HANFORD SITE
Cleanup Completion Framework

July 2010

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Preface

The Hanford Site was created in 1943 with the intent of ending World War II. Operations to make the raw materials for nuclear weapons continued until the late 1980s. The waste remaining from those operations is a potential threat to the Columbia River. Cleanup of Hanford and its environmental contamination began in 1989. The progress to date has been supported by a dialogue among Hanford's regulators, Tribal representatives, diverse stakeholders, and public interest groups. Completing Hanford cleanup will require several more decades and the sustained investment of significant public resources. Those public resources must compete with many other national priorities. Completion of cleanup will require a sustained, open, and informed dialogue among Hanford's many interest groups. This document is intended to enhance that dialogue.

When faced with any single cleanup decision, Hanford's stakeholders have long desired a broader view of how that one decision fits with other Hanford cleanup decisions. It is in response to those desires that the U.S. Department of Energy (DOE) has prepared this document. In doing so, DOE hopes to make the long and complex task of cleaning up the Hanford Site more understandable to all interested parties. Through improved understanding, more effective involvement in cleanup decisions will result.

This document provides a comprehensive overview of Hanford cleanup. Cleanup requires many dozens of individual decisions. This document shows how single decisions lead to completion of cleanup for the site as a whole, i.e., (1) it describes the challenges facing cleanup, (2) it describes the approaches for making decisions for the three major components of cleanup, and (3) it describes the actions needed to move from cleanup to post-cleanup activities.

This framework document defines the main components of cleanup. The River Corridor and Central Plateau represent the two main geographic areas of cleanup work. The River Corridor includes the former fuel fabrication and reactor operations areas. This region is adjacent to the Columbia River and cleanup must deal with the threats to that valuable resource. The Central Plateau includes the former fuel processing facilities and numerous waste disposal facilities. Included within the Central Plateau area of the Hanford Site is Hanford's most significant challenge – Tank Waste cleanup. Thus, this framework describes the three main components of cleanup – River Corridor, Central Plateau, and Tank Waste. Each of these components of cleanup is in itself a complex and challenging task requiring many years and billions of dollars to complete.

This document guides the reader to other information that will aid in learning about Hanford cleanup. It does not make regulatory decisions nor does it provide any budgetary information. Many separate, formal regulatory decisions must still be made.

In August 2009, DOE released a draft of this document for public review and comment. The comment period was 90 days in length. DOE received comments from a diverse set of organizations, Tribal Nations, and individuals. This feedback was used to improve and update this document. The specific comments received and DOE's responses to those comments can be found on the Hanford web site at http://hanford.gov/page.cfm/OfficialDocuments. DOE recognizes that this cleanup framework will evolve as cleanup progress occurs and as input from interested parties is received. DOE continues to seek your feedback on this *Completion Framework* and how it can better inform interested parties on matters related to Hanford cleanup. Refer to information inside the back cover for details about other DOE information resources pertaining to Hanford Site cleanup. DOE continues to seek your feedback on the Completion Framework and how it can better inform interested parties on matters related to Hanford cleanup (please send comments to CleanupFramework@rl.gov).

Summary

Cleanup of the Hanford Site is a complex and challenging undertaking. This document provides a comprehensive overview for completing Hanford's cleanup including the transition to post-cleanup activities. This framework describes three major components of cleanup – River Corridor, Central Plateau, and Tank Waste. It provides the context for individual cleanup actions by describing the key challenges and approaches for the decisions needed to complete cleanup.

The U.S. Department of Energy (DOE), as regulated by the U.S. Environmental Protection Agency (EPA) and Washington State Department of Ecology (Ecology), is implementing a strategy to achieve final cleanup decisions for the River Corridor portion of the Hanford Site. The DOE Richland Operations Office (RL) and DOE Office of River Protection (ORP) have prepared this document to describe that strategy and to begin developing the approach for making cleanup decisions for the remainder of the Hanford Site.

While it is important to understand what this overview document is, it is just as important to understand what it is not. This document does not make or replace any regulatory decision nor is it a *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) or *Resource Conservation and Recovery Act* (RCRA) document. This document does not substitute for, nor preempt, the regulatory decision processes as set forth in the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989), also known as the Tri-Party Agreement, and applicable laws, regulations, and other legal requirements. DOE's intent is that this document will facilitate dialogue among the Tri-Parties and with Hanford's diverse interest groups, including Tribal Nations, State of Oregon, Hanford Advisory Board, Natural Resource Trustees, and the public. Future cleanup decisions will be enhanced by an improved understanding of the challenges facing cleanup and a common understanding of the goals and approaches for cleanup completion.

The overarching goals for cleanup are stated in Figure S-1. These goals embody more than 20 years of dialogue among the Tri-Party Agencies, Tribal Nations, State of Oregon, stakeholders, and the public. They carry forward key values captured in forums such as the Hanford Future Site Uses Working Group, Tank Waste Task Force, Hanford Summits, and Hanford Advisory Board Exposure Scenario Workshops, as well as more than 200 advice letters issued by the Hanford Advisory Board (http://www.hanford.gov/page.cfm/hab). These goals help guide all aspects of Hanford Site cleanup. Cleanup activities at various areas of the site support the achievement of one or more of these goals. These goals help set priorities to apply resources and sequence cleanup efforts for the greatest benefit.

These goals reflect DOE's recognition that the Columbia River is a critical resource for the people and ecology of the Pacific Northwest. The 50-mile stretch of the river known as the Hanford Reach is the last free flowing section of the river in the U.S. As one of the largest rivers in North America, its waters support a multitude of uses that are vital to the economic and environmental well being of the region and it is particularly important in sustaining the culture of Native Americans. Cleanup actions must protect this river.

Goals for Cleanup
Goal 1: Protect the Columbia River.
Goal 2: Restore groundwater to its beneficial use to protect human health, the environment, and the Columbia River.
Goal 3: Clean up River Corridor waste sites and facilities to: • Protect groundwater and the Columbia River. • Shrink the active cleanup footprint to the Central Plateau. • Support anticipated future land uses.
Goal 4: Clean up Central Plateau waste sites, tank farms, and facilities to: • Protect groundwater. • Minimize the footprint of areas requiring long-term waste management activities. • Support anticipated future land uses.
Goal 5: Safely manage and transfer legacy materials scheduled for off-site disposition including special nuclear material (including plutonium), spent nuclear fuel, transuranic waste, and immobilized high-level waste.
Goal 6: Consolidate waste treatment, storage, and disposal operations on the Central Plateau.
Goal 7: Develop and implement institutional controls and long-term stewardship activities that protect human health, the environment, and Hanford's unique cultural, historical and ecological resources after cleanup activities are completed.

Figure S-1. Goals for Cleanup

The Hanford Site cleanup consists of three major components: (1) River Corridor, (2) Central Plateau, and (3) Tank Waste (note that the Tank Waste component is contained within the geographic boundaries of the Central Plateau). Each component of cleanup is in itself a complex and challenging undertaking involving multiple projects and contractors and requiring many years and billions of dollars to complete. These components are shown in Figure S-2.

Active Cleanup Footprint Reduction. Figure S-3 illustrates the principal components of active cleanup footprint reduction. The Hanford Reach National Monument lands (~290 square miles) surround the Hanford Site. These lands are primarily managed to preserve natural and cultural resources. A portion of the monument along the south shore of the Columbia River is included in cleanup of the River Corridor. DOE expects to complete cleanup of the other portions of the national monument in fiscal year 2011. The following sections describe the components of active cleanup footprint reduction that will occur beyond the footprint reduction due to the national monument: the River Corridor, Central Plateau, and Tank Waste.

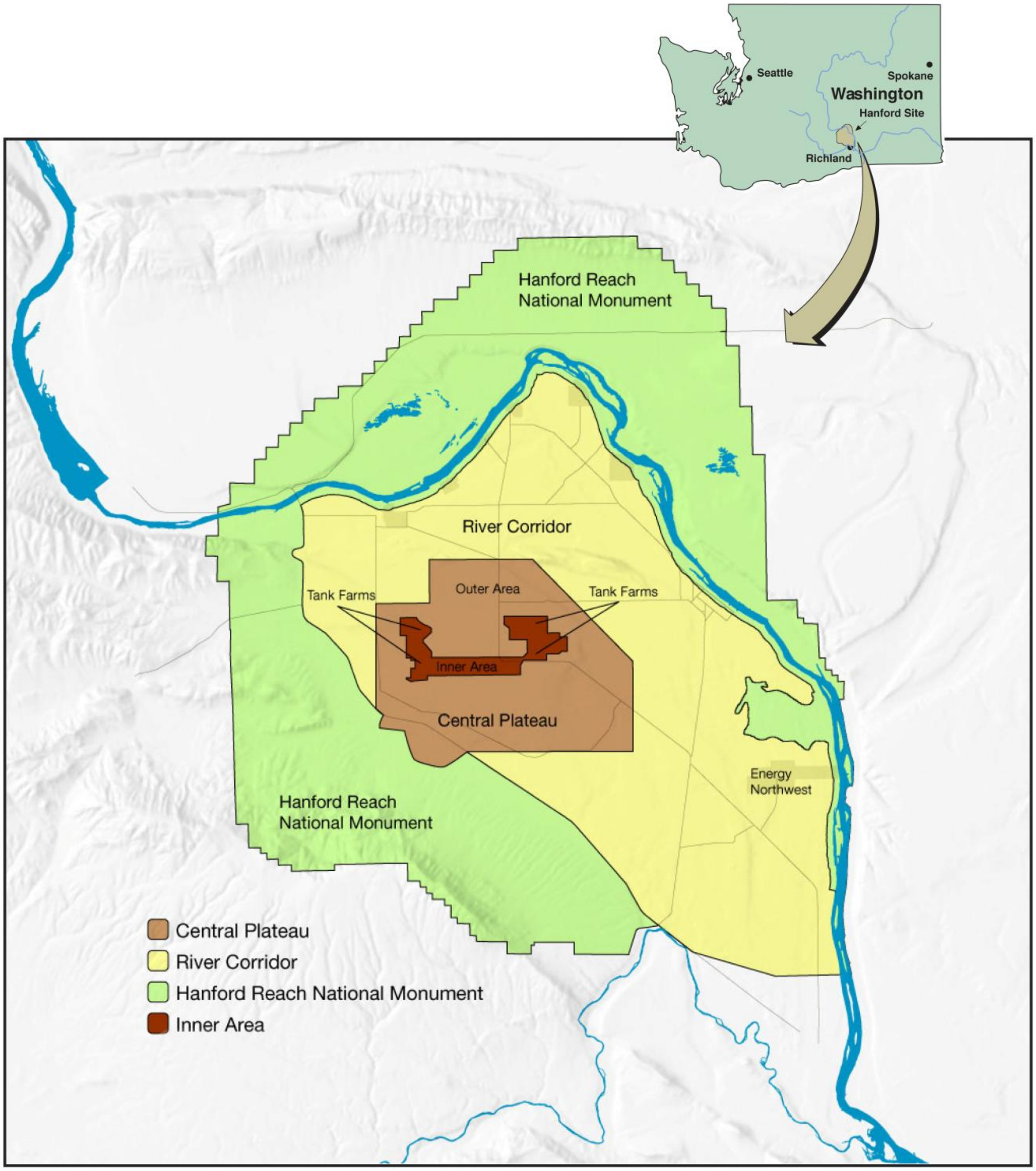

Figure S-2. Principal Components of Hanford's Cleanup Completion Framework: River Corridor, Central Plateau, and Tank Waste (Note: River Corridor Cleanup includes the south shore of the river that is part of the Hanford Reach National Monument.)

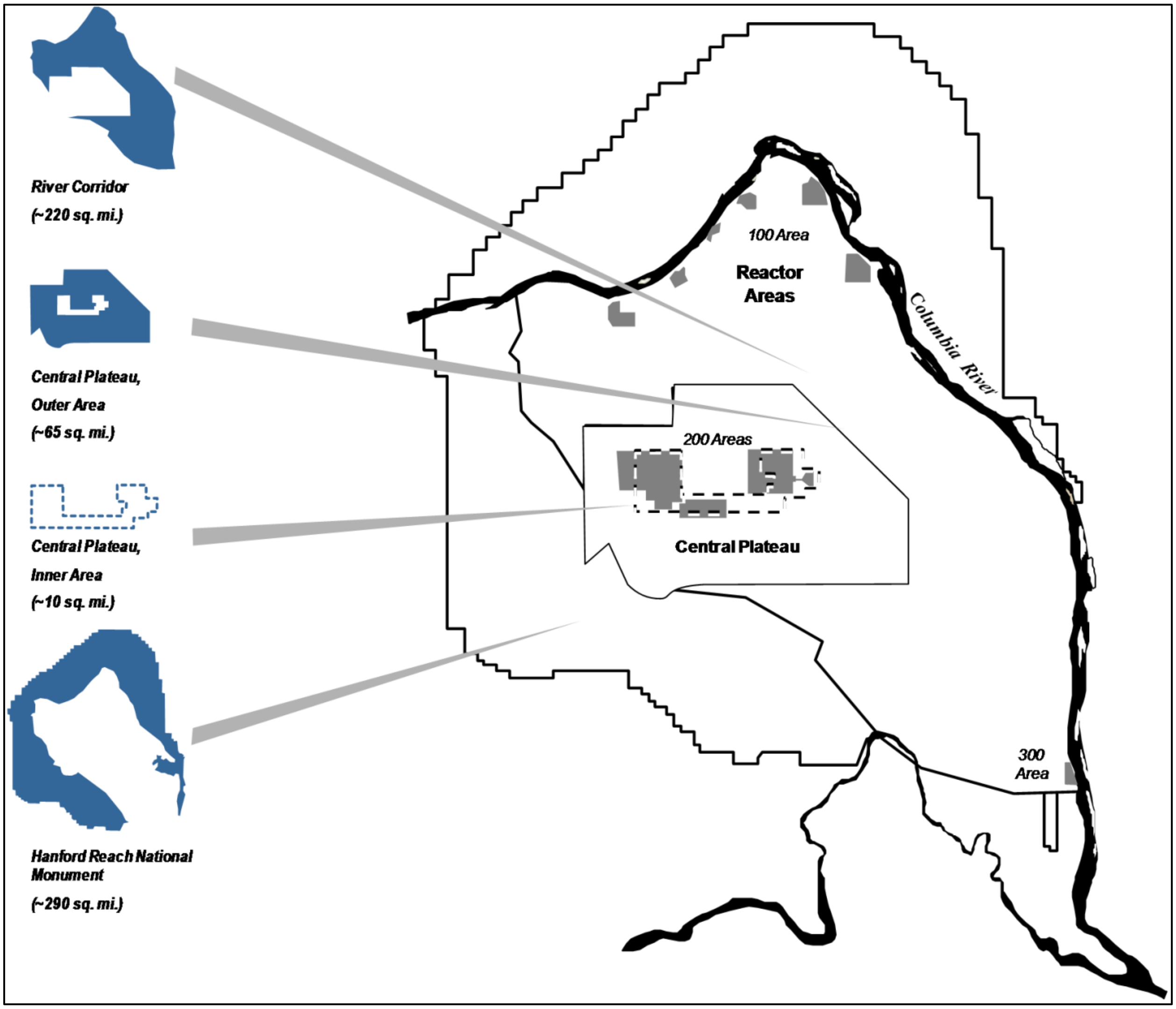

Figure S-3. Principal Components of Active Cleanup Footprint Reduction at Hanford (from DOE 2010c)

River Corridor Cleanup. Cleanup of the River Corridor has been one of Hanford's top priorities since the early 1990s. This urgency is due to the proximity of hundreds of waste sites to the Columbia River. In addition, removal of the sludge from K West Basin, which is near the river, remains a high priority. (Refer to Chapter 3 for details about River Corridor cleanup.)

This component of cleanup includes approximately 220 square miles of the Hanford Site as shown in Figure S-2. The River Corridor portion of the Hanford Site includes the 100 and 300 Areas along the south shore of the Columbia River:

- The 100 Areas contains nine retired plutonium production reactors. These areas are also the location of numerous support facilities and solid and liquid waste disposal sites that have contaminated groundwater and soil.

- The 300 Area, located north of the city of Richland, contains fuel fabrication facilities, nuclear research and development facilities, and their associated solid and liquid waste disposal sites that have contaminated groundwater and soil.

For purposes of this completion framework and to ensure that cleanup actions address all threats to human health and the environmental, the River Corridor includes the adjacent areas that extend from the 100 Areas and 300 Area to the Central Plateau.

For sites in the River Corridor, remedial actions are expected to restore groundwater to drinking water standards and to ensure that the aquatic life in the Columbia River is protected by achieving ambient water quality standards in the river. It is intended that these objectives be achieved, unless technically impracticable, within a reasonable time frame. In those instances where remedial action objectives are not achievable in a reasonable time frame, or are determined to be technically impracticable, programs will be implemented to contain the plume, prevent exposure to contaminated groundwater, and evaluate further risk reduction opportunities as new technologies become available. River Corridor cleanup work also removes potential sources of contamination, which are close to the Columbia River, to the Central Plateau for final disposal. The intent is to shrink the footprint of active cleanup to within the 75-square-mile area of the Central Plateau by removing excess facilities and remediating waste sites. Cleanup actions will support anticipated future land uses consistent with the Hanford Reach National Monument, where applicable, and the *Hanford Comprehensive Land-Use Plan* (DOE 1999).

The River Corridor has been divided into six geographic decision areas to achieve source and groundwater remedy decisions. These decisions will provide comprehensive coverage for all areas within the River Corridor and will incorporate ongoing interim action cleanup activities. Cleanup levels will be achieved that support the anticipated land uses of conservation and preservation for most of this area and industrial use for the 300 Area. At the conclusion of cleanup actions, the federal government will retain ownership of land in the River Corridor and will implement long-term stewardship activities to ensure protection of human health and the environment.

Central Plateau Cleanup. The Central Plateau component of cleanup includes approximately 75 square miles in the central portion of the Hanford Site as shown in Figure S-2. This component includes the Inner Area (~10 square miles) that contains the major nuclear fuel processing, waste management, and disposal facilities. This Inner Area is anticipated to be the final footprint of Hanford (see Figure S-3), and will be dedicated to long-term waste management and containment of residual contamination. The Outer Area (~65 square miles) is that portion of the Central Plateau outside the boundary of the Inner Area. The Outer Area waste sites are being cleaned up to a level comparable to that achieved for River Corridor waste sites. Cleanup of the Outer Area is planned to be completed in the 2015 to 2020 time period. Completing cleanup of the Outer Area will shrink the footprint of active cleanup by an additional 65 square miles leaving just the Inner Area remaining. (Refer to Chapter 4 for details about Central Plateau cleanup.)

Cleanup of the Central Plateau is a highly complex activity because of the large number of waste sites, surplus facilities, active treatment and disposal facilities, and areas of deep soil contamination. Past discharges of more than 450 billion gallons of liquid waste and cooling water to the soil have resulted in about 60 square miles of contaminated groundwater. Today, some plumes extend far beyond the plateau. Containing and remediating these plumes remains a high priority. For areas of groundwater contamination in the Central Plateau, the goal is to restore the aquifer to achieve drinking water standards. In those instances where remediation goals are not achievable in a reasonable time frame, programs will be implemented to contain the plumes, prevent exposure to contaminated groundwater, and evaluate further risk reduction opportunities as new technologies become available. Near-term actions will be taken to control plume migration until remediation goals are achieved.

At the completion of cleanup efforts, residual hazardous and radioactive contamination will remain, both in surface disposal facilities and in subsurface media within portions of the Central Plateau. It is DOE's intent to minimize the area requiring long-term institutional controls for protection of human health and the environment. However, some areas of the Central Plateau will require long-term waste management activities. For the foreseeable future, it is expected that the Inner Area of the plateau will remain a waste management area.

The Central Plateau cleanup strategy includes the following elements:

- Implement groundwater treatment systems to contain contaminant plumes within the footprint of the Central Plateau, thereby protecting the Columbia River.
- Implement groundwater treatment systems to restore the groundwater.
- Develop a geographic cleanup strategy, analogous to the geographic strategy for the River Corridor.
- Develop and apply deep vadose zone treatment technologies to protect the groundwater.
- Implement cleanup decisions that are protective of human health and the environment and that support anticipated future land use.
- Remediate the outer portion of the Central Plateau to further reduce the active cleanup footprint of the Hanford Site.
- Remediate the inner portion of the plateau to minimize the area requiring long-term waste management activities.
- Regularly evaluate new and improved cleanup technologies to assess their potential to improve cleanup effectiveness and to allow for greater footprint reduction.

Tank Waste Cleanup. This component of cleanup lies within the Central Plateau and is one of Hanford's most challenging legacies. The tank farms contain approximately 53 million gallons of radioactive waste stored in 177 underground tanks. Sixty-seven of these tanks have or are suspected to have leaked up to 1 million gallons of waste. Releases from some single-shell tank farms have reached groundwater. DOE expects these impacts to increase in the future unless prompt actions are taken.

Today, actions are being taken to slow the movement of those contaminants. DOE is also containing and recovering those contaminants once they reach groundwater. A key step in fixing this problem is to retrieve as much waste from single-shell tanks as possible and put it into double-shell tanks. Then, the waste must be fed to the Waste Treatment Plant for processing and placed into solid glass waste forms.

The tasks of tank waste cleanup are to retrieve and treat Hanford's tank waste and close or remediate the tank farms within the Inner Area of the Central Plateau Area (see Figure S-2). Retrieval and treatment of tank waste will remain the most important and difficult task facing completion of cleanup for several decades to come. However, these efforts will protect the groundwater on the Central Plateau, thereby protecting the Columbia River.

The tank waste cleanup strategy includes the following elements:

- Complete construction of the Waste Treatment Plant.
- Provide treatment capacity to enable mission completion.
- Treat tank waste and retrieve tank waste at a rate that supports treatment capacity.
- Store tank waste safely until it is retrieved for treatment.
- Safely store immobilized high-level waste pending ultimate disposition.
- Implement remedies that protect the groundwater and environment from past tank farm releases – in conjunction with surrounding waste sites and groundwater operable units.
- Complete closure of tank farms in coordination with, and consistent with, the Central Plateau cleanup completion strategy.

Long-Term Stewardship. Following the completion Hanford Site cleanup actions, there will be disposal facilities and other areas that will necessitate long-term management activities. DOE-RL has established a Hanford Long-Term Stewardship Program to ensure continued protectiveness of cleanup remedies, as defined by CERCLA and RCRA cleanup decision documents, and to ensure protection of natural resources, the environment, and human health. Long-term stewardship will include monitoring and maintenance activities to ensure continued protectiveness.

DOE is committed to maintaining the protection of human health and the environment and to meeting its long-term, post-cleanup obligations in a safe and cost-effective manner. The completion of cleanup and the transition to long-term stewardship are approaching. Therefore, cleanup actions are being considered and taken to mitigate natural resource concerns and ensure long-term stewardship considerations are incorporated into the cleanup decisions.

Acronyms

AEA	*Atomic Energy Act*
ALE	Arid Lands Ecology (Reserve)
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DOE-ORP	U.S. Department of Energy, Office of River Protection
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EPA	Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FTF	Fast Flux Test Facility
NEPA	*National Environmental Policy Act*
NPL	National Priorities List
OSWER	(EPA) Office of Solid Waste and Emergency Response
PUREX	Plutonium Uranium Extraction (Plant)
RCRA	*Resource Conservation and Recovery Act*
RCW	Revised Code of Washington
REDOX	Reduction-Oxidation (Plant)
USFWS	U.S. Fish and Wildlife Service
WAC	Washington Administrative Code
WTP	Waste Treatment and Immobilization Plant

Contents

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1.0 Introduction

Cleanup of the Hanford Site is a complex and challenging undertaking. This document provides a comprehensive overview of Hanford cleanup. Cleanup requires many dozens of individual decisions. This document shows how single decisions lead to completion of cleanup for the site as a whole, i.e., (1) it describes the technical challenges facing cleanup, (2) it describes the approaches for making decisions for three major components of cleanup, and (3) it describes the actions needed to move from cleanup to post-cleanup activities.

When faced with any single cleanup decision, Hanford's stakeholders have long desired a broader view of how that one decision fits with other Hanford cleanup decisions. It is in response to those desires that the two Hanford Site cleanup offices - DOE's Richland Operations Office (DOE-RL) and DOE's Office of River Protection (DOE-ORP) - have prepared this document. In doing so, DOE hopes to make the long and complex task of cleaning up the Hanford Site more understandable to all interested parties. Through improved understanding, more effective involvement in cleanup decisions will result.

1.1 Purpose of the Document

The purpose of this document[1] is to provide a comprehensive description for completing Hanford's cleanup mission including the transition to post-cleanup activities. This document does not make or replace any regulatory decisions. This framework defines the principal components of cleanup – River Corridor, Central Plateau, and Tank Waste – and provides the context for individual cleanup actions by providing the approaches and key guiding principles for those decisions needed to complete Hanford cleanup. This framework also defines the relationships among the principal Hanford cleanup components, i.e., River Corridor, Central Plateau, and Tank Waste.

DOE, as regulated by the U.S. Environmental Protection Agency (EPA) and Washington State Department of Ecology (Ecology), is implementing a strategy to achieve cleanup decisions for the River Corridor portion of the Hanford Site (DOE 2009a). The DOE Richland Operations Office (RL) and DOE Office of River Protection (ORP) have prepared this document to begin developing the approach to complete the remainder of the cleanup mission.

This document guides the reader to other information that will aid in learning about cleanup decisions. This document does not make regulatory decisions nor does it describe future budgets. However, it is DOE's intent that this document will facilitate continued constructive dialogue with the Tri-Party Agencies, Tribal Nations, State of Oregon, stakeholders and the public resulting in a common understanding of the goals and approaches for cleanup completion. DOE recognizes that this document does not substitute for, nor preempt, the regulatory decision processes as set forth in the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989), also known as the Tri-Party Agreement, and applicable laws, regulations, and other legal requirements.

[1] This document replaces the *River Corridor Cleanup Strategy* (DOE 2002b) from September 2002. This document also updates and replaces the *Hanford Site End State Vision* (DOE 2005) and meets the requirements of DOE Policy 455.1.

1.2 Organization of the Document

The introduction defines the three principal components of Hanford's cleanup mission and articulates the over-arching goals that guide cleanup. Section 2.0 provides background regarding Hanford's cleanup mission, including the transition from a mission of plutonium production (1943 – 1989) to the mission of waste management and environmental cleanup (1989 to present). Section 2.0 also provides background information on land use plans, the regulatory framework for making cleanup decisions, and the role of the Natural Resources Injury Assessments. Sections 3.0, 4.0, and 5.0 describe the strategies for completion of the River Corridor, Central Plateau, and the Tank Waste components. These sections also describe the primary areas of interaction and coordination between each component. Section 6.0 describes the final stages of completing cleanup including the transition to post-cleanup activities such as maintaining institutional controls and long-term stewardship of the site. Appendix A is a reprint of *Hanford's Vision 2015*. Appendix B is an overview of Hanford's Energy Park Initiative.

