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DOCUMENT #: DOE/EIS-0222F

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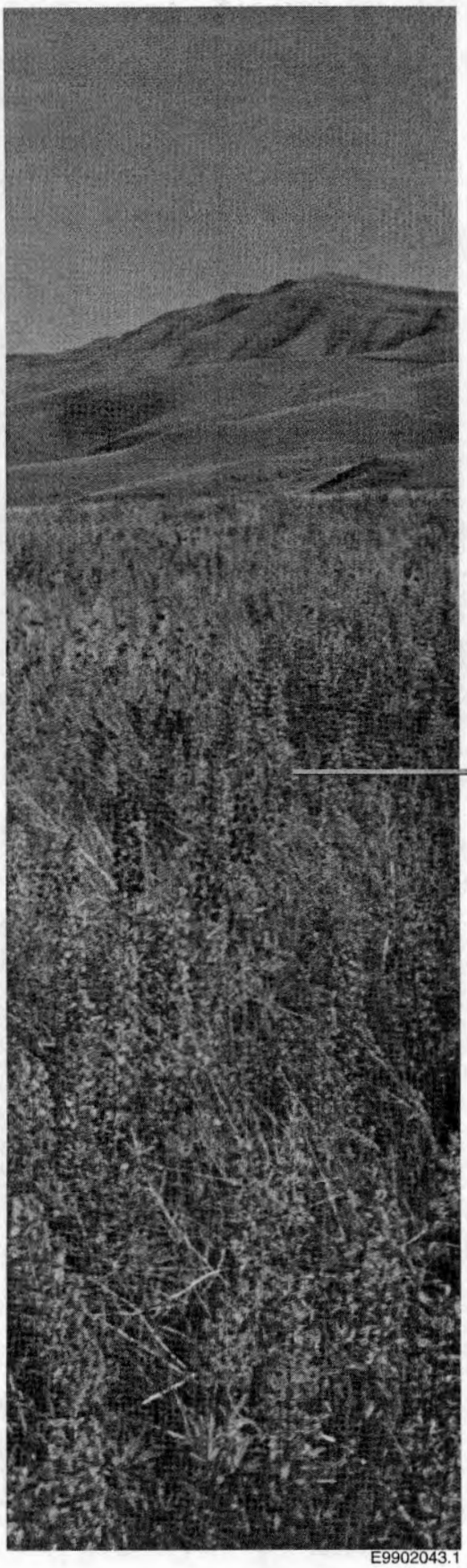

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Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement

U.S. Department of Energy
September 1999

Cover Sheet

Lead Federal Agency: U.S. Department of Energy (DOE)

Cooperating Agencies: U.S. Department of the Interior (Bureau of Land Management, Bureau of Reclamation, and U.S. Fish and Wildlife Service); Benton, Franklin, and Grant counties; and the City of Richland, Washington

Consulting Tribal Governments: Nez Perce Tribe Department of Environmental Restoration and Waste Management and the Confederated Tribes of the Umatilla Indian Reservation

Title: *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (HCP EIS), Hanford Site, Richland, Washington

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For general information on DOE's *National Environmental Policy Act of 1969* (NEPA) process, call 1-800-472-2756 to leave a message, or contact: Carol Borgstrom, Director, Office of NEPA Policy and Assistance (EH-42), U.S. Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585, (202) 586-4600.

Abstract: The DOE prepared this *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (HCP EIS) to evaluate the potential environmental impacts associated with implementing a comprehensive land-use plan for the Hanford Site for at least the next 50 years. With the exception of the required No-Action Alternative, each of the six alternatives presented represents a Tribal, Federal, state, or local agency's Preferred Alternative. Each alternative is presented separately. The DOE's Preferred Alternative anticipates multiple uses of the Hanford Site, including: consolidating Waste Management operations in the Central Plateau, allowing industrial development in the eastern and southern portions of the Site, increasing recreational access to the Columbia River, and expanding the Saddle Mountain National Wildlife Refuge to include all of the Wahluke Slope and ALE (managed by the U.S. Fish and Wildlife Service).

The Hanford Site occupies 1,517 square kilometers (km^2) (586 square miles [mi^2]) in southeastern Washington. Today, the Hanford Site has diverse missions associated with environmental restoration, Waste Management, and Science and Technology. These missions have resulted in the growing need for a comprehensive, long-term approach to planning and development for the Site.

Public Comments: The Final EIS is a revision of the *Revised Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan* (HRA-EIS) published in April 1999 and responds to comments received in writing and at public hearings. The Final EIS is being transmitted to commenting agencies and individuals, made available to the public, and filed with the Environmental Protection Agency (EPA). A DOE decision on proposed actions will not be made earlier than 30 days after EPA issues a public notice of availability for the Final EIS. The DOE will issue a Record of Decision (ROD) published in the *Federal Register*.

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Foreword[1]

Objective of the EIS

This Final HCP EIS was prepared by the Department of Energy (DOE) and its nine cooperating and consulting agencies to develop a comprehensive land-use plan (CLUP) for the Hanford Site. The DOE will use the Final HCP EIS as a basis for a Record of Decision (ROD) on a CLUP for the Hanford Site. While development of the CLUP will be complete with release of the HCP EIS ROD, full implementation of the CLUP is expected to take at least 50 years.

Implementation of the CLUP will begin a more detailed planning process for land-use and facility-use decisions at the Hanford Site. The DOE will use the CLUP to screen proposals. Eventually, management of Hanford Site areas will move toward the CLUP land-use goals. This CLUP process could take more than 50 years to fully achieve the land-use goals.

The final CLUP will consist of the following:

A Final Land-Use Map, depicting the desired future patterns of land use on the Hanford Site. This map will be one of the alternative land-use maps presented in the EIS, or a map that combines features of several of the alternatives maps such as the new Preferred Alternative based on public comment.

Land-Use Definitions, describing the purpose, intent, and principal use(s) of each land-use designation on the final CLUP map.

Land-Use Policies, directing land-use actions. These policies will help to ensure that individual actions of successive managers collectively advance the adopted CLUP map, goals, and objectives over time.

Land-Use Implementing Procedures, including:

- Administrative procedures for reviewing and approving requests for use of Hanford Site lands.

- A Site Planning Advisory Board (SPAB), consisting of representatives from DOE, the cooperating agencies with land-use authority, and the affected Tribes, to evaluate and make recommendations on development proposals and land-use requests. It is anticipated that some requested activities will be permitted under the plan, but that others will need to be modified or required to incorporate mitigation to reduce potential impacts.

- New or revised "area" and "resource" management plans for the Site aligned and coordinated with the new land-use maps, policies and procedures of the adopted CLUP.

[1]Vertical lines in the margins like these to the right indicate where changes have been made since the publication of the Revised Draft HRA-EIS in April, 1999.

Integration of the CLUP

The process described above would be integrated with existing DOE land-use review procedures (e.g., the Draft *Biological Resources Management Plan* and the Draft *Cultural Resources Management Plan*). The final CLUP map, policies, and implementing procedures would be integrated with and addressed at the threshold decision points of all authorizations, operational plans, and actions, including contracts and budget proposals that directly or indirectly affect land use so that they would not create unintentional conflicts with the CLUP, or fail to advance CLUP objectives where the opportunity and ability to do so exists.

The DOE would have the final approval of all land-use decisions taking place on the Hanford Site while under DOE responsibility. The DOE Richland Operations Office would coordinate review of Hanford land development and land-use requests and determine, with input from the SPAB, whether a request represents an *allowable use*, *special use*, or whether the request would require an *amendment* to the CLUP.

Cooperating Agencies and Consulting Tribal Governments

The nine cooperating agencies and consulting Tribal governments that participated in the preparation of this Final HCP EIS are the U.S. Department of the Interior (Bureau of Land Management [BLM], Bureau of Reclamation [BoR], and the U.S. Fish and Wildlife Service [USFWS]); the City of Richland, Washington; Benton, Franklin, and Grant counties; the Nez Perce Tribe, Department of Environmental Restoration and Waste Management; and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR).

The HCP EIS Alternatives

Six land-use alternatives (including the No-Action) were developed by the nine Cooperating Agencies and Consulting Tribal Governments using common land-use designations and definitions. With the exception of the No-Action Alternative, each of the six alternatives presented represents a Tribal, Federal, state, or local agency's Preferred Alternative.

No-Action Alternative. This alternative, developed by DOE in compliance with the *National Environmental Policy Act of 1969* (NEPA), presents the current status of land use at the Hanford Site and represents no change from current land-management processes or intergovernmental relationships with the cooperating agencies. Specific land-use decisions for Hanford would continue to be made under the NEPA process and the Tri-Party Agreement, based on the current *Hanford Strategic Plan* (Mission Plan) and on a project-by-project basis.

DOE's Preferred Alternative. DOE's Preferred Alternative anticipates multiple uses of the Hanford Site, including anticipated future DOE missions, non-DOE Federal missions, and other public and private-sector land uses. The DOE Preferred Alternative would do the following:

- *For the cleanup mission* – Consolidate Waste Management operations on 50.1 km^2 (20 mi^2) in the Central Plateau of the Site.

- *For the economic development mission* – Allow industrial development in the eastern and southern portions of Hanford and increase recreational access to the Columbia River.

- *For the Natural Resource Trustee mission* – Expand the existing Saddle Mountain National Wildlife Refuge to include all of the Wahluke Slope (North Slope) of the Site, consistent with the 1994 Hanford Reach EIS and 1996 Hanford Reach ROD; place the Fitzner/Eberhardt Arid Lands Ecology Reserve (ALE Reserve) under USFWS management by permit so it may be included in the overlay wildlife refuge, add McGee Ranch to the overlay wildlife refuge; and ensure that, where practicable, withdrawn BLM lands are clean enough to support BLM's multiple-use mandate.

Alternative One (Natural Resource Trustee). The USFWS's alternative emphasizes a Federal stewardship role for managing the natural resources at Hanford. This alternative considers these resources in a regional context, and would expand the existing Saddle Mountain National Wildlife Refuge to include all of the Wahluke Slope (North Slope), the Riverlands, McGee Ranch, and the ALE Reserve (e.g., all of the Hanford lands north and east of the Columbia River and west of State Highways 24 and 240). The vision of Alternative One is to conserve the Hanford Site shrub-steppe ecosystem and protect the Hanford Reach of the Columbia River.

Alternative Two (Nez Perce Tribe, Environmental Restoration and Waste Management Department). This Nez Perce alternative calls for preservation of natural and cultural resources and traditional Tribal use at the Site. Future DOE missions would be constrained to the Central Plateau, 300 Area, and 400 Area. Both this alternative and Alternative Four (developed by the CTUIR) reflect Tribal visions and views of Tribal members' treaty rights and traditional Tribal uses of Hanford lands. The Tribes and DOE have "agreed to disagree" on the interpretation of treaty rights on Hanford lands in the interest of moving the EIS process forward. Each party reserves the right to assert its respective interpretation of treaty rights at Hanford.

Alternative Three (Cities and Counties). This local governments' alternative is based on the individual planning efforts of local agencies and organizations including Benton County, Franklin County, Grant County, and the City of Richland. Alternative Three recognizes the potential that land use at the Hanford Site has in relation to economic development. Alternative Three would allow dryland (non-irrigated) agricultural and grazing activities, and irrigated agriculture on the Hanford Site. The land-use designations contained in Alternative Three were developed consistent with local availability of infrastructure, nearness of urban areas, soils capabilities, and current use patterns.

Alternative Four (Confederated Tribes of the Umatilla Indian Reservation, CTUIR). This CTUIR alternative calls for preservation of natural resources and areas of religious importance to the CTUIR as well as traditional Tribal use at the Site. Both this alternative and Alternative Two (developed by the Nez Perce Tribe, Environmental Restoration and Waste Management Department) reflect Tribal visions and views of Tribal members' treaty rights and traditional Tribal uses of Hanford lands. The Tribes and DOE have "agreed to disagree" on the interpretation of treaty rights on Hanford lands in the interest of moving the EIS process forward. Each party reserves the right to assert its respective interpretation of treaty rights at Hanford.

Public Comment

The DOE received more than 400 comment letters, 30 E-mails, and 86 transcript comments from four public hearings on the Revised Draft HRA-EIS. The DOE also accepted a binder with 922 endorsements for the Wild and Scenic River (with the inclusion of a Wahluke Wildlife Refuge) that were collected for the Department of the Interior's Hanford Reach EIS in 1994. More than 200 request forms for farmland on the Wahluke Slope (also generated for the

Hanford Reach EIS in 1994) were accepted in the same spirit. Each of these signature-gathering efforts were assigned only one comment number. Based on the public comment received, the following changes have been made to the DOE's Preferred Alternative:

- All Conservation (Mining and Grazing) has been changed to Conservation (Mining).
- The National Wildlife Refuge designation (from Alternative One) has been extended to include the ALE Reserve, the Riverlands, and McGee Ranch; and all river islands not in Benton County. The Preferred Alternative clarifies that the refuge will be an overlay wildlife refuge (without a transfer of title from DOE), and that DOE retains the right to mine the ALE insert for cover materials.
- A railroad right-of-way through the Riverlands portion of the proposed Refuge will be given status as a preexisting condition and included in the proposed USFWS permit to manage the Refuge.
- The White Bluffs town-site (from Alternatives One and Three) has been added to the Preferred Alternative map as Low-Intensity Recreation to serve as the White Bluffs Memorial.
- The Low-Intensity Recreation dots (comfort stations) along the river which could eventually serve as anchor points for a river trail from Richland to Vernita Bridge have been moved to ensure that they have both river and road access.
- A High-Intensity Recreation triangle (from Alternative Three) has been added to the Preferred Alternative map near Horn Rapids Park on the Yakima River

In addition to changes made to the Preferred Alternative, and the identifying of Alternative One as the environmentally preferable alternative, many other changes were made to the document updating items, refining analyses, and correcting errors. Each change in the Final EIS from the Revised Draft EIS is identified by vertical line on the outside margin of the page such as the one that accompanies this paragraph.

Preamble

In response to public comment, the U.S. Department of Energy (DOE) has changed the name of this environmental impact statement (EIS) from the *Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan* (HRA-EIS) to the **Hanford Comprehensive Land-Use Plan EIS (HCP EIS)**. In the Notice of Intent in 1992, establishing future land uses was listed as one of the HRA-EIS objectives. Since that time, various considerations have led to this Final HCP EIS in which future land use is now the EIS's main objective. To reflect this reduction in scope from the 1996 Draft HRA-EIS, DOE solicited comments on the proposed name change (as well as the contents), and in response to comments has changed the name to the HCP EIS.

Originally, this EIS was intended to provide an environmental review under the *National Environmental Policy Act of 1969* (NEPA) for all aspects of the developing Hanford Environmental Restoration Project. The document, however, no longer directly considers remediation issues. Instead, remediation issues are now integrated into specific Tri-Party Agreement remediation decision documents. Remediation decisions are made by the U.S. Environmental Protection Agency and the State of Washington, as lead regulatory agencies, and DOE as lead implementing agency. The DOE does expect that the EIS process will assist Hanford remediation efforts by determining reasonably foreseeable land uses and establishing land-use decision-making processes to ensure the viability of any future institutional control that might be required.

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Acronyms and Initialisms

ac	acres
AEA	*Atomic Energy Act*
AEC	Atomic Energy Commission
ALE	Fitzner/Eberhardt Arid Lands Ecology Reserve
AMP	area management plan
ATG	Allied Technology Group
BLM	Bureau of Land Management
BoR	Bureau of Reclamation
BPA	Bonneville Power Administration
BRMA	B Reactor Museum Association
BRMaP	Biological Resources Management Plan
BRMiS	Biological Resources Mitigation Strategy Plan
CAA	*Clean Air Act of 1970*
CAAA	*Clean Air Act Amendments of 1990*
CBC	Columbia Basin College
CBRP	Columbia Basin Reclamation Project
CCP	Comprehensive Conservation Plan
CEQ	Council on Environmental Quality
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CLUP	comprehensive land-use plan
CRADA	Cooperative Research & Development Agreement
CRMP	Cultural Resources Management Plan
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
D&D	decontamination and decommissioning
DCGL	derived concentration guide level
DOE	U.S. Department of Energy
DOH	Department of Health (State of Washington)
DOI	U.S. Department of the Interior
DSTs	double-shell tanks
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EM	Environmental Management
EMSL	Environmental Molecular Sciences Laboratory
Energy Northwest	formerly known as the Washington Public Power Supply System (WPPSS)
EPA	U.S. Environmental Protection Agency
EPZ	emergency planning zone
ERDF	Environmental Restoration Disposal Facility
ERWM	(Nez Perce Tribe) Environmental Restoration and Waste Management (Program)
ESU	Evolutionary Significant Units
EUZ	exclusive-use zone
FFCA	*Federal Facilities Compliance Act of 1992*

FFTF	Fast Flux Test Facility
FLEFA	*Federal Land Exchange Facilitation Act of 1988*
FLPMA	*Federal Land Policy and Management Act of 1976*
RI/FS	remedial investigation/feasibility study
FONSI	finding of no significant impact
Working Group	Future Site Uses Working Group
GIS	Geographic Information System
GMA	*Growth Management Act*
GSA	General Services Administration
ha	hectares
HAB	Hanford Advisory Board
HAMMER	Hazardous Materials Management and Emergency Response
HAP	hazardous air pollutants
HCP EIS	*Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (formerly named the *Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan* [HRA-EIS])
HCRL	Hanford Cultural Resources Laboratory
HEHF	Hanford Environmental Health Foundation
HGIS	Hanford Geographic Information System (database)
HMS	Hanford Meteorological Station
I&I	irreversible and irretrievable
ICBEMP	Interior Columbia Basin Ecosystem Management Project
ILCR	incremental lifetime cancer rate
INEEL	Idaho National Engineering and Environmental Laboratory
km^2	square kilometers
LIGO	Laser Interferometer Gravitational-Wave Observatory
LLW	low-level waste
MCL	maximum contamination level
MEI	maximally exposed individual
mi^2	square miles
MMI	Modified Mercalli Intensity
MOA	Memorandum of Agreement
MTCA	*Model Toxics Control Act of 1989*
MOX	mixed oxide
NAAQS	National Ambient Air Quality Standards
NARM	naturally occurring and accelerator-produced radioactive materials
NCO	NEPA Compliance Officer
NCP	National Contingency Plan
NEPA	*National Environmental Policy Act of 1969*
NERP	National Environmental Research Park
NOA	Notice of Availability
NOI	Notice of Intent
NPA	*Northwest Power Act*
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPPC	Northwest Power Planning Council
NPS	U.S. National Park Service
NWR	National Wildlife Refuge

ORP	Office of River Protection (formerly Tank Waste Remediation System [TWRS])	
OSHA	Occupational Safety and Health Administration	
PCB	polychlorinated biphenyl	
PFP	Plutonium Finishing Plant	
PNNL	Pacific Northwest National Laboratory	
PSD	Prevention of Significant Deterioration	
PUD	Public Utility District	
PUREX	Plutonium-Uranium Extraction	
R&D	research and development	
RCRA	*Resource Conservation and Recovery Act of 1976*	
RCW	*Revised Code of Washington*	
REO	Real Estate Officer	
RL	(U.S. Department of Energy) Richland Operations Office	
RMP	resource management plan	
ROD	Record of Decision	
SALDS	state-approved land disposal structure	
SARA	*Superfund Amendments and Reauthorization Act of 1986*	
SDWA	*Safe Drinking Water Act of 1974*	
SEPA	*State Environmental Policy Act of 1971*	
SHPO	State Historic Preservation Office	
SMB	Site Management Board	
SPAB	Site Planning Advisory Board	
SRS	Savannah River Site	
SSTs	single-shell tanks	
TAP	toxic air pollutants	
THPO	Tribal Historic Preservation Officer	
TPA	Tri-Party Agreement	
TRIDEC	Tri-City Industrial Development Council	
TSCA	*Toxic Substances Control Act of 1976*	
TSD	treatment, storage and disposal	
TSP	total suspended particulates	
TWRS	Tank Waste Remediation System (now known as the Office of River Protection [ORP])	
UBC	Uniform Building Code	
USACE	U.S. Army Corps of Engineers	
USFWS	U.S. Fish and Wildlife Service	
VOC	volatile organic compound	
WAC	*Washington Administrative Code*	
WCAA	*Washington Clean Air Act of 1991*	
WDFW	Washington Department of Fish and Wildlife	
WIDS	Waste Information Data System (database)	
WNP-2	Washington Nuclear Plant Number 2	
WSU-TC	Washington State University - Tri-Cities	

1.0 Introduction[2]

Coordinated land-use planning is one of the many trustee responsibilities the U.S. Department of Energy (DOE) has, as a Federal agency holding Federal assets. This *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (HCP EIS) considers several land uses for the Hanford Site planned for at least the next 50 years. As Hanford cleanup progresses through the next 40 years, cleanup Records of Decision (RODs) issued under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) and decisions made through the *Resource Conservation and Recovery Act of 1976* (RCRA) permitting process will impact some areas within the proposed land uses. Likewise, other DOE missions, such as research and development (R&D), might be collocated at Hanford because of DOE's continued Federal presence as the long-term caretaker of CERCLA/RCRA or low-level waste (LLW) disposal sites. Other DOE missions ,such as economic development or even other Federal mandates such as natural resource protection, could also impact Hanford land uses.

As with all Federal activities, where, when, and how quickly Hanford waste sites are remediated and proposed land uses are achieved depends on Congressional funding. It is DOE's responsibility to include in its annual budget request sufficient funds for applicable environmental requirements. The Tri-Party Agreement, which defines the schedule for clean-up activities at the Hanford Site is one source of such requirements, and is itself dependent on Congressional funding. These cleanup activities are an important factor in determining when, or even if, proposed land uses might be fulfilled.

The DOE has prepared this HCP EIS to evaluate the potential environmental impacts associated with implementing a comprehensive land-use plan (CLUP) for the Hanford Site for at least the next 50 years. The DOE is expected to use this land-use plan in its decision-making process to establish what is the "highest and best use" of the land (41 *Code of Federal Regulations* [CFR] 101-47, "Federal Property Management Regulations"). The final selection of a land-use map, land-use policies, and implementing procedures would create the working CLUP when they are adopted through the ROD for this EIS.

Creating this land-use plan benefits DOE in several ways:

- As a Natural Resource Trustee, DOE is encouraged by the Council on Environmental Quality (CEQ) to further the goals of biodiversity and actively manage the land's intrinsic resources.

- Federal law and Executive Orders require that executive agencies hold only that land necessary to economically and efficiently support agency missions.[3]

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[2] Vertical lines in the margins like these to the right indicate where changes have been made since the publication of the Revised Draft HRA-EIS in April, 1999.

[3] Specifically, Executive Order 12512, *Federal Real Property Management*, requires executive agencies to ensure the effective use of real property in support of mission-related activities. Also, to stimulate the identification and reporting of excess real property and to achieve maximum utilization, the *Federal Property and Administrative Services Act of 1949*, as amended, requires all executive agencies to periodically review their real property holdings. These reviews identify property which is "not needed," "underutilized," or "not being put to optimum use." Property determined to be excess should be promptly reported to the Federal General Services Administration (DOE 1997b).

- DOE is required to develop a future use plan for the Hanford Site by 42 U.S.C. 7274k (Public Law 104-201, Section 3153, *National Defense Authorization Act for Fiscal Year 1997*).

- DOE's *Land- and Facility-Use Policy* is to develop a comprehensive plan to support the Department's critical missions, stimulate the economy, and protect the environment.

- A land-use plan provides a means for coordinating planning and plan implementation with Tribal governments and local jurisdictions, as well as facilitating site and infrastructure transition and privatization activities.

- A land-use plan formed with cooperating agencies and consulting Tribal governments establishes a planning baseline for the Hanford Site in a regional context, from which DOE and stakeholders can deliberate from, and depart on new future directions.

- Completing this HCP EIS and subsequent publication of the ROD finalizes the Hanford Future Site Uses Working Group (Working Group) process begun in 1992 as scoping for this EIS.

- This land-use plan can be used by the regulators to establish goals for the CERCLA/RCRA cleanup (i.e., remediation) processes (see Table 1-3). Remediation will be conducted under CERCLA/RCRA authority. If the remediation process cannot support the proposed land use within the National Contingency Plan's (NCP's) 10^{-4} to 10^{-6} risk range, then this EIS contains a proposed process for changing the "highest and best use" of the land while maintaining institutional controls (see Chapter 6).

In this EIS, DOE is working with Tribal governments and Federal, state, and local agencies to develop several land-use alternatives – specifically, the potential environmental consequences associated with each alternative – for at least the next 50-year time frame. These individual land-use plans, together with a common set of policy statements, represent the distinct alternatives developed by the cooperating agencies and consulting Tribal governments on this document. The cooperating agencies are the U.S. Department of the Interior (DOI), which includes the Bureau of Land Management (BLM), Bureau of Reclamation (BoR), and U.S. Fish and Wildlife Service (USFWS); Benton, Franklin, and Grant counties; and the City of Richland. The consulting Tribal governments are the Nez Perce Tribe Department of Environmental Restoration and Waste Management (Nez Perce Tribe) and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR).

With the exception of the required No-Action Alternative, each alternative presented represents a Tribal, Federal, state, or local agency's Preferred Alternative. Each alternative is presented independently. Effort was taken to present each alternative with equal measure to encourage public comment.

This CLUP's authority is limited to as long as DOE retains legal control of some portion of the real estate. This EIS does not contain any new mechanisms or preferences regarding the transfer of land, but with input from the cooperating agencies and consulting Tribal governments, this EIS would continue to be useful for considering proposals regarding Hanford lands that might be transferred beyond the control of DOE. This EIS is not focused on land transfer, but rather speaks to the integrated use and management of land and resources independent of who owns the land. Land transfer is a complicated and separate process from the CLUP and once property leaves DOE control, DOE has no more authority over the use of

that land unless the property was conveyed with deed or other legal restrictions. For more information about the process for transferring property, see Section 1.4.3.

The HCP EIS provides environmental review for the following DOE actions:

- Designation of existing and future land uses, and land-use policies and implementing procedures, through the adoption of a CLUP for the Hanford Site.
- Incorporation of site-specific CERCLA RODs into a regional land-use planning process.

1.1 Historic Background

The Hanford Site is a geographically diverse land area in southeastern Washington State. A large area of pristine shrub-steppe habitat, the Hanford Site is bisected by the last free-flowing stretch of the Northwest's Columbia River. In contrast, the Hanford Site is also included on the CERCLA National Priorities List (NPL) of contaminated sites. About 4 percent of the Site is surface contaminated, and 30 percent of the Site overlays contaminated groundwater from the past production of defense nuclear materials.

The Hanford Site occupies 1,517 square kilometers (km^2) (586 square miles [mi^2]) in the southeastern portion of the State of Washington (see text box, *"How Big is Hanford?"* and Figure 1-1, Location of the Hanford Site). Figure 1-2 shows the names and locations of local landmarks that are referenced throughout this EIS. Within the geographic boundary of the Site, there are 36.42 km^2 (14.1 mi^2) of Columbia River surface water and one section (1 mi^2) of land owned by the State of Washington. Established by the Federal government in 1943, the Hanford Site is owned by the Federal government and is managed by the U.S. Department of Energy, Richland Operations Office (RL).

1.1.1 Early Land Use of the Region

The Hanford Site is located within the Pasco Basin, a unique feature of the Columbia Plateau. The basin is the only area along the mid-Columbia River where the river is not confined within a gorge. Instead, the river is bounded by wide expanses of uplands. During the pre-contact era, these uplands contained abundant natural resources, including native plants, wildlife, and geologic resources. In addition, the Pasco Basin is where the Snake River and the Yakima River join the Columbia River, providing a wealth of riparian areas as well as an excellent means of transportation throughout the semiarid inland northwest. These rivers once contained enormous fisheries of salmon, steelhead, sturgeon, eels, freshwater clams, and other aquatic resources.

