2.89E-06 | 2.70E+00 | 5.04E-07 |
| Cm-243 | 8.60E+01 | 6.93E-01 | 7.74E-07 | 8.37E-01 | 1.56E-07 |
| Cm-244 | 3.90E+01 | 2.83E+00 | 3.16E-06 | 4.24E+00 | 7.93E-07 |
| Cm-245 | 5.60E-02 | 5.29E-07 | 5.91E-13 | 5.29E-07 | 9.87E-14 |
| Cm-246 | 1.00E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 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 | 6.19E-01 | 6.91E-07 | 1.41E+00 | 2.62E-07 |
| Co-60 | N/A | 1.04E+03 | 1.17E-03 | 1.15E+04 | 2.15E-03 |
| Cs-134 | N/A | 9.30E-01 | 1.04E-06 | 2.28E+01 | 4.26E-06 |
| Cs-135 | 8.80E+00 | 4.27E-01 | 4.78E-07 | 5.32E-01 | 9.94E-08 |
| Cs-137 | 3.20E+01 | 7.64E+03 | 8.53E-03 | 2.43E+04 | 4.55E-03 |
| Eu-150 | 1.70E+02 | 6.85E-04 | 7.65E-10 | 8.83E-04 | 1.65E-10 |
| Eu-152 | 2.10E+07 | 3.44E+02 | 3.84E-04 | 6.91E+03 | 1.29E-03 |
| Eu-154 | N/A | 1.23E+02 | 1.38E-04 | 2.20E+03 | 4.10E-04 |
| Eu-155 | N/A | 2.17E+01 | 2.42E-05 | 2.65E+02 | 4.95E-05 |
| Fe-55 | N/A | 3.68E+00 | 4.12E-06 | 3.24E+01 | 6.05E-06 |
| Fe-59 | N/A | 0.00E+00 | 0.00E+00 | 8.73E-04 | 1.63E-10 |
| H-3 | N/A | 2.18E+03 | 2.43E-03 | 1.17E+04 | 2.19E-03 |
| I-129 | 8.00E-02 | 3.63E-02 | 4.05E-08 | 5.52E-02 | 1.03E-08 |
| K-40 | 1.20E-03 | 7.58E+00 | 8.47E-06 | 5.74E+01 | 1.07E-05 |
| Kr-85 | N/A | 0.00E+00 | 0.00E+00 | 1.93E-01 | 3.61E-08 |
| Mn-54 | N/A | 5.00E-03 | 5.59E-09 | 1.14E-01 | 2.13E-08 |
| Mo-93 | 5.10E+01 | 2.58E-01 | 2.88E-07 | 1.57E+00 | 2.93E-07 |
| Na-22 | N/A | 6.91E-04 | 7.72E-10 | 1.02E+01 | 1.91E-06 |
| Nb-93m | N/A | 2.86E-01 | 3.19E-07 | 6.90E+00 | 1.29E-06 |
| Nb-94 | 1.20E-02 | 6.53E-02 | 7.30E-08 | 6.60E+00 | 1.23E-06 |
| Nb-94A | 1.20E-01 | 1.78E-02 | 1.98E-08 | 6.41E-01 | 1.20E-07 |

**Table A-2. Summary of Environmental Restoration Disposal Facility Radionuclide Inventory Fiscal Year 2011 and Total Since Inception**

| Radionuclide | ERDF WAC[a] | FY 2011 | | Inception through FY 2011 | |
|---|---|---|---|---|---|
| | (Ci/m$^3$) | (Ci) | (Ci/m$^3$)[b] | (Ci) | (Ci/m$^3$)[b] |
| Ni-59 | 2.10E+02 | 3.88E+01 | 4.33E-05 | 1.67E+02 | 3.11E-05 |
| Ni-59A | 2.20E+02 | 1.36E+01 | 1.52E-05 | 5.93E+02 | 1.11E-04 |
| Ni-63 | 7.00E+02 | 1.09E+02 | 1.22E-04 | 1.92E+04 | 3.59E-03 |
| Ni-63A | 7.00E+03 | 1.23E+03 | 1.38E-03 | 1.57E+04 | 2.94E-03 |
| Np-237 | 1.50E-03 | 1.33E-01 | 1.48E-07 | 5.63E-01 | 1.05E-07 |
| Pa-231 | 7.40E-03 | 1.06E-04 | 1.18E-10 | 1.06E-04 | 1.99E-11 |
| Pb-210 | 5.10E+05 | 2.28E-01 | 2.55E-07 | 2.28E-01 | 4.26E-08 |
| Pb-212 | N/A | 1.78E+01 | 1.99E-05 | 1.78E+01 | 3.33E-06 |
| Pd-107 | 8.20E+02 | 4.33E-03 | 4.84E-09 | 2.16E-02 | 4.04E-09 |
| Pm-147 | N/A | 1.32E+01 | 1.47E-05 | 1.39E+02 | 2.59E-05 |
| Po-209 | 7.90E+00 | 6.85E-04 | 7.65E-10 | 6.85E-04 | 1.28E-10 |
| Pu-238 | 1.50E+00 | 2.36E+01 | 2.64E-05 | 6.57E+01 | 1.23E-05 |
| Pu-239 | 2.90E-02 | 9.37E+01 | 1.05E-04 | 3.38E+02 | 6.32E-05 |
| Pu-240 | 2.90E-02 | 6.99E+01 | 7.81E-05 | 1.88E+02 | 3.50E-05 |
| Pu-241 | 5.60E+00 | 1.52E+03 | 1.70E-03 | 8.02E+03 | 1.50E-03 |
| Pu-242 | 1.10E-01 | 7.37E-01 | 8.24E-07 | 1.40E+00 | 2.61E-07 |
| Pu-244 | 3.20E-02 | 0.00E+00 | 0.00E+00 | 8.44E-04 | 1.58E-10 |
| Ra-226 | 1.40E-04 | 9.84E-01 | 1.10E-06 | 1.88E+00 | 3.51E-07 |
| Ra-228 | 2.20E-04 | 2.06E-01 | 2.30E-07 | 5.67E-01 | 1.06E-07 |
| Re-187 | N/A | 6.25E-08 | 6.98E-14 | 1.59E-07 | 2.96E-14 |
| Ru-103 | N/A | 0.00E+00 | 0.00E+00 | 2.22E-03 | 4.14E-10 |
| Ru-106 | N/A | 3.06E-07 | 3.42E-13 | 3.72E-02 | 6.96E-09 |
| Sb-125 | N/A | 2.13E+01 | 2.38E-05 | 7.32E+01 | 1.37E-05 |
| Se-79 | 2.70E+01 | 3.71E-02 | 4.15E-08 | 3.51E+01 | 6.56E-06 |
| Sm-151 | 5.30E+04 | 5.87E+02 | 6.56E-04 | 8.57E+02 | 1.60E-04 |
| Sn-113 | N/A | 1.00E-03 | 1.12E-09 | 2.38E-03 | 4.44E-10 |
| Sn-121m | 5.60E+03 | 7.68E-02 | 8.58E-08 | 1.82E+01 | 3.40E-06 |
| Sn-126 | 8.40E-03 | 3.55E-02 | 3.97E-08 | 2.57E-01 | 4.80E-08 |