1.3 Components of Hanford's Cleanup

This framework document defines the main components of cleanup. The River Corridor and Central Plateau represent the two main geographic areas of cleanup work. The River Corridor includes the former fuel fabrication and reactor operations areas. This region is adjacent to the Columbia River and cleanup must deal with the threats to that valuable resource. The Central Plateau includes the former fuel processing facilities and numerous waste disposal facilities. Included within the Central Plateau area of the Hanford Site is Hanford's most significant challenge – Tank Waste cleanup. Thus, this framework describes the three main components of cleanup – River Corridor, Central Plateau, and Tank Waste. Each of these components of cleanup is in itself a complex and challenging task requiring many years and billions of dollars to complete. These components are shown in Figure 1-1.

The River Corridor component includes approximately 220 square miles of the Hanford Site as shown in Figure 1-1. The River Corridor portion of the Hanford Site includes the 100 and 300 Areas along the south shore of the Columbia River. The 100 Area contains nine retired plutonium production reactors, numerous support facilities, solid and liquid waste disposal sites, contaminated groundwater, and uncontaminated areas. The 300 Area, located north of the city of Richland, contains former fuel fabrication facilities, nuclear research and development facilities, associated solid and liquid waste disposal sites, and contaminated groundwater. The River Corridor encompasses the 100 Area and 300 Area National Priorities List sites. For purposes of this completion framework and to ensure that cleanup actions address all threats to human and environmental health, the River Corridor component includes the contiguous areas that extend from the 100 Areas and 300 Area to the Central Plateau boundaries.

The Central Plateau component[2] includes approximately 75 square miles in the central portion of the Hanford Site as shown in Figure 1-1. This region contains the 200 East and 200 West Areas that have been used primarily for nuclear fuel processing, waste management and disposal activities.

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[2] The *Central Plateau Cleanup Completion Strategy* (DOE 2009c) defines two distinct portions of the Central Plateau – Inner Area and Outer Area. The Outer Area is approximately 65 square miles and will be cleaned up to levels comparable to the River Corridor. The Inner Area is about 10 square miles and is the area dedicated to waste management and containment of residual contamination. Section 4.0 provides additional details regarding these two areas.

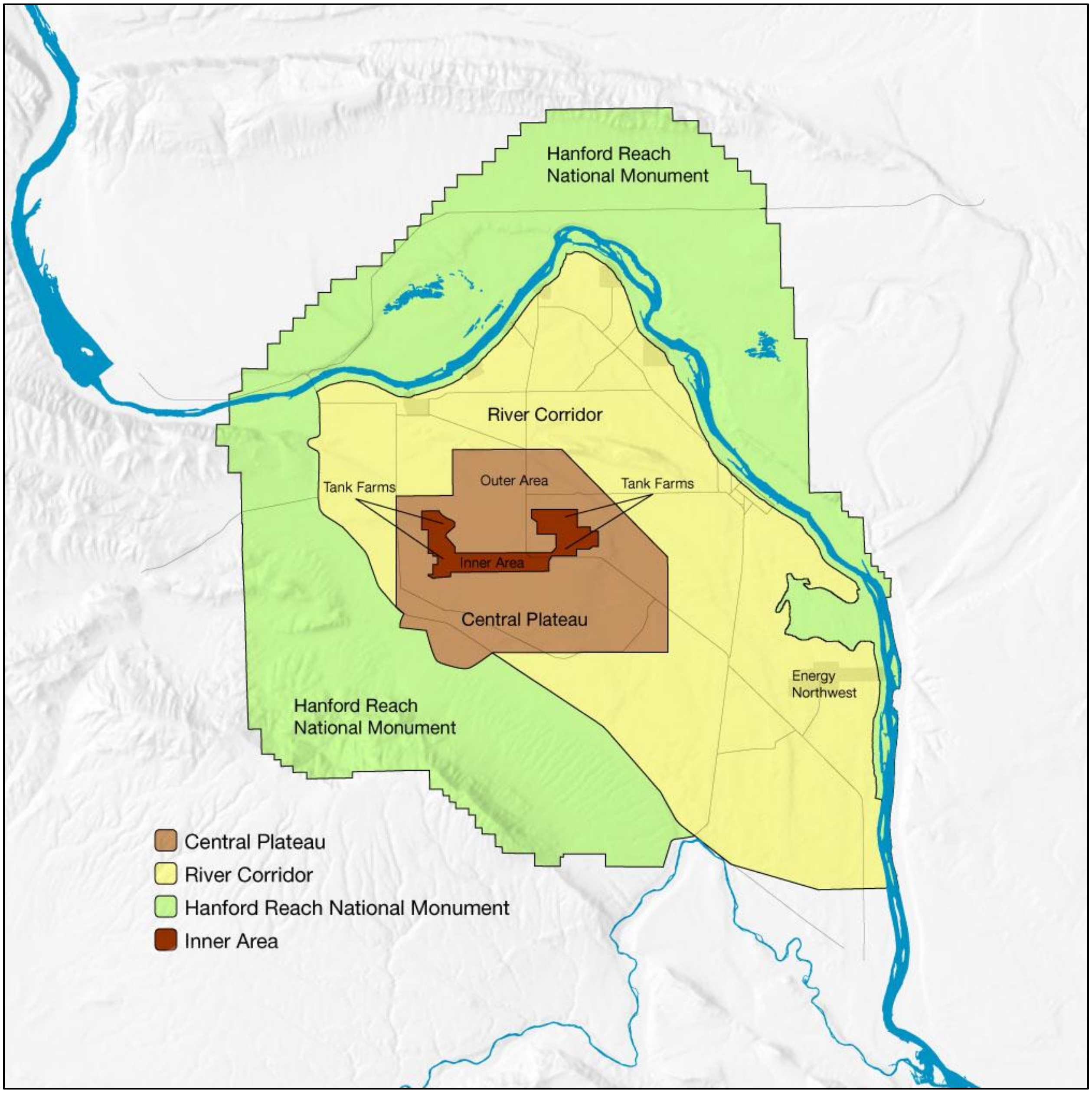


Figure 1-1. Principal Components of Hanford's Cleanup Completion Framework: River Corridor, Central Plateau, and Tank Waste

The Central Plateau encompasses the 200 Area National Priorities List (NPL) site. The Central Plateau has a large inventory of processing and support facilities, tank systems, liquid and solid waste disposal and storage facilities, utility systems, and contaminated groundwater.

Within the Central Plateau, the Tank Waste component (inside the Inner Area in Figure 1-1) includes retrieving and treating Hanford's tank waste and closing tank farms to protect the groundwater on the Central Plateau, thereby protecting the Columbia River. The tank farms include 177 underground storage tanks (149 single-shell tanks and 28 double-shell tanks) containing approximately 53 million gallons of chemically hazardous radioactive waste from past nuclear processing operations. Sixty-seven of Hanford's tanks have or are suspected to have collectively leaked up to 1 million gallons of contamination into the ground.

1.4 Goals for Cleanup

The overarching goals for cleanup are stated and discussed in the following paragraphs. These goals reflect more than 20 years of dialogue among the Tri-Party Agencies, Tribal Nations, State of Oregon, stakeholders, and the public. They carry forward key values captured in forums such as the Hanford Future Site Uses Working Group, Tank Waste Task Force, Hanford Summits, and Hanford Advisory Board Exposure Scenario Workshops, as well as more than 200 advice letters issued by the Hanford Advisory Board. These goals provide a set of principles that guide all aspects of Hanford Site cleanup. Cleanup activities at various areas of the site support the achievement of one or more of these goals. These goals help set priorities to apply resources and sequence cleanup efforts for the greatest benefit.

Goal 1: Protect the Columbia River.

The Columbia River is a critical resource to the people of the Pacific Northwest. As one of the largest rivers in North America, its waters support a multitude of uses that are vital to the economic and environmental well-being of the region. These uses include irrigating crops, generating hydroelectric power, providing outdoor recreation, serving as a transportation route, supplying drinking water, and providing habitat for native plants, fish, and wildlife. In addition, the Columbia River and its salmon are vital aspects of the Native American culture and, through established treaties, Tribal Nations retain the right to fish at usual and accustomed places along the Columbia River. Cleanup actions must protect this river.

Goal 2: Restore groundwater to its beneficial use to protect human health, the environment, and the Columbia River.

For sites in the River Corridor, remedial actions are expected to restore groundwater to drinking water standards, and in those cases where groundwater discharges may impact surface water, ensure that the water quality criteria for aquatic life are achieved in areas where Hanford groundwater reaches the Columbia River.

For areas of groundwater contamination in the Central Plateau, the goal is to restore the aquifer to achieve drinking water standards. In those instances where remediation goals are not achievable in a reasonable time frame, programs will be implemented to contain the plume, prevent exposure to contaminated

EPA Policy for Groundwater Restoration

DOE's approach to groundwater cleanup is fully consistent with EPA policy:

> *EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the sites. When restoration of ground water to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated ground water, and evaluate further risk reduction.* [From 40 CFR 300.430(a)(1)(iii)(F), see also EPA OSWER Directive 9283.1-33, June 2009. EPA 2009].

The term "beneficial use" is established by federal policy. At Hanford, beneficial use will usually mean a level that supports use as a source of drinking water. But for some contaminants (e.g., hexavalent chromium), a more stringent cleanup level is set to ensure protection of aquatic life in the Columbia River.

groundwater, and evaluate further risk reduction opportunities as new technologies become available. Near-term actions will be taken when appropriate to control plume migration until remediation goals are achieved.

Goal 3: Clean up River Corridor waste sites and facilities to:

- Protect groundwater and the Columbia River.
- Shrink the active cleanup footprint to the Central Plateau.
- Support anticipated future land uses.

Cleanup of the River Corridor has been one of Hanford's top priorities since the early 1990s. This urgency is due to the proximity of hundreds of waste sites to the Columbia River. River Corridor cleanup work will remove potential sources of contamination that are close to the Columbia River to a disposal facility in the Central Plateau, or to other disposal facilities as appropriate. Cleanup actions will restore groundwater and protect the Columbia River. The intent is to shrink the footprint of active cleanup to within the Central Plateau by removing excess facilities and remediating waste sites within the River Corridor. Cleanup actions will support anticipated future land uses (see Section 2.0). The Hanford Reach National Monument (see Section 2.0) includes a ¼-mile-wide corridor on the south and west sides of the Columbia River that is included in cleanup of the River Corridor.

Goal 4: Clean up Central Plateau waste sites, tank farms, and facilities to:

- Protect groundwater.
- Minimize the footprint of areas requiring long-term waste management activities.
- Support anticipated future land uses.

The Central Plateau has been used for waste management (treatment, storage, and disposal) operations since the beginning of Hanford's production mission. This makes the cleanup of the Central Plateau a highly complex activity because of the large number of waste sites, surplus facilities, active treatment and disposal facilities, and areas of deep soil contamination. Past discharges of more than 450 billion gallons of liquid waste and cooling water to the soil have resulted in about 60 square miles of contaminated groundwater. Today, some plumes extend far beyond the plateau. Containing and remediating these plumes remains a high priority and remediation of Central Plateau waste sites and facilities must be protective of groundwater. In addition, to enable cleanup of the River Corridor, waste is brought to the Central Plateau for final treatment, storage, or disposal. It is DOE's intent to minimize the area requiring long-term waste management activities for protection of human health and the environment. For the foreseeable future, it is expected that a core portion of the plateau will remain a waste management area and could support compatible federal government activities.

> **Goal 5:** Safely manage and transfer legacy materials scheduled for off-site disposition including special nuclear material (including plutonium), spent nuclear fuel, transuranic waste, and immobilized high-level waste.

Among the waste management operations underway within the Central Plateau is the management of spent nuclear fuel and high-level waste management. Some of these materials are yet to be generated, e.g., immobilized high-level waste from Hanford's tanks; therefore, safe management of these materials will be required for many decades.

> **Goal 6**: Consolidate waste treatment, storage, and disposal operations on the Central Plateau.

To support cleanup of the entire Hanford Site, treatment, storage, and disposal facilities will continue to be used and in some cases expanded from current capabilities, e.g., disposal of immobilized low-activity waste from tank waste processing and systems for treatment of contaminated groundwater. It is DOE's intent to consolidate these services within the central portion of the Central Plateau. As a pre-scoping document to the *Hanford Comprehensive Land-Use Plan EIS* (DOE 1999), the *Hanford Future Site Uses Working Group* (Hanford Future Site Uses Working Group 1992) recommended:

"***Use the Central Plateau Wisely for Waste Management.*** *Wastes would be moving in the Central Plateau from across the site. Waste storage, treatment and disposal activities in the Central Plateau should be concentrated within this area as well, whenever feasible, to minimize the amount of land devoted to, or contaminated by, waste management activities.*"

> **Goal 7:** Develop and implement institutional controls and long-term stewardship activities that protect human health, the environment, and Hanford's unique cultural, historical, and ecological resources after cleanup activities are completed.

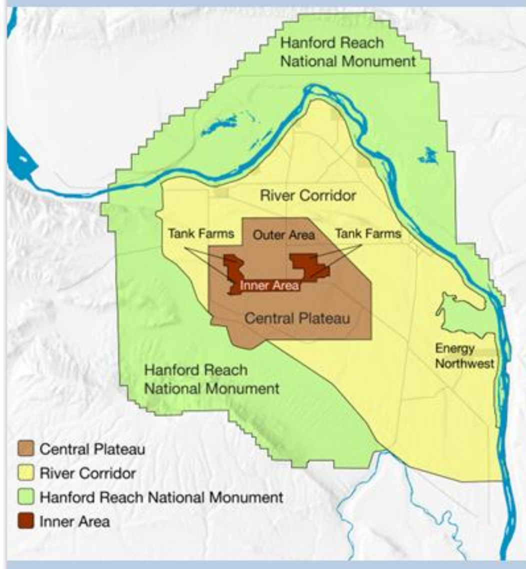
Completion of cleanup will not result in the total elimination of all contamination from the site. Long-term controls will be necessary to ensure protection of human health and the environment. These controls need to be developed from a holistic, or site-wide, perspective.

1.5 Vision for Completion

Figure 1-2 illustrates a concept for successive stages of Hanford Site cleanup. The first map shows the full Hanford Site including the Hanford Reach National Monument (~290 square miles). The second map shows the Central Plateau and the River Corridor with its six River Corridor geographic decision areas. Most cleanup of the River Corridor is expected to be complete by 2015. The third map shows the Central Plateau (~75 square miles) after completion of the River Corridor cleanup. The fourth map shows an intermediate stage of completion for the Central Plateau with sites outside of the Inner Area having been

Hanford Site Cleanup Completion Framework – Shrinking the Hanford Cleanup Footprint

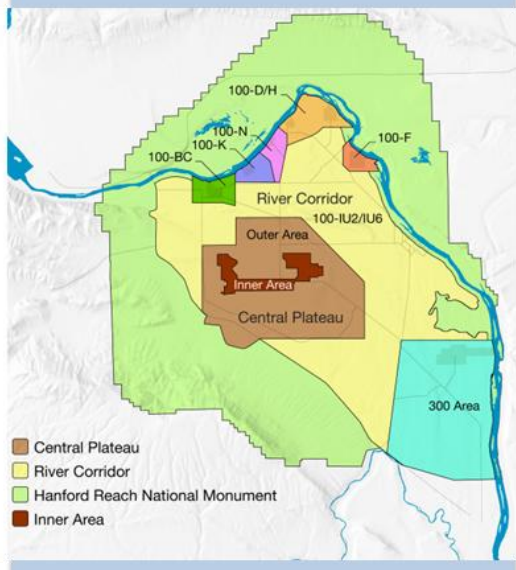
Hanford Lands – 586 square miles



- Creation of the Hanford Reach National Monument in June 2000 withdrew ~290 square miles of Hanford lands for permanent protection and preservation. The federal government will retain ownership of this land.
- Current active footprint of cleanup is distributed across the remaining ~295 square miles of the Hanford Site.

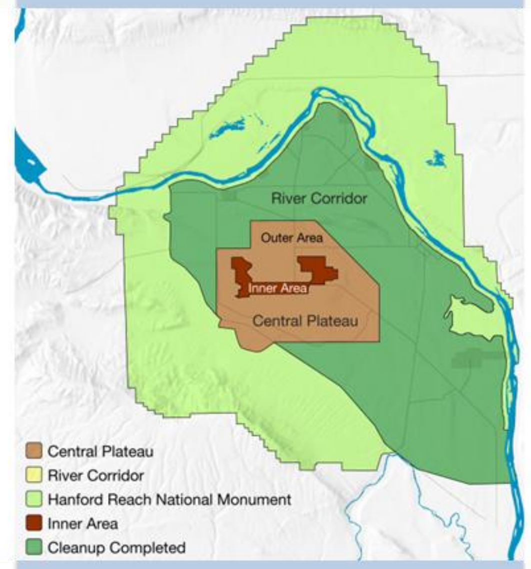
> Overarching goals for Hanford Site cleanup completion include:
>
> - Protect the Columbia River
> - Restore groundwater to its beneficial use.
> - Complete River Corridor and Central Plateau Cleanup to support anticipated future land uses consistent with the Hanford Reach National Monument, where applicable, and the Hanford Comprehensive Land Use Plan.

River Corridor Cleanup Underway



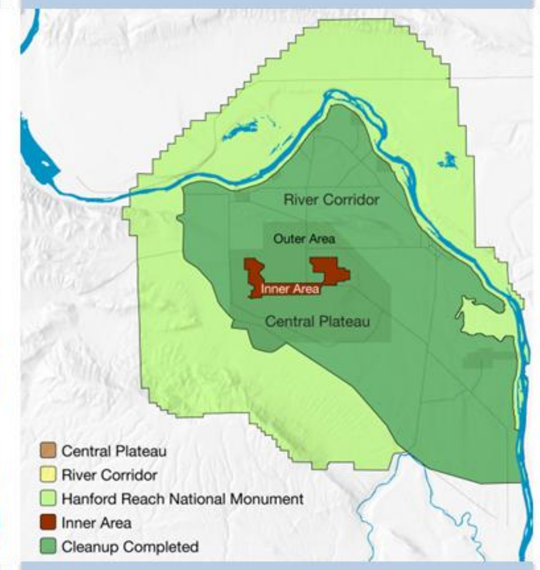
- The River Corridor (~220 square miles) divided into six geographic decision areas (to be addressed in six CERCLA records of decision) to ensure that environmental threats are remediated in a comprehensive manner.
- DOE is conducting an assessment of Hanford releases to the Columbia River to determine if there is a need for cleanup actions.
- Cleanup of the River Corridor generates large quantities of contaminated material that is removed and disposed of in the Environmental Restoration Disposal Facility within the Central Plateau.
- Cleanup levels will support the intended land uses consistent with the *Hanford Comprehensive Land Use Plan* and the *Hanford Reach Comprehensive Conservation Plan and EIS* (FWS 2008).
- The federal government will retain ownership of this land for the foreseeable future.

Cleanup Footprint Reduced to 75 square miles



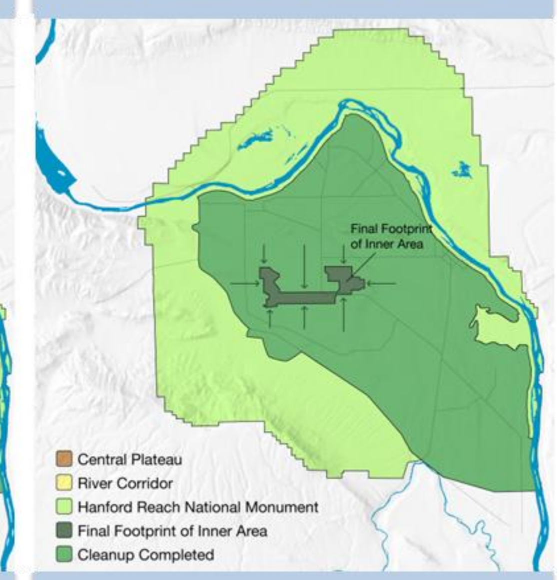
- Central Plateau includes the 10 square mile Inner Area and the 65 square mile Outer Area.
- A record of decision for waste sites in the Outer Area will enable further reduction of the active cleanup footprint.
- Waste storage, treatment, and disposal activities will be conducted only within the Inner Area.
- Groundwater treatment systems are being installed to contain contaminant plumes and to eventually restore the groundwater to its beneficial use, i.e., drinking water, if practical.
- Other high priority risks to be addressed include removal of all PFP special nuclear material for off-site disposal, and reduction of the PFP complex to slab-on-grade.
- The federal government will retain ownership of this land for the foreseeable future.

Cleanup Footprint Reduced to ~10 square miles



- Contamination will remain in disposal facilities in the Inner Area and will require long term waste management activities.
- DOE intends to make this long term management area as small as practical.
- Central Plateau cleanup completion strategy elements include:
  - Remedy selection driven by performance-based standards that ensure consistent and protective cleanup
  - Cleanup levels for all areas will be protective of: 1) groundwater; 2) ecological receptors; and 3) surface users consistent with designated land uses.
- Cleanup of the Inner Area includes completion of tank waste cleanup:
  - Complete Waste Treatment Plant
  - Retrieve and treat tank waste
  - Close tank farms including cleanup of past releases

Final Waste Management Area less than 10 square miles



- Completion of the Hanford Site cleanup mission will result in an area committed to waste management of an area that is less than 10 square miles.
- Long-term waste management, post-closure care and stewardship activities where required to ensure protection of human health and the environment. Stewardship activities will include:
  - Maintain institutional controls
  - Maintain final remedies
  - Conduct environmental monitoring
  - Conduct CERCLA five-year reviews
  - Preserve the Hanford Site's unique biological, natural, and cultural resources.

Figure 1-2. Successive Stages of Hanford Site Completion

Table 1-1. Time-Phased Cleanup Priorities for Hanford Site Cleanup Completion[3]

	2010 - 2015	2015 - 2020	2020 - Completion
River Corridor	• Complete waste site remediation per interim records of decision for 100 Areas and 300 Area • Obtain records of decision • Commence site remediation per records of decision • Complete surplus facility removal in 100 Areas and 300 Area • Complete installation of final groundwater remedies in all areas; stop chromium from entering the Columbia River, implement remedies for strontium-90 and 300 Area uranium • Complete transition of eight surplus production reactors to interim safe storage configuration (not B Reactor) • Remove sludge from K West Basin • Complete transition of Fast Flux Test Facility to surveillance and maintenance	• Transition areas for which cleanup has been completed to long-term stewardship • Maintain reactors in interim safe storage condition • Continue surveillance and maintenance of Fast Flux Test Facility (FFTF) • Demolish K West Basin • Achieve groundwater and aquatic protection standards for all areas where practicable	• Complete final actions for surplus production reactors (e.g., remove or entomb) • Complete final action for Fast Flux Test Facility (e.g., remove or entomb) • Return to DOE-RL the four 300 Area facilities retained for near-term use by DOE Office of Science; remove facilities and remediate waste sites • Transition remaining areas to long-term stewardship
Central Plateau	• Complete removal of Plutonium Finishing Plant complex • Complete construction and begin operation of 200-West Area groundwater treatment system • Implement groundwater remedies for 200-West Area and for 200-East Area • Initiate cleanup of Outer Area • Continue retrieval, packaging and offsite shipment of retrievable-stored transuranic materials • Complete decision documentation for Inner area, Outer Area, and groundwater	• Complete remediation of Outer Area waste sites, closure of RCRA treatment, storage and disposal facilities and removal of surplus facilities; transition to long-term stewardship • Complete demolition of U Plant Canyon and cleanup of first Inner Area geographic zone • Start cleanup of additional Inner Area zones • Operate and maintain groundwater remediation systems • Initiate implementation of remedies for deep vadose zone contamination • Complete retrieval of retrievably-stored transuranic waste; complete offsite shipment of contact-handled transuranic materials • Start construction and operation of solid waste treatment capability for large box and remote-handled waste • Complete installation of Central Plateau groundwater treatment systems	• Complete cleanup of Inner Area geographic zones – waste site remediation, facility cleanup, and treatment, storage, and disposal facility closure • Provide waste disposal capability for WTP operations • Complete packaging and offsite shipment of transuranic materials • Complete canyon cleanup and implement remedy configuration • Complete active groundwater treatment operations • Complete transition to long-term stewardship
Tank Waste	• Continue construction of Waste Treatment Plant (WTP) • Complete waste retrieval from C Farm tanks • Maintain and upgrade tank farm infrastructure • Develop waste feed delivery infrastructure • Mitigate impacts from past tank leaks	• Complete WTP construction • Complete WTP startup and commissioning • Close C Tank Farm; demonstrate closure methods and approaches for future single shell tank farms • Implement waste feed delivery systems and tank infrastructure to support WTP operation • Initiate supplemental low-activity waste treatment	• Implement supplemental treatment capacity, as necessary • Close all single shell tanks • Complete treatment of tank waste • Close all double shell tanks

[3] Most of these activities support achievement of a Tri-Party Agreement milestone. More specific details of the scope, schedule and cost for all cleanup activities will be contained in the forthcoming annual *Hanford Lifecycle Scope, Schedule and Cost Report* required by a new Tri-Party Agreement milestone, M-036-01A, that is currently in draft.

remediated. Remediation of this area will further reduce the active cleanup footprint of the Hanford Site to about 10 square miles. The last map shows the Inner Area that will be dedicated to waste management and containment of residual contamination. Completion of this final step requires completion of all cleanup activities at Hanford including retrieval and treatment of radioactive tank waste and closure of tank farms which is expected to be complete by 2050. The Hanford Advisory Board (2002) previously stated similar expectations for shrinking this final area requiring long-term controls:

> *"The Board acknowledges that some waste will remain in the core zone when this cleanup is complete. However, the core zone should be as small as possible and should not include contaminated areas outside the 200 Area fences. The waste within the core zone should be stored and managed to make it inaccessible to inadvertent intruding humans and animals."*

1.6 Priorities for Completing Hanford Site Cleanup

While this *Completion Framework* is not a budget document, it is important for DOE to state its priorities for cleanup. These priorities help to guide budget requests and ensure that cleanup funds support DOE's vision for completing cleanup. Cleanup priorities help DOE to schedule portions of work and to allocate cleanup funds to achieve the most benefit. Not all work can be done at the same time. Priorities are generally risk based. Initial cleanup efforts focused on immediate threats such as tanks with safety hazards and spent fuel stored in leaking storage basins near the Columbia River. Today, Hanford's highest priority is completing construction of the Waste Treatment Plant. This work will enable DOE to deal with Hanford's greatest cleanup challenge – treatment of 53 million gallons of radioactive and chemically hazardous tank waste. DOE also places a priority on activities that provide the greatest benefit to the environment and public health (e.g., cleanup of waste sites and groundwater close to the Columbia River) and activities that, once they are completed, will free funds for additional cleanup (e.g., removal of the Plutonium Finishing Plant Complex).

