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Revision 1

Central Plateau Ecological Risk Assessment Data Package Report

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

U.S. DEPARTMENT OF ENERGY

Richland Operations Office

P.O. Box 550
Richland, Washington 99352

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Executive Summary

This executive summary provides an overview of the ecological risk assessment (ERA) activities conducted to date at the Hanford Site Central Plateau, including a discussion of the regulatory framework, methods used in the risk assessment activities, data collected to measure risk, and published reports that document these activities and the data generated.

The scope and objectives of this data package summary report, described in Chapter 1, provide a strengthened, detailed, and transparent presentation of data, methods, and associated uncertainties with those data and methods. The revised report presents the status of the ERA activities in the Central Plateau and describes the transition to the ERA approach that supports the Central Plateau completion strategy. Ecological risk conclusions will not be presented in the revised data package completion summary report but will be incorporated into baseline risk assessment (BRA) reports completed as part of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*[1] (CERCLA) process for the Outer and Inner Areas of the Central Plateau.

The specific objectives of this *Central Plateau Ecological Risk Assessment Data Package Report* (CP ERA) are to:

- Provide an overview of the ERA process as historically applied to the Central Plateau.
- Discuss how cleanup approaches have evolved (DOE/RL-2009-81, *Central Plateau Cleanup Completion Strategy*)[2] and how the ecological data developed for the Central Plateau support the remedial investigation (RI)/feasibility study (FS) documents developed under that strategy.
- Summarize the data sets generated by the CP ERA effort.
- Discuss limitation with the existing CP ERA and describe the usability of the data that were collected for ERAs supporting upcoming RI/FSs in the Central Plateau.

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[1] *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq. Available at: http://uscode.house.gov/download/pls/42C103.txt.

[2] DOE/RL-2009-81, 2009, *Central Plateau Cleanup Completion Strategy*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=1002180676.

- Present the path forward for assessing ecological risks in a manner that supports the strategy outlined in DOE/RL-2009-81.

Hanford Site and Project Background

The Hanford Site is a federal facility in southeastern Washington State that was acquired by the U.S. Government in 1943 to produce nuclear materials for defense purposes. Plutonium production at the Hanford Site continued until the late 1980s, when the mission changed to cleaning up radioactive and hazardous wastes generated during the previous years. Operations at the Hanford Site are now segregated into two key areas: the River Corridor, where nuclear production reactors were sited, and the Central Plateau, which was designated for nuclear fuel separation and reprocessing operations. This summary report focuses on activities designed to develop an understanding of potential ecological risks from contamination resulting from waste discharges strictly in the Central Plateau.

The Central Plateau covers an area of approximately 195 km^2 (75 mi^2) located near the middle of the Hanford Site. It contains approximately 900 facilities formerly used in the plutonium production process. Fuel fabrication, chemical processing, and waste management operations conducted in the Central Plateau resulted in releases of chemicals and radionuclides to the environment.

In 1989, certain areas of the Hanford Site were placed on the National Priorities List (NPL), 40 CFR 300, Appendix B,[3] pursuant to CERCLA. Also in 1989, the U.S. Department of Energy (DOE) entered into the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989),[4] known as the Tri-Party Agreement (TPA), which governs cleanup of the Hanford Site.

Detailed characterization activities and studies have been conducted on the Hanford Site and adjacent areas since the 1940s. Investigations are carried out in accordance with various laws and regulations, including the *Superfund Amendments and Reauthorization*

[3] 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List," Code of Federal Regulations. Available at: http://edocket.access.gpo.gov/cfr_2010/julqtr/40cfr300AppB.htm.

[4] Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

Act of 1986[5] remedial action provisions, the *Resource Conservation and Recovery Act of 1976*[6] (RCRA), and the TPA. The various CP ERA activities described in this summary report are part of the RI, which is Step 2 of the CERCLA process shown in Figure ES-1. The ERA activities integrate with other work to provide an assessment of risks at the Hanford Site (Figure ES-2). Additional information on the integration of risk assessments at the Hanford Site is presented in Chapter 2.

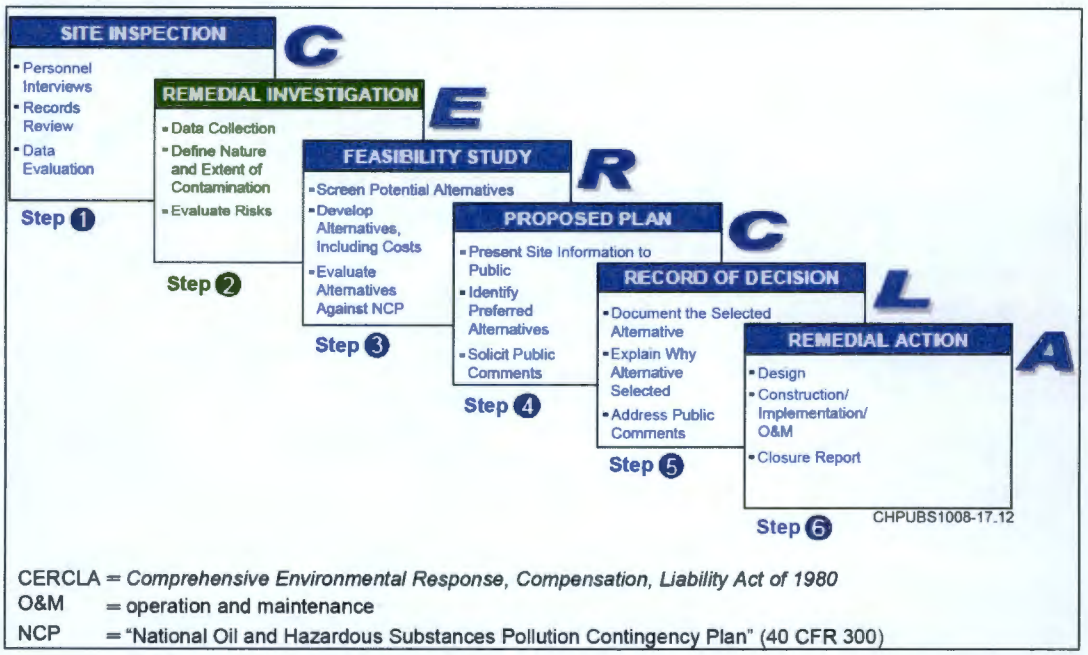

Figure ES-1. Risk Assessment Within the CERCLA Process

Risk Assessment Approach

Chapter 3 summarizes the history of specific ERA activities that have occurred over the years at the Hanford Site. Initial work on the ERA began with a qualitative evaluation of ecological risk presented in DOE/RL-2000-35, *200-CW-1 Operable Unit Remedial Investigation Report.*[7]

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[5] *Superfund Amendments and Reauthorization Act of 1986*, 42 USC 103, et seq. Available at: http://www.epa.gov/superfund/policy/sara.htm.

[6] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://www4.law.cornell.edu/uscode/42/6901.html.

[7] DOE/RL-2000-35, 2001, *200-CW-1 Operable Unit Remedial Investigation Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=D8629315.

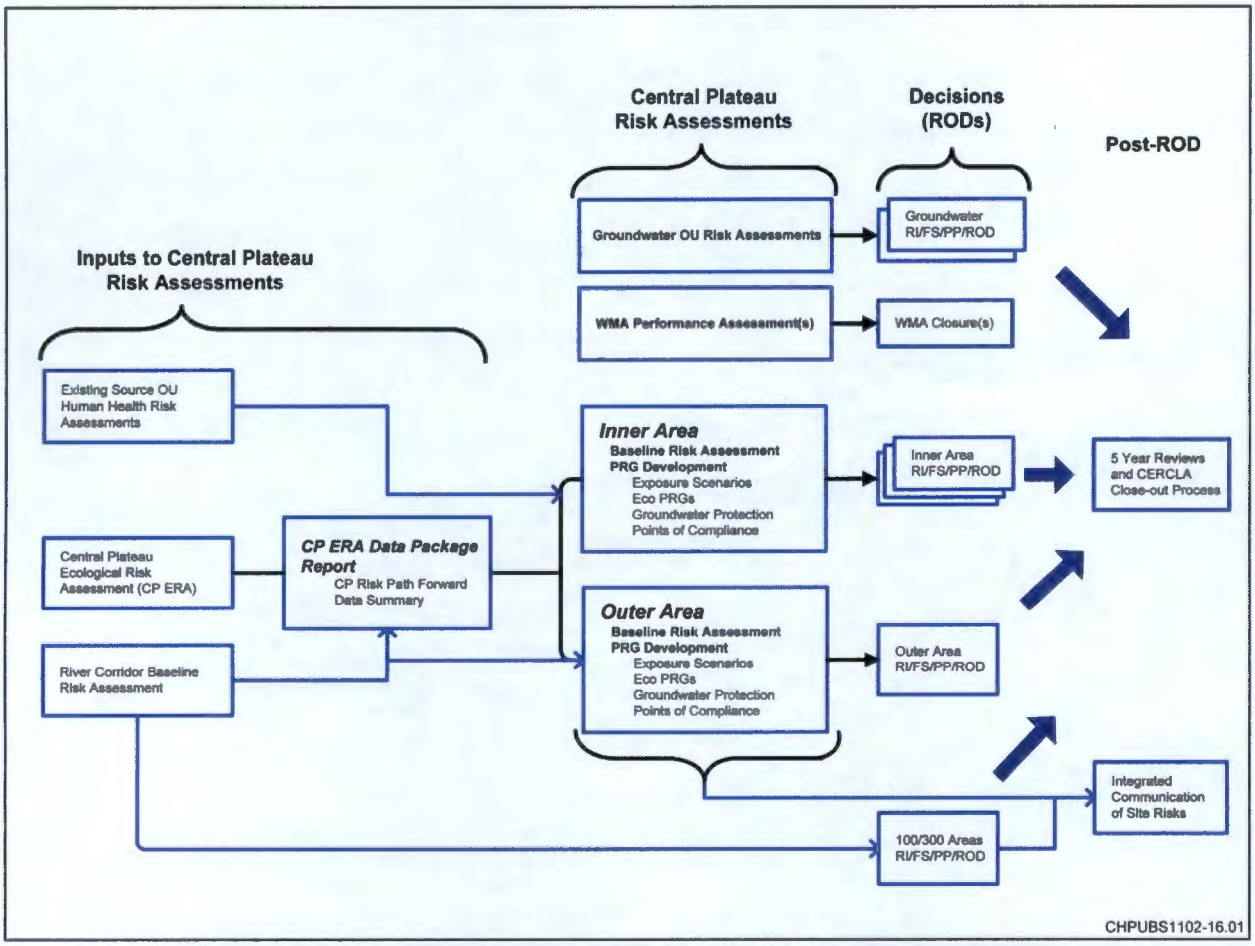

Figure ES-2. Proposed Approach to the Central Plateau Risk Assessments

Subsequent ERA work was completed in 2001 with the *Central Plateau Ecological Evaluation* (CPEE) (DOE/RL-2001-54).[8] Following the CPEE, a Central Plateau-wide ERA was conducted with the development of project planning documents. The risk assessment process included an iterative study design documented through the development of data quality objectives (DQOs) presented in a series of three documents (WMP-20570, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report—Phase I*;[9] WMP-25493, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report—Phase II*,[10] and

[8] DOE/RL-2001-54, 2002, *Ecological Evaluation of the Hanford 200 Areas—Phase I: Compilation of Existing 200 Areas Ecological Data*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D9061462.

[9] WMP-20570, 2006, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report—Phase I*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

[10] WMP-25493, 2005, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report—Phase II*, Rev. 0, Fluor Hanford, Inc., Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=DA06717797.

WMP-29253, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report—Phase III*)[11] completed over eight months (June 2006 to February 2007). As stated in the DQO reports, the approach follows federal and state guidance, including the following:

- EPA 540-R-97-006, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments: Interim Final*[12]
- EPA/630/R-95/002F, *Guidelines for Ecological Risk Assessment*[13]
- WAC 173-340-7490, "Terrestrial Ecological Evaluation Procedures"[14]

The technical approach also incorporates concepts discussed in the following documents:

- EPA/120/R-07/001, *Framework for Metals Risk Assessment*[15]
- 4WD-OTS, "Amended Guidance on Ecological Risk Assessment at Military Bases: Process Considerations, Timing of Activities, and Inclusion of Stakeholders"[16]
- EPA 540/F-01/014, *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments*[17]

These ecological risk documents, the associated sampling and analysis plans (SAPs) and field sampling plans, and other historical documentation of ecological evaluations are included as Appendices A through K.

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[11] WMP-29253, 2007, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report—Phase III*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

[12] EPA 540-R-97-006, 1997, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments: Interim Final*, OSWER 9285.7-25, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/swerrims/riskassessment/ecorisk/ecorisk.htm.

[13] EPA/630/R-95/002F, 1998, *Guidelines for Ecological Risk Assessment*, U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, D.C.

[14] WAC 173-340-7493, "Model Toxics Control Act—Cleanup," "Site-Specific Terrestrial Ecological Evaluation Procedures," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340.

[15] EPA/120/R-07/001, 2007, *Framework for Metals Risk Assessment*, U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, D.C. Available at: http://www.epa.gov/osa/metalsframework/.

[16] 4WD-OTS, 2000, "Amended Guidance on Ecological Risk Assessment at Military Bases: Process Considerations, Timing of Activities, and Inclusion of Stakeholders" (Memorandum to Jon D. Johnston, Chief, FFB, and Earl Bozeman, Chief, DOD Section, FFB, from Ted W. Simon), United States Environmental Protection Agency Region 4, Atlanta, Georgia, June 23. Available at: http://rais.ornl.gov/documents/ecoproc2.pdf.

[17] EPA 540/F-01/014, 2001, *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments*, ECO Update, Intermittent Bulletin, Publication 9345.0-14, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/oswer/riskassessment/ecoup/pdf/slera0601.pdf.

Summary of Central Plateau Ecological Risk Activities

Chapter 4 summarizes the steps of the ERA that have been conducted for the Central Plateau and specifically explains within which published report each step is documented. The basic approach for the ERA presented in the DQO documents was consistent with EPA guidance (EPA/540/R-97-006, EPA/630/R-95/002F, 4WD-OTS, and EPA/540/F-01/014), which provides an eight-step process with built-in critical management and decision points to allow stakeholder input on the evaluation of interim findings and refinement of the technical approach. Step 1 and Step 2 make up the screening level ecological risk assessment (SLERA), while Step 3 through Step 8 comprise the baseline ecological risk assessment (BERA).

The initial SLERA was provided in the CPEE (DOE/RL-2001-54); however, due to comments received from Ecology, the SLERA was refined through the three-phased DQO process. The refined SLERA in Phase I (WMP-20570) focused on the 200 Area. The Phase II DQOs report (WMP-25493) evaluated the need for ecological sampling at the U.S. Ecology Site, tank farms, and the BC Controlled Area. However, due to the similarity of contaminants of potential ecological concern (COPECs) and habitat at study sites between Phase I and Phase II, the conceptual model, risk questions, assessment endpoints, measures, and study design developed in the Phase I DQO were also used for the Phase II DQO. The Phase III DQOs report (WMP-29253) addressed data gaps identified from Phase I and Phase II, evaluated the need for ecological sampling in non-waste site areas outside of the 200 East and 200 West Areas, addressed the dispersed carbon tetrachloride plume in the 200 West Area, and conducted a preliminary SLERA for West Lake.

Following the DQO process, the CP ERA was published as DOE/RL-2007-50, Draft A.[18] This draft report was submitted to the regulatory agencies in March 2008. Since the original submittal of DOE/RL-2007-50 in March 2008, DOE has developed DOE/RL-2009-10, *Cleanup Completion Framework for the Hanford Site*,[19] and a more detailed strategy for cleanup of the Central Plateau (DOE/RL-2009-81). The cleanup approach that is outlined in these documents substantially influences how ecological risks

[18] DOE/RL-2007-50, 2008, *Central Plateau Terrestrial Ecological Risk Assessment Report*, Draft A Reissue, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=DA06834859.

[19] DOE/RL-2009-10, 2010, *Hanford Site Cleanup Completion Framework*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

should be incorporated into the Central Plateau cleanup decision making process. In response to the comments from and issues raised by regulatory agencies, and to reflect the evolution of the cleanup strategy for the Central Plateau, this document has been developed as a significant revision to the DOE/RL-2007-50, Draft A Reissue.

The completion of the DQO process for each phase resulted in a study design consisting of field screening, multi-increment sampling (MIS) of environmental media, chemical analysis of environmental media, tissue chemistry analysis, and field measurements. After Phase I (WMP-20570) and Phase II (WMP-25493), Phase III (WMP-29253) included an evaluation of the data collected for Phase I and Phase II, and then DQOs and sampling design were aimed at filling any data gaps identified.

Appendix L presents a summary of the data collected from the three phases of the investigation. Phase I and Phase II data collection efforts included the following:

- Radiological field data for beta- and gamma-emitting radionuclides in soils (e.g., burrow spoils and ant nests) and plant material to test the conceptual site model of upward contaminant transport (the conceptual model suggests that the 0 to 15 cm [0 to 6 in.] soil interval is important for exposure, but deeper soil also may be important).
- Chemical analysis of surface soil samples collected from 0 to 15 cm (0 to 6 in.) for metals, radionuclides, and organics (e.g., polychlorinated biphenyls [PCBs] and pesticides). Note: A 15 cm (6 in.) depth was selected for Phase I to evaluate the importance of near-surface contaminant exposure to biota.
- Plant cover estimation data (provides information on habitat and potential effects to plants).
- Biological data including body burden analysis for metals, radionuclides, and organics (e.g., PCBs and pesticides) in insects, lizards, and small mammals (these animals were considered common and likely to have sufficient mass for analysis of all COPECs).
- Notation of any abnormalities for the vertebrate animals handled, in the field logbooks (these notes provide qualitative information of the possible effects of COPECs on biota).

- A literature review of studies, relevant to the Hanford Site, and collection of exposure parameter data relevant to the Hanford Site terrestrial receptors and exposure pathways.

Phase III field efforts were similar but focused on target areas requiring further data collection as well as an aquatic investigation at West Lake that included sampling of both abiotic and biotic media.

Uncertainty Analysis

An important part of a risk assessment is to analyze both the assessment methods and inputs to the assessment itself in order to evaluate the results of the risk assessment. Consideration of the results of the risk characterization in the context of the uncertainties associated with those results and how they were obtained is one of the inputs that leads to the risk management decision made in Step 8. The uncertainties associated with risk characterization for the Central Plateau, both in the data collected and the methods employed for characterizing the risk, are significant to the point where the analysis is not considered valid. The uncertainty analysis presented in Chapter 5 discusses the uncertainties associated with the risk assessment in more detail to provide input to the development of future recommendations that can be integrated into the current risk assessment strategy for the Hanford Site. The following major uncertainties are discussed:

- Overall approach to the CP ERA
- Waste site selection
- Selection of COPECs
- Use of MIS data
- Application of reference site data
- Adequately characterizing exposure to biota
- Drawing risk conclusions

Conclusions and Recommendations

Previously, the CP ERA concluded that although there was evidence of exposure to COPECs, there was no evidence of adverse effects to any ecological receptors in the Central Plateau.[20] However, when uncertainties in the data, methods, and analyses are

[20] Presented in DOE/RL-2007-50, Draft A Reissue, February 2008.

taken into consideration, there are substantial limitations to these conclusions which limit the usability of the CP ERA conclusions for cleanup decision making in the Central Plateau.

Although the existing data for the Central Plateau are not definitive concerning the presence or absence of ecological risks, portions of these data provide a foundation from which to build future ERA efforts that will support upcoming RI/FSs in the Central Plateau. This document is intended to serve as a component of the technical basis for the completion of ERAs in support of upcoming RI/FSs in the Central Plateau. To do this, an updated approach for the evaluation of ecological risks on the Central Plateau is being developed that integrates and builds on the existing data, and identifies additional data needs, along with next steps for completion of the ERAs for the Central Plateau. Several components are integral to this updated approach. These include developing a robust set of preliminary remedial goals (PRGs) for ecological receptors, identifying an expanded list of COPECs, describing and documenting the understanding of biointrusion in the Central Plateau, and integrating the human health risk assessment and ERA into the broader remedial process.

Graded Approach to PRG Development

An integral component of the proposed framework for Central Plateau risk assessments is employing a tiered approach for post-remediation evaluation of Hanford waste sites, including development of three tiers of PRGs. Chapter 6 presents the highlights of the approach. Up to three tiers of progressively more site-specific and ecologically realistic PRGs will be employed to evaluate the degree of protectiveness and risk reduction afforded by previously completed remedial actions. This iterative process begins conservatively and generic (Tier 1) and progresses to be less conservative and more site- and receptor-specific, incorporating additional information as appropriate to provide more realistic PRGs (Tier 1Refined PRGs and Tier 2 and Tier 3 PRGs) to aid in decision making.

The intended application of these values is for Tier 1 PRGs to be used for characterization of site contamination (i.e., delineation of nature and extent of contamination) or as a simple tool to evaluate the potential needs for additional site-specific evaluation, data gap sampling and analysis, or remedial actions. In some cases, Tier 1 PRGs may be used as cleanup goals, but only if the remedial action is readily attainable and cost effective. Otherwise, further refinement of PRGs using

additional site-specific information (i.e., Tier 2 or Tier 3 PRGs) is recommended to determine whether remedial action is necessary and which levels are protective.

Application of Existing Data

To meet the completion schedules and milestones for the Hanford Site closure strategy, it is imperative that these data be integrated into the RI/FS process for the waste sites at Hanford to the extent possible. Thus, the approach for completing the RIs for the Inner and Outer Areas includes an initial assessment of existing data with a bias toward remediation as an outcome. Chapter 6 of the report outlines guidelines for assessing the usability of existing data, plus the potential applications and limitations of the various types of historical data that have been collected to date. As is described, some data with acknowledged limitations may still be adequate to provide the basis for action needed to complete the RI and for characterizing risk for some waste sites.

Further Data Collection

While existing data will be sufficient in providing a basis for action to complete the RI, the data may fall short with the acceptability of the ecological risk characterization. Further data collection may be recommended primarily to refine the risk characterization and/or to support the development of Tier 2 or Tier 3 PRGs. Those data collection activities could be as simple as chemical analysis of additional soil samples but could be as extensive as ex situ toxicity sampling or tissue sampling. If ex situ toxicity testing or tissue sampling is part of future data collection activities, these samples will be collected with co-located soil analytical chemistry samples in order to evaluate dose response relationships that can be applied across multiple waste units at the Hanford Site.

Next Steps

The next steps for completing an ERA for the Central Plateau will be work planning within the RI/FS process. An outline of the ERA approach will be presented in the work plans for the Inner Area and Outer Area RI/FSs. The following general approaches will be presented:

- Use of the available characterization data for assessing ecological risks
- Initial risk-based screening using data from across waste sites for COPCs, as identified by nature and extent, to identify COPECs

- Subsequent risk-based screening at individual waste sites for COPECs identified across waste sites
- Implementation of the tiered approach to risk screening using PRGs
- Use of central tendency estimates and point by point risk estimation at waste sites with multiple data points

Additional work planning activities to occur include the following:

- Integrating the ongoing risk assessments with the development of a SAP to address data gaps
- Working with risk managers to evaluate the need for additional ecological sampling to support the BRA and development of Tier 2 or Tier 3 PRGs

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Terms

BERA	baseline ecological risk assessment
bgs	below ground surface
BRA	baseline risk assessment
CA	composite analysis
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COPC	contaminant of potential concern
COPEC	contaminant of potential ecological concern
CP ERA	*Central Plateau Ecological Risk Assessment Data Package Report*
CPEE	*Central Plateau Ecological Evaluation*
DOE	U.S. Department of Energy
DQO	data quality objective
EcoDQO	ecological data quality objective
Ecology	Washington Department of Ecology
EcoSSL	ecological soil screening level
EMC	ecological monitoring and compliance
EMCP	Ecological Monitoring and Compliance Program
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ERDF	Environmental Restoration Disposal Facility
ESL	ecological screening level
FE	fundamental error
FS	feasibility study
HEIS	*Hanford Environmental Information System*
HHE	human health and the environment
LOAEL	lowest observed adverse effect level
LOEC	lowest observed effect concentration
MIS	multi-increment sampling
MTCA	Model Toxics Control Act
NFM	Near-Facility Monitoring

NOAEL	no observed adverse effect level
NPL	National Priorities List
OC	organic carbon
OU	operable unit
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PNNL	Pacific Northwest National Laboratory
PRG	preliminary remediation goal
PUREX	Plutonium-Uranium Extraction (Plant)
PVC	polyvinyl chloride
RCBRA	River Corridor Baseline Risk Assessment
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	Reduction-Oxidation (Plant)
RI	remedial investigation
ROD	record of decision
SAP	sampling and analysis plan
SESP	Surface Environmental Surveillance Project
SLERA	screening level ecological risk assessment
SOF	sum of fractions
SSL	soil screening level
SSV	soil screening value
TAL	target analyte list
TOC	total organic carbon
TPA	Tri-Party Agreement
Tri-Parties	Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
WIDS	Waste Information Data System
WMA	waste management area

1 Introduction

The Central Plateau component includes approximately 194.2 km^2 (75 mi^2) 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 and waste management and disposal activities. 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.

In 1989, the 200 Area was placed on the NPL in 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan" pursuant to the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). Also in 1989, the U.S. Department of Energy (DOE) entered into the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al, 1989), also known as the Tri-Party Agreement (TPA), which governs cleanup of the Hanford Site. The Tri-Parties consist of DOE, the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology).