**Table A-2. Summary of Environmental Restoration Disposal Facility Radionuclide Inventory Fiscal Year 2011 and Total Since Inception**

| Radionuclide | ERDF WAC[a] | FY 2011 | | Inception through FY 2011 | |
|---|---|---|---|---|---|
| | (Ci/m³) | (Ci) | (Ci/m³)[b] | (Ci) | (Ci/m³)[b] |
| Sr-90 | 7.00E+03 | 1.92E+03 | 2.14E-03 | 1.48E+04 | 2.77E-03 |
| ***Tc-99 | 1.30E+00 | 1.60E+01 | 1.79E-05 | 1.00E+02 | 1.87E-05 |
| Th-228 | 1.20E-04 | 1.42E-01 | 1.58E-07 | 1.51E+00 | 2.81E-07 |
| Th-229 | 2.50E-02 | 8.04E-04 | 8.99E-10 | 8.05E-04 | 1.50E-10 |
| Th-230 | 3.80E-02 | 2.11E-01 | 2.36E-07 | 2.13E-01 | 3.97E-08 |
| Th-232 | 5.80E-03 | 3.37E-01 | 3.77E-07 | 1.45E+00 | 2.72E-07 |
| Th-234 | N/A | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Ti-44 | N/A | 0.00E+00 | 0.00E+00 | 2.52E-05 | 4.70E-12 |
| U-232 | 1.20E+00 | 2.22E-04 | 2.48E-10 | 9.66E-04 | 1.80E-10 |
| U-233/234 | 7.40E-02 | 2.40E+01 | 2.68E-05 | 1.19E+02 | 2.23E-05 |
| U-235 | 2.70E-03 | 6.87E-01 | 7.68E-07 | 2.86E+01 | 5.33E-06 |
| U-236 | 5.10E-01 | 3.43E-01 | 3.83E-07 | 1.30E+00 | 2.43E-07 |
| U-238 | 1.20E-02 | 9.94E+00 | 1.11E-05 | 2.54E+02 | 4.75E-05 |
| Y-90 | N/A | 2.47E+00 | 2.77E-06 | 2.47E+00 | 4.62E-07 |
| Zn-65 | N/A | 0.00E+00 | 0.00E+00 | 1.15E-03 | 2.16E-10 |
| Zr-93 | 1.40E+02 | 5.36E-01 | 5.99E-07 | 4.52E+01 | 8.45E-06 |
| **Total** | | **2.14E+04** | | **1.25E+05** | |

a. WAC = Waste Acceptance Criteria.

b. Activity densities (Ci/m3) were calculated using the waste disposal volumes reported in Table A-3.

c. N/A = Not Applicable.

d. C-14 and C-14A (activated metal) inventories have been adjusted per CCN 088793, "White Paper on Environmental Restoration Disposal Facility Inventory and Waste Acceptance Practices."

**Table A-3. Summary of Environmental Restoration Disposal Facility Waste Weight and Volume Disposed in Fiscal Year 2011 and Total Since Inception**

| Period | Weight (U.S. tons)[a] | Volume ($m^3$)[b] |
|---|---|---|
| Disposed in Fiscal Year 2011 | 2.05E+06 | 8.95E+05 |
| Disposed from Inception through Fiscal Year 2011 | 1.23E+07 | 5.35E+06 |

a. To obtain metric tons from U.S. tons, multiply by 0.90718474.

b. To obtain cubic yards ($yd^3$) from cubic meters ($m^3$), multiply by 1.30795062.

## Reference

CCN 088793, 2001, "White Paper on Environmental Restoration Disposal Facility Inventory and Waste Acceptance Practices," Bechtel Hanford, Inc., Richland, Washington.