Table 1-1 shows DOE's priorities for several time periods. These priorities are consistent with Hanford's *2015 Vision* (included as Appendix A). The *2015 Vision* calls for completion of most work within the River Corridor by 2015 to address the threat to the Columbia River posed by existing waste sites and groundwater contamination. Secondly, by implementing the *2015 Vision*, DOE expects to free money currently used for River Corridor cleanup and for maintaining the Plutonium Finishing Plant complex. Those funds can then be used to carry out cleanup in other portions of the Site. Table 1-1 describes the primary cleanup priorities and actions for all three components of cleanup – River Corridor, Central Plateau and Tank Waste. Priorities are generally more detailed and specific for the time periods before 2020. These priorities also reflect commitments within the Tri-Party Agreement.

Hanford Lifecycle Scope, Schedule and Cost Report

The Tri-Parties have negotiated a new milestone (M-036-01A) that calls for DOE to prepare an annual report "setting out the lifecycle scope, schedule and cost for completion of the Hanford Site cleanup mission. The report shall reflect all of those actions necessary for the DOE to fully meet all applicable environmental obligations…" The report will encompass the work scope of both DOE-RL and DOE-ORP including the waste treatment and immobilization plant. The report will also include post-closure activities (including monitoring) so as to provide a complete understanding of the resources necessary for completing the Hanford cleanup mission.

In carrying out work, DOE maintains the utmost attention and priority on the safety of Hanford's workers. Hanford has an outstanding record for worker safety. DOE maintains the Integrated Safety Management Systems (DOE Policy 450.4, Safety Management System Policy, 1996 and DOE Guide 450.4-1B, Integrated Safety Management System Guide, 2001) and associated policies and procedures to ensure worker safety. In addition, DOE maintains a policy that allows workers to stop work that they deem to pose an "imminent danger" or "serious hazard." DOE works continuously with employees to ensure a safe work place.

The remainder of this document describes DOE's framework for reaching decisions for all areas of the Hanford Site to support completion of Hanford Site cleanup.

2.0 Background for Cleanup Decision Making

2.1 Hanford's Past and Present Missions

Established in 1943, the Hanford Site's original mission was to produce plutonium for national defense. Ultimately, nine nuclear reactors were built along the banks of the Columbia River as the defense mission continued throughout the Cold War years. Uranium metal billets were received in the 300 Area and fabricated into fuel rods suitable for loading into nuclear reactors. The fuel rods were placed in the reactors in the 100 Areas and irradiated by nuclear fission reactions. Past waste disposal practices for the 100 Area reactors resulted in releases of radionuclides and other chemicals to soil and groundwater near the reactors. The primary source of these contaminants was cooling water that flowed through the reactor core, leaks in the reactor cooling water transfer systems, and intentional effluent disposal into cribs and trenches. In addition, solid waste containing radionuclides and chemicals were buried in unlined burial grounds to isolate the waste from ongoing operations.

The irradiated fuel rods were taken to the 200 Areas, where plutonium and uranium were separated from the residual activation and fission products using chemical separation processes. Chemical separations process facilities were located in both the 200 East and 200 West Areas. The 200 North Area temporarily stored irradiated fuel rods, allowing certain short-lived radionuclides to decay before being shipped to separations facilities. When the separation facilities were operating, large quantities of liquid waste (including cooling water) containing radionuclides and chemicals were discharged to the soil column and percolated into the vadose zone, i.e., the area between the surface of the land and the water table. Liquid waste was discharged to surface ponds and ditches or to underground cribs, reverse wells, and french drains. These infiltration facilities were generally located in the 200 Areas near the processing facilities.

This type of plutonium production ended at Hanford in 1988. However, more than 40 years of plutonium production created tremendous amounts of radioactive and chemically hazardous waste. In 1989, with the cessation of weapons production, the Hanford mission shifted to waste management and environmental cleanup. The Tri-Parties signed a cleanup agreement (Ecology et al. 1989) and the task of cleaning up the site began.

At the very beginning of cleanup efforts, the focus was to resolve immediate threats, e.g., tanks with immediate safety hazards, spent nuclear fuel stored in leaking basins near the Columbia River, and unstable plutonium. Cleanup has now reached the point where most immediate risks have been resolved and the task of mitigating the long-term risks is underway. Groundwater remains contaminated and contamination is still moving in the vadose zone toward the groundwater. Additionally, the majority of the waste in the single- and double-shell tanks remains to be retrieved, treated, and disposed.

2.2 Tri-Party Agreement and the Framework for Decision Making

DOE, EPA, and Ecology signed a cleanup and compliance agreement on May 15, 1989. The *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989), known as the Tri-Party Agreement, is a CERCLA federal facility agreement, a RCRA corrective action order, and a *Hazardous Waste Management Act* consent order. It also is a framework for implementing the many environmental regulations that apply to Hanford. The agreement establishes the methods to achieve compliance with the CERCLA remedial action provisions and with the RCRA treatment, storage, and disposal unit regulations and corrective action provisions. More specifically, the Tri-Party Agreement includes, but is not limited to (1) cleanup commitments, (2) agency cleanup responsibilities, (3) enforceable milestones to achieve regulatory compliance and remediation, and (4) a basis for budgeting and requesting funds from Congress to support cleanup commitments.

2.2.1 Regulatory Processes

The primary regulatory processes that must be implemented and integrated to achieve cleanup decisions include the following:

- The CERCLA process guides cleanup decisions for most waste sites, canyon facilities, and structures that contain radioactive contamination or other hazardous substances. The Tri-Party Agreement also identifies a subset of waste sites as "RCRA past-practice"[4] sites. The Tri-Party Agreement establishes the expectation that either a RCRA corrective action[5] or a CERCLA cleanup will satisfy the requirements of both laws. In practice, this expectation becomes problematic because RCRA authority does not extend to radionuclides (e.g., see Section 2.2.2 regarding RCRA/CERCLA integration). Regardless of this issue with RCRA, Hanford cleanup of radionuclides in RCRA waste sites will be protective of human health and the environment and consistent with CERCLA cleanup practices and *Atomic Energy Act* (AEA) requirements. The *Hazardous Waste Management Act* incorporates the state's *Model Toxics Control Act* regulations (WAC 173-340) by reference for purposes of meeting RCRA and *Hazardous Waste Management Act* corrective action. Additionally, *Model Toxics Control Act* substantive standards may be applicable or relevant and appropriate requirements for CERCLA cleanup actions.
- The RCRA closure process usually guides decisions for active RCRA treatment, storage, and disposal facilities. EPA has authorized the RCRA program to the state of Washington in lieu of the federal program. Ecology implements the program via Washington's *Hazardous Waste Management Act* **(**RCW 70.105), Dangerous Waste Regulations, Chapter 173-303 of the *Washington Administrative Code* (WAC 173-303), and through facility specific permits. RCRA closure and post-closure requirements are contained in the Hanford Site RCRA Permit (Ecology 1994).
- *National Environmental Policy Act* (NEPA) requires DOE to evaluate the significant impacts of major actions and their alternatives prior to making a decision and making irrevocable commitments. This includes the selection of major cleanup and closure actions. The CERCLA process parallels the NEPA process and for CERCLA actions, DOE policy (DOE 2002a) calls for CERCLA documentation to incorporate NEPA values. When NEPA values are explicitly addressed in CERCLA remedial investigations/feasibility studies and records of decision, separate NEPA review of the action is not required. RCRA, however, does not provide the same NEPA functional equivalency as CERCLA; therefore, DOE must conduct a NEPA review for RCRA-regulated actions. NEPA review and documentation is also required for decisions on demolishing surplus structures under the AEA that do not contain radioactive or hazardous contaminants and are not otherwise regulated under RCRA or CERCLA.

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[4] The Tri-Party Agreement defines past-practice waste sites as sites where waste or substances have been disposed (either intentionally or unintentionally) and that are not subject to regulation as active treatment, storage, and disposal units.

[5] *Model Toxics Control Act* regulations (WAC 173-340) are applicable or relevant and appropriate requirements for CERCLA actions for purposes of meeting RCRA corrective action requirements.

- DOE Order 435.1, *Radioactive Waste Management*, defines additional requirements and processes that are applicable to closure of tank farms and radioactive waste disposal facilities.

Figure 2-1 provides an overview of the sequence of steps for making cleanup decisions, implementing remedies, completing cleanup actions, and conducting post-completion or post-closure activities, i.e. long-term stewardship. Summary steps are shown for both CERCLA actions[6] and RCRA closure actions for treatment, storage and disposal facilities.

The NPL close-out procedures are described in *Close Out Procedures for National Priorities List Sites* (EPA 2000). The discrete stages of cleanup completion are:

- Construction Completion – Occurs when any necessary physical construction is complete, whether or not cleanup levels or other requirements have been achieved. In situ (passive) groundwater remediation may still be occurring at this stage.
- Remedial Action Completion – Occurs when remedial action objectives for an operable unit have been achieved and are documented in a remedial action report.
- Site Completion – Signifies that the response actions at the site were successful and no further action is required to protect human health and the environment; however, continuing CERCLA five-year review is still conducted.
- Partial Deletion – Applicable to large sites where portions of the site meet deletion criteria (e.g., portions of the 100 Area).
- Site Deletion – Applicable when all response actions have been implemented, it is determined that no further action is needed, and documentation is complete (e.g., the 1100 Area).

2.2.2 Integration of RCRA and CERCLA Processes

The clear intent of the Tri-Party Agreement and the site RCRA permit (Ecology 1994) is to minimize duplication and overlap of regulatory authorities while ensuring compliance with applicable requirements. As noted above, RCRA authority does not extend to the cleanup of radionuclides, while CERCLA and the AEA do. The Tri-Party Agreement states that the past-practice process selected for an operable unit shall be sufficiently comprehensive to satisfy the technical requirements of both authorities and their respective regulations.

For groundwater contamination, whether currently regulated under RCRA or CERCLA, the Tri-Parties agree that the past-practice authority may provide the most efficient means of selecting remedies for groundwater plumes originating from both treatment, storage, and disposal units and past-practice units – provided remedial actions ensure compliance with applicable and relevant/appropriate requirements. Consequently, CERCLA decision processes may be used to reach decisions regarding groundwater operable unit remedies, and these decisions will also meet RCRA corrective action and other applicable requirements. Ecology, however, retains the right to enforce timely cleanup of groundwater contamination that is associated with treatment, storage, and disposal units as provided under its RCRA authority.

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[6] The Hanford Site also applies the RCRA corrective action process to the cleanup of some past-practice waste sites. These processes are very similar to the CERCLA process with the principal difference being the use of the RCRA Permit for specifying corrective action decisions. Section 5.4 of the Tri-Party Agreement (Ecology et al. 1989) Action Plan provides more detail on the corrective action process, which is not shown here in Figure 2-1.

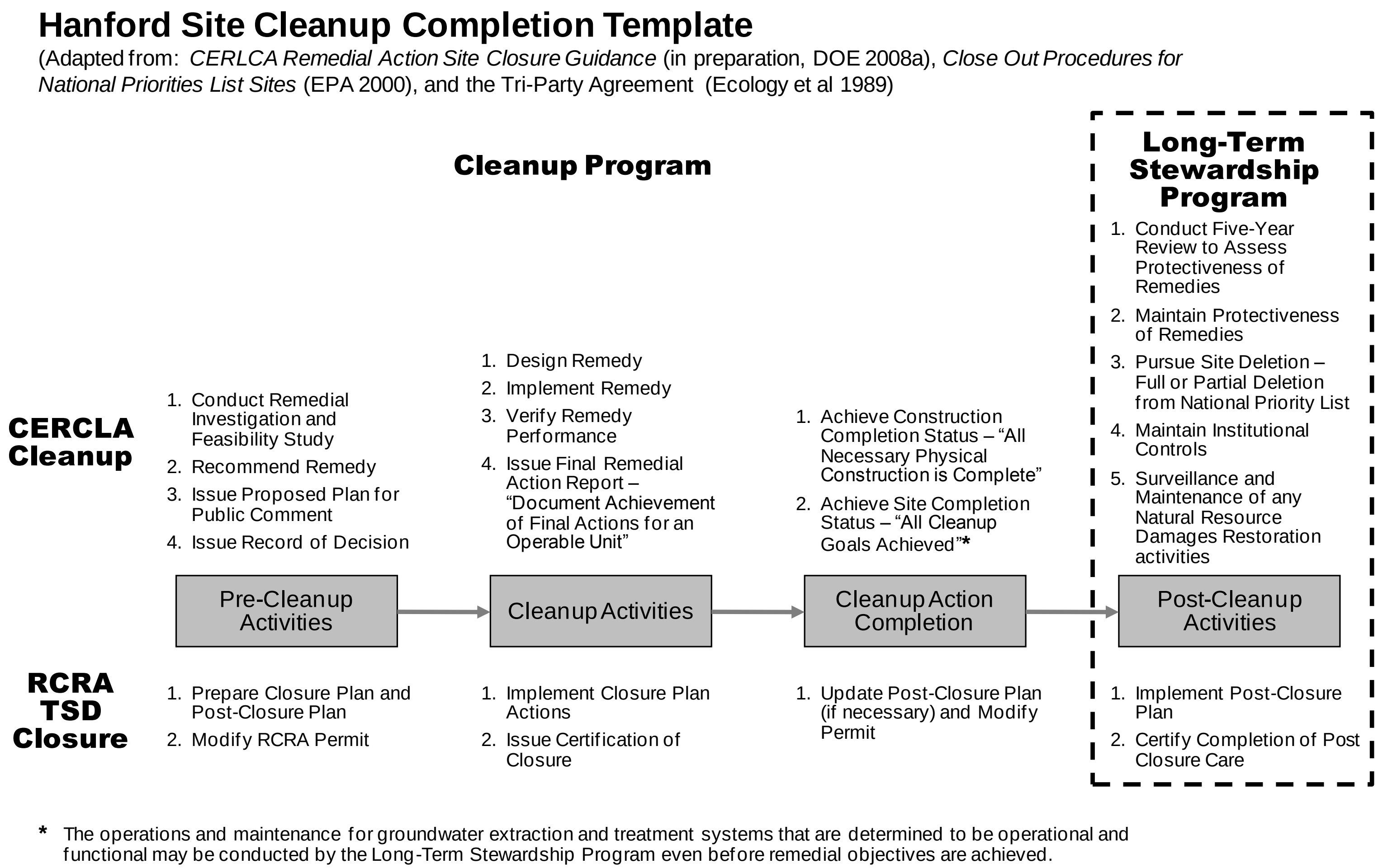

Figure 2-1. Overview of Sequence to Reach Cleanup Decisions, Implement Remedies, Complete Cleanup Actions, and Conduct Post-Completion or Post-Closure Activities

Recent discussions among the Tri-Parties have identified an opportunity to conduct joint RCRA/CERCLA investigations and decisions for sites with both chemical and radiological contamination. It is DOE's intent to work with EPA and Ecology to implement a way for both the River Corridor and Central Plateau areas to integrate RCRA/CERCLA requirements not only for CERCLA sites but also for RCRA past-practice sites and tank farm corrective actions that include radionuclide releases from treatment, storage, and disposal units. An initial step in this effort is included in the *Tentative Agreement on Hanford Federal Facility Agreement and Consent Order Change Forms Implementing Changes to Central Plateau Cleanup* (DOE 2010d) and associated change packages.[7] CERCLA decisions will be pursued that encompass geographic decision areas inclusive of all CERCLA cleanup and RCRA corrective action sites. This approach will ensure that there is CERCLA coverage for radionuclides while maintaining RCRA coverage for RCRA constituents in the contaminated media. In addition, documentation that supports these decisions will be prepared that incorporates both CERCLA and RCRA requirements with the intent of minimizing administrative workload and duplication of paperwork. The process for performing this function has not been fully developed at this time, but it will need to integrate the hazardous waste standards of RCRA corrective action and closure performance standards into the CERCLA process for remedial decision making, design, and remedial action. This process is expected to include approval of the action in both a CERCLA record of decision and in the RCRA site permit where applicable.

2.3 Anticipated Land Use and Cleanup

Anticipated land use plays a key role in selecting cleanup remedies. This section provides an overview of the *Hanford Comprehensive Land-Use Plan* (DOE 1999) that established land-use designations for the Hanford Site. This section also summarizes the role of land use in remedy selection, and the role of land use in setting remedial action objectives and exposure scenarios for risk assessments to determine whether conditions are protective of people and the environment. Congress directed DOE to establish a land-use plan for the Hanford Site (*National Defense Authorization Act*, 42 USC. 7274k, redesignated 50 USC. 2582 – required DOE to develop future use plans for environmental management sites). As directed by Congress, DOE exercised its responsibility to determine reasonably anticipated land use as input to the CERCLA process. Similar land-use determinations have been applied at other superfund sites as well as at other DOE cleanup sites. Hanford's approach for designating reasonably foreseeable future land use is consistent with Congressional direction and EPA guidance.

[7] From Tri-Party Agreement Change Package P-00-09-01 (DOE 2010e, March 2010). "The Tri-Parties have negotiated the coordination of RCRA corrective action and CERCLA decision processes (to produce a corrective action decision and record of decision, or corrective action decision and record of decision) for selected past-practice units in the 200 Areas. This change will align CERCLA and RCRA decision-making processes and procedures for past-practice units that, without the change, would have been addressed under corrective action authority under the Tri-Party Agreement Action Plan (with CERCLA authority reserved). Specifically, by adding a CERCLA decision-making process to selected past-practice units that previously would have been addressed under RCRA Corrective Action authority and by providing for Corrective Action Decisions to be prepared, issued and implemented under the authority of the Tri-Party Agreement, the coordinated RCRA and CERCLA processes will address all hazardous substances under the TPA using the authority of both jurisdictions."

2.3.1 Hanford's Comprehensive Land-Use Plan

DOE is responsible for designating the land use of Hanford. As the lead agency for CERCLA cleanup of the Hanford Site,[8] DOE is also responsible for identifying future land uses that will guide CERCLA risk assessments and cleanup decisions. DOE used the NEPA Environmental Impact Statement (EIS) process (*Hanford Site Comprehensive Land-Use Plan EIS* [DOE 1999]) to examine land use alternatives and conducted this process with nine cooperating agencies and consulting Tribal governments as a basis for determining future anticipated land uses.[9] This effort resulted in the *Hanford Comprehensive Land-Use Plan* (DOE 1999) that DOE adopted and implemented in the record of decision published on November 2, 1999 (64 FR 61615). The *Hanford Comprehensive Land-Use Plan* (DOE 1999) must be reviewed periodically to ensure that it remains current. The first review since adoption and implementation was documented in a supplement analysis that resulted in DOE issuing an amendment to the record of decision (73 FR 55824) on September 26, 2008. The *Hanford Comprehensive Land-Use Plan* is intended to provide "…a land-use plan for DOE's Hanford Site for at least the next 50-year planning period and lasting as long as DOE retains legal control of some portion of the real estate" (DOE 2008e).

The *Hanford Comprehensive Land-Use Plan* record of decision (64 FR 61615) designated land uses for the Hanford Site. The 2008 amended record of decision (73 FR 55824) maintained those anticipated land uses, which are summarized below. Figure 2-2 shows the full set of nine land-use designations established by the plan. The following selected land-use designations[10] are most relevant to this document:

- 100 Areas – Conservation-Mining.[11] An area reserved for protection of archeological, cultural, ecological and natural resources. Remediation activities in the 100 Areas (i.e., 100-B/C, 100-K, 100-N, 100-D, 100-H, and 100-F) are considered pre-existing land use in the preservation land-use designation.
- 300 Area – Industrial. An area suitable for industrial activities such as reactor operations and manufacturing.
- Central Plateau (200 Areas) – Industrial Exclusive. An area suitable for treatment, storage, and disposal of hazardous and/or radioactive waste under federal control.
- Wahluke Slope, Saddle Mountains, Fitzner/Eberhardt Arid Lands Ecology Reserve (ALE Reserve), Gable Mountain, and Gable Butte – Preservation. An area managed for the preservation of archeological, cultural, ecological, and natural resources.

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[8] Executive Order 12580, *Superfund Implementation*, (52 FR 2923) designated DOE as the "lead agency" for CERCLA cleanup at DOE sites.

[9] The cooperating entities were the U.S. Department of the Interior (Bureau of Land Management, Bureau of Reclamation, and the U.S. Fish and Wildlife Service); the City of Richland; Benton, Franklin, and Grant Counties; the Nez Perce Tribe; and the Confederated Tribes of the Umatilla Indian Reservation. Although not a cooperating agency, the Yakama Nation participated at points throughout the seven-year-long EIS process.

[10] Refer to the *Hanford Site Comprehensive Land-Use Plan* (DOE 1999) and Supplement Analysis (DOE 2008e) for the land-use map, the full set of nine land-use designations that define the permissible uses for each area of the site, and the implementing procedures that govern the review and approval of future land uses.

[11] Limited mining may occur, such as quarrying for gravel, for governmental purposes only.

- Columbia River Corridor – High-Intensity Recreation, Low-Intensity Recreation, Conservation-Mining, and Preservation. High and low-intensity recreation allow for a range of visitor-serving activities and facilities.

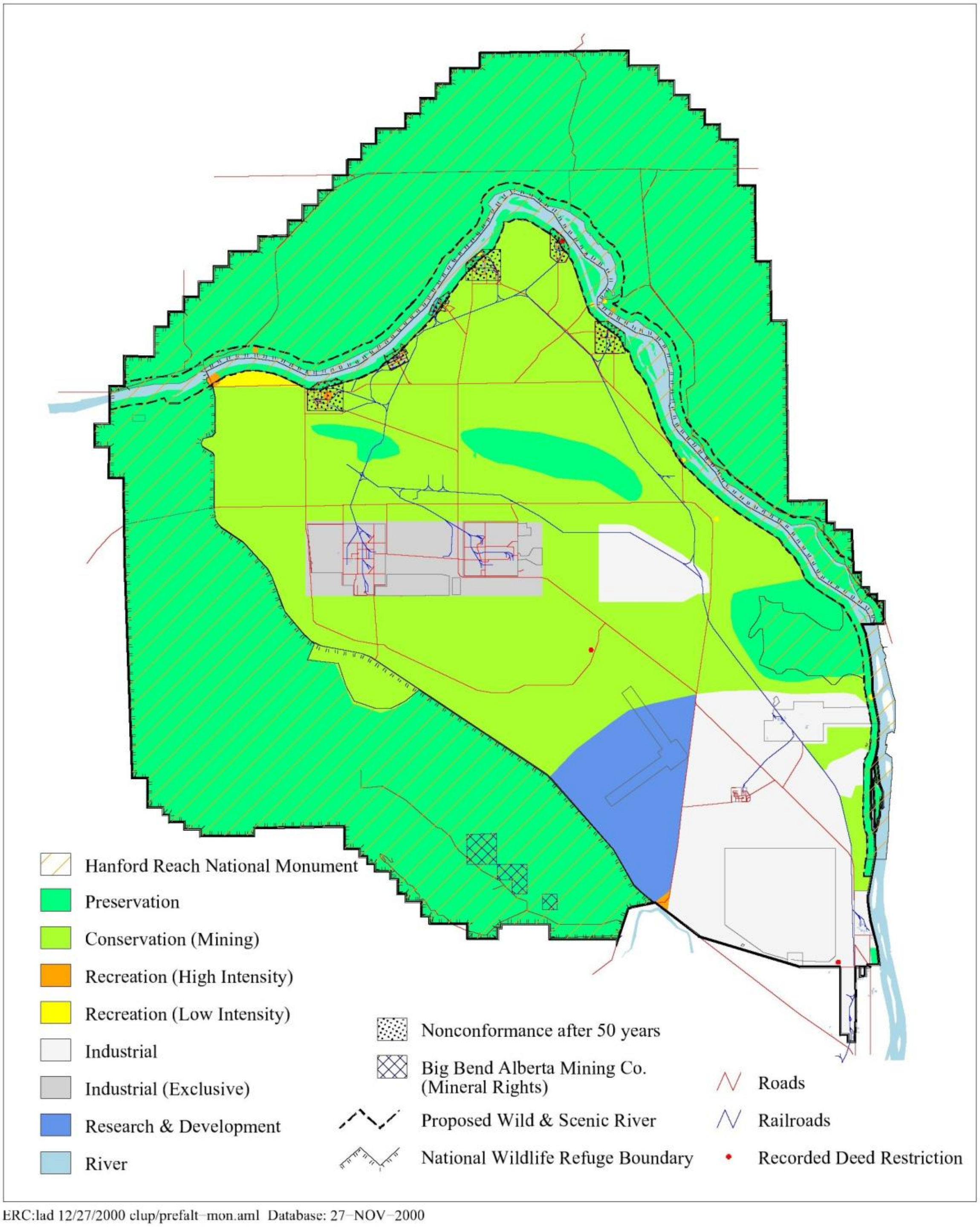

Figure 2-2. Final Designations from the Hanford Comprehensive Land-Use Plan

In June 2000, most of the lands that are designated as "preservation" were permanently withdrawn and protected by presidential proclamation (65 FR 37253, Proclamation 7319 of June 9, 2000) with the establishment of the Hanford Reach National Monument. The monument is superimposed over approximately 195,000 acres (304 square miles) of the 586-square-mile DOE Hanford Site.

> *The Hanford Reach National Monument is a unique and biologically diverse landscape, encompassing an array of scientific and historic objects. This magnificent area contains an irreplaceable natural and historic legacy, preserved by unusual circumstances. Maintained as a buffer area in a Federal reservation conducting nuclear weapons development and, more recently, environmental cleanup activities, with limits on development and human use for the past 50 years, the monument is now a haven for important and increasingly scarce objects of scientific and historic interest.* (65 FR 37253)

The majority of the monument is managed by the United States Fish and Wildlife Service (USFWS) through a Permit and Memorandum of Understanding granted by DOE (DOE 2001b). The remaining monument lands that are managed by DOE are undergoing or supporting environmental cleanup (e.g., River Corridor Unit, McGee Ranch Unit). The Hanford Reach National Monument land continues to be under the custody and accountability of DOE for the federal government. Monument lands will remain under federal ownership and control for the foreseeable future.

2.3.2 Role of Land Use in CERCLA Remedy Selection

Land use is an important factor in selecting cleanup remedies under CERCLA. Figure 2-3 illustrates the primary relationships between current and future land use and the CERCLA remedy selection process. Remedial action objectives that are developed as part of the remedial investigation and feasibility study process are to reflect the reasonably anticipated future land use(s). These future land-use assumptions allow the baseline risk assessment and the feasibility study to focus on developing practical and cost-effective remedial alternatives. These alternatives should then support future site activities that are consistent with the reasonably anticipated future land use.