How Big is Hanford?

The Hanford Site boundary encloses 1,517 square kilometers (km^2) (586 square miles [mi^2]) based on the newest GIS interpolation of the legal site boundary. Historically the site area of 1,450 km^2 (560 mi^2) was calculated by addition of sections and their subunits based on surveys from the 1800's. Included within the Site is 36.42 km^2 (14.1 mi^2) of Columbia River surface water and one square mile of Washington State land. A square mile is 1,609 meters (5,280 feet) to a side. A square mile is also known as a section, equal to 259.2 hectares (ha) (640 acres [ac]). Typically, in eastern Washington agriculture, four 65-ha (160-ac), center-pivot circle irrigation systems would occupy each section.

In this document, all measurements are in metric units, followed by the British equivalents. The DOE's documents use metric units as required by Executive Order 12770, Metric Usage in Federal Government Programs"; the *Metric Conversion Act of 1975* (Public Law 94-168, as amended by Public Law 100-418); and various Title 15, *Code of Federal Regulations*.

Figure 1-1. Location of the Hanford Site.

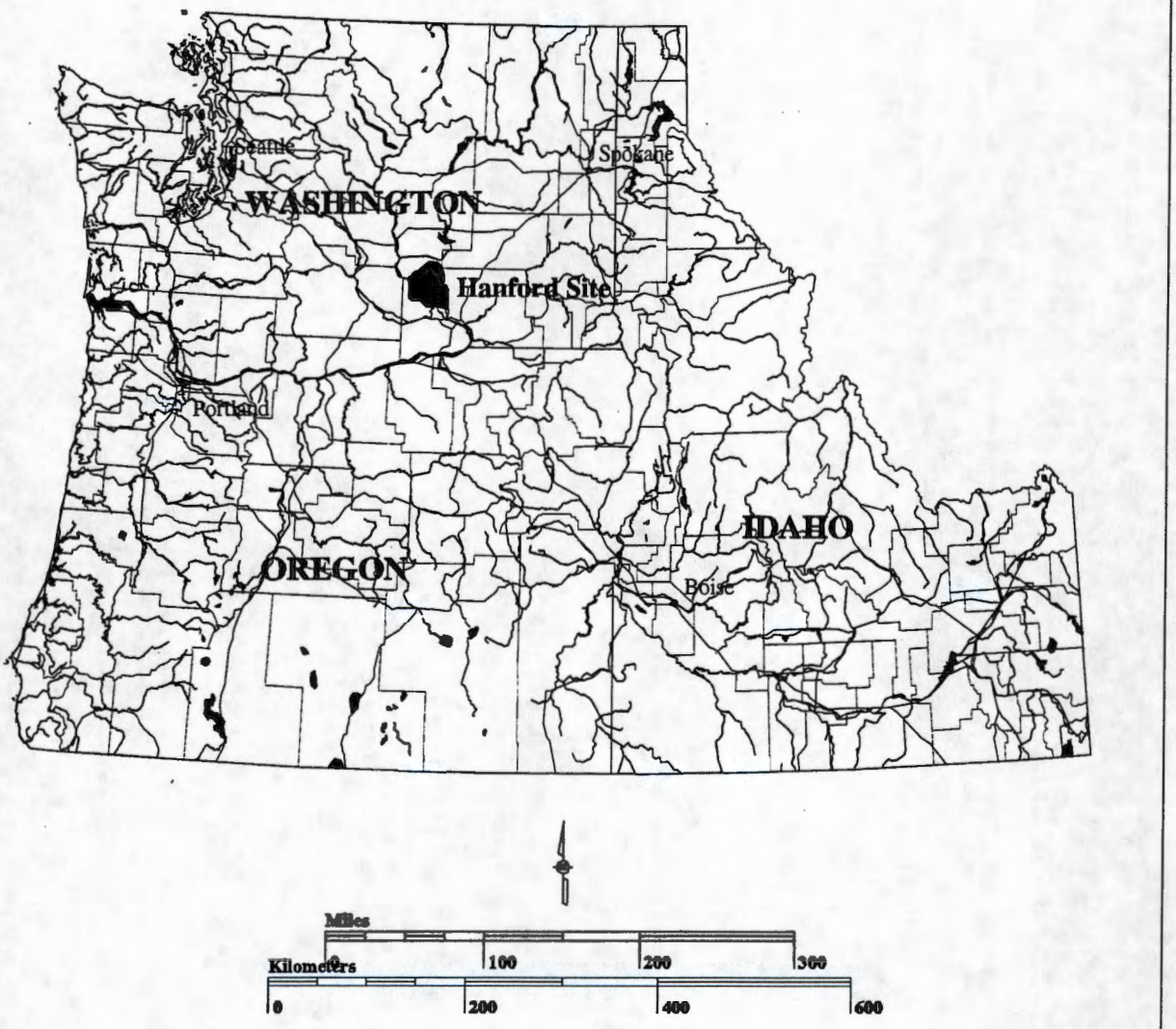

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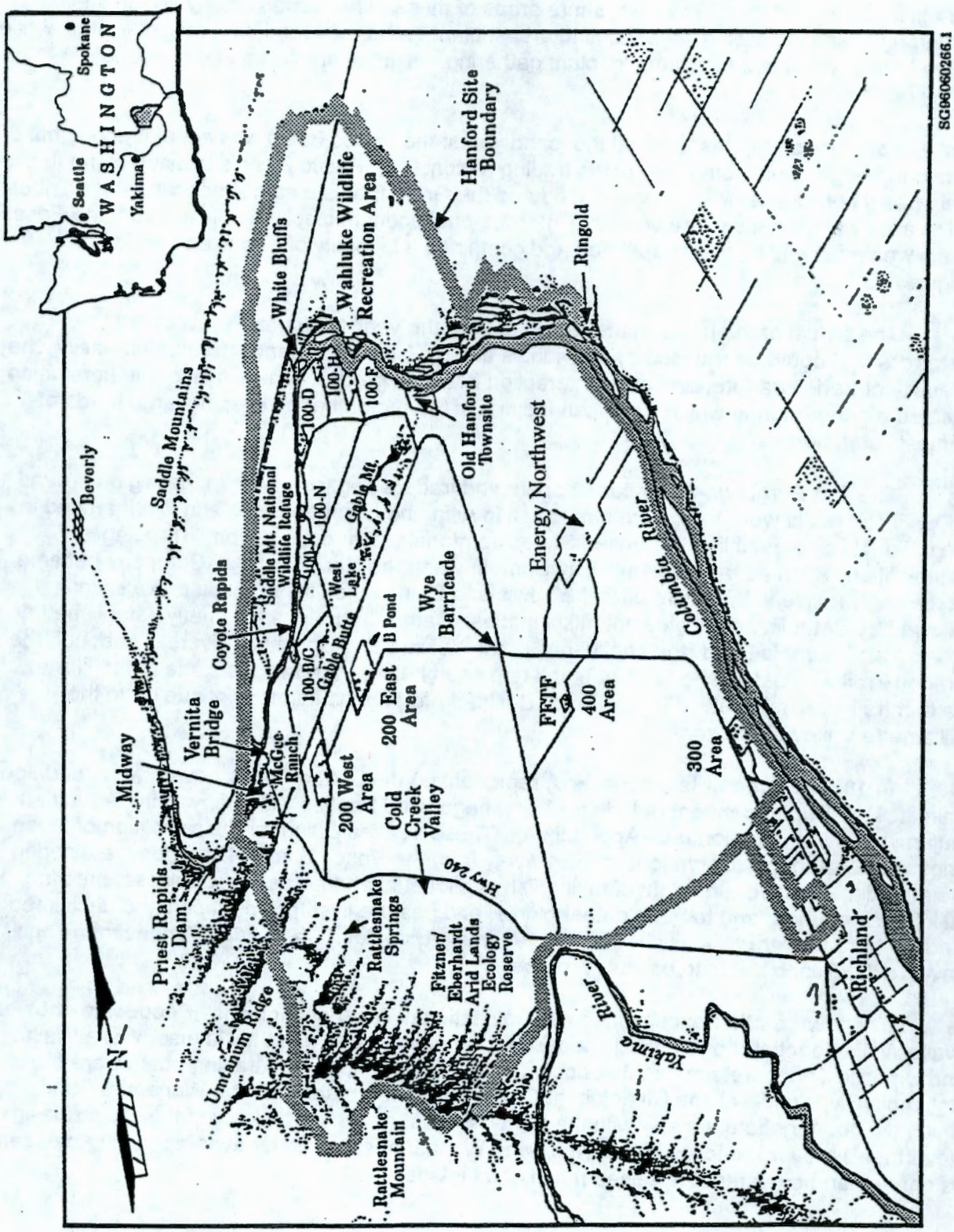
Figure 1-2. Hanford Site Local Names and Landmarks.



These physical features of the Pasco Basin made the basin highly attractive to American Indian Tribes. Archeologic evidence has demonstrated their presence in the area for more than 10,000 years. Tribal oral histories confirm that Tribes have been in the region for a very great period of time. The near-shore areas of these rivers contain many village sites, fishing and fish processing sites, hunting areas, plant gathering areas, and religious sites, while upland areas were used for hunting, plant gathering, religious practices, and overland transportation.

For at least the past several thousand years, the Pasco Basin was a major economic hub in the larger Columbia River Basin trading region. The Pasco Basin's location along the main travel corridor between Puget Sound and the Great Plains meant American Indian Tribes in the area were extensively involved in inter-regional economic activity. As a result, the Pasco Basin was relatively densely populated and contained a diversity of Tribes and bands (Figure 1-3).

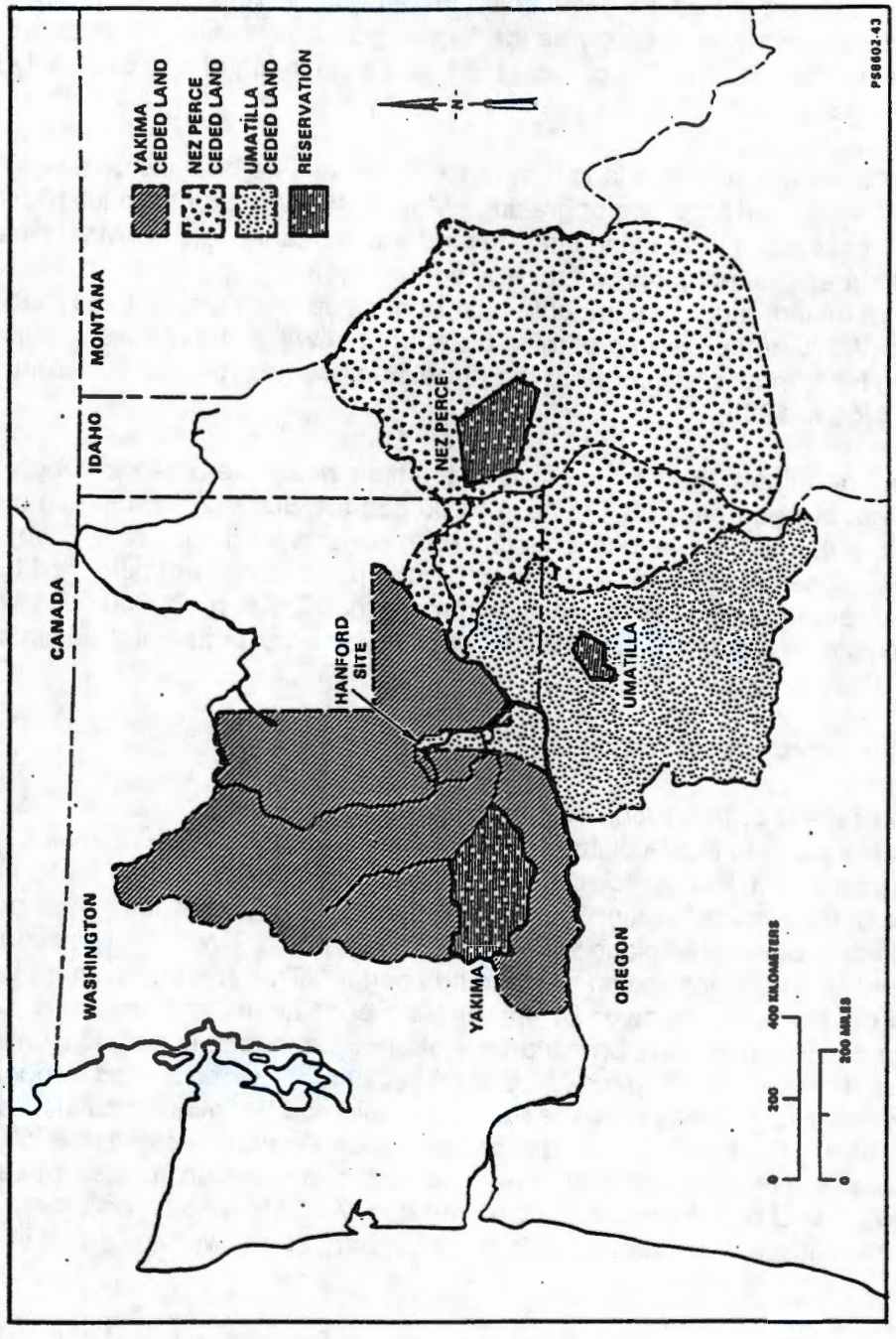
The arrival of the horse in the region around the year 1700 greatly increased the distances that could be traveled by individuals and by Tribes and bands, further increasing the intensity of trade, warfare, and other interaction between groups. The arrival of the horse also initiated a period during which American Indians of the region began keeping large herds of domesticated horses.

The first European-American trappers and traders began arriving in the region around 1800. Their goals were to acquire furs to sell in Asia and Europe. Lewis and Clark arrived in the fall of 1805 to establish the United States' territorial claim to the region. Trapping organizations such as the Hudson's Bay Company and the Northwest Bay Company became increasingly active in the years after the Lewis and Clark expedition. These arrivals were followed by Catholic and Protestant missionaries. Catholic missionaries briefly established a mission at Columbia Point (the confluence of the Yakima and Columbia Rivers). Although the Oregon Trail was established in 1843, and large numbers of non-Indians came to the Northwest via that trail, very few settled in the Pasco Basin, preferring instead to continue on to the Willamette Valley of Oregon.

In 1855, Governor Isaac Stevens, representing the United States government, and Joel Palmer, U.S. Superintendent of Indian Affairs, negotiated treaties with many of the American Indian Tribes in the region (see Appendix A). These treaties called for the relocation of those Tribes to permanent reservations located away from the Pasco Basin. The Tribes retained in their treaties, however, the right of taking fish at all "usual and accustomed" places; erecting buildings for curing; and to hunt, gather plants, and pasture livestock on "open and unclaimed lands" where they traditionally had conducted these activities. To this day, American Indians travel to the Pasco Basin to use its resources.

There were other exceptions to the relocation of American Indians. Peopeomoxmox, a Walla Walla negotiator of the treaty between the United States and the Cayuse, Walla Walla, and Umatilla Tribes, retained in that document the right to operate a trading post where the Columbia River and Yakima River join at Columbia Point. In addition, the Wanapum Band, which did not negotiate a treaty with the United States, remained resident in the Pasco Basin. Nevertheless, over the following 88 years, the Wanapum came under ever-increasing pressure as non-Indian homesteaders seized much of their lands.

Figure 1-3. American Indian Ceded Land and Retained Reservations.



Significant non-Indian settlement of the region began relatively late. In 1888, small irrigation companies and farmer cooperatives began to develop irrigation systems in the Columbia Basin. The agricultural economy of the region saw upswings and downswings, from agricultural price increases during World Wars I and II, drought during the 1920s, and the Great Depression during the 1930s. While, principally, non-Indian farmers lived on the adjacent private lands, members of the Wanapum Band continued to reside on portions of the future Hanford Site that remained in Federal ownership. In 1942, approximately 19,000 people lived in Benton and Franklin counties. Pasco was the largest population center, with approximately 3,900 people (Gerber 1992). The City of Richland had a population of approximately 200 people (Relander 1956).

In the 1940s, almost all of the land that would at some time be considered part of the Hanford Site was being used for crops or grazing. More than 88 percent (about 152,971 ha [378,000 ac]) was sagebrush range land interspersed with volcanic outcroppings, where some 18,000 to 20,000 sheep grazed during winter and spring. Some 11 percent (almost 19,830 ha [49,000 ac]) was farmland, much of it irrigable but not all under cultivation. Less than 1 percent (less than 809 ha [2,000 ac]) consisted of town plots, right of ways, school sites, cemeteries, and similarly used land, most of it in or near the three small communities of Richland, Hanford, and White Bluffs (Jones 1985).

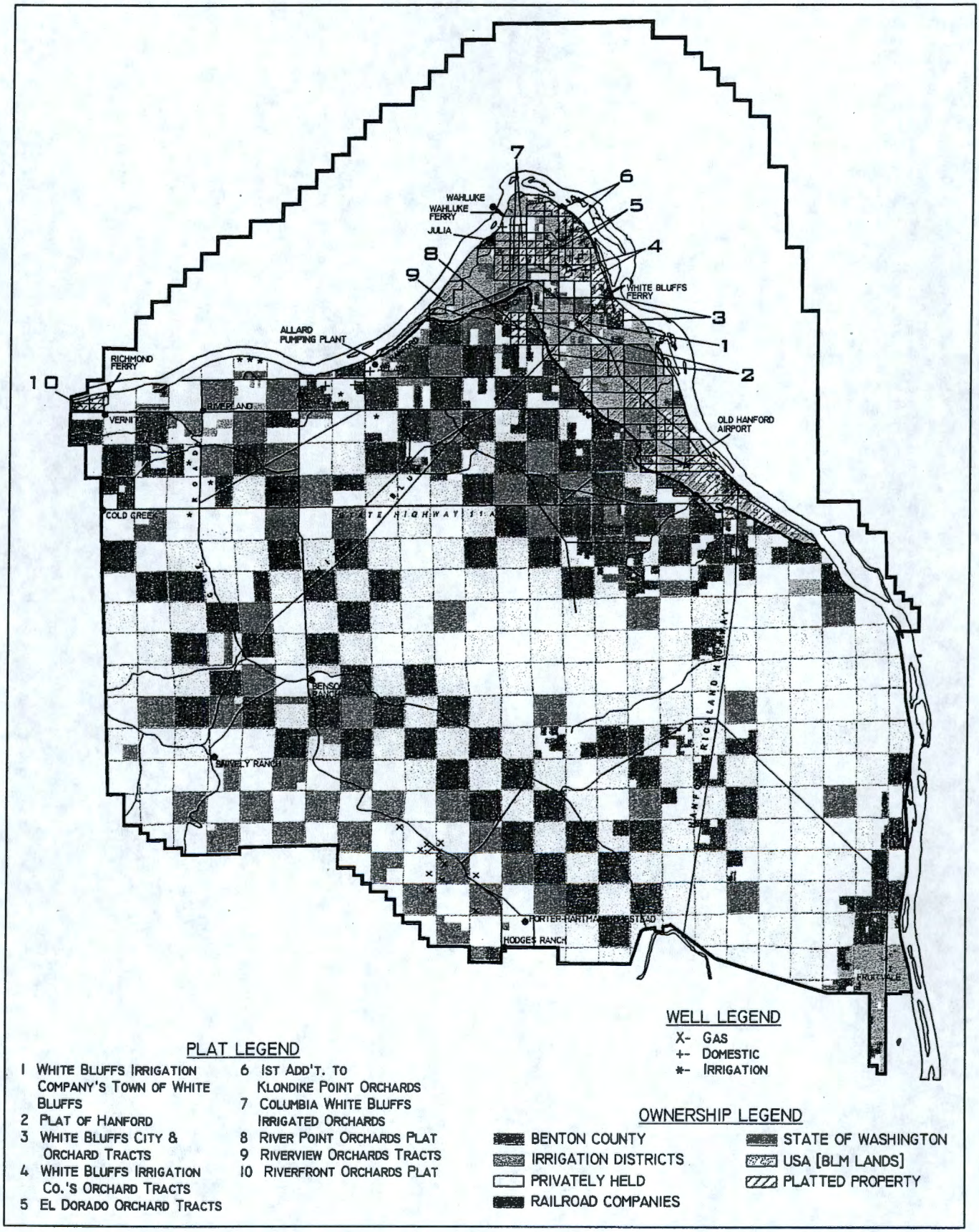
More than one-third of the Hanford area at the time was government-owned. The Federal government owned nearly 28,733 ha (71,000 ac); the State of Washington more than 18,211 ha (45,000 ac); and the five local counties (i.e., Benton, Yakima, Grant, Franklin, and Adams) about 16,592 ha (41,000 ac). More than 91,054 ha (225,000 ac) belonged to private individuals or to corporate organizations, including more than 2,428 ha (6,000 ac) owned by several irrigation districts (Jones 1985). Figure 1-4 provides an example of pre-Hanford Benton County lands in 1943.

1.1.2 Establishment of the Hanford Site

The entry of the U.S. into World War II and the race to develop an atomic bomb led to a search for a suitable place to locate plutonium production and purification facilities. The U.S. Army Corps of Engineers (USACE) selected the site near the towns of White Bluffs and Hanford because of the remote location, good climate, and, most importantly, the abundant supply of hydroelectric power and clean water from the Columbia River. The selection was made in early 1943 and land acquisition proceedings began. The War Department began with condemnation of private lands, followed by appraisals, negotiations, and payments to landowners. Some property owners protested the offered purchase prices and won larger settlements through the courts. Originally, 1,605 km^2 (620 mi^2) were acquired through a combination of withdrawal of lands from the Public Domain and the acquisition of state and privately owned lands. The towns of Hanford and White Bluffs were vacated, the Wanapum were relocated to above the Priest Rapids area, and Richland was transformed into a government town. The U.S. Atomic Energy Commission (AEC) leased an additional 70,000 ha (173,000 ac) as secondary control zones. These secondary zones were released in 1953 and 1958.

For more than 40 years, the primary mission at Hanford was associated with the production of nuclear materials for national defense. Land management and development practices at the Hanford Site were driven by resource needs for nuclear production, chemical processing, Waste Management, and R&D activities. The DOE developed infrastructure and facility complexes to accomplish this work, but large tracts of land used as protective buffer zones for safety and security purposes remained undisturbed. These buffer zones preserved a biological and cultural resource setting unique in the Columbia Basin region.

Figure 1-4. Pre-Hanford Benton County Lands - 1943.



1.1.3 Change in Mission from Defense Production to Environmental Restoration

In the late 1980s, the primary DOE mission changed from defense materials production to environmental restoration. In 1989, DOE entered into the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) with the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) (Ecology et al. 1989). This agreement is intended to accomplish the following:

- Define EPA's CERCLA cleanup provisions for remediation of hazardous substances.
- Define the RCRA waste treatment, storage, and disposal requirements and corrective actions for hazardous waste management as administered by Ecology.
- Establish the responsibilities for each agency (DOE, EPA, and Ecology).
- Establish milestones for achieving remediation and regulatory compliance.

The DOE expects that CERCLA/RCRA authority will be used to remediate areas of the Hanford Site consistent with applicable requirements to support "highest and best use" land use. If the remediation process cannot support the proposed land use within the NCP's 10^{-4} to 10^{-6} risk range, then this EIS contains a proposed process for changing the "highest and best use" of the land (see Chapter 6).

Today, the Hanford Site has a diverse set of missions associated with environmental restoration, Waste Management, and Science and Technology. These missions have resulted in the growing need for a comprehensive, long-term approach to planning and development for the Site. Additionally, DOE's *Land- and Facility-Use Policy* (DOE 1994b); DOE Order 430.1, *Life-Cycle Asset Management* (DOE 1995c); and the *National Defense Authorization Act for Fiscal Year 1997* each require the development of a CLUP for the Hanford Site.

To comply with these requirements, DOE has developed a process for implementing a Hanford CLUP, and has integrated this process into this Final HCP EIS (see Chapter 6). The NEPA ROD issued for this EIS would create the CLUP by documenting a final land-use map and adopting final Hanford land-use policies and implementing procedures. Together, these pieces would form the CLUP. The CLUP would consider the role of the Hanford Site in a regional context, and would integrate mission requirements and other factors as directed by the Secretary of Energy (see text box, *"Land- and Facility-Use Policy"* [DOE 1994b]).

DOE's Land- and Facility-Use Policy

On December 21, 1994, the Secretary of Energy issued a *Land- and Facility-Use Policy* for DOE, which contains the following statement:

"It is Department of Energy policy to manage all of its land and facilities as valuable national resources. Our stewardship will be based on the principles of ecosystem management and sustainable development. We will integrate mission, economic, ecological, social, and cultural factors in a comprehensive plan for each site that will guide land and facility use decisions. Each comprehensive plan will consider the site's larger regional context and be developed with stakeholder participation. This policy will result in land and facility uses which support the Department's critical missions, stimulate the economy, and protect the environment."

1.2 The National Environmental Policy Act Process

The *National Environmental Policy Act of 1969* (NEPA) requires consideration of potential environmental impacts associated with Federal agency actions and provides opportunities for public involvement in the decision-making process. In accordance with NEPA requirements, DOE has prepared this Final HCP EIS to help decision makers and the public understand the potential environmental impacts associated with establishing future (for at least

the next 50 years) land uses at the Hanford Site through the adoption of a CLUP and its integral land-use maps, policies, and implementing procedures.

1.2.1 Scope of the Hanford Comprehensive Land-Use Plan Environmental Impact Statement and Comprehensive Land-Use Plan

The DOE received more than 2,000 comments from approximately 233 commenters on the August 1996 Draft HRA-EIS. Response was mixed. Many commenters felt land-use planning was poorly integrated into the public scoping process and the Draft HRA-EIS. Ecology's and EPA's comments centered around disagreements with the CERCLA/RCRA assumptions that were used for the waste volume, cost, and risk assessments. Several key stakeholders (i.e.; the DOI, City of Richland, Benton County, and Nez Perce Tribe) felt that with the magnitude of the land-use decision, they needed to be invited into the process as cooperating agencies.

The DOE realized that, without stakeholder support, the regulators (EPA and Ecology) would not be able to use the Draft HRA-EIS land-use plan, as presented, in terms of factoring in potential future land use into the cleanup decision-making process. The DOE then formally invited local land-use planning authorities and Tribes to be cooperating agencies and consulting Tribal governments. From January through March 1997, DOE worked with the cooperating agencies and consulting Tribal governments to clarify and resolve the issues, still with the intent of incorporating comments on the August 1996 Draft HRA-EIS to produce a final EIS. However, through this consultation process, DOE determined that stakeholders wanted an EIS emphasizing land-use maps as alternatives (as opposed to alternatives representing levels of access independent of the land use[s], as presented in the August 1996 Draft HRA-EIS). The DOE then decided to produce a Revised Draft HRA-EIS in cooperation with, and response to EPA, Ecology, Tribal governments, local governments, and other stakeholder comments.

On April 23, 1999, DOE published the Revised Draft HRA-EIS. A public comment period was held from April 23, 1999, to June 7, 1999. Comments on the Revised Draft HRA-EIS have been incorporated into this Final HCP EIS as appropriate. The DOE's responses to comments are presented in the Comment Response Document of this Final EIS.