Over the past several years, DOE has undertaken several ecological studies and risk assessment activities in the Central Plateau of the Hanford Site, including risk assessment activities to support cleanup decision making under CERCLA. Beginning in 2003, a series of ecological sampling and risk assessment activities were planned and scoped in collaboration with the EPA, Ecology, Tribes, and other stakeholders. The intent of these activities was to produce a Central Plateau-wide assessment of ecological risks that would support cleanup decision making for waste sites under CERCLA. That Central Plateau-wide ecological risk assessment was published as the *Central Plateau Ecological Risk Assessment Report* (CP ERA) (DOE/RL-2007-50, Draft A Reissue; referred to hereafter as the Draft A Reissue report). This draft report was submitted to the regulatory agencies in March 2008.

Regulatory agency comments received by DOE on the DOE/RL-2007-50, Draft A Reissue report expressed concerns with the conclusions of the risk assessment, citing limitations with transparency and insufficient discussion of uncertainties in data collection and analytical methods. Other concerns were raised regarding the lack of analysis of animal and plant biointrusion into contaminated soils, and the disparity in spatial scales (i.e., ecological results obtained from a limited number of waste sites studied in detail [10 sites] being extrapolated to the Central Plateau at large [approximately 900 sites]). In addition, since the original submittal of the Draft A Reissue report in March 2008, DOE has developed the *Hanford Site Cleanup Completion Framework* (DOE/RL-2009-10), and the more detailed strategy for the cleanup of the Central Plateau, the *Central Plateau Cleanup Completion Strategy* (DOE/RL-2009-81). The strategy provides context for the approach proposed by DOE to address potential ecological risk issues in the Central Plateau cleanup decision making process.

1.1 Purpose and Objectives

As originally defined, the purpose of the CP ERA was to support waste site decision making for remedy selection. In addition, the CP ERA was intended to provide information to evaluate the health or condition of the Central Plateau ecosystem (WMP-20570, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report—Phase I*; henceforth, the Phase I DQO Report). The CP ERA used historical soil sampling data collected as part of CERCLA remedial investigations (RIs) to identify contaminants of potential ecological concern (COPECs), and evaluated potential ecological risks, primarily using data obtained from soil and biological media, and species surveys conducted between 2005 and 2007. These data were collected in accordance with the agency approved sampling and analysis plans (SAPs).

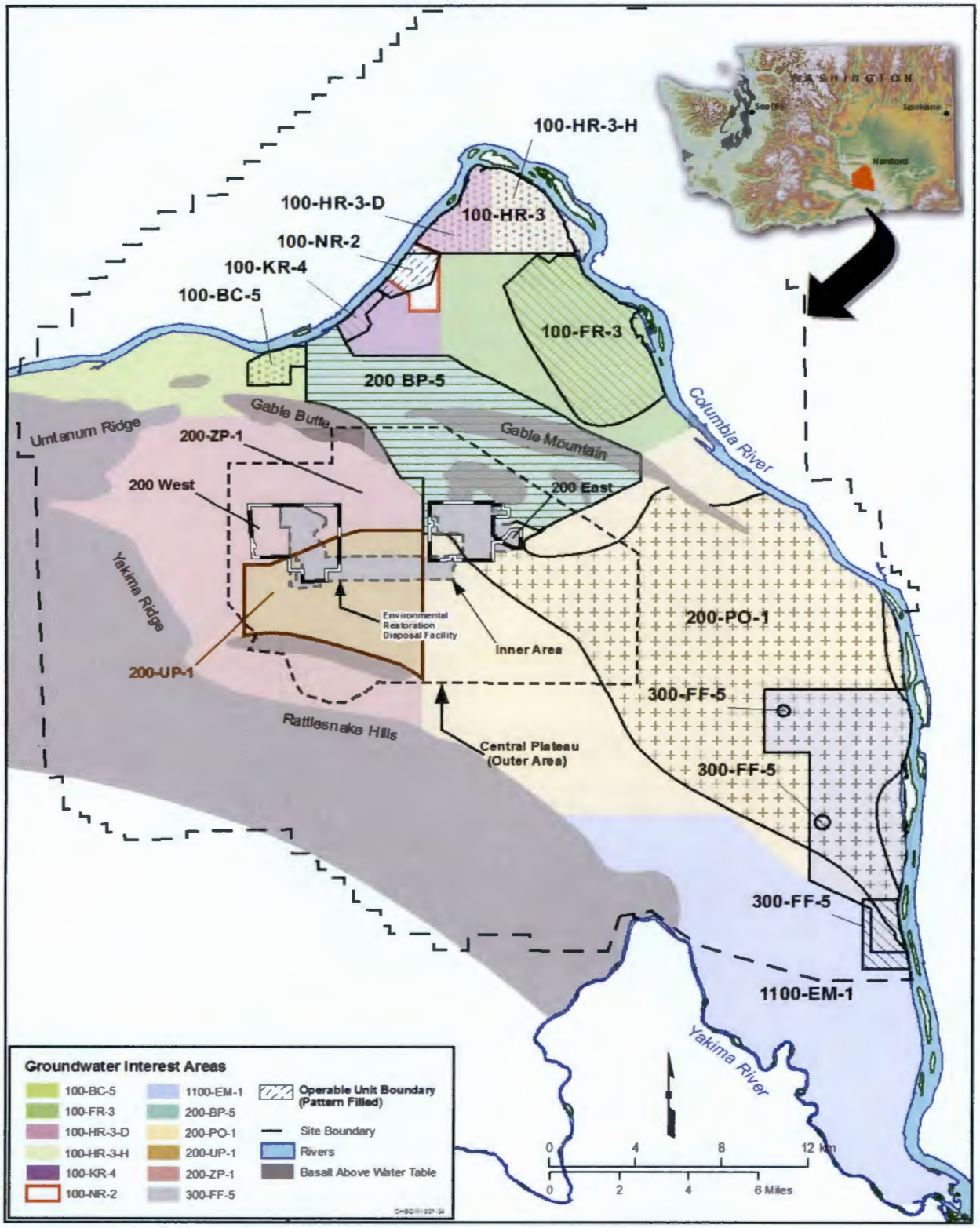

Figure 1-1. Hanford Site and the Central Plateau

Following consideration of the Tri-Party comments, the results from a subsequent review of the CP ERA report and the development of the Central Plateau cleanup completion strategy, this document (DOE/RL-2007-50) has been published as a data package report with following objectives:

- Provide an overview of the ecological risk assessment (ERA) process as historically applied to the Central Plateau.
- Discuss how cleanup approaches have evolved (i.e., the Central Plateau Strategy) and how data developed for the CP ERA supports these cleanup approaches.
- Summarize the data sets generated by the CP ERA effort.
- Discuss limitation with the existing CP ERA and describe the usability of the data for upcoming RI/feasibility studies (FSs).
- Present the path forward for assessing ecological risks in upcoming RI/FSs that supports the Central Plateau Cleanup Completion Strategy (DOE/RL-2009-81).

1.2 Report Organization

This document is organized as follows:

Chapter 1 contains an introduction, presents the purpose and objectives of the report, and describes how the report is organized.

Chapter 2 summarizes the Central Plateau cleanup completion strategy and the role of the CP ERA in the implementation of that strategy.

Chapter 3 presents the chronology of ERA activities conducted in the Central Plateau. It describes ERA activities initiated prior to the CP ERA and describes the phases involved with the CP ERA. A brief description is presented of the regulatory comments on the Draft A Reissue report (DOE/RL-2007-50) submitted in March 2008, along with the steps involved with preparation of this CP ERA Data Package Summary Report. In addition, this chapter maps out the consistency of the CP ERA activities with EPA CERCLA ERA guidance.

Chapter 4 summarizes all of the previously completed ERA activities for the Central Plateau. This section briefly summarizes the phased data quality objectives (DQOs) process and the resultant SAPs. All data sets used in and produced for the CP ERA are also presented.

Chapter 5 summarizes the uncertainties associated with the CP ERA data and documents the usability of these data for future assessment of risks in the Central Plateau. Uncertainties and limitations associated with the CP ERA are largely based on and documented by the regulatory comments on the Draft A Reissue report (DOE/RL-2007-50), which will be described in this chapter.

Chapter 6 provides recommendations that include the introduction of the updated CP ERA approach that supports the Central Plateau strategy, roles for which the existing data may be reliably used, a discussion of additional data needed to support ERA in the Central Plateau, and an outline for the next steps that should be taken to move the process forward.

Chapter 7 provides the references cited.

Several documents have been produced as part of the CP ERA and are included on a supplementary disk as appendices. This accompanying disk includes the database containing all of the investigation data collected as part of the CP ERA.

Appendix A is the Central Plateau ERA-related report: *Central Plateau Ecological Evaluation*, Draft B (DOE/RL-2001-54, Rev. 0).

Appendix B is WMP-20570, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report—Phase I*, Rev. 0.

Appendix C is WMP-25493, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report—Phase II*, Rev. 0.

Appendix D is WMP-29253, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report—Phase III*, Rev. 0.

Appendix E is DOE/RL-2004-42, *Central Plateau Terrestrial Ecological Sampling and Analysis Plan—Phase I.*

Appendix F is DOE/RL-2005-30, *Central Plateau Terrestrial Ecological Sampling and Analysis Plan—Phase II.*

Appendix G is DOE/RL-2006-27, *Central Plateau Terrestrial Ecological Sampling and Analysis Plan—Phase III.*

Appendix H is D&D-28419, *Ecological Evaluations of Selected Central Plateau Waste Sites; With Addendum—Review of Potential No Action or Institutional Control Waste Sites*, Rev. 0.

Appendix I is DTS-RPT-077, *Central Plateau Terrestrial Ecological Sampling Report—Phase I.*

Appendix J is DTS-RPT-078, *Central Plateau Terrestrial Ecological Sampling Report—Phase II.*

Appendix K is DOE/RL-2007-50, *Central Plateau Terrestrial Ecological Risk Assessment Report*, Draft A Reissue.

Appendix L provides tables tracking the details of the process for developing a representative waste site list for evaluation within the CP ERA (e.g., the waste site selection process).

Appendix M summarizes the CP ERA data and includes a crosswalk spreadsheet summarizing sampling data. Appendix M also includes a data dictionary explaining the data codes and their meanings.

Appendix N provides the comments from EPA and Ecology on the Draft A Reissue report (DOE/RL-2007-50).

2 Completion and Integration of Central Plateau Risk Assessments

A primary objective of the CP ERA is to integrate with overall cleanup approaches developed for the Central Plateau. Specifically, the CP ERA needs to align with the cleanup framework that has been outlined in two documents published in 2009. The first document is DOE/RL-2009-10, which describes the overall approach for cleanup of the Central Plateau in coordination with the River Corridor and tank waste components of the Hanford cleanup. As identified in this document, the goals for Hanford Site cleanup are:

- Protect the Columbia River.
- Restore groundwater to its beneficial use to protect human health and the environment (HHE) and the Columbia River.
- 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.
- 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.
- Safely manage and transfer legacy materials scheduled for offsite disposition including special nuclear material (including plutonium), spent nuclear fuel, transuranic waste, and immobilized high-level waste.
- Consolidate waste treatment, storage, and disposal (TSD) operations on the Central Plateau.
- Develop and implement institutional controls and long-term stewardship activities that ensure protection of HHE after cleanup activities are completed.

The second document is DOE/RL-2009-81, which includes the following principal elements of the Central Plateau cleanup approach as shown in Figure 2-1:

- The Inner Area is defined as the final footprint area of the Hanford Site that will be dedicated to waste management and containment of residual contamination, which will remain under federal ownership and control. This boundary is defined by waste disposal decisions already in place and anticipated future decisions that will result in the requirement for continued waste management and containment of residual contamination. The locations of these sites were key considerations in development of DOE's preliminary boundary of the Inner Area as shown in Figure 2-1. The Inner Area is approximately 10 square miles in size.
- The Outer Area is defined as all areas of the Central Plateau beyond the boundary of the Inner Area. It is DOE's intent to clean up this portion of the site to a level comparable to that achieved for the River Corridor (i.e., suitable for unrestricted surface use under continued federal ownership and control). Contaminated soils and debris will be removed to the Environmental Restoration Disposal Facility (ERDF) within the Inner Area for final disposal. Completion of cleanup of the Outer Area

will shrink the footprint of active cleanup to the final 26 square kilometer (10 square mile) Inner Area.

- Groundwater Restoration is acknowledged in the Hanford Site Groundwater Strategy and the Hanford Integrated Groundwater and Vadose Zone Management Plan and is reaffirmed in the 200-ZP-1 final record of decision (ROD). The goal is to restore groundwater to permit its potential beneficial use as a source of domestic drinking water, unless determined to be technically impracticable.

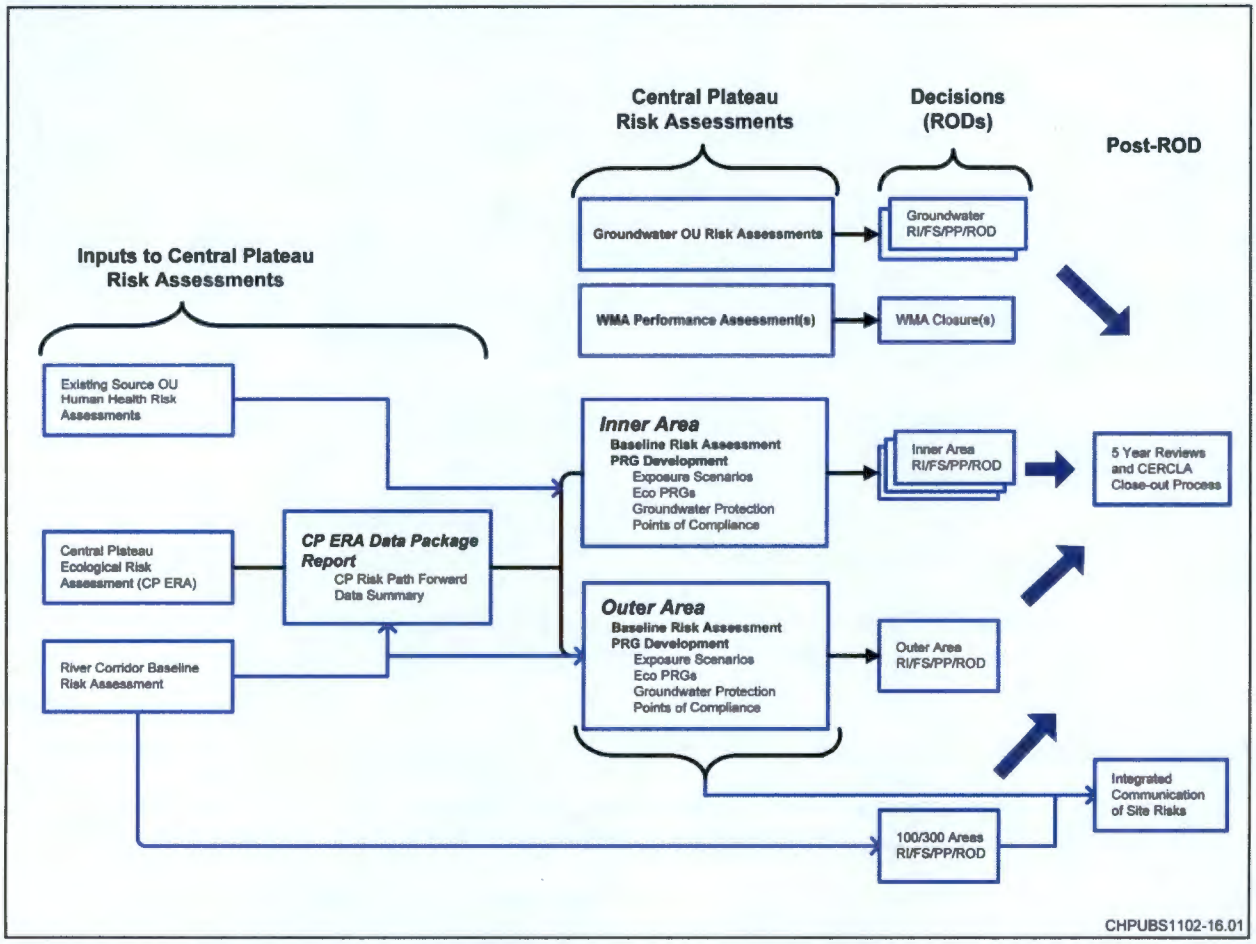

Figure 2-1. Proposed Approach to the Central Plateau Risk Assessments

On March 31, 2010, the Tri-Parties signed an Agreement in Principle to implement a Central Plateau cleanup completion strategy that includes waste site OUs, excess facilities, and groundwater. This completion strategy includes logic ties to both completion of tank farm closures and River Corridor cleanup. Risk assessments will be aligned to support each of these three major cleanup elements. This chapter outlines the reasonably anticipated risk assessment activities that will support the remedial decisions for the Central Plateau. This includes a discussion of the linkage of the CP ERA to these other Central Plateau risk assessments.

2.1 Proposed Framework for Central Plateau Risk Assessments

Reasonably anticipated risk assessment activities in the Central Plateau that are aligned with the completion strategy are described in this chapter. These reasonably anticipated activities are:

- **CP ERA Data Package Report.** Completing and issuing this CP ERA data package report. Activities that have been conducted under the CP ERA will transition to the risk assessments conducted for the Inner and Outer Areas.
- **Outer Area.** Conducting a baseline risk assessment (BRA) and other associated activities to assess human health and ecological risks in support of an RI/FS for the Outer Area.
- **Inner Area.** Conducting BRAs and other associated activities to assess human health and ecological risks, in support of Inner Area RI/FSs. The RI/FSs in the Inner Area where ecological risks could be an issue include the 200 West Area RI/FS, the 200 East Area RI/FS, and the pipelines.
- **Integrated Presentation and Communication of Site Risks.** An integrated site-wide depiction of risks will be important in presenting and communicating the results from these risk assessments and the risk reduction over time as remedial actions are completed. This integrated presentation and communication of site risks will be an ongoing activity that will capture information and results from risk assessments and other data analyses as they are completed. This integrated presentation of site-wide risks will incorporate results from the risk assessments prepared for groundwater OUs, the risk assessments prepared for the Outer and Inner Area RI/FSs, DOE/RL-2007-21, *River Corridor Baseline Risk Assessment*, hereafter referred to as the River Corridor Baseline Risk Assessment (RCBRA), and preliminary assessments prepared for waste management areas (WMAs) in the Tank Farms. In addition to these risk assessments, the information and characterizing conditions in nonoperational areas also will be incorporated into this integrated presentation.

2.1.1 Completing the Central Plateau Ecological Risk Assessment

This data compilation and status report summarizes the ERA activities that have been undertaken in the Central Plateau, describes the data that had been collected during three investigation phases conducted between 2005 and 2007, discusses the uncertainties in the assessment and data, outlines suitable applications for these data, and describes the ERA activities to be conducted as part of future RI/FSs in the Central Plateau, including the development of ecological preliminary remediation goals (PRGs).

2.1.2 Outer Area Risk Assessment Activities

DOE has proposed that the Outer Area of the Central Plateau be remediated to support unrestricted surface use comparable to adjacent land of the River Corridor, to accelerate cleanup with interim (removal) actions, and to select a final remedy with a consolidated Outer Area ROD. A baseline human health ERA will be conducted in support of an Outer Area RI/FS. The scope of this risk assessment will include three principal areas in the Outer Area: waste sites that have undergone removal actions, the large pond sites, and nonoperational areas. Residual risks will also be evaluated at the waste sites that have undergone removal actions; this will help determine if further cleanup is needed to achieve remedial action objectives. The risk assessment also will help determine the basis for action for the large pond sites and will be used to provide input to development of PRGs as part of the evaluation of remedial alternatives in the FS.

Most of the Outer Area did not have specific Hanford Site operations, waste management, or disposal activities. However, it is possible that contaminants have migrated from waste sites to soils in nonoperational areas through deposition of stack emissions from former facilities, windblown dust from

waste sites, and dispersal of contaminants from biointrusion (for example, the BC Controlled Area). In addition to evaluating the need for action, evaluation of the presence of additional waste sites potentially located in the non-operational areas will be integrated with waste site risks to provide a geographically integrated assessment for the Outer Area.

The methods for assessing ecological risks used for the Outer Area BRA will support integration of risk assessment approaches between the River Corridor and Central Plateau, and will provide consistency with DOE's intent to clean up the Outer Area in a manner comparable to the River Corridor.

2.1.3 Inner Area Risk Assessment Activities

The Inner Area represents the smallest practical area where permanent waste disposal and isolation of residual contamination will occur. The Inner Area will include permanent waste disposal facilities already in place, such as ERDF, the Integrated Disposal Facility, a naval reactor disposal site, mixed waste disposal trenches, U Plant canyon, and the U.S. Ecology commercial low-level waste disposal facility (Figure 2-1). As with the Outer Area, the objectives for risk assessments in the Inner Area will be to provide an analysis of baseline human health and ecological risks to help determine the basis for action at sites, and to provide input to development of PRGs as part of the evaluation of remedial alternatives in the FSs. Key ecological risk questions for the Inner Area include:

- At which waste sites do exposure pathways currently exist?
- What are the likely COPECs at Inner Area waste sites?
- At which waste sites are exposure pathways likely to be present in the future?
- What ecological risks would exist if intensive management practices (e.g., surveillance and pest control) were no longer present?
- At what depth would biointrusion take place for purposes of defining a point of compliance for protection of ecological receptors?

2.1.4 Integrated Presentation of Hanford Site Risks

A site-wide depiction of risk will be important for documenting and communicating risk reduction and the residual risk over time as remedial actions are completed and areas of the site are considered for close out. An integrated assessment of site risks will be developed to incorporate the results of the different risk assessments being conducted in the River Corridor and the Central Plateau. Risk assessments in the River Corridor and Central Plateau support regulatory requirements specified in the TPA (Ecology et al., 1989). These risk assessments are focused on determining the need for remedial action and developing PRGs to support evaluation of remedial alternatives. Observations about Hanford Site risk assessments that have been provided to DOE by regulators and stakeholders include a lack of a site-wide integration of risks both geographically and temporally. In addition, the deletion of the Hanford Site from the NPL involves demonstrating that the site (beyond the waste sites and facilities) achieves CERCLA thresholds for protectiveness. This communication of site risks will be an ongoing activity that will capture information and results from risk assessments as they are completed. Risk assessments that will be incorporated into the communication of site-wide risks include the risk assessments prepared for groundwater OUs, the risk assessments prepared for the Outer and Inner Area RI/FSs, and the RCBRA.

In addition to these risk assessments, evaluation of conditions in the nonoperational area also will be incorporated into the integrated presentation of site-wide risks. The characterization of conditions in the nonoperational area will include background soil sampling studies, environmental monitoring data, air emissions studies, results from orphan sites evaluations, monitoring performed as part of permitting and

compliance activities, as well as technical baseline reports and other historical studies. Combining risk assessment results from waste sites with information evaluating conditions in the nonoperational area will provide a geographic depiction of Hanford Site risks to HHE. While the primary role for this integrated assessment is risk communication, it may also provide information to support eventual delisting of portions of the Hanford Site.[1]

2.2 Integration with Other Ecological Risk Activities

The ERAs that will be conducted as part of the Inner and Outer Area RI/FSs will need to be integrated with these other ecological risk activities, including the RCBRA and environmental surveillance activities conducted at the Hanford Site. This section briefly describes these activities and discusses integration points with these activities.

2.2.1 River Corridor Baseline Risk Assessment

The RCBRA (DOE/RL-2007-21) provides key risk assessment information that supports risk management decisions and RODs that will protect HHE. The RCBRA has two key elements: (1) the source and groundwater component (which addresses potential upland, shoreline, and groundwater risks), and (2) the Columbia River component (which addresses potential risks from Hanford Site releases to the Columbia River). The RCBRA source and groundwater component involves assessing risks in upland areas and shoreline environments, shorelines between operational areas, and potential risks from groundwater contamination.

Points of integration between the RCBRA and ERAs in the Central Plateau include common ecological settings and reference areas between the Central Plateau and the upland areas in the River Corridor. As described in Section 4.2, reference areas have been identified for assessing ecological risks at the Hanford Site (WMP-29253). A reference site is a location that is ecologically similar to the study site, preferably nearby, with little or no contamination. Data sets collected as part of the RCBRA, and as part of the ecological sampling conducted in the Central Plateau, have been used as develop reference areas to assess ecological risks at the Hanford Site. In addition, the common ecological settings between the upland areas of the River Corridor and the Central Plateau indicate that there should be some comparability in risk assessment approaches between the RCBRA and the ERAs to be conducted in support of the Inner and Outer Area RI/FSs.

2.2.2 Other Programs Integrated with the Central Plateau Ecological Risk Assessment

Other programs at the Hanford Site that conduct environmental monitoring or assessment of ecological resources include the Near-Facility Monitoring (NFM) Program currently conducted by CH2M HILL Plateau Remediation Company (available at: http://prc.rl.gov/rapidweb/Environmental/index.cfm?PageNum=38), the Surface Environmental Surveillance Program (SESP) operated by Pacific Northwest National Laboratory (PNNL) (available at: http://ecragroup.pnl.gov/projects/project_description.asp?id=102), and the Ecological Monitoring and Compliance Program (EMCP) also operated by PNNL (available at: http://www.pnl.gov/ecomon/compliance/compliance.asp). Other sampling programs include preoperational monitoring conducted for new facilities or processes that have the potential for adverse environmental impact and sampling performed to evaluate background concentrations of radionuclides

[1] A composite analysis (CA) was prepared (PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*) for continued disposal authorization for waste management activities. This integrated assessment of site risks will focus primarily on vadose zone and groundwater contamination being addressed under CERCLA and the *Resource Conservation and Recovery Act of 1976* (RCRA), and will be a distinct activity from the CA.

and inorganic constituents in Hanford Site soils. Data collected from these programs were evaluated in WMP-29253. These programs are described briefly in the following subsections.