The CERCLA remedy selection uses a multi-step process that applies ***nine criteria*** (shown in Figure 2-3) to support remedy selection in a record of decision. The first two criteria, the ***threshold criteria,*** are used to eliminate non-viable alternatives, i.e., those that cannot meet protection and regulatory requirements. Remedies are screened out at this stage if they are unable to satisfactorily protect human health and the environment, which in part depends on future uses of the land. The next five criteria, ***balancing criteria,*** are used to compare each viable alternative against other important considerations. Based on evaluation of these seven criteria, a proposed plan is developed that summarizes the preliminary conclusions as to why that option appears most favorable. The proposed plan is provided to the public and stakeholders for review and comment. The final step of the process considers comments on the proposed plan that are evaluated against the last two CERCLA criteria, ***modifying criteria***. This evaluation may result in modification to the remedy to improve its overall public acceptance. The final remedy is described in the record of decision.

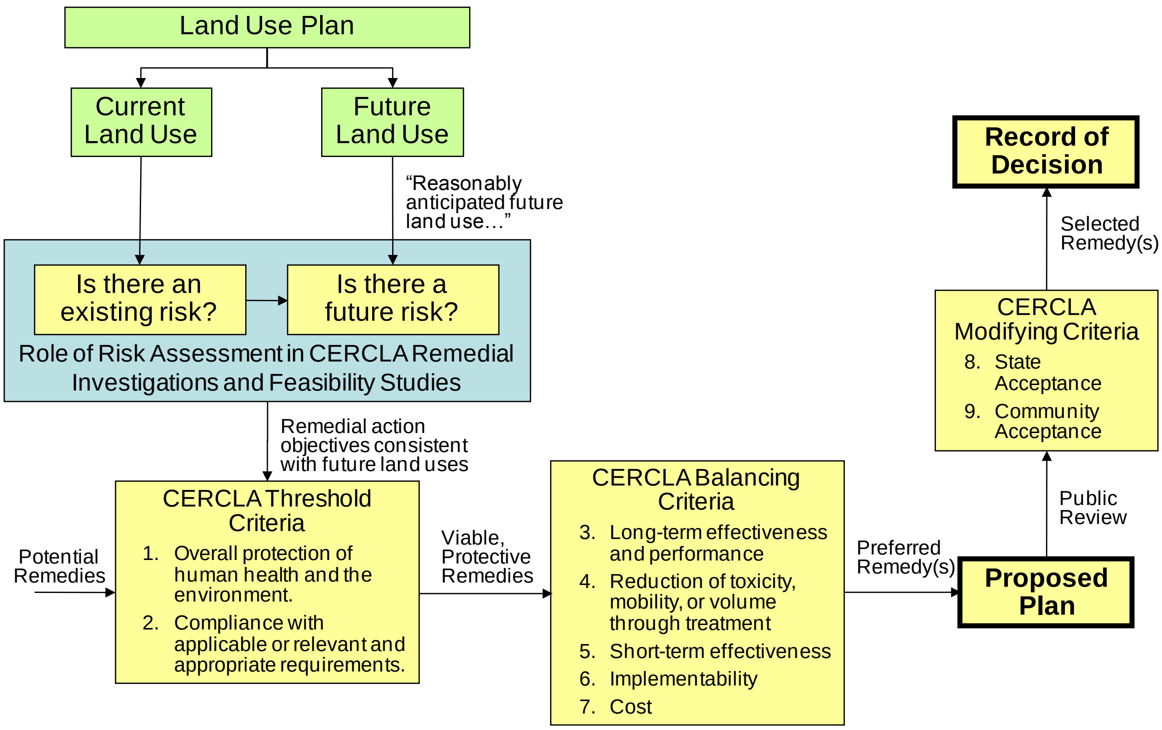

Figure 2-3. Land Use and CERCLA Remedy Selection (adapted from EPA 1995c)

Alternate land uses are examined in the CERCLA process to compare how long-term effectiveness of remedies might vary under different hypothetical scenarios as part of the balancing criteria evaluations. For example, a residential farmer or a residential Tribal member land-use scenario, which differ from the anticipated land uses, can be used to inform the decision maker about the potential impacts to specific populations from unexpected exposures. However, consistent with the EPA Guidance (EPA 1995c) concerning land use in the CERCLA remedy selection process, the remedial alternatives developed "…should lead to site activities which are consistent with the reasonable anticipated future land use." The following text box provides some key elements from the EPA directive (EPA 1995c).

2.3.3 Land Use to Support the Cleanup Completion Framework

As noted in Section 2.3.2, future land uses influence the baseline risk assessment, the development of alternatives, and the cleanup remedy selection process. As recognized in the final *Hanford Comprehensive Land-Use Plan EIS* (DOE 1999), Hanford lands, including the Hanford Reach National Monument, are expected to remain under federal ownership and control for the foreseeable future.[12] The southeastern portion of the Hanford Site, close to Richland and the 300 Area, is designated as "industrial" or "research and development." These areas, while remaining under government control and ownership,

[12] Further information on Hanford land-use designations and processes can be found in the *Hanford Comprehensive Land-Use Plan EIS* (DOE 1999), the corresponding record of decision (64 FR 61615) of November 2, 1999, the recently released supplement analysis (DOE 2008e), and the amended record of decision (73 FR 55824) of September 26, 2008.

Land Use in the CERCLA Remedy Selection Process

The EPA Office of Solid Waste and Emergency Response (OSWER) directive on the CERCLA remedy process (EPA 1995c) establishes EPA direction for consideration of future land use when selecting a CERCLA remedy. Remedial actions consistent with future land uses help to ensure that potential remedies are protective of human health and the environment in the future. The following key elements are some of the directives from that document:

- "Future land use assumptions allow the baseline risk assessment and the feasibility study to be focused on developing practicable and cost effective remedial alternatives. These alternatives should lead to site activities which are consistent with the reasonable anticipated future land use."
- "Current land use is critical in determining whether there is a current risk associated with a Superfund site, and future land use is important in estimating potential future threats. The results of the risk assessment aid in determining the degree of remediation necessary to ensure long-term protection at NPL sites."
- "More than one future land use assumption may be considered when decision makers wish to understand the implications of unexpected exposures."
- "In general, remedial action objectives should be developed in order to develop alternatives that would achieve cleanup levels associated with the reasonable anticipated future land use over as much of the site as possible."
- "A landfill site is an example where it is highly likely that the future land use will remain unchanged (i.e., long-term waste management area), given the National Contingency Plan's expectation that treatment of high volumes of waste generally will be impracticable and the fact that EPA's presumptive remedy for landfills is containment."
- "If any remedial alternative developed during the feasibility study will require a restricted land use in order to be protective, it is essential that the alternative include components that will ensure that it remains protective. In particular, institutional controls will generally have to be included in the alternative to prevent an unanticipated change in land use that could result in unacceptable exposures to residual contamination."

are viable for leasing to public and private entities for uses that are consistent with the *Hanford Comprehensive Land-Use Plan EIS* (DOE 1999). Discussions are currently underway exploring the potential use of a portion of these areas as an Energy Park. This park would support the Nation's and DOE's goals of developing safe, secure, clean and sustainable energy sources for the future. The development and management of an Energy Park, or other compatible uses, would be consistent with the *Hanford Comprehensive Land-Use Plan EIS* and associated policies. Appendix B provides additional information on the Energy Park Initiative.

The federal government will retain ownership of the conservation and preservation areas of the Hanford Site for the foreseeable future. These areas are not expected to be defined as excess to DOE missions. Access to these areas will be controlled, as necessary, to protect human health and safety as long as active waste management operations are being conducted.

The central portion of the Hanford Site includes an area designated as the Industrial-Exclusive Area. This is an area of 20 square miles that is designated for continued use for waste management operations and related activities. The *Hanford Comprehensive Land-Use Plan EIS* (DOE 1999) provides further clarification of what the Industrial-Exclusive Area would be use for.

> "*DOE has defined two zones that are necessary to protect human health and safety – an inner exclusive-use zone and an emergency planning zone. The exclusive-use zone is reserved for DOE or other hazardous operations with severely restricted public access. This zone extends from the facility*

> *fence line to a distance at which threats to the public diminish and where public access can be routinely allowed. The exclusive-use zone is located within the emergency planning zone.*"

The final EIS record of decision (64 FR 61615), which established the comprehensive land-use plan, goes on to state that as the cleanup mission progresses exclusive-use zones will shrink and migrate inward to the Central Plateau. This expectation is further reflected in the land use policy (DOE 1999): "reduce exclusive use zone to maximize the amount of land available for alternate uses while still protecting the public from inherently hazardous operations." Emergency planning zones will be maintained to ensure public safety as long as waste management operations (e.g., Canister Storage Building and Waste Treatment Plant) are occurring on the Central Plateau.

DOE recognizes that permanent disposal, isolation, and protection of waste inventories will be required. Within this area, DOE intends to shrink the region requiring permanent isolation and control to be much smaller than the current 20-square-mile area. Consistent with other DOE and non-DOE sites around the nation (e.g., Fernald, Rocky Flats, and Savannah River Site), Hanford's Industrial-Exclusive Area will be controlled for the foreseeable future.

2.3.4 Cleanup Objectives and Risk Assessment

Cleanup objectives must address the protection of human health, ecological receptors, and groundwater resources as well as meeting applicable or relevant and appropriate requirements. Different levels of cleanup may be required to achieve these cleanup objectives. From a CERCLA cleanup standpoint, anticipated future land use is particularly relevant in situations where near-surface contamination or consumption of groundwater is a primary exposure pathway. Where soil contamination is affecting groundwater, protection of the groundwater may drive more stringent soil cleanup levels than those required to be protective of human health based on the reasonably anticipated future land use. It is important to note that objectives for remediating groundwater and protecting it from future contamination, and protecting surface water, are consistent across all areas of the Hanford Site. Remedial action objectives for the protection of direct human exposure vary across the Hanford Site. These differences in remedial action objectives are due to differences in the designated future land uses that exist across the Hanford Site.

For the area of the Central Plateau outside of the Industrial-Exclusive Area, remedial action objectives will be evaluated using an exposure scenario that is consistent with the anticipated conservation land use, e.g., a National Monument worker, although a variety of exposure scenarios will be evaluated in the risk assessment process to support risk management decisions made in selecting cleanup actions.[13] For the area of the Central Plateau inside the Industrial-Exclusive Area, remedial action objectives will be evaluated using an exposure scenario that is consistent with industrial-exclusive land use.[14]

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[13] It is expected that this will achieve a level of cleanup for the outer areas of the Central Plateau that is consistent with cleanup levels established for the River Corridor.

[14] These uses could be for a long-term institutional control worker or a post-cleanup industrial worker supporting compatible federal activities. As described throughout this document, DOE is working with the regulatory agencies to define final-land-use-based exposure scenarios for the Central Plateau and to identify the designated areas where waste will permanently remain in place under institutional controls.

EPA guidance (EPA 1995c) provides that risk assessments generally need to consider only the reasonably anticipated future land use; however, it may be valuable to evaluate risks associated with other land uses. DOE has developed realistic and defensible human health exposure scenarios for risk assessments required for site cleanup that reflect the reasonably anticipated land uses. It is DOE's intent to analyze, through a collaborative process, certain Tribal uses that may be allowed by DOE in the future. DOE will also continue to calculate risks using human health exposure scenarios provided by the Tribal Nations to understand the implications of such unexpected exposures for consideration in cleanup decisions.

2.4 Natural Resource Injury Assessment

In enacting CERCLA, Congress intended to ensure the timely cleanup of contaminated sites and to place the cleanup costs on those responsible for the contamination. In addition to remediation of past releases, CERCLA also provides that injuries to natural resources and any service losses to baseline conditions resulting from certain past releases be identified in a process – known as Natural Resource Damage Assessment. Federal, State, and Tribal Natural Resource Trustees are authorized to act on behalf of the public as trustees for site natural resources. This document focuses primarily on CERCLA's cleanup requirements; however, coordination with Natural Resource Trustees is an important element of selection and implementation of remedial actions.

The CERCLA-designated Natural Resource Trustees at Hanford include DOE, U.S. Department of Interior, U.S. Department of Commerce (through the National Oceanic and Atmospheric Administration); the states of Washington and Oregon; and the Yakama Nation, the Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe. The Trustees' role under CERCLA is to determine injuries to and loss of natural resources caused by releases of hazardous substances and to determine the extent of restoration appropriate. Recognizing the potential benefit of an approach to National Resource Damage Assessment that integrates Trustee viewpoints, the Trustees formed the Hanford Natural Resource Trustee Council in 1993.

In April of 2007, DOE and the other federal trustees determined it was appropriate to begin planning Natural Resource Injury Assessment activities. The objective of this effort is to produce an injury assessment plan that will be used to identify natural resources that could potentially be injured from releases of hazardous substances from the Hanford Site and that could benefit from early restoration. The plan will likely describe a holistic, site-wide approach for injury assessment and restoration. The effort will ultimately define those efforts desired for natural resource restoration of the Hanford Site.

3.0 River Corridor Cleanup Completion Strategy

The River Corridor portion of the Hanford Site is approximately 220 square miles and includes the 100 and 300 Areas along the south shore of the Columbia River. This area contains nine retired plutonium production reactors, numerous support facilities, solid and liquid waste disposal sites, and contaminated groundwater. The 300 Area, located north of the city of Richland, contained fuel fabrication facilities, nuclear research and development facilities, and associated solid and liquid waste disposal sites. Both of these areas are on the NPL (or Superfund).

Summary of River Corridor Cleanup Progress (through FY 2009)

- In the 300 Area:
  - More than 9 million curies of radioactivity removed from clean out of 324 Building B-Cell near the City of Richland.
  - Nearly 2,000 tons of uranium disposed of or removed for offsite reuse.
  - More than 174 of 270 radioactive and/or hazardous facilities have been decontaminated and demolished.
- In the 100 Areas:
  - More than 7.5 million tons of waste, including building rubble, contaminated soil, and burial ground contents have been removed and disposed of at ERDF.
  - 2,300 tons spent fuel packaged and moved to dry, safe storage on the Central Plateau.
  - Contaminated water removed from K East Basin; K East Basin has been removed and soil remediation initiated near the K East Reactor.
  - Groundwater treatment systems (~1,500 gallons per minute) installed to remove hexavalent chromium from groundwater plumes that threaten the Columbia River in the 100 Areas.
  - New and innovative technologies implemented to reduce groundwater contamination.
  - Five of nine surplus production reactors placed in interim safe storage configuration.
- Fast Flux Test Facility completed deactivation of auxiliary plant systems and began surveillance and maintenance.

3.1 Current Status

Since 1995, DOE has implemented CERCLA records of decision for interim and final actions. These records of decision require removal of contaminated soil from waste sites (primarily the upper 15 feet of soil) and debris from demolished facilities in the 100 and 300 Areas (Figure 3-1) and disposal of the resulting waste in the Environment Restoration Disposal Facility (ERDF) located in the 200 Area (for example, see *Record of Decision for 100-BC-1, 100-DR-1 and 100-HR-1 Operable Units*, EPA [EPA 1995d]). The spent fuel in the K Basins has been removed and is in dry storage in the 200 Area. Reactors are being placed in interim safe storage to allow time for additional radioactive decay in the reactor core. Groundwater treatment systems have been operating and are being upgraded to prevent hexavalent chromium, uranium, and strontium-90 in groundwater from entering the Columbia River at levels harmful to human health or the environment. As described in *Hanford's 2015 Vision* (see Appendix A), between 2010 and 2015 all areas of the River Corridor will be cleaned up consistent with records of decision for interim actions.

3.2 Key Challenges for River Corridor Cleanup

Cleanup of the River Corridor has been one of Hanford's top priorities since the early 1990s. This urgency is due to the proximity of hundreds of waste sites to the Columbia River. In addition, removal of the sludge from K West Basin, which is near the river, remains a high priority and significant progress is being made. Highly radioactive materials have been removed from the 300 Area where they were stored close to populated communities. Spent fuel stored in the 100-K Area has been safely removed and placed in dry storage on the Central Plateau. Because groundwater contamination continues to threaten the

Columbia River, DOE has set aggressive goals for cleaning groundwater to levels that protect the river by 2020.[15] For one of these contaminants, chromium, DOE will take steps to ensure that by 2012 groundwater entering the Columbia River will not be harmful to aquatic species.

To successfully complete cleanup of the River Corridor, DOE and its contractors face several important challenges:

1. Remove and Dispose of K Basin Sludge

- **What is the challenge?** Although the spent fuel has been removed from the K Basins, the sludge that remains in the bottom of the K West Basin poses a significant challenge (see Section 3.4.2). The sludge poses a challenge because it contains some of the highest concentrations of radioactive materials (after spent nuclear fuel) on the Hanford Site. The composition of the sludge varies greatly and, because of its hazards to workers, must be handled remotely. Shielding and other radiological controls are required once the sludge is removed from the basin for packaging. Because of the sludge's unique composition, processing it for disposal could also be difficult.

- **Where are we today?** A total of 2,300 tons of spent fuel has been removed from the K East and K West Basins. The spent fuel was packaged and moved to dry, safe storage on the Central Plateau. Contaminated water has been removed from the K East Basin and the basin has been removed. The sludge from both basins has been placed in containers that now reside in the K West Basin. The K East Basin has been completely demolished. After completion of sludge removal, the K West Basin will be demolished. The transuranic sludge will be treated and stored on the Central Plateau pending shipment to the Waste Isolation Pilot Plant in New Mexico.

2. Store Surplus Production Reactors Until Final Disposal

- **What is the challenge?** Three surplus production reactors (K East, K West, and N) remain to be placed into interim safe storage configuration. The B Reactor is being preserved as a National Historic Landmark. Final disposition of the reactors will be determined by future decisions (see Section 3.4.1). If removal and burial on the Central Plateau is chosen, there will remain significant technical challenges to dismantle and move the radioactive graphite cores.

- **Where are we today**? Final reactor decommissioning actions could be established through either a NEPA record of decision and implemented through DOE's *Atomic Energy Act* (AEA) authority, or through a CERCLA decision and action. Until reactor removal is complete, DOE will continue to conduct routine maintenance, surveillance, and radiological monitoring activities to ensure continued protection of human health and the environment during the interim storage period. Following reactor removal, any remaining waste sites will be remediated.

3. Prevent Hexavalent Chromium from Impacting the Columbia River

- **What is the challenge?** Hexavalent chromium is a significant groundwater contaminant in the 100-D, 100-H, and 100-K Areas. Chromium is present in groundwater at more than 10 times drinking water standards. Hexavalent chromium poses a potential threat to the health of aquatic life along the shores of the river. Chromium was used as a water treatment chemical for cooling

[15] See Tri-Party Agreement Milestones M-016-110-T01 through M016-110-T05 for descriptions of the specific goals and timing for cleanup of 100 Area and 300 Area groundwater contaminants.

water used in Hanford's production reactors. Cooling water from the single-pass reactors was discharged to retention basins and eventually to the Columbia River. In addition to the cooling water discharges, much more concentrated sources of chromium have been found at locations where the chemical was brought to the Hanford Site and unloaded for use. It is not known with certainty if all of the areas have been identified where hexavalent chromium was unloaded for use at the site.

- **Where are we today?** Remediation goals have been established that are well below drinking water standards so that cleanup is also protective of aquatic species. Pump-and-treat systems have been effective in removing chromium from groundwater at Hanford. These systems are being expanded to achieve remediation goals. Sources of chromium in the groundwater are being removed and work continues on identifying all the sources of hexavalent chromium contamination. Moreover, recent sampling within the Columbia River itself has identified locations where chromium-contaminated groundwater is upwelling into the river. This phenomenon needs to be better understood to design and implement effective remedies.

4. Achieve Strontium-90 River Protection Goal

- **What is the challenge?** The strontium-90 plume at 100-N Area exceeds drinking water standards by approximately three orders of magnitude. There is no ambient water quality standard for strontium-90, so the drinking water standard is used as a default standard. However, the actual dose to aquatic receptors is significantly below published risk-based dose guidelines. Strontium-90 tends to bind tightly to soil and consequently is difficult to remove by standard pump-and-treat systems.

- **Where are we today?** In the mid-1990s, a CERCLA interim action led to operation of a pump-and-treat system to reduce the amount of strontium-90 entering the Columbia River. However, this effort was discontinued when it was determined that the system was ineffective and provided only about one-tenth of the mass removal compared to natural radioactive decay (DOE 2006b). The pump-and-treat system is currently in cold-standby status. Subsequently, DOE has begun testing alternate remedies including a permeable reactive barrier using apatite sequestration (*Strontium-90 Treatability Test Plan for 100-NR-02 Groundwater Operable Unit* [DOE 2006a reissue]) and a method called phytoextraction that uses plants to extract and sequester soil and waterborne contaminants.

5. Remediate the 300 Area Uranium Plume

- **What is the challenge?** The uranium plume in the 300 Area has proven to be difficult to understand, predict, and remediate. An original remedy of monitored natural attenuation did not achieve cleanup levels within the predicted timeframe (EPA 1996 and DOE 2006b).

- **Where are we today?** A new remedial investigation/feasibility study supported by advanced science and technology investigations and applications is underway to tackle this complex uranium plume and other contaminants of concern. One of the new technologies is the experimental application of polyphosphate injection aimed at sequestering uranium in the vadose zone. In addition, DOE's Office of Science has put in place an Integrated Field Challenge test site in the 300 Area to enhance the understanding of the complex geochemistry and interactions with fluctuating Columbia River levels. This project is expected to improve the understanding of this plume and support development of effective remedies.

3.3 River Corridor – Final Decisions

Final records of decision are required for the 100 and 300 Areas to guide future remediation, to ensure that remedial actions performed under interim action records of decision are protective of human health and the environment, and to determine if additional actions are required. To proceed toward records of decision for the 100 and 300 Areas, six geographic decision areas (Figure 3-1) have been defined for the River Corridor: 100 B/C Area, 100-K Area, 100-N Area, 100-D and H Areas, 100-F Area combined with 100-IU-2/6 Areas, and 300 Area (including nearby 600 Area waste sites). These decision areas contain liquid waste sites, solid waste burial grounds, surplus facilities and infrastructure, contaminated groundwater plumes, and surplus production reactors. These decision areas encompass the 100 and 300 Areas NPL sites.

To support decisions, DOE is undertaking remedial investigations in each of the six geographic decision areas. In addition, DOE is assessing Hanford releases into the Columbia River to determine the extent of Hanford contamination in the river. These six decision areas have been developed to ensure that final remedy decisions address the entirety of the 100 and 300 Areas. Together, surface remedies (i.e., for waste sites and facilities) and groundwater remedies must protect human health and the environment. Cleanup levels for final remedies will be protective of future uses consistent with the land use designations in the *Hanford Comprehensive Land-Use Plan* (DOE 1999), i.e., conservation and preservation for most of the area and industrial use in the 300 Area. When interim records of decision for River Corridor 100 Area waste sites were selected in the mid-1990s, a conservative residential exposure scenario was used to determine protectiveness for those interim actions because DOE had not yet designated land uses. Cleanup goals established through interim records of decision will continue to be used to guide future remedial actions and will support reasonably foreseeable land uses in the River Corridor.

As shown in Figure 3-2, DOE will complete remedial investigations/feasibility studies for both source and groundwater operable units within each geographic decision area. The purpose of the remedial investigation is to characterize the nature and extent of Hanford contaminants and assess the risk from exposure to those contaminants within a decision area. The River Corridor Baseline Risk Assessment, Columbia River remedial investigation (*Remedial Investigation of Hanford Site Releases to the Columbia River*[DOE 2008f]), waste site cleanup verification data, and field investigation data will provide characterization and baseline risk assessment information for contaminated areas within all six decision areas and the Columbia River. The feasibility studies will compare cleanup alternatives using the CERCLA criteria. A plan will be prepared for each of the six decision areas to propose final remedies for both source and groundwater operable units. The six records of decision will describe the remaining cleanup actions required for River Corridor cleanup completion. These six decisions (proposed plans and records of decision) are scheduled to be completed by 2014. Most cleanup actions are scheduled to be completed by 2015. However, some waste site cleanup associated with some major facilities will not be completed until after the facilities have been removed, e.g., waste sites associated with 100-K Area and K Basins.