The Final HCP EIS evaluates the potential environmental impacts from establishing land uses at the Hanford Site for at least the next 50 years, defers the evaluation of impacts associated with remedial actions to Tri-Party Agreement documents, and includes the entire Hanford Site within the scope of the document. In general, the differences between the Final HCP EIS and the August 1996 Draft HRA-EIS can be summarized as follows:

- This Final HCP EIS focuses on land-use impacts and decisions rather than potential remediation impacts.
- Each alternative in the Final HCP EIS features a Site-wide map designating land uses, whereas alternatives in the August 1996 Draft HRA-EIS focused on individual geographic areas.
- In response to public comment, the Final HCP EIS includes a new DOE Preferred Alternative as well as land-use alternatives developed by the cooperating agencies and consulting Tribal governments.
- The Final HCP EIS contains land-use policies and implementing procedures for integration into the Hanford CLUP (see Chapter 6).

Preparation of the Final HCP EIS is consistent with the *National Defense Authorization Act of 1994*, which requires the development of a future-use plan for the Hanford Site; and is responsive to public comments received during scoping and during public comment periods on the 1996 original draft and the 1999 Revised Draft HRA-EIS. The Final HCP EIS also provides a basis for considering potential future proposals regarding transferring ownership and control of some or all of the Hanford Site such as the Wahluke Slope. As the original 1996 Draft EIS provided for consideration of land use, no additional scoping meetings were required.

1.2.1.1 Public Review of the Revised Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan. Once DOE made the decision to reduce the scope of the August 1996 Draft HRA-EIS and issue a Revised Draft, the agency announced it would conduct a 45-day public review and comment period following issuance of the Revised Draft EIS to the public. This public review and comment period, held from April 23, 1999, to June 7, 1999, included four formal public hearings in Portland, Oregon; Richland, Washington; Mattawa, Washington; and Spokane, Washington. The DOE accepted public comments on the Revised Draft HRA-EIS at these hearings and throughout the comment period, and has responded in writing to those comments in this Final HCP EIS.

1.2.2 External Coordination/Involvement in the Preparation of the Revised Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan

During the public comment period on the August 1996 Draft HRA-EIS, several agencies and American Indian Tribes expressed an interest in working with DOE to establish alternative visions for land use. To encourage a variety of viewpoints and strengthen the EIS, DOE involved representatives of other Federal agencies, American Indian Tribes, and state and local governments in ongoing planning efforts. Eventually, these groups received formal invitations from DOE to become cooperating agencies and consulting Tribal governments in the preparation of the Revised Draft HRA-EIS.

Since March 1997, DOE has worked with the cooperating agencies and consulting Tribal governments to establish a framework for the environmental analyses presented in this Final HCP EIS. Substantial agreement was reached among the cooperating agencies and consulting Tribal governments on the development of land-use designations and on the format for determining the potential environmental impacts associated with the land uses carried forward in this Final HCP EIS (see Chapters 3 and 5). The cooperating agencies and consulting Tribal governments also worked together to develop the policies and implementing procedures for the CLUP (see Chapter 6). Alternatives that reflect the land-use values and preferences of different organizations were developed because the cooperating agencies and consulting Tribal governments have different resource usage requirements and goals.

1.2.3 Identification of Public Land-Use Values

Through cooperative activities during the past seven years, diverse stakeholder groups have developed statements of values related to the future of the Hanford Site to provide guidance to Congress, the states of Oregon and Washington, DOE, Ecology, and EPA. It is from this guidance that the proposed policies and implementing procedures for the CLUP have been developed. The first set of values was formulated in 1992 by the Hanford Future Site Uses Working Group (FSUWG 1992) and includes the following statements:

- Protect the Columbia River.
- Deal realistically and forcefully with groundwater contamination.

- Use the Central Plateau wisely for Waste Management.
- Do no harm during cleanup or with new development.
- Cleanup of areas of high future use value is important.
- Clean up to the level necessary to enable the future use option to occur.
- Transport waste safely and be prepared.
- Capture economic development opportunities locally.
- Involve the public in future decisions about the Hanford Site.

After the success of the Hanford Future Site Uses Working Group, other similar stakeholder groups were formed, including the Hanford Tank Waste Task Force and the Hanford Advisory Board (HAB). In 1993, the Hanford Tank Waste Task Force reinforced the first set of values by adding the following statements (Hanford Waste Tank Task Force 1993):

- Protect the environment.
- Protect public/worker health and safety.
- "Get on with the cleanup" to achieve substantive progress in a timely manner.
- Use a systems design approach that keeps endpoints in mind as intermediate decisions are made.
- Establish management practices that ensure accountability, efficiency, and allocation of funds to high priority items.

The first major action taken by the HAB in early 1994 was to endorse and adopt both previously issued sets of values. In September 1994, acting on a recommendation from the Cultural and Socioeconomic Committee, the HAB adopted the following additional values (Takaro 1995):

- Historic and cultural resources have value and should not be degraded or destroyed. Appropriate access to those resources is a part of that value.
- Workforce stability and reasonable stability in the demand for public services are important for the affected communities. In decisions on projects and contractors, consideration should be given to affected workforce and population shifts.
- Cleanup and Waste Management decisions should be coordinated with the efforts of the affected communities, to shift toward more private business activity and away from dependence on Federal projects that have adverse environmental or economic impact.
- The importance of ecological diversity and recreational opportunities should be recognized; those resources should be enhanced as a result of cleanup and Waste Management decisions.

- These concerns should be considered while promoting the most effective and efficient means that will protect environmental quality, and public health and safety, now and for future generations.

- Cleanup activities should protect, to the maximum degree possible, the integrity of all biological resources, with specific attention to rare, threatened, and endangered species and their related habitats.

1.2.4 *Development of the August 1996 Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan*

The Notice of Intent (NOI) to prepare the HRA-EIS was published in the *Federal Register* (57 FR 37959) on August 21, 1992. The NOI stated that the EIS would evaluate a range of reasonable alternatives to accomplish the scope of the Tri-Party Agreement within the framework of potential future Hanford Site use/cleanup strategies.

Public scoping meetings were held at four locations in the Northwest: Spokane, Washington, on September 29, 1992; Pasco, Washington, on October 1, 1992; Seattle, Washington, on October 5, 1992; and Portland, Oregon, on October 8, 1992. The public scoping period for the HRA-EIS ended on January 15, 1993.

As discussed in Section 1.2.3, in 1992 the EPA, Ecology, and DOE, in cooperation with other interested parties, organized a process to involve stakeholders in the development of a vision for the future of the Hanford Site. A committee consisting of representatives of labor, environmental, governmental, agricultural, economic development, citizen-interest groups, and Tribal governments was established and became known as the Hanford Future Site Uses Working Group (Working Group). The Working Group was charged with three related tasks (see text box, *"Working Group's Objectives"*). The result of the Working Group's efforts, a report entitled, *The Future for Hanford: Uses and Cleanup -- The Final Report of the Hanford Future Site Uses Working Group*, was issued in December 1992 (FSUWG 1992), and was submitted to DOE as a formal scoping comment for the HRA-EIS.

Working Group's Objectives

- Identify a range of potential future uses for the Hanford Site.
- Select cleanup scenarios enabling the future uses in light of potential exposure to contaminants, if any, after cleanup.
- Probe for convergence among the cleanup scenarios to identify priorities or criteria that could prove useful in focusing or conducting the cleanup.

The August 1996 Draft HRA-EIS was developed to assess the potential environmental impacts, primarily from remediation activities, associated with establishing land-use objectives for the Hanford Site. The land-use objectives were developed by DOE using concepts developed by the Working Group. In 1996, DOE decided to expand the land-use planning initiative into a formal CLUP in the August 1996 Draft HRA-EIS to conform to the Secretary of Energy's new *Land- and Facility-Use Policy* (DOE 1994b) and DOE Order 430.1, *Life-Cycle Asset Management.*

1.2.5 *Public Review of the August 1996 Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan*

The August 1996 Draft HRA-EIS, which addressed impacts associated with remedial actions and land-use planning, was released to the public during the week of August 26, 1996. A public hearing was held in Richland, Washington, on October 17, 1996, and additional public meetings were held throughout the Northwest during the public comment period, which ended December 10, 1996.

1.2.5.1 Major Issues. Numerous public agencies, American Indian Tribes, interest groups, and members of the public provided comments that indicated a diverse range of values and objectives. Several major issues and concerns were identified by commenters during the August 1996 Draft HRA-EIS formal public comment period. The primary issues identified by the commenters included the following:

- Remedial action cost and volume of contaminated material estimates in the August 1996 Draft HRA-EIS were not considered to be consistent with similar estimates made in support of CERCLA documentation.

- Analyses of potential impacts associated with remediation were considered duplicative of the CERCLA process.

- The combination of a land-use plan with remedial action evaluations was confusing. Suggestions were made to reduce or eliminate emphasis on remedial actions and focus instead on those elements of the HRA-EIS pertaining to land-use planning. Widespread support for the development of a comprehensive land-use plan was evident, though not necessarily for the "Hanford Site Comprehensive Land-Use Plan," presented in Volume 4 of the August 1996 Draft HRA-EIS.

- The August 1996 Draft HRA-EIS did not identify DOE's Preferred Alternative for level-of-access controls (i.e., unrestricted, restricted, or exclusive use) for the Hanford Site although there was only one land-use map presented.

- The Comprehensive Land-Use Plan was considered by commenters to be a major Federal action that was not only inadequately integrated in the August 1996 Draft HRA-EIS, but also was out of the scope of the EIS.

- Land-use alternatives, other than the one plan presented in Volume 4 of the August 1996 Draft HRA-EIS, were not evaluated.

- Tribal members' treaty rights and authority were inadequately addressed in the August 1996 Draft HRA-EIS.

- Cumulative impact analyses were considered inadequate.

- The August 1996 Draft HRA-EIS did not adequately address the need of the local community to diversify and strengthen the economy to offset the decline of Hanford Site employment and did not sufficiently emphasize the role that agriculture and related industries play in the region.

- Many commenters requested that the entire Hanford Site be cleaned up to a level that would allow for unrestricted level-of-access use.

- DOE should coordinate with Benton County and the City of Richland to develop an integrated land-use planning process.

- The level-of-access alternatives (unrestricted, restricted, and exclusive) were confusing without an actual land-use designation.

The comments received on the August 1996 Draft HRA-EIS, as well as transcripts from the public hearing are contained in a Revised Draft HRA-EIS Comment and Response Document, which is available for review in the public reading rooms. In addition, a comment

summary is provided in Appendix F of the Revised Draft document. A summary of comments received on the Revised Draft HRA-EIS is included as part of this Final HCP EIS.

1.2.6 Public Review of the Revised Draft HRA-EIS and Summary of Major Issues

On April 23, 1999, DOE published the Revised Draft HRA-EIS. A public comment period was held from April 23, 1999 to June 7, 1999. Public hearings on the Revised Draft HRA-EIS were held on May 18, 1999, in Portland, OR; on May 20, 1999, in Richland, WA; on June 2, 1999 in Mattawa, WA; and on June 3, 1999 in Spokane, WA. Comments on the Revised Draft HRA-EIS have been incorporated into this *Final Hanford Comprehensive Land-Use Plan* EIS (HCP EIS), as appropriate. The DOE's responses to comments are presented in the Comment Response Document of this Final EIS.

More than 400 comment documents were received by DOE, including letters, postcards, questionnaires, and surveys as well as electronic mail. In addition, more than 200 pages of transcripts were generated during the four public hearings.

The DOE considered all comments received on the Revised Draft HRA-EIS. Many of the comments supported particular alternatives, or a combination of alternatives. A significant number of the comments addressed environmental issues, such as the plight of wildlife habitat and the continued preservation of habitat for plants and animals, including the diminishing population of salmon, and the Hanford Reach designation as a Wild and Scenic River. The comments and comment responses are given in the Final HCP-EIS Comment Response Document, and summarized comments and responses are found in Appendix F.

Twenty-eight major topics were identified and given general responses from the hundreds of comments received. More than 200 detailed comments were given individual responses in the Comment Response Document. The major topics are summarized below.

No-Action Alternative. A few commenters gave input regarding this alternative, with two supporting it and two opposing the lack of planning in this alternative.

DOE's Preferred Alternative. Most commenters citing this alternative offered support, albeit with many favoring some modification to further protect the environment. Those opposed cited the lack of economic development for Grant County and keeping the Wahluke Slope under Federal control as the basis for their opposition.

Alternative One. Almost all letters received regarding this alternative were in favor of this alternative, citing the emphasis on preservation and the additional protection that it provides for high value or sensitive ecological areas on the Hanford Site, and the prohibition against agriculture, mining, grazing, and intensive recreational uses that would compromise the ecological and wildlife values presented. The opposing letter expressed the need for economic development.

Alternative Two. Almost all commenters citing this alternative were in favor of it. The primary issue expressed in the supporting comments was the additional protection given to the environment, particularly that afforded to the high value ecological areas and natural and sensitive lands on the Hanford Site. Some commenters expressed the desire for even more protection of the environment, citing this alternative as the one closest to total preservation. The two opposing commenters cited lack of economic development.

Alternative Three. A significant majority of the commenters citing this alternative supported it, particularly the economic development provided to Grant County. These commenters wanted

the land returned to farming. Opposing commenters cited the lack of adequate protection of the shrub-steppe habitat, and the concern that irrigation would undermine the White Bluffs.

Alternative Four. Commenters expressing an opinion on this alternative generally supported it, citing the large amount of preservation. Those opposed expressed concern that there was no economic development.

National Wildlife Refuge/DOE's Preferred Alternative. More than 300 commenters wrote concerning the DOE's Preferred Alternative, with the modification that a National Wildlife Refuge be created/expanded for additional protection of the environment. Six commenters were against this combination, citing as their reasons the USFWS's lack of adequate resources to properly manage the land, and the lack of consideration of the previous use in farming and future economic development.

Other Combinations. More than 100 comments expressed concern or support for parts of alternatives or an additional alternative. A few submitted their own alternative maps. Some commenters addressed the issue of Federal versus local control. A few supported an extension to the public comment period. The comment was made that additional mapping be done to better represent the wildlife population picture. Others suggested that cleanup, not planning, be the focus of the mission at the Hanford Site.

Preservation. Several commenters expressed their support for preservation of the Hanford Site, varying from preservation of the entire Hanford Site, to the addition of the 200 West Area sagebrush to preservation. Many cited the Hanford Reach, the creation of a National Wildlife Refuge, McGee Ranch, May Junction, the islands, the LIGO land, Gable Mountain, Gable Butte, and the sand dunes. Reasons cited were historical, ecological, cultural, biological, and economic.

Conservation (Mining). A large majority of the commenters expressing a view on this topic said mining could be allowed but only for the necessary materials to support cleanup of the Hanford Site. Some letters described specific areas that should not be mined (primarily the ALE Reserve), while one commenter cited the need for McGee Ranch silt specifically for the cleanup program.

Conservation (Mining and Grazing). More than 200 commenters were against allowing any commercial grazing on the Hanford Site. Many commenters cited grazing as being incompatible with wildlife protection. The spreading of noxious weeds was attributed to livestock grazing, because hooves tear up the delicate ground cover habitat. There was a concern raised regarding possible plutonium contamination of the livestock.

Low-Intensity Recreation. Commenters gave a variety of views regarding recreation. Boat launches were generally supported, although a boat launch at White Bluffs drew comments for and against. Two commenters opposed any recreation at the Hanford Site. Several expressed the view that only non-motorized vehicles or recreation be allowed on constructed trails, while others supported access for limited recreation such as campsites for paddlers and access for kayakers and rafters.

High-Intensity Recreation. Most of the commenters who expressed views on High-Intensity Recreation were in support of the B Reactor Museum. Some commenters were opposed to any High-Intensity Recreation on the Hanford Site.

Research and Development. Letters received on this land-use designation cited the need for restricting or prohibiting research and development, using only the 300 Area, LIGO, and FFTF, for example.

Industrial. Some commenters addressing this topic recommended limiting industrial development to the 300 Area and 1100 Area, or areas near the Tri-Cities, which would support the industry with infrastructure. A few commenters were against any industrial development at Hanford, while some expressed that timing was important, with cleanup of the site first, then development.

Industrial-Exclusive. Several commenters stated that the area designated for Industrial-Exclusive land use should be reconfigured to represent what was shown in Alternatives One and Two.

Agriculture. Ninety percent of the more than 200 commenters addressing Agriculture were opposed to any agriculture on the Hanford Site, citing the possible endangering of the health of the Columbia River from irrigation runoff, the potential damage to the White Bluffs from irrigation, the need for preservation of the shrub-steppe habitat for wildlife, and the possibility that agriculture on the Hanford Site would be bad, perceptually, for all Washington State agriculture. The commenters in support cited the need to support world food production, schools, and the rural area in Grant County.

Policy. Several letters were received addressing payment in lieu of taxes (PILT), expressing support for DOE to give Grant County PILT; others would like the PILT based on lost opportunity instead of current land use. Commenters also reiterated the need for continuation of the cleanup mission, the need to consider human health and safety, and the need to better address environmental justice by expanding farming opportunities on the Wahluke Slope.

Procedure. Several letters addressed the membership of the Site Planning Advisory Board, wanting to add regulators and Tribes as sovereign nations, and to limit counties involvement. Several commenters expressed the opinion that the Secretary's announcement in April 1999 of the DOE's Preferred Alternative prejudiced the outcome. Commenters also wanted a document name change, a change in timing, and cultural reviews and natural resources for land-use planning.

Plan. Some commenters addressed the comprehensive land-use plan, citing a variety of items. These included the concern that "management by committee" is too risky, thanking the DOE for keeping an open process, lack of impacts from industrial development, the recommendation that planning should be seven generations out, and concerns regarding the sensitivity of LIGO to noise and vibration.

Public Involvement. Several letters cited the commenter's appreciation for the opportunity to comment, positive feedback on multiple public hearings, and complimented DOE and the Cooperating Agencies on the quality of the document and the work that went into preparing the document.

Salmon and Steelhead. All letters addressing salmon were in support of protection of salmon and salmon habitat and salmon recovery efforts, and this extended to other anadromous fish, such as steelhead, as well.

Hanford Reach. More than 100 letters were received supporting protection of the Hanford Reach, citing the importance of the salmon spawning habitat and the welfare of the eagles and other wildlife that eat the salmon. Concern was expressed for the erosion of the White Bluffs, and the effects of regional agricultural growth on spawning habitat.

Tribal Rights. Several commenters expressed their concern that Tribal rights be honored by the DOE. Many expressed an opinion that no grazing of any type should be allowed on the

Hanford Site. Also supported was the protection of cultural and religious sites, working with the Yakama Indian Nation, and consideration of an option to deed stewardship back to the Tribes.

Wild and Scenic River. Several commenters supported a Wild and Scenic River designation for the Columbia River flowing through the Hanford Reach, citing protection of the river and the riverbanks. A few of those opposed the designation were concerned for future local needs, such as water rights.

Habitat. Many commenters were in favor of setting aside land for conservation and preservation of habitat, noting that the wildlife needs protection. Many of the commenters mentioned the valuable shrub-steppe habitat, which is home to many species, including the sage sparrow, desert butterflies, and species of snakes, other reptiles, and amphibians. A few commenters did not support wildlife habitat, noting that shrub-steppe is only weeds, or that wildlife can coexist with farming.

Wahluke Slope. Many commenters addressed the Wahluke Slope, with more than half against any farming there. Other commenters supported farming, or an impartial study of all the potential uses of the land.

Split Record of Decision. Over 180 commenters supported a split ROD in the interest of moving the designation of a wildlife refuge forward, without waiting for cleanup of the site to be completed.

1.2.7 Summary of Changes Made in Response to Public Comment

Based on the public comment received, the following changes have been made to the DOE's Preferred Alternative:

- All Conservation (Mining and Grazing) has been changed to Conservation (Mining).
- The National Wildlife Refuge designation (from Alternative One) has been extended to include the ALE Reserve, the Riverlands, and McGee Ranch; and all river islands not in Benton County. The Preferred Alternative clarifies that the refuge would be an overlay wildlife refuge (without a transfer of title from DOE), and that DOE retains the right to mine the ALE insert for cover materials.
- A railroad right-of-way through the Riverlands portion of the proposed Refuge would be given status as a preexisting condition and included in the proposed USFWS permit to manage the Refuge.
- The White Bluffs town-site (from Alternatives One and Three) has been added to the Preferred Alternative map as Low-Intensity Recreation to serve as the White Bluffs Memorial.
- The Low-Intensity Recreation dots (comfort stations) along the river which could eventually serve as anchor points for a river trail from Richland to Vernita Bridge have been moved to ensure that they have both river and road access.
- A High-Intensity Recreation triangle (from Alternative Three) has been added to the Preferred Alternative map near Horn Rapids Park on the Yakima River.

In addition to changes made to the Preferred Alternative, and the identifying of Alternative One as the environmentally preferable alternative, many other changes were made to the document updating items, refining analyses, and correcting errors.

1.2.8 *Biodiversity in the National Environmental Policy Act Process*

In January 1993, the CEQ issued a report titled, *Incorporating Biodiversity Considerations Into Environmental Impact Analysis Under the National Environmental Policy Act* (CEQ 1993). This report was designed with the following objectives:

- Provide an overview of major issues related to biodiversity
- Outline general concepts regarding biodiversity analysis and management
- Describe how biodiversity is addressed in NEPA analyses
- Provide options for agencies undertaking NEPA analyses that consider biodiversity.

The CEQ report indicated that physical alteration, as a result of changing land use, is the most profound cause of biodiversity loss. When natural, undisturbed lands (resembling much of the land at the Hanford Site) are converted to industrial, residential, agricultural, or recreational uses, ecosystems are disrupted and biodiversity is diminished. The CEQ report further states that, "Beyond the direct removal of vegetation and natural landforms in local areas, development of sites for human use fragments larger ecosystems and produces isolated patches of natural areas. Activities such as timber harvesting and grazing also may fragment natural areas, but more important, they result in simplification of ecosystems."

On February 11, 1999, the President issued Executive Order 13112, *Invasive Species*, intended to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts caused by invasive species. The Order, which is applicable to each Federal agency whose actions may affect the status of invasive species, establishes an Invasive Species Council made up of the Secretaries of various Federal agencies, and also calls for the formation of a stakeholders' Invasive Species Advisory Committee to provide information and advice to the Council.

Each disturbance factor on a given tract of land weakens the native plant community, causing potentially catastrophic and accelerated change in landscape components. Therefore, any activity proposed for a site that disturbs the vegetation and soil surfaces of that site should be examined for its effect on invasive weeds and consequences to site biodiversity. If such disturbance activities do occur, it is important to consider how the effects of the disturbance would be managed, before the action takes place. Specific actions can be taken to help prevent the introduction and/or spread of invasive weeds onto the Wildlife Refuge areas of the Hanford Site. For example, equipment being moved onto the Refuge could be steam-cleaned and washed free of vegetation and soil debris at an offsite location before being placed onsite to remove invasive plant seeds and reproductive parts. Additionally, Hanford road activity should be monitored and immediate management action should be taken, when necessary, to prevent invasive species from becoming established along roadsides.

It is the goal of DOE to ensure that the Hanford Site lands are managed in a way that allows biodiversity to be considered prior to finalizing any land-use or land-management decision. To further the biodiversity goal, DOE contacted the Interior Columbia Basin

Ecosystem Management Project (ICBEMP)[1], and provided the Geographic Information System (GIS) database developed for this EIS as a contribution to that project.

1.2.9 Environmental Justice in the National Environmental Policy Act Process

On February 11, 1994, the President of the U.S. issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.* This Executive Order mandates each Federal agency to make environmental justice part of the agency mission. To the greatest extent practicable and permitted by law, Federal agencies must identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations.

As stated in the President's February 11, 1994, memorandum to Heads of Agencies that accompanied the Executive Order, "Each Federal agency shall analyze the environmental effects, including human health, economic, and social effects, of Federal actions, including effects on minority communities and low-income communities, when such analysis is required by NEPA. Mitigation measures outlined or analyzed in an environmental assessment, EIS, or ROD, whenever feasible, should address significant and adverse environmental effects of proposed Federal actions on minority communities and low-income communities." The memorandum and Executive Order ensure that minority and low-income communities will have a voice in the development and implementation of any Federal action that might adversely affect those communities.

In addition, the memorandum and Executive Order indicated that all Federal agencies were to be proactive in identifying and, to the extent practicable, mitigating any potential disproportionately high and adverse impacts on minority and low-income communities that could result from proposed Federal actions. In order to implement the provisions of Executive Order 12898, the *U.S. Department of Energy Environmental Justice Strategy* (DOE 1995a), was prepared. Guidance provided in this publication, as well as CEQ's *Environmental Justice Guidance under NEPA* (March 1998) and EPA's *Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses* (April 1998), were used to the extent practicable in the HRA-EIS.

1.3 National Environmental Policy Act and Other Environmental Reviews

Past land-use commitments, based on other NEPA documents, as well as CERCLA RODs addressing remediation, have had a direct impact on the development of the land-use alternatives presented in this Final HCP EIS. Table 1-1 summarizes the Hanford-related EISs and RODs and shows the relationships these documents have to land-use planning. Table 1-2

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[1] The Interior Columbia Basin Ecosystem Management Project is a Federal land- and ecosystem-management plan commissioned in 1993. The plan affects 100 counties in seven states (including all of eastern Washington and eastern Oregon), and includes more than nearly 22 million ha (54 million ac) of private property. Federal agencies involved are the BLM, National Marine Fisheries Service, Forest Service, and the EPA. Much of the plan deals with water. The plan also proposes aggressive ecosystem restoration practices in order to better control fire, insect outbreaks, and noxious disease spread. Over 75,000 comments (mostly form letters) have been received on the project. In June 1998, the U.S. House Appropriations Subcommittee on the Interior said that ICBEMP should be stopped, its field offices closed, and its studies turned over to the appropriate Federal agencies (TCH 1998a). If the project is stopped, either by Congressional action or lack of funding, the thousands of pages of studies and ideas that have been produced by the project will be given to Federal land management agencies such as the Forest Service.

summarizes the regional *State Environmental Policy Act of 1971* (SEPA) EISs. Table 1-3 summarizes CERCLA RODs.

The restrictions posed by approved CERCLA RODs were taken into consideration in the development of the land-use alternatives in this Final HCP EIS. Conversely, the land-use alternative selected for implementation in the ROD for this EIS would be useful for remediation decisions yet to be made in other areas of the Hanford Site. The EPA, Ecology, and DOE consider land-use designations in a given area when determining cleanup levels. If the desired "highest and best use" land use cannot be attained because of remediation-linked technical or economic constraints, or if the remedial action required to achieve that land use would cause unacceptable-unavoidable impacts, then the land use designation of this EIS would be amended using the policies and implementing procedures in Chapter 6 to the next "highest and best use" land use. If required by the CERCLA ROD/RCRA Permit, a deed restriction would be filed with the local land-use jurisdictional agency to conditionally implement the land use.

1.3.1 Interim Actions

During the preparation of this EIS, several outside parties have made proposals to DOE regarding future uses of portions of the Hanford Site. Such proposals undergo NEPA review to determine whether they are major Federal actions, or if they have significant environmental impacts that would require preparation of EISs. This is consistent with the CEQ's regulation in 40 CFR 1506.1(b), "Limitations on Actions During the NEPA Process."

The Hanford 1100 Area and the Hanford railroad southern connection (from Horn Rapids Road to Columbia Center) have been transferred from DOE ownership to Port of Benton ownership in order to support future economic development. Land use of the 1100 Area and the railroad southern connection would remain Industrial, as proposed in all alternatives of this EIS. The DOE prepared an environmental assessment that resulted in a finding of no significant impact (FONSI) on August 27, 1998, transferring the 1100 Area and the Southern rail connection to the Port of Benton (DOE/RL EA-1260). The Port officially took ownership and control of the "1100 Area" (consisting of 318 ha [786 ac], 26 buildings, and 26 km [16 mi] of rail tract) on October 1, 1998, and is currently studying the feasibility of reconnecting the Hanford main rail line to Ellensburg, Washington, as it was in the 1970s, as an alternative route for Yakima Valley rail traffic flowing between the Puget Sound and the Tri-Cities. Although the 1100 Area is no longer under DOE control, it is included in this EIS to support the local governments with their SEPA EIS analyses of the Hanford sub-area of Benton County under the State of Washington's Growth Management Act.