2.2.2.1 Near-Facility Monitoring

NFM consists of pre-operational monitoring surveys and operational monitoring. Pre-operational monitoring surveys are conducted to obtain environmental monitoring baseline information that can be used to design a routine operational environmental monitoring program. Operational monitoring is conducted near active facilities and operations that have the potential to impact the Hanford environment significantly and at inactive contaminated facilities, such as former waste storage and disposal facilities (DOE/RL-91-50, *Environmental Monitoring Plan United States Department of Energy Richland Operations Office*). The NFM group conducts routine and "as-needed" environmental monitoring efforts in the 100, 200, 300, 400, and 600 Areas to determine radionuclide levels in air, water, soil, vegetation, and animals. NFM efforts have focused primarily on waste management sites, such as cribs, trenches, ditches, burial grounds, and other types of liquid waste disposal facilities, and on the ongoing waste management activities conducted within and around these sites. Results from the NFM are documented in the annual Hanford Site Environmental Reports.

2.2.2.2 Surface Environmental Surveillance Program

The SESP program collects the various samples from the far-field environment on the Hanford Site but not proximal to the operations areas, as well as the offsite sampling and analysis effort. Environmental media that are routinely monitored include air, surface water, sediments, soil, vegetation, agricultural products, fish, and wildlife. These are monitored for radionuclides and nonradiological constituents including metals, organic compounds, and on occasion, pesticides and polychlorinated biphenyls (PCBs). The data are used to document Hanford Site compliance with environmental regulations in order to provide information to the public about environmental conditions on the Hanford Site and adjoining properties and satisfy environmental monitoring requirements of other Hanford Site contractors engaged in site cleanup activities. The environmental data collected are published annually in the Hanford Site Environmental Report and are made available to regulatory agencies, Tribes, other stakeholders, and the general public.

2.2.2.3 Hanford Site Background Studies

Three reports have been prepared to document the range of radionuclide and nonradioactive analyte concentrations that occur naturally in soil in the vadose zone on the Hanford Site (DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*; DOE/RL-95-55, *Hanford Site Background: Evaluation of Existing Soil Radionuclide Data*; DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides*). The data compiled in these reports have been used to develop site-wide background concentrations in soil. At the Hanford Site, the soil background serves as the basis for defining contamination and the baseline for determining risk-based soil cleanup levels (DOE/RL-92-24).

2.2.2.4 Ecological Monitoring and Compliance Program

The EMCP conducts surveys and collects data to monitor the status and condition of biological resources on the Hanford Site. Information is used to identify sensitive habitats and species and assure compliance with legal and regulatory requirements for natural resources and environmental monitoring. Ecological compliance assessment at the Hanford Site is guided by DOE/RL-96-32, *Hanford Site Biological Resources Management Plan*, and DOE/RL-96-88, *Hanford Site Biological Resources Mitigation Strategy Plan*. Baseline field surveys of the Hanford Site are performed annually, and the species and habitat information is preserved in an electronic database for DOE. This database includes a geographic information system interface to map proposed DOE actions and compares these actions to distributions of

critical species and habitats. Ecological impact reviews are conducted and documented for all projects on the Hanford Site with the potential for impacting the biological environment. These reviews include a brief description of the proposed action as it pertains to the biological environment, a complete description of the species and habitats that will be affected, an analysis of the significance of the impacts, and identification of mitigation needs.

3 Status and Chronology of Central Plateau Ecological Risk Assessment Activities

This chapter summarizes the chronology of ecological data collection and risk assessment activities that have been conducted in the Central Plateau. Development of the CP ERA grew out of the initial regulatory agency concerns expressed during the RI for the 200-CW-1 OU. In response to these concerns, DOE initiated an ecological evaluation approach to address potential ecological risks from past releases to waste sites in the 200 Area. This evaluation was structured in a phased manner that was consistent with EPA's eight-step process for ERA. The initial step to assessing ecological risks for 200 Area waste sites involved a screening level ecological risk assessment (SLERA), which was documented in the *Central Plateau Ecological Evaluation* (CPEE) report (DOE/RL-2001-54). Data gaps identified in the CPEE were addressed through a subsequent ecological DQO process. From that initial ecological DQO process, the approach to the CP ERA evolved into a three-phased investigation effort, followed by a fourth phase involving the analysis of the data and preparation of a draft ERA report.

In describing the major elements of the ERA process in the Central Plateau, this chronology documents how those elements fit into EPA's eight-step process for conducting ERAs. In addition, the CP ERA encompasses the results from assessments, evaluations, studies, and other activities conducted over the past nine years at the Hanford Site. The purpose for this section is to provide a narrative summarizing those activities and cataloging the primary technical resources for assessing ecological risks in the Central Plateau, for use in future remedial response actions.

The milestones associated with CP ERA activities that are discussed in this section include:

- A brief chronology of the development of DOE/RL-2000-35, *200-CW-1 Operable Unit Remedial Investigation Report* (Gable Mountain/B Ponds and ditches cooling water process units), with a focus on agency concerns regarding assessment of ecological risks.
- A description of the CPEE (DOE/RL-2001-54). The purpose of this document was to provide a SLERA for the Central Plateau in accordance with EPA's eight-step ERA process.
- A description of the CP ERA. This focuses on the development of the ecological DQOs and field investigations that were incorporated into the Draft A Reissue report (DOE/RL-2007-50). Following regulatory agency comments on that report and with the initiation of the Central Plateau Cleanup Completion Strategy (DOE/RL-2009-81), the CP ERA report has been revised and repackaged into the current data package report.

3.1 200-CW-1 Operable Unit Remedial Investigation Report

The 200-CW-1 RI (DOE/RL-2000-35) reported on characterization activities associated with four representative waste sites in the OU (i.e., 216-B-2-2 Ditch, 216-A-25 Gable Mountain Pond, 216-B-3 Main Pond, and 216-B-3-3 Ditch). Waste sites in the 200-CW-1 OU received predominantly cooling water from facilities in the 200 East Area, which contained both chemicals and radionuclides. Unplanned releases of radioactive materials, including releases associated with equipment failures in the facilities, contributed large amounts of radioactivity to several of the waste sites. During the period from August 1999 through December 1999, RI activities on these representative sites generated data to determine the need to proceed with an FS, support the evaluation of remedial alternative for the OU, and develop closure options for the TSD sites. The RI report also included a qualitative evaluation of ecological risk using characterization data collected during other investigations. The sources for ecological data evaluated in the 200-CW-1 RI included the following:

- WHC-MR-0418, *Historical Records of Radioactive Contamination in Biota in the 200 Areas of the Hanford Site*
- WHC-EP-0601, *Synthesis of Ecological Data from the 100 Areas of the Hanford Site*

In comments (dated December 18, 2000) provided by Ecology for the 200-CW-1 Gable Mountain/ B Ponds and Ditches Cooling Water Group OU Remedial Investigation Report, the agency determined that the RI evaluation was sufficient to move forward to the FS for the 200 Area in the industrial exclusive category (Ecology, 2000, "Comments on the Evaluation of the Report, 200-CW-1 Gable Mountain/B Ponds and Ditches Cooling Water Group Operable Unit Remedial Investigation Report, DOE/RL-2000-35, Draft A"). However, the evaluation did not adequately determine which constituents and site-specific considerations need to be addressed in the FS for the conservation (mining) areas, specifically the large ponds and ditches outside the industrial exclusive boundary. Ecology commented that these pond areas were spatially extensive, may be impacted by site-related contaminants, and represent potential habitat for ecological receptors. Therefore, Ecology requested that DOE conduct further study to characterize the potential transport and uptake of contaminants by plants and animals in areas outside of the industrial exclusive core zone. Similar concerns regarding the ecological evaluation of the 200 Areas were expressed by Ecology in comments (dated December 4, 2000) for DOE/RL-99-07, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan*. Ecology approved the work plan, but requested that DOE provide an issue resolution relating to these ecological evaluations within the RI report. In the DOE response letter to Ecology comments for both of these reports (01-ERD-033, "Responses to the State of Washington Department of Ecology's (Ecology) December 4, 2000, Comments on the 200-CW-1 Operable Unit Remedial Investigation/Feasibility Study (RI/FS) Work Plan; 216-B-3 Resource Conservation and Recovery Act (RCRA) Treatment, Storage, and Disposal (TSD) Unit Sampling Plan, DOE/EL-99-07, Rev. 0; and December 18, 2000, Comments on the 200-CW-1 Operable Unit Remedial Investigation Report, Draft A"), DOE agreed to develop a strategy for evaluating the ecological impacts in the 200 Areas.

3.2 Central Plateau Ecological Evaluation

The CPEE (DOE/RL-2001-54) provided a description of the environmental setting of the 200 Areas, including a summary of historical facility processes, the natural environment, and the ecological monitoring programs at the site. In addition, the report presented an ecological conceptual model, including contaminant fate and transport, exposure pathways, and ecological receptors. A preliminary assessment of ecological risk was conducted by comparing COPECs selected from existing sampling and analytical data in soil against screening level benchmark values and Hanford Site background values. Lastly, the report provided a discussion of "path-forward" activities required for completion of the ERA requirements to support RODs for the 200 Area non-tank farm related soil waste sites. The complete document is provided on a supplementary disk as Appendix A to this report.

The data gaps from this assessment were incorporated into an ecological DQO process for the plateau; that ecological DQO process was expanded and incorporated into the CP ERA, discussed below in Section 3.3.

Several appendices to the CPEE provide useful background information for evaluating and characterizing potential ecological risks on the Central Plateau. These appendices include:

- A compilation of Central Plateau ecological data, including descriptions of habitats and species of concern and a bibliography of papers and reports discussing Central Plateau ecological topics

- A review of Hanford Site ecological update and mobility studies which summarizes data and reports that address the uptake and concentrations of radionuclides and metals in biota (animals and vegetation) accumulated from soils and wastes
- A preliminary list of COPECs, along with descriptions of how these potentially relate to former operations
- A summary of Central Plateau waste sites with available ecological sampling data
- The results of ecological sampling in areas of higher habitat quality to identify new-to-science arthropod species

The CPEE (DOE/RL-2001-54) provided a SLERA for the Central Plateau in accordance with EPA guidance. EPA's eight-step ERA process is presented in EPA/540/R-97-006, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments: Interim Final.* The SLERA consists of the first two steps of the ERA process (e.g., a screening level problem formulation and a screening level exposure estimation). The CPEE report (DOE/RL-2001-54) and associated appendices are provided on a supplementary disk along with this CP ERA data package report.

3.3 Central Plateau Ecological Risk Assessment

Several comments were received on the CPEE (DOE/RL-2001-54) from Ecology on the lack of detail in the purpose and scope and on the SLERA approach. Specific concerns with the SLERA included an absence of clearly defined goals, endpoints that were ambiguous and difficult to define and measure, and a failure to identify important risks (Ecology, 2002, "Review of the Ecological Evaluation of the Hanford 200 Areas-Phase I: Compilation of Existing 200 Areas Ecological Data, DOE/RL-2001-54, Draft A - United States Department of Energy Letters 02-WMD-0136 and 02-WMD-190 through 02-WMD-193"). In addition, during the April 23, 2003, Tri-Party meeting (Ecology et al., 2003, *Tri-Party Agreement Milestone Review*), Ecology raised concerns regarding ecological data collection. DOE stated that the soil sampling conducted through the RI provided sufficient data to conduct ERAs in accordance with the EPA guidance for ecological risk evaluations and to support final remedy selection decisions. Ecology asserted that some biological sampling is required as part of the RI to meet the regulatory requirement to characterize the current and potential threats to the environment.

DOE, in response to the regulator agencies' concerns and Ecology's comments on the CPEE, began the DQO process in 2003 to identify sampling data needs for the Central Plateau. The DQO process was initiated to focus on additional data collection needs and to ensure that sufficient information was available to complete FSs and support remedial decisions that are protective of the environment. The following sections summarize the three-phase DQO and investigation process undertaken as part of the CP ERA, which follows federal and state guidance, including the following:

- EPA 540-R-97-006, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments: Interim Final*
- EPA/630/R-95/002F, *Guidelines for Ecological Risk Assessment*
- WAC 173-340-7490, "Terrestrial Ecological Evaluation Procedures"

The technical approach also incorporates concepts discussed in the following documents:

- EPA/120/R-07/001, *Framework for Metals Risk Assessment*

- 4WD-OTS, "Amended Guidance on Ecological Risk Assessment at Military Bases: Process Considerations, Timing of Activities, and Inclusion of Stakeholders"
- EPA/540/F-01/014, *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments*

The basic approach for the ERA followed an eight-step process with built-in critical management and decision points to allow stakeholder input on the evaluation of interim findings and refinement of the technical approach. The DQO process was initiated in 2003, by conducting interviews with the Tri-Parties, Natural Resource Trustee Council representatives, Hanford Advisory Board members, and Tribal representatives. In addition to interviews, workshops were held to present and receive feedback for proposed data collection. Within these DQOs, risk questions were developed and data needed to characterize ecological risks were identified. A description of the stakeholder input is summarized in the DQO reports and in the Draft A Reissue report, which are included as appendices on supplementary disks. Steps 1 and 2 of the ERA process make up the SLERA, while Steps 3 through 8 comprise the baseline ecological risk assessment (BERA), as shown in Figure 3-1.

3.3.1 Summary of Documentation for the Central Plateau Ecological Risk Assessment

This section introduces the key documents that were prepared under the CP ERA. Elements of the data and evaluations presented in these reports will be carried forward into the ERAs that will support the upcoming RI/FSs in the Central Plateau Inner and Outer Areas. For these documents, a description is provided for how the information in each document will be used in future ERAs.

The ERA was implemented using a phased approach to characterize ecological risks based on spatial domains where waste sites are located. Identification of COPECs and potential ecological risk receptors was presented initially in the CPEE (DOE/RL-2001-54). Phase I activities focused on waste sites in the 200 East and 200 West Areas (WMP-20570 and DOE/RL-2004-42). Phase II evaluated the BC Controlled Area (WMP-25493 and DOE/RL-2005-30).[2] Phase III identified and addressed the supplemental data needs for waste sites from Phase I and II investigations (WMP-29253 and DOE/RL-2006-27). Complete copies of the reports described in this section are provided on supplemental disks as Appendices B through G to this data package report.

3.3.1.1 Summary of Phase I Ecological Data Quality Objective

The Phase I DQOs report (WMP-20750) developed the list of COPECs, risk questions, and candidate waste sites in the 200 Area for evaluation in an ERA.

COPECs that were evaluated initially in the Draft A Reissue report (DOE/RL-2007-50) were identified based on shallow zone data available from the Hanford Environmental Information System (HEIS) and from DOE/RL-2001-54. Analytes were included as COPECs if the maximum detected concentrations exceeded the soil-screening values or contributed to the sum of fractions (SOF) for radiological dose to terrestrial receptors. A description of the sampling and analytical data is included on a supplemental disk as Appendix L.

Assessment endpoints were developed that are representative of terrestrial ecological receptors potentially at risk from COPECs in soil. Plants and soil macroinvertebrates were considered valuable assessment endpoint entities because, considering the lack of inorganic trophic transfer, they potentially were more exposed indicators for evaluating the adverse effects of inorganic COPECs.

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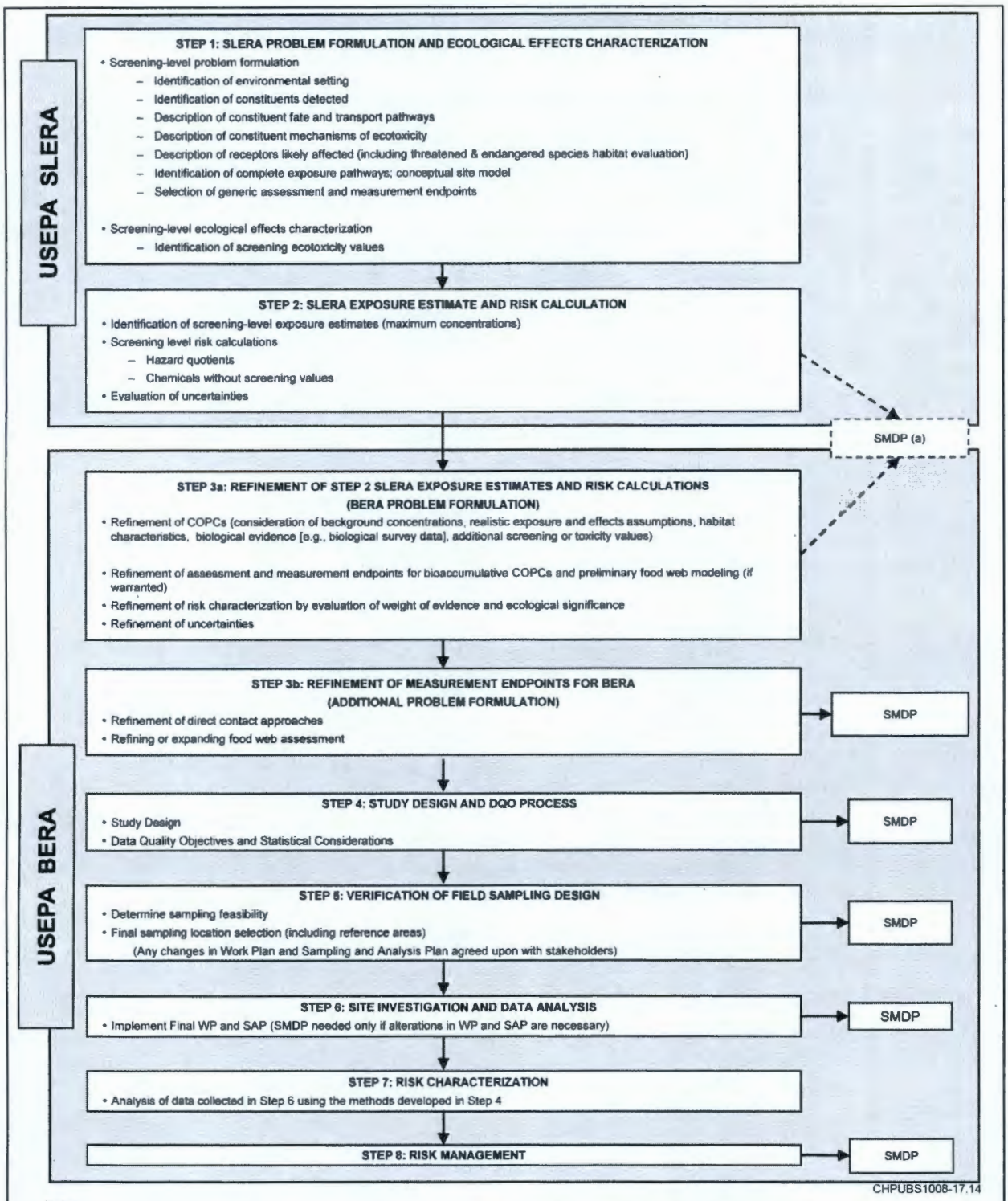
[2] The tank farms and the Ecology site were initially considered in the Phase II DQO, but were later removed from ecological sampling in Phase II because their operations, regulatory plans, and interim stabilization plans represented a poor fit from an ecological risk characterization standpoint.



Notes:

(a) SMDP occurs EITHER after Step 2 or after Step 3a
COPCs Constituents of Potential Concern
DQO Data Quality Objectives
GW Groundwater
SAP Sampling and Analysis Plan
SW/SD Surface water and sediment
WP Work Plan
Sources: USEPA Process Adapted from USEPA, 1997, 2000, 2001

SMDP Scientific Management Decision Point [Note that SMDPs do not identify formal reporting requirements, but identify when stakeholder communication should be considered]
BERA Baseline ERA
SLERA Screening-level ERA
USEPA United States Environmental Protection Agency
USEPA, 1997. Ecological Risk Assessment Guidance for Superfund.
USEPA, 2000. Amended Guidance on Ecological Risk Assessment at Military Bases: Process Considerations, Timing of Activities, and Inclusion of Stakeholders .
USEPA, 2001. ECO-Update: Role of Screening-level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments.

Figure 3-1. USEPA Expanded Eight-Step Ecological Risk Assessment Process

Central Plateau-specific receptors were suggested as ecological and societal relevant assessment endpoints that also addressed management goals. Central Plateau-specific receptors were suggested as surrogates for the *Washington Administrative Code* feeding guilds.

The following eight risk questions were developed to identify measures of effect, exposure, and ecosystem/receptor characteristics:

- Do COPECs in shallow zone soils decrease plant survival or growth?
- Do COPECs in shallow zone soils affect decomposition by soil biota?
- Do COPECs in shallow zone soils affect soil macroinvertebrate survival or growth?
- Do COPECs in shallow zone soils and food decrease herbivorous, insectivorous, or omnivorous bird survival, growth, reproduction, or abundance or affect balanced gender ratios?
- Do COPECs in shallow zone soils and food decrease insectivorous reptile abundance or biomass or affect size structure?
- Do COPECs in shallow zone soils and food decrease herbivorous, insectivorous, or omnivorous mammal survival, growth, reproduction, abundance, or biomass or affect balanced gender ratios?
- Do COPECs in shallow zone soils and food decrease carnivorous bird survival, growth, or reproduction?
- Do COPECs in shallow zone soils and food decrease carnivorous mammal survival, growth, or reproduction?

More specific risk questions were posed in the Phase I SAP (DOE/RL-2004-42):

- For nonradionuclide COPECs: Are mean concentrations in soil greater than mean concentrations in the reference site soils (or mean of background concentrations) and, if so, are they greater than soil-screening values or literature no-adverse-effect levels or toxicity reference values for the receptor, based on effects of each individual COPEC or combined effects of COPECs where appropriate? (Note that the toxicity values used for comparison are typically bounding cases such as no observed adverse effect levels.)
- For radionuclide COPECs: Is the contribution to the SOF based on mean concentrations greater than 1 and also greater than the SOF based on mean concentrations for the reference site, or greater than the SOF based on background mean concentrations?
- Do mean COPEC concentrations in the receptor increase compared to mean COPEC concentrations in the reference site receptors or along a gradient with increasing COPEC concentrations greater than published levels associated with toxicity?
- Do mean COPEC concentrations in the receptor diet increase from those of the reference site or along a gradient with increasing COPEC concentrations greater than toxicity reference value?

Measures of effect, exposure, and receptor/ecosystem characteristics were selected. These measures formed the basis of the data needs for the study design. Measures of exposure include COPEC concentrations in soil and biota. Measures of effect include the following:

- Comparison of COPEC concentrations in soil to literature-derived adverse-effect level for plants and invertebrates in soil

- Modeled extrapolation of COPEC concentrations in soil to literature-derived adverse-effect level for diet (wildlife only)
- Comparison of COPEC concentrations in tissue to literature-derived adverse-effect level for assessment endpoint body burden (wildlife only)
- Field study of the potential for adverse effects (conditional on field verification efforts)

Ecosystem/receptor characteristics were identified by various Central Plateau habitat types. The study design, which resulted from the Phase I DQO and is presented in the Phase I SAP (DOE/RL-2004-42), is summarized in greater detail in Section 4 of this report.

Some key assumptions regarding the conceptual model of ecological exposure were made in developing the study design:

- Surface soil, in particular the first foot, was considered important as an exposure medium for direct contact with wildlife, root uptake, and animal burrowing. Thus, surface samples (from the first foot of soil) can be collected along with specific biological samples to test for COPEC uptake (WMP-20750).
- An investigation area of 1 ha (2.47 ac) was selected as an appropriate scale over which to evaluate the measures considered in this plan. The home range (most typically representing the foraging area) and the median dispersal distance were evaluated to identify 1 ha (2.47 ac) as an appropriate spatial scale to evaluate ecological risk. The mean over this 1 ha (2.47 ac) investigation area was considered the best estimate of the representative COPEC concentration in soil and the concentration of COPECs in biota (WMP-20750; DOE/RL-2004-42).

3.3.1.2 Summary of Phase II Ecological Data Quality Objective

The Phase II DQO evaluated the need for ecological sampling in the Ecology site, tank farms, the BC Controlled Area, and West Lake. Ecological sampling was not proposed for the U.S. Ecology site and the tank farms for different reasons: the U.S. Ecology site because it remains in operation and the tank farms because they are actively managed by DOE to prevent biointrusion and continue to undergo remediation. Because West Lake represented a unique and changing ecological feature at the Hanford Site, further data compilation was recommended to define data gaps more accurately before commencing with an ecological DQO (EcoDQO). Therefore, the Phase II DQO focused on the BC Controlled Area.

The BC Controlled Area is an area of approximately 3,471 ha (13.4 mi^2) located to the south of the BC Cribs and Trenches. The BC Cribs and Trenches received wastes primarily from the Uranium Recovery Project and secondarily from 300 Area wastes (WMP-18647). Anecdotal information indicated that the trenches were periodically left open (e.g., over weekends) and animals drank from these and probably dispersed contaminants as a result. There was also evidence of biointrusion into trenches. It is thought that animal burrows created access to radionuclide-contaminated salts; other animals ingested the salts and deposited radionuclides through defecation and urination, thereby contaminating shallow soils throughout the BC Controlled Area. The northern part of the BC Controlled Area (approximately 57 ha [141 ac]) contains the highest levels of contamination of cesium-137 (Cs-137) and strontium-90 (Sr-90) from the BC Cribs and Trenches. The remainder of the BC Controlled Area contains lower levels of contaminants that are irregularly distributed.