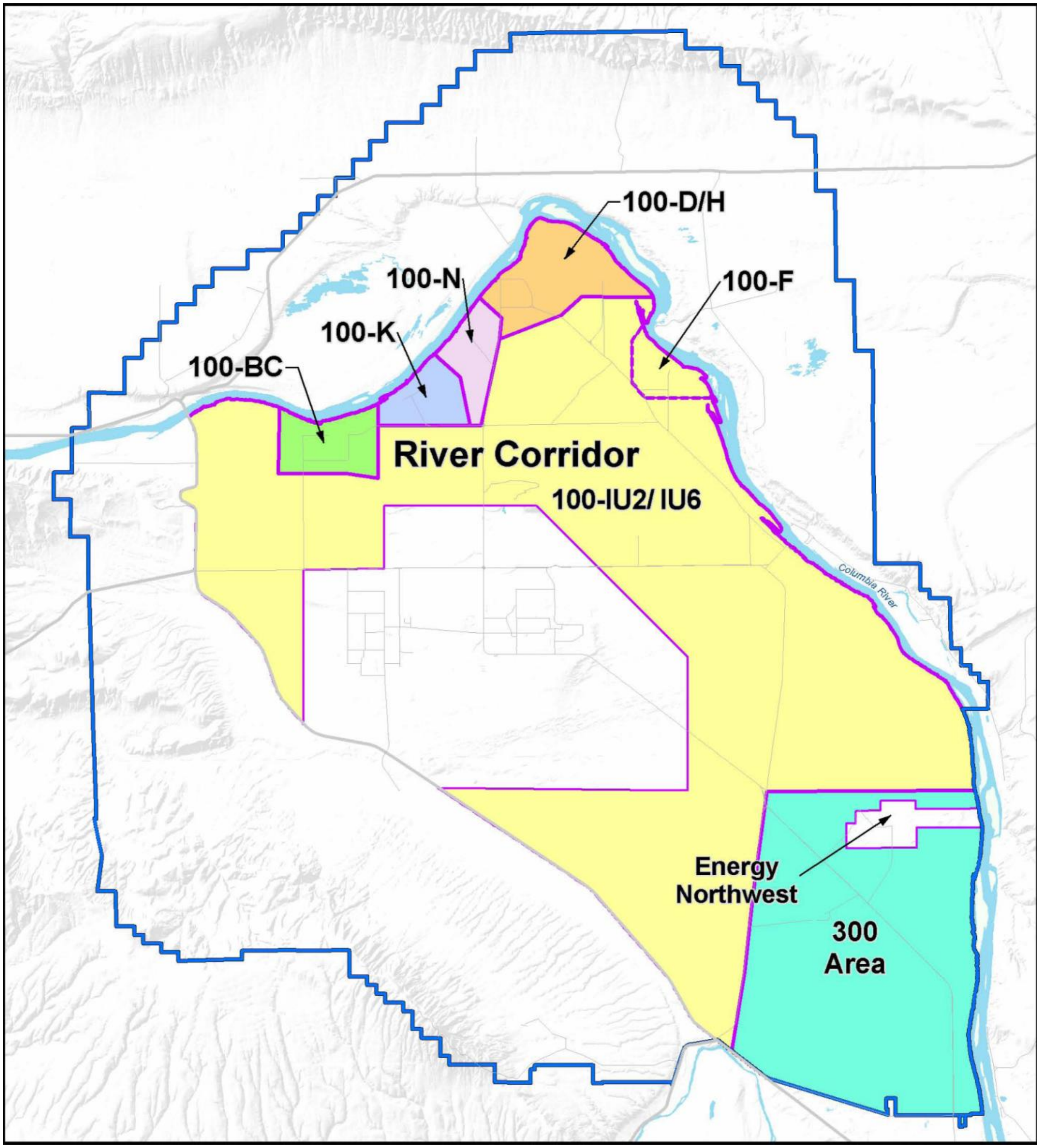

Figure 3-1. Geographic Decisions Areas within the River Corridor

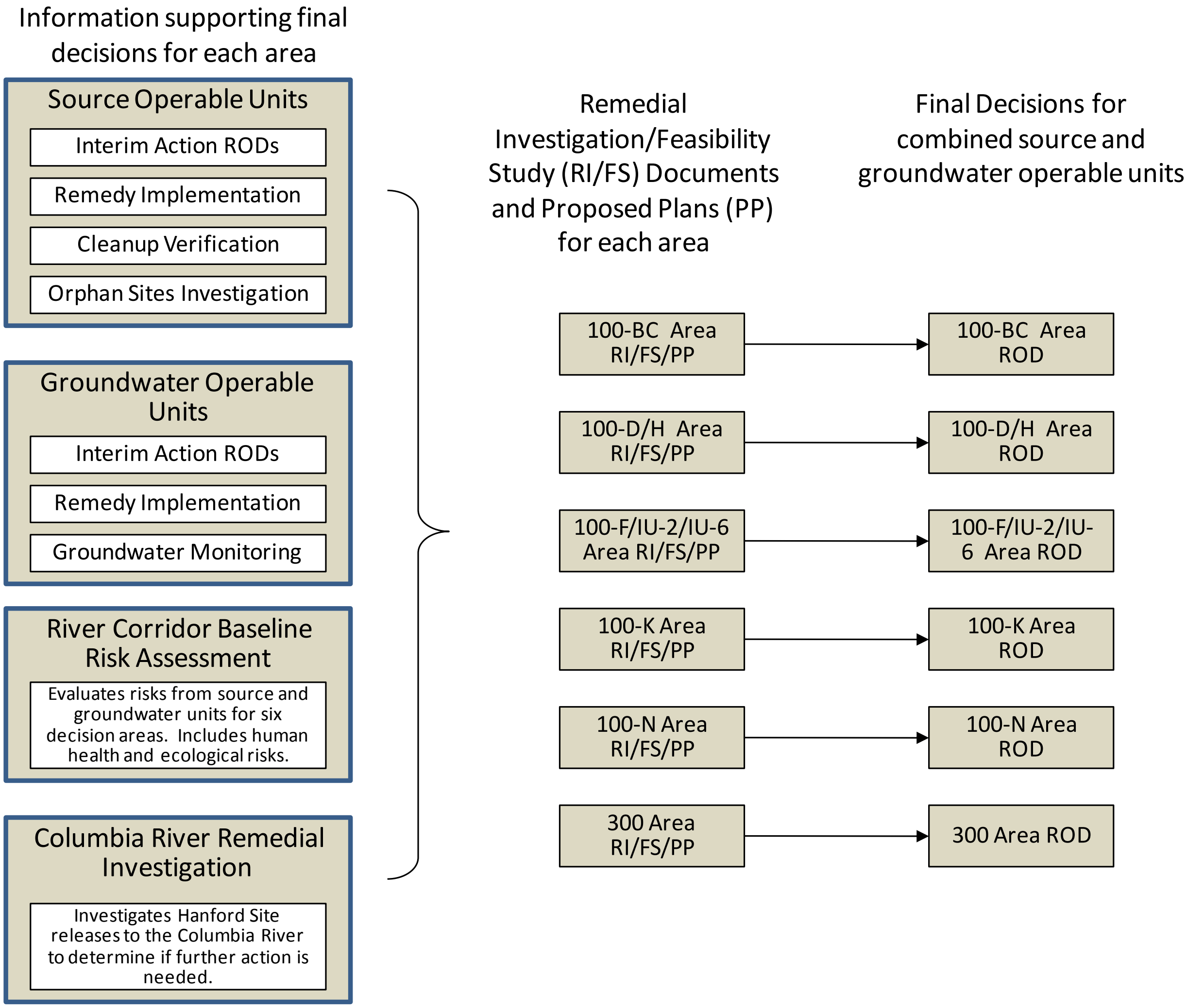

Figure 3-2. Strategy to Align River Corridor Geographic Decision Area Records of Decision

3.4 Cleanup of Major Facilities within the River Corridor

Within the six geographic decision areas described in Section 3.3, there are major facilities whose final disposition must be included in the completion of the River Corridor remediation. There are nine surplus plutonium productions reactors along the Columbia River in the 100 Areas. In the 100-K Area, the spent fuel storage basins have had the spent fuel removed. However, the K West Basin contains approximately 1000 cubic feet (~30 cubic meters) of sludge that presents a significant challenge to completion. The Fast Flux Test Facility (FFTF), a prototype breeder reactor, also must be put into a final safe configuration. Finally, within the 300 Area, the DOE Office of Science will retain four facilities that will need to be removed on a schedule that is a decade or more after other work in the 300 Area is to be completed.

3.4.1 Surplus Production Reactors

In 1998, C Reactor was the first reactor in the DOE complex to transition to safe storage. Cocooning the reactor demonstrated new technologies to reduce worker exposure to radiation, lower maintenance costs, and accelerate site cleanup by transferring lessons learned about safe storage[16] to other reactors.

> **Columbia River Remedial Investigation**
>
> To complement the source and groundwater investigations for the River Corridor and to ensure that River Corridor cleanup is protective, DOE has initiated a remedial investigation of Hanford Site releases to the Columbia River. The intent of this work is threefold:
>
> 1. Samples will be collected and analyzed to identify presence, concentration and location of Hanford Site-related contaminants in the Columbia River.
> 2. These sample results will be used to estimate the current risk to human health and environment.
> 3. This work will determine whether or not any cleanup actions are needed to lower the risk to humans, animals, and plants from being exposed to Hanford Site-related contaminants.

The NEPA *Record of Decision for the Decommissioning of Eight Surplus Production Reactors EIS* (58 FR 48509) documents DOE's decision of interim safe storage followed by one-piece removal to a Central Plateau disposal facility. N Reactor was not included in the EIS as it was not available for decommissioning at the time of the NEPA EIS and interim safe storage was approved through the CERCLA process. Final disposition will be handled by a subsequent NEPA or CERCLA decision process. B Reactor has been designated as a National Historic Landmark and will be placed in a configuration consistent with that use and controlled access by the general public for the foreseeable future. For all reactors except B, interim safe storage actions, selected through the CERCLA removal action process, are designed to prevent deterioration and release of contamination from the reactors for up to 75 years.

The NEPA record of decision for the reactors (58 FR 48509) also indicated DOE's intent to complete these decommissioning actions consistent with the proposed cleanup schedule for remedial actions. For each reactor, Table 3-1 summarizes its current status, identifies the geographic decision area within which it is contained, and indicates the basis for a final decision. As DOE completes remedial investigation/feasibility study reports for the six geographic areas, these reports will describe how and when final reactor decommissioning actions will be coordinated with cleanup actions. Final reactor decommissioning actions, however, could be established through either a NEPA record of decision and implemented through DOE's AEA authority, or through a CERCLA decision and action. Until reactor removal is complete, DOE will continue to conduct routine maintenance, surveillance, and radiological monitoring activities to ensure continued protection of human health and the environment during the interim storage period. Following reactor removal, any remaining waste sites will be remediated.

[16] Note: Safe storage means dismantling all support facilities surrounding a reactor, demolishing the reactor building back to its shield wall, sealing openings, and installing a durable 75-year metal roof. These actions reduce a reactor's footprint by 80%, allowing for continued decay of short-lived radionuclides, and preventing contamination from leaking out of the reactor. For example, in the late 1990s, KE and KW Reactors each contained about 25,000 curies of radioactivity though each reactor had been shut down since the early 1970s.

Table 3-1. Hanford Reactor Status and Final Disposition

Reactor	Current Status[a]	Decision Area	Final Disposition
B	National Historic Landmark 2008	100-B/C	ROD for Decommissioning of Eight Surplus Production Reactors EIS (58 FR 48509).
C	ISS since 1998		
D	ISS since 2004	100-D and H	
DR	ISS since 2002		
H	ISS since 2005		
F	ISS since 2003	100-F and IU-2/6	
KE	ISS to be completed.	100-K	
KW	ISS to be completed.		
N	ISS to be completed.	100-N	ISS approved through EE/CA Action Memorandum. Final disposition will be addressed by NEPA or CERCLA decision.

[a]ISS decisions made through CERCLA removal action authority.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act*
EE/CA = Engineering Evaluation/Cost Analysis
EIS = Environmental impact statement.
ISS = Interim safe storage.
NEPA = *National Environmental Policy Act.*
ROD = Record of decision.

3.4.2 K Basins

The 100-K Area includes the K East and K West spent fuel storage basins (K Basins). The spent fuel has been removed and is in dry storage in the 200 Area. Over the lifetime of these basins, debris, silt, sand, and material from operations resulted in the formation of sludge that accumulated in the bottom of these basins. There is a total of about 1000 cubic feet (~30 cubic meters) of sludge contaminated with fission and activation products and uranium. The sludge from both basins has been placed in containers that now reside in the K West Basin. The K East Basin has been completely demolished. After completion of sludge removal, the K West Basin will be demolished. The transuranic sludge will be treated and stored on the Central Plateau pending shipment to the Waste Isolation Pilot Plant in New Mexico. The 100-K Reactors will be placed in interim safe storage.

3.4.3 Fast Flux Test Facility

The FFTF lies within the 300 Area decision area. DOE is currently evaluating decommissioning and final disposition options for FFTF through the *Tank Closure and Waste Management Environmental Impact Statement* (DOE 2009e). The EIS record of decision will identify the final disposition approach for FFTF. Pending implementation of a final decision, DOE has placed the facility in a minimum-safe surveillance and maintenance mode by deactivation of appropriate FFTF plant systems and components and removal of potential hazards.

3.4.4 Retained Facilities in the 300 Area

In 2007, DOE's Office of Science elected to retain four facility complexes in the 300 Area – Buildings 325, 331, 318, and 350 – for up to 20 years. These facilities will continue to support Office of Science missions implemented through the Pacific Northwest National Laboratory. When these facilities are determined to be excess to these missions, they will be returned to DOE-RL for final removal and remediation of any associated waste sites. The 300 Area record of decision will identify mitigation actions needed to address waste sites associated with these buildings.

3.5 Interfaces with Central Plateau Cleanup

3.5.1 Impact of Central Plateau Groundwater Contamination on River Corridor Cleanup

There are historical groundwater contaminant plumes from the Central Plateau (200-BP-5 and 200-PO-1 Operable Units) that have reached the 100 and 300 Areas and the Columbia River. The principal contaminants are tritium, iodine-129, and nitrate that resulted from Hanford's last fuel processing operations at the Plutonium Uranium Extraction (PUREX) Plant in the 1980s. For legacy groundwater contamination plumes that have migrated off the Central Plateau, the higher concentration portion of the plumes has declined significantly in the past 10 years (DOE 2008c). It is anticipated that ongoing efforts to decrease groundwater recharge in the Central Plateau (e.g., cut-and-cap leaking water lines), coupled with natural processes occurring within the groundwater system itself, will result in these plumes meeting drinking water standards in a reasonable time frame.

The remedial investigation/feasibility study for the affected 100 Area decision area (100-IU-2/6 and 100-F) and the 300 Area decision area will evaluate current groundwater conditions to determine the overall protectiveness of the proposed source remedies. However, remedy decisions for the iodine, tritium, and nitrate plumes will be made through the record of decision for 200-PO-1 Operable Unit as part of the Central Plateau cleanup. Cleanup decisions and actions for the Central Plateau, including pump-and-treat systems and monitoring networks, are anticipated to prevent additional plumes from reaching the River Corridor area above drinking water standards; therefore, future plumes from the Central Plateau do not need to be considered in River Corridor decisions.

3.5.2 Environmental Restoration Disposal Facility

Remediation of River Corridor waste sites and contaminated facilities generate low-level, mixed low-level and other remediation waste requiring disposal. These types of waste will be transported to ERDF, an engineered disposal facility with its own CERCLA record of decision (EPA 1995a). ERDF is located on the Central Plateau between the 200 East and 200 West Areas, more than 7 miles from the Columbia River. Other materials, such as transuranic materials and spent nuclear fuel will be removed for appropriate disposition.

3.6 Close Out of the 100 Area and 300 Area National Priorities List Sites

Upon completion of cleanup as specified in the CERCLA records of decision, DOE will close out the 100 Area and 300 Area NPL sites in accordance with CERCLA requirements (EPA 2000). NPL close out procedures, such as site deletion, include a cumulative assessment of remedial actions taken to ensure they are protective of human health and the environment and that no future response action is likely.

Close out of these units will also include integration with the DOE-RL Long-Term Stewardship Program to ensure institutional controls are implemented in accordance with records of decisions.

The CERCLA process requires DOE as lead agency for the Hanford Site, to conduct five-year reviews to be triggered by any remedial action that leaves hazardous substances onsite at levels that do not allow for unlimited use and unrestricted exposure (EPA 2001). See Section 6.4 for a description of the CERCLA five-year review process.

You may find more detailed information about River Corridor cleanup and remediation in the following resources:

- Records of decision and 5-year CERCLA reviews can be accessed at the EPA Region 10 site: http://yosemite.epa.gov/R10/CLEANUP.NSF/sites/Hanford
- *Hanford Site Active Cleanup Footprint Reduction*, DOE/RL-2010-18, US Department of Energy, Richland, Washington (DOE 2010f).
- *Hanford's 2015 Vision* (see Appendix A)
- DOE Hanford Site web site at http://www.hanford.gov

4.0 Central Plateau Cleanup Completion Strategy

The Central Plateau is a 75-square-mile region near the center of the Hanford Site including the area designated in the *Hanford Comprehensive Land Use Plan Environmental Impact Statement* (DOE 1999) and *Record of Decision* (64 FR 61615) as the Industrial-Exclusive Area, a rectangular area of about 20 square miles in the center of the Central Plateau (Figure 4-1). The Industrial-Exclusive Area contains the 200 East and 200 West Areas that have been used primarily for Hanford's nuclear fuel processing and waste management and disposal activities. The Central Plateau also encompasses the 200 Area CERCLA NPL site. The Central Plateau has a large physical inventory of chemical processing and support facilities, tank systems, liquid and solid-waste disposal and storage facilities, utility systems, administrative facilities, and groundwater monitoring wells.

As a companion to the *Hanford Site Cleanup Completion Framework* document, DOE issued its draft *Central Plateau Cleanup Completion Strategy* (DOE 2009c) in September 2009 to provide an outline of DOE's vision for completion of cleanup activities across the Central Plateau. As major elements of the Hanford cleanup along the Columbia River Corridor near completion, DOE believed it appropriate to articulate the agency vision for the remainder of the cleanup mission. The *Central Plateau Cleanup Completion Strategy* and the *Hanford Site Cleanup Completion Framework* were provided to the regulatory community, the Tribal Nations, political leaders, the public, and Hanford stakeholders to promote dialogue on Hanford's future.

Summary of Central Plateau Cleanup Progress (through FY 2009)

- More than 90 tons of carbon tetrachloride removed from soil and groundwater. Final record of decision obtained for cleanup of 5-square-mile carbon tetrachloride groundwater plume.
- Additional groundwater remediation actions in place for technetium-99 and uranium in the groundwater plumes in 200 West Area. Proceeding with design and siting of new 200W pump-and-treat facility.
- Plutonium Finishing Plant complex:
  - Packaged 20 tons of plutonium-bearing materials in safe, stable forms.
  - Completed shipment of plutonium to Savannah River and fuel shipment to ISA.
  - Removed 61 contaminated glove boxes
- Transuranic waste retrieval and shipment off site:
  - Retrieved 50,000 drum-equivalents of suspect transuranic waste from trenches.
  - Made 430 shipments (14,600 drum equivalents) of transuranic waste to the Waste Isolation Pilot Plant in New Mexico. An additional 1,000 drums have been certified for shipment.
- Demolished more than 20 Nuclear, Radiological and Industrial Facilities. Completed demolition of 212-N/P/R facilities.
- Canyon facilities:
  - Four of five canyon facilities deactivated and placed in surveillance and maintenance mode (T Plant continues to support waste management operations).
  - Obtained record of decision for the U Plant canyon final disposition.
  - Completed demolition of U Canyon ancillary tanks.

The *Central Plateau Cleanup Completion Strategy* (DOE 2009c) describes DOE's vision for completion of Central Plateau cleanup and outlines the decisions needed to achieve the vision. The Central Plateau strategy involves steps to: (1) contain and remediate contaminated groundwater, (2) implement a geographic cleanup approach that guides remedy selection from a plateau-wide perspective, (3) evaluate and deploy viable treatment methods for deep vadose contamination to provide long-term protection of the groundwater, and (4) conduct essential waste management operations in coordination with cleanup

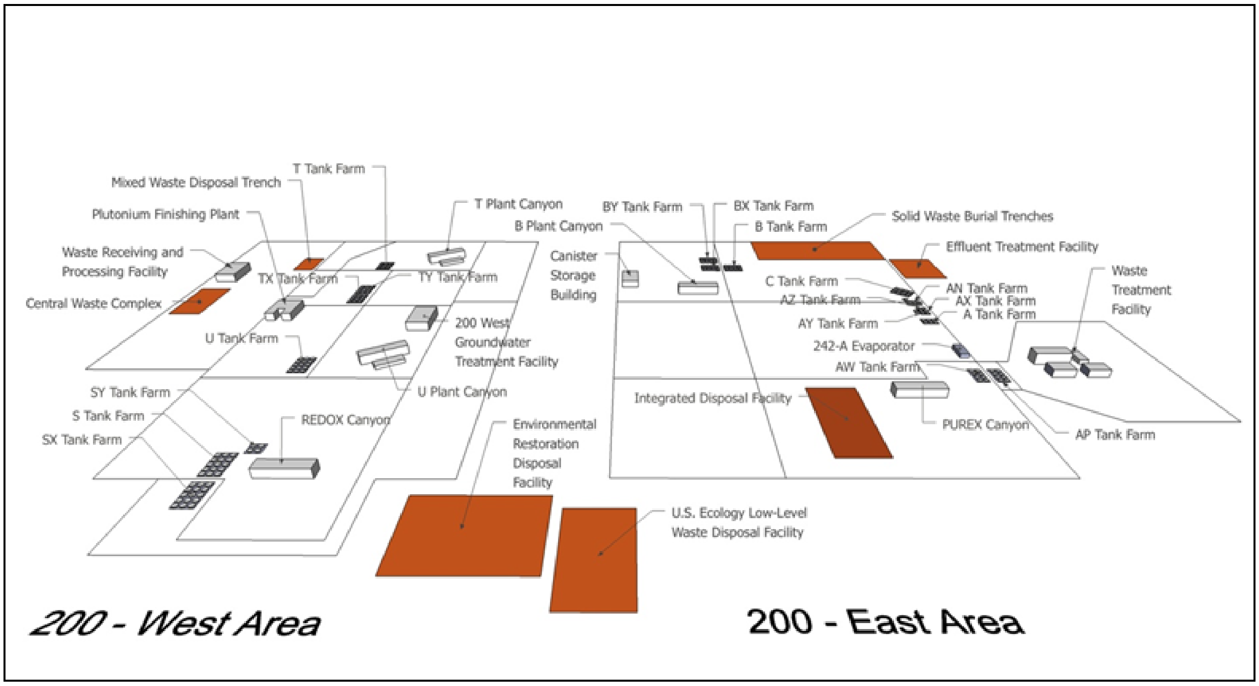

Figure 4-1. Major Facilities in 200 Areas of Hanford's Central Plateau

actions. The strategy will also help optimize Central Plateau readiness to use funding when it is available upon completion of River Corridor cleanup projects.

One aspect of the Central Plateau strategy is to put in place the process to identify the final footprint for permanent waste management and containment of residual contamination within the 20-square-mile Industrial-Exclusive Area. The final footprint identified for permanent waste management and containment of residual contamination should be as small as practical and remain under federal ownership and control for as long as a potential hazard exists. Outside the final footprint, the remainder of the Central Plateau will be available for other uses consistent with the *Hanford Comprehensive Land-Use Plan* (DOE 1999), while maintained under federal ownership and control.

Accordingly, the Central Plateau strategy is organized into the following three principal components:

- **Inner Area** – defined as the final footprint area of the Hanford Site that will be dedicated to permanent waste management and containment of residual contamination. The boundary of the Inner Area is defined by waste disposal decisions already in place and the anticipated future decisions that will result in the requirement for continued waste management and control of residual contamination. The Inner Area is anticipated to be approximately 10 square miles, or less, in size and will remain under federal ownership and control for as long as potential hazards exist. If future waste management facilities are required to support mission completion, e.g., tank waste treatment, those facilities will be located within the Inner Area.

- **Outer Area** – defined as all areas of the Central Plateau beyond the boundary of the Inner Area. It is DOE's intent to clean up the Outer Area to a level comparable to that achieved for the River Corridor. Contaminated soil and debris removed as part of Outer Area cleanup will be placed within the Inner Area for final disposal. Completion of cleanup for the approximately 65-square-mile Outer Area will shrink the active footprint of cleanup for the Central Plateau to the Inner Area.

- **Groundwater Remediation** – as acknowledged in the *Hanford Site Groundwater Strategy Protection, Monitoring, and Remediation* (DOE 2004), the *Hanford Integrated Groundwater and Vadose Zone Management Plan* (DOE 2007), and then reaffirmed in the 200-ZP-1 record of decision (EPA 2008), DOE's goal is to restore Central Plateau groundwater to its beneficial uses, unless restoration is determined to be technically impracticable. This includes the groundwater underlying both the Inner and Outer Areas.

In 2009, the Tri-Parties agreed to negotiate changes to the Tri-Party Agreement that would address Central Plateau cleanup completion strategies and integration of facility disposition with remediation of geographically associated waste sites, among other topics. In March of 2010, the Tri-Parties signed a Tentative Agreement (*Tentative Agreement on Hanford Facility Agreement and Consent Order Change Forms Implementing Changes to Central Plateau Cleanup*, DOE 2010d) and proposed Tri-Party Agreement change packages to implement the new approach for Central Plateau cleanup. Among other changes, this agreement re-aligns the existing process-based operable units on the Central Plateau to be more geographical in nature and consolidates the decision making to support a more holistic approach to Central Plateau cleanup.

4.1 Current Situation

Liquid waste sites on the Central Plateau have discharged more than 450 billion gallons of liquid waste and cooling water to the ground. These past releases have created extensive plumes of groundwater contamination originating from the Central Plateau with a combined area of about 60 square miles above drinking water standards (DOE 2009d). A significant portion of the previously released contamination remains above the water table and poses a threat to groundwater. Interim groundwater treatment is in place for contaminant plumes in the 200 West Area. A record of decision for the large carbon tetrachloride plume (200-ZP-1 Operable Unit) has recently been signed (EPA 2008), and design and construction of the 200-ZP-1 groundwater plume containment and restoration system is underway. Active waste management facilities are operating to support the ongoing cleanup, and many of these facilities will be required to support cleanup until completion. These facilities include liquid effluent treatment, solid waste packaging and handling, solid waste disposal, spent fuel storage, analytical laboratories, and eventually the Waste Treatment and Immobilization Plant (WTP) for treatment of radioactive tank waste.

4.2 Key Challenges for Central Plateau Cleanup

The challenges for cleanup of the Central Plateau differ from those in the River Corridor. Most cleanup efforts along the River Corridor have focused on removal of contaminants to the Central Plateau. A portion of the plateau, however, will retain significant inventories of contamination and long-term waste management activities will be required to ensure protection of human health and the environment. The Inner Area will continue to be used until completion of all cleanup activities including tank waste treatment and closure.

Cleanup of the Central Plateau is a highly complex activity because of the large number of waste sites, surplus facilities, active treatment and disposal facilities, and areas of deep soil contamination. Past discharges of more than 450 billion gallons of liquid waste and cooling water to the soil have resulted in about 60 square miles of contaminated groundwater. Today, some plumes extend far beyond the plateau. Containing and remediating these plumes remains a high priority. Another priority has been removal of nuclear materials stored at the Plutonium Finishing Plant. Complete removal of the Plutonium Finishing Plant complex is expected by 2015. Removing waste sites in the approximately 65 square mile Outer Area of the plateau is underway. In tandem with River Corridor cleanup, removal of these Outer Area waste sites will shrink the footprint of active cleanup to an area of approximately 10 square miles. The following paragraphs describe some of the significant challenges facing the cleanup of the Central Plateau:

1. Number, Variety, and Complexity of Cleanup Actions

- **What is the challenge?** There are more than 800 waste sites on the Central Plateau and the cleanup of the plateau will involve a mix of containment, removal, and disposal (e.g., to ERDF), and in-place remediation (e.g., for groundwater). The number and variety of waste sites, surplus facilities (900+), active and inactive burial grounds, and active and inactive processing facilities means that many cleanup decisions must be coordinated. Also, the actions to implement cleanup decisions will need to be coordinated to make the efficient use of cleanup resources.
- **Where are we today?** The *Central Plateau Cleanup Completion Strategy* (DOE 2009c) seeks to arrive at timely and integrated decisions to implement efficient cleanup actions. Approaching remedy selection in a holistic, rather than sequential, manner will assure the public and taxpayers that remediation dollars are focused on the highest priority actions.