Energy Northwest (formerly known as the Washington Public Power Supply System, or WPPSS) has requested DOE approval of a sublease of a portion of the land they lease from DOE north of the 300 Area. This sublease would be for siting, construction, and operation of an aluminum smelter. Land use of the Energy Northwest-leased land would remain Industrial, as proposed in all alternatives of this EIS. The environmental effects of the proposed sublease and aluminum smelter were being considered in DOE/EA-1259, which was suspended due to lack of response from the proponents.

Table 1-1. NEPA Reviews Affecting the Hanford Site. (5 pages)

NEPA EISs	Purpose	Status	Potential Mission Impacts on Hanford	Relationship to Land-Use Planning
Double-Shell Tanks for Defense High-Level Radioactive Waste Storage, Hanford Site, Richland, Washington (DOE/EIS-0062, April 1980)	To complete construction and operation of 13, 1-million gallon double-shell waste tanks. These tanks would be used to manage defense high-level radioactive wastes resulting from the chemical processing of spent nuclear fuel in the 200 East Area.	The ROD was published in the *Federal Register* on July 9, 1980.	The double-shell tanks were constructed and are currently in operation.	Committed the 200 Areas to continued Waste Management (Industrial-Exclusive use).
Decommissioning of the Shippingport Atomic Power Station, Hanford Site, Richland, Washington (DOE/EIS - 0080, May 1982)	Dismantle and remove all fluids, piping, equipment, components, structures, and waste to a waste disposal facility.	The ROD was published in the *Federal Register* on August 19, 1982.	The Shippingport Atomic Power Station Waste was disposed at the Hanford Site.	Committed the 200 Areas to continued Waste Management (Industrial-Exclusive use).
Operation of PUREX and Uranium Oxide Plant Facilities, Hanford Site, Richland, Washington (DOE/EIS - 0089, February 1983)	This EIS analyzed the environmental effects of DOE's proposal to resume operations of the PUREX and Uranium Trioxide chemical processing plants.	The ROD was published in the *Federal Register* on May 16, 1983.	In 1990, DOE determined that the PUREX Facility would no longer operate. The plant has been shutdown, deactivated, and readied for decontamination and decommissioning (D&D). Operation up until 1990 resulted in discharge of liquid effluents to the ground in the 200 East Area.	Committed the 200 Areas to continued Waste Management (Industrial-Exclusive use).
Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes, Hanford Site, Richland, Washington (DOE/EIS-0113, December 1987)	Examined the potential impacts for final disposal of existing high-level, tranuranic, and tank waste stored at the Hanford Site.	The ROD was published in the *Federal Register* on April 14, 1988.	Committed to dispose of double-shell tank waste, cesium and strontium capsules, retrievably stored and newly generated transuranic waste in the 200 Areas. Also committed to construct and operate facilities associated with high-level waste vitrification; construct and operate the WRAP facility for transuranic soil waste, and a grout facility for LLW.	Committed to Waste Management (Industrial-Exclusive use) in the 200 Area. Many of the tank waste issues were superseded by the *Tank Waste Remediation System EIS* (DOE/EIS-189).
Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington (DOE/EIS-0119, December 1991)	Evaluated decommissioning alternatives for the eight surplus plutonium production reactors at the Hanford Site.	The ROD was published in the *Federal Register* in September 1993.	The DOE determined that the reactor blocks for the eight plutonium reactors will be kept at their present sites for up to 75 years until their radiation level lowers through natural decay. The reactor blocks would then be moved to the 200 Areas for burial.	Commits to restrictive land use of the 100 Areas surrounding the reactors until 2068. Constitutes a future committed land use, Waste Management (Industrial-Exclusive use), for the 200 Areas.

Table 1-1. NEPA Reviews Affecting the Hanford Site. (5 pages)

NEPA EISs	Purpose	Status	Potential Mission Impacts on Hanford	Relationship to Land-Use Planning
Columbia River System Operation Review Environmental Impact Statement (DOE/EIS-0170, November 1995)	To develop Bureau of Reclamation (BoR), U.S. Army Corps of Engineers (USACE), DOE, and Bonneville Power Administration (BPA) management strategy for multiple uses of the Columbia River System.	The ROD was approved on March 10, 1997. This was prepared by the BPA, USACE, and the BoR.	May control Columbia River flows.	May limit land use along the Columbia River (Low-Intensity Recreation use).
Tank Waste Remediation System, Hanford Site, Richland, Washington (DOE/EIS-0189, August 1996)	This EIS addressed management and disposal of the contents of 177 high-level radioactive waste tanks and cesium and strontium capsules.	The ROD was published in the *Federal Register* on February 27, 1997.	The DOE would implement the preferred alternative to retrieve, separate, vitrify, and dispose of the tank waste. The low-level fraction of the separation process would be disposed of onsite in subsurface vaults. The high-level fraction would be disposed of offsite at the potential geologic repository. A decision on the cesium and strontium capsules was deferred.	Commits the 200 Areas to Waste Management (Industrial-Exclusive use) during the retrieval, separation, and vitrification process. It also constitutes a long-term commitment of the 200 Areas for onsite disposal of LLW.
Waste Management Programmatic Environmental Impact Statement (DOE/EIS-0200, May 1997)	This EIS is a nationwide study that examines the management of five types of radioactive and hazardous waste: tranuranic, hazardous waste, high-level waste, and low-level and low-level mixed waste.	*Federal Register* notice announcing change in scope of PEIS (narrowing to Waste Management alternatives) 1/24/95. Eleven regional public hearings held on DEIS (10/17-11/14/95). Public comment period extended through 2/19/96. ROD for treatment and storage of tranuranic waste (63 FR 3629, 1/23/98). ROD for treatment of non-waste water hazardous waste (63 FR 41810, 8/5/98). ROD for storage of High-level Radioactive Waste (64 FR 46661, 8/26/99. Planning additional RODs.	Alternatives considered include centralizing or regionalizing the waste at one or two sites. Those sites that have the largest volumes of a given waste type generally were considered as sites for treatment, storage, or disposal.	A decision to centralize the waste could commit the 200 Areas to Waste Management (Industrial-Exclusive use).

Table 1-1. NEPA Reviews Affecting the Hanford Site. (5 pages)

NEPA EISs	Purpose	Status	Potential Mission Impacts on Hanford	Relationship to Land-Use Planning
Idaho High Level Waste and Facility Disposition Environmental Impact Statement (DOE/EIS-0287)	This EIS is a site specific EIS tiering from the *Waste Management Programmatic Environmental Impact Statement* (DOE/EIS-0200, May 1997 and the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement* (DOE/EIS-203-F).	In preparation.	Calcined wastes would be shipped to Hanford for vitrification under an alternative in the EIS.	Area in the Central Plateau would be required to stage the wastes before and after treatment.
Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs (DOE/EIS-0203, April 1995)	EIS evaluated programmatic alternatives to managing spent nuclear fuel until 2035. This EIS did not evaluate the final disposition of the spent nuclear fuel.	The ROD was published in the *Federal Register* on June 2, 1995. An amended ROD was published in the *Federal Register* on February 28, 1996.	According to this ROD, Hanford production reactor fuel would remain at the Hanford Site pending ultimate disposition. Fast Flux Test Facility (FFTF) fuel will be sent to the Idaho National Engineering and Environmental Laboratory (INEEL). The amended ROD reduced the number of shipments of sodium-bonded fuel from Hanford to the INEEL from 524 to 12.	This decision commits to onsite storage of spent fuel in the 200 Areas until as late as 2035.
Safe Retrieval, Transfer and Interim Storage of Hanford Tank Wastes, Hanford Site, Richland, Washington (DOE/EIS-0212, October 1995)	EIS evaluated alternatives for addressing near-term safety issues in the Hanford Site priority watch list tanks. Accumulation of flammable gas in three tanks had been identified as a safety issue.	The ROD was published in the *Federal Register* on November 21, 1995.	Construction of a replacement Cross-Site Transfer System (pipeline) for moving waste from the 200 West Area to the 200 East Area. Construction of a waste retrieval system in one tank and continuation of mitigation actions to control flammable gas.	This decision creates infrastructure support to tank waste management in the 200 East Area, and commits the new cross-site transfer system pipeline (Industrial-Exclusive use).
Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement (DOE/EIS-0229, November 1996) *Surplus Plutonium Disposition Environmental Impact Statement* (DOE/EIS-0283)	DOE/EIS-0229 evaluated alternatives of facilities for plutonium disposition. Included conversion of bomb components into plutonium oxide, immobilization of surplus plutonium in glass, and mixed oxide fuel fabrication. Site-specific decisions would be made in DOE/EIS-0283.	The ROD for DOE/EIS-0229 was published in the *Federal Register* on January 14, 1997. The Notice of Intent for DOE/EIS-0283 was published in the *Federal Register* on May 18, 1997. The Draft EIS was released in July 1998, and a supplement to the Draft EIS was released in May,1999.	May result in plutonium or highly enriched uranium storage in the 200 West or 400 Areas. Under EIS-0283, the SRS is the site chosen for siting the facility for weapons-useable plutonium disposition.	The 400 Area would remain as Industrial use, with the exception of one to two buildings being used for nuclear materials storage (Industrial use).

Table 1-1. NEPA Reviews Affecting the Hanford Site. (5 pages)

NEPA EISs	Purpose	Status	Potential Mission Impacts on Hanford	Relationship to Land-Use Planning
Plutonium Finishing Plant Stabilization Environmental Impact Statement (DOE/EIS-0244, May 1996)	To reduce potential health risks and environmental risks associated with 3,800 kg (8,400 lbs) of plutonium within the Plutonium Finishing Plant.	The ROD was published in the *Federal Register* on July 10, 1996.	Stabilized forms of plutonium would be stored within vaults at the Plutonium Finishing Plant pending ultimate disposition.	Commits the 200 West Area to long-tem storage of plutonium and other transuranic materials (Industrial-Exclusive use).
Management of Spent Nuclear Fuel from the K Basins Hanford Site, Richland, Washington (DOE/EIS-0245, January 1996)	Evaluated alternatives for spent nuclear fuel stored in the 100-K Area Basins to reduce risk to public health and the environment.	The ROD was published in the *Federal Register* on March 15, 1996.	Irradiated fuel will be removed from 100 K-Basins, treated, and sealed in canisters and stored in the 200 Area. Sludge from the K Basins will be disposed of in existing double-shelled tanks or grouted and packaged for disposal in the 200 Areas.	Commits the 200 Area to the storage of the K Basin fuels and conversion of sludge. Future uses must accommodate restoration after 105-K fuel storage basins are remediated (Industrial-Exclusive use).
Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (DOE/EIS-0250) In preparation.	Would evaluate the suitability of a geologic repository (e.g., Yucca Mountain at the Nevada Test Site) for the disposal of commercial and defense high-level radioactive waste.	The Notice of Intent (NOI) was published in the *Federal Register* in August 1995. The Draft EIS was published in July 1999.	The Yucca Mountain site would accept up to 7000 metric tonnes (7,700 tons) of vitrified defense waste from Hanford and other DOE sites.	Until the Yucca Mountain facility is licensed by the Nuclear Regulatory Commission, high-level radioactive waste and spent nuclear fuel would be stored in the 200 Areas (Industrial-Exclusive use).
Disposal of Decommissioned, Defueled Cruiser, Ohio Class, and Los Angeles Class Naval Reactor Plants Environmental Impact Statement (Adopted by DOE as DOE/EIS-0259, April 1996)	Evaluated alternatives for the disposal of defueled reactor compartments from cruisers and submarines.	The ROD was published in the *Federal Register* on August 9, 1996.	Approximately 100 cruiser and submarine reactor compartments would be disposed of in a 70-ha (173-ac) waste disposal unit in the 200 East Area.	Commits the 200 East Area to Waste Management activities (Industrial-Exclusive use).
Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement (DOE/EIS-0286) In preparation.	To review ongoing and proposed waste management activities, to implement programmatic RODs that result from the *Final Waste Management Programmatic EIS (DOE/EIS-0200)*, and to facilitate decisions on the future operation of Hanford waste treatment, storage, and disposal facilities.	The NOI was published in the *Federal Register* on October 27, 1997. The scoping period closed January 30, 1998. In April 1998, DOE accepted the request of the Yakama Nation that they be co-preparers of the EIS. The Draft EIS is expected sometime in late 1999.	May result in unchanged, minimized, or maximized levels of waste storage, treatment, and disposal of low-level, low-level mixed, transuranic, and hazardous waste and contaminated equipment at Hanford.	Is expected to require continued use of the 200 Areas for Waste Management purposes (Industrial-Exclusive use).

Table 1-1. NEPA Reviews Affecting the Hanford Site. (5 pages)

NEPA EISs	Purpose	Status	Potential Mission Impacts on Hanford	Relationship to Land-Use Planning
Waste Management Operations, Hanford Reservation, Richland, Washington (ERDA-1538, December 1975)	To provide information for use in planning and decision making to ensure that future waste management practices would be conducted to minimize adverse environmental consequences.	Final EIS issued December 1975. Predates final Council on Environmental Quality (CEQ) NEPA regulations; therefore, ROD not required.	Reassessed the environmental impacts associated with continuing the Hanford Site Waste Management Operations Program to provide information for use in planning and decision making. Addressed waste generated by nuclear defense production, research and development, and other programs and activities at the Hanford Site. The high-level waste preferred alternative was to continue solidifying liquid tank waste to a salt cake form and construct additional double-shell tanks.	Committed portions of the 100, 200, and 300 Areas to continued Waste Management (Industrial-Exclusive use).
Bonneville Power Administration Transmission System Vegetation Management Program Draft Environmental Impact Statement (DOE/EIS-0285)	This DEIS establishes Planning Steps for managing vegetation across 24,000 km (15,000mi) of power lines and 350 substations in the northwest.	The Draft EIS was issued August, 1999 and public comment is open until October 9,1999.	Establishes BPA's vegetation management preferences across several areas of the Hanford Site. Noxious weeds and weed corridors are associated with access roads.	Would determine the available vegetation control techniques, herbicides used, and acceptable biological impacts.
Disposal of Decommissioned, Defueled Naval Submarine Reactor Plants (Lead Agency - Department of the Navy; DOE was a Cooperating Agency) (May 1984)	Evaluated disposition of defueled reactor compartments from decommissioned nuclear submarines. (See also DOE/EIS-0259.)	The ROD was published in the *Federal Register* in December 1984.	Land disposal of reactor compartments in the 200 East Areas	Committed the 200 East Area to Waste Management (Industrial-Exclusive use).
Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility (DOE/EIS-0310)	Would evaluate expansion of FFTF missions.	The Secretary decided on August 18, 1999, that the DOE would conduct a programmatic National Environmental Policy Act (NEPA) review, including an Environmental Impact Statement.	Potential environmental impacts associated with proposed expansion of infrastructure, including the possible role of the FFTF, for civilian nuclear energy research and development activities; production of isotopes for medical, research, and industrial uses; and production of plutonium-238 for use in advanced radioisotope power systems for future NASA space missions.	Proposed FFTF uses are compatible with Industrial or Research and Development land uses.
Hanford Reach of the Columbia River, Comprehensive River Conservation Study and Final Environmental Impact Statement (National Park Service, June 1994)	The Department of the Interior (DOI) and DOE evaluated alternatives for protecting and managing the Hanford Reach and environs of the Columbia River.	The ROD was approved in July 1996. Congressional action is required for the recommended Wild and Scenic River. The proposed National Wildlife Refuge could be established administratively.	Wild and Scenic designation (recreational) would eliminate certain land uses (residential, agricultural, and waste management) within the study area. Establishes wildlife and habitat management access for other areas.	Compatible land uses with the recommendation include: recreation, wildlife, and habitat management for the river corridor and areas north of the river (Low-Intensity Recreation use). Incompatible land uses include: industrial, waste management, agricultural, and grazing.

Table 1-2. SEPA Reviews Affecting the Hanford Site. (2 pages)

SEPA EISs	Purpose	Status	Potential Mission Impact on Hanford	Relationship to Land-Use Planning
Commercial Low-Level Radioactive Waste Disposal Site (U.S. Ecology) on the Hanford Site Environmental Impact Statement - In preparation.	To provide sufficient information to allow state agencies to make the following key decisions: approval of a site closure plan, renewal of the operating license, and an amendment to the regulations limiting the receipt of naturally occurring and accelerator-produced radioactive materials (NARM).	The lead agencies are the Washington Department of Ecology (Ecology) and the Washington Department of Health (DOH). Public scoping - February 1997 through March 27, 1997. A public meeting was held March 5, 1997 at Ecology's office in Kennewick, Washington. Ecology and Health have invited DOE Richland Operations Office (RL) to consult with them on issues, concerns, and potential impacts that should be considered in the EIS. The three agencies met on March 25, 1997, and on April 8, 1997, RL sent a response letter to DOH and Ecology outlining DOE's issues and concerns, and RL's role.	May allow additional amounts of low-level radioactive wastes and NARM to be disposed in the Central Plateau at the privately owned US Ecology site, which was leased by the State from the Federal government.	Expected to continue to require waste management in the 200 Areas (Industrial-Exclusive use).
City of Richland Comprehensive Plan/EIS (August, 1997)	When adopted, the Comprehensive Plan will include the mandated elements on land use, housing, transportation, capital facilities, and utilities, with an optional element on economic development.	The lead agency is the City of Richland. The Final EIS was issued on August 27, 1997.	The City of Richland's Comprehensive Plan is consistent with current and proposed land uses at Hanford and DOE missions.	The City of Richland's Comprehensive Plan addresses land use within the City boundary, and zones land within the City of Richland's urban growth area that extends into the 300 Area of the Hanford Site (Industrial use).
SEPA EIS on Treatment of Low-Level Mixed Wastes (ATG) City of Richland EIS (EA6-97, March 1998)	ATG proposes to build a gasification and vitrification treatment, storage and disposal (TSD) facility in Richland, Washington.	The Final SEPA EIS was issued on March 9, 1998.	Effect of construction and overall operation of the building was evaluated under SEPA. The action would be undertaken as a private action in anticipation of future work for a variety of contracts, including DOE. ATG may proceed with the facility whether or not the Hanford Site low-level mixed waste is included.	A mixed waste TSD facility would be built in an area which is outside of, but in close proximity to the Hanford Site boundary. A TSD facility is a compatible land use under the Heavy Industrial land-use designation in the City of Richland's Comprehensive Plan. The Hanford CLUP does not have a Heavy Industrial land-use designation.

Table 1-2. SEPA Reviews Affecting the Hanford Site. (2 pages)

SEPA EISs	Purpose	Status	Potential Mission Impact on Hanford	Relationship to Land-Use Planning
Draft Benton County Comprehensive Plan (SEPA EIS Addendum) (September 1997)	To revise the Benton County Comprehensive Plan in accordance with the *State Growth Management Act* and SEPA. The Comprehensive Plan is being updated to address land-use planning for all of Benton County, including the portion of the Hanford Site that lies within Benton County. The Comprehensive Plan includes an addendum to the Final SEPA EIS, dated March 1981, prepared for the 1985 Benton County Comprehensive Plan. Detailed planning for the Hanford sub-area was not included in the 1985 plan.	The Final HCP EIS would provide the basis for the Benton County SEPA review for the Hanford sub-area plan of the Benton County Comprehensive Plan. The lead agency is Benton County.	The Benton County Comprehensive Plan will not affect DOE missions at Hanford while DOE retains management of the Site. If, however, land is turned over to state or local governments, such as the Port of Benton, then the stipulations identified in the Benton County Comprehensive Plan would apply. Such transfers might help to fulfill DOE's mission of economic transition and diversification of the local economy.	The Benton County Comprehensive Plan addresses land uses for the County, including the portion of the Hanford Site that lies within Benton County (Industrial, Industrial-Exclusive, Research and Development, High-Intensity Recreation, and Low-Intensity Recreation use). The 1100 Area and 300 Area would remain in an Industrial use designation. The HCP EIS could fulfill the SEPA requirements for the Counties and, as cooperating agencies, they could identify another alternative as their Preferred Alternative.

SEPA = *State Environmental Policy Act of 1971*

Table 1-3. CERCLA Reviews Affecting the Hanford Site.

CERCLA RODs	Purpose	Status	Potential Mission Impact on Hanford	Relationship to Land-Use Planning
1100 Area	Remediation of the 1100 Area and scattered other waste sites still within the southern portion of the Hanford Site.	1100-EM-1, 1100-EM-2, 1100-EM-3, and 1100-IU-1 - Final Record of Decision (ROD) issued September 24, 1993. Certified remedial action - July 1996 Delisted from National Priorities List	1100 Area remediated and available for other compatible uses.	Institutional controls required to prevent disturbance of the asbestos landfill barrier and groundwater. A deed restriction for the Horn Rapids asbestos landfill has been filed with the Benton County Auditor's Office. Industrial-Exclusive equivalent land-use designation.
300 Area	Remediation of the 300 Area	300-FF-1, 300-FF-5 - Final ROD issued July 17, 1996. Remedial Investigation/Feasibility Study (RI/FS) for NPL Site - to be completed after all operable units are addressed.	Remediation would allow industrial use.	Institutional controls required to prevent disturbance of soil below 15 ft and groundwater. Restricted subsurface and groundwater use. Industrial-Exclusive equivalent land-use designation.
100 Area	Remediation of the 100 Areas	100-BC-1, 100-HR-1, and 100-DR-1 - Interim ROD for 37 high-priority waste sites issued September 1995. The ROD was amended May 14, 1997, to include additional waste sites. 100-HR-3/100-KR-4 (Groundwater OUs) - Interim ROD April 1, 1996 100-IU-1, 100-IU-3, 100-IU-4, 100-IU-5 - Interim ROD issued February 12, 1996. RI/FS for NPL Site - to be completed after all operable units are addressed.	100 Areas to be remediated to allow unrestricted residential use: - Unrestricted surface use - Restricted subsurface and groundwater use - Support facilities for groundwater pump-and-treat remediation systems must be maintained.	Institutional controls required to prevent disturbance of soil below 15 feet and groundwater. A deed restriction has been filed for the 183-H Solar Basin RCRA closure with the Benton County Auditor's Office. Industrial-Exclusive equivalent land-use designation. Restricted subsurface and groundwater use.
200 Areas	Remediation of the 200 Areas	Environmental Restoration Disposal Facility - Final ROD issued January 1995. 200-ZP-1 (Groundwater OU) - Interim ROD issued June 5, 1995. 200-UP-1 (Groundwater OU) - Interim ROD issued February 24, 1997. RI/FS for NPL Site - to be completed after all operable units are addressed.	200 Areas to be remediated to industrial-exclusive use. Support facilities for groundwater pump-and-treat remediation systems must be maintained.	Institutional controls required to prevent disturbance of barriers and groundwater. Restricted surface, subsurface, and groundwater use. A deed restriction has been filed for an asbestos trench in the Central Waste Landfill with the Benton County Auditor's Office. Industrial-Exclusive equivalent land-use designation.

1.4 Hanford Site Planning Efforts

1.4.1 Hanford Site Planning Documents

Several Hanford Site planning documents have been developed to address the various information needs of DOE managers. These planning documents are periodically updated to reflect new information and DOE decision making, such as the decision(s) DOE will make based on this Final HCP EIS. Summarized below these planning documents are:

- Draft *Hanford Cultural Resources Management Plan* (CRMP) (DOE-RL 1999)
- Draft *Hanford Biological Resources Management Plan* (BRMaP) (DOE-RL 1996c)
- *Hanford Strategic Plan* (DOE-RL 1996b)
- *Accelerating Cleanup: Paths to Closure at the Hanford Site* (DOE 1998)
- *Hanford Site Ground-Water Protection Management Plan* (DOE-RL 1995c)
- *Management and Integration of Hanford Site Groundwater and Vadose Zone Activities* (DOE-RL 1998).

The CRMP establishes guidance for the identification, evaluation, recordation, curation, and management of archaeological, historic, and traditional cultural resources. The plan specifies methods of consultation with affected Tribes, government agencies, and interested parties; and includes strategies for the preservation and/or curation of representative properties, archives, and objects. This plan is currently being revised with the active participation of affected Tribes and government agencies.

The BRMaP provides DOE and DOE contractors with a consistent approach for protecting biological resources and for monitoring, assessing, and mitigating impacts to biological resources from site development and environmental restoration activities. Primarily, the BRMaP supports DOE's Hanford missions; provides a mechanism for ensuring compliance with laws protecting biological resources; provides a framework for ensuring that appropriate biological resource goals, objectives, and tools are in place to make DOE an effective steward of the Hanford biological resources; and implements an ecosystem management approach for biological resources on the Site. The BRMaP provides a comprehensive direction that specifies DOE biological resource policies, goals, and objectives.

Hanford Strategic Plan

The 1996 *Hanford Strategic Plan* identifies six critical success factors to achieve the Hanford vision and missions. It will be periodically updated.

Protect worker safety and health
- reduce accidents and radiological exposure
- achieve voluntary protection program "star" status

Protect public health and the environment
- reduce or eliminate emissions and effluents
- regulatory and Tri-Party Agreement compliance

Manage Hanford to achieve progress
- projectize Hanford for clear management accountability, responsibility, and authority
- establish and control project baselines
- link key performance measures to results
- maintain a well-trained and qualified workforce

Optimize the Hanford Site infrastructure
- develop cost-competitive infrastructure commensurate with mission needs
- involve staff and community in the outsourcing process

Contribute to economic diversification
- blend economic diversification strategies with all Hanford activities and contractors
- involve local community and leaders in projects

Build and strengthen partnerships for progress
- include American Indian Tribes, regulators, and stakeholders in planning processes
- champion the public's right to know with prompt, accurate information

The *Hanford Strategic Plan* is a planning document that articulates DOE's current vision and commitments to a long-range strategic direction for the Hanford Site missions (see text

box, *"Hanford Strategic Plan"* on previous page). Decisions and actions are made using NEPA, CERCLA, RCRA, and recognized processes as appropriate.

A revision of the *2006 Plan*, the *Accelerating Cleanup: Paths to Closure at the Hanford Site* builds on an already accelerated pace of activities and numerous efficiencies implemented at the Hanford Site during the last few years. It commits to significant cleanup progress on the Site by 2006, while recognizing that much cleanup effort will remain beyond 2006.

The *Hanford Site Ground-Water Protection Management Plan*, and the *Management and Integration of Hanford Site Groundwater and Vadose Zone Activities* documents both provide management and protection guidelines to protect groundwater from radioactive and nonradioactive hazardous substances.

This Final HCP EIS builds on these past planning efforts to address land-use planning at the Hanford Site and presents a range of alternative land uses that represents different visions.

1.4.2 Integrating Planning Efforts by Other Governments and Agencies

This section includes information supplied to DOE by representatives of other governments and agencies about their respective planning efforts. The concept of "agreeing to disagree" on issues such as Tribal members' treaty rights allowed the agencies to set aside differences and work together on the land-use planning process.

1.4.2.1 Tribal Rights. Tribal governments and DOE agree that the Tribal members' treaty-reserved right of taking fish at all "usual and accustomed" places applies to the Hanford Reach of the Columbia River where it passes through Hanford.