Evaluation of existing sampling and analytical data indicated that the COPECs for the BC Controlled Area were limited to cesium-137 and strontium-90. Given the similarity of radionuclide COPECs between Phase I and Phase II and the similarity of the BC Controlled Area to habitat in and around the Central Plateau waste sites, the conceptual model, risk questions, assessment endpoints, measures and

study design developed in Phase I (WMP-20570) were used for the Phase II DQO (see Table 3-1). The conceptual model and sample results for contamination in the BC Controlled Area also suggested that concentrations of radionuclides will be in the upper part of the soil column. Thus, surface samples (e.g., from the top 15.24 cm [6 in.] of soil) could be collected along with specific biological samples to test for COPEC uptake. In addition, the conceptual model of possible mobility of subsurface contamination through animal burrowing and plant uptake also was assessed using radiological field data collection. Soils interrogated by the field data were biased toward areas with a high potential for mobilized subsurface waste (i.e., mammal burrow spoils and ant mounds). Additional data collection would be considered, depending on the results of the initial investigation phases; the additional data needs included characterization of soils deeper than 15.24 cm (0.5 ft), plant tissue concentrations, population measures for mammals and lizards, field verification for middle trophic-level birds, litterbag studies, and toxicity tests for plants and invertebrates (WMP-25493; DOE/RL-2005-30).

3.3.1.3 Summary of Phase III Ecological Data Quality Objective

The Phase III DQO addressed data needs identified from the assessment of data collected during the Phases I and Phase II investigations. The Phase III DQO addressed distribution of radionuclides in non-waste site areas potentially associated with air emissions from stacks, in addition to two spatial domains: the dispersed carbon tetrachloride plume in the 200 West Area and West Lake (216-N-8 Pond). Sampling at West Lake was intended to address ecological risks associated with aquatic media, soil, and biotic tissues. Sampling of the dispersed carbon tetrachloride plume was intended to assess ecological risk of subsurface vapor inhalation by burrowing animals.

The conceptual model, risk questions, assessment endpoints, and measures developed in Phase I (WMP-20570) and Phase II (WMP-25493) are applicable to the data collection plans in Phase III. Supplemental data collection was proposed to address uncertainties regarding the identification of COPECs. Resurveys of plant cover were planned in Phase III for the Phase I waste sites to determine if additional plant species could be documented following the wet winter/spring conditions at the Hanford Site. Supplemental data needs identified for Phase III also included additional invertebrate cyanide data from reference sites and waste sites and additional sampling for 43 select PCB congeners and strontium-90 in lizards and mammals. Supplemental data also were collected for worst-case conditions in the BC Controlled Area to assess the potential risk from cesium-137 and strontium-90.

The Phase III DQO included supplemental data collection and sampling supporting the EcoDQOs for West Lake, the 200 West Area dispersed carbon tetrachloride plume, and surface soil sampling in non-waste site areas to evaluate the air deposition pathway for radionuclides. Finally, two new provisions were added to the sampling activities to resolve concerns expressed by the Hanford Natural Resource Trustees and the TPA agency decision makers. The first is the installation of artificial animal burrows in the 200 West Area for carbon tetrachloride vapor sampling; this is a contingency that will be performed if reconnaissance surveys did not identify animal burrows that intersect the 200 West Area dispersed carbon tetrachloride vapor plume. The second was the addition of two offsite reference sites for soil sampling outside the Hanford Site boundary (WMP-29253; DOE/RL-2006-27).

3.3.1.4 Field Characterization Activities

The following reports summarize field characterization activities supporting the ERA:

- D&D-28419 (included on a supplementary disk as Appendix H to this report). This report provides evaluations of the surface characteristics and the surrounding areas around selected waste sites. It also describes a methodology for performing waste site ecological evaluations.

- DTS-RPT-077 (included on a supplementary disk as Appendix I to this report) and DTS-RPT-078 (included on a supplementary disk as Appendix J to this report). These two sampling reports present further details about the field investigation data collected as part of Phase I and Phase II of the CP ERA and included with the database in Appendix L.

The information provided in these investigation reports may be used refine the conceptual exposure models for future ERAs conducted as part of Central Plateau Inner and Outer Area RI/FSs.

3.3.1.5 Ecological Risk Conclusions

The analyses, results, and conclusions drawn from the data collected during the Phases I, II, and III field investigations were presented in February 2008 in the Draft A Reissue report, provided on a supplementary disk to this report as Appendix K. The following subsection summarizes the initial conclusions presented for the CP ERA and the regulatory agency comments on those conclusions submitted in May 2008.

Initial Results and Conclusions. The analysis developed in 2008 for the CP ERA concluded that evidence for contaminant exposure was observed at selected sites and receptors, but there was a lack of correlation between COPECs in soil and tissue and the various measures of effect. It was argued that these results suggested no risk from Hanford Site contaminants at waste sites or at the BC Controlled Area. Soil gas sampling in animal burrows was considered to provide an estimate of reasonable worst case concentration of carbon tetrachloride in burrow air. Those exposure concentrations were judged to be well below the applicable ecological screening level (ESL), indicating that the dispersed carbon tetrachloride plume did not present an ecological risk. Ecological risk conclusions were not developed for West Lake; however, metals and radionuclides in multiple media sampled from West Lake were identified as COPECs when compared to media based benchmarks and evaluated using wildlife exposure models incorporating site-specific assumptions. Dietary exposure for insect-eating wildlife was of primary interest with regard to potential ecological risks at West Lake. The overall ecological risk conclusion in the Draft A Reissue report was that no ecological risk exists at terrestrial waste sites, the BC Controlled Area, or the diffuse carbon tetrachloride plume. Contaminants of potential ecological concern had been identified at West Lake and further assessment would be planned for that waste site.

Regulatory Comments and Key Concerns. Regulatory agency comments were provided by EPA and Ecology to DOE in May 2008. The agency comments are provided in Appendix N. The following key concerns were raised in the agency comments:

- The agencies advised DOE not to overreach when drawing conclusions about ecological risk in the Hanford Site's Central Plateau (includes the 200 Area NPL site). EPA observed that the initial goal for the scope of the ERA was to focus on waste sites where ecological risk might make the difference in remedy selection. It was not aimed at the sites where human health risk is a known driver for a response action. Some of these sites with human-health risk drivers also have shallow contamination that may pose ecological risk. This risk would have to be estimated under the RI/FS for individual OUs.

- Waste site characterization information from the OU investigations must be used to complete the RI/FS process for individual OUs. Due to the need to utilize data from waste sites in individual OUs, the scope of the CP ERA does not include the completion of the ERA portion of the RI/FS process for individual OUs.

- EPA stated that the report needed to be written more as a tool to communicate ecological risks to stakeholders and the public. EPA felt it was important that documents such as the risk assessments

present information and conclusions in a clear and understandable manner, including clear presentation of the uncertainties associated with the sampling design.

- The results of the risk assessment must be viewed in light of the intensive management of many Central Plateau waste sites, including several of the sites studied. EPA stated that contaminant uptake would be greater if deep-rooted plants were allowed to grow unchecked and animal intrusion was not controlled. A better examination was needed in the report on why these transient, or nuisance, exposures are not significant for the food web and the greater ecology of the Central Plateau.
- The risk assessment report culminates a major technical effort for a large and complex CERCLA site. The conclusions needed to address several key points:
  - What impact does uncertainty have on the conclusions?
  - What can be concluded about the ecological risk at waste sites that were sampled for this risk assessment?
  - What can be concluded about the waste sites that were not sampled?
  - What can be concluded about the areas in between individual waste sites?
- Ecology, CERCLA Natural Resource Trustees, and stakeholders have noted the selection of suitable reference sites as a technical challenge throughout the development and execution of this risk assessment. The conclusions should be re-written to address the issue of reference sites in more detail, including their impact on the uncertainty analysis. The discussion of uncertainty deserves commensurate attention in this report.
- The report should provide possible conclusions about ecological risk from uranium outside of waste sites. This is an important goal for this report because the ecological indicator soil concentration for uranium (WAC 173-340, Table 749-3) is expected to be lower than cleanup values for direct contact to humans, or cleanup values for soil to protect groundwater or surface water.

4 Summary of Central Plateau Ecological Risk Activities

This section describes the key planning, sample collection, and data analysis activities conducted as part of the CP ERA. It presents additional discussion of the rationale for these activities, as drawn from the DQO reports and the Draft A Reissue report (provided in the appendices). The information developed in this section is intended to assist in determining how the results from these activities will be carried forward into upcoming RI/FSs for the Central Plateau. The following multiple activities were performed and data sets were generated, as part of the development of the documents supporting the CP ERA (see Chapter 3):

- Selection of waste sites for data collection and evaluation
- Selection of reference sites for data collection and evaluation
- Identification of COPECs
- Data collected as part of the Phase I, Phase II, and Phase III DQO programs

Descriptions of each of these activities or data sets are summarized in the following subsections.

4.1 Selection of Waste Sites for Data Collection and Evaluation

Characterization of ecological risks at Central Plateau waste sites was performed in Phase I of the CP ERA. A key consideration in the sample design for Phase I was the selection of areas for sampling and analysis (WMP-20570). The following discussion summarizes the waste site selection process originally developed in the Phase I DQO and implemented in the Phase I SAP (DOE/RL-2004-42). As described in the following paragraphs, key assumptions in the site selection process limited the application of the original ecological risk data and conclusions to waste sites in the Central Plateau beyond the study areas. For the purpose of future RI/FSs, the process for selecting and evaluating waste sites will be modified to address these limitations.

Approximately 1,500 Central Plateau waste sites were screened. Approximately 1,000 sites were excluded because they had contamination in soil that was deeper than 4.6 m (15 ft), which is the standard point of compliance for protection of ecological receptors according to WAC 173-340-7490. The remaining 600 sites were judged to have "high" or "moderate" levels of contamination. The CP ERA DQO process made the assumption that these "high" or "moderate" contaminated sites would be remediated to achieve protection of human health, which would also achieve protection of ecological receptors. Therefore, the objective of the CP ERA was to focus on lower level contaminated sites, which may be judged to require no further action for protection of human health, but that still may pose an ecological risk.

The exclusion of "high" or "moderate" contaminated sites left 89 sites that were evaluated for ecological sampling (D&D-28419). This selection process is documented in a spreadsheet (included as Appendix L), which corresponds to a flow chart provided in Figure 9-2 of the Phase I DQO Report (WMP-20570). Out of those 89 sites, 6 waste sites were selected for sampling. Most of the 89 sites were excluded because these were underneath buildings or did not have habitat present. In addition, four locations were sampled in the BC Controlled Area (DOE/RL-2005-30). Two locations were placed where the highest contamination levels in soil were detected: one location was placed in an area with intermediate levels of contamination in soil, and another location was placed in the south of the BC Controlled Area where radiation levels were similar to Hanford Site background. These sample locations were selected to obtain a concentration gradient in soil for purposes of assessing potential accumulation of radionuclides into plants and animals.

Limitations with the waste site selection process originally used for the CP ERA included the following considerations:

- The approach of not examining "high" contamination sites for ecological risk may not have provided a full characterization of ecological risks, potentially understating ecological risks in Central Plateau waste sites. In addition, information from "high" contamination sites would be valuable for the development of site-specific ecological PRGs by identifying concentrations likely to show ecological effects or by evaluating bioaccumulation at higher concentrations.
- An assumption was made in the site selection process not to assess sites that are being actively managed to eliminate deep-rooted plant or animal intrusion. While it was acknowledged in the Draft A Reissue report that ecological exposure pathways could be complete at these sites, they were not considered for sampling and analysis. In addition, only sites where habitat currently was present were considered further for sampling. This may have further limited the opportunity to examine "high" contamination sites for ecological risks.
- Based on the outcome of six low-contamination waste sites and the gradient in the BC Controlled Area, the Draft A Reissue report concluded in February 2008 that waste sites throughout the Central Plateau did not pose a significant ecological risk. Questions were raised in the agency comments about the feasibility of extrapolating the results from the study sites to the Central Plateau at large.

The process for evaluating waste sites for the presence of ecological exposure pathways or risks will be revisited in the upcoming RI/FSs for the Central Plateau. Ecological exposure pathways will be identified under baseline conditions (e.g., without taking into consideration existing programs for controlling pathways), and assessment of ecological exposures will address potential risks under both current and potential future conditions.

4.2 Selection of Reference Sites for Data Collection and Evaluation

All of the risk questions posed in the ecological DQOs for the CP ERA were evaluated using a study design that involved a gradient of COPEC concentrations and reference areas (WMP-20570). EPA guidance (EPA/540/F-94/014, *Field Studies for Ecological Risk Assessment*) indicates that reference sites should closely resemble the terrain, hydrologic regime, soil types, vegetation, and wildlife of the Superfund Site. Moreover, the reference area should be located as near as possible to the Superfund Site without being influenced by the Site. If particular ecological risk measures (for example, comparison of an exposure point concentration of a COPEC with an ESL benchmark level) were similar for a waste site and a reference area, this might be evidence that waste disposal activities were not associated with increased risks to ecological receptors. This kind of information could be factored into an RI/FS for determining if remedial alternatives should be evaluated at waste sites to address ecological risks.

Central Plateau Reference Site 1 was selected during the Phase I DQO process (WMP-20570) from waste sites that had been re-vegetated with wheatgrass (*Agropyron* spp.) to provide the closest match with the habitats at the selected waste sites, most of which have been re-vegetated with wheatgrass. In contrast, Central Plateau Reference Site 2 was selected based on the presence of mature stands of sagebrush, a habitat characteristic of the BC Controlled Area (Phase II DQOs report [WMP-25493]). An additional nine reference sites that were selected originally for use in the RCBRA (DOE/RL-2007-21) were selected to characterize (1) backfilled and re-vegetated areas that are ecologically similar to Phase I waste sites, and (2) mature sagebrush areas that are similar to Phase II waste sites.

In addition to whether the reference site was re-vegetated or mature sagebrush, the following characteristics were considered for reference site selection:

- The reference site should be ecologically similar so that risk questions regarding receptor populations (e.g., abundance, reproduction, and gender ratios) can be evaluated.
- The reference site should have little or no contamination (i.e., COPEC concentrations should reflect Hanford Site background levels).
- Because airborne deposition of COPECs is possible, the reference site should be located upwind of the prevailing (northwest) winds and existing waste management facilities.
- Other factors considered in selecting reference sites included dominant plant species and cover, soil type and texture, burn history, and elevation (WMP-20570).

The locations of reference sites selected for the CP ERA are presented in Figure 4-1. Additional details regarding the selection and evaluation of reference sites are presented in the Draft A Reissue report, which is included as Appendix K. Data collected from the reference sites will be considered in upcoming Central Plateau RI/FSs for characterizing ecological risks at waste sites. There are uncertainties in the sampling of reference sites, which limit their usability in characterizing ecological risks; these uncertainties are discussed further in Chapter 5 of this report.

4.3 Identification of Contaminants of Potential Ecological Concern

The Phase I DQO report describes the process used originally to select COPECs for the CP ERA. COPECs were selected through a two-step process. The starting data set consisted of all analytical results from the CPEE (DOE/RL-2001-54) and "relevant" shallow-zone waste site soil data from discrete soil samples found in HEIS. These contaminants initially were screened using Hanford Site background concentrations in soil and ecological soil screening level (EcoSSL) benchmarks. Radionuclides with short half-lives or that were naturally-occurring also were excluded as COPECs. Chemical contaminants that were non-persistent in soil also were excluded as COPECs. Process knowledge also was used to exclude analytes unrelated to Hanford Site operations or present only in minor quantities. Contaminants remaining following this screening process were carried into the SAPs, and were analyzed in soil, plants, invertebrates, and animal's tissue (DOE/RL-2004-42). The second step is described as "COPEC refinement" and was based on statistical comparisons of soil and biotic tissues between Hanford areas and background and reference areas. Refined COPECs were used to characterize ecological risks. The COPEC screening process and data used in it are presented in the Phase I DQO report (WMP-20570). The Phase I DQO report is included as Appendix B.

Selection of COPECs will be revisited and updated as part of ERAs supporting upcoming RI/FSs in the Central Plateau. Many of the steps for identifying COPECs, as presented originally in the Phase I DQO report, will be retained for upcoming RI/FS reports. However, the COPEC refinement process, which used statistical comparisons with background and reference areas, may have dropped out some contaminants too early in the ERA process. These statistical comparisons may continue to have a role in the overall assessment of ecological risks, but they will not be used in future Central Plateau ERAs for identification of COPECs.

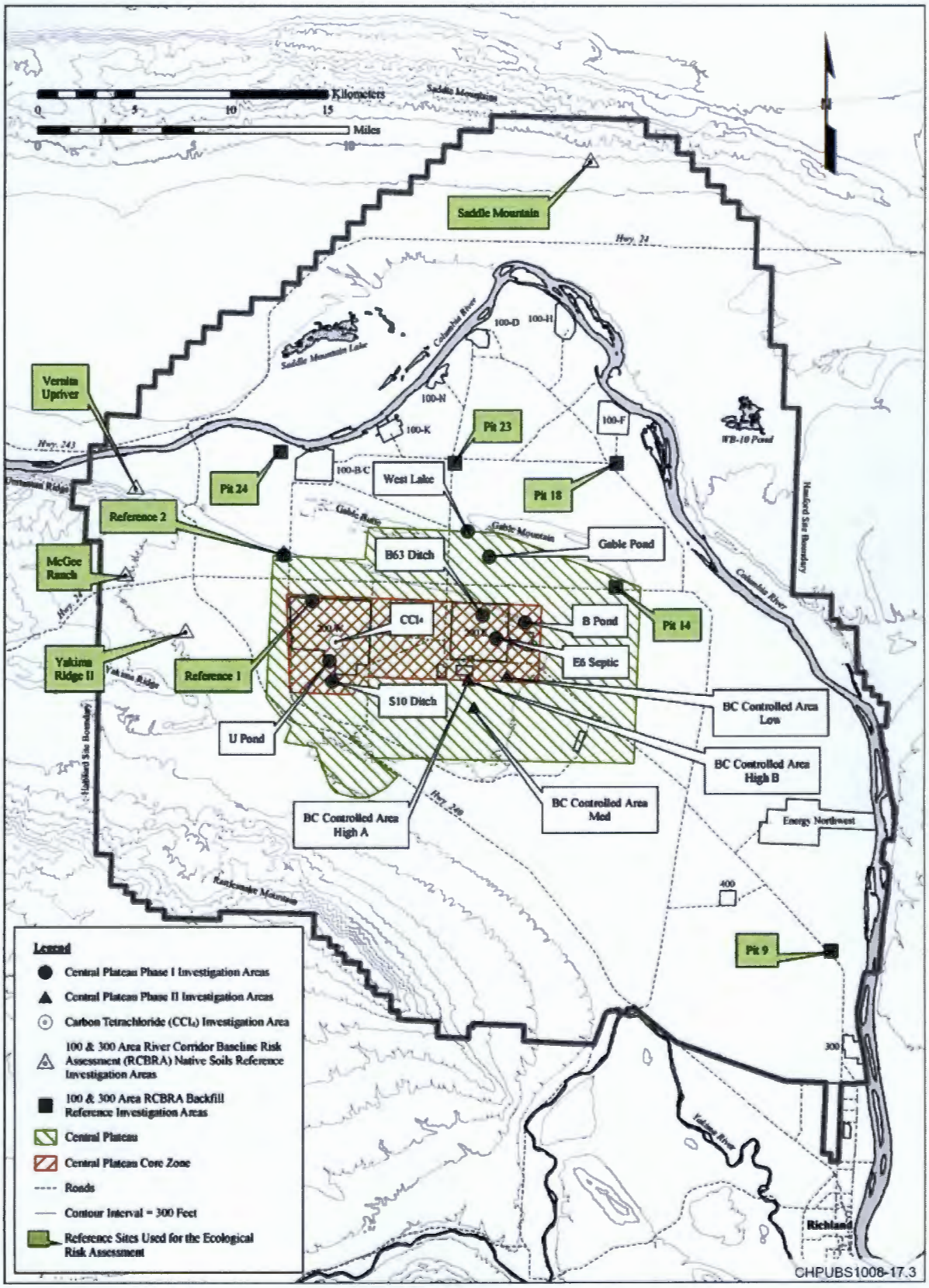


Figure 4-1. Location of Waste Sites and Reference Sites Selected for further Evaluation

4.4 Data Collected as Part of Phase I, Phase II, and Phase III of the Central Plateau Ecological Risk Assessment

This section summarizes the data collected during the three investigation phases of the CP ERA. This summary of the data collection activities has been drawn from the reports provided in the appendices, and further details of the sampling activities and resulting data can be found in those reports. The data are provided in one consolidated package on a supplementary disk included as Appendix M. A data crosswalk and a data dictionary, to facilitate review of the data, are also included. The types of data and their intended purposes are summarized in Tables 4-1 through 4-3, with additional information provided in narrative descriptions in the following subsections.

Data were collected in the three-phase DQO effort to address multiple objectives. The objective of Phase I was to characterize exposure and ecological effects of COPECs from Central Plateau Core Zone waste sites (potentially impacted locations) and a reference area (assumed unimpacted area, also referred to as control site). This phase focused on supplemental data collection efforts at waste sites with existing soil COPEC concentration data. The BC Controlled Area was the focus of data collection in Phase II. Phase III sampling was performed to address data gaps identified through the evaluation of data generated from the Phases I and II sampling efforts. The following data were collected over the three phases:

- Radiological field data for beta and gamma emitting radionuclides in soils (e.g., burrow spoils and ant nests) and plant material (Phases I, II, and III)
- Chemical analysis of surface soil samples collected from 0 to 15 cm (0 to 6 in.) for metals, radionuclides, and organics (e.g., PCBs and pesticides) using the multi-increment sampling (MIS) technique. (Note: A 15 cm[6 in.] depth was selected for Phase I to evaluate the importance of near-surface contaminant exposure to biota for Phases I and Phase II.)
- Plant cover estimation data (Phases I, II, and III)
- Biological data including body burden analysis for metals, radionuclides, and organics (e.g., PCBs and pesticides) in insects, lizards, and small mammals (Phases I, II, and III)
- Notation in the field logbooks of any abnormalities for the vertebrate animals handled (Phases I and Phase II)
- A literature review of studies relevant to the Hanford Site and collection of exposure parameter data relevant to the Hanford Site terrestrial receptors and exposure pathways (Phase I)
- Non-waste site MIS soil data (Phase III)
- Dispersed subsurface carbon tetrachloride vapor data to evaluate inhalation by burrowing animals (Phase III)
- Aquatic media, soil, and biotic tissue data for West Lake (Phase III)

Table 4-1. Phase I Sampling Design Summary Table Linking Data to Risk Questions and Assessment Endpoints

Data Type	Assessment Endpoint and Attribute	Measures	Population	Key Features of Design	Basis for Study Design
Reconnaissance and field verification	Herbivorous, insectivorous, and omnivorous bird and mammal, insectivorous reptile, and carnivorous bird and mammal attributes based on field measures	Basis for comparing all field-related measures in future phases of the SAP	Waste sites and reference sites	All sites will be classified according to vegetation and habitat status. Modified Daubenmire plots will be used to assess cover of dominant plants, bare ground, and cryptogams. Reconnaissance also helps to determine where and when to sample.	Field verification necessary to assess the comparability of habitat types among waste sites and reference areas.
Field radiological data	Information used to guide sampling and test conceptual model of contaminant transport	Radiological COPECs in soil and radiological COPECs in plant tissue	Waste site soils, plants, ant mounds, burrow spoil material	Used before sampling the soil.	Supports testing of the conceptual model of biological transport.
Surface soil sampling	Herbivorous, insectivorous and omnivorous bird and mammal, and carnivorous bird and mammal attributes of survival, growth, and reproduction	COPECs in soil	Waste site and reference site soils	Multi-increment samples representing 0 to 15 cm (0 to 0.5 ft).	Multi-increment samples for estimate of average exposure over sampling area.
Biota sampling	Insectivorous and omnivorous mammal, insectivorous reptile, and carnivorous mammal attributes of survival, growth, and reproduction	COPECs in macroinvertebrates, small mammals, and lizards	Invertebrates caught in pitfall traps, small mammals, lizards/reptiles	For invertebrates, composite of pitfall trap contents. For lizards/reptiles, individual animals. For mammals, individual animals.	Samples of insects, reptiles, and small mammals provide information for comparison to literature information on toxic tissue concentrations and for contaminant loading in middle trophic levels, to be used in modeling upper trophic-level exposure.

Table 4-1. Phase I Sampling Design Summary Table Linking Data to Risk Questions and Assessment Endpoints

Data Type	Assessment Endpoint and Attribute	Measures	Population	Key Features of Design	Basis for Study Design
Literature reviews on COPEC concentrations or other information relevant to risk characterization	All assessment endpoints and attributes for which information can be gathered	Compilation of existing site-specific or relevant data on COPEC concentrations or other information relevant to risk characterization	Relevant literature or unpublished but documented data sources	Consult with subject matter experts to identify relevant published or documented in-house information.	Make use of existing Hanford Site or other relevant data on COPEC concentrations and other information relevant to risk characterization, which will support and aid in the interpretation of other data.
Exposure modeling parameters	Herbivorous, insectivorous and omnivorous bird and mammal, and carnivorous bird and mammal attributes of survival, growth, and reproduction	Uses data on COPECs in soil and in macroinvertebrates, small mammals, and lizards	Waste site and reference site soils and biotic tissues	Use of Hanford Site-specific uptake factors for soil to prey reduces uncertainty in use of non-site-specific literature values.	Exposure modeling especially useful in assessing endpoints for which field measures would not be resource effective.

Sources:

DOE/RL-2004-42, *Central Plateau Terrestrial Ecological Sampling and Analysis Plan—Phase I.*

Daubenmire, 1959, "A Canopy-Coverage Method of Vegetational Analysis," *Northwest Science*, Vol. 33, pp. 43-64.