2. Need for Remediation of Deep Vadose Zone Contamination

- **What is the challenge?** A vast majority of Hanford's remaining in-ground contaminants reside in the vadose zone of the 200 Area Central Plateau, where reprocessing operations occurred. The vadose zone at this location is comprised of about 250 feet of water-unsaturated soil above groundwater that discharges to the Columbia River. Contaminants in this zone originated from intentional liquid discharges to cribs, retention basins, and trenches and from unintended tank waste releases in the tank farms. The deep vadose zone is defined as the region below the practical depth of surface remedy influence (e.g., excavation or surface barrier). Traditional remedies will have limited effectiveness to solve these problems because of contaminant depth, contaminant sorption, and the presence of a complex geologic, geochemical and microbial environment.
- **Where are we today?** DOE has initiated a series of treatability tests to identify and evaluate potential approaches to deep vadose zone contamination. These tests (DOE 2008b)

Vadose Zone

The vadose zone is the area between the ground surface and the water table. On the Central Plateau, the deep vadose zone is defined as the region below the practical depth of surface remedy influence. Central Plateau waste sites have discharged more than 450 billion gallons of liquid waste and cooling water to the ground. Much of this contamination, however, remains above the water table and has the potential to contaminate groundwater in the future.

What is the Deep Vadose Zone?

The deep vadose zone is defined as the region below the practical depth of surface remedy influence (e.g., excavation or barrier). In some areas of the Central Plateau, the deep vadose zone contains mobile contaminants that may impact groundwater in the future. These deeper sections of the vadose zone pose unique problems for characterization and remediation of contaminants.

focus on technologies for remediating deep technetium-99 and uranium. Initial field testing is underway for desiccation[17] technology to reduce the mobility of technetium-99 in the vadose zone. Additional tests are planned for sequestration of uranium to immobilize subsurface uranium. Refer to Section 4.6 for more details about deep vadose zone remediation.

3. Long-Term Effectiveness of Engineered Surface Barriers

- **What is the challenge?** Engineered surface barriers will be required for disposal sites on the Central Plateau including ERDF, the Integrated Disposal Facility, and the mixed-waste disposal trenches. There is growing recognition that surface and subsurface engineered barriers are an integral part of waste site remediation that is needed to minimize further contamination spread, allow time for additional radionuclide decay, and lower worker and environmental risks. Nonetheless, DOE also recognizes concerns remain over the long-term effectiveness of barriers and their expected longevity. Long-term assurance of barrier performance will build upon near-term research, analysis, and field-testing of each barrier component and the integrated barrier system to ensure that it will work as designed.
- **Where are we today?** The best example within the DOE complex of testing barrier performance is the 5-acre surface-engineered barrier built in 1994 atop a liquid waste site in the 200 East Area, called the Hanford Prototype Barrier. Barrier design was based on years of material and soil research that provided the foundation for barrier construction. Thus, the 1994 barrier was built from layers of natural sediments and human-made materials that control moisture and plant and animal entry while minimizing erosion. Barrier performance has now been monitored for 16 years—the longest period of any surface barrier in the DOE complex. Data confirm the barrier continues to achieve its performance goals. Results from such short-term (years to a few decades) research and tests are fed into models to continuously refine barrier performance predictions. In addition, post-remediation monitoring will be required to confirm and validate continued barrier performance. Performance monitoring and barrier maintenance would be carried out under the long-term site stewardship responsibilities (see Section 6.0).

4. Remediation of Legacy Solid Waste Burial Grounds

- **What is the challenge?** Sixty percent of Hanford's solid waste volume was disposed before 1970, mostly on the Central Plateau in large landfills using common waste management practices of the day. A key challenge for remediating these landfills is to obtain a common understanding of the potential risk the waste poses to the environment and how to best minimize that risk. Burial grounds could have the waste removed and disposed elsewhere on the Hanford Site, they could have an engineered surface barrier installed, or a combination of the two actions could be taken. If decisions are made to remove waste from some or all of the burial grounds, then robotics and surface enclosures would be required to ensure worker and environmental protection while characterization, removal, treatment, and/or repacking takes place.
- **Where are we today?** This remains one of Hanford's more challenging decisions. The decisions will involve comparing the risk of two options: (1) leaving waste where it is buried, with sufficient controls provided to contain contaminants from the accessible environment, or (2) incurring the risk and cost of exhuming more concentrated and dangerous materials and re-

[17] Desiccation involves drying a targeted portion of the vadose zone by injecting dry air and extracting soil moisture. This method reduces the amount of pore fluid that could transport contaminants, impedes water movement, and augments the impact of surface water infiltration controls.

disposing of them elsewhere on the site or at an offsite location. Public workshops, sponsored by DOE, Ecology and EPA, will be held to have a public dialogue on the remediation of Central Plateau radioactive landfills.

4.3 Strategy for Inner Area Cleanup

Recognizing that past decisions have already established permanent waste management areas within the Central Plateau Inner Area, the senior executives of the Tri-Parties have acknowledged that there will be a portion of the Central Plateau that will be required for continued waste management and containment of residual contamination. These existing commitments to continued waste management form the basis for defining the Inner Area. Reducing the area where this occurs to the smallest practical size is consistent with CERCLA and RCRA policy, DOE management goals, sound fiscal practices, and stakeholder input.

Figure 4-2 highlights DOE's initial proposed boundary for the Inner Area. In developing the proposed boundary, DOE considered:

- Waste disposal decisions already in place, such as ERDF, the Integrated Disposal Facility, the Naval Reactor Compartment Disposal trench, Trench 31 and 34 Mixed Waste Landfills, the U Plant canyon decision, and the US Ecology Washington Low-Level Radioactive Waste facility.
- Areas where post-closure and cleanup actions would likely result in engineered surface barriers even if some waste removal was performed, such as the remaining canyons, tank farms, portions of the Waste Treatment Plant, and existing low-level waste burial grounds.
- Areas where deep vadose zone contamination exists below the effective range of surface remedies, which will therefore likely require long-term surface controls.

As cleanup decisions are made and implementation progresses, the boundary of the Inner Area will be refined as appropriate to reflect the final management/containment area.

DOE's strategy for remediation of the Inner Area is to:

- Ensure that the configuration of the waste disposal facilities and residual contamination remaining after cleanup is protective of groundwater, human health, and ecological receptors.
- Apply the decision-making steps of the CERCLA process for the Inner Area's excess facilities, waste sites, burial grounds, and tank farm environmental media contaminated by radionuclides. Apply corrective action and closure requirements from RCRA and Washington state's *Hazardous Waste Management Act* (RCW 70.105), where applicable.
- Use sound technical cleanup principles as the basis for remedy selection to ensure that remedy selection criteria are applied consistently across the entire Inner Area.
- Use a comprehensive approach to evaluate remedial alternatives (1) to improve DOE's ability to evaluate each site in the context of the entire Inner Area cleanup, (2) to provide the best assurance that the full scope of potential risks and impacts are taken into account by decision-makers when selecting remedies for specific sites and (3) to appropriately balance other criteria such as long-term effectiveness and cost, and consider public acceptance across the entire Inner Area.

- Integrate groundwater and soil remediation using a defense-in-depth approach that applies a combination of actions including infiltration barriers, vadose zone monitoring, groundwater monitoring, and readiness to implement groundwater treatment, when necessary.
- Establish institutional controls that will complement engineered controls selected in decision documents. Continued federal ownership combined with institutional controls will ensure long-term protection of human health and the environment.
- As part of the CERCLA five-year review process, monitor the Inner Area to ensure cleanup remedies remain protective and enable early action in the event of emerging contaminant plumes that could potentially impact groundwater.

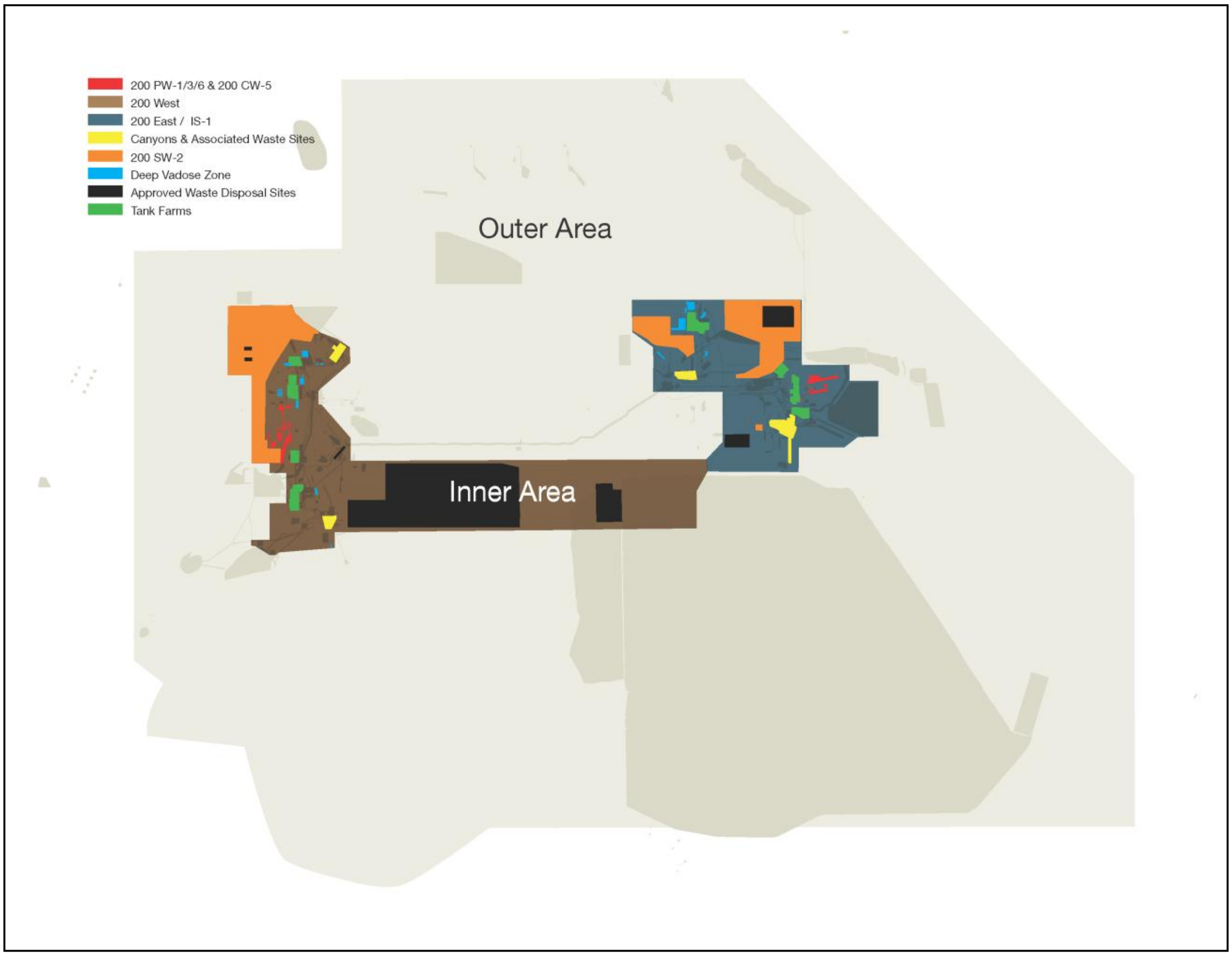

Figure 4-2. Initial Boundary for Central Plateau Inner Area

To achieve consistent and protective cleanup decisions for the Inner Area, DOE intends to develop cleanup levels that (1) satisfy applicable or relevant and appropriate regulatory requirements and (2) ensure that the selected remedies are protective of groundwater, protective of ecological resources, and are protective of human health for future surface users consistent with the designated reasonably anticipated land use. For protection of future surface users, exposure scenarios will be developed that are consistent with the long-term waste management obligations, institutional controls, and surveillance activities required for the Inner Area.

4.3.1 Surplus Facilities

The Central Plateau includes more than 900 facilities and structures including offices, shops, and trailers, as well as large processing, storage, or handling facilities such as the Plutonium Finishing Plant. A combination of regulatory decision paths will be applied to structures depending on the extent of radioactive or hazardous chemical contamination present. DOE will manage the process to determine what cleanup remedy will be used for most uncontaminated structures. Contaminated structures will be dismantled in accordance with DOE decommissioning policies or as CERCLA removal actions if a threat of release of hazardous substances to the environment is present.

At the Plutonium Finishing Plant, the final steps in Hanford's plutonium production mission were performed. DOE shut down the facility in 1996, and most of the plutonium inventory has been shipped to other sites. In 2009, all special nuclear material was removed from the Plutonium Finishing Plant complex. This included slightly irradiated spent fuel that has been transferred to the Canister Storage Building for safe, interim storage and the Plutonium Finishing Plant complex will be reduced to slab on grade. The complex included numerous facilities and infrastructure including waste lines, ditches, and drain fields that are now identified as plutonium- and carbon-tetrachloride-contaminated waste sites.

4.3.2 Canyon Facilities

The Central Plateau contains five large defense production facilities, referred to as canyons (see Figure 4-1) that originally were designed for fuel reprocessing operations. Four of the five canyons (i.e., U Plant, PUREX Plant, B Plant, and REDOX Plant) currently are in an inactive surveillance and maintenance mode. The fifth canyon, T Plant, is still part of active waste management operations. The canyon buildings range from approximately 500 feet long to approximately 1,000 feet long and are constructed of thick (5 to 9 feet) reinforced concrete. These facilities contain large amounts of residual radioactive material and pose a significant challenge for final disposition. Each canyon facility was supported by ancillary facilities and infrastructure including waste lines, ditches, and drain fields. Faced with this significant challenge, in the mid-1990s the Tri-Parties selected U Plant as a prototype for cleanup actions, and the CERCLA process was used to select its final configuration through a record of decision (EPA 2005). The U Plant canyon completion approach includes the following steps:

- Remove material and equipment requiring disposal at a different location; place contaminated equipment and materials in cells, below-ground galleries, or other below ground portions of the building.
- Demolish the upper structure of the canyon leaving demolition debris in place.
- Place a protective barrier over the demolished building and adjacent waste sites and demolished structures.

DOE expects to also apply the CERCLA process to reach final completion decisions for the remaining four canyon facilities (PUREX, REDOX, B Plant, and T Plant) and that similar completion decisions will be selected. RCRA requirements will also be incorporated into the completion decisions.

Similar to the decision structure anticipated for the waste sites above, each of the five canyons will be assigned to its own geographic zone for decision making and remedy implementation purposes. Nearby waste sites will also be included with the final canyon cleanup decisions. Each canyon-oriented zone will include associated facilities, infrastructure, pipelines, and waste sites.

4.4 Strategy for Outer Area Cleanup

The Outer Area covers approximately 65 square miles and contains more than 100 waste sites and structures scattered throughout largely undisturbed sagebrush steppe habitat (see Figure 4-2). Most of the waste sites in the Outer Area are small near-surface sites that will be removed for treatment as needed for onsite disposal or sampled to confirm that no additional action is required, except for implementation of appropriate institutional controls. The largest components of the Outer Area remediation are the ponds where cooling water and chemical sewer effluents were discharged and the BC Control Area where surface contamination was spread because of animal intrusion into a waste site.

Most of the Outer Area of the Central Plateau will be remediated to unrestricted surface levels comparable to the adjacent River Corridor to support the future reasonably anticipated land use of conservation/mining. Most of this area is reserved for the management and protection of archeological, cultural, ecological, and natural resources and related uses which require protection of human health and ecological pathways. Limited and managed mining (e.g., quarrying for sand, gravel, basalt, and topsoil for governmental purposes only) could also occur. Approximately 10 square miles of the Outer Area lies within the Industrial-Exclusive Area previously designated by the *Hanford Comprehensive Land-Use Plan* (DOE 1999) and the record of decision (64 FR 61615), and, following cleanup, would be available for uses consistent with that designation.

Outer Area remediation up to a depth of 15 feet is planned, to be consistent with the River Corridor and to enable authorized surface uses. Institutional controls will be required in limited areas as there may be restrictions on sub-surface use in portions of the Outer Area. Similar to cleanup of the River Corridor, cleanup of the Outer Area primarily involves removal of contaminated soil and surplus facilities with disposal in ERDF or other approved disposal locations. Monitoring and continued institutional control will likely be required at the large ponds in the Outer Area to allow radioactive contaminants to decay to levels suitable for unrestricted surface use, consistent with reasonably anticipated future land use of conservation/mining. A small area in the southeastern portion of the Outer Area containing two inactive landfills will be closed under Washington state landfill closure regulations (that is, placement of a cap and continued monitoring/institutional control). These lands are expected to remain under continued federal ownership and control.

DOE and the regulatory agencies have reached a tentative agreement (DOE 2010d) on the decision structure that will be used to make the CERCLA and RCRA decisions for the Outer Area. This agreement and associated Tri-Party Agreement change packages define the Outer Area decision structure and timing for completing remediation decisions.

Funding provided by the *American Recovery and Reinvestment Act* is supporting accelerated cleanup in the Outer Area. A variety of interim actions is underway to "shrink the active cleanup footprint" and support final cleanup decisions planned in an Outer Area record of decision as part of the new *Central Plateau Cleanup Completion Strategy* (DOE 2009c). Key activities include the demolition of the 212-N, 212-P and 212-R facilities (complete) and remediation of associated waste sites, and remediation of the large BC Control area (17 acres complete and greater than 65,000 tons of soil disposed at ERDF) based on recently completed aerial-based radiological survey. In addition, actions on dozens of small miscellaneous waste sites in the 200-MG-1 Operable Unit have been accelerated with *American Recovery and Reinvestment Act* funding. Characterization of Outer Area ponds and pipelines is also underway to support preparation of an Outer Area remedial investigation/feasibility study CERCLA documentation.

4.5 Strategy for Central Plateau Groundwater Cleanup

A key element of the Central Plateau cleanup strategy is groundwater remediation and protection. Protection of the groundwater and ultimately the Columbia River is essential. The groundwater beneath the Central Plateau is currently divided into four operable units (Figure 4-3) for purposes of remedial investigation:

- The 200-PO-1 Operable Unit is located in the southern half of the 200 East Area and includes extensive plumes of tritium, iodine-129, and nitrate.
- The 200-BP-5 Operable Unit is located in the northern half of the 200 East Area and includes contaminant plumes of uranium and technetium-99.
- The 200-UP-1 Operable Unit is located in the southern half of the 200 West Area and includes contaminant plumes of technetium-99 and uranium.
- The 200-ZP-1 Operable Unit is located in the northern half of the 200 West Area and includes a large plume of carbon tetrachloride and smaller plumes of technetium-99, chromium, trichloroethylene, and iodine-129.

For areas of groundwater contamination in the Central Plateau, the goal is remediation of the aquifer to achieve drinking water standards, unless determined to be technically impracticable. In those instances where remediation goals are not achievable in a reasonable time frame, programs will be implemented to contain the plume, prevent exposure to contaminated groundwater, and evaluate further risk reduction opportunities as new technologies become available. Near-term actions will be taken when appropriate to control plume migration until remediation goals are achieved. This goal is consistent with the *Hanford Site Groundwater Strateg*y (DOE 2004).

Currently, the 200 West Area groundwater operable units, 200-UP-1 Operable Unit (EPA 1997) and 200-ZP-1 Operable Unit (EPA 1995b), have interim pump-and-treat systems that attack the highest concentration portions of the plumes. DOE's strategy to enhance the existing interim pump-and-treat systems reflects the need to improve containment of contamination and to return the aquifer to drinking water standards. DOE is implementing this strategy through a remedy decision (200-ZP-1 Operable Unit, DOE 2008d and EPA 2008). DOE is currently designing and building the treatment system for the 200-ZP-1 Operable Unit and intends to include sufficient capacity to also treat the uranium and technetium-99 plumes that are part of the 200-UP-1 Operable Unit. This treatment system is anticipated to be used for 25 years with the intent of removing 95% of the mass of carbon tetrachloride currently in the aquifer.

Analyses supporting the record of decision for 200-ZP-1 indicate that an additional 100 year period of monitored natural attenuation will be needed for contaminant levels to reach cleanup levels. As part of the *Central Plateau Cleanup Completion Strategy* (DOE 2009c), the Tri-Party Agencies have agreed to address the future 200-UP-1 Operable Unit remedy decision as a future record of decision amendment to the 2008 200-ZP-1 Operable Unit record of decision, resulting in a consolidated remedy decision for the 200 West Area groundwater plumes. It is anticipated that the new combined remedial investigation/feasibility study and proposed plan for the 200 West Area groundwater plumes will be issued by September 30, 2010, with a record of decision in early 2011.

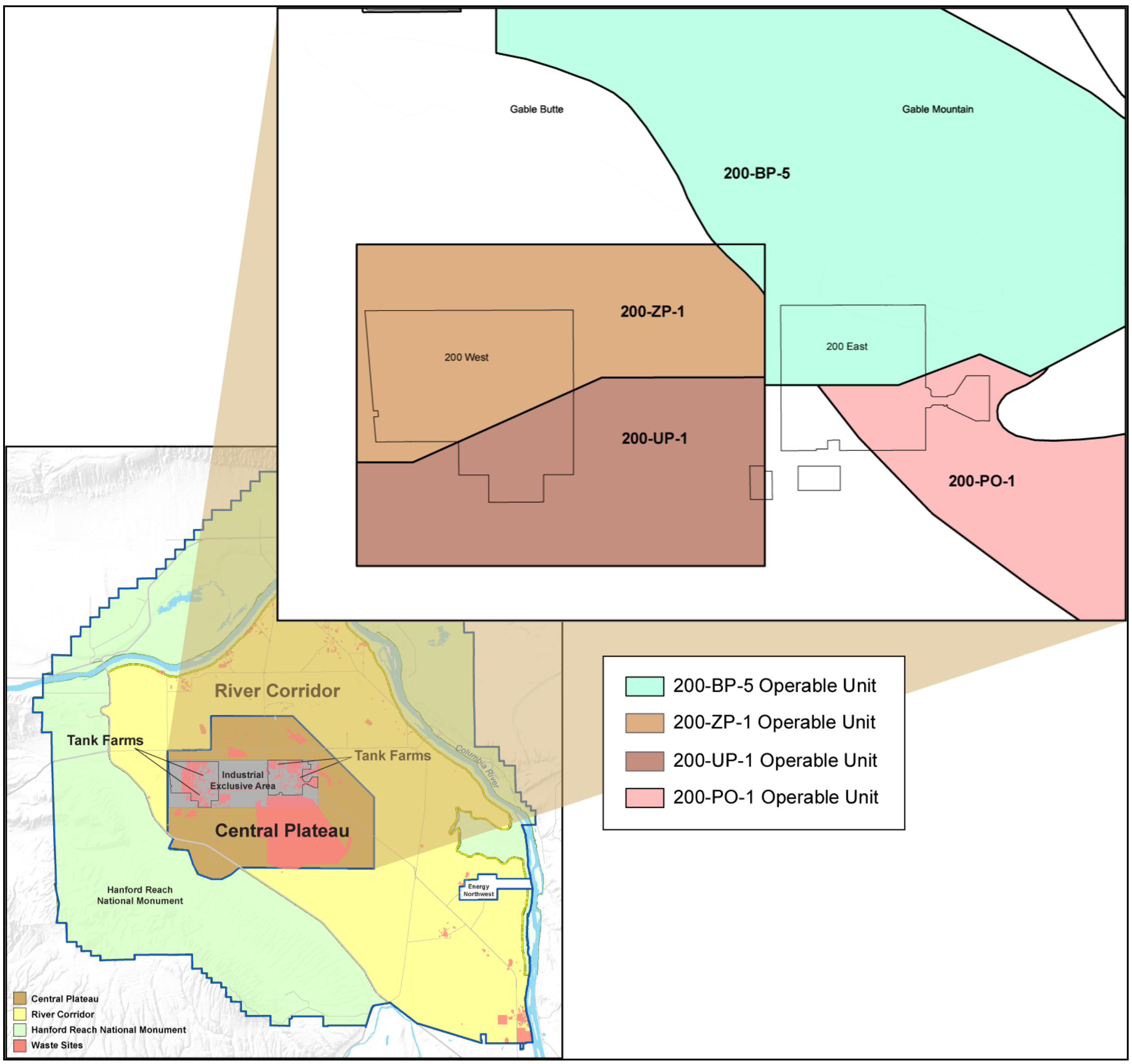

Figure 4-3. Groundwater Operable Units on the Central Plateau

DOE is scheduled to continue investigations and make remedy decisions for the 200 East Area groundwater plumes through a consolidated remedial investigation/feasibility study and proposed plan, anticipated to be issued by December 31, 2012. The consolidated remedial investigation/feasibility study and proposed plan will result in a combined record of decision for the East Area 200-BP-5 and 200-PO-1 Operable Units in 2013. For the 200-PO-1 Operable Unit, the likely response will be to monitor the existing iodine, tritium, and nitrate plumes to ensure that these plumes decay or attenuate to levels below drinking water standards within a reasonable timeframe. For the 200-BP-5 Operable Unit plumes of uranium and technetium-99, treatment options will be investigated to contain these plumes within the plateau and return the groundwater to drinking water standards.

DOE expects that groundwater plumes will be successfully contained within the Central Plateau and eventually returned to drinking water standards. Treatment systems have been installed and are being expanded to support this intent. DOE expects to simplify and streamline the regulatory decision process for final groundwater remedy selection by amending the existing 200-ZP-1 record of decision (EPA 2008) to encompass remedy decisions for the 200-UP-1 operable unit in the 200 West Area. Subsequently, DOE expects to issue one additional record of decision to encompass both 200-BP-5 and 200-PO-1 operable units in the 200 East Area.

4.6 Deep Vadose Zone Strategy

On the Central Plateau, the deep vadose zone is defined as the region below the practical depth of surface remedy influence (e.g., excavation or barrier). Deep vadose zone contamination presents unique characterization and remediation challenges. This type of contamination is not considered to pose environmental or health risks through direct exposure or uptake by biota. However, it is a primary concern as a conduit and ongoing source of groundwater contamination and exposure to human or ecological receptors through the groundwater pathway.

This subsurface environment consists of complex stratified and sometimes discontinuous layers of unconsolidated to semi-consolidated and water-unsaturated sediments that are in many places contaminated with radionuclides, metals, organics, and, in some cases, complex mixtures. Contamination originated from intentional liquid disposal to ground surface waste disposal facilities and from unintended tank waste releases. A number of the released contaminants (e.g., strontium,-90, cesium-137, and plutonium) have limited mobility in the vadose zone and groundwater. Other contaminants (e.g., technetium-99, uranium, and carbon tetrachloride) have the ability to migrate to regions deep within the vadose zone, reaching the groundwater in some locations and posing a long-term threat in others. A lack of understanding of key processes (e.g., biogeochemical and hydrologic) affecting contaminant migration makes it difficult to predict the location, transport, and fate of these contaminants in the subsurface. These factors also make it difficult to design and deploy sustainable remedial approaches and monitor long-term contaminant behavior and the performance of remedial actions. These and other issues make the deep vadose zone contamination one of the most challenging remediation problems at the Hanford Site.