Tribal governments and DOE, however, disagree over the applicability of Tribal member's treaty-reserved rights to hunt, gather plants, and pasture livestock on the Hanford Site. The Tribal governments and DOE have decided not to delay completion and implementation of a comprehensive land-use plan for the Hanford Site. Instead, the Tribes and DOE have gone ahead with the land-use planning process while reserving all rights to assert their respective positions regarding treaty rights. Neither the existence of this EIS nor any portion of its contents is intended to have any influence over the resolution of the treaty rights dispute.

1.4.2.2 Other Federal Agencies. In 1943, the USACE began the acquisition of the Hanford Site. Public land managed by the BLM was withdrawn from BLM and placed under DOE control by a land withdrawal order. The BoR land was placed under DOE control by a memorandum of agreement and, finally, land was purchased (sometimes via condemnation) from private owners. Today, DOE continues to manage these acquired lands, which form a checkerboard pattern of underlying ownership over large portions of the Hanford Site (for additional information, see Section 4.1.3).

The BLM and BoR continue to retain an interest in their original property holdings prior to the establishment of the Hanford Site. The DOE must use the land consistent with the purposes for which they were originally acquired from BLM and BoR. Any other use of these lands by DOE requires BLM and BoR involvement. The BLM is responsible for administering Public Domain land. The BoR is responsible for the ultimate development of the irrigable lands within the Wahluke Slope as part of the Columbia Basin Reclamation Project. Both the BLM and BoR have an interest in the Hanford resources and in management of those resources over the long term. When DOE relinquishes its withdrawals on these lands, the BLM and/or BoR would have the right of first refusal to the land. The BLM would examine the lands for

current uses and suitability for return to the Public Domain. Depending upon condition, and after public involvement, suitable lands could be retained and designated for a special protective classification, recreational use, multiple use management, exchange, etc. If unsuitable, then DOE or the Federal General Services Administration (GSA) would have the responsibility to dispose of the land.

In addition to BoR's irrigation system maintenance activities, DOE lands on the Wahluke Slope, have been managed in part by the Washington Department of Fish and Wildlife (WDFW) as the Wahluke State Wildlife Recreation Area and, in part, by the USFWS as the Saddle Mountain National Wildlife Refuge. In April 1999, the WDFW and the USFWS notified the DOE of their intent to modify their management responsibilities on the Wahluke Slope under the 1971 agreement. The USFWS informed the DOE that it intends to allow essentially the same uses permitted by the State of Washington under the WDFW's management of the Wahluke Slope. Therefore, transfer of management of the Wahluke Slope from the WDFW to the USFWS involves only a change in the agency managing the property and does not involve any change in the management activities for the Wahluke Slope. Management of the entire Wahluke Slope by the USFWS as an overlay wildlife refuge is consistent with the 1996 DOI Hanford Reach EIS ROD. The ROD recommended the Wahluke Slope be designated a wildlife refuge and the Hanford Reach a Wild and Scenic River, and that the wildlife refuge be managed by the USFWS.

The USFWS is managing the Fitzner/Eberhardt Arid Lands Ecology Reserve (ALE Reserve) under a cooperative agreement with DOE that was signed on August 27, 1997. The USFWS is currently preparing a Comprehensive Conservation Plan (CCP) (equivalent to an area management plan [AMP]; see Chapter 6) for the ALE Reserve.

Aside from BoR, BLM, and the USFWS current management responsibilities, the U.S. National Park Service (NPS) has, with DOE as a co-preparer, completed an EIS for the Hanford Reach of the Columbia River in 1994. The *Hanford Reach of the Columbia River, Comprehensive River Conservation Study and Final Environmental Impact Statement* (Hanford Reach EIS) (NPS 1994) examines alternatives for preservation of the resources and features of the Hanford Reach (including addition of the Hanford Reach to the National Wild and Scenic Rivers System), and evaluates impacts that could result from various uses of the river. The DOI's ROD (NPS 1996) recommends that the Congress designate federally owned and privately owned lands within 0.4 km (0.25 mi) of the Columbia River, on both banks from river mile 396 to 346.5 as a Recreational River under the Wild and Scenic Rivers System; and that the portion of the Hanford Site that lies north of the river be designated as a National Wildlife Refuge managed by the USFWS. Congress is still contemplating actions that are necessary to implement the DOI's ROD.

In addition to the proposed wild and scenic discussions, other discussions have occurred to transfer administrative jurisdiction over certain parcels of land in the State of Washington from the Secretary of Energy to the Secretary of the Interior, affecting ownership of about 19,943 ha (49,280 ac, 197 km^2, 75 mi^2) of the Hanford Site. This swap would consolidate the scattered Benton County portion of Hanford's BLM Public Domain lands, into an area beginning near 100-D, running south and east along the Columbia River shore, to just north of Energy Northwest (formerly known as WPPSS) and then west to Gable Mountain.

As long as these lands are needed by DOE (i.e., still withdrawn from the BLM by DOE), this legislative action would not affect DOE's administration of the areas involved (see Figure 4-3). The DOE's use of withdrawn BLM Public Domain lands is consistent with most land-use designations with the exceptions of Industrial Exclusive, Research and Development, High-Intensity Recreation, or Industrial designations where BLM's multiple-use mandate would be limited by an extensive infrastructure.

1.4.2.3 Local Governments. Portions of the Hanford Site lie within Benton, Franklin, Adams, and Grant counties. The primary contaminated portion of the Site falls within Benton County, and parts of the Wahluke Slope fall within Franklin, Grant, and Adams counties. The City of Richland abuts the southern boundary of the Hanford Site in Benton County. The City of Richland's urban growth area (UGA) extends into the Hanford Site's 300 Area and considerable development within the city limits and adjacent to the Site has already occurred.

Most planning by local governments falls under the *State of Washington Growth Management Act of 1990* (GMA), which established a statewide planning framework and created roles and responsibilities for planning at the local, regional, and state level. The GMA requires the largest and fastest growing counties (counties with more than 50,000 people or population growth of more than 20 percent in the past 10 years), and cities within those counties to develop new comprehensive plans. Counties not required to plan under the GMA may elect to do so. Benton, Franklin, and Grant counties, along with the City of Richland, have elected to plan under the GMA requirements.

Under the GMA, any county or city that implements the GMA is required to: (1) have the county legislative authority adopt a county-wide planning policy under the *Revised Code of Washington* (RCW) 36.70A.210; (2) have the county and each city located within that county adopt development regulations conserving agricultural lands, forest lands, mineral resource lands, and critical areas which must be designated by the local government within one year of the date the county legislative authority adopts its resolution of intention; (3) have the county designate the UGAs in cooperation with each city under RCW 36.70A.110; and (4) have the county and each city located within the county produce a comprehensive plan and development regulations within four years of the county announcing its intention to plan.

1.4.2.3.1 Benton County. The relationship between DOE and Benton County differs from DOE's relationship to other counties with an interest in Hanford because most of the Hanford Site is located within Benton County. As a cooperating agency, Benton County does not agree with the Tribal view that Hanford lands are "open and unclaimed." Benton County is preparing a comprehensive land-use plan that covers the entire county, which includes a portion of the Hanford Site. The DOE is committed to cooperating with the Benton County's planning effort, per a signed agreement by the Secretary of Energy in March 1996 with local governments, titled *Statement of Principles Outlining the Relationship Between the U.S. Department of Energy and Local Governments* (RL No. 98-089, dated June 1998).

As part of its planning effort, Benton County has developed a proposed critical areas map, which depicts lands identified as critical areas under the GMA (see Figure 1-5). The county has completed its SEPA review of the critical areas map and draft implementing ordinance provisions, which would be amended to the county's adopted Critical Resources Protection Ordinance. The Benton County Planning Commission has reviewed and approved the map and ordinance amendments at public hearings, and has forwarded them to the Board of County Commissioners for action, which is pending. Critical areas include wetlands areas with a critical recharging effect on aquifers used for potable water, fish and wildlife habitat conservation areas, frequently flooded areas, and geologically hazardous areas.

The Port of Benton, which must comply with county land-use plans, has already received the 1100 and 3000 Areas, and has expressed interest in the industrial development of portions of the 300 Area and in the area south of Energy Northwest (formerly known as WPPSS) Plant Number 2.

1.4.2.3.2 City of Richland. The City of Richland plans in coordination with Benton County under the GMA. Richland is greatly influenced by activities at the Hanford Site and has gone through several boom-and-bust cycles in response to employment levels at Hanford. Land

use at Hanford has the potential to affect the economic development of Richland. The city currently provides services such as water, electricity, and sanitary sewers to the southern portion of the Hanford Site. The City of Richland has identified portions of the southern Hanford Site (Figure 1-6) suitable for industrial development and possible annexation.

1.4.2.3.3 Counties of the Wahluke Slope. Franklin, Grant, and Adams counties also contain portions of the Hanford Site. The planning efforts of these local county governments vary by each planning jurisdiction. For example, land-use planning for Grant County reflects the Wahluke 2000 Plan prepared by farming interests in 1992 and supported by Grant County (Figure 1-7). Land-use planning for Franklin County reflects the results from a land-use analysis conducted by the Franklin County Planning Department.

1.4.3 Federal Land-Transfer Procedures

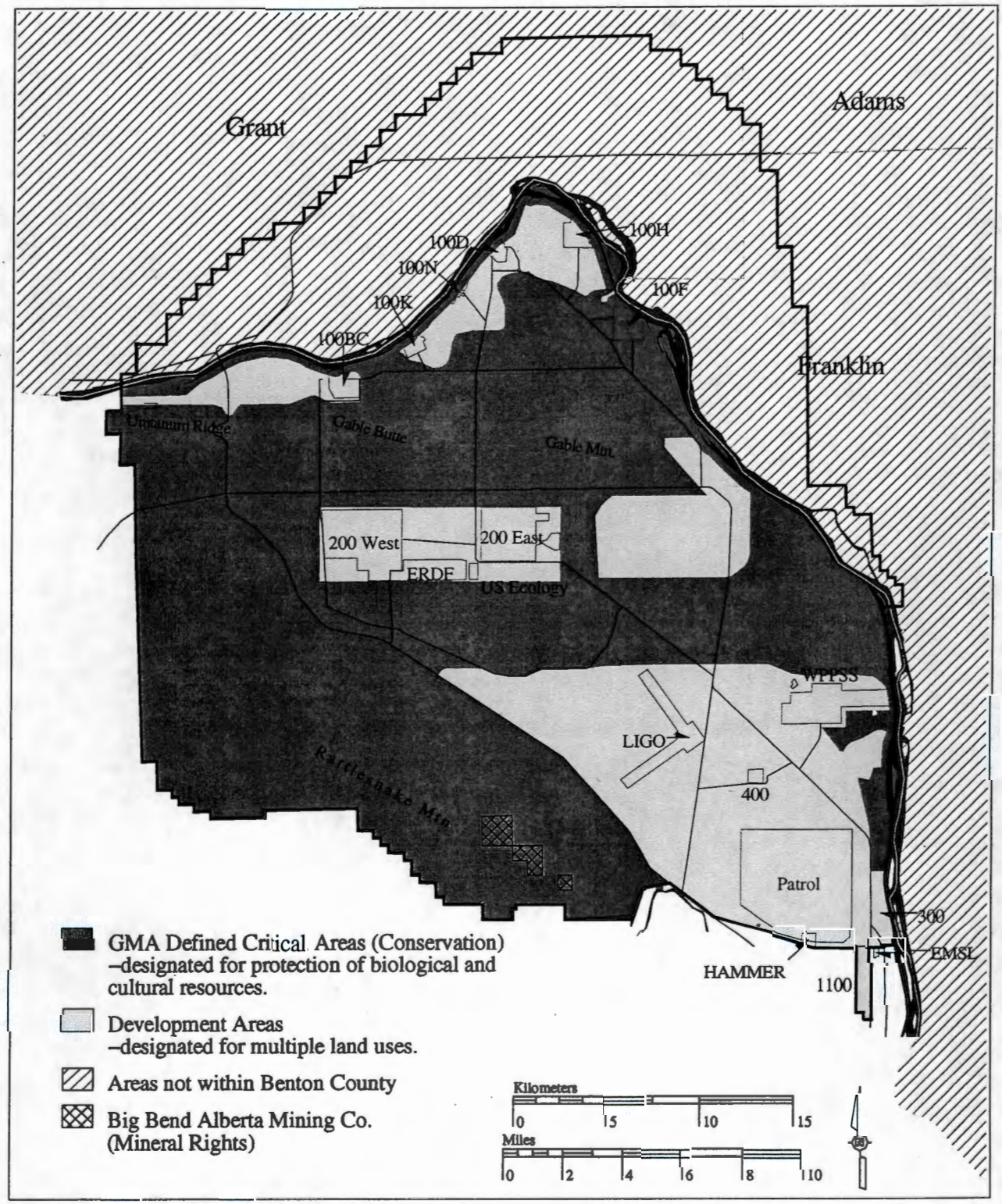
The DOE annually examines its real estate holdings to identify any excess properties. The GSA has developed the following questions for executive agencies such as DOE to consider in identifying valid real property needs (DOE 1997c):

- Is all of the property essential for program requirements?
- Are buffer zones kept to a minimum?
- Can the land be disposed of and program requirements satisfied through reserving rights and interests in the property?
- Is the land being retained merely because it is landlocked?
- Is the land being retained merely because it is considered undesirable due to topographical features or believed to be not disposable?
- Is any portion of the property being retained primarily because the present boundaries are marked by existing fences, roads, and utility systems?

These questions are specifically applicable to purchased land. However, in the absence of other guidance, it is reasonable to apply these same factors when assessing the need for land withdrawn from the Public Domain.

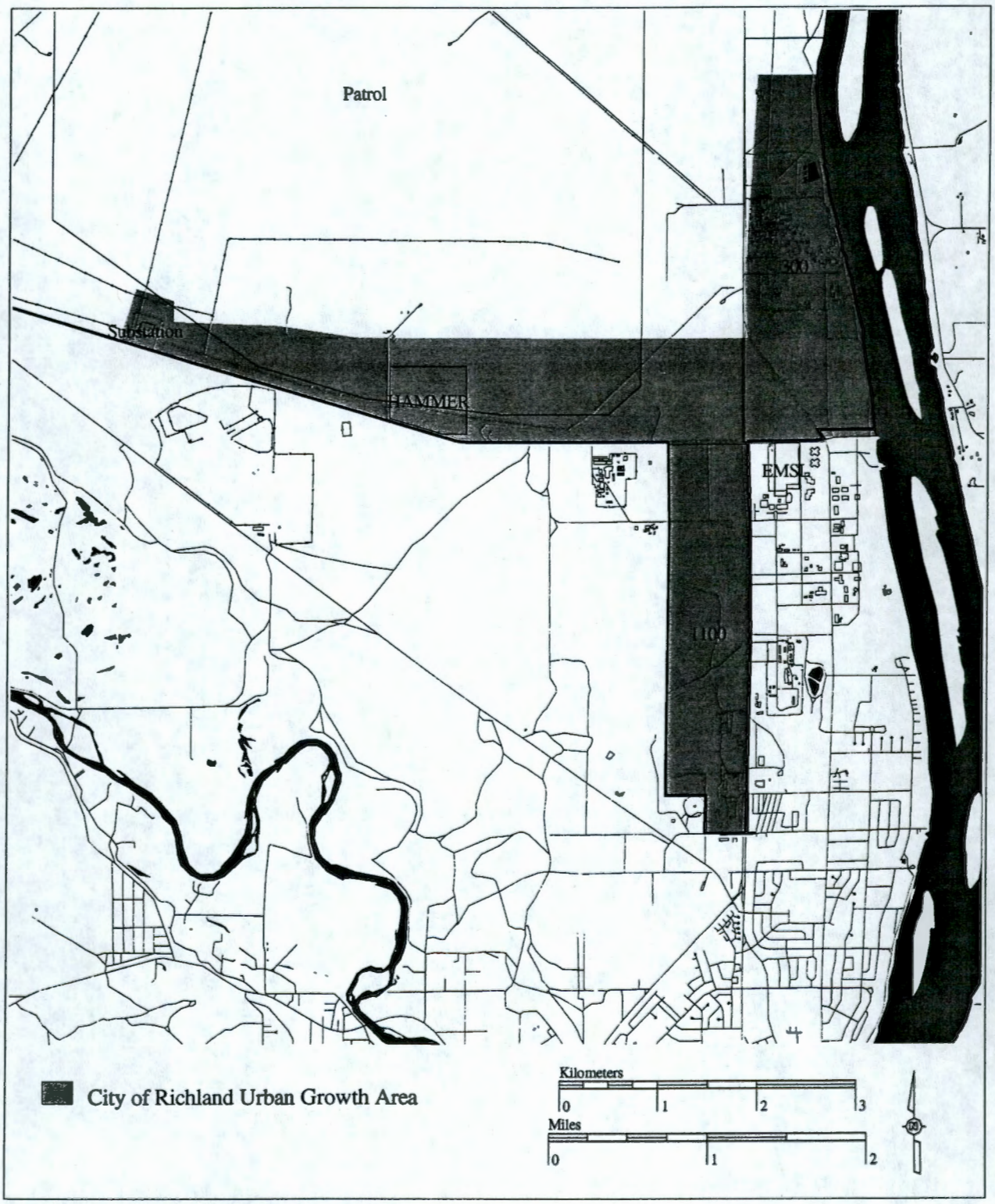
Within the context of Hanford, the CLUP's authority exists only as long as DOE retains legal control of some portion of the real estate. For example, in the Columbia River Corridor, DOE might decide to retain control of the subsurface or groundwater and release only the first 4.6 m (15 ft) of the surface. However, because of the cooperating agencies' involvement in the CLUP process, the CLUP can provide reasonable assurance as to what the land use would be if the land is transferred to the control of one of the cooperating agencies. Further, the creation of a land-use plan through the NEPA process would provide a basis for considering future land transfer proposals. The DOE would conduct appropriate further NEPA review (i.e., EIS, environmental assessment, or categorical exclusion), tiered from this EIS, before making decisions on any specific future land-transfer proposals.

Figure 1-5. Benton County Proposed Critical Areas Map.



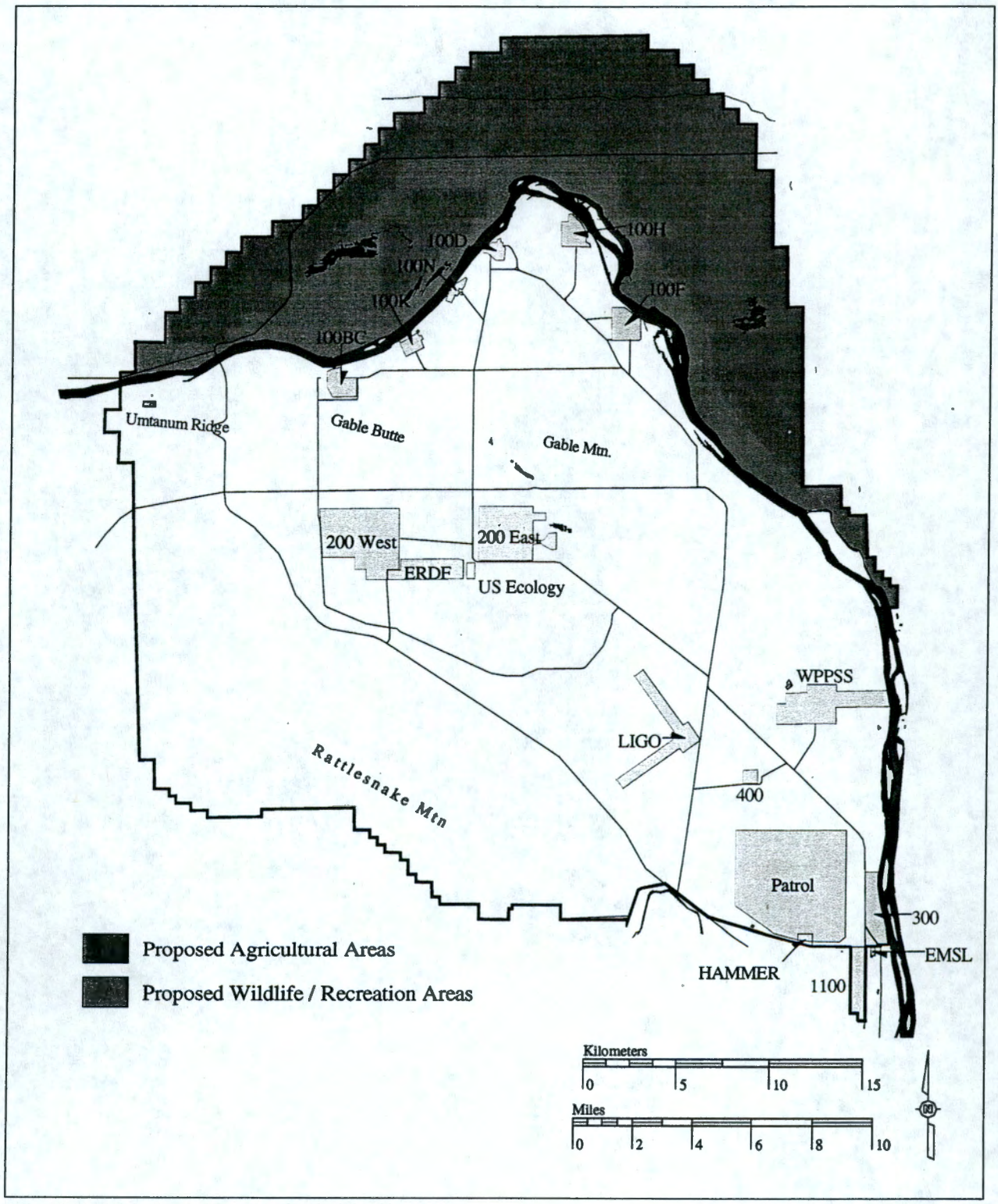
BHI:rpp 04/23/96 cmp/bentonco1.ami Database: 03-AUG-1998

Figure 1-6. City of Richland Urban Growth Area.



BHI:cpp 01/13/98 draft_2/urban1.aml Database: 03-AUG-1998

Figure 1-7. Wahluke 2000 Plan Map.



BHI:rpp 01/13/98 draft_2/urban4.aml Database: 03-AUG-1998

In its NEPA regulations (10 CFR 1021), DOE has identified several categorical exclusions of typical classes of action relevant to land transfers that normally do not require an EIS or an environmental assessment. As described in 10 CFR 1021.410, to find that a proposal may be categorically excluded, DOE must determine that the proposal fits within the class of action (see text box, "*DOE's Land Transfer CXs*") that there are no extraordinary circumstances that may affect the significance of the proposal (e.g., "... unresolved conflicts regarding alternate uses of available resources..."), and that the proposal is not connected to other actions with potentially significant impacts. Departmental policy requires field activities to identify long-term mission needs and rationally plan for future site development. More specifically, policy requires that comprehensive land-use plans be developed based on mission needs, site and regional conditions, strategic goals, and other technical information such as the need for buffer zones. Also, disposals are made through the Department's certified realty specialists at field sites in accordance with statutory and regulatory requirements. This CLUP's authority is limited to as long as DOE retains legal control of some portion of the real estate.

DOE's Land Transfer CXs

A.7 Transfer, lease, disposition, or acquisition of interests in personal property (e.g., equipment and materials) or real property (e.g., permanent structures and land), if property use is to remain unchanged; i.e., the type and magnitude of impacts would remain essentially the same.

B1.24 Transfer, lease, disposition or acquisition of interests in uncontaminated permanent or temporary structures, equipment therein, and only land that is necessary for use of the transferred structures and equipment, for residential, commercial, or industrial uses (including, but not limited to, office space, warehouses, equipment storage facilities) where, under reasonably foreseeable uses, there would not be any lessening in quality, or increases in volumes, concentrations, or discharge rates, of wastes, air emissions, or water effluents, and environmental impacts would generally be similar to those before the transfer, lease, disposition, or acquisition of interests. Uncontaminated means that there would be no potential for release of substances at a level, or in a form, that would pose a threat to public health or the environment.

B1.25 Transfer, lease, disposition or acquisition of interests in uncontaminated land for habitat preservation or wildlife management, and only associated buildings that support these purposes. Uncontaminated means that there would be no potential for release of substances at a level, or in a form, that would pose a threat to public health or the environment.

This EIS does not contain any new mechanisms or preferences regarding the transfer of land, but with the input from the cooperating agencies and consulting Tribal governments, this EIS would continue to be useful for considering proposals regarding Hanford lands that might be transferred beyond the control of DOE. This EIS is not focused on land transfer, but instead focuses on the integrated use and management of land and resources independent of who owns the land. Land transfer is a complicated and separate process from the CLUP and, once property leaves DOE control, DOE has no control over the use of that land unless the property was conveyed with deed or other legal restrictions. For more information about regulations pertaining to land transfer or facility leasing, see Table 1-4. For more information about the process for transferring property, refer to the guidebook, *Cross-Cut Guidance on Environmental Requirements for DOE Real Property Transfers* (DOE 1997b), or Ecology's guidebook, *Hanford Land Transfer* (Ecology 1993).

Table 1-4. Regulations Affecting Land Transfer. (3 pages)

Year	Law	Name	Mechanism	Term	Approvals	Major Elements
1954	PL 83-703, Sec. 161(g)	*Atomic Energy Act* (AEA)	– Lease Real Property – Lease Personal Property – Sell Real Property – Sell Personal Property	Not specified	Sec. of Energy approval delegated to field offices	– General authority to sell, lease, grant, and dispose of real and personal property. (There must be a direct correlation between the purpose of the lease and the mission of DOE derived from the AEA.) – Limited to R&D efforts or efforts to support atomic energy, or efforts to support international agreements
1955	PL 221-Chapter 543: 69 STAT 471, as amended 1964 (PL 88-394); (US Code 42 U.S.C. 2349)	*Atomic Energy Community Act*	– Lease Land – Lease Equipment – Sell Equipment	Not specified	Sec. of Energy approval Congressional Review	– Applies to Hanford Site only – Must obtain fair market value – Congress has 45 day review – Must reduce adverse economic impact in local area
1977	PL 95-91, 91 STAT 565, as amended, 42 U.S.C. 701 et. seq., August 4, 1977	*Energy Organization Act*	Lease Real Property	5 years	Local DOE field office authority for approval established under DOE Order 4300.1C	– Not currently needed, but not yet excessed – Does not require fair market value, but implementing DOE Order 4300.1C does require fair market value
1948	PL 80-537	Authorizing the transfer of certain property for wildlife, or other purposes	Transfer of excess	Not specified	General Services Administration	Upon application to GSA, the Secretary of the Interior is authorized to accept transfer of federally excessed land that has value for migratory birds without compensating the excessing agency.
1954	43 U.S.C. Section 931c, Chapter 22	*Public Lands Authorization for Certain Uses*	Lease Land	30 years	Secretary or designee	– DOE must have authority over land – Fair market value must be received – Can only lease to states, counties, cities, towns, townships, municipal corporations, or other public agencies for the purpose of construction and maintaining on such lands, public buildings or other public works

Table 1-4. Regulations Affecting Land Transfer. (3 pages)

Year	Law	Name	Mechanism	Term	Approvals	Major Elements
1980	PL 96-480	*Stephen-Wydler Technology Innovation Act*	– Technology Transfer – Cooperative Research Agreements – Licensing	N/A	Local DOE field office authority	– Established technology transfer as a mission of the Federal government
1949	Chapter 288, 63 STAT 377 40 U.S.C. 471 et. seq.	*Federal Property and Administrative Services Act of 1949*, as amended				
1994	PL 103-251, 15 USCA 3710a	*Cooperative Research & Development Agreements* (CRADA)	– Land Use – Facility Use – Equipment Transfer	5 years	Local DOE field office authority	– Must be joint effort between one or more government laboratories and one or more non-Federal parties – Work scope must be research and development – Special consideration to small businesses – Both parties can provide people, services, facilities, equipment, intellectual property, and other resources, except government cannot provide cash

Table 1-4. Regulations Affecting Land Transfer. (3 pages)

Year	Law	Name	Mechanism	Term	Approvals	Major Elements
1994	PL 103-160, Sec 3154, 3155	*Defense Authorization Act* (Hall Amendment)	Section 3154: – Lease Real Property and related personal property	Section 3154: 10 years - option for additional term (unspecified)	Section 3154: – Requires Secretary approval or designee plus administrator of EPA for NPL Site or appropriate state official. State official has 60 days to reject request for concurrence	Section 3154: – Located at DOE facility to be closed or reconfigured – Not needed by DOE – Under DOE's control – Must be acquired land, not Public Domain land – Can be leased for less than fair market value – Lease revenues can be used at the Site generating the revenues.
			Section 3155: – Transfer Personal Property		Section 3155: – Secretary or designee approval required	Section 3155: – Can be used if transfer mitigates adverse economic consequences that might otherwise arise from the closure of the facility – Equipment must be located at the facility to be closed – Must be excess to DOE needs – Must cost more than 110% of new cost to relocate if needed elsewhere in DOE – Consideration received may be less than fair market value – Additional terms may be required that Secretary deems necessary to protect U.S. interests

2.0 Purpose and Need

The U.S. Department of Energy (DOE) has several missions to fulfill at the Hanford Site that include, but are not limited to, being a natural resource trustee, developing economic diversification, managing energy research, and remediating legacy wastes. These missions have competing natural resource consumption needs and management values. Governments and stakeholders within the region have an interest in Hanford resources and in management of those resources over the long-term. The DOE needs to assess the relative qualities of Hanford's resources, compare the priorities and needs of Hanford's missions, and reach decisions such as the identification and disposal of any excess lands. DOE Order 430.1 and Federal Law 42 U.S.C. 7274k require a land-use plan for the Hanford Site. This Final HCP EIS provides the analysis needed to adopt a land-use plan.