Table 4-2. Phase II Sampling Design Summary Table Linking Data to Risk Questions and Assessment Endpoints

Data Type	Assessment Endpoint and Attribute	Measures	Population	Key Features of Design	Basis for Study Design
Reconnaissance and field verification	Herbivorous, insectivorous, and omnivorous bird and mammal, insectivorous reptile, and carnivorous bird and mammal attributes based on field measures	Basis for comparing all field-related measures in future phases of the sampling and analysis plan	BC Controlled Area and reference sites	All sites will be classified according to vegetation and habitat status. Line transects will be used to assess cover of dominant plants, bare ground, and cryptogams. Reconnaissance also will help to determine where and when to sample.	Field verification necessary to assess the comparability of habitat types among investigation areas and reference areas.
Field radiological data	Information used to guide sampling and test conceptual model of contaminant transport	Radiological COPECs in soil and radiological COPECs in plant tissue	BC Controlled Area soils, plants, ant mounds, burrow spoil material	Used before sampling the soil.	Supports testing of the conceptual model of biological transport.
Surface soil sampling	Herbivorous, insectivorous, and omnivorous bird and mammal, and carnivorous bird and mammal attributes of survival, growth, and reproduction	COPECs in soil	BC Controlled Area and reference site soils	Multi-increment samples representing 0 to15 cm (0 to 6 in.).	Multi-increment samples for estimate of average exposure over investigation area.
Biota sampling	Insectivorous and omnivorous mammal, insectivorous reptile, and carnivorous mammal attributes of survival, growth, and reproduction	COPECs in macroinvertebrates, small mammals, and lizards	Invertebrates caught in pitfall traps, small mammals, lizards/reptiles	For invertebrates, composite of pitfall trap contents. For lizards/reptiles, individual animals. For mammals, individual animals.	Samples of insects, reptiles, and small mammals provide information for comparison to literature information on toxic body burdens and for contaminant loading in middle trophic levels, to be used in modeling upper trophic-level exposure.

Table 4-2. Phase II Sampling Design Summary Table Linking Data to Risk Questions and Assessment Endpoints

Data Type	Assessment Endpoint and Attribute	Measures	Population	Key Features of Design	Basis for Study Design
Literature reviews on COPEC concentrations or other information relevant to risk characterization	All assessment endpoints and attributes for which information can be gathered	Compilation of existing site-specific or relevant data on COPEC concentrations or other information relevant to risk characterization	Relevant literature or unpublished but documented data sources	Consult with subject matter experts to identify relevant published or documented in-house information.	Make use of existing Hanford Site or other relevant data on COPEC concentrations and other information relevant to risk characterization that will support and aid in the interpretation of other data.
Exposure modeling parameters	Herbivorous, insectivorous, and omnivorous bird and mammal, and carnivorous bird and mammal attributes of survival, growth, and reproduction	Uses data on COPECs in soil and in macroinvertebrates, small mammals, and lizards	BC Controlled Area and reference site soils and biotic tissues	Use of Hanford Site-specific uptake factors for soil-to-prey reduces uncertainty in use of non-site-specific literature values.	Exposure modeling especially useful in assessing endpoints for which field measures would not be resource effective.

Table 4-3. Phase III Study Design Synopsis

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Supplemental Waste Site Sampling		
Invertebrate sampling for cyanide	Collect invertebrates in Phase I waste sites, Phase I and Phase II reference sites, and RCBRA reference sites for cyanide analysis (15 sites).	Determine significance of positive cyanide results in Phase I invertebrate samples and the general distribution of cyanide in tissues across the Hanford Site.
Lizard and small mammal sampling for 43 select PCB congeners	Collect lizards and mice in select Phase I investigation areas and four new sample sites near security roads that may have been sprayed with PCB-laden oils (8 sites).	PCB sampling conducted in Phase I was not conclusive. Determine concentrations of PCBs in biota at Phase I waste sites and where PCB laden oils may have been applied for dust control.
Lizard and small mammal sampling for strontium-90	Collect lizards and mice at select Phase I investigation areas and at an additional site (6 sites).	Strontium-90 sampling conducted in Phase I was not conclusive. Determine concentrations of strontium-90 in biota at select Phase I investigation areas and at one additional site. This effort will assess the distribution of strontium-90 in vertebrate tissues in waste sites and from non-waste site areas, addressing the spatial extent of strontium-90 in the Hanford Site food web.
Reanalysis of Phase I small mammal tissues for strontium-90	Reanalyze 20% of mouse tissue samples collected from Phase I for strontium-90 using an independent laboratory.	Quality control samples to resolve uncertainties in the Phase I strontium-90 analytical results for biota.
Vegetative characterization in Phase I areas	Repeat vegetative characterization in Phase I areas (7 sites).	The wet conditions observed in 2006 are expected to yield greater numbers and a more complete characterization of Phase I plant species per plot.
Characterization in BC Controlled Area Zone A	Deploy one replicate Phase II investigation area (1 ha [2.47 ac] in Zone A to assess ecological risks associated with strontium-90 and cesium-137.	Sum of fractions for Phase II investigation area in the high zone was close (0.083 rad/day) to the DOE dose threshold of 0.1 rad/day for terrestrial wildlife.
Non-Waste Site Soil Radiological Sampling		
Soil sampling in non-waste site areas around 200 East and 200 West Areas	Collect multi-increment shallow soil samples along transects near the Phase I and Phase II reference sites and in non-waste site locations outside of 200 East and 200 West Areas for analysis of americium-241, cesium-137, plutonium-238, plutonium-239/240, and strontium-90.	Multi-increment sample data collected near reference sites will be used to assess the adequacy of Central Plateau reference sites; multi-increment sample data collected in other non-waste site areas will fill spatial data gaps in existing data sets for soil activity levels.

Table 4-3. Phase III Study Design Synopsis

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Offsite reference site sampling	Collect soil sites from two offsite reference sites in 1 ha (2.47 ac) sample plots. Collect two multi-increment samples from each, from the 0 to 2.5 cm and 2.5 to 5.1 cm (0 to 1 in. and 1 to 2 in.) depths. Collect 50 soil increments from each sample. Duplicate this sampling in the Phase I and Phase II onsite reference sites.	This responds to concerns expressed by the Hanford Natural Resource Trustees and the Tri-Party Agreement agency decision makers over the use of reference sites within the Hanford Site boundary.
Carbon Tetrachloride Sampling		
Passive gas measurements of carbon tetrachloride in surface soil	Collect EMFLUX® samples to screen for presence and relative magnitude of carbon tetrachloride at animal burrows targeted for pore-gas sampling.	Provide verification that carbon tetrachloride is present in soils around burrows targeted for active soil-gas measurements before initiating active gas-data collection.
Active gas measurements of burrow air	Quantify carbon tetrachloride concentration in burrows by actively withdrawing sample of burrow air.	Perform field verification of carbon tetrachloride concentration in animal burrows to evaluate exposures to burrowing receptors.
Contingency installation of artificial animal burrows for active burrow air measurements	If animal burrows are not detected in the habitat areas during reconnaissance surveys, six artificial animal burrows will be installed for the collection of vapor samples.	Perform field verification of carbon tetrachloride concentrations in artificial animal burrows to evaluate exposures to potential burrowing receptors.
West Lake		
Soil radiation surveys	Perform radiological surveys around the perimeter of West Lake. Existing data show that 1 of 11 soil samples was above the screening value for cesium-137 in soil.	Determine if there are elevated radiological measurements in soils surrounding West Lake.
Surface water sampling	Collect multi-increment surface water samples from West Lake. Subsample into filtered and unfiltered sample. Analyze for radionuclides, metals, and anions. Perform non-COPEC analyses for chemical characterization of lake water.	Determine if existing data on unfiltered water is representative of surface water in West Lake. Pore water is collected on the assumption that it represents the most concentrated constituent conditions. Non-COPEC analyses will provide insight into the chemical/ geological nature of West Lake.
Pore water sampling	Collect multi-increment pore water samples from West Lake. Subsample into filtered and unfiltered sample. Analyze for radionuclides, metals, and anions. Perform non-COPEC analyses for chemical characterization of lake water.	

Table 4-3. Phase III Study Design Synopsis

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Sediment sampling	Collect multi-increment sediment samples from the perimeter of the West Lake shoreline. Analyze for radionuclides and metals, total organic carbon, acid volatile sulfide, total sulfides.	Determine biotic exposure from sediments.
	Analyze sediment samples for semivolatile organic compounds, tributyl phosphate, and normal paraffin hydrocarbons.	Test the conceptual model that organic contaminants are not in West Lake.
Salt-crust sampling	Collect multi-increment salt-crust samples around the perimeter of West Lake. Analyze for radionuclides, metals, and anions. Perform non-COPECs analyses for total hydroxide and total carbonate, and for crystal structure.	Evaluate radiological dose and metal exposure to animals using the crust as a source of minerals. Non-COPEC analyses will provide insight into the chemical/geological nature of West Lake.
Brine fly sampling	Collect larvae or adult brine flies around West Lake and analyze for radionuclides and metals.	Determine contaminant uptake in brine flies for modeling effects on aerial insectivores (bats, birds).
Reconnaissance surveys	Perform monthly biological surveys at West Lake and aquatic macroinvertebrate collection. Include monthly measurements on conductance, pH, dissolved oxygen, and temperature at West Lake.	Determine biological use and diversity at West Lake.

Source: DOE/RL-2006-27, *Central Plateau Terrestrial Ecological Sampling and Analysis Plan—Phase III.*

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4.4.1 Phase I—Data Collection

A key assumption of the Phase I study design was that biological activity decreases with depth. An evaluation of site-specific data indicated that a sampling depth of 1.8 m (6 ft) is most appropriate for Central Plateau receptors.[3] Based on the decreasing biological activity with depth, representative surface soil samples for Phase I were collected from 0 to 15 cm (0 to 0.5 ft), with deeper soils (0.152 to 1.83 m [0.5 to 6 ft]) proposed for collection in later phases, if warranted. It was expected that the Phase I data could be used to test the hypothesis that there is a correlation between the near-surface soil concentrations and organism concentrations. This comparison would involve exploratory data analysis of soil concentrations from each depth interval and the depth-weighted soil concentrations versus organism concentrations.

[3] Analysis of these data (provided in WMP-20570) indicated that the majority of root and burrow depths (more than 80 percent) were less than 1.83 m (6 ft). Consequently, a depth of 1.83 m (6 ft) was selected for the shallow zone soil boundary.

An area of 1 ha (2.47 ac) was assumed for averaging exposure to invertebrate and wildlife receptors.[4] The historic COPEC soil concentration data were used to determine the area of highest concentrations within each waste site, and the 1 ha (2.47 ac) investigation plot was located within this area. For waste sites that are smaller than 1 ha (2.47 ac), the center of the 1 ha (2.47 ac) plot was located at the center of the waste site and the sampling extended into the adjacent habitat. Because animals are mobile, organisms captured from the investigation area may not have been resident in this area. To minimize the chance of capturing transient animals, biota collection was focused on the central portion of the investigation area.

The MIS sampling approach was selected to collect soil for determining average exposure in the CP ERA. Collection and analysis of multi-increment samples was deemed appropriate, because the statistical parameter of interest is the mean concentration (Ecology Publication 92-54, *Statistical Guidance for Ecology Site Managers*) over hectare-size or larger exposure areas. Mean or average concentrations were considered more representative of wildlife exposure to individuals and populations.

Figure 4-2 is a hypothetical schematic illustrating these sampling concepts.

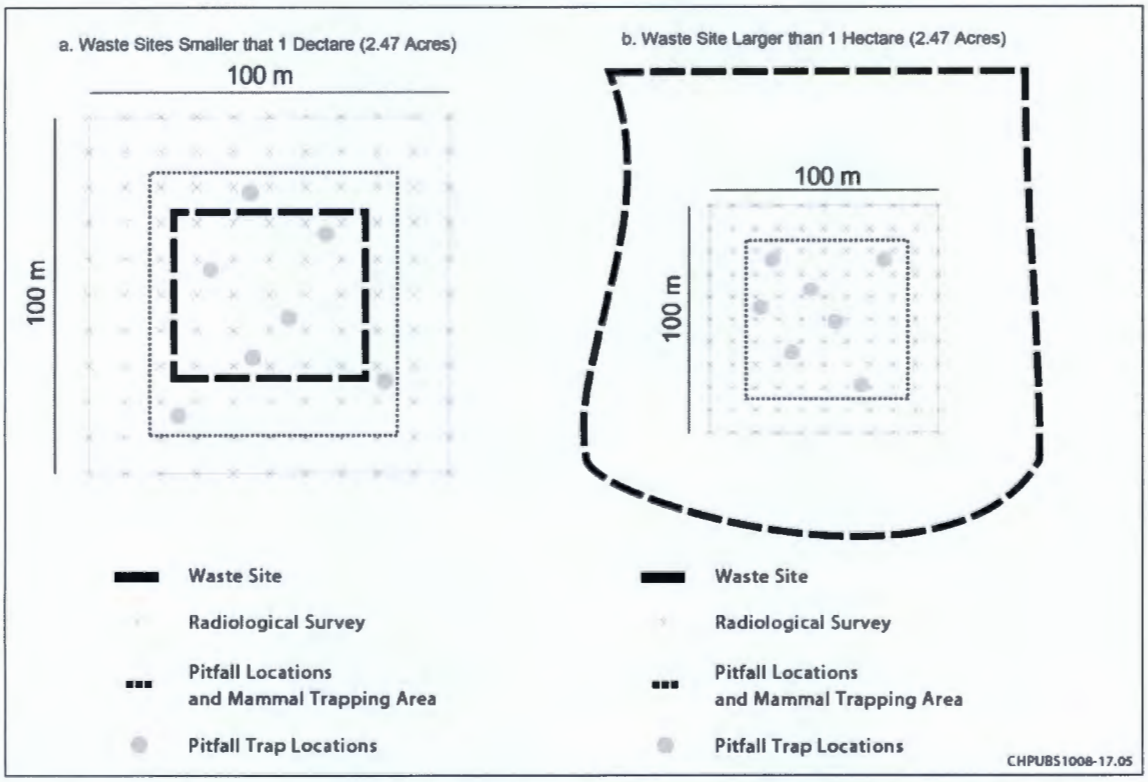

Figure 4-2. Schematic for Possible Implementation of Hypothetical Sampling of Waste Sites Smaller than 1 ha (2.47 ac) and Larger than 1 ha (2.47 ac)

[4] For wildlife receptors, information on home range, dispersal distance, minimum critical patch size, population density, and assessment population area were considered in determining the spatial boundaries. Although the home range of several receptors (Great Basin pocket mouse, deer mouse, and side-blotched lizard) was less than 1 ha (2.47 ac), estimates of assessment population areas and minimum critical patch size indicate that an area of 1 ha (2.47 ac) or more is needed to support populations of these receptors with small home range sizes. Therefore, 1 ha (2.47 ac) was considered a "reasonable minimum area" for averaging wildlife exposures. It was also assumed that this was an appropriate spatial scale for soil invertebrates, though no rationale was given in the Phase I DQO report (WMP-20570). In contrast, plants were considered to interact with contaminated soil on a smaller scale (e.g., point-by-point in the radiological surveys).

4.4.1.1 Radiological Field Survey Data

Radiological field data collection for gamma-emitting radionuclides was conducted to provide information on the general radioactivity levels across the investigation area and to provide information for evaluation of biological transport of radionuclides. Specific radiological field survey methods are detailed in the Phase I SAP (DOE/RL-2004-42).

Briefly, a grid of 1 ha (2.47 ac) (100 by 100 m [328 by 328 ft]) was delineated with grid nodes placed at 10 m intervals, such that 121 nodes (11 by 11) were flagged for each 1 ha (2.47 ac) investigation area. For waste sites with an area of less than 10,000 m^2 (107,600 ft^2), the waste site was placed in the center of the grid as shown in Figure 4-4. If the waste area was larger than 1 ha (2.47 ac), the investigation plot was placed in the area of the anticipated greatest COPEC concentrations, based on previously conducted Rad Rover radiological field data results from sodium iodide measurements. Surface soil and plant radiological readings (both beta and gamma) were measured in a 1 m^2 (10.76 ft^2) area surrounding each node flag and located within the 1 ha (2.47 ac) study site.

The investigation area was also surveyed for ant mounds and burrowing animal activity. Based on availability, 15 to 20 ant mounds and 30 to 50 burrow spoils were surveyed beginning in one of the four quadrants of the 1 ha (2.47 ac) plot and extending to the other quadrants as needed to obtain the target sample size. The sampling design also included survey of ant mounds and/or burrows outside of the 1 ha (2.47 ac) investigation areas to achieve target sample sizes.

4.4.1.2 Soil Concentrations

Soil concentrations were used to develop site-specific uptake to biota (invertebrates, lizards, and small mammals) and to make comparisons between COPEC concentrations in soil at waste, reference, and background sites. Additionally, soil concentrations were compared to literature-derived toxicity data for Central Plateau ecological receptors.

Soil sampling was conducted using MIS. This soil sampling plan was based on MIS procedures that are designed to control the fundamental error (FE) for an average, based on collecting an adequate sample mass (Pitard, 1993, *Pierre Gy's Sampling Theory and Sampling Practice: Heterogeneity, Sampling Correctness, and Statistical Process Control*; Ramsey, 2004, *Sampling for Environmental Activities*). This method is detailed in the Phase I SAP (DOE/RL-2004-42), and the salient features as applied to the Central Plateau waste and reference sites are as follows:

- The MIS protocol used the grid pattern delineated for the radiological field survey. Of the 100 grid boxes in each 1 ha (2.47 ac) plot, soil was collected from 50 grid boxes. The soil sample increments were collected from each investigation area to provide a single multi-increment sample representing the 0 to 15 cm (0 to 6 in.) depth.
- If the results of the gamma field data indicated that the investigation area was heterogeneous in COPEC concentrations, the investigation area may have been subdivided into more equal contaminant levels. Then, within each subarea, the MIS strategy was employed.
- Assuming sampling at 50 grid box locations within the 1 ha (2.47 ac) investigation area, a reasonable maximum particle size of 2 mm (0.0787 in.) based on typical definition of soil, and an FE of 10 percent corresponding to the standard error on the mean concentration, a minimum sample mass of 18 g (0.635 oz) was calculated.
- A scoop large enough to capture the maximum particle size and collect enough sample increments (k = 50) to at least equal a total composite sample of 18 g (0.635 oz) was used to collect soil.

- Two field replicate samples were also collected within each investigation area by sampling from two additional sets of 50 systematic locations, each with a different random start.
- Sample information (e.g., soil description, sample depths, sample locations, HEIS database sample numbers) was recorded in the field logbook.

Each composited MIS was analyzed for PCBs/pesticides (using EPA Method 8082/8081A from SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-A*), target analyte list (TAL) metals (including hexavalent chromium, mercury, and cyanide), and radionuclides (cesium-137, strontium-90, isotopic plutonium, and isotopic uranium).

During Phase I sampling, a location near or on a road previously believed to be treated with transformer oil for dust suppression also was identified and sampled. Five samples and a field duplicate were collected in this area and analyzed for PCBs.

4.4.1.3 Plant Cover Estimation

Plant cover surveys were conducted within each investigation area to provide data for an evaluation of relationships between plant composition and cover and COPEC concentrations in soil. Additionally, this information provided insight on the habitat quality relative to invertebrate, lizard, and small mammal receptors.

A modified Daubenmire method (Daubenmire, 1959) of line transects was used to estimate canopy cover of dominant plant species, bare ground, and cryptogam (plants that reproduce by spores such as algae, lichens, mosses, and ferns) cover. The Daubenmire method consists of systematically placing a 20 by 50 cm (7.9 by 19.7 in.) quadrat frame along a tape on permanently located transects. Each investigation area was divided into 0.25 ha (0.62 ac) sections. Within each 0.25 ha (0.62 ac) subarea, 4 to 10 Daubenmire plots were placed using a systematic sampling array with a random start. This resulted in 16 to 40 Daubenmire plots for each investigation area. Canopy cover was visually estimated for each plant species and percent cover for bare ground and cryptogamic crust within each quadrat. Species with less than or equal to two percent cover were assigned a value of one percent.

4.4.1.4 Invertebrate Concentrations

Invertebrate tissue was collected to develop site-specific uptake relationships between COPEC concentrations in soil and in invertebrates. Additionally, these data were used for comparisons between COPEC concentrations in biota at waste and reference sites, as well as across a gradient of COPEC concentrations in soil. Measured COPEC concentrations were also compared to literature-derived toxic body burdens as possible.

Methods for invertebrate collection are detailed in the Phase I SAP and summarized here. Pitfall traps located within a 70 by 70 m (229.7 by 229.7 ft) grid in the center of the 100 by 100 m grid (328.1 by 328.1 ft) (see Figure 4-4) were used to collect ground-dwelling invertebrates such as darkling beetles, harvester ants, and spiders (all representations of the soil biota guild specified in WAC 173-340-7493). The pitfall traps consisted of 3.8 L (1 gal) metal or plastic containers buried at grade, and were left open for at least five nights at each sampling area. Invertebrates were also collected by hand when necessary to meet sample size requirements. Invertebrates caught during trapping were collected and composited for each sampling area for contaminant analysis.

Composite invertebrate samples were analyzed for PCBs/pesticides, TAL metals (including mercury and cyanide), and radionuclides (cesium-137, strontium-90, isotopic plutonium, and isotopic uranium). Invertebrates were not depurated, because these data are primarily intended to assess risks to upper trophic level receptors, and depuration does not occur before predation. However, invertebrates were

rinsed with deionized water by the analytical laboratory to remove any exterior contamination. In cases where biomass was sufficient, the sample was divided into three subsamples for analysis. In addition, desktop exposure dose food chain models for wildlife planned for the BERA would have incorporated incidental soil ingestion, and rinsing the invertebrates prevented double counting soil ingestion in exposure model calculations.

4.4.1.5 Lizard Concentrations

As with invertebrates, lizards were collected to develop site-specific uptake relationships between COPEC concentrations in soil and lizard tissue. Additionally, these data were used for comparisons between COPEC concentrations in biota at waste and reference sites, as well as across a gradient of COPEC concentrations in soil. Measured COPEC concentrations were also compared to literature-derived toxic body burdens as possible. Lastly, relative abundance of lizards was estimated using the total number of lizards collected and the number of trap nights.

Lizards were captured using the pitfall traps installed for the invertebrate collection or by hand collection (e.g., noosing) within the inner 70 by 70 m (229.7 by 229.7 ft) portion of the investigation area. A minimum of six lizards per investigation area was targeted and, as a measure of relative density, the number of trap days required to achieve this sample size was recorded. Captured lizards were also surveyed for external radiation and examined for physical abnormalities, and data on total length, snout-to-vent length, and gender were recorded. Greater detail is provided in the Phase I SAP.

Whole, individual lizards were analyzed for PCBs/pesticides, TAL metals (including mercury and cyanide), and radionuclides (cesium-137, strontium-90, isotopic plutonium, and isotopic uranium). Each lizard sample was rinsed with deionized water by the analytical laboratory to remove any exterior contamination. Lizard tissues were analyzed exclusive of external radionuclide concentrations because data were collected to develop bioaccumulation models. In addition, desktop exposure dose food chain models of wildlife planned for the BERA would have incorporated incidental soil ingestion, and rinsing the lizards prevented double counting soil ingestion in exposure model calculations.

4.4.1.6 Small Mammal Concentrations

Small mammals were collected to develop site-specific uptake relationships between COPEC concentrations in soil and mammal tissue. Additionally, these data were used for comparisons between COPEC concentrations in biota at waste and reference sites, as well as across a gradient of COPEC concentrations in soil. Measured COPEC concentrations were also compared to literature-derived toxic body burdens as possible. Lastly, relative abundance of small mammals was estimated using the total number of animals collected and the number of trap nights.

Small mammals were sampled using live traps laid in the 70 by 70 m (229.7 by 229.7 ft) array in the center of the 100 by 100 m (328 by 328 ft) investigation area. Sampling was conducted between April and September, when animals are most likely to be active. Traps were spaced systematically, and identical trapping methods were employed in similar habitats at reference locations. Target species included deer mice (omnivore) and pocket mice (granivore), which are likely present in the Central Plateau, and are considered representative food items for the mammalian predator guild (as recommended in WAC 173-340-7490). A minimum of six small mammals per investigation area was targeted, and, as a measure of relative density, the number of trap days required to achieve this sample size was recorded. Captured small mammals were also surveyed for external radiation and examined for physical abnormalities, and data on animal condition (e.g., species, sex, weight, and reproductive class) were recorded (see Phase I SAP [DOE/RL-2004-42] for details).

The mammals (whole animal) were analyzed for PCBs/pesticides, TAL metals (including mercury and cyanide), and radionuclides (cesium-137, strontium-90, isotopic plutonium, and isotopic uranium). The mammals were rinsed with deionized water by the analytical laboratory to remove any exterior contamination. Small mammal tissues were analyzed exclusive of external radionuclide concentrations as these data were collected to develop bioaccumulation models. In addition, the exposure models incorporate incidental soil ingestion and rinsing the mammals prevents double counting soil ingestion in exposure model calculations.

4.4.2 Phase II—Data Collection

The Phase II DQO report (WMP-25493) and SAP (DOE/RL-2005-30) considered characterization needs for ecological effects of COPECs from the BC Controlled Area.

The general soil sampling approach for the BC Controlled Area was the same as described for Phase I. Namely, soil samples were collected from 0 to 15 cm (0 to 0.5 ft), investigation areas were 1 ha (2.47 ac) in size, and MIS was used to obtain average concentrations across the investigation area.

The radiological field survey and plant cover survey at the BC Controlled Area waste and reference sites were conducted as outlined above for Phase I sampling at the 200 Area. Similarly, the sampling design for soil, invertebrates, lizards, and small mammals at the BC Controlled Area was the same as that developed for Phase I, except for the following two differences:

- Only cesium-137 and strontium-90 were analyzed for in soil and biota.
- Drift fences were added to the pitfall traps to enhance collection of invertebrates.