DOE has initiated a series of treatability tests to identify and evaluate potential approaches to deep vadose zone contamination. These tests (DOE 2008b) are focused on technologies to remediate deep technetium-99 and uranium. Initial test plans have been developed for field testing of desiccation technology to reduce the mobility of technetium-99 in the vadose zone. Additional tests have been planned for sequestration of uranium to immobilize subsurface uranium.

At the completion of all Central Plateau remediation activities, there are some waste sites where soil contamination will remain, e.g., under caps or very deep contaminants. Inclusion of an integrated monitoring approach that is designed to provide early warning of significant contaminant movement or impact to groundwater is a necessary part of the long-term institutional controls identified in source and groundwater records of decision. A comprehensive, defense-in-depth approach could include monitoring of the applied remedy (such as monitoring installed into barriers to detect elevated soil moisture beneath selected areas of the remedy), monitoring in the vadose zone beneath the remaining contamination, and monitoring in the groundwater. This defense-in-depth approach includes the following elements:

- Implementation of ***appropriate surface remedies*** (e.g., excavation or infiltration barriers) to mitigate the potential impacts of deep vadose zone contamination.
- Inclusion of an ***integrated groundwater and vadose zone monitoring system*** that is designed to provide early warning of significant contaminant movement or impact to groundwater.
- Implementation of ***groundwater treatment systems*** that can expand to handle emerging plumes, when necessary.
- Continued investment in ***treatability tests*** to evaluate potential approaches to remediate deep vadose zone contamination.
- Sustained investment in ***advanced science and technology solutions*** to tackle deep vadose zone challenges including characterization, prediction, remediation, and monitoring.
- Periodically revisit the ***effectiveness of remedies*** and possible changes in environmental conditions through the CERCLA five-year review process.

This effort is necessary to improve understanding of the deep vadose zone problem, to develop cost effective characterization and monitoring methods, and to develop effective remediation approaches that do not rely solely on extraction of contaminated groundwater.

An important additional activity that is related to the ***defense-in-depth*** monitoring approach is DOE's commitment to initiate a series of treatability tests to identify and evaluate potential approaches to deep vadose zone contamination. If viable technologies are developed here or elsewhere, then remedies could be selected and implemented across broad regions of the Central Plateau in a manner analogous to groundwater remedy selection. If viable technologies are not available, then long-term institutional controls focused on groundwater monitoring would provide early warning of new contamination entering the groundwater below the Central Plateau and would provide time to implement existing remedies such as groundwater pump-and-treat systems. To complement these treatability tests, a new research and technology development approach is needed. Given the large number and depth of vadose zone plumes in the 200 Area, it is clear that a holistic understanding of water, gas, and chemical exchange within this complex region is needed to improve long-term predictions of contaminant movement and flux into the groundwater. Through improved understanding of the deep vadose zone region, DOE intends to devise and demonstrate effective remedial actions that control the migration of deep subsurface contaminants so as to protect groundwater.

The Tri-Parties have agreed to realign operable units within the Inner Area of the Central Plateau to be generally more geographic in nature rather than based on process history (DOE 2010d). In addition, a deep vadose zone operable unit will be created to support investigation and remedy selection for this challenging type of waste site. These investigations and remedy selection actions will be coordinated with similar actions for past releases to the soil from single-shell tank farms. Many deep vadose zone sites are in close proximity to tank farm waste management areas, and commingled tank farm and non-tank farm vadose zone plumes exist. A common approach will be applied to ensure that consistent and protective remedies are developed. For waste sites that are part of the geographic operable units (e.g., 200 West Inner Area and 200 East Inner Area), it is anticipated that deep vadose zone sites will be identified for which remedies protective of groundwater cannot be assured and for which further technology development and treatability testing will be needed. In this situation, these sites will be evaluated first for the need to apply interim actions (e.g., soil removal or interim barriers) and then these sites will be assigned to the deep vadose zone operable unit for final remedy selection. These final remedies will be supported by the ongoing treatability testing and science and technology development efforts that DOE has initiated for the deep vadose portion of the Central Plateau. It is expected that some of these final remedies will not be implemented until adjacent tank farms are ready for final closure, which could be two or more decades in the future.

4.7 Ongoing Waste Management

The Central Plateau contains the primary waste management facilities that support cleanup. These treatment, storage, and disposal facilities will continue to be used and, in some cases, expanded from current capabilities, e.g., disposal of immobilized low-activity waste from tank waste processing or systems for treatment of contaminated groundwater. It is DOE's intent to consolidate these services within the central portion of the plateau compliant with the *Hanford Comprehensive Land-Use Plan EIS* (DOE 1999). As a pre-scoping document to the *Hanford Comprehensive Land-Use Plan*, in 1992, the Hanford Future Site Uses Working Group (Hanford Future Site Uses Working Group 1992) recommended:

> "***Use the Central Plateau Wisely for Waste Management.*** *Wastes would be moving in the Central Plateau from across the site. Waste storage, treatment and disposal activities in the Central Plateau should be concentrated within this area as well, whenever feasible, to minimize the amount of land devoted to , or contaminated by, waste management activities.*"

One of the waste management operations provided within the Central Plateau is the management of used fuel and nuclear materials that will be removed to off-site locations. Some of these materials are yet to be generated, e.g., immobilized high-level waste from Hanford's tanks. Therefore, safe management of these materials will be required for decades. Any new waste management or disposal facilities that are needed to support mission completion (e.g., for completion of the tank waste mission) will be located within the Inner Area of the Central Plateau.

DOE has completed shipping special nuclear material (plutonium) from the Plutonium Finishing Plant to an off-site facility. Transuranic waste is being shipped to the Waste Isolation Pilot Plant in New Mexico. This waste results from the retrieval of stored waste and from transuranic-contaminated materials that are newly generated as a result of cleanup operations. Funds provided by the *American Recovery and*

Reinvestment Act are supporting increases in the effort to retrieve stored suspect transuranic waste. Activities are also underway to develop and implement new retrieval capabilities for difficult to handle items such as larger packages, failed containers, and highly radioactive wastes. Engineering work is also underway to identify processing and disposal capabilities needed to deal with waste streams that currently do not have a defined treatment or disposal pathway.

Nearly 2,000 cesium and strontium capsules are currently stored under water inside the Waste Encapsulation and Storage Facility adjoining the B Plant canyon facility. Current planning indicates that B Plant would be next in line after U Plant for completion of final disposition activities. The cesium and strontium capsules will need to be removed prior to starting those efforts. One option would be to pack the capsules in canisters and store them onsite and above ground on an interim basis pending final disposition.

The following operations are part of Hanford's waste management efforts (see Figure 4-1):

- Package, certify, and ship transuranic waste to the Waste Isolation Pilot Plant in New Mexico.
- Operate solid low-level waste and mixed low-level waste disposal facilities including solid waste burial grounds, the Integrated Disposal Facility, and the ERDF.
- Operate liquid waste treatment and disposal facilities including the Effluent Treatment Facility and Liquid Effluent Retention Facility.
- Operate the Canister Storage Building to provide safe storage for spent fuel and immobilized high-level waste pending ultimate disposition.
- Operate other waste management facilities including the Waste Receiving and Processing Facility, Central Waste Complex, 222-S Laboratory, and the Waste Sampling and Characterization Facility.

As these facilities complete their missions, they will undergo final remediation through RCRA treatment, storage, and disposal unit closure or deactivation/decommissioning per DOE or CERCLA requirements.

Waste disposal decisions, both for low-level and mixed low-level waste, will be supported by performance assessments that meet DOE requirements (DOE Order 435.1), and in some cases, RCRA permit requirements (e.g., for an Integrated Disposal Facility).[18] The disposal and closure conditions are intended to ensure that these sources do not pose a future threat to the groundwater. In addition to performance assessments for individual disposal facilities, DOE is required to maintain a composite analysis[19] (per DOE Order 435.1) that is intended to ensure that the cumulative impact from Hanford Site disposal and closure actions comply with DOE performance criteria for radiological exposure. This analysis will draw upon the results of other remediation, closure and disposal decisions.

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[18] DOE is currently preparing the *Tank Closure & Waste Management Environmental Impact Statement* (DOE 2009e). Among other things, this EIS evaluates on-site disposal alternatives for Hanford's low-level waste and mixed low-level waste and low-level waste and mixed low-level waste from other DOE sites.

[19] After completion of the *Tank Closure and Waste Management Environmental Impact Statement*, DOE plans to update the Composite Analysis by building upon the EIS's cumulative impact analysis.

4.8 Central Plateau at Cleanup Completion

A significant amount of hazardous and radioactive material will remain on the Central Plateau after cleanup actions have been implemented. For example, current decisions that leave contamination on the Central Plateau include the ERDF record of decision (EPA 1995a) and the U Canyon record of decision (EPA 2005). Although many Central Plateau cleanup decisions remain to be made, DOE anticipates that additional decisions will also leave contamination in the Central Plateau, consistent with the Inner Area concept. Accordingly, institutional controls will be required after completion of cleanup for as long as potential hazards exist.

Cleanup of Hanford's Central Plateau will take decades to complete. The Central Plateau cleanup schedule is driven by the construction of the WTP and the subsequent retrieval and treatment of tank waste. Current schedules show completion of cleanup for the Central Plateau by 2050 time frame. The CERCLA five-year review process will provide a continuing mechanism to ensure that remedial actions, including institutional controls, have been successfully implemented and are protective. In addition, RCRA post-closure care requirements will need to be met.

DOE anticipates seeking site completion status for the Central Plateau in accordance with CERCLA closeout procedures for NPL Sites (EPA 2000) when Central Plateau groundwater meets drinking water standards for key contaminants, all cleanup remedies are implemented, and institutional controls are in place. A final close-out report will be developed that describes how Central Plateau cleanup was accomplished and will provide overall technical justification for site completion.

You may find more detailed information about Central Plateau cleanup and remediation in the following resources:

- Records of decision and 5-year CERCLA reviews can be accessed at the EPA Region 10 site: http://yosemite.epa.gov/R10/CLEANUP.NSF/sites/Hanford
- *Central Plateau Cleanup Completion Strategy,* DOE/RL-2009-81, Rev. 0, (DOE 2009c).
- DOE Hanford Site web site at http://www.hanford.gov

5.0 Tank Waste Cleanup Completion Strategy

In 1998, Congress directed the Secretary of Energy to establish the Office of River Protection (ORP) at the Hanford Site in Washington state to safely retrieve and treat Hanford's tank waste and close the tank farms to protect the Columbia River. At the Hanford Site, DOE-ORP is responsible for managing all aspects of tank waste storage, waste retrieval, treatment, construction of facilities, interim storage of immobilized waste, and waste disposal.

The tank farms (see Figure 4-1) include 177 underground storage tanks (149 single-shell tanks and 28 double-shell tanks) containing approximately 53 million gallons of chemically hazardous radioactive waste from past nuclear processing operations. Sixty-seven of Hanford's tanks have or are suspected to have collectively leaked up to 1 million gallons of waste into the ground. The tanks were built between 1943 and 1986. The first tanks were built with a single carbon steel wall and floor that was covered by a dome and outer shell made of concrete. Beginning in 1968, tanks were built with two carbon steel liners along the walls and floor and a single steel dome liner, thus 'double-shell' tanks.

Summary of Tank Waste Cleanup Progress (through FY 2009)

- Tank safety issues resolved – 60 tanks removed from Congressional safety Watch List (1994 – 2001).
- Interim stabilization of 149 single-shell tanks completed in 2004 – safely removed more than 3 million gallons of remaining pumpable liquid.
- As of September 2009, retrieval of seven single-shell tanks has been carried out, and four additional single-shell tanks have been retrieved to the limits of technology.
- Interim measures put in place to mitigate the effects of past tank leaks including construction of an interim barrier at T Tank Farm, the largest past tank leak.
- Construction of Waste Treatment Plant complex underway. The overall project is about 53% complete.

DOE-ORP is responsible for retrieving and treating Hanford's tank waste and for closing tank farms to protect the groundwater on the Central Plateau and thereby protect the Columbia River. This includes the following activities:

- Complete construction of the Waste Treatment and Immobilization Plant (WTP).
- Provide sufficient treatment capacity to enable tank waste mission completion (DOE 2008g).
- Begin treatment and immobilization of tank waste to enable tank retrieval to proceed at a rate that supports treatment capacity.
- Store tank waste safely until it is retrieved for treatment.
- Store immobilized high-level waste safely pending ultimate disposition.
- Implement remedies that protect the groundwater and environment from past tank farm releases in cooperation with surrounding waste sites and groundwater operable units.
- Complete closure of tank farms in coordination with, and consistent with the Central Plateau cleanup completion strategy.

The current strategy for tank waste cleanup is anchored by the Tri-Party Agreement and the proposed Consent Decree (Washington v. DOE, Case No. 08-5085-FVS, 2010) and subsequent Tri-Party Agreement modifications. The success criteria for meeting these agreements are detailed in DOE-ORP's System Plan (DOE 2008g) and in Table 5-1.

Table 5-1. Tank Waste Cleanup Metrics and Dates

Metric	Complete By
Complete C Tank Farm retrievals (10 tanks)	September 2014
Close C Tank Farm	June 2019
Waste Treatment Plant “hot start”	December 2019
Waste Treatment Plant “initial operations”	December 2022
Complete nine single-shell retrievals beyond C Tank Farm	September 2022
Complete all single-shell tank retrievals	December 2040
Close all single-shell tank farms	January 2043
Complete tank waste treatment	December 2047
Close all double-shell tank farms	September 2052

The cornerstone of the DOE-ORP tank waste cleanup project at Hanford is the WTP (Figure 5-1). Efforts are underway to design, build, and commission the WTP. The WTP will use a proven technology − called vitrification − to immobilize chemical and radioactive waste from the tanks in an exceptionally sturdy form of glass to isolate it from the environment. The WTP project is an unprecedented engineering and construction undertaking.

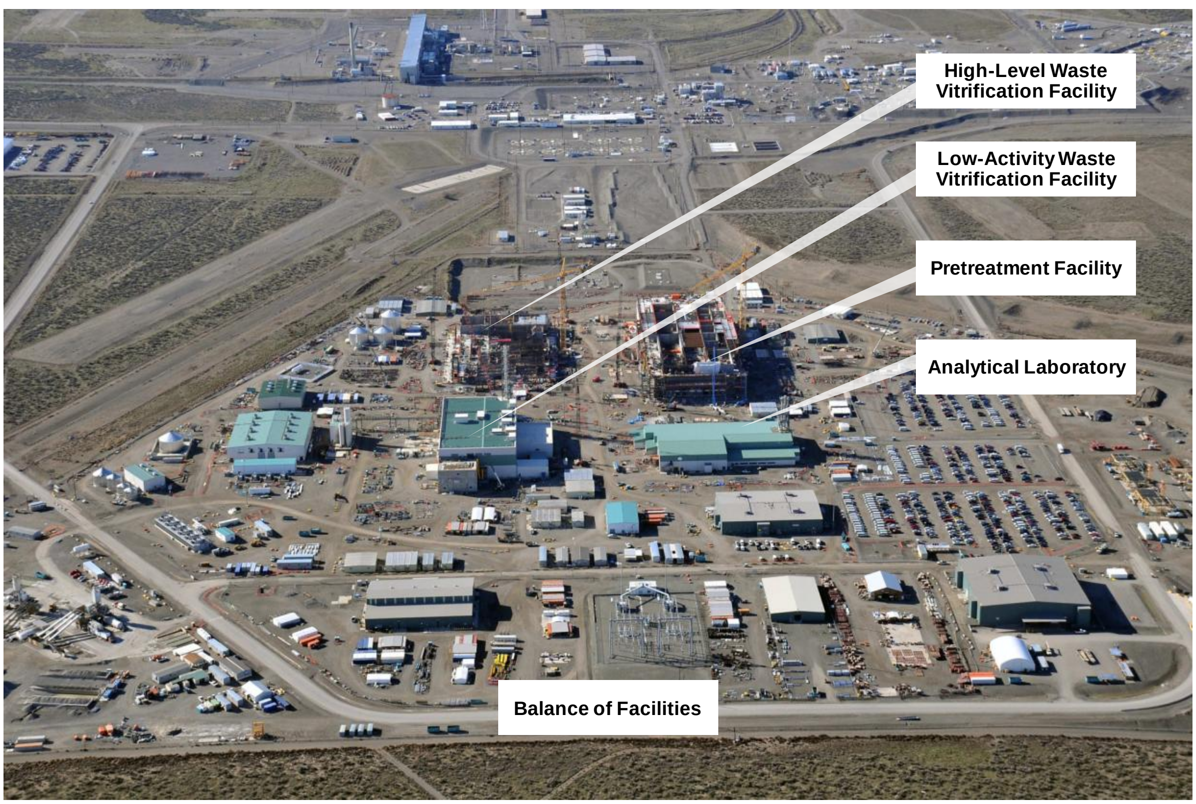

Figure 5-1. Aerial Photo of Waste Treatment and Immobilization Plant

5.1 Key Challenges for Tank Waste Cleanup

Hanford's biggest challenge is 53 million gallons of radioactive waste stored in 177 underground tanks. Sixty-seven of these tanks have or are suspected to have leaked up to 1 million gallons of waste. Releases from some single-shell tank farms have reached groundwater. DOE expects the impact from these releases to increase in the future unless prompt actions are taken. Today, actions are being taken to slow the movement of the contaminants. DOE is also recovering the contaminants once they reach groundwater. More work is needed to permanently remove the threat from tank waste. The most important step in fixing this problem is to retrieve the waste from single-shell tanks and put it into double-shell tanks. Then, the waste must be fed to the Waste Treatment Plant for processing and placed into solid glass waste forms. Retrieval and treatment of tank waste will remain the most important and difficult task facing completion of cleanup for several decades to come. Completion of tank waste cleanup has faced many challenges in the past and will continue to face challenges in the future. The following paragraphs identify the key challenges for tank waste cleanup:

1. Continue to Safely Store Waste in Single-Shell and Double-Shell Tanks

- **What is the challenge?** Extension of the tank mission (DOE 2008g) until increases the importance of maintaining safe storage of waste in single-shell and double-shell tanks. The single-shell tanks have exceeded their intended design lives (~25 years) and 67 single-shell tanks have or are suspected to have leaked in the past. Four double-shell tanks have exceeded their original design lives, and the remaining 24 double-shell tanks will do so before tank waste treatment is scheduled to be complete.
- **Where are we today?** DOE-ORP actively maintains programs to ensure the integrity of both double-shell and single-shell tanks. These efforts include structural analyses to evaluate and confirm tank structural integrity; analyses of tank corrosion and tank liner degradation to assess future leak potential and to identify methods to prevent leaks (e.g., adjustments to tank chemistry to control corrosion); and improved methods for leak monitoring and mitigation. Refer to Section 5.4 for more details about safe storage.

2. Successfully Retrieve Waste and Feed Waste to Treatment

- **What is the challenge?** Based on retrieval system experience, waste in some tanks will be difficult to retrieve. Use of multiple technologies may be required in a single tank to meet retrieval requirements, including retrieval rates needed to maintain feed delivery for treatment purposes. Single-shell tanks that have previously leaked may present additional challenges. Also, the potential exists for a single-shell tank to leak during retrieval operations. In this event, retrieval may be halted and a different retrieval method deployed.
- **Where are we today?** DOE-ORP is continuing to evaluate and deploy improved retrieval methods, is developing leak monitoring and response methods, and is evaluating the leak integrity status of single-shell tanks. Refer to Section 5.3 for more details about retrieving waste.

3. Overall Waste Treatment Capacity

- **What is the challenge?** To achieve current commitments, extra capacity will be needed to treat low-activity waste in addition to the facilities currently under construction. Options for providing this increased capacity include addition of a second low-activity waste vitrification plant or use of alternate immobilization technology such as bulk vitrification or steam reforming. In addition to low-activity waste immobilization, supplemental pretreatment capacity may also be required to mitigate the issue of excessive sodium. The throughput of the overall treatment system is affected by the amount of waste that can be captured in the vitrified high-level waste form (waste loading). Waste loading is sensitive to the presence of non-waste elements, such as aluminum. Aluminum can be reduced in the high-level waste feed by adding sodium hydroxide, but increases in sodium content increase the amount of low-activity waste to be immobilized, which can also lengthen the time needed complete the mission. Sodium is also added to double-shell tanks for corrosion control and is used in a pretreatment step called caustic leaching.

- **Where are we today?** To tackle this challenge, DOE-ORP is evaluating options including enhanced waste loading for low-activity and high-level waste forms, expansion of low-activity waste immobilization capacity, and methods of blending or pre-conditioning waste fed to the treatment plant to improve operational efficiency.

4. Maintain and Upgrade Treatment of Secondary Waste to Meet Throughput and Safe Disposal Requirements

- **What is the challenge?** The current Effluent Treatment Facility is inadequate to treat the projected liquid secondary waste stream that will be generated by the WTP. This liquid secondary waste stream will also contain contaminants (e.g., iodine-129 and technetium-99) that pose a long-term threat to groundwater and will need to be contained within a suitably robust waste form.
- **Where are we today?** DOE will need to upgrade the Effluent Treatment Facility to handle the quantity and compositions of liquid secondary waste generated at the WTP. Secondary waste forms will need to be investigated and developed to ensure that these materials can be safely disposed of in the Integrated Disposal Facility.

5. Reach Timely Tank Closure Decisions and Meet Closure Requirements

- **What is the challenge?** Current commitments call for closure of the first tank farm, C Tank Farm, in 2019. To accomplish this, (1) C Tank Farm retrievals need to be completed, (2) a record of decision from the *Tank Closure and Waste Management Environmental Impact Statement* (DOE 2009e) must be attained, (3) DOE and regulatory approval of closure plans must be achieved, and (4) closure actions specified in those closure plans must be completed. Achieving these first-of-a-kind milestones requires close and continuing cooperation between DOE and Ecology.
- **Where are we today?** To facilitate this process, DOE and Ecology are conducting a joint process to develop a performance assessment for C Tank Farm. This performance assessment will provide a tool for both parties to evaluate the merits of closure actions. In addition, DOE and Ecology have initiated a closure demonstration project that will evaluate prototype actions related to tank farm closure. This demonstration is also intended to resolve regulatory challenges to enable timely tank closure.

5.2 Treatment

The long-standing strategy for the treatment of Hanford tank waste is to immobilize the waste as a glass product that meets durability standards. The strategy includes pretreatment, i.e., a separation of key radionuclides from relatively benign elements so that the key radionuclides can be immobilized and stored pending ultimate disposition and the remaining waste (low-activity waste) can be immobilized and would stay on-site in a disposal facility. DOE-ORP is constructing the WTP, which will safely treat all of the high-level waste fraction contained in the tank farms,[20] and will immobilize approximately one-half of the low-activity waste in the WTP Low-Activity Waste Vitrification Facility. An additional facility will be developed to immobilize the remaining low-activity waste. To treat the remaining output and to optimize completion of cleanup activities, DOE is evaluating other technologies to immobilize low-activity waste. DOE is currently preparing the *Tank Closure and Waste Management Environmental Impact Statement* to evaluate reasonable alternatives for supplemental treatment of tank waste and for closure of single-shell tanks.

The WTP is a 65-acre complex with three major nuclear facilities, an analytical laboratory, office space, support facilities, and utilities. Started in 2001, the WTP is expected to be completed in 2019. The five major components of the WTP are:

- Pretreatment Facility – Separate the waste.
- High-Level Waste Facility – Vitrify high-level waste; the facility has the capacity to process all the output from the Pretreatment Facility.
- Low-Activity Waste Facility – Vitrify the low-activity waste; the facility has the capacity to accept approximately 50 percent of the output from the Pretreatment Facility.
- Analytical Laboratory – To test the quality of the glass.
- Balance of Facilities – Includes more than 20 support facilities

5.3 Retrieval of Tank Waste

Prior to start of full WTP operations, tank waste retrieval is limited by the amount of available unused space in double-shell tanks and potential interim pretreatment capacity. DOE intends to focus waste retrieval activities on the closure of C Tank Farm. The retrieval efforts at C Tank Farm will provide additional experience to develop and optimize retrieval technologies and will help retain a proficient work force to support the beginning of retrieval operations when the WTP begins operating. This phase of retrieval will provide valuable insights into the cost-effectiveness of alternative retrieval methods, new information regarding the composition of remaining tank residuals, and information regarding the structural integrity of the emptied tanks.

The initial tank retrieval sequence has been agreed upon and calls for completion of retrieval from Waste Management Area C by September 30, 2014. Nine additional single-shell tanks will be selected by DOE, after consultation with the state of Washington, to be retrieved by December 31, 2022. The sequence and schedule for retrieving the remaining single-shell tanks will be the subject of future negotiations between DOE and the state of Washington.

The extent of retrieval is such that tank residues are not to exceed 360 cubic feet in 100 series tanks (75-foot diameter) and 30 cubic feet in 200 series tanks (20-foot diameter). Those residual volumes

[20] The term high-level waste refers to the fraction of the tank waste containing most of the radioactivity that will be immobilized into glass and disposed at an off-site repository; the term low-activity waste refers to the fraction of the tank waste that will be immobilized into glass and disposed on site.

represent 1% of the average volume of waste stored in the respective tank series for all 149 single-shell tanks and correspond to the 99% minimum retrieval goal established for retrieval from all tanks.[21]

Hanford currently has developed and applied multiple retrieval methods including sluicing using raw water or supernatant liquid in the tank, chemical dissolution methods that break down hard to remove solids, and dry retrieval methods such as vacuum retrieval. To carry out retrieval for those tanks covered by the proposed consent decree, two retrieval technologies would be employed. However, if the residual volume is achieved with the first technology, that technology would be used to the limits of its capability, and a second technology would not be employed. If the residual volume is not achieved, there are provisions for determining if additional methods should be deployed. Retrieval is considered complete after these attempts.

5.4 Safe Storage

DOE recognizes that single-shell tanks will be required to safely store waste beyond their original intended life. The intent of this portion of the tank waste mission is to safely store tank waste until it is retrieved. A double-shell tank integrity program has been in place since the mid-1990s. Recently, DOE-ORP initiated a similar integrity program for single-shell tanks to review the structural and leak integrity of single-shell tanks and to develop a way to minimize further degradation of the single-shell tanks. Development of the integrity program for the single-shell tanks has been enhanced by the use of a panel of experts from academia and industry that DOE-ORP uses to provide recommendations and oversee the program.