The DOE needs to determine (1) if DOE wants to plan with the cooperating agencies and Tribal governments, and (2) how the land-use planning process should be integrated into the current Hanford Site management systems. The decision to cooperatively plan involves the adoption of a comprehensive land-use plan that contains three parts, as outlined in Chapter 6: a land-use map, planning policies, and implementing procedures. The default would be no comprehensive land-use plan as referenced in the No-Action Alternative.

The role of the Final HCP EIS is to document, in a public forum, the process of determining the best combination of land uses required to meet DOE mission needs for minimally the next 50 years. Through this EIS, DOE is responding to the following needs:

- Meet the mandate set forth in 42 U.S.C. 7274k, requiring the development of a final future-use plan
- Support the U.S. Environmental Protection Agency, Washington State Department of Ecology, and DOE remediation decision-making processes
- Develop a comprehensive land-use plan for the Hanford Site in accordance with DOE Order 430.1 (DOE 1995c).

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3.0 Description of the Proposed Action and Alternatives

This chapter describes the proposed action and the alternative methods by which the proposed action could be accomplished. Also included is a discussion of the No-Action Alternative. A No-Action Alternative is required by the *National Environmental Policy Act of 1969* (NEPA) and provides a baseline against which the impacts of the other alternatives can be compared.

3.1 Proposed Action

The proposed action for the *Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (HCP EIS) is to develop and implement a comprehensive land-use plan (CLUP) for the Hanford Site. As mandated by 42 U.S.C. 7274k, the land-use plan must address at least a 50-year planning period, although some specific DOE activities such as decommissioning of reactors are expected to take longer. The CLUP would include the following sections which are the minimum parts of a "comprehensive" land-use plan.

- A land-use map with land-use designations. The Record of Decision (ROD) for this HCP EIS would select one of the alternative land-use maps presented in Chapter 3 or would select a land-use map such as the revised Preferred Alternative that combines features of several alternatives.

- A set of definitions for each land-use map designation that apply to all of the alternative land-use maps (not applicable to the No-Action Alternative).

- A set of land-use plan policies (see Chapter 6) that apply to all of the alternative land-use maps (not applicable to the No-Action Alternative).

- A set of procedures for plan implementation (see Chapter 6) that would promote DOE's responsibility for coordination of land-use decisions with cooperating agencies and consulting Tribal governments (not applicable to the No-Action Alternative).

Once established, this land-use plan would provide a framework for making Hanford Site land-use and facility-use decisions.

3.2 Development of the Alternatives

Alternative land-use plans for the Hanford Site were developed through a cooperative effort with DOE; the Confederated Tribes of the Umatilla Indian Reservation (CTUIR); the Nez Perce Tribe Department of Environmental Restoration and Waste Management (Nez Perce Tribe); the U.S. Department of the Interior (DOI) via the Bureau of Land Management (BLM), Bureau of Reclamation (BoR), and the U.S. Fish and Wildlife Service (USFWS); the Washington Department of Fish and Wildlife (WDFW); the City of Richland; and Benton, Franklin, and Grant counties. Following development of the alternatives, an analysis of potential environmental impacts resulting from proposed land uses associated with each alternative was conducted. With the exception of DOE's Preferred Alternative and the No-Action Alternative (both of which were written by DOE), the narratives of each alternative do not contain parallel information because each alternative was written by a separate cooperating agency or consulting Tribal government with differing management goals. The results of these impact analyses are presented in Chapter 5.

3.2.1 *Involvement of the Cooperating Agencies*

During the public comment period on the August 1996 Draft HRA-EIS, several entities formally requested cooperating agency status in developing the Final HCP EIS. These agencies included the DOI, the City of Richland, and Benton and Franklin counties (with whom the State of Washington has placed land-use planning authority under the *Washington Growth Management Act of 1990* [GMA]). Each of these agencies has a legal interest in land-use planning at the Hanford Site because each has some responsibility or interest in managing Hanford lands or dependent resources. From a management perspective, it is also important to understand who orchestrates Columbia River activities (see text box, *"The Managed River"*).

The Managed River

Because ownership is integral to land-use planning, it is important to understand who owns the Columbia River. Within the Hanford Comprehensive Land-Use Plan, DOE, Bureau of Land Management (BLM), Bureau of Reclamation (BoR), U.S. Army Corps of Engineers (USACE), and Washington State Department of Natural Resources all own portions of the Columbia River's islands, riverbed, shoreline, water, or adjoining riverbanks. The Columbia River is central to both commerce and environmental quality for the Northwest.

In addition to ownership, it also helps to know what activities are regulated and who the managers are in the Columbia River Corridor. The Columbia River is a highly managed river. At the top of the Federal responsibilities are Congressional Treaties. There are treaties with Tribal Nations concerning fishing rights, international treaties concerning migratory birds, and specific treaties with Canada that concern river flows, hydropower marketing, and migratory fish stocks. Next is the authority of the Federal agencies. Section 404 of the *Clean Water Act* involves two lead agencies — the U.S. Environmental Protection Agency (EPA), whose regulations implement the Dredged and Fill Material Discharge Permit Program of Section 404, and the USACE, whose regulations also implement the permit program and who control river flows via their dams.

The DOI has several agencies with regulatory authority on the river, including the USFWS for the migratory and listed *Endangered Species Act* plants or animals, the National Park Service while the river is being considered for Wild and Scenic Recreational status, and the BoR which controls river flows via their dams. The U.S. Department of Commerce's National Oceanic and Atmospheric Administration, National Marine Fisheries Service (or "NOAA Fisheries") administers NOAA's programs that support the migratory salmon and steelhead stocks. The DOE regulates the Columbia River flow through its agency, the Bonneville Power Administration, marketing

Discussions with the interested agencies were initiated in January 1997 to provide a forum to participate in Hanford Site land-use planning and alternatives development. On March 4, 1997, DOE issued letters formally requesting the participation of these agencies, as well as Grant County and affected Tribal governments, in the development of a Revised Draft HRA-EIS. Later, upon request, a letter was also issued to the USFWS (see Appendix B).

For the convenience of DOE, there are two permits with the USFWS for managing land on the Hanford Site. On the Wahluke Slope, the USFWS manages the Saddle Mountain National Wildlife Refuge (NWR) under a permit signed in 1971. Unless this agreement is dissolved, the Saddle Mountain National Wildlife Refuge would continue to be managed as part of the NWR System under all alternatives described in this chapter. On the Fitzner/Eberhardt Arid Lands Ecology Reserve (ALE Reserve), the USFWS and DOE have a 25-year agreement, signed in 1997, that the USFWS will manage the ALE Reserve consistent with the existing ALE Reserve Management Plan until the new plan is developed. This new Comprehensive Conservation Plan (CCP) is being developed by the USFWS under DOE funding. Through the CCP, the USFWS will identify USFWS proposed management actions. The finished CCP will, in turn, give the USFWS the authority to manage the ALE Reserve as a part of the NWR System. The CCP would be the equivalent of an area management plan (AMP) developed under the guidelines in Chapter 6. Unless the DOE permit is revoked, the USFWS would manage the ALE Reserve and proceed with CCP preparation to identify refuge management actions to bring the ALE Reserve into the NWR System.

The land-use planning sessions with the participating agencies resulted in development of the nine land-use designations, six alternatives (including the No-Action Alternative), land-use planning policies and implementing procedures, the potential environmental impacts analysis,

and the structure of the Revised Draft HRA-EIS. The cooperating agency land-use planning sessions are expected to continue through publication of the HCP EIS ROD and implementation of the CLUP (see Chapter 6).

3.2.2 Development of the Nine Hanford Site Land-Use Designations

The following land-use designations and their definitions were co-written by the cooperating agencies and consulting Tribal governments so alternative land-use plans could be commonly developed and compared. These land-use groupings determined to be suitable for the Hanford Site lands include the following designations:

- Industrial-Exclusive
- Industrial
- Agricultural
- Research and Development
- High-Intensity Recreation
- Low-Intensity Recreation
- Conservation (Mining and Grazing)
- Conservation (Mining)
- Preservation.

These Hanford Site land-use designations and their definitions are presented in Table 3-1. In developing these land-use designation definitions, the cooperating agencies and consulting Tribal governments drew from the Final Report of the Future Site Uses Working Group (Working Group), the August 1996 Draft HRA-EIS, Benton County's GMA planning effort, and the City of Richland's GMA planning effort.

3.2.3 Identification of Land-Use Suitability

Developing alternatives was preceded by a land-use suitability analysis for a given area of the Hanford Site. A roundtable opportunity-and-constraint discussion on existing Site conditions was shared by the cooperating agencies and consulting Tribal governments. During these discussions, the land-use designations in Table 3-1 were developed. While land-use decisions are fundamentally value-driven decisions, they also should be decisions formed by opportunities and constraints (see text box, *"What is an Opportunity or Constraint?"*). Existing Site conditions and resources analyzed in the Final HCP EIS include the following:

- Biological
- Surface water
- Groundwater
- Waste sites including vadose zone
- Geological
- Cultural
- Economic (e.g., infrastructure).

These land-use designations, while based on land-use suitability, also provide insight into a myriad of potential land-use opportunities and reflect the many and varied interests of the cooperating agencies and consulting Tribal governments. Examples of potential land-use activities taking place under each land-use designation are defined in Table 3-1.

Table 3-1. Hanford Site Land-Use Designations.

Land-Use Designation	Definition
Industrial-Exclusive	An area suitable and desirable for treatment, storage, and disposal of hazardous, dangerous, radioactive, and nonradioactive wastes. Includes related activities consistent with Industrial-Exclusive uses.
Industrial	An area suitable and desirable for activities, such as reactor operations, rail, barge transport facilities, mining, manufacturing, food processing, assembly, warehouse, and distribution operations. Includes related activities consistent with Industrial uses.
Agricultural	An area designated for the tilling of soil, raising of crops and livestock, and horticulture for commercial purposes along with all those activities normally and routinely involved in horticulture and the production of crops and livestock. Includes related activities consistent with Agricultural uses.
Research and Development	An area designated for conducting basic or applied research that requires the use of a large-scale or isolated facility, or smaller scale time-limited research conducted in the field or within facilities that consume limited resources. Includes scientific, engineering, technology development, technology transfer, and technology deployment activities to meet regional and national needs. Includes related activities consistent with Research and Development.
High-Intensity Recreation	An area allocated for high-intensity, visitor-serving activities and facilities (commercial and governmental), such as golf courses, recreational vehicle parks, boat launching facilities, Tribal fishing facilities, destination resorts, cultural centers, and museums. Includes related activities consistent with High-Intensity Recreation.
Low-Intensity Recreation	An area allocated for low-intensity, visitor-serving activities and facilities, such as improved recreational trails, primitive boat launching facilities, and permitted campgrounds. Includes related activities consistent with Low-Intensity Recreation.
Conservation (Mining and Grazing)	An area reserved for the management and protection of archeological, cultural, ecological, and natural resources. Limited and managed mining (e.g., quarrying for sand, gravel, basalt, and topsoil for governmental purposes) and grazing could occur as a special use (i.e., a permit would be required) within appropriate areas. Limited public access would be consistent with resource conservation. Includes activities related to Conservation (Mining and Grazing), consistent with the protection of archeological, cultural, ecological, and natural resources.
Conservation (Mining)	An area reserved for the management and protection of archeological, cultural, ecological, and natural resources. Limited and managed mining (e.g., quarrying for sand, gravel, basalt, and topsoil for governmental purposes) could occur as a special use (i.e., a permit would be required) within appropriate areas. Limited public access would be consistent with resource conservation. Includes activities related to Conservation (Mining), consistent with the protection of archeological, cultural, ecological, and natural resources.
Preservation	An area managed for the preservation of archeological, cultural, ecological, and natural resources. No new consumptive uses (i.e., mining or extraction of non-renewable resources) would be allowed within this area. Limited public access would be consistent with resource preservation. Includes activities related to Preservation uses.

Industrial-Exclusive – Would use existing waste management areas, such as the 200 Area. This land-use designation would preserve DOE control of the continuing remediation activities and use the existing compatible infrastructure required to support activities such as dangerous waste, radioactive waste, and mixed waste treatment, storage, and disposal facilities. The DOE and its contractors, and the Department of Defense and its contractors, could continue their federal waste disposal missions; and the Northwest Low-Level Radioactive Waste Compact could continue using the U.S. Ecology site for commercial radioactive waste. Research supporting the dangerous waste, radioactive waste, and mixed waste treatment, storage, and disposal facilities would be also encouraged within this land-use designation. New uses of radioactive materials such as food irradiation could be developed and packaged for commercial distribution here under this land-use designation. This land-use designation supports the Environmental Protection Agency (EPA) Brownfields Initiative for contaminated areas (EPA 1997).

What is an Opportunity or Constraint?

In land-use planning, existing conditions offer a mix of "opportunities and constraints." Not all opportunities are equally viable at a specific point in time. And, few constraints are insurmountable given today's engineering and construction capabilities.

For example, shorelines of navigable water bodies typically have *constraints* to development because of potential flooding, geologic instability, bank erosion, wildlife habitat, and cultural resources. However, shorelines also offer excellent *opportunities* for enhancing recreation, cultural resources, fishery habitat, and water quality. These shorelines also are unique in that siting of needed water "dependent" and water "related" developments that cannot be an opportunity (physically located) in upland landscapes.

Landscapes with few or no constraints present the greatest challenges because they represent boundless opportunities with no hint as to their inherent suitability for one land use or another. Consequently, unless a site's suitability for a particular land use is narrowly prescribed by law (e.g., wetlands are protected for biological and water quality needs), the land-use decision is fundamentally value driven. Therefore, when the opportunities and constraints of a particular landscape are analyzed together, the "suitability" for different land uses can be compared and contrasted for an informed and value-driven decision.

Industrial – Would allow the opportunity for expanded economic growth as a result of an increased and diversified regional marketplace. This land-use designation would use existing compatible infrastructure, including transportation corridors, utilities and availability of energy, and suitable buildings or building space to encourage redevelopment and current DOE missions of research into energy resources development and other research opportunities. Redevelopment could include leasing or selling of idle industrial equipment currently held by DOE such as has been done for the aluminum extrusion presses in the 300 Area or the locomotive machine shop in the 1100 Area, to laboratory facilities and other infrastructure. Leases for industrial facilities such as the Energy Northwest's (formerly the Washington Public Power Supply System, or WPPSS) reactor or a proposed metal smelter cluster would be encouraged. This land-use designation supports the EPA Brownfields Initiative for contaminated areas (EPA 1997).

Agricultural – Would use the economic potential of the Columbia River Basin in eastern Washington (see text box, "*Hanford's Agricultural Opportunity Cost,*" Section 3.3.5.3.1). Under the Agricultural land-use designation, the land would be grazed, irrigated, plowed, planted with monocultures (e.g., wheat, grapes, apples, cherries, alfalfa, potatoes, etc.), fallowed, chemically managed (e.g., fertilizers, and pesticides would be applied), burned to control weeds and disease, and otherwise utilized consistent with common regional agricultural practices.

Research and Development – Would allow economic growth potential from research activities associated with the Hanford Science and Technology Mission, the Hanford Site remediation mission, and non-DOE-related research activities including large-scale, multi-decade research and development (R&D) facilities such as the Environmental Molecular Sciences Laboratory (EMSL) and the Laser Interferometer Gravitational Wave Observatory (LIGO), as well as smaller scale and/or time-limited research conducted in the field or within facilities that consume limited resources. Examples include environmental characterization or monitoring studies, site-specific testing of waste management or cleanup technologies, or environmental research in unique areas such as the Columbia River or the ALE Reserve. This

land-use designation would take advantage of existing compatible infrastructure, including transportation corridors, utilities, and availability of energy, suitable buildings or building space, security (i.e., controlled access), and the isolation of the Hanford Site from large population centers.

High-Intensity Recreation – Would use the economic potential of planned multi-activity recreational uses, including destination resorts, golf courses, and recreational vehicle service areas. High-Intensity Recreation is also used to accommodate recreational activities that would require a permanent commitment for infrastructure such as a septic drain field for flush toilets or waste water from fish cleaning stations associated with Tribal-reserved use sites or other public use sites.

Low-Intensity Recreation – Would allow use of the Hanford Site's natural features and the opportunity for human recreational activities (e.g., birding, fishing, hunting, rafting, kayaking, hiking, and biking), which would result in minimal disturbance and require minimal development. Low-Intensity Recreation would require active management practices to enhance or maintain the existing resources, and to minimize or eliminate undesirable or non-native species.

Conservation (Mining and Grazing) – Would enable the extraction of valuable near-surface geologic resources at some locations on the Hanford Site after obtaining NEPA, RCRA, CERCLA, or, where applicable, *State Environmental Policy Act* (SEPA) approval to protect NEPA-sensitive (e.g., biologic, geologic, historic, or cultural) resources. This land-use designation would allow permitted (i.e., conditional) livestock grazing and mining (quarrying) activities for governmental purposes in specific, limited areas. The Hanford Site has no proven reserve of any metallic ore bodies; therefore, heap/leach or open-pit mining methods would not be applicable. Should DOE determine that some or all of the Public Domain lands are surplus to DOE's needs and release the Public Domain lands back to the DOI, the DOI could then determine if the Tribal treaty language "the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land" is applicable. Conservation (Mining and Grazing) would afford protection of natural resources; however, other compatible uses, such as recreation, or non-intrusive environmental research activities would also be allowed provided those activities are consistent with the purposes of the Conservation land-use designation. Conservation would require active management practices to enhance or maintain the existing resources, and to minimize or eliminate undesirable or non-native species.

Conservation (Mining) – Would allow the same permitted uses as Conservation (Mining and Grazing), except grazing would be prohibited. This land-use designation reflects the anticipated need for onsite geologic resources to construct surface barriers as required by Hanford Site remediation activities. Conservation would require active management practices to enhance or maintain the existing resources, and to minimize or eliminate undesirable or non-native species.

Preservation – Would protect the unique Hanford Site natural resources and would enhance the benefits resulting from the protection of these resources. Preservation would require active management practices which could include grazing for fire and weed control to preserve the existing resources, and to minimize or eliminate undesirable or non-native species. Commercial grazing of domesticated livestock would not be allowed. An approved wildfire management plan that manages biological resources and protects cultural resources in addition to infrastructure also would be required. Preservation would not preclude all access, but would allow only uses such as nonintrusive environmental research or game-management activities, provided that those activities are consistent with the purposes of the preservation of natural resources.

A discussion of the affected environment and the existing constraints due to legacy

waste contamination and other features is presented in Chapter 4. Chapter 4 also contains Hanford Site maps that illustrate the relevant Site characteristics of the natural environment and individual constraints.

3.2.4 Developing the Environmental Impact Statement Alternatives

Following identification of the opportunities and constraints on the Hanford Site (see Chapter 4), and development of the nine land-use designations, individual alternatives were developed. Based on visions, goals, and objectives of the cooperating agencies and consulting Tribal governments, the land-use designations were applied to specific tracts of land on the Hanford Site. This process resulted in the development of the five (six, including the No-Action) alternatives that are presented and analyzed in this Final HCP EIS.

3.2.5 Incorporation of the Future Site Uses Working Group's Geographic Study Areas into the Alternatives

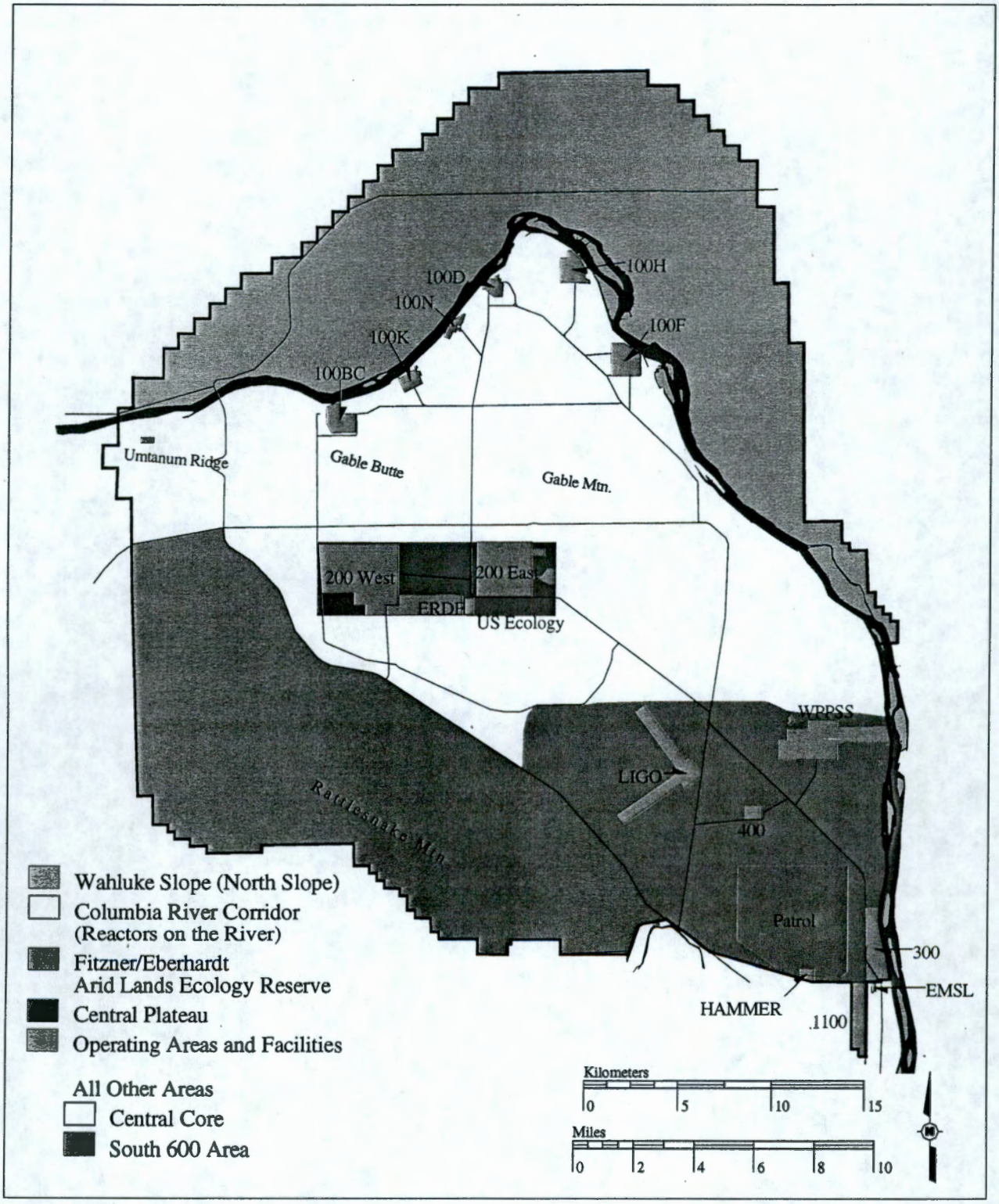
On December 22, 1992, the Hanford Future Site Uses Working Group (Working Group) which submitted its report into the official scoping record for the HRA-EIS, provided one of the first coordinated outside looks into the future of the Hanford Site. One of the important contributions of the Working Group was the establishment of six geographic study areas for the Hanford Site for planning purposes (see Figure 3-1). These geographic areas were North of the River, the Columbia River, Reactors on the River, the Central Plateau, All Other Areas, and the ALE Reserve. These original geographic areas are used in this EIS with the following slight modifications:

- The North of the River geographic area has adopted the local name, the Wahluke Slope.
- Two geographic areas – the Reactors on the River and the Columbia River – have been combined into a single geographic area, the Columbia River Corridor, consistent with Hanford Advisory Board (HAB) advice.
- The buffer area associated with the Central Plateau geographic area is not shown; instead, the Central Plateau geographic area represents only the central waste management area and defers the point of compliance for groundwater to the Tri-Party Agreement's processes.
- The All Other Areas geographic area was divided into the South 600 Area to reflect the clusters of infrastructure located there, and the Central Core that surrounds the Central Plateau but contains less developed infrastructure.

3.2.6 Screening for Reasonable Alternatives

As discussed in the "Memorandum to Agencies: Forty Most Asked Questions Concerning the Council on Environmental Quality's (CEQ) *National Environmental Policy Act* Regulations" (40 FR 18026), reasonable alternatives include the alternatives that are feasible from a common sense, technical, and economic standpoint. Further, the CEQ guidance states that the number of reasonable alternatives considered in detail should represent the full spectrum of alternatives for meeting the purpose and need of the agency, but should not discuss every unique alternative when an unmanageably large number of alternatives would be involved.

Figure 3-1. Geographic Study Areas on the Hanford Site.



BHI:rpp 04/23/96 clup/geogareac1.aml Database: 03-DEC-1998

An infinite number of land-use alternatives could be developed for the Hanford Site. Consequently, DOE and the cooperating agencies and consulting Tribal governments developed a process for generating a series of alternatives representative of the many stakeholder desires for the future of the Hanford Site lands. This involved considering the relevant factors that influence land use at the Hanford Site. These factors include the following:

- Consider public values from scoping and comments on the August 1996 Draft HRA-EIS
- Consider land commitments that have been previously made by major Federal actions (NEPA and CERCLA RODs)
- Consider current DOE missions, including economic diversification
- Consider site characteristics
- Consider regional development and ecosystem characteristics
- Consider the Working Group's possible future-use options and HAB advice
- Consider existing land uses, permits, easements, and current ownerships (i.e., the BLM, BoR, DOE, State of Washington, and Big Bend Alberta Mining Company) in developing proposed land uses
- Consider projected changes to the natural and built environment for at least the next 50 years
- Consider projected land uses for at least 50 years (in the year 2046)
- Evaluate projected land uses against the values, goals, and objectives of the expressed public interests and the cooperating agencies and consulting Tribal governments
- Consider contamination institutional controls
- Honor treaties.