4.4.3 Phase III—Supplemental Data Collection, Non-Operation Areas, Carbon Tetrachloride Plume, and West Lake

Phase III began with a data assessment of the results from the Phase I and Phase II data collection.

4.4.3.1 Cyanide in Invertebrates

Cyanide was regularly detected in biotic tissues (invertebrates, mice, and lizards) from waste sites and from the Phase I reference site. Additionally, exposure modeling indicated that consumption of cyanide-containing invertebrates may pose a potential risk to insectivorous birds (killdeer). Therefore, additional invertebrates were to be collected and analyzed for cyanide to provide a better understanding of the magnitude and general distribution of cyanide detections in tissues. Fifteen locations were planned for sampling, including the two Phase I and Phase II reference sites, the six Phase I waste sites, and the seven reference sites of the 100 Area and 300 Area component of the RCBRA.

Sampling methods followed those described for invertebrates for Phase I. Namely, invertebrates were collected using pitfall traps and/or handpicked within the center 70 by 70 m (230 by 230 ft) grid of the 1 ha (2.47 ac) investigation area. Invertebrates from each location were divided into three subsamples for analysis. These invertebrate composites were to be analyzed for cyanide only. As with Phase I and Phase II invertebrate analyses, invertebrates were not to be depurated.

4.4.3.2 Polychlorinated Biphenyls and Strontium-90 in Lizard and Small Mammal Tissues

Results of Phase I sampling indicated that PCB detections were not consistent within soil and biota samples collected from within an investigation area. For strontium-90, detects in lizard and small mammal tissue from the Phase I reference site could not be verified with re-analysis. To address these uncertainties, lizards and small mammals were planned for collection at four Phase I investigation areas and four non-waste locations in the vicinity of roads that may have been sprayed with PCB oils as a dust suppression measure to evaluate those areas as potential sources for PCBs. Additionally, three Phase I

sites (including the reference) and two of the non-waste sites were planned for analysis of strontium-90 in lizards (all five sites) and small mammals (one Phase I waste site and Phase I reference site only). Consensus on these locations was reached in consultation with a representative of the Hanford Natural Resource Trustee Council (D&D-29483).

Lizards and small mammals were trapped according to the methods described for Phase I. As with the Phase I sampling, six lizards and six small mammals (most likely deer or pocket mice) from each sampling area were targeted, and analysis was for whole-body individual lizards or small mammals. Additionally, trap activity (i.e., number of trap days needed to obtain sample target numbers) was to be used as a semi-quantitative measure of abundance of lizards and small mammals at each site.

The Phase I samples were analyzed for PCBs using the Aroclor method, and only two of eight PCB Aroclor mixtures (Aroclor 1254 and Aroclor 1260) were detected. This is consistent with the Aroclors routinely observed in waste samples from Hanford waste sites (WMP-20570, Appendix D). However, an issue raised during the DQO workshop was stakeholder concern that weathering of the PCBs could change the pattern used for identification of each Aroclor, thus creating false negatives; therefore, Phase III samples were analyzed for PCB congeners. EPA Method 8082 (gas chromatography from SW-846 with electron capture detection) was selected to meet detection limit requirements based on a calculated benchmark of 0.1 mg/kg in tissue or 100 µg/kg, the concentration in prey necessary to exceed the WAC 173-340-900, Table 749-5, PCB mixture's toxicological reference value. The Phase III DQO report (WMP-29253) also delineated the process used to select the PCB congeners for analysis. Briefly, congeners with the following characteristics were analyzed which resulted in a list of 45 congeners, 43 of which were measured:

- Dioxin-like
- Recommended for analysis by the EPA Region 9 Biological Technical Assistance Group
- Of the highest or second highest potential toxicity, frequency of occurrence, and relative abundance
- Present in Aroclor 1254 and Aroclor 1260

4.4.3.3 Re-survey of Vegetation at Phase I Sites

Vegetation cover was planned to be re-surveyed at all Phase I investigation areas (including the reference area) as part of the Phase III field activities. This vegetation information was collected to supplement data gathered to assess relationships between plant composition and cover with other measures of environmental quality identified in the SAP (DOE/RL-2006-27) (e.g., population/community health attributes of plants, invertebrates, lizards, small mammals, and birds). Surveys of Phase I waste sites occurred early in a dry year (2005), and the vegetation recorded may not be comprehensive of species present in an average-to-above average rainfall year. Therefore, plant species data gathered in Phase III was planned for collection during the spring (April to May), when conditions are favorable to visually observe and identify a nearly complete list of plant species. This period was captured for Phase II sites during 2005, thus, these sites did not need to be re-sampled. In addition, shrub canopy-cover surveys were only conducted during Phase III, because the results generated from 2005 are not expected to change substantially between two consecutive years.

The methods (modified Daubenmire technique) used for this re-survey were the same as those described for Phase I.

4.4.3.4 Expanded Radionuclide Evaluation for BC Controlled Area—Zone A

Although not addressed in the Phase III DQOs (WMP-29253), the Phase III SAP (DOE/RL-2006-27) indicates that an expanded investigation area in Zone A was planned for characterization in Phase III to

provide supplemental data for assessing ecological risk from cesium-137 and strontium-90. This included a radiological field survey in which field radionuclide measurements (cesium-137 and gross beta/gamma levels) were obtained for collocated soil and plants, as well as for ant mounds and small mammal burrow spoils. Additionally, collection of soil (using MIS) and invertebrates, lizards, and small mammals, as well as plant cover surveys were also planned for this Phase III sampling.

The 1 ha (2.47 mi) investigation area was selected based on available radiological data to be an area of high radionuclide concentrations within Zone A. Methods for the radiological field survey, plant cover survey, and collection of soil and biota followed the methods outlined above for Phases I and II. Target sample sizes included one MIS soil sample (with two replicates), three composite invertebrate samples, six individual lizard samples, and six individual small mammal samples.

4.4.3.5 Non-Waste Site Areas

Past Hanford Site operations released radionuclides and metals through air-stack emissions, which represent a source for surface-soil contamination. Therefore, a focus of the Phase III sampling was to assess non-waste site areas that were potentially affected by air-stack contamination deposition. Soil concentrations measured through this effort were compared to literature-derived toxicity data for Central Plateau ecological receptors.

Sample locations were selected to the northwest and west of the 200 West Area and to the north and southeast of the 200 East Area in the Central Plateau Core Zone in order to address deposition from T Plant (Figure 4-3). These locations were selected to supplement surface radiological data in the vicinity of the Phase I and Phase II reference sites and along a potential gradient of historical stack deposition from the 200 Areas. Transects (as shown in figure) were to be set up in each non-waste site area targeted for soil sampling. Based on feedback from Hanford Natural Resource Trustees at the Phase III DQO workshop, it was decided that MIS was the preferred method to obtain surface soil radionuclide concentration data. While MIS soil samples were different from the local composite samples used by the near-facility and SESP programs to characterize soil concentrations, MIS data were considered to be comparable to the mean values obtained by these programs. Additionally, an investigation area size of 0.0625 ha (0.1544 ac) area was selected for soil sampling.[5]

This soil sampling plan was based on MIS procedures that are designed to control the FE for an average, based on collecting an adequate sample mass (Pitard, 1993; Ramsey, 2004). This method is detailed in the Phase III SAP (DOE/RL-2006-27), and the salient features as applied to the non-waste sites are as follows:

- The multi-increment soil sampling protocol used a grid pattern of 25 × 25 m (five rows and five columns) set up over the 0.0625 ha (0.1544 ac) area. Soil was collected to a depth of 0 to 2.5 cm (0 to 1 in.) from 25 grid boxes, with 2 increments collected per grid to obtain 50 increments per investigation area. The soil sample increments were collected from three to four locations along each transect within the identified non-waste site areas.

- Assuming 2 increments at each of the 25 grid box locations within the 0.0625 ha (0.1544 ac) investigation area, a reasonable maximum particle size of 2 mm (0.079 in.) (based on typical definition of soil), and a FE of 10 percent corresponding to the standard error on the mean concentration, a minimum sample mass of 18 g (0.6 oz) was calculated.

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[5] An area of 0.0625 ha (0.1544 ac) or 625 m^2 (6,727 ft^2) was selected because this area corresponds to the size of the pocket mouse and deer mouse home ranges (0.05 and 0.077 ha [0.1236 and 0.1903 ac]). This area also is approximately equal to the typical size of a residential lot (500 m^2 [598 yd^2]), and 625 m^2 (747.5 yd^2) also is logistically simple to implement in the field (25 × 25 m [82 × 82 ft).

- A scoop large enough to capture the maximum particle size and collect enough sample increments (k = 50) to at least equal a total composite sample of 18 g (0.6 oz) was used to collect soil.
- Two field replicate samples were also collected within each investigation area by sampling from two additional sets of 25 systematic locations, each with a different random start.
- Sample information (e.g., soil description, sample depths, sample locations, HEIS database sample numbers) was recorded in the field logbook.
- Each composited multi-increment sample was analyzed for americium-241, cesium-137, strontium-90, and isotopic plutonium (radionuclides associated with stack emissions).

4.4.3.6 200 West Area Dispersed Carbon Tetrachloride Plume

Areas for investigation of inhalation risks to burrowing mammals for Phase III were identified based on the results of preliminary soil-gas data analysis and field reconnaissance activities to scope potential habitat. Initial selection of investigation areas was based on analytical data, including the magnitude and frequency of ESL exceedances (as represented by hazard quotients), and the presence of near-surface carbon tetrachloride reported by 2003 and 2004 passive soil-gas survey results. The passive gas samples (EMFLUX) showed where carbon tetrachloride was detected in the 0 to 1.5 m (0 to 5 ft) samples. Reconnaissance of habitat suitability and receptor presence/absence was to be performed to assess the likelihood of exposure to burrowing small mammals in locations where carbon tetrachloride has been documented in soils. This information was also collected to potentially select areas for burrow gas sampling.

During the field reconnaissance surveys, the presence of fossorial small mammals was assessed visually, with observations of burrow holes and mounds, runways, and small-mammal droppings noted. These reconnaissance activities also provided information for identification of candidate burrows for burrow air sampling. Of these, about 10 burrows were targeted for sampling.

Before the active burrow-gas measurements were collected, EMFLUX tube measurements were collected at animal burrows targeted for gas sampling to verify that carbon tetrachloride was present in subsurface. In this screening step, EMFLUX tubes were placed in association with candidate burrows and burrows with higher readings were targeted for active-gas measurements. If burrows were not observed, six artificial animal burrows were installed (three in worst case locations near the waste sites that discharged carbon tetrachloride and three at the onset of vegetation at the 218-W-4C Burial Ground Annex). Burrow tubes were placed in narrow slit trenches. Burrows were left in place for one week to allow soil vapor conditions to reach equilibrium with surrounding soils.

Burrow air was measured by actively collecting gases (Summa canister) from within burrows to empirically estimate the carbon tetrachloride gas concentrations to which fossorial animals are exposed. Where artificial tubes were used, EMFLUX tube passive gas samples were also collected from the soils near the artificial burrows to verify the adjacent carbon tetrachloride concentrations.

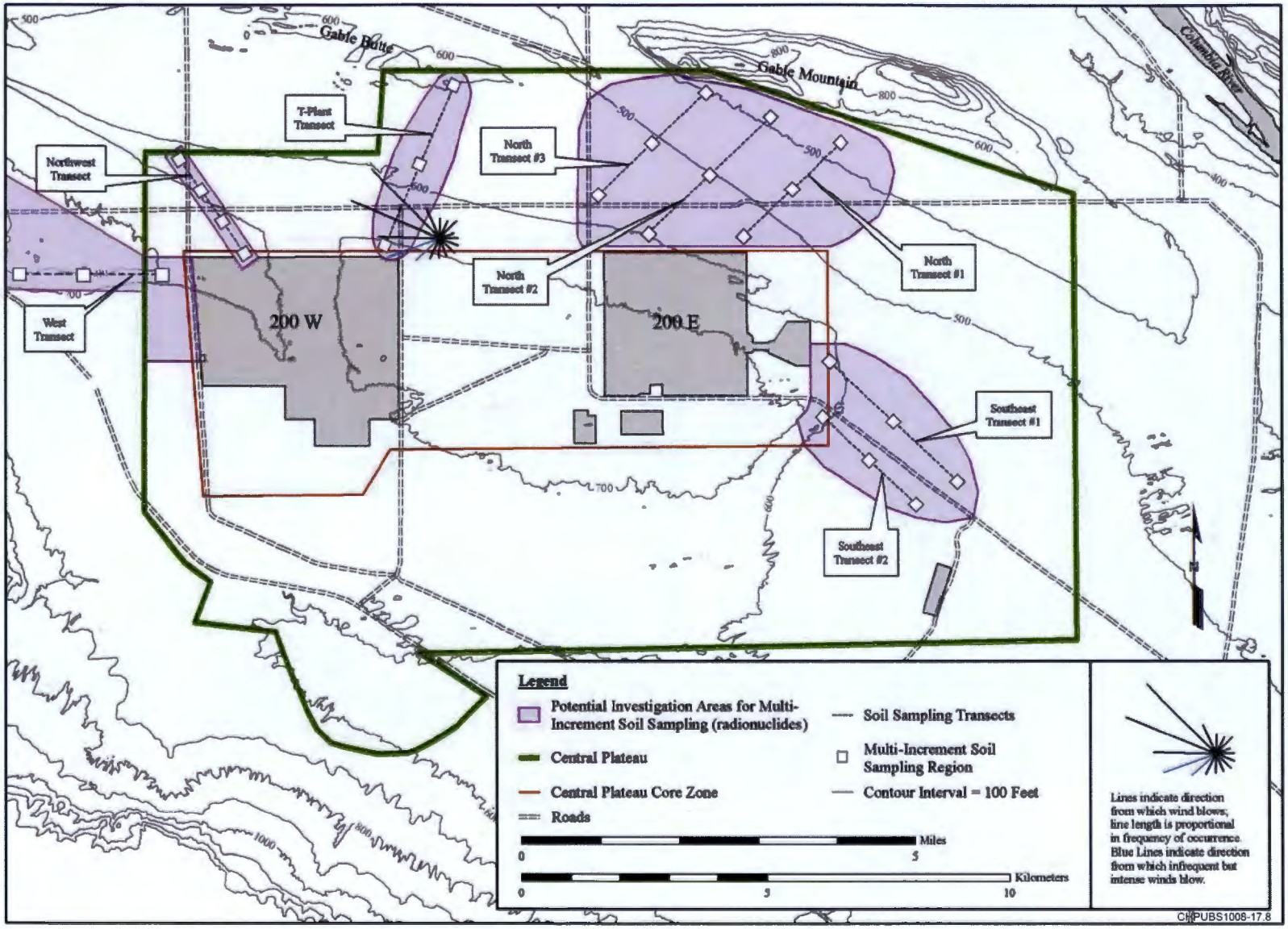

Figure 4-3. Map Displaying Locations for Air-Stack Radionuclides in Non-Waste Site Area Sampling

4.4.3.7 West Lake

The study design for West Lake included reconnaissance of the flora present and fauna using the site beta and gamma radiological surface soil surveys along the lake perimeter and collection of abiotic (surface water, pore water, sediment, and salt crust) and biotic media (brine flies) to characterize potential exposure to COPECs. A map of West Lake and the proposed sampling design is shown in Figure 4-4.

In the Phase III DQO workshop (February 22 and 23, 2006), Hanford Natural Resource Trustees indicated that MIS was the preferred method to obtain abiotic media data for this project. The media-specific subsections below identify sample depth, the spatial scale over which the MIS was collected, and the number of increments needed to adequately characterize the area.

Figure 4-4. Sampling Design for West Lake Characterization

4.4.3.8 Reconnaissance Surveys

Reconnaissance surveys (visual observations, radiological activity measurements, and mapping) at West Lake were needed to better describe the biological pathways and to estimate the percent of year these pathways exist. These efforts collectively included conducting periodic surveys of wildlife using West Lake between March and September. Biological pathway surveys were conducted twice per month, and included both daylight and evening periods. The following specific tasks were performed as part of this reconnaissance effort:

- Avian point counts
- Mammalian use/activity surveys
- Amphibian surveys
- Aquatic invertebrate surveys
- Plant community composition surveys
- Water quantity/quality monitoring

Avian use was monitored by conducting several 5-minute point counts at one or more fixed stations located near the edge of West Lake. Indirect evidence of avian use (e.g., scat, tracks, and feathers) at West Lake also was recorded in the field record book or on the point count survey forms. Relative abundance estimates, a complete species observation list, and types of avian use activities observed were recorded.

Mammals using the West Lake habitats were documented more qualitatively than avian species by conducting a walk-through of the West Lake habitats during each daylight survey event. Indirect evidence of mammals (e.g., scat, tracks, burrows, and evidence of browsing or licking salts, hair) was recorded, as were indications of active animal use of West Lake (e.g., animals observed drinking water, foraging on grasses). Night surveys using an echolocation device were conducted each month to record bat presence and, to a more qualitative degree, the relative abundance of bat activity over West Lake.

Amphibian surveys were conducted during both daytime and evening periods. Day surveys included visually examining West Lake for egg masses or adult salamanders, frogs, or toads. Artificial cover (plywood boards) was placed at three sites along the shoreline of West Lake and checked each daytime survey period to help confirm the presence/absence of amphibians. In addition, several 5-minute point count anuran breeding call surveys were conducted during the night survey periods.

Aquatic macroinvertebrates in West Lake were assessed by opportunistically collecting specimens by hand or using a kicknet (Turtox bottom kick net-mesh 800 by 900 μm [0.0315 by 0.03543 in.]). Macroinvertebrate taxa were to be identified down to Orders, Families, Genera, or in some cases the species. Numbers of individuals of each Order and in some cases families of each Order were also documented.

A single reconnaissance survey for saline-tolerant plants found in the riparian habitats surrounding West Lake was conducted. The reconnaissance effort included a general description of the flora communities surrounding West Lake, noting the location and general numbers/areal extent of unique plant populations found there.

Water quantity/quality was evaluated periodically beginning in spring 2006. Photographs of West Lake were taken at three marked, fixed stations (an oblique aerial view from Gable Mountain and two points selected adjacent to West Lake) to help document changes in the lake size and availability of water over the spring and summer period. Measures of pH, temperature, conductance, and dissolved oxygen

also were recorded each month to help assess the water quality over the course of the spring and summer periods.

4.4.3.9 Perimeter Radiological Survey

Radiological surveys for gamma-emitting radionuclides provide information on the general radioactivity levels across the investigation area and can help to evaluate biological transport. The field radiological survey of the perimeter of West Lake was performed following a grid survey technique. Systematic grid surveys were based on a specified pattern, with samples taken at regular intervals along a defined pattern. Radiological surveys were conducted at every node on a grid laid over an area of interest representing sampling in two dimensions.

In the event that elevated radiological levels were recorded, the radiological control technician may have collected a soil sample for laboratory analyses of radionuclides. In this case, elevated was generally defined as three times the background readings, but specific judgment on relative elevation was left to the discretion of the technician. For this exercise, background was based on an average of 20 readings.

4.4.3.10 Surface Water Collection

Surface water was sampled by collecting about 20 increments around the lake perimeter. Assuming the lake is about 200 by 50 m (65.62 by 164 ft) in size, and the stride length of the sampler is a meter, this equates to pulling a sample every 25 strides. If the lake had receded when sampling occurred, samples were to be pulled more frequently than every 25 strides to account for the necessary 20 increments.

Approximately 1,000 mL (33.81 oz) of water per sample (filtered and unfiltered each) was needed; consequently, each increment was about 100 mL (3.381 oz). Increments were collected with a wide-mouth plastic container attached to the end of a pole, extended out from the shore and dipped just under the surface of the lake water. Water was filtered to exclude particles greater than 0.45 µm size. The filtered sample and unfiltered sample were drawn from the same multi-incremental surface water sample.

Surface water samples were analyzed for metals and radionuclides, total organic carbon (TOC), alkalinity, calcium, potassium, iron, magnesium, sodium, anions, total dissolved solids, and titrations for total hydroxide and total carbonate.

4.4.3.11 Pore Water

Pore water (filtered and unfiltered) was sampled by collecting more than 10 increments. The lake's perimeter was surveyed with a global positioning system and points (±1 m [3.3 ft]) were systematically selected within the near-shore boundaries. A polyvinyl chloride (PVC) pipe about 3.8 cm (1.5 in.) in diameter and 2 to 3 m (6.56 to 9.8 ft) long slotted with about 1.5 mm (0.06 in.) wide openings was driven into sediment to a depth of 1 m (3.3 ft). The portion of PVC pipe above the sediment bed was not slotted. Assuming the sampling requirement for both filtered and unfiltered samples is 6 L (1.6 gal), approximately 300 mL (10.1 oz) of water was drawn from each point and placed into a common container. The filtered sample and unfiltered sample were drawn from the same multi-incremental pore water sample.

Pore water samples were analyzed for metals and radionuclides, TOC, alkalinity, calcium, potassium, iron, magnesium, sodium, anions, total dissolved solids, and titrations for total hydroxide and total carbonate.

4.4.3.12 Sediment and Salt Crust Collection

Sediment and salt crust were sampled along the shoreline of West Lake in a similar fashion as the surface water sampling using the MIS technique. Sediment samples consisted of 40 increments collected to a depth of 10 cm (3.937 in.). The sediment was then spread evenly onto a stainless steel tray and systematically sub-sampled 30 times in approximately equal fractions and placed into sample containers. For both sediment and salt crust, two total MIS, including one field replicate, were collected. Salt crust samples also consisted of 40 increments in which salt crust increments were carefully removed to minimize contact with the underlying sediment. The salt crust MIS was not subsampled, but delivered to the laboratory en mass where it was dissolved in deionized water for analysis.

Sediment samples were analyzed for metals, radionuclides, organic compounds, acid volatile sulfide, total sulfides and salt crust samples were analyzed for radionuclides, metals, alkalinity, calcium, potassium, iron, magnesium, sodium, anions, titrations for total hydroxide and total carbonate, as well as for crystal structure using x-ray diffraction.

4.4.3.13 Aquatic Macroinvertebrate Collection

Five aquatic macroinvertebrate samples (brine flies) were collected for analyses of metals and radionuclides using sweep nets or black-light traps along the shorelines of West Lake. Sample material was only rinsed if large quantities of sediment particles were present in the sample.

4.5 Final Data

The full set of all data that were collected as part of the three phased sampling program that resulted from the DQO and study design process, as documented in the Phase I, Phase II, and Phase III DQO reports and SAPS (WMP-20570; WMP-25493; WMP-29253; DOE/RL-2004-42; DOE/RL-2005-30; DOE/RL-2006-27) is presented on a supplemental disk as Appendix M. Included with the database is a data dictionary and crosswalk to facilitate review of the data.

5 Uncertainty Analysis

The following section presents the uncertainties in the data, methods, and analyses used in the CP ERA. An analysis of the uncertainties is an important part of a risk assessment and is used to evaluate the strengths and limitations of the results and conclusions. The uncertainties associated with risk characterization for the Central Plateau, both in the data collected and the methods employed for characterizing the risk, are pertinent in determining which portions of the existing data and analyses will be carried forward into upcoming RI/FSs for the Central Plateau. This uncertainty analysis is intended to discuss the uncertainties associated with the risk assessment in more detail to provide input to the development of recommendations (Chapter 6) to be integrated into future ERAs that will be conducted in support of RI/FSs in the Central Plateau.

5.1 Overall Central Plateau Ecological Risk Assessment Approach

The approach to the CP ERA was based on two overarching assumptions. First, the Central Plateau-wide risks could be characterized based on the results from the study of a limited number of waste sites. Second, ecological risk conclusions for the purpose of CERCLA decision making for Central Plateau waste sites could be based on data that met two criteria. Specifically, the data (1) reflected exposure under waste site conditions and (2) reflected interim stabilization and management, rather than baseline conditions.

Characterizing risks for an area as large as the Central Plateau is certainly challenging. The approach taken in the CP ERA to characterize ecological risks was to collect data and assess exposure from ten 1 ha (2.47 ac) plots. These plots were selected based on the current presence of habitat and exposure pathways, and the assumption that low-level contamination was present that would not be remediated for other purposes, such as protection of human health or protection of groundwater. The results from these sites were then considered to characterize risk for the Central Plateau at large (a 195 km^2 [75 mi^2] area). The limitation to this approach is that the area sampled and characterized represents a small portion of the total area with impacted media in the Central Plateau. While the percentage of the Central Plateau that was sampled is low, this could be offset in part if the sampled area is assumed to represent the worst case of the baseline conditions. However, as described in Section 5.2, many of the 10 areas selected represent sites for which no further remedial action was expected due to moderate-to-low waste concentrations. This approach potentially understated the assessment of ecological risks in the Central Plateau by not addressing the sites with higher concentrations.

Another uncertainty with the overall approach was whether the areas sampled represented baseline conditions for the waste sites within which they were located. Several of the areas sampled were previously surface-stabilized.[6] Thus, the samples collected and the estimated risks, which were assumed from the characterization of those samples, represented existing conditions of fill material and not the baseline risk condition. The latter would have been the waste underlying the fill material. Further, samples from the 10 areas were collected at the surface level (0 to 15.24 cm [0 to 6 in.]) although there has been evidence of biointrusion by plants and animals based on data collected as part of the SESP and DOE's biocontrol program. The results from bioaccumulation testing (analyses of paired soil and plant or animal tissue samples) presented in the Draft A Reissue report showed inconsistent evidence of bioaccumulation, in part, because sampling surface soils did not focus on the actual exposure points

[6] Surface stabilization was an interim remedy implemented at several waste sites whereby clean fill material was placed within ditches and ponds to level the land. Fill material was placed directly over waste material left in place such as the sediments at the bottom of waste ponds. Vertical surveys of the ponds in the Outer Area of the Central plateau suggest the depths to waste material are primarily in the 0.9 to 3.1 m (3 to10 ft range), averaging between 1.8 and 2.4 m (6 and 8 ft).

where plants and animals may come into contact with contaminants. In these cases, the samples were not reflective of the concentrations to which site receptors could be exposed. Therefore, they could not reliably be used to characterize ecological risks.