DOE-ORP actively maintains the integrity of both double-shell and single-shell tanks. These efforts include structural analyses to evaluate and confirm tank structural integrity; analyses of tank corrosion and tank liner degradation to assess future leak potential and to identify methods to prevent leaks (e.g., adjustments to tank chemistry to control corrosion); and improved methods for leak monitoring and mitigation. An in-depth structural analysis has been performed for the double-shell tanks and a similar effort is currently underway for the single-shell tanks. The double-shell tank integrity program uses ultrasonic-testing devices to measure the thickness of the tank liner and look for cracks to ensure that the tank liners are not being compromised due to corrosion. Probes are used within select double-shell tanks to monitor corrosion or the potential for corrosion. Inspection of the double-shell tanks using a camera inserted into the tanks is also performed. DOE-ORP is in the process of starting a similar visual inspection of the single-shell tanks. Single-shell tanks are continually surveyed to ensure that the concrete domes retain their strength. A deflection in the dome would indicate structural distress. This work is important to ensure safe and environmentally sound completion of the Hanford cleanup mission.

Tank Waste Closure and Waste Management Environmental Impact Statement

DOE is preparing a new environmental impact statement (EIS) that, among other things, is evaluating options for closing Hanford's single-shell tanks and for treating the waste retrieved from those tanks (DOE 2009e). A broad range of tank closure options are defined and evaluated. These options range from "no action" to "clean closure" which could require much more extensive waste retrieval than is currently planned and complete removal of tanks, nearby equipment, and underlying contaminated soil. A record of decision resulting from this EIS will allow DOE to move forward with tank closure.

[21] Extent of retrieval is subject to the provisions in Appendix H of the Tri-Party Agreement.

5.5 Tank Farm Closure

The overall objective of closing the tank farms is to protect human health and the environment and protect the groundwater on the Central Plateau. Closure of tanks and tank farms is being evaluated in the forthcoming Tank Closure and Waste Management Environmental Impact Statement (DOE 2009e). The single-shell tank closure process is described in Tri-Party Agreement (Ecology et al. 1989), Appendix I, Section 3.1. As described in Appendix I, waste management areas will be closed in coordination with other closure and cleanup activities on the Central Plateau. Also, closure of the single-shell tank system will be done in a manner that integrates the requirements of RCRA treatment, storage, and disposal facility closure; RCRA corrective action; the AEA; and the Central Plateau CERCLA remedial actions.

Closure of the tank farms will incorporate the following actions:

- Closure of tank farms will require that remedies are in place for all contaminated media, including vadose zone and groundwater that has been impacted by past tank farm releases. AEA, RCRA and CERCLA requirements need to be met. Groundwater remedy decisions will be reached through the CERCLA process. DOE intends to also use the CERCLA process to reach remediation decisions for vadose zone regions on the Central Plateau, including the regions beneath tank farms.
- Transfer lines run across tank farm boundaries and connect tank farms with separations facilities, former liquid discharge sites, and other tank farms. Investigation and remediation of these transfer lines will be integrated so that common approaches and solutions are developed and implemented.
- If landfill closure is supported by the Tank Closure and Waste Management EIS record of decision, the final closure configuration for tank farms may involve a surface barrier. The optimal size of the surface barrier may extend beyond the physical boundaries of the tank farm, and non-tank farm waste sites could fall within the footprint of the barrier. Selecting the remedy for those waste sites will be coordinated with final closure of the tank farm through the geographic approach to cleanup.

DOE is using the 16 tanks in C Tank Farm to develop closure plans for single-shell tanks. Completion of tank waste retrieval for this farm is projected for 2014. In parallel, DOE will conduct a prototype closure demonstration for this tank farm zone that will identify and resolve decision pathways and interface requirements for all elements within the zone. This demonstration is also intended to resolve regulatory challenges to enable timely tank closure. The lessons learned from this prototype effort will be applied to the remaining tank farms following completion of closure for Waste Management Area C.

To support closure decisions, the DOE-ORP is developing a performance assessment for Waste Management Area C. This effort is supported by a series of cooperative technical exchanges among DOE and its contractors, the Nuclear Regulatory Commission, Washington State Department of Ecology, EPA, Tribal Nations, the State of Oregon, and Hanford stakeholder representatives. The intent of the performance assessment is to provide a comprehensive understanding of the long-term performance of the closure system to ensure that closure actions are protective of the human health and the environment.

5.6 Coordination with Central Plateau

Coordination is necessary to successfully complete the cleanup mission at the tank farms and the Central Plateau. The Tri-Parties have recently signed an Agreement in Principle to improve the coordination between cleanup of tank farm and non-tank farm soil, including deep vadose zone contamination. (DOE 2010a, March 30, 2010, *Agreement in Principle: Negotiation of Hanford Federal Facility Agreement and Consent Order Revisions to Address Soil Contamination from Single Shell Tanks and Coordination of Investigation and Remediation of this Contamination with Other Deep Vadose Zone Investigation and Remedial Actions*) The primary areas where coordination will be required between the Tank Waste Cleanup component and the Central Plateau Cleanup component are listed below:

- Storage of immobilized high-level waste canisters in the Canister Storage Building.
- Disposal of immobilized low-activity waste in the Integrated Disposal Facility.
- Treatment and disposal of secondary waste from WTP and supplemental treatment operations.
- Remediation of past releases from tank farms in coordination with adjacent waste sites.
- Treatability testing of deep vadose zone remediation for past tank farm and non-tank farm releases to ensure long-term protection of groundwater.
- Maintenance of site access controls to provide a public safety buffer during WTP and other waste management operations.
- Investigation and remediation of transfer lines that cross waste management area boundaries.
- Coordination of the final closure configuration for tank farms with remediation of adjacent waste sites.
- Conduct of pre- and post-closure groundwater monitoring for tank farms and adjacent facilities.

You may find more detailed information about Tank Waste cleanup and remediation in the following resources:

- *River Protection Project System Plan*, ORP-11242, Revision 4. http://www.hanford.gov/orp/uploadfiles/ORP-11242%20-%20%5B0909150188%5D%5B1%5D.pdf (DOE 2008g)
- *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*, DOE/EIS-0391, (DOE 2009e) October 2009.
- DOE Office of River Protection web site at http://www.hanford.gov/orp
- Hanford Vitrification Plant web site at http://www.hanfordvitplant.com

6.0 Long-Term Stewardship

Because the completion of cleanup will not result in the total elimination of all contamination (radiological and/or hazardous), long-term stewardship activities will be required for portions of the Hanford Site to ensure protection of human health and the environment. At the conclusion of the cleanup activities, residual contamination will remain, both in surface disposal facilities and in subsurface media.

This section describes the key elements of post-cleanup activities including the Hanford Long-Term Stewardship Program, maintenance of institutional controls, and conduct of CERCLA five-year reviews.

> **Long-Term Stewardship**
>
> "*…refers to all activities necessary to ensure protection of human health and the environment following completion of remediation, disposal, or stabilization of a site or a portion of a site. Long-term stewardship includes all engineered and institutional controls designed to contain or to prevent exposures to residual contamination and waste, such as surveillance activities, record-keeping activities, inspections, groundwater monitoring, ongoing pump and treat activities, cap repair, maintenance of entombed buildings or facilities, maintenance of other barriers and containment structures, access control, and posting signs.*"
>
> - *A Report to Congress on Long-Term Stewardship* (DOE 2001a)

6.1 Challenges for Long-Term Stewardship

Institutional controls and long-term stewardship continue to be a topic of high interest to the Hanford communities, stakeholders and Native American tribes. The Hanford Advisory Board has issued at least six letters of advice to the Tri-Parties[22] related to these topics. The Board's advice has been based on consistent principles of "permanent retrieval, treatment and disposal of all production mission hazards, and to protect and preserve human, biological, natural, and cultural resources in a manner that does not impose a burden on future generations."

DOE-RL has recently developed its Hanford Long-Term Stewardship Program. A draft document was issued for public feedback in February 2010 – *Hanford Long-Term Stewardship Program Plan – Preliminary Draft* (DOE 2010b). The final document is anticipated to be published in summer 2010. This document describes the DOE-RL Long-Term Stewardship Program for managing post-cleanup obligations at the Hanford Site in a safe and cost-effective manner. Development of this document included feedback from the Tribal Nations, the Hanford Advisory Board, as well as other stakeholders. Implementation of institutional controls and long-term stewardship functions will be required as soon as areas of the Hanford Site have completed cleanup actions. These functions will transition from the cleanup program to the Hanford Long-Term Stewardship Program as cleanup is completed per CERCLA and RCRA records of decision for specific geographic areas. Also, these functions will need to be maintained for as long as areas of the site remain hazardous to human health and the environment – which could be required for many generations and for a period longer than nearly any other human institution has survived intact. These functions must address significant challenges to demonstrate long-term fiscal viability and minimization of the liability to future generations. An additional challenge is to provide coordination and transition among completion of cleanup, completion of natural-resource damage restoration actions, and initiation of long-term stewardship functions.

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[22] See Hanford Advisory Board Advice #63, #132, #141, #180, #190, and #230, for example. Hanford Advisory Board advice documents can be found at http://www.hanford.gov/?page=453

6.2 Hanford Long-Term Stewardship Program

DOE is committed to maintaining the protection of human health and the environment and to managing its post-cleanup obligations in a safe and cost-effective manner (DOE 2010b). Remediated geographic areas of land will transition into the long-term stewardship program when their required cleanup activities are completed in accordance with the post-cleanup requirements specified in the associated decision documents. DOE-RL will manage the long-term stewardship program until all DOE Office of Environmental Management missions at the Hanford Site are complete. When cleanup at the site is complete, it is anticipated that the DOE Office of Legacy Management will assume responsibility for the Hanford Site. In the interim, DOE-RL will manage a long-term stewardship program in a manner consistent with Legacy Management's goals, policies, and procedures.

The first element of long-term stewardship is to ensure the post cleanup requirements of CERCLA and RCRA cleanup decisions are implemented. The second element of long-term stewardship includes consideration of the Hanford Site's unique biological, natural, and cultural resources, which include the following items:

- Surface water, groundwater, land, natural gas, minerals, and other natural resources.
- Fish, wildlife, and plant populations and their habitats.
- Prehistoric archaeological sites.
- Native American sacred and ceremonial places.
- Historical and cultural resources.

As DOE completes cleanup of segments of land at the Hanford Site, these areas will transition into long-term stewardship rather than wait until all cleanup is accomplished. The land will be prepared for future uses consistent with designations in the *Hanford Comprehensive Land-Use Plan* (DOE 1999).

Hanford's long-term stewardship program is still in its infancy stage. DOE is building a dynamic program that will be updated as needed to address emerging issues and lessons learned, implement new technologies, and incorporate requirements from future Hanford Site regulatory cleanup decision documents. Ultimately the long-term stewardship program is designed to ensure continued protection of human health and the environment and to manage and protect important resources. Development of this program continues to be enhanced by ongoing dialogue with Tribal Nations and stakeholders. It is important that this dialogue continues as Hanford Site cleanup progresses and areas of the site transition to long-term stewardship.

6.3 Institutional Controls

Institutional controls generally include non-engineered restrictions on activities and access to land, groundwater, surface water, waste sites, waste disposal areas, and other areas or media that contain hazardous substances, to minimize the potential for human exposure to the substances. Common types of institutional controls include procedural restriction for access, fencing, warning notices, permits, easements, deed notifications, leases and contracts, and land-use controls.

Institutional controls will be required for some areas of the Hanford Site including:

- River Corridor – Potential institutional controls may be needed to restrict activities that disturb soils that are deeper than 15 feet below the surface, ensure interim safe storage of reactors until they are removed, and restrict groundwater use until contaminant levels drop below drinking water standards.
- Central Plateau – Institutional controls will be needed for waste disposal sites, canyon facilities, and other areas where access restrictions will be required and groundwater use will remain restricted until contaminant levels drop below drinking water standards.

Institutional controls are considered to be integral components of remedial alternatives that rely on land-use controls to ensure protectiveness of remedies. Institutional controls are evaluated along with remedial alternatives and are selected in records of decision along with the remedial action.

The Hanford Site maintains a site-wide institutional control plan (DOE 2009b) that describes the institutional controls for the current CERCLA remediation actions. This plan describes how DOE will implement and maintain the operable unit-specific institutional controls specified in CERCLA decision documents. The plan is updated as new CERCLA decisions are reached that contain requirements for institutional controls for the affected waste sites. Continuing maintenance of necessary institutional controls is an important element of the long-term stewardship function at the Hanford Site.

6.4 CERCLA Five-Year Reviews

CERCLA five-year reviews are conducted for sites cleaned up under CERCLA when hazardous substances, pollutants, or contaminants remain above levels that allow for unlimited use and unrestricted exposure. Five-year reviews seek to answer the following questions (EPA 1995c):

- Is the remedy functioning as intended by the decision documents?
- Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy still valid?
- Has any other information come to light that could call into question the protectiveness of the remedy?

The CERCLA review does not reconsider remedial cleanup decisions; it is an evaluation of the implementation and performance of the current cleanup strategy to determine if the remedy is or will be protective. The review determines if the measures taken are still successful in protecting workers, the public, and the environment. Long-term stewardship activities, primarily institutional controls, are one component to be considered in the five-year review. The five-year review also evaluates current and future protectiveness relative to remedial actions that are ongoing.

The review may conclude that the remedy is protective and that no further action is necessary; alternatively, it may conclude that further evaluation is needed, may recommend certain actions to improve the efficiency of a remedy, or may recommend changes in the remedy. This review process can also provide a forum for introducing new information and/or how changes in assumptions will be managed in the future. If cleanup decisions are required to be revisited, the applicable regulatory process is to be followed.

The first five-year review was completed in 2001 by the EPA (EPA 2001). The second was completed by DOE in 2006 (DOE 2006b). The long-term stewardship program will work with the DOE-RL Environmental Management Division to conduct the next five-year review (scheduled for completion in 2011), which will include review of the long-term stewardship components of the remedies, such as existing institutional controls in place to prevent exposure to the public and the environment. DOE-RL will conduct the CERCLA five-year reviews and submit the reports to the EPA for its review of the protectiveness determination made by DOE-RL.

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Appendix A

Hanford's 2015 Vision

Appendix A

Hanford's 2015 Vision

(From www.hanford.gov/page.cfm/2015VISION)

Hanford officials have developed a road map for finishing the cleanup activities on the 218-square-mile River Corridor portion of the Site by the year 2015. Called the 2015 Vision[1], the cleanup projects extend along the shore of the Columbia River from north of Richland to the far boundary of the Site near Highway 240 and the Vernita Bridge. The work includes cleanup of the 300 Area (the manufacturing and laboratory parts of the Site) and the 100 Area (the reactors along the river).

The 2015 Vision reflects the desire shared between officials with the Department of Energy, the Environmental Protection Agency, and the Washington Department of Ecology to protect the Columbia River from Hanford contamination. As part of the plan, more than 235 facilities will be decommissioned, deactivated, decontaminated, and demolished. 300 waste sites will be remediated. More than 4.6 million tons of waste and debris will be sent to Hanford's landfill, the Environmental Restoration Disposal Facility.

Cleaning up these high priority facilities and burial grounds associated with the 2015 Vision will also mean that some adjacent, lower priority projects can be done at the same time. In doing so, Hanford's cleanup dollars can go further, resulting in cleanup work being done more effectively and efficiently.

As projects are completed along the River Corridor, there won't be as much of a need for utilities, roads to be maintained, or surveillance to be conducted in those areas. Put another way, it will free up money that can be used toward cleaning up other places at Hanford that are not associated with the River Corridor project.

When the River Corridor projects are cleaned up, workers can shift their attention to the Central Plateau region of Hanford. This part of the Site, consisting of the 200 East, 200 West, and 200 North Areas, is home to a majority of Hanford's solid waste burial grounds and underground liquid waste storage tanks. It makes up about 75 square miles of the Site, which will be the last area of Hanford that will be cleaned up.

Figure A-1 shows the anticipated cleanup activities that are elements of *Hanford's 2015 Vision*.

[1] The Vision can be found on the web at http://www.hanford.gov/page.cfm/2015VISION .

Figure A-1. Elements of *Hanford's 2015 Vision*

Appendix B

Hanford Site Energy Park Initiative

Appendix B

Hanford Site Energy Park Initiative

In fiscal year 2009, the U.S. Department of Energy (DOE) began looking at establishing "Energy Parks" throughout the DOE complex using land made available by environmental cleanup efforts. Energy parks would support national priorities for developing safe, secure, and clean energy sources. The DOE complex holds large tracts of land that are being cleaned up. This land contains significant infrastructure assets that could support development of large-scale facilities for development and demonstration of clean energy sources and for deployment of energy production facilities. This initiative has received a boost from the economic stimulus funding that is accelerating the reduction of the footprint of active cleanup and the completion of small sites around the complex. In addition, this initiative has received a very strong push from the communities surrounding DOE cleanup sites that are requesting that land be set aside for potential reuse and energy facility development. Energy Parks are of national importance because of the growing recognition that success in energy independence, national security, economic growth, and environmental sustainability are intrinsically linked to one another. Energy Parks could be an effective tool for mobilizing DOE assets and capabilities to address key challenges facing the nation:

- Providing safe, secure and clean energy
- Enhancing environmental sustainability, such as meeting the federal government's commitment to reduce green house gas emissions by 28 percent by 2020 (fulfilling a commitment from Executive Order 13514)
- Providing long-term economic development opportunities and green jobs
- Enhancing global competitiveness.

B.1 Benefits of Hanford

Given its vast size, presence of energy-related infrastructure and highly skilled work force, the Hanford site warrants consideration as a location for an energy park. DOE has demonstrated that alternate mission activities can be done on the Hanford site. Energy Northwest has an operating commercial nuclear reactor on site and shares key infrastructure with DOE. The National Science Foundation operates the Laser Interferometer Gravitational-Wave Observatory.

Commercial nuclear, coal, natural gas, and bioenergy projects are well-suited to the site, and there is potential opportunity for wind, solar, and other renewable projects as well. *Hanford's Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999) already designates areas of the site that are suitable for "Research and Development" shown in blue on Figure B-1 and "Industrial" shown in white. Other benefits of using portions of the Hanford Site for an energy park include:

- **Land and Infrastructure**: DOE has custody and accountability of the Hanford Site for the federal government. The site includes important physical amenities such as close proximity to electrical transmission lines, water resources, telecommunications, railroad access, and barge access. Access to cooling water from the Columbia River could be a significant advantage for some types of energy plants.

- **Workforce**: The Tri-Cities area has a highly trained workforce including highly skilled craftsmen and among the highest ratio of scientists/engineers per capita in the country. This area is home to the Pacific Northwest National Laboratory, a national leader in Smart Grid technology and to Washington State University's Bioproducts Science and Engineering Laboratory.
- **Site Characterization**: Hanford is one of the most thoroughly characterized sites in terms of environmental, wind, solar, and biological conditions. DOE spent $200 million characterizing Hanford's basalt geology in the 1980s to support the geologic repository program. This means Hanford's geology is some of the best characterized in the country.

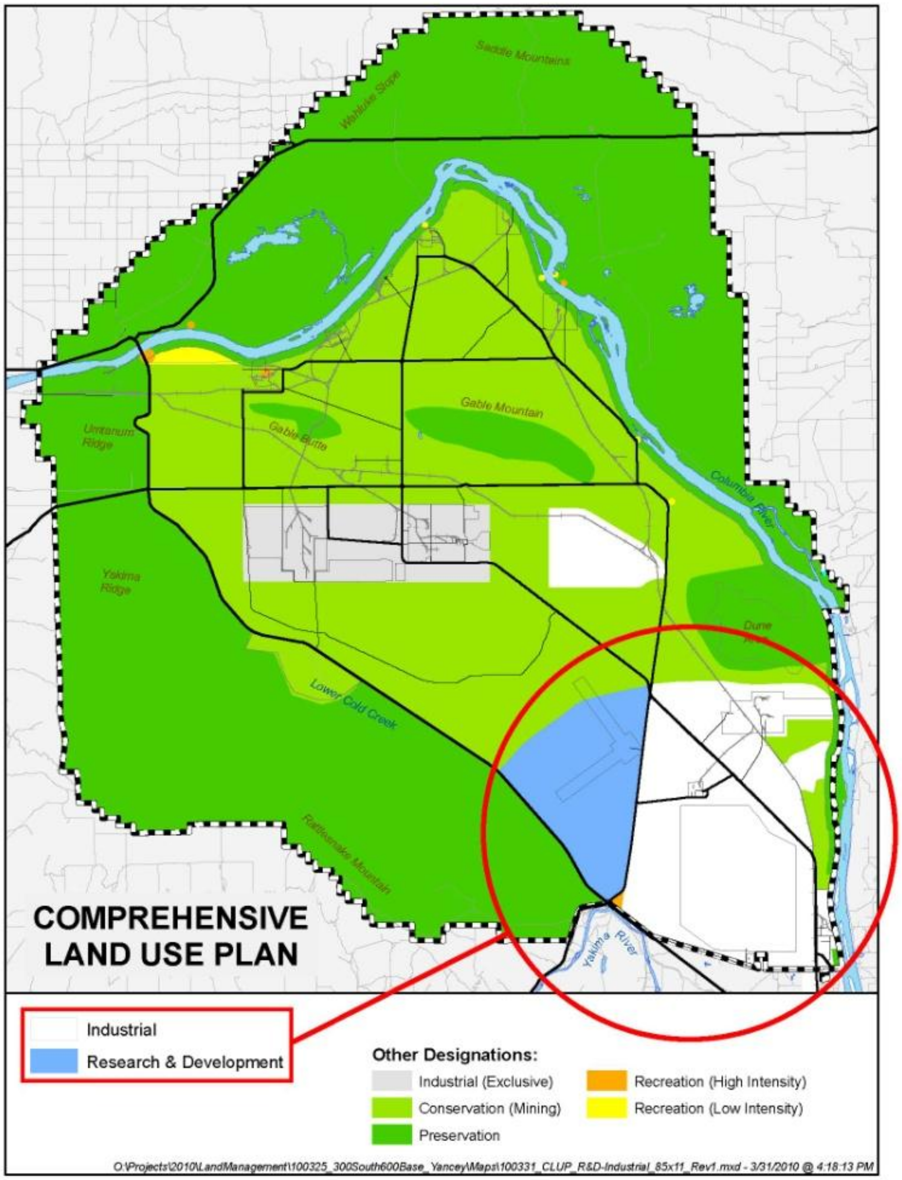

Figure B-1. Land-Use Designations from Hanford's Comprehensive Land-Use Plan

B.2 Community Interest and Discussions

As DOE makes continuing progress in cleanup up the Hanford site, it recognizes the need to work with the local communities, private industry, and other stakeholders to transition the site to future beneficial uses. The Tri-City Development Council (TRIDEC) organized the Mid-Columbia Energy Initiative, a group made up of local leaders. The Mid-Columbia Energy Initiative has received unsolicited proposals to provide alternative energy sources for the Waste Treatment and Immobilization Plant. One approach would replace up to 45,000 gallons of diesel fuel per day. The Mid-Columbia Energy Initiative has been endorsed by Washington State Governor Christine Gregoire:

> *Without question, this initiative will reduce operating costs for DOE, decrease our nation's dependence on foreign oil, and bring renewable energy demonstration and development to the Pacific Northwest and our nation. Therefore, I am pleased to offer my endorsement of the MCEI, relative to the Waste Treatment Plant and energy park at Hanford, and respectfully request your support for this effort.*[1]

DOE Richland Operations Office (RL) is working to establish geographic boundaries within the red circle area as shown on Figure B-1 that will define the Energy Park. Activities will include identifying and minimizing land-use constraints (e.g., withdrawn lands, availability of infrastructure and existing land uses) and maximizing the size of the park. The management of an Energy Park will be consistent with the *Hanford's Comprehensive Land-Use Plan Environmental Impact Statement* record of decision (64 FR 61615) and amended record of decision (73 FR 55824). The record of decision adopted the comprehensive land-use plan map, land-use policies and implementing controls and procedures that govern the review and approval of future land use proposals. Appropriate *National Environmental Policy Act* reviews will be required for future energy park development proposals. DOE supports the establishment of an Energy Park at the Hanford Site and is currently seeking to determine the best path forward by opening a dialog with parties that may be interested in leasing land for compatible uses. In February 2010, DOE received a formal request from Energy Northwest to lease land for a proposed Mid-Columbia Energy Initiative. This request is supported by the Mid-Columbia Energy Initiative and community leaders who want DOE to establish an energy park on 20 square miles of the Hanford Site. They have suggested leasing land for clean energy production. DOE-RL is reviewing this request and looks forward to an active dialogue with Tribal Nations and other stakeholders on the Energy Park Initiative concept and implementation.

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[1] Letter from Governor Christine Gregoire to Dr. Steven Chu, Secretary of Energy, U.S. Department of Energy, Washington, D.C., December 21, 2009.

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How to get Information about Hanford Cleanup

To receive information about Hanford cleanup call the Hanford Cleanup Hotline at 1-800-321-2008. To find information about upcoming public involvement activities, such as public meetings or documents for public review and comment, visit the Hanford Events Calendar at http://www.hanford.gov/

To find out more about Hanford cleanup and environmental compliance, information is maintained at these locations:

Tri-Party Agreement Administrative Record
2440 Steven Center, Room 1101
PO Box 950, Mail Stop H6-08
Richland, WA 99352
Phone: (509) 376-2530; Fax: (509) 376-4989
Hours: 9:00- 11: 30 am and 1:00 – 3:30 pm
Office closed every other Friday
http://www2.hanford.gov/arpir/

The Tri-Party Agreement Administrative Record site is the body of documents and information that are considered or relied upon to arrive at a final decision for remedial action or hazardous waste management.

DOE Public Reading Room
Washington State University Tri-Cities Campus
Consolidated Information Center, Room 101L
2770 University Drive
Richland, WA 99352
Phone: (509) 372-7443; Fax: (509) 372-7444
http://reading-room.pnl.gov/

The DOE Public Reading Room collection includes technical reports, administrative materials, factsheets, and handouts. The catalog is searchable via the Internet.

The following Internet sites also are available for information:

- Hanford Declassified Document Retrieval System provides a catalog of declassified documents regarding Hanford. http://www2.hanford.gov/DDRS/
- Electronic Freedom of Information Act (FOIA) Reading Room has information to meet the requirements of FOIA that certain kinds of documents to be made available to the public for inspection and copying. http://www.hanford.gov/?page=69
- Hanford Advisory Board site makes available information about their activities to provide informed recommendations and advice to the U.S. Department of Energy (DOE), the US Environmental Protection Agency (EPA), and the Washington Department of Ecology (Ecology) on selected major policy issues related to the cleanup of the Hanford site. http://www.hanford.gov/page.cfm/hab
- CERCLA 5-year review site provides the actual text of the 2001 and 2006 review. http://www.hanford.gov/page.cfm/CERCLA
- Hanford Site Environmental Report provides information about environmental monitoring on the Hanford Site. http://hanford-site.pnl.gov/envreport/

The Tri-Party Agencies also have contacts that are listed below:

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