3.3 *Description of the Alternatives*

The individual alternative land-use plans developed for this Final HCP EIS, as well as the No-Action Alternative, are discussed in the following sections. The No-Action and DOE's Preferred Alternatives were written by DOE, Alternative One was written by DOE with input from the USFWS, Alternative Two was written by a representative of the Nez Perce Tribe Department for Environmental Restoration and Waste Management, Alternative Three was written by local government land-use planners (Benton, Franklin and Grant counties, and the City of Richland), and Alternative Four was written by a representative from the Confederated Tribes of the Umatilla Indian Reservation. Differences between alternatives are the result of each respective agency having unique values, goals, and objectives (vision) that the agency applies to the common set of resources and, from which, each agency develops a vision for the Hanford Site. Each alternative discussion begins with the values used to develop that alternative. Agency goals were used to develop the nine land-use designations listed in Table 3-1. These land-use designations and the agencies' values were, in turn, used to generate the six alternatives.

3.3.1 No-Action Alternative

As required by CEQ regulations for implementing NEPA (40 CFR 1502.14[d]), the No-Action Alternative have been included. Question 3 of CEQ's *NEPA's Forty Most Asked Questions* guidance, "Council on Environmental Quality Regulations for Implementing the Procedural Provisions of the *National Environmental Policy Act*" (40 CFR 1500-1508), 46 FR 18026-18038, explains how DOE is to develop the No-Action Alternative:

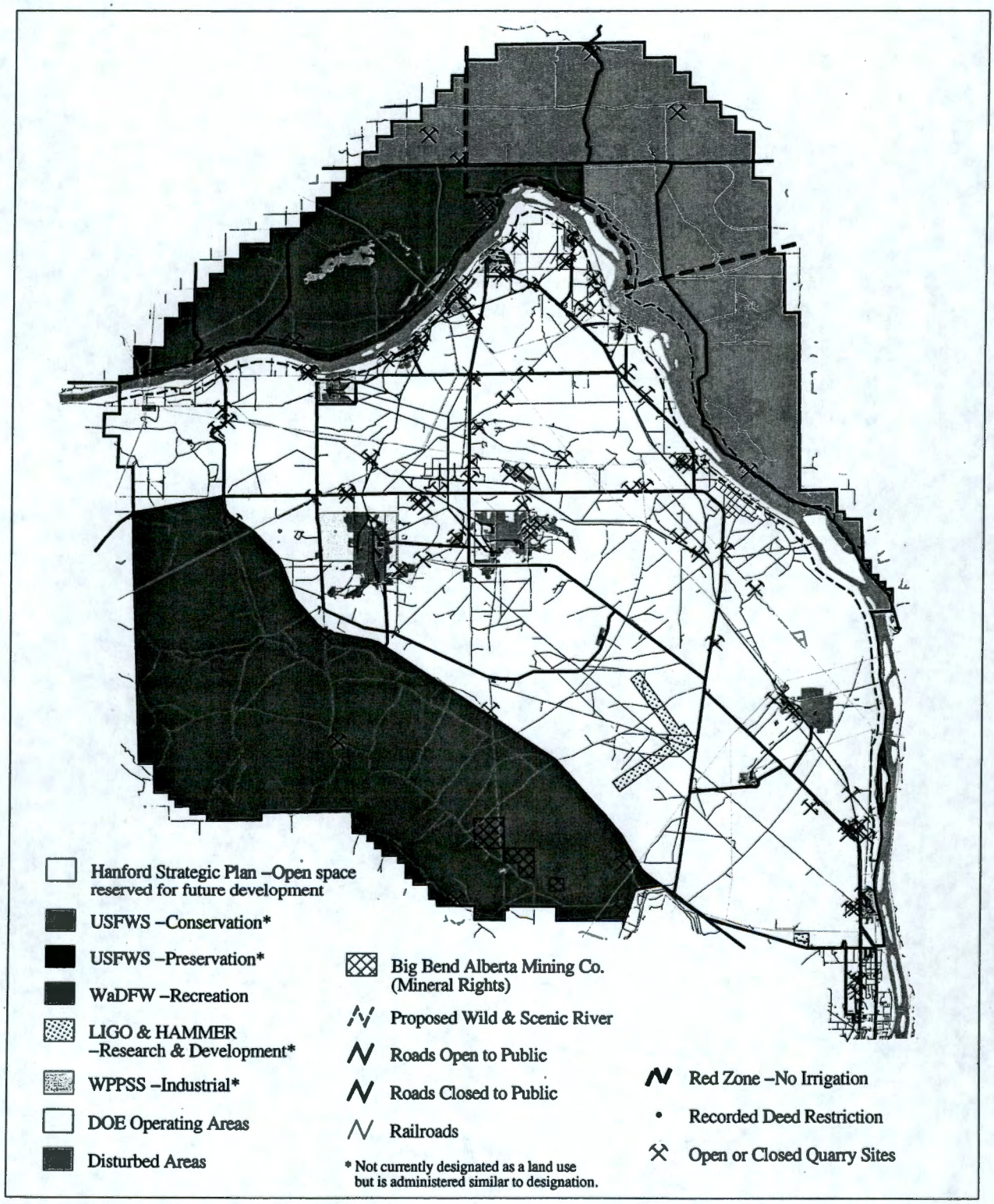
> *There are two distinct interpretations of "no action" that must be considered, depending on the nature of the proposal being evaluated. The first situation might involve an action such as updating a land management plan where ongoing programs initiated under existing legislation and regulations will continue, even as new plans are developed. In these cases "no action" is "no change" from current management direction or level of management intensity. To construct an alternative that is based on no management at all would be a useless academic exercise. Therefore, the "no action" alternative may be thought of in terms of continuing with the present course of action until the action is changed. Consequently, projected impacts of alternative management schemes would be compared in the EIS to those impacts projected for the existing plan. In this case, alternatives would include management plans of both greater and lesser intensity, especially greater and lesser levels of resource development.*

Therefore, in keeping with CEQ guidance, the No-Action Alternative is presented as "no change" from current management direction or level of management intensity. Specifically "no change" means that DOE would not employ the land uses shown in Table 3-1, any of the alternative maps (or combination of alternative maps), and the CLUP policies and implementing procedures in Chapter 6 for managing Hanford Site lands into the future. The No-Action Alternative is DOE's mission-related operation provisions and managerial values of the 1996 *Hanford Strategic Plan* (DOE-RL 1996b) without a framework and implementation procedures to assure the planned use and sustainability of the Site's land and resources. If an alternative is adopted in the ROD, it would simply add more structure to the implementation of the current *Hanford Strategic Plan*.

The No-Action Alternative serves two purposes. First, it serves as a true baseline common to all of the alternatives that presents the current status of land use and land management on the Hanford Site. For this purpose, a baseline no-action map was developed that contains available information defining existing buildings and infrastructure at the Hanford Site. Second, the No-Action Alternative provides a basis for comparing the alternatives against a "no change" in land-use management policy baseline.

To analyze the impacts associated with implementing the no change in land-use management policy/No-Action Alternative, assumptions regarding land-management options were applied. In the No-Action Alternative, specific land-use decisions and designations would be made through the NEPA process on a project-by-project basis as needed. Still there would not be a true land-use designation, land-use policies, or implementing procedures. There would only be areas of the Hanford Site that are currently used or managed for specific purposes guided by administrative agreements (e.g., the ALE Reserve and the Wahluke Slope) and areas of the Hanford Site that are committed to a general land-use because of historical uses and existing NEPA or CERCLA/RCRA ROD commitments but are subject to change by future projects or missions that are unknown at this time. Consequently, potential uses for the Hanford Site lands under the No-Action Alternative are mapped using the policies presented in *Hanford Strategic Plan* (DOE-RL 1996b) (Figure 3-2). Impacts associated with these potential future uses are analyzed and presented in Chapter 5.

Figure 3-2. No-Action Alternative.



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3.3.1.1 Planning Goals, Objectives, and Values (Vision). No publicly reviewed land-management plan has been developed for the Hanford Site since 1975 (ERDA 1975) (see text box, *"Permanent Commitments"*). In the incorporated by reference *Waste Management Operations, Hanford Reservation, Richland, Washington: Final Environmental Statement* (ERDA 1975), the Section IX.2.3, "Land Use," states:

> *Continuation of the Hanford Waste Management Operations Program will result in (1) occupancy of land by structures containing radionuclides, and (2) restricted use of land containing radionuclides. The quantity of land committed will remain essentially constant for about 300 years because of the presence of ^{137}Cs, ^{90}Sr, and transuranium materials in the burial grounds and crib sites unless major recovery and cleanup programs are initiated. After 300 years, the quantity of land required for such purposes will decrease to the lands which contain plutonium or other long-lived transuranics. Recovery of plutonium from stored waste would eliminate the need for long-term control and surveillance.*
>
> *A summary description of the committed lands is presented in Table IX-2. The areas in that table include appropriate buffer zones for surveillance and prevention of disturbance of the radionuclides by nearby activities such as irrigation agriculture.*

Permanent Commitments

The resources that are considered to be committed in an irretrievable and irreversible manner by the Hanford Waste Management Operations are (1) land and materials containing or used for storing radionuclides with a half-life longer than 10 years; (2) labor expended by construction and operating personnel; and (3) materials, such as fuels and chemicals, that are burned, diluted, or consumed during use.

Most land containing fission product radionuclides with long half-lives can be considered unusable for agricultural purposes for centuries. Although most of these radionuclides probably could be separated from the land, reduction of the concentration to a level which would permit unrestricted use undoubtedly would cost more than the value associated with normally expected uses. This land will require a commitment of both people and surveillance equipment until the radioactivity is essentially removed by processing or decay.

Land containing transuranic materials, particularly plutonium, can be considered unusable for any purpose for hundreds of thousands of years. Until any recovery program for the transuranic materials would be completed, this land will require a commitment of both people and surveillance equipment.

About half a million tons of fossil fuels and 50,000 tons of chemicals are expected to be irreversibly consumed by the Hanford Waste Management Operations. Some components of the concrete structures and equipment, as well as about 2,428 ha (6,000 ac) of desert land, are essentially irretrievable due to the practical aspects of reclamation and/or radioactive decontamination. Present operating practices will not require additional land usage for cribs (ERDA 1975).

Commitment of some of the Hanford lands to waste management makes that land unavailable for other uses. Because there are tens of thousands of acres of similar desert land available throughout the western United States, the dedicated land cannot be considered to have rare characteristics that result in a premium value, such as for residential or industrial use. Ample similar land is available nearby for any such uses foreseen.

Table IX-2. Dedicated Waste Management Lands.

General Location	Content[a]	Approximate Area (Acres)
100 Areas	Burial Grounds	70
200 Areas	Burial Grounds, Process Buildings, Tank Farms, Cribs, and Ponds	5,100
300 Area	Burial Grounds and Process Ponds	50
600 Area	Burial Grounds	10
Total		5,230[b]

*Table is a quote from the **Waste Management Operations, Hanford Reservation, Richland, Washington: Final Environmental Statement** (ERDA 1538, 1975). Other EIS's and CERCLA RODs have committed even more areas such as ERDF, the 200 West expansion and the 200 East trenches to DOE waste disposal activities.*

[a] Excludes standby facilities.

[b] This is 1.4% of the total Hanford Reservation land area.

In place of any formalized plan, land management at the Hanford Site would be administered using the visions outlined in the *Hanford Strategic Plan* (DOE-RL 1996b), which is not a land-use plan but is instead a DOE mission plan that is periodically updated. The 1996 *Hanford Strategic Plan* details the management direction for the Site. As outlined in the Strategic Plan, Hanford's environmental management, or cleanup mission is to protect the health and safety of the public, workers, and the environment; control hazardous materials; and utilize the assets (i.e., people, infrastructure, site) for other missions. Hanford's Science and Technology mission is to develop and deploy Science and Technology in the service of the nation, including stewardship of the Hanford Site.

Hanford Site managerial values, which are further explained in the 1996 Strategic Plan, are identified below:

- **Safety** -- The safety and health of our workers and the public will not be compromised. We place a high priority on managing and reducing the risks in our workplace, as well as risks to the public and the environment.

- **Results** -- We are committed to environmental and scientific excellence. We will meet or exceed the needs and expectations of our customers. Our employees are encouraged to seek creative and innovative solutions and to continuously find ways to improve what we do.

- **Teamwork** -- We work as a team to accomplish our missions. We regard all concerned parties as essential members of the team and value and plan for their participation. "Win-win" solutions are essential elements of the way we do business. We value the diversity of our employees and all other members of the team.

- **Integrity** -- We conduct ourselves with the highest standards of professionalism and ethical behavior. We honor our commitments and comply with applicable laws and regulations. We are proper stewards of the taxpayers' interest.

The 1996 *Hanford Strategic Plan* divided the Hanford Site into five distinct geographic study areas, including the Columbia River, Reactors on the River (100 Areas), Central Core, Central Plateau (200 Areas), and the South 600 Area (DOE-RL 1996b). These areas were modified to be consistent with the geographic areas used in this Final HCP EIS. Specifically, the Columbia River and Reactors on the River geographic areas were combined to create the Columbia River Corridor geographic area. The Wahluke Slope and ALE Reserve were not included in the 1996 *Hanford Strategic Plan* but have been included in this alternative, since these areas would remain under DOE authority.

3.3.1.2 Assumptions Regarding Future Use. Specific land-use decisions under the No-Action Alternative would continue to be made through the NEPA or the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989) process on a project-by-project, as-needed basis and without consideration of conformance to a CLUP.

3.3.1.3 Application of the Land-Use Designations.

3.3.1.3.1 The Wahluke Slope. The entire Wahluke Slope is managed for DOE by other agencies by permit. The western portion of the Wahluke Slope is managed by the USFWS as the Saddle Mountain NWR. Current permit conditions require this area to be closed to the public as part of a security zone for the N Reactor (now shut down), and the area would continue to be managed similar to the Preservation designation. This permit also provides protection for the K Basin spent nuclear fuel (SNF) removal project. The USFWS permit provides additional protection to sensitive areas and species of concern. The remainder of this geographic area has been managed by the WDFW and is now designated the Wahluke Wildlife Recreation Area.

In April 1999, the WDFW and the USFWS notified the DOE of their intent to modify their management responsibilities on the Wahluke Slope under the 1971 agreement leaving only a small portion (about 324 ha (800 ac)) northwest of the Vernita bridge under WDFW permit. The USFWS informed the DOE that it intends to allow essentially the same uses permitted by the State of Washington under the WDFW's management of the Wahluke Slope. Therefore, transfer of management of the Wahluke Slope from the WDFW to the USFWS involves only a change in the agency managing the property and does not involve any change in the management activities for the Wahluke Slope. Management of the entire Wahluke Slope by the USFWS as an overlay wildlife refuge is consistent with the 1996 DOI Hanford Reach EIS ROD. The ROD recommended the Wahluke Slope be designated a wildlife refuge and the Hanford Reach a Wild and Scenic River, and that the wildlife refuge be managed by the USFWS.

Consistent with the permit, this land is managed similar to the Conservation (Mining and Grazing) designation. These designations are also consistent with the BoR's Red Zone, in which irrigation is prohibited to minimize slumping of the bluffs into the Columbia River. Under this alternative, limited public access for hunting, fishing, or recreation; permitted mining and grazing activities; and agricultural leases would continue. Existing permits with the USFWS can be revoked by DOE at any time.

3.3.1.3.2 The Columbia River Corridor. The surface water in this geographic area would continue to be managed to allow limited public access and use as a Low-Intensity Recreation area. Access to the Columbia River's islands would remain restricted to provide protection for cultural, aesthetic, biological, and geologic resources. Restrictions that are intended to preserve the unique character of the Hanford Reach portion of the Columbia River (Public Law 100-605) would also remain in effect. Public access to the Reactors on the River area (i.e., the 100 Areas) would remain restricted, which is consistent with current management.

Hazardous and/or dangerous waste has been disposed of at the 183-H Solar Evaporation Basins under the terms of EPA and Ecology regulations. Future use restrictions associated with this parcel of land are to be consistent with the terms of 40 CFR 264.117(c) and *Washington Administrative Code* (WAC) 173-303-610(7)(d). The WAC 173-303-610(7)(d) and 40 CFR 264.117(c) are identical in intent and similar in text and state the following:

> *Post-closure use of property on or in which [hazardous and/or] dangerous wastes remain after partial or final closure must never be allowed to disturb the integrity of the final cover, liner(s), or any other components of any containment system, or the function of the facility's monitoring system, unless the department finds that the disturbance: (i) Is necessary to the proposed use of the property, and will not increase the potential hazard to human health or the environment; or (ii) Is necessary to reduce a threat to human health or the environment.*

A deed restriction has been filed with Benton County for the 183-H Solar Basin RCRA corrective action (BHI 1997) because of residual contamination. Other deed restrictions or covenants for activities that potentially may extend beyond 4.6 m (15 ft) below ground surface are expected for the CERCLA remediation areas (see Figure 4-34).

3.3.1.3.3 The Central Plateau. Lands within the Central Plateau geographic area would continue to be used for the management of radioactive and hazardous waste materials. These management activities would include collection and disposal of radioactive and/or hazardous waste materials that remain onsite, contaminated groundwater management, current offsite commitments, and other related and compatible uses. After incorporating by reference the previous 1975 ERDA 1538 irreversible and irretrievable (I&I) commitments and other documented commitments into this EIS (see Section 1.3), future individual project land-use requirements would be I&I committed through the appropriate NEPA and CERCLA/RCRA/NEPA integrated processes. Deed restrictions or covenants also would be applied to this area through the CERCLA and RCRA processes.

3.3.1.3.4 The All Other Areas. These areas would be available for other Federal programs or leased for non-Federal uses, provided that such uses are consistent with the safety requirements and address the cultural and biological resource issues through DOE's NEPA process. After incorporating by reference the previous 1975 ERDA 1538 irreversible and irretrievable (I&I) commitments and other documented commitments into this EIS (see Section 1.3), future individual project land-use requirements would be I&I committed through the appropriate NEPA and CERCLA/RCRA/NEPA integrated processes. The All Other Areas geographic area would remain under Federal ownership to protect the public from routine or accidental releases of radiological contaminants and/or hazardous materials. The use of protective buffer zones surrounding the waste remediation, processing, and disposal areas is required by DOE Order 151.1, *Comprehensive Emergency Management System* (DOE 1996f), and Occupational Safety and Health Administration (OSHA) regulations 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response" (Site Safety and Control Plan), and OSHA 29 CFR 1910.119, "Process Safety Management (PSM) Rule." These buffer zones limit public exposure to radiological and hazardous chemicals from routine operations and accidents.

A portion of this geographic area (just north of the City of Richland) would be used for industrial purposes. An Industrial use would allow R&D facilities similar to the EMSL. The lands in and adjacent to the 300 and 400 Areas would remain under Federal ownership, but DOE would be able to lease lands for private and public uses (including withdrawn public lands with the owning agency's permission) to support regional industrial and economic development (e.g., Energy Northwest [formerly known as WPPSS]). Other Federal uses would be allowed by permit (e.g., LIGO). This area includes a section south of the 200 Areas that was sold to the

State of Washington for a dangerous waste, non-nuclear disposal site but remains undeveloped. If the state were to develop that property per its Quit Claim Deed (State of Washington 1980), the state would have to obtain appropriate county, state, and Federal permits.

The Horn Rapids Landfill (HRL), operated by the U.S. Department of Energy Richland Operations Office (RL), encompasses approximately 20 ha (50 ac) of the 600 Area. Originally, the landfill was a quarry for sand and gravel. Subsequently, the HRL was used as a landfill for office and construction waste, asbestos, sewage sludge, fly ash, and reportedly numerous drums of unidentified organic liquids. Consistent with EPA recommendations for operators of landfills that handle asbestos, fencing and warning signs have been erected around the perimeter of the HRL to control public access. The HRL has been remediated under the terms of the 1100 Area CERCLA ROD. Future-use restrictions associated with this parcel of land as an asbestos-containing landfill are to be consistent with the terms of 40 CFR 61.151. In general, for the purposes of restrictions on land uses, 40 CFR 61.151 indicates that a notation must be made on the deed or covenant notifying a potential purchaser that the land has been used for asbestos-containing waste material. A deed restriction for asbestos has been filed with Benton County for the HRL. Other deed restrictions or covenants would likely be applied to this area through the CERCLA and RCRA processes.

The DOE's transfer of the 1100 Area to the Port of Benton for economic development was approved through an interim action environmental assessment. The DOE prepared an environmental assessment that resulted in a finding of no significant impact (FONSI) on August 27, 1998, transferring the 1100 Area and the Southern rail connection to the Port of Benton (DOE/RL EA-1260). Although the 1100 Area is no longer under DOE control, it is included in this EIS to support the local governments with their SEPA EIS analyses of the Hanford sub-area of Benton County under the State of Washington's Growth Management Act.

The Port of Benton officially took ownership and control of the "1100 Area" (consisting of 318 ha [786 ac], 26 buildings, and 26 km [16 mi] of rail tract) on October 1, 1998. Together with the Washington State Department of Transportation and Legislature Transportation Committee, the Port of Benton is funding a major study ($600,000) to determine the feasibility of reconnecting the Hanford main rail line to Ellensburg, Washington, as it was in the 1970s, as an alternative route for Yakima Valley rail traffic flowing between the Puget Sound and the Tri-Cities. The current Yakima Valley route passes directly through all the cities in the Valley, including the cities of Yakima and Kennewick, which have plans to develop their downtown areas to be more people friendly.

Specifically, the Port of Benton has expressed a desire to use the Hanford rail system and extend the current system upriver where there is currently only an abandoned railroad grade. Provisions for the reconnection would be made in DOE's permit to the USFWS for management of the Riverlands. The DOE Preferred Alternative would not hinder the rail option because it would be considered a pre-existing, nonconforming use (see Chapter 6). At this time, DOE has no plans to maintain the northern portions of the existing rail line.

3.3.1.3.5 The Fitzner/Eberhardt Arid Lands Ecology Reserve (ALE Reserve). The ALE Reserve geographic area would continue to be managed similar to the Preservation designation in accordance with the Rattlesnake Hills Research Natural Area designation and the USFWS permit. Big Bend Alberta Mining Company holds mineral rights on about 5 km^2 (2 mi^2) under the southern portion of the ALE Reserve (see Section 4.2.3.1). The USFWS and DOE have a 25-year agreement signed in 1997 that the USFWS will manage the ALE Reserve consistent with the existing ALE Management Plan until the new plan is developed. This new Comprehensive Conservation Plan (CCP) is being developed by the USFWS under DOE funding. Through the CCP, the USFWS will identify USFWS proposed management actions.

The CCP will give the USFWS the authority to manage the ALE Reserve as a part of the NWR System. The CCP would be the equivalent of an area management plan (AMP) developed under the guidelines in Chapter 6. Unless the DOE permit is revoked, the USFWS would manage the ALE Reserve and proceed with CCP preparation to identify refuge management actions that could bring the ALE Reserve into the NWR System.

Currently, persons wishing to visit the ALE Reserve must first contact an appropriate staff member of either DOE or the USFWS.

3.3.2 The Agency's (DOE's) Preferred Alternative

The CEQ requires an agency to ". . . identify the agency's Preferred Alternative if one or more exists, in the draft statement, and identify such alternative in the final statement . . . (40 CFR 1502.14[e])." In the development of the Preferred Alternative, DOE took into account its role as the long-term caretaker for the Site for at least the next 50 years. The DOE used information from the Hanford Geographic Information System (HGIS) and Waste Information Data System (WIDS) databases. Information considered by DOE includes:

- All surface waste sites, including those remediated (Figure 4-34)
- Groundwater contaminants and flow direction (Figures 4-15, 4-35, and 4-36)
- Cultural and biological resources (Figure 4-27)
- Exclusive-use zones (EUZs) and emergency planning zones (EPZs) associated with DOE and other Hanford activities (e.g., Energy Northwest's nuclear power reactor, U.S. Ecology's low-level waste [LLW] disposal site, LIGO, etc.) (Figure 4-37).

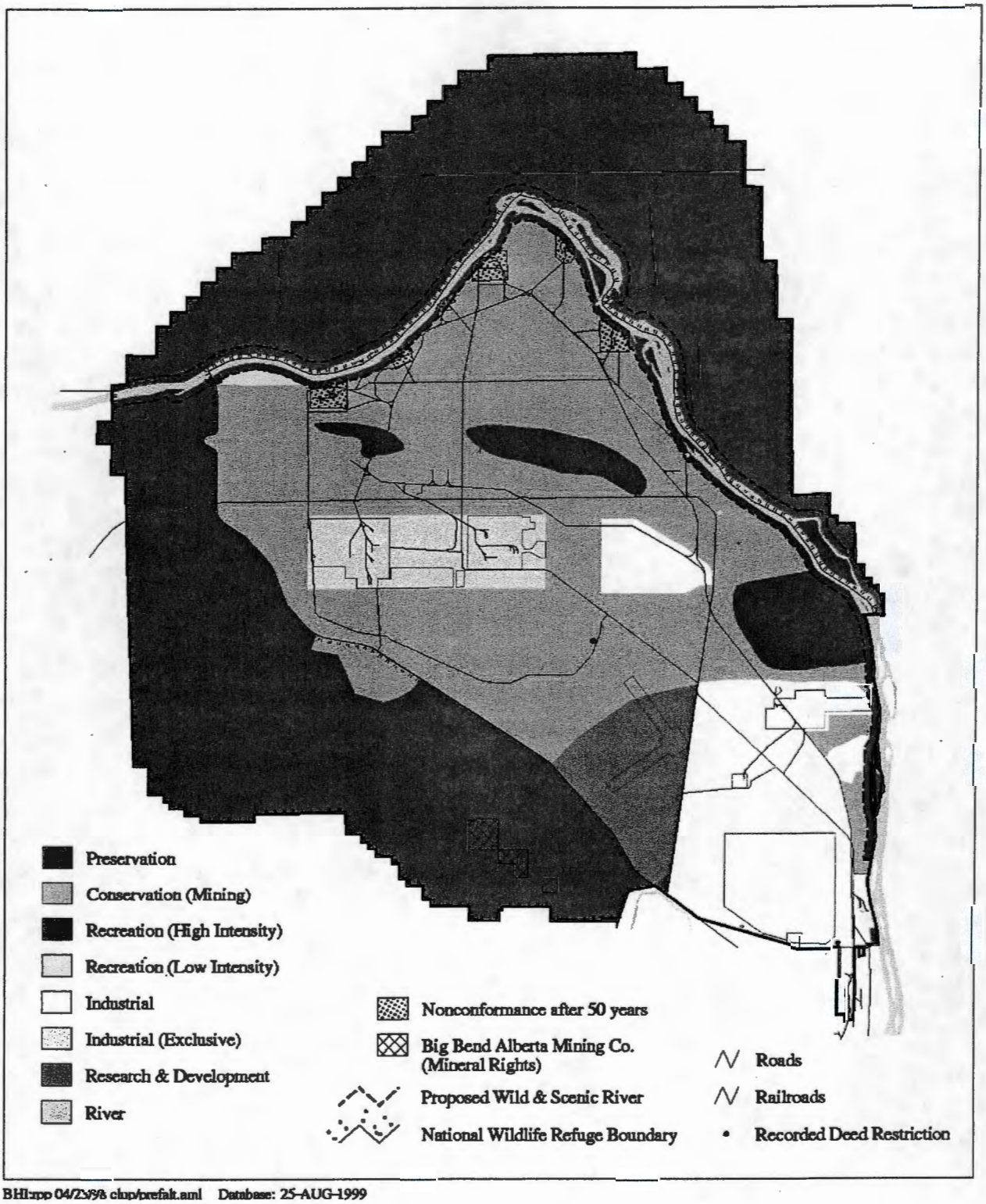
The DOE believes that the Preferred Alternative would fulfill the statutory mission and responsibilities of the agency and give adequate consideration to economic, environmental, technical, and other factors.