5.2 Waste Site Selection

As described in Chapter 4, approximately 1,600 waste sites were evaluated for their potential to have complete exposure pathways for ecological receptors. Approximately 1,000 of these sites were eliminated from further evaluation in the CP ERA because contamination in the soil was below Ecology's point of compliance of 4.57 m (15 ft) (WAC 173-340-7490). Based on the available information characterizing the potential for biointrusion of plants and animals (presented in WMP-20570), it was plausible to conclude that complete ecological exposure pathways to these 1,000 sites were unlikely to be present. Another 500 sites were eliminated from further evaluation in the screening problem formulation (Step 1) because the level of contamination was considered to be either "moderate" or "high." It was assumed that these sites would be remediated to address human health risks due to the existing contaminant levels and that the remedial measures selected would either eliminate complete exposure pathways for ecological receptors or achieve an acceptable level of protection. The remaining 89 "low" level risk sites were screened to select representative waste sites. The underlying rationale with this approach was that sites that were not cleaned up for protection of human health might have residual risks to ecological receptors. The following concerns with this approach were raised by the Tri-Parties through comments on the Draft A Reissue report (DOE/RL-2007-50):

- The detailed documentation of the site selection was never presented in the Phase I DQO Report or the Draft A Reissue report. This documentation, which consists of a spreadsheet that implements the waste site selection process described in the Phase I DQO report is presented in Appendix L.
- Excluding the "high" and "medium" level waste sites from further assessment assumed that remedial measures to address human health would be sufficient to address those for ecological risk. For this decision to be acceptable, it also assumed that the COPECs for the "high" and "medium" level waste sites are the same as the human health constituents of concern. It also assumed that the footprint of the area requiring remedial measures to address ecological risks is equal to that for human health. Significant uncertainty is associated with both of these assumptions.
- Excluding the "high" contamination level waste sites resulted in an incomplete characterization of ecological risks at the site and may have potentially created a false impression that ecological risks are not significant.
- Because the "high" and "medium" level waste sites were eliminated as areas warranting investigation in the DQO process, they also were not considered as potential areas for further data collection during Study Design (Step 4 of the 8-step ERA process). This decision limited the ability to assess the relationship between soil concentrations and contaminant uptake into prey tissues or the community structure measures that were included in the field efforts. Limiting the data collection efforts to only those areas where contamination was low may have masked the relationships between soil concentrations of COPECs and bioavailability, contaminant uptake, toxicity, and measures of community structure.
- The conclusions for the Draft A Reissue report relied on data collected from 10 areas within the waste sites, including 6 "low" contamination level sites, that were then applied to draw conclusions about the entire Central Plateau, which has approximately 600 waste sites with potentially complete ecological exposure pathways. The 10 areas were selected because they each reflected a varying range of conditions, such that there was a sample size of n = 1 for each unique site type. The sample

size did not allow for the ability to perform any power analysis or statistical analysis to demonstrate the ability of extrapolating results from these 10 areas to waste sites across the Central Plateau or results for a unique site type to waste sites with similar characteristics.

5.3 Contaminant of Potential Ecological Concern Selection

COPEC selection was based upon discrete historic data from HEIS collected as part of source area OU RI reports (WMP-20570). Specific concerns with the COPEC selection process employed and the data used to implement that process are as follows:

- The sample-by-sample analytical results, used to develop the summary tables employed in the COPEC selection, were not presented in the Phase I DQO Report (WMP-20570).
- There was no discussion or visual presentation of the sample locations to evaluate the analytical data from a spatial context.
- There was no significant discussion of the adequacy of the detection limits relative to screening limits, particularly for older historic data.
- Some COPEC refinement may have occurred earlier in the process than proscribed in Ecology and EPA guidance. Specifically, comparison to background should have been presented after the exposure assessment or as context in the risk characterization and discussion of results. COPEC selection also included statistical comparisons to reference areas. However, there are uncertainties with the selection of the Central Plateau reference areas as discussed below.

5.4 Use of Multi-Increment Sampling Data

The Phase I DQO (WMP-20570) proposed collection of discrete grab samples and MIS stratified over a depth from 0 to 1.83 m (0 to 6 ft) in soil and collocated with plant tissue samples to evaluate contaminant uptake. However, grab sampling was not included in the final Phase I and Phase II SAPs (DOE/RL-2004-42 and DOE/RL-2005-30, respectively) beyond collection of some soil samples for PCB analysis. MIS sample collection was reduced to 0 to 15.24 cm (0 to 6 in.) surface samples only. Exposure analysis in the CP ERA was based solely on MIS surface soil data with the assumption that MIS data provided an estimate of average exposure over the sampled area.

The rationale for using MIS to develop representative exposure concentrations in surface soil over a 1 ha (2.47 ac) plot is described in the Phase I DQOs report (WMP-20570). Uncertainties identified with the MIS data collected and how the data were incorporated into the risk characterization for the Central Plateau are as follows:

- Use of MIS to calculate an average exposure over a 1 ha (2.47 ac) plot may have been insufficient for some of the exposure scenarios that exist within the Central Plateau. Specifically, the average across 1 ha (2.47 ac) may not be representative in areas where the conceptual model does not reflect random movement such as exposure to ants within their mounds, birds preferentially feeding on ants in and around their mounds, or within animal burrows.
- MIS data were collected only from within the top 15.24 cm (6 in.) of soil at the waste sites. The use of samples from this depth to express exposure to terrestrial receptors is common in ERAs; use of surface samples exclusively is insufficient to represent all exposure pathways in the Central Plateau. Analysis of rooting and burrowing depths in arid soils presented in the Phase I DQO report (WMP-20570) suggests that exposure to plant routes and burrowing mammals occurs below 15.24 cm (6 in.) of soil. As discussed in Section 5.1, the MIS from the former waste ponds was collected from

areas that were surface stabilized with clean fill material. The measured concentrations of contaminants, therefore, do not reflect the baseline risk nor can they be used to understand contaminant uptake as a result of biointrusion into the buried sediments of the buried historic waste ponds.

- MIS was selected to provide an estimate of average concentrations over the exposure unit (the exposure unit is assumed to be 1 ha [2.47 ac]). EPA guidance for ERAs (EPA, 1998) supports the use of averages for estimating exposures to ecological receptors. While there is a conceptual basis for its use in representing the average concentration within an exposure unit, the use of MIS data for characterization of average exposure to contaminants in soil is not yet well represented in regulatory guidance or the technical literature.
- Risk characterization results for some COPECs based upon discrete historical samples differed from those based upon the MIS data. While these differences could reflect the differences between a screening and a more detailed assessment of risks, these differences in results were not fully discussed within the Draft A CP Reissue report.
- The discrete samples collected during the RIs should have been used more extensively to support risk conclusions for the Central Plateau waste sites, rather than being confined to the selection of COPECs. Areas with high concentrations and high frequency of exceeding screening levels based on RI data were drivers for the selection of areas for MIS sampling. Reanalysis of the RI data should have served as a line of evidence for assessing ecological risks. MIS could then have been used in support of the analysis of the RI data to develop risk conclusions.

5.5 Application of Reference Site Data

Data collected from reference areas were used to make statistical comparisons with waste sites for refining the COPECs used to characterize ecological risks, and for characterizing ecological risks. The Phase III DQOs looked at historical air deposition from former industrial stacks at Central Plateau industrial facilities, and information and sampling at non-waste sites (WMP-29253), to identify and collect additional data to confirm whether or not reference sites were appropriate for use in the CP ERA. Based on this DQO, additional transects were sampled to fill in gaps in the understanding of non-waste site areas.

As noted in a review of reference sites conducted for Ecology (Hart Crowser, 2007), the definition and use of reference sites in the CP ERA requires clarification; the CP ERA did not clearly document how the sampling approach demonstrates that the sites qualify as reference sites. In addition, several of the non-waste site data sets used in the Phase III DQOs are from Hanford Site soil background studies. A more detailed justification (which is available in the background reports) of why these samples reflect background or non-waste site conditions was needed to verify that they support the selection of reference sites. However, these limitations with the reference areas were not addressed as uncertainties when presenting COPEC selections or risk conclusions that make use of reference area data.

Anomalies observed in the reference site data also raise uncertainty with the reference site data and comparisons to the data. Soil cesium concentrations from reference sites 1 and 2 were similar to other reference sites, but cesium in mammal and lizard tissues was elevated to levels similar to those found in the BC controlled area, and were orders of magnitude higher than tissue results from other reference sites. Cyanide was also measured in tissues of invertebrates, mice, and lizards at the Phase I reference sites. The finding that tissue concentrations appeared to be elevated in the reference area created uncertainties in the screening of contaminants, which is based on reference area concentrations and risk decisions based on ecological measures. Further review of the data suggested that the elevated levels in the reference site

mammal and lizard tissue samples may have been artifacts of elevated reporting limits, and did not reflect detected concentrations. However, this uncertainty had not been identified in the Draft A Reissue report.

A final concern with the reference data is that some samples from reference areas were collected from a depth of 2.54 cm (1 in.) in soil. Soils sampled from this shallow depth could have been influenced by wind-blown scour or redeposition. While this may still reflect reference conditions, the possible influence of wind-blown scour or redeposition was an uncertainty that warranted discussion in the Draft A Reissue report.

5.6 Characterization of Exposure to Biota

The Phase I DQO Report stated that surface soil was important as an exposure medium for direct contact with wildlife, root uptake and animal burrowing, and that surface samples (of 15 cm [6 in.]) could be collected, along with specific biological samples, to test for COPEC uptake (WMP-20570). However, sampling only from within the top 15 cm (6 in.) of soil would not fully account for the potential for biointrusion. Many of the waste sites in the Central Plateau have soil covers placed over waste sites as interim stabilization measures during active investigation and remediation. The depth of cover ranges from 9 to 3.1 m (3 to 10 ft), averaging 1.8 to 2.4 m (6 to 8 ft). As documented in the Phase 1 DQO Report, exposure to terrestrial organisms at the Hanford Site occurs as low as 2.4 m (8 ft) for insects and mammals and 3.1 m (10 ft) for plants (WMP-20570). The exclusive use of surface soil data, therefore, did not allow for the assessment of ecological exposure occurring, below the surface within the waste sites, with soil covers as interim stabilization measures.

Analysis of paired soil and tissue sample results collected in the CP ERA showed the lack of a correlation between concentrations in soil and concentrations in biota, with concentrations within some biota samples being detected in areas where concentrations were not detected in soil samples. These findings may reflect the uncertainty associated with the depth and locations characterized in soil compared with the actual exposure points for the plants and wildlife. Given the mobility of receptors and potential for burrowing, exposure may have occurred outside or below the boundaries of the area sampled. The lack of correlation between concentrations in soil and concentrations in biota also may be due to a limitation of the sampling design because sampling at lower concentrations in soil limits the ability to develop a conceptual model of bioaccumulation from soil.

5.7 Risk Conclusions and Lines of Evidence

Questions regarding the risk conclusions and the associated lines of evidence for the CP ERA, which are provided in the Draft A Reissue report, included the following:

- There was evidence of biointrusion, both by plants and animals based on data collected as part of the SESP and DOE's biocontrol program. The conceptual ecological exposure model, as assessed with the site selection process and the use of MIS for estimating exposure, did not adequately address biointrusion. Waste sites that were surface stabilized with clean fill material were only sampled at the surface, not across the entire depth to which organisms are exposed. Not addressing biointrusion limits the ability to use the results of the risk assessment to evaluate remedial alternatives in Central Plateau FSs. Remedial alternatives need to be evaluated for permanence (including biointrusion), and there currently is no information on waste sites with contaminants in the biologically active zone. While exposure to plants is currently controlled via herbicide application, these waste sites may or may not become colonized with plants and wildlife in the future.

- The CP ERA (in the Draft A Reissue report) concluded that the results of assessment of the waste sites and BC Controlled Area suggest no risk from Hanford Site contaminants. The ability to draw

conclusions for unsampled waste sites based on the results from the studied sites was not explored in the CP ERA. As discussed previously, 10 areas were sampled (between waste sites and locations in the BC Controlled Area). Each of these areas reflected different characteristics, so that there essentially is a sample size of n = 1 available for extrapolating risk assessment results across the approximately 600 waste sites with potentially complete ecological exposure pathways. This raises the following question: What is the power of these data to provide reliable support for a conclusion of no ecological risk for the range of waste sites within the Central Plateau?

- The CP ERA included community structure measurement data (called "ecological measures" in the document) within the risk characterization. The CP ERA places considerable weight on these ecological measures in characterizing ecological risks associated with waste site contaminants. These ecological measures were drawn from a limited set of data collected during the CP ERA field activities. The uncertainties in these measures were not drawn out in the Draft A Reissue report. This contrasts in how ecological measures were used in the RCBRA, where these were given less weighting among the multiple lines of evidence considered (*River Corridor Baseline Risk Assessment: Evaluation of Current Conditions and Completed Interim Actions Volume 1: Ecological Risk Assessment*, DOE/RL-2007-21, Draft B).

- Insectivorous birds were not quantitatively evaluated as an assessment endpoint in the CP ERA. Birds that eat ants may represent a high-end exposure scenario that might not be addressed using the area-averaged exposure concentrations estimated with MIS. An ant burrow represents a single point where birds might become exposed to subsurface contaminants. In addition, insect-eating birds might have higher soil ingestion rates than published in the literature on wildlife exposure factors.

- The conclusion from the CP ERA, that threatened or endangered species were not found in the Central Plateau, differs from other surveys. For example, The Nature Conservancy annual surveys have identified pockets of rare plants (TNC, 1995, 1996, 1998, and 1999). Also, the risk assessment may not have fully addressed issues with the *Migratory Bird Treaty Act of 1918*.

- Presentation of appropriate risk conclusions requires that uncertainties be integrated into discussion of the results. Uncertainties were not discussed consistently throughout the CP ERA process: these were specified in detail in the DQO reports (WMP-20570, WMP-25493, and WMP-29253), but were expressed in much more general terms in the Draft A Reissue report (DOE/RL-2007-50). Some of the following key uncertainties were included:

  - Limitations in replication in the MIS sampling design.

  - Soil sampling in waste sites which did not intercept exposure points for burrowing animals (in certain cases, concentrations in soil samples were below detection, while animals that were trapped at the site and sampled had bioaccumulated contaminants), and lack of sampling along edges of covered waste sites.

  - Uncertainties present in the data used to verify reference sites. (The non-waste site samples were collected from a depth of 2.54 cm [1 in.] in soil, and could have been influenced by wind-blown scour or redeposition.)

  - Data sets from downwind not incorporated into the analysis supporting the selection and use of reference sites.

The CP ERA concluded, as described in the Draft A Reissue report, that no significant ecological risks were present in Central Plateau waste sites or the BC Controlled Area. The uncertainties presented in this

section limit the ability of the CP ERA to support a conclusion of no significant ecological risk in the Central Plateau as a whole.

5.8 Additional Uncertainties Both General and Specific to the Central Plateau Ecological Risk Assessment

In addition to the more overarching uncertainties previously discussed, other uncertainties, both general to most risk assessments and specific to the ERA for the Central Plateau, exist. For the Draft A Reissue Report (DOE/RL-2007-50), a separate or distinct uncertainty analysis section was not included in the Phases I, II, and III DQO documents (WMP-20570, WMP-25493, and WMP-29253) that describe the screening level steps of the ERA. The same is true for the Draft A Reissue Report except for the discussion of uncertainty with respect to the evaluation of the diffuse carbon tetrachloride plume. A discussion of these additional uncertainties is presented in the following steps.

Step 1—Constituents of Potential Ecological Concern. The data considered and process for selecting the initial COPEC list presented in the Phase I DQO Report (WMP-20570) was previously discussed in Section 5.3. The raw data are presented in Appendix A. The main uncertainty associated with the COPEC selection is that a data usability assessment was not included in the Phase I DQO Report. An assessment of the available data and its usability should have been performed. Specifically, for COPECs identified at the screening level, an assessment should have been conducted that answers the following questions:

- Were the locations of samples sufficiently located to represent the waste sites identified for quantitative evaluation and those being represented by the selected waste sites?
- Was the sample size sufficient to represent the number of waste sites selected and the footprint of the study area?
- Was there adequate spatial coverage of data on a COPEC-specific basis?
- Were the detection limits of the data set sufficiently below soil screening levels (SSLs) for the initial COPECs identified in the screening assessment (Step 1)?

A data usability assessment that considers the questions outlined above should be completed and documented before these data are considered in any further risk assessments as part of the Inner Area and Outer Area RI/FS Reports.

There is an additional uncertainty with the COPEC selection identified by Ecology in comments on the Draft A Reissue report (May 20, 2008):

> *Synergistic, additive, and antagonistic effects of contaminants are not considered in the contaminant screening as maximum concentrations were compared to single-chemical, literature-derived toxicity data. This may result in the screening out of contaminants that may contribute to risk when coupled with other contaminants at the site. Conversely, this may result in the selection of some COPECs that may not pose a risk due to antagonistic effects with other contaminants at the site.*

Reassessment of the COPEC list for future ERAs for the Central Plateau will consider this uncertainty. Compounds with mixtures effects such as polynuclear aromatic hydrocarbons (PAHs), PCBs, and organochlorine pesticides will be evaluated to determine if these should be included as COPECs.

Step 2—Screening Level Risk Characterization. Uncertainty for the screening risk characterization was primarily associated with uncertainty already discussed for the problem formulation centered on the data used to complete the characterization. In particular, without an understanding of whether the sampling

density was sufficient or whether the samples were located appropriately relative to exposure areas, conclusions of the risk characterization were uncertain. That uncertainty would apply to both the magnitude and nature of the risks because data uncertainty may have resulted in false negatives in the initial COPEC identification. Given the results of the COPEC refinement exercise referenced in Chapter 4 that has been conducted since the Phase I DQO Report (WMP-20570) was submitted, false negatives definitely existed because the COPEC list has been expanded significantly.

With West Lake, uncertainty was even greater because not all of the appropriate media were sampled and the target analyte list was inadequate. The uncertainty for West Lake was addressed by conducting an expanded sampling of environmental media, results were included in Appendix D of the Draft A Reissue report (DOE/RL-2007-50).

Step 4—Study Design. The Phases I, II, and III study designs are thorough in the identification of measures to address risk questions. Little uncertainty is associated with the types of data identified for collection. Uncertainties in the study design associated with the method of sample collection (i.e., MIS), the number of samples collected, and the selection of reference locations. Additional uncertainties are discussed below, with particular focus on the data quality assessment in the Phase III DQO Report (WMP-29253).

Proposed quantitation limits for tissue samples were based upon back calculating tissue concentrations protective of wildlife consuming the tissue. However, the calculations assumed that only one tissue type would be consumed and that no soil ingestion occurs. For omnivorous wildlife, total exposure dose is from multiple prey items and potentially from incidental ingestion of contaminated soil. Thus, doses below quantitation limits for multiple tissue items could incrementally lead to a total dose that exceeds the toxicity threshold. Since decisions regarding COPECs in tissue were based upon detections within tissues, this assumption could have led to false negatives when the results of Phase I data were compared to tissue screening values and in statistical comparisons to reference data as part of the Phase III DQO process to determine data gaps for further analytical sampling.

Identification of COPECs and further data needs for plants was decided exclusively by screening of radiological data in the Phase III DQOs Report (WMP-29253), which may have led to incomplete characterization. Using radiological data exclusively assumes that the distribution and the fate and transport within biotic and abiotic media is equal for radiological and nonradiological COPECs, which is a flawed assumption that likely led to false negatives. Further, a comparison to SSLs for nonradioactive COPECs may have led to a decision to collect additional data including tissue samples and ex situ toxicity testing.

Statistical Analysis of soil to determine additional Phase III sampling relied on MIS surface soil samples from waste sites for most COPECs to perform the statistical analysis and comparisons to reference data. Statistical power was limited as previously discussed (Section 6.2.5).

Soil sampling during Phase I consisted of the collection of surface samples only. The decision not to collect subsurface soil was based upon comparing Phase I data versus SSLs and statistical comparisons to reference data. This decision resulted in an uncertainty with respect to subsurface exposure since exposure to terrestrial organisms at Hanford occurs as low as 2.4 m (8 ft) for insects and mammals and 3.1 m (10 ft) for plants (WMP-20570). This may be part of the explanation of why tissue residues of some COPECs were detected when surface soil samples were nondetect. Further, the collection of plant tissue samples and soil samples for ex situ plant toxicity proposed for Phase III was also eliminated by comparison of surface soil data only. Thus, wildlife exposure dose modeling for herbivorous receptors and the evaluation of direct toxicity using site-specific data were both eliminated.

Measurement endpoints (measures of exposure and effects) proposed were appropriate for the assessment endpoints selected. However, the measures were collected incrementally with evaluations of initial data used to determine the need for the collection of additional measures. Some measures proposed for Phase III sampling were never collected. Based upon some of the uncertainties discussed, the decision not to collect data for these additional measures could lead to an underestimate of risk as significant lines of evidence were not generated. The lines of evidence include:

- **Subsurface Exposure**—Exposure pathways were not assessed because subsurface soil (0 to 1.83 m [0 to 6 ft]) samples were not collected, although data suggesting exposure to 1.83 m (6 ft) is complete for multiple assessment endpoints.
- **Direct Toxicity**—Measurements were through ex situ toxicity testing of soil (plants and nematodes).
- **Bioaccumulation into Plants**—Plant tissue samples were not collected.

Further, the decision not to collect these data also limits development of site-specific PRGs without the collection of additional data. Some site-specific information has been incorporated; however, assumptions regarding bioaccumulation into plant tissues and direct toxicity to plants and invertebrates may be overly conservative and could have been refined further had this data been collected.

Steps 6 and 7—Risk Analysis and Baseline Risk Characterization. The overarching comments discussed in this chapter call into question whether or not the data collected in 2005 and 2006 were representative of complete exposure pathways and how these data were evaluated within the BRA completed in 2008 (Draft A Reissue report [DOE/RL-2007-50]). Because of the unacceptable uncertainties associated with these data and the subsequent evaluation, the risk conclusions presented in the Draft A Reissue report are not being used for cleanup decision making in the Central Plateau. If these data were to be used for future risk assessments or drawing risk conclusions for risk management purposes, a data usability assessment should be completed that includes, but is not limited to, a focus on the uncertainties discussed in this chapter. While uncertainty with the tissue residue data and field measures of ecosystem characteristics (e.g., relative abundance, diversity, and reproductive status) was not discussed, a data usability assessment of these data will also be completed before they are used for ERAs supporting upcoming RI/FSs in the Central Plateau.

6 Conclusions and Recommendations

The conclusions of the CP ERA (as presented in the Draft A Reissue report) stated that there was evidence of exposure of multiple ecological receptors to COPECs in soil, but there was no evidence of adverse effects to ecological receptors in the Central Plateau. However, when uncertainties in the data, methods, and analyses are taken into consideration, there are substantial limitations to these conclusions which limit the usability of the CP ERA conclusions for cleanup decision making in the Central Plateau.

Although the existing data for the Central Plateau are not definitive concerning the presence or absence of ecological risks, portions of these data provide a foundation from which to build future ERA efforts that will support upcoming RI/FSs in the Central Plateau. As described in Chapter 2, this document is intended to serve as a component of the technical basis for the completion of ERAs in support of RI/FSs for the Inner and Outer Areas of the Central Plateau. To do this, an updated approach for the evaluation of ecological risks on the Central Plateau is being developed that integrates and builds on the existing data, and identifies additional data needs, along with next steps for completion of the ERAs for the Central Plateau. The following subsections present an overview of the updated ERA approach for the Central Plateau, the key components to this approach, the role for the data currently available from the CP ERA, potential additional data needs, and recommendations for next steps.

6.1 Updated Approach for Evaluation of Risks in the Central Plateau

An updated approach for completing ERAs for the Inner Area and Outer Area is being developed in response to the issues identified with the Draft A Reissue report. This approach, with its key components described in this chapter, recognizes the uncertainties from the CP ERA that need to be addressed in future ERAs and is aligned with DOE/RL-2009-81.

One of the major TPA comments indicated that the approach employed in the Draft A Reissue report; whereby data from a small number of studied sites were used to draw conclusions for the Central Plateau, does not adequately quantify risks within localized areas of the Central Plateau. In response, the updated approach for the Central Plateau ecological risks will address specific lists of waste sites identified for each Central Plateau OU. In this updated approach, ecological risks will be assessed and documented in BRAs associated with RI/FS reports. The general outline for this approach is as follows. Ecological risks would be evaluated for sites for which sampling and analytical data are currently available. Sites where the information available includes radiological survey data, historical information, or inventory information, but may be lacking sampling and analytical data, will be evaluated qualitatively; for example, the potential for ecological exposure will be evaluated taking into consideration the potential for complete exposure pathways or the proximity of ecological receptors. Analogous and representative sites that are similar in terms of the sources, inventories, site configurations, and site histories will be identified for comparison to sites for which sampling and analytical data are available. Sites for which a remedial alternative is selected to protect ecological receptors would be sampled later as part remedial design/remedial action to verify that ecological cleanup goals have been achieved. Remedial alternatives developed for Central Plateau waste sites also may include plans for long-term monitoring to evaluate the effectiveness of cleanup activities in protecting ecological receptors. Further details of this process will be described and presented in the approach sections of the RI/FS work plans for the Outer and Inner Areas. It is important to emphasize that under this approach, most waste sites will undergo sampling and characterization at some point—either prior to issuing a ROD (e.g., during the RI/FS process) or following the ROD (e.g., during the remedial design/remedial action process).[7] Regardless of where in

[7] Some small waste sites within the WIDS database that may have undergone removal actions without verification could result in a risk management decision that concludes sampling is not needed.

the process samples are collected and evaluations are performed, by the end of the CERCLA remedial response process, it is anticipated that a large proportion waste sites will have been sampled and all will have been assessed with regard to potential for ecological risk.

Several components are integral to this updated approach. These include a robust set of PRGs for ecological receptors, an expanded list of COPECs, an understanding of biointrusion in the Hanford Central Plateau, and mechanisms for integrating the human health risk assessment and ERA into the broader remedial process.

6.1.1 Ecological Preliminary Remediation Goals

At most CERCLA sites, risks are evaluated based on extensive characterization and forward calculations (estimation of exposure and risks associated with measured concentrations in environmental media), and then remedial actions are planned based on the risk conclusions. In contrast, a bias for action has been employed at the Hanford Site, in which interim remedial actions were undertaken if site history or limited characterization data suggested potential for unacceptable risk. Although this approach resulted in extensive near-term risk reduction (especially for human health), one consequence is the availability of characterization data at some sites that can be used to establish baseline risks. The absence of characterization data puts greater weight on the development of PRGs. A robust set of ecological PRGs are therefore needed to facilitate evaluation of diversity of sites present that may or may not have undergone an interim action. This would be a set of PRGs that adequately represent the diversity of receptors and COPECs that may be present, and that allow for refinement from conservative screening values to more refined, ecologically realistic and site-specific values.

A tiered framework has been devised to develop ecological PRGs that will be applied to upland environments across the Hanford Site (CHPRC-00784, *Soil-Based Tier 1 Preliminary Remediation Goals for Ecological Receptors at the Central Plateau Area, Hanford*). This tiered framework describes a general process for progression to increasingly more biologically realistic and site-specific ecological values for use as PRGs in RI/FSs. Higher tiers reflect increasing complexity and greater investment of time and resources. Higher tiers also reflect more refined characterization of ecological risks, which may be important in cleanup decision making. Central to the concept of a systematic, informed progression is an iterative process (i.e., cycles) of decision making involving evaluation of existing information, deliberation, data collection, and communication. All of these steps should be focused on the following decisions:

- Whether or not the ecological risk-based concentrations at the current tier are sufficient to be used as an ecological PRG and support cleanup decision making (a process for exiting the tiered approach is available at each tier)
- Whether or not progression to a higher tier of refinement would sufficiently reduce uncertainties to warrant the additional effort, if the information available at the current tier is determined to be insufficient for use in developing an ecological PRG

The tiers are described as follows:

- **Generic Screening Levels.** Generic Screening Levels for plants, soil invertebrates, birds, and mammals are obtained from existing published and accepted sources: EPA (EcoSSLs), Ecology (Ecological Indicator Soil Concentrations), Oak Ridge National Laboratory (screening level benchmarks), and DOE (Biota Concentration Guides). Generic Screening Levels are not specific to the Hanford Site; rather, they represent conservative, literature-based screening values. Because of

their inherent conservatism, Generic Screening Levels are intended to differentiate between contaminants that clearly present no risk and those for which additional evaluation may be warranted.

- **Tier 1 Values.** Tier 1 ecological risk-based concentration values are developed to reflect Hanford-specific conditions using information obtained from the literature. The Tier 1 values are calculated for bird and mammal species found at the Hanford Site. Exposure factors, such as food and soil ingestion rates, were derived for Hanford-specific wildlife from a review of the literature. Concentrations in food items were calculated with bioaccumulation models drawn primarily from EPA EcoSSL guidance.
- **Tier 2 Values.** Tier 2 values are calculated for the same bird and mammal species found at the Hanford Site and used to develop Tier 1 values. They incorporate additional Hanford Site-specific information; in particular, bioaccumulation models, based on arthropods in soil, which represent food chains present at the Hanford Site. In addition, these bioaccumulation models incorporate soil and tissue data collected from the site.
- **Tier 3 Values.** Tier 3 values represent waste site-specific or location-specific PRGs, based on data (e.g., bioaccumulation sampling, bioassays, and exposure factors) collected for specific locations at the Hanford Site. Development of Tier 3 values would involve development of separate SAPs and field sampling plans to support data collection. Tier 3 values would be the most refined and would be developed on an as needed basis to address specific receptor contaminant issues for which existing data are inadequate to reduce uncertainty about residual risks and environmental protection.

6.1.2 Contaminant of Potential Ecological Concern Selection

The updated approach for evaluation of ecological risks in the Central Plateau requires a robust set of PRGs. COPEC identification for the Central Plateau provides the basis for determining the analytes for which PRGs should be developed. Development of the original COPEC list for the Central Plateau was described in Section 4.3. That list and the listing in Table 6-1 represent 137 constituents, 91 that were originally identified during the Phase I DQO process, all COPECs identified in the RCBRA (DOE/RL-2007-21), several constituents with ubiquitous detection across the Hanford Site, and a number of persistent organic compounds including PAHs, organochlorine pesticides, and PCBs as aroclors. This initial list of COPECs, presented in Table 6-1, provides the foundation for the development of a comprehensive set of ecological PRGs (CHPRC-00784) for Hanford Site ERAs. Should additional COPECs[8] be identified through individual RI/FSs, then PRGs will be developed to the extent feasible following the process outlined in CHPRC-00784.

Table 6-1. Initial List of Contaminants of Potential Ecological Concern

Radionuclides			
Americium-241	Curium-244	Nickel-63	Technetium-99
Antimony-125	Europium-152	Plutonium-238	Thorium-232
Carbon-14	Europium-154	Plutonium-239/240	Uranium-234

[8] The COPECs that are carried forward for consideration in the nature and extent of contamination evaluation and the BRA are those chemicals that are present at concentrations greater than background levels (metals and radionuclides that have established background levels) or greater than reporting limits (remaining metals and radionuclides and organic compounds). The intent is to be inclusive; however, consideration of risk-based screening that will be conducted in the human health, ecological, and groundwater protection components of the BRA is not included.

Table 6-1. Initial List of Contaminants of Potential Ecological Concern

Cesium-134	Europium-155	Radium-226	Uranium-235
Cesium-137	Hydrogen-3 (Tritium)	Radium-228	Uranium-238
Cobalt-60	Neptunium-237	Strontium-90	
Inorganics			
Aluminum	Boron	Lithium	Thallium
Antimony	Cadmium	Manganese	Tin
Arsenic, total	Chromium, Total	Mercury (Inorganic)	Uranium
Arsenic (III)	Chromium (III)	Molybdenum	Vanadium
Arsenic (V)	Chromium (VI)	Nickel	Zinc
Barium	Cobalt	Selenium	
Beryllium	Copper	Silver	
Bismuth	Lead	Strontium	
General Inorganics			
Ammonia	Cyanide	Nitrate	Sulfate
Ammonium	Fluoride	Nitrite	Sulfite
Chloride	Iodine	Phosphate	Total Organic Carbon
Volatile Organics			
1,1-Dichloroethane		Chlorobenzene	
1,1-Dichloroethene		Chloroform	
1,1,1-Trichloroethane (TCA)		*cis*-1,2-dichloroethylene	
1,1,2-Trichloroethane		Dichloromethane (Methylene Chloride)	
1,1,2,2-Tetrachloroethane		Ethyl Benzene	
1,2-Dichlorobenzene		Methyl Isobutyl Ketone (Hexone)	
1,2-Dichloroethane (DCA)		*n*-Butyl Benzene	
1,3-Dichlorobenzene		Tetrachloroethylene	
2-Butanone (Methyl Ethyl Ketone)		Toluene	
2-Hexanone		*trans*-1,2-dichloroethylene	
Benzene		Trichloroethylene	
Butanol		Xylene	
Carbon Tetrachloride			
Polycyclic Aromatic Hydrocarbons (PAHs)			
Acenaphthene		Dibenz(ah)anthracene	
Acenaphthylene		Fluoranthene	
Anthracene		Fluorene	
Benzo[*a*]pyrene		Indeno[1,2,3-cd]pyrene	

Table 6-1. Initial List of Contaminants of Potential Ecological Concern

Benzo[*a*]anthracene	2-Methylnaphthalene	
Benzo[*b*]fluoranthene	Naphthalene	
Benzo[*ghi*]perylene	Phenanthrene	
Benzo[*k*]fluoranthene	Pyrene	
Chrysene		
Semivolatile Organics		
Normal Paraffin Hydrocarbons	2-Methylphenol (*o*-cresol)	Aroclor 1254
Bis(2-ethylhexyl)phthalate	2,4-Dinitrotoluene	Aroclor 1260
Phenol	4-Methylphenol (*p*-cresol)	Aroclor 1262
Polychlorinated Biphenyls	Aroclor 1232	
Aroclor 1016	Aroclor 1242	
Aroclor 1221	Aroclor 1248	
Petroleum Hydrocarbons		
Gasoline Range Organics	Total Petroleum Hydrocarbon Kerosene	
Diesel Range Organics		
Herbicides and Pesticides		
Aldrin	Dieldrin	
beta-1,2,3,4,5,6-Hexachlorocyclohexane	Endosulfan I	
alpha-Chlordane	Endosulfan II	
gamma-Chlordane	Endosulfan Sulfate	
Dichlorodiphenyldichloroethylene	Endrin Aldehyde	
Dichlorodiphenyltrichloroethane	Methoxychlor	
Dichloroprop		

6.1.3 Assessment of Biointrusion

To provide adequate protection for ecological receptors, the depth below the soil surface to which biota may have access and be exposed (i.e., biointrusion) needs to be quantified. A technical report that summarizes exposure depths for ecological receptors at the Hanford Site has been developed (CHPRC-00651), and issues associated with biointrusion and adequately characterizing exposure to ecological receptors were discussed in Chapter 5. ERAs for the Inner Area will include data that align with the conceptual ecological exposure model (e.g., receptors present, depth below surface they may be exposed, and depth of contaminated media) and supporting documentation from CHPRC-00651 and data that address MTCA guidance on developing appropriate points of compliance for ecological receptors (WAC 173-340-7490[4]). As such, data collected from areas that have received interim measures such as surface stabilization with clean fill will be considered for evaluating current and future ecological exposure pathways, but not for characterizing ecological exposures or effects. Further, surface soil data from clean fill material will not be used to evaluate correlation between soil chemistry and contaminant uptake or observed toxicity in ex-situ toxicity tests as part of refined risk characterization activities.

Additional detail on the integration of biointrusion and determination of points of compliance will be described and presented in the approach to the RI/FS work plans for the Central Plateau Outer and Inner Areas.

6.2 Application of Existing Data

As documented in Chapter 4 of this report, a significant volume of ecological data has been collected for the Central Plateau. These data will be integrated into the upcoming RI/FSs for the Central Plateau to the extent possible. Thus, the approach for completing the RIs for the Inner and Outer Areas includes an initial assessment of existing data consistent with the use of ERAs in the RI/FS process (see Section 6.1). Guidelines for assessing the usability of existing CP ERA data, plus the potential applications and limitations of these data, are outlined below. It should be noted that some data with acknowledged limitations may be still be adequate to provide the basis for action needed to complete the RI and for characterizing ecological risk for some waste sites.

6.2.1 Assessment of Data Usability

The need for a comprehensive data usability study was discussed in the uncertainty analysis (see Chapter 5). In order to complete the investigation using existing data, a thorough data usability assessment should be completed that evaluates whether the existing data can provide a defendable assessment of complete exposure pathways identified for the conceptual exposure models developed for each waste site. While general discussions of the contents of the data usability assessment have been presented previously, an example of more detailed list of questions that should be considered in a data usability assessment is provided below. However, given a bias for a remedial action on risk management decisions at the Hanford Site, many data gaps identified by the questions below may be acceptable. In addition, answers to these questions may serve as a basis of DQO development for either data gap sampling or confirmatory sampling conducted as recommended in association with the proposed remedy for individual waste sites.

6.2.1.1 Data Usability Questions for Abiotic Media

The following key questions are to be answered prior to use of existing abiotic data from the Central Plateau:

- Are detection limits below ecological PRGs (CHPRC-00784)?
- Were data collected from depths representative of the ecological exposure scenarios?
- Were data co-located with biota data or bioassays?
- Are there sufficient data for performing a time trend analysis?
- Is there sufficient spatial coverage of COPECs across waste units?
- Is there sufficient spatial coverage of COPECs across the combined Inner Area or Outer Area?
- Are there a sufficient number of samples across waste units for performing statistical analysis?
- Are there a sufficient number of samples across the combined Inner Area or Outer Area for performing statistical analysis?
- Are analyte suites consistent and complete over depth, time, within, and across waste sites to allow adequate characterization of exposure?

- What type and extraction was performed for metals in soil (need to make sure to identify any data like that from the 100-BC pilot that PNNL generated that was total analysis in which the soil matrix was also dissolved—extraction should be the same as what is normally performed for total analysis)?

6.2.1.2 Data Usability Questions for Biotic Media

The following key questions are to be answered prior to use of existing biotic data from the Central Plateau:

- Are biota data collocated in space and time with soil data?
- Do soil and biota data represent the same analyte suites?
- Do animal tissue samples represent the whole body or specific organs?
- Is biota sampling and preparation adequately described to understand how and where samples were collected and prepared?
- Were tissue samples washed prior to analysis?
- Are tissue data reported in wet or dry weight?
- Is the water content of tissue samples available?
- Are there a sufficient number of samples across the combined Inner Area or Outer Area for performing correlation analysis with tissue and soil concentrations?
- Are there a sufficient number of samples across the combined Inner Area or Outer Area and River Corridor for performing correlation analysis with tissue and soil concentrations?
- How do soil concentrations co-located with tissue samples compare to those found at the exposure areas within the Inner Area or Outer Area (i.e., does the bioaccumulation data represent an adequately broad range to indicate uptake at high environmental concentrations)?
- For which waste sites would tissue samples (correlation or maximum detects) be representative?

Future risk assessments will need to include a discussion of uncertainties with data gaps identified by the data usability assessment and how these uncertainties should be considered in interpreting results of analysis using these data.

6.2.2 Summary of Usability of Existing Central Plateau Ecological Risk Assessment Data

Based upon the uncertainty analysis in Chapter 5 and recommendations on the assessment of usability of the historic data presented in this chapter, a determination of potential applications of the data collected as part of the three-phased ERA approach for the Central Plateau was made and is presented in the following subsections.

6.2.2.1 Conceptual Exposure Models

Existing conceptual ecological exposure models for the Central Plateau from the Phase 1 DQO report (WMP-20570) adequately describe the complete exposure pathways. The fate of contaminants in the environment and transport mechanisms were well documented. Description of the food web with specific groups of organisms organized as feeding guilds within the terrestrial food web of the Central Plateau and the aquatic environment of West Lake were also included. These components of the conceptual ecological exposure model were used in the Tiered Approach to PRG development documented in CHPRC-00784. The models were used to focus on specific feeding guilds and identify specific receptors for the Tier 1

refined values for terrestrial wildlife. The conceptual models will continue to be used in future PRG development for Tier 2 PRGs if warranted and PRGs for aquatic and semi aquatic receptors at West Lake, as necessary.

6.2.2.2 Historic Discrete Soil Chemistry Data

Historic discrete soil data can be used for risk characterization of waste sites in the Central Plateau provided that it meets the requirements of a standard data quality assessment (see Section 6.2.1.1). The qualified data can be used for estimating exposure provided that the dates of collection and the depths from which the data were collected are reflective of baseline exposure conditions for the receptors being evaluated.

At sites with no interim remedial actions such as surface stabilization, use of historic data would be acceptable. For sites with interim stabilization covers, only data collected before the remedial actions or from depths reflective of the soil surface prior to stabilization, are representative of baseline conditions. Data collected at sites that have been surface stabilized should also be reviewed to be sure that they are reflective of the targeted exposure depth that is appropriate for the intended analysis.

"In process" data[9] are acceptable for identifying COPCs but confirmation sampling would be recommended prior to implementation of remedial actions other than monitoring.

When considering historic data for making decisions for sites with no prior characterization data, the historic data for one suite of analytes should not be used to draw conclusions about different analytical suites (e.g., decisions regarding metals should not be made based upon historic radionuclide data).

6.2.2.3 Surface Soil Chemistry Data Collected via Multi-Increment Sampling

The MIS samples were collected from 0 to 15.24 cm (0 to 6 in.) and, therefore, should not be used for characterizing risks via exposure to subsurface soils without statistical analysis confirming that concentrations at the surface and subsurface are not significantly different.

For the MIS samples collected from surface stabilized waste sites (e.g., B Pond, U Pond, S-10 ditch, and Gable Mountain Pond), these data are reflective of post remedial conditions and therefore should only be used for evaluation of the effectiveness of interim actions, not pre-remediation conditions. Additionally, given the shallow depth of these samples, it should be emphasized that these data only represent surface exposure and do not represent subsurface conditions.

For the MIS samples collected from waste sites with no prior interim action (e.g., the BC Controlled Area samples), the MIS samples may be used for establishing COPECs within the risk assessment and for surface exposure estimation.

It is imperative that due to significant differences in sampling methodology, MIS data must be evaluated independent of discrete data from the same location. MIS data should never be combined with discrete data for the purpose of generating summary statistics.

6.2.2.4 Tissue Chemistry Data

Detection of COPECs in tissue of resident biota indicates the presence of complete exposure pathways and can support a basis for action. These data can also be used in forward calculations of exposure and may be considered in identifying target areas for any future assessment activities.

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[9] Data collected during removal actions typically were used to confirm that the contaminated soil has been completely removed.

Tissue samples collected from waste sites with no prior interim action (e.g., the BC control area samples), can be used in quantitative analysis of risk (e.g., exposure dose estimating). Tissue samples collected from sites with interim remedial actions can be used to evaluate remedy effectiveness if the mobility of the organisms is weighed into the evaluation (e.g., site fidelity, home range size relative to waste site size, and how much of the exposure occurred offsite versus onsite).

Tissue data generated as part of the three-phased ERA effort for the Central Plateau cannot be used to describe correlation between soil chemistry and tissue chemistry (e.g., develop bioaccumulation models) because the soil chemistry data co-located with tissue chemistry data was nondetect for many COPECs, even when detected in tissue. This indicates that the soil samples do not adequately represent the exposure medium (either insufficient depth or inadequate spatial association) to which resident biota are exposed.

6.2.2.5 Ecological Measures

These data include the observations of abundance, diversity, sex ratios, etc., at waste sites and reference locations. These data can be highly variable in both space and time for factors independent of contamination. As a consequence, sampling over multiple years is needed to develop these data to sufficient quality for application in risk assessments.

Ecological measures data from the Central Plateau, therefore, can only be used as supplemental information supporting a weight-of-evidence risk assessment. They may be used to support conclusions of presence or absence of adverse effects, but they are not definitively indicative of risk by themselves. Because of the multiple confounding factors, the cause of observed effects may not be easily identified through the existing data.

In addition, ecological measures data cannot be used to describe correlations between soil chemistry and the ecological measures because the co-located soil chemistry data were not collected from the full depth to which exposure occurs.

6.2.2.6 Radionuclide Screening in Soil and Plants

These data can be used for making decisions regarding exposure to radionuclides and detections are indications of exposure. The detected concentrations can help support a basis for action by demonstrating that exposure is occurring. These data may also be used as part of an analysis in the non-operational areas to help identify areas to be considered in the waste site identification process and may be entered into Waste Information Data System (WIDS).

These data should not be used for making decisions regarding exposure to other suites of analytes. Also, they should not be used for quantitative risk estimation (e.g., wildlife exposure dose modeling) since the data are based upon field screening methods. Finally, the data should not be aggregated with results of radionuclide data obtained by laboratory analysis.

6.2.2.7 Further Defining Reference Conditions

Additional justification (presented in the background reports) of why non-waste site samples reflect background conditions was needed to verify that they support the evaluation and selection of reference sites. The definition and use of reference sites in the CP ERA required clarification, a point noted in comments from Ecology's contractor who reviewed the selection and use of reference sites in 2007 (Hart Crowser, 2007). A more extensive analysis of the non-waste site data will be performed to better support the use of reference areas in the preparation of future ERAs in the Central Plateau. The data sets identified in the Phase III DQOs report (WMP-29253) could be evaluated and combined with other surveillance data to identify spatial trends in contaminant concentrations. One analysis could be used to identify how concentrations exceeding a 90th percentile value are clustered; if these are uniformly distributed (and not

clustered near waste sites), there is a stronger case that the non-waste site data reflect background conditions.

6.2.2.8 Plant and Nematode Ex Situ Bioassays Collected for the River Corridor Baseline Risk Assessment

Application of these data is limited because the concentration range of co-located soil samples does not represent the full range present at waste sites in the Central Plateau. As a consequence, the absence of effects in bioassays cannot be construed as evidence of absence of effects in Central Plateau soils. It may be possible to use these data, in combination with bioassays collected at a future date, should a higher concentration range be included in the sampling design.

6.3 Potential Future Data Needs

As the development of RI/FS work plans proceeds ahead for the Central Plateau Outer and Inner Areas, data needs may be identified for assessing ecological risks. While the data currently available may be sufficient for developing a conservative ecological risk characterization and establishing a basis for action, there may be uncertainties that affect the development and implementation of remedial alternatives that are protective of ecological receptors. The use of generic default assumptions and literature-based information in estimating ecological exposure and toxicity provides many assumptions that are purposefully conservative as a response to uncertainty. Use of these purposefully conservative assumptions is intended to limit the chances of incorrectly concluding that there is no risk or that risk is acceptable, in the face of uncertainty regarding actual ecological risks. However, development of remedial alternatives based on these conservative risk conclusions could result in the selection of alternatives for ecological risks that may not be real or actually present. Throughout the RI/FS process, risk managers will need to consider if additional data collection is warranted considering these uncertainties.

Further data collection to assess ecological risks might include the collection of ex situ bioassays or tissue sampling to support risk characterizations or to support the development of Tier 2 or Tier 3 PRGs. More specific detail regarding the uncertainties and conservative assumptions that could be refined with the collection of site-specific data is presented below. Should supplemental data specific to characterizing ecological risks be warranted, a SAP specific to ecological data collection will be developed in coordination with a SAP for other RI/FS data collection.

It should be noted that these same data and/or species surveys may also be collected for many other purposes including: as part of conformation sampling; for support of alternatives evaluation; monitoring programs developed; or remedial design and execution during remedy implementation. The use of the data itself could be multi-purpose though the collection methods would be similar.

6.3.1 Ex Situ Toxicity Tests on Plants and invertebrates

The Tier 1 values for plants and soil invertebrates described in Section 6.1 are based exclusively on published laboratory toxicity data. These data often are derived from studies where more bioavailable forms (i.e., soluble salts) are added, and tests are conducted on unweathered mixtures. As a result, contaminants may be significantly more bioavailable to the target organisms than conditions found in the field. While the exceedance of Tier 1 values may indicate potential risks, the presence of observable effects at the site is unknown. For this reason, the values developed from these tests are conservative and not always representative of the levels at which risk may be expected at a site. Site-specific studies could be conducted to explore the dose response relationship that might be expected across the Hanford Site. If such studies are conducted, soil samples should be collected from a range of locations at the site representing low to high COPEC levels (a range is necessary to develop a dose-response relationship).

Sufficient sample volume will need to be collected to allow splits for (1) chemical analyses, (2) plant bioassays, and (3) soil invertebrate bioassays. Bioassays should be based on existing standardized protocols (i.e., EPA, American Society for Testing and Materials, Organization of Economic Cooperation and Development, and others) and should focus on taxa most representative of the Hanford Site (e.g., tests on earthworms are not relevant to the Hanford Site; an arthropod test, such as collembola, is more appropriate).

6.3.2 Bioaccumulation into Plants, Invertebrates, and Small Mammals

To calculate ecological risk-based concentrations for wildlife receptors, bioaccumulation models are needed to estimate contaminant concentrations in prey. Tier 1 values relied exclusively on bioaccumulation models extracted from published literature. These models may not accurately reflect site-specific Hanford conditions or food types most likely to be consumed by Hanford Site receptors. Although measured tissue concentrations were not available for samples collected from within most of the waste sites on the Outer Area list, some Hanford Site-specific bioaccumulation data are available. These data, collected for the Draft A Reissue report (DOE/RL-2007-50) and the RCBRA (DOE/RL-2007-21), may be used in the calculation of Tier 2 values. Development of site-specific soil bioaccumulation models would require co-located soil and biota, collected over a range of concentrations reflecting a sufficient concentration gradient (e.g. sites with a sufficient range of low to high concentrations in soil). Both soils and biota samples would be analyzed for the same suite of analytes.

6.4 Next Steps

The next steps for completing ERAs for the Central Plateau will be work planning within the RI/FS process. An outline of the approach to ERAs will be presented in the Inner Area and Outer Area RI/FS work plans. Some of the following general approaches will be presented:

- Use of the available characterization data for ERA
- Initial risk-based screening using available data from across waste sites for COPCs (as identified by nature and extent) to identify COPECs
- Subsequent risk-based screening at individual waste sites for COPECs identified across waste sites
- Implementation of the tiered approach using ecological PRGs
- The use of central tendency estimates and point by point risk estimation at waste sites with multiple data points

Additional work planning activities to occur include the following:

- Integration with non-operational area evaluation to identify potential areas to be considered in the waste site identification process
- Working with risk managers to evaluate the need for additional ecological sampling to support the BRA and development of Tier 2 or Tier 3 PRG values

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