3.3.2.1 Planning Goals, Objectives, and Values (Vision). Much like the No-Action Alternative, DOE's Preferred Alternative was developed based on policies that are consistent with the 1996 *Hanford Strategic Plan* (DOE-RL 1996b). However, unlike the No-Action Alternative, DOE's Preferred Alternative would establish policies and implementing procedures that would place Hanford's land-use planning decisions in a regional context.

The DOE has identified the map alternative presented in Figure 3-3 and the land-use policies and implementing procedures of Chapter 6 as the Agency's (DOE's) Preferred Alternative. The DOE's Preferred Alternative represents land-management values, goals, and objectives of DOE for at least the next 50 years. It also represents a multiple-use theme of Industrial-Exclusive, Industrial, Research and Development, High-Intensity Recreation, Low-Intensity Recreation, Conservation (Mining), and Preservation land uses that have been identified by the public, cooperating agencies, and consulting Tribal governments as being important to the region.

1
2
3

Figure 3-3. DOE's Preferred Alternative.



BHI:rpp 04/23/98 clip/prefalt.aml Database: 25-AUG-1999

3.3.2.2 Assumptions Regarding Future Use. The assumptions used to develop DOE's Preferred Alternative are as follows:

- DOE, as a Federal agency, has a Trust responsibility to protect Tribal interests.
- DOE has a responsibility to consult with and recognize the interests of the cooperating agencies. The DOE continues to support DOI's proposal to expand the Saddle Mountain NWR to include all of the Wahluke Slope, consistent with the 1994 Hanford Reach EIS and 1996 Hanford Reach ROD.
- DOE will support economic transition and potential industrial development by the City of Richland or the Port of Benton by encouraging the use of existing utility infrastructure on the Hanford Site.
- Other entities will ask for Hanford's resources and lands.
- The public will continue to support protection of cultural and natural resources on the Site, especially on the Wahluke Slope, the Columbia River Corridor, the McGee Ranch, and the ALE Reserve.
- Mining of onsite geologic materials will be needed to construct surface barriers as required by Hanford Site remediation activities.
- Remediation of the Site will continue and, where necessary, the institutional controls currently in place will continue to be required at some level for at least the next 50 years. Institutional controls are transferrable and can be shared with other governmental agencies.
- Plutonium production reactor blocks will remain in the 100 Areas throughout the planning period and will be considered a pre-existing, nonconforming use.
- Vadose zone contamination will persist in the All Other Areas, Central Plateau, and 100 Area. Contaminated groundwater will remain unremediated in the All Other Areas, Central Plateau, and 100 Area.
- The public will support preservation of the Manhattan Project's historical legacy and development of a High-Intensity Recreation area, consistent with the B Reactor Museum proposal.
- The public will support access to the Columbia River for recreational activities and public restrictions consistent with the protection of cultural and biological resources.
- Areas will be set aside specifically for R&D projects.
- Sufficient area will be retained to support current and expected DOE facility safety authorization basis.

Planning for Possible Future Missions

The Preferred Alternative identifies lands required to support DOE's current Environmental Management and Science and Technology missions at the Hanford Site, as well as lands for future industrial development by the City of Richland and the Port of Benton. The DOE is proposing that additional lands be maintained under the Industrial land-use designation in areas where existing infrastructure is available and other compatible uses exist. The DOE believes it is prudent to retain land under the Industrial land-use designation to support possible future missions, rather than convert the land to the Conservation or Preservation land-use designation at this time. This would avoid possible conflicts with future missions. The DOE anticipates that the need for land under the Industrial land-use designation would continue to be evaluated during future planning efforts, which may result in conversion of some lands to the Conservation, Preservation, or other land-use designations.

- An adequate land base and utility infrastructure will be maintained to support possible industrial development associated with future DOE missions.

3.3.2.3 Application of the Land-Use Designations. Land-use designations identified for DOE's Preferred Alternative are Industrial-Exclusive, Industrial, Research and Development, High-Intensity Recreation, Low-Intensity Recreation, Conservation (Mining), and Preservation (see text box, "*Planning for Possible Future Missions,*" and Figure 3-3).

3.3.2.3.1 The Wahluke Slope. Recently the Wahluke Slope was administered for wildlife and recreation as the Saddle Mountain NWR and the Wahluke Wildlife State Recreation Area under permits granted by DOE to the USFWS and WDFW, respectively. In April 1999, the WDFW and the USFWS notified the DOE of their intent to modify their management responsibilities on the Wahluke Slope under the 1971 agreement leaving only a small portion (about 324 ha (800 ac)) northwest of the Vernita bridge under WDFW permit. The USFWS informed the DOE that it intends to allow essentially the same uses permitted by the State of Washington under the WDFW's management of the Wahluke Slope. Therefore, transfer of management of the Wahluke Slope from the WDFW to the USFWS involves only a change in the agency managing the property and does not involve any change in the management activities for the Wahluke Slope. Management of the entire Wahluke Slope by the USFWS as an overlay wildlife refuge is consistent with the 1996 DOI Hanford Reach EIS ROD. The ROD recommended the Wahluke Slope be designated a wildlife refuge and the Hanford Reach a Wild and Scenic River, and that the wildlife refuge be managed by the USFWS.

The DOE's Preferred Alternative would expand the existing Saddle Mountain National Wildlife as an overlay wildlife refuge to include all of the Wahluke Slope consolidating management of the Wahluke Slope under the USFWS, consistent with the Hanford Reach EIS's ROD (DOI 1996). An overlay refuge is one where the land belongs to one or more Federal agency, but it is managed by the USFWS.

The entire Wahluke Slope would be designated Preservation, with the exceptions near the Columbia River as discussed in the Columbia River Corridor section below. The major reason for designating this area as Preservation would be to provide protection for sensitive areas or species of concern (e.g., wetlands, sand dunes, steep slopes, or the White Bluffs) from impacts associated with intensive land-disturbing activities.

A CCP (see Area Management Plans, Chapter 6) for the Wahluke Slope would be developed by USFWS in accordance with the *National Wildlife Refuge System Improvement Act of 1997*. This Act provides significant guidance for management and public use of refuges allowing for wildlife-dependent recreation uses such as hunting, fishing, wildlife observation and photography, and environmental education and interpretation. The USFWS would consult with DOE during the development of this plan to ensure necessary and appropriate buffer zones for ongoing and potential future missions at the Hanford Site.

3.3.2.3.2 The Columbia River Corridor. The Columbia River Corridor has historically contained reactors and associated buildings to support Hanford's former defense production and energy research missions. Nevertheless, remediation planning documents, public statements of advisory groups, and such planning documents as the *Environmental Impact Statement: The Decommissioning of Eight Surplus Reactors* (DOE 1992a) have determined that remediation and restoration of the Columbia River Corridor would return the corridor to a nondeveloped, natural condition. Restrictions on certain activities may continue to be necessary to prevent the mobilization of contaminants, the most likely example of such restrictions being on activities that discharge water to the soil or excavate below 4.6 m (15 ft). Although the Surplus Reactor NEPA

ROD calls for the reactor buildings to be demolished and the reactor blocks to be moved to the Central Plateau, this action might not take place until 2068 or until a new Tri-Party Agreement milestone is negotiated. As a result, the reactor buildings could remain in the Columbia River Corridor throughout the 50-year-plus planning period addressed by the HCP EIS and would be considered a pre-existing nonconformance into the future.

The Columbia River Corridor would include High-Intensity Recreation, Low-Intensity Recreation, Conservation (Mining), and Preservation land-use designations. The river islands and a quarter-mile buffer zone would be designated as Preservation to protect cultural and ecological resources. Those islands not in Benton County would be included in the Refuge.

- Four sites, away from existing contamination, would be designated High-Intensity Recreation to support visitor-serving activities and facilities development. The B Reactor would be converted into a museum and the surrounding area would be available for museum-support facilities (see text box, "*B Reactor Museum Proposal*"). The High-Intensity Recreation area near Vernita Bridge (where the current Washington State rest stop is located) would be expanded across State Highway 240 and to the south to include a boat ramp and other visitor-serving facilities. Two areas on the Wahluke Slope would be designated as High-Intensity Recreation for potential exclusive Tribal fishing villages.

- Six areas would be designated for Low-Intensity Recreation. The area west of the B Reactor would be used as a corridor between the High-Intensity Recreation areas associated with the B Reactor and the Vernita Bridge rest stop and boat ramp. A second area near the D/DR Reactors site would be used for visitor services along a proposed recreational trail as conceptualized on Alternative Three's map. The third and fourth areas, the White Bluffs boat launch, and its counterpart on the Wahluke Slope, are located between the H and F Reactors and would be used for primitive boat launch facilities. A fifth area, near the old Hanford High School, would accommodate visitor facilities and access to the former town site and provide visitor services for hiking and biking trails that could be developed

B Reactor Museum Proposal

Preserving the history of the Hanford Site, and the public's knowledge and understanding of the events that occurred during World War II and the years which followed are the basis for the existence of the B Reactor Museum Association (BRMA). The primary mission of the organization is the long-term preservation of the retired B Reactor at the Hanford Site, and the upgrading of the structure to allow public access and unrestricted tours.

The B Reactor produced the plutonium for the first manmade nuclear explosion – the Trinity test – in New Mexico on July 16, 1945. The second bomb used in World War II contained plutonium produced by B Reactor. That bomb was dropped on Nagasaki on August 9, 1945, and was credited with bringing about the final surrender of Japan and the ending of the war. Plutonium production operation of the B Reactor was permanently stopped in 1968, and the reactor is currently functioning as a controlled-access museum in the 100-B/C Area of the Hanford Site.

As envisioned by the BRMA, the museum would be within the 105-B Reactor building itself, near the east end of a proposed State park. The new park would include the south shore of the Columbia River extending from the Vernita Bridge rest area on State Highway 240, eastward to the 100-B Area (a distance of about 6 km [4 mi]). The park area, the road providing access from Highway 240, and the museum area would be fenced off from the adjacent Hanford area. Ideally, access would be by private automobile, by train across the Hanford Site from Richland, and by boat from the Columbia River.

The B Reactor was entered into the National Register of Historic Places on April 3, 1992, by the National Park Service. Because of this placement, DOE must comply with the *National Historic Preservation Act* (16 U.S.C. 470) prior to taking any action on the historic site. A report, entitled *105-B Reactor Facility Museum Phase I Feasibility Study Report* (BHI 1995a), concluded that the use of the facility as a museum is feasible.

along the Hanford Reach. A sixth site, just north of Energy Northwest (formerly known as WPPSS), would also provide visitor services for recreational trails (e.g., hiking and biking) along the Hanford Reach. On the Wahluke Slope side of the Columbia River, the White Bluffs boat launch would remain managed as is, with a Low-Intensity Recreation designation. A Low-Intensity Recreation designation for the water surface of the Columbia River would be consistent with current management practices and the wishes of many stakeholders in the region.

- The remainder of land within the Columbia River Corridor outside the quarter-mile buffer zone would be designated for Conservation (Mining). This designation would allow for DOE-permitted mining activities and support BLM's mission of multiple use. Mining would be permitted only in support of governmental missions or to further the biological function of wetlands (i.e., conversion of a gravel pit to a wetland by excavating to groundwater). Should DOE determine that some or all of the withdrawn lands are surplus to DOE's needs and releases the Public Domain lands back to the DOI, then the DOI could determine if the Tribal treaty language – "the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land" – is applicable. A Conservation (Mining) designation would allow DOE to provide protection to sensitive cultural and biological resource areas, while allowing access to geologic resources.

- A Preservation land-use designation for the Columbia River islands would be consistent with the Hanford Reach EIS ROD (DOI 1996) and would provide additional protection to sensitive cultural areas, wetlands, floodplains, Upper Columbia Run steelhead, and bald eagles from impacts associated with intensive land-disturbing activities. Remediation activities would continue in the 100 Areas (i.e., 100-B/C, 100-KE, 100-KW, 100-N, 100-D, 100-DR, 100-H, and 100-F), and would be considered a pre-existing, nonconforming use in the Preservation land-use designation.

3.3.2.3.3 The Central Plateau. The Central Plateau (200 Areas) geographic area would be designated for Industrial-Exclusive use. An Industrial-Exclusive land-use designation would allow for continued Waste Management operations within the Central Plateau geographic area. This designation would also allow expansion of existing facilities or development of new compatible facilities. Designating the Central Plateau as Industrial-Exclusive would be consistent with the Working Group's recommendations, current DOE management practice, other governments' recommendations, and many public stakeholder values throughout the region.

To keep the 1975 I&I commitments (see text box in Section 3.3.1.1) and to help maintain the current Waste Management mission, there have been several Notices of Deed Restriction placed with the Benton County Assessor's Office and the Benton County Planning Office. The No-Action Alternative (Figure 3-2) shows where these Notice of Deed Restrictions have been placed across the Hanford Site. They are currently being used mainly for asbestos left in landfills (e.g., the HRL and the Central Waste Complex Landfill) and concrete structures that were surface contaminated (e.g., the 183-H Solar Basins) (BHI 1997). As remediation continues, DOE expects to file more restrictions that would institutionalize the 5-m (15-ft) depth restriction for excavation in the 100 Areas CERCLA RODs, the Industrial land-use restriction CERCLA ROD in the 300 Area, the expected Industrial land-use RODs for the Central Plateau, and point-of-compliance boundaries for groundwater remediation or LLW disposal facility

performance assessment purposes. After incorporating by reference the previous 1975 ERDA 1538 irreversible and irretrievable (I&I) commitments and other documented commitments into this EIS (see Section 1.3), future individual project land-use requirements would be I&I committed through the appropriate NEPA and CERCLA/RCRA/NEPA integrated processes.

3.3.2.3.4 The All Other Areas. Within the All Other Areas geographic area, the Preferred Alternative would include Industrial, Research and Development, High-Intensity Recreation, Low-Intensity Recreation, Conservation, and Preservation land-use designations. The majority of the All Other Areas would be designated Conservation (Mining) to support a possible BLM's mission of multiple uses.

Several areas that would be designated as Conservation (Mining) would be unable to fulfill the designated land use:

- A Notice of Deed Restriction would be placed in those areas where vadose zone contamination remained in-place, according to the CERCLA ROD or RCRA Closure Permit (e.g., the HRL, Central Waste Complex, 183-H Solar Basins, etc.), foreclosing the mining option.

- The section of Washington State land that is deed restricted to waste management activities would be designated as Conservation (Mining) consistent with Benton County's Alternative Three (GMA authority) and, therefore, could not fulfill any waste management purpose.

Other land-use designations would introduce new land management priorities into the All Other Areas. These designations and the areas affected are as follows:

- Two distinct areas, one located east of the 200 Areas (i.e., May Junction) and the other located north of Richland, would be designated for Industrial use to support new DOE missions or economic development. This designation would provide additional industrial development and/or expansion area for current facilities.

- An area west of State Highway 10 and east of State Highway 240 would be designated for Research and Development to support economic diversification and DOE's Energy Research mission. This area would allow for the development of R&D facilities, such as LIGO, which could require substantial buffer zones for operation. In addition, R&D facilities not requiring large areas for operation would also be located within this area.

- A small area at the junction of State Highway 10 and State Highway 240 would be designated High Intensity Recreation to allow for visitor serving facilities at the gateway to the Hanford Reach, ALE, Horn Rapids Park and other recreational activities.

- Gable Mountain, Gable Butte, the area west of State Highway 240 from the Columbia River across Umtanum Ridge to the ALE Reserve, and the active sand dunes areas would be designated for Preservation, which would provide additional protection of these sensitive areas. The extant railroad grade across the Riverlands area would be considered an active permitted infrastructure.

After incorporating by reference the previous 1975 ERDA 1538 irreversible and irretrievable (I&I) commitments and other documented commitments into this EIS (see Section 1.3), future individual project land-use requirements would be I&I committed through the appropriate NEPA and CERCLA/RCRA/NEPA integrated processes.

3.3.2.3.5 The Fitzner/Eberhardt Arid Lands Ecology Reserve (ALE Reserve). Nearly all of the ALE Reserve geographic area would be designated as Preservation. This designation would be consistent with current management practices of the Rattlesnake Hills Research Natural Area and the USFWS permit. A portion of the ALE Reserve would be managed as Conservation (Mining) during the remediation of the Hanford Site as a trade-off developed during the cooperating agencies discussions for preservation of a wildlife corridor through the McGee Ranch and after public comment, the inclusion of the McGee Ranch within the Refuge designation. The wildlife corridor through the McGee Ranch/Umtanum Ridge area had been identified by DOE as the preferred quarry site for basalt rock and silty soil materials that could be required for large waste-management area covers (RCRA caps or the Hanford Barrier) in the Central Plateau. In addition to the wildlife corridor function, the mature shrub-steppe vegetation structure in the McGee Ranch area has greater wildlife value (i.e., BRMaP Levels III and IV) than the cheat grass (BRMaP Level I) in the ALE Reserve quarry site (see Section 5.1.2). The BRMaP (DOE-RL 1996c) levels of concern run from Level I through Level IV, increasing in biological importance as the numbers increase, with Level I being the level of least importance.

3.3.3 Alternative One

3.3.3.1 Planning Goals, Objectives, and Values (Vision). Alternative One represents a Federal stewardship role for managing national resources on the Hanford Site with the acknowledged consumptive treaty-reserved "right of taking fish at all usual and accustomed places in common with citizens of the Territory; and of erecting temporary (suitable instead of temporary for the CTUIR) buildings for curing." This does not include the tribal vision of consumptive non-fishing activities by tribal member's exercising their reserved treaty rights, implicit in Alternatives Two and Four. Specifically these rights are, "the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle (stock instead of horses and cattle for the CTUIR) upon open and unclaimed land" (just unclaimed and not open and unclaimed for the CTUIR). The DOE regards Alternative One as the Environmentally Preferable Alternative.

Environmentally Preferable Alternative

Section 1505.2(b) of CEQ's NEPA regulations requires that in cases where an EIS has been prepared, the Record of Decision (ROD) must identify all alternatives that were considered, ". . . specifying the alternative or alternatives which were considered to be environmentally preferable." The environmentally preferable alternative is the alternative that will promote the national environmental policy as expressed in NEPA's Section 101. Ordinarily, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources.

The land-use designations included in Alternative One are presented in Figure 3-4. This alternative considers Hanford resources (i.e., ecological, historic, cultural, and economic resources) in a regional context. Enlarging the existing Federal Saddle Mountain NWR, to include all of the undisturbed natural area north and east of the Columbia River and west of State Highways 24 and 240, is seen as the best way to preserve these resources. The vision of Alternative One is to preserve the Hanford Site shrub-steppe ecosystem by protecting the high-quality habitat that runs contiguously along the west of the Site from the Wahluke Slope to the ALE Reserve, and at the same time, protect the Hanford Reach of the Columbia River.

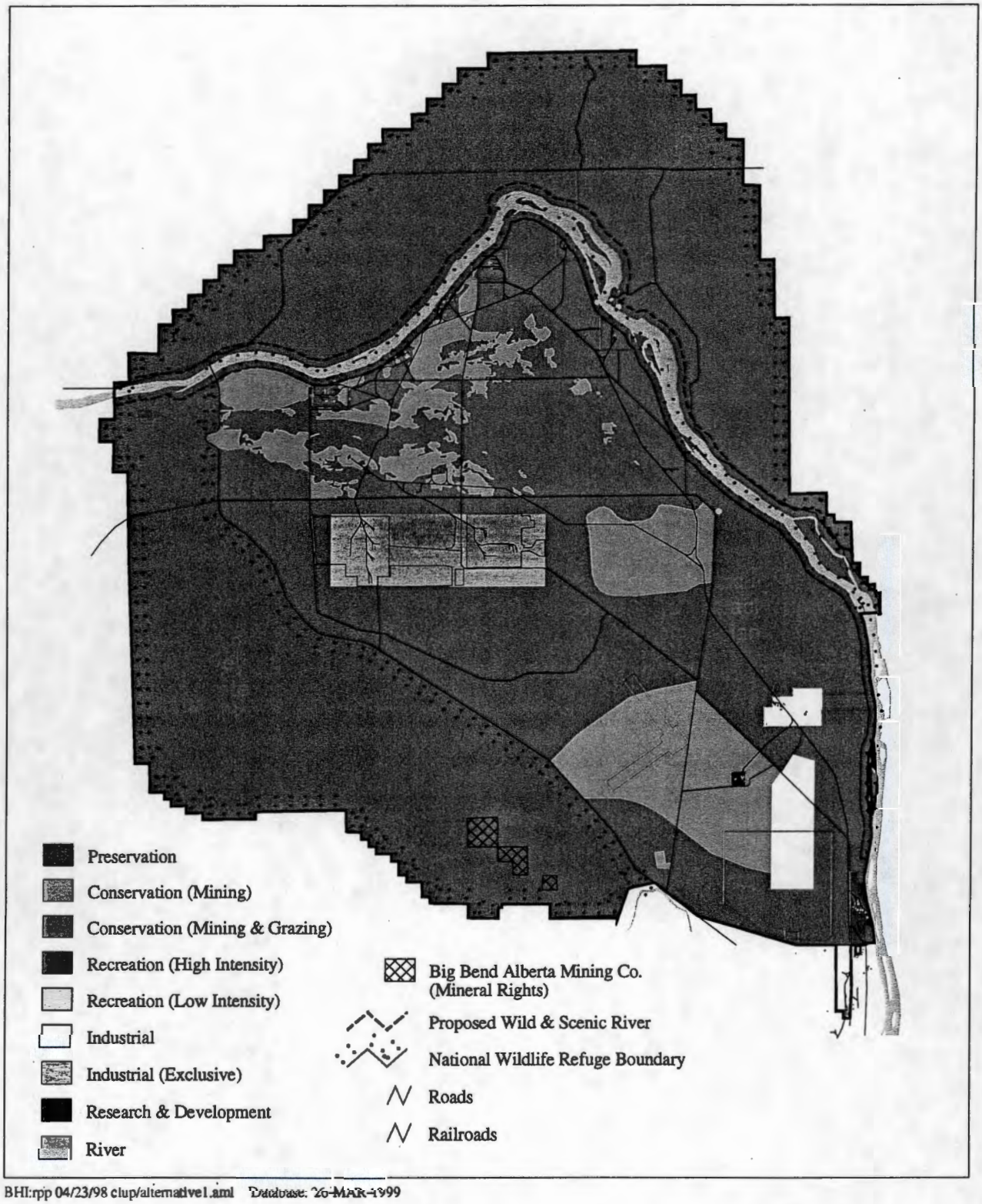
Alternative One was developed using the seven land-use planning goals listed below:

- Integrate mission, economic, ecological, social, and cultural factors as stated in the Secretary of Energy's *Land- and Facility-Use Policy* (DOE 1994b), which includes sustaining the valuable biological resources of the Hanford Site and supporting sustainable economic development.
- Support the Rattlesnake Hills Research Natural Area, established in 1971.
- Reduce the inappropriate conversion of undeveloped land into sprawling, low-density development by encouraging siting of high-density development areas.
- Achieve ecosystem planning based on a regional perspective.

Commonly Identified Goals of Alternative One

- Encourage economic development and diversification.
- Protect the Columbia River.
- Use the Central Plateau wisely for Waste Management.
- Do no harm during cleanup.
- Recognize the importance of ecological diversity and recreational opportunities and that the quality of those resources should be maintained or improved as a result of cleanup and Waste Management decisions.
- Protect the integrity of all biological resources, with specific attention given to rare, threatened, and endangered species and their habitats.

Figure 3-4. Alternative One.



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- Preserve the lands, sites, and structures of historical, cultural, or archaeological significance on the Hanford Site.

- Consider the resource needs of the Hanford cleanup program.

- Encourage the retention of open space.

The land-use designations in Alternative One incorporate the commonly identified goals of the Working Group, Hanford Tank Waste Task Force, and HAB as well as DOE's adoption of these stakeholder values (see text box, "*Commonly Identified Goals of Alternative One*").

Wildlife Viewing in Washington

More than a third of the population in Washington state participates in wildlife viewing and those wildlife watchers spent nearly $1.7 billion on the pursuit in 1996, according to a 1998 WDFW report.

The "Economic Benefits of Wildlife-Watching Activities in Washington" report found that wildlife watchers spent $1.1 billion on equipment purchases, $509 million on trip-related expenses including food and lodging, $106 million for land-use fees and rentals, and $59 million for items such as magazines, books, membership dues, and other items.

The popularity of wildlife-viewing activities in Washington translates to:

- Nearly 8,000 jobs supported by watchable wildlife activities.
- Destination tourism drawing about 270,000 out-of-state visitors who spent nearly 6 million visitor-days here in 1996.
- State sales tax proceeds amounting to $56.9 million.

The growing interest in wildlife viewing prompted WDFW to establish a Watchable Wildlife program in 1997, aimed at providing recreational opportunities to the public, promoting understanding of wildlife habitat needs and linking wildlife conservation and management to economic opportunities in local communities.

The objectives of Alternative One are to promote, through the enlargement of an existing Federal wildlife refuge, the protection and recovery of state and federally listed species, a wide range of fish and wildlife recreational opportunities (see text box, "*Wildlife Viewing in Washington*"), aquatic and terrestrial habitats and associated fish and wildlife populations, and the utilization of the existing infrastructure (especially in the southeast portion of the Site and the Central Plateau) for development. The vision of Alternative One is to conserve the Hanford Site shrub-steppe ecosystem, which provides a sanctuary for River and riparian areas to maintain the high quality of the salmon and steelhead spawning areas, and to maintain a habitat link between the Hanford Site and the Yakima Training Center, which is Washington State's second largest shrub-steppe ecosystem. This would ensure conservation of the region's shrub-steppe heritage for future generations to enjoy.

3.3.3.2 Assumptions Regarding Future Use. The assumptions used to develop Alternative One are as follows:

- Existing hazardous waste and ongoing remedial actions will require DOE to maintain control of portions of the Site for the proposed planning period.

- DOE control of the Site will be required to provide a safety buffer for the public from unforeseeable accidents that pose health risks to workers and the public (e.g., the Plutonium Reclamation Facility explosion) during the cleanup mission.

- Plutonium production reactor blocks will remain in the 100 Areas throughout the planning period and will be considered a pre-existing, nonconforming use.

- DOE will continue to practice "as low as reasonably achievable" (ALARA) management designed to keep human exposure to a minimum by only approving staff and projects on the Hanford Site necessary for management of radioactive and hazardous wastes. The intent of the ALARA program is to avoid unnecessary exposure and potential risks from radioactive, hazardous, or biological materials to

workers, public, and/or the environment. These risks could include unexpected air releases.

- DOE will find new missions for buildings in the 300 and 400 Areas for exploring new technologies related to the treatment and handling of hazardous waste, developing energy technologies, and other DOE missions. These new missions may be conducted by Federal and non-Federal entities.

- Expansion for future development during the planning period will not exceed historical acreage used by DOE and its predecessors. This projected future development expansion will occur as high-density development to conserve the other natural resources present on the Site.

- Stewardship will be based on the principles of ecosystem management and sustainable development.

- Existing permits and Memoranda of Agreement made by DOE with other entities for land-management purposes will continue, with the exception of the Wahluke State Wildlife Recreation Area, which be terminated to allow management of the expanded Saddle Mountain NWR by the USFWS.

- USFWS will manage the ALE Reserve, McGee Ranch site, Riverlands, and Wahluke State Wildlife Recreation Area.

- The R&D necessary for cleanup will occur in a manner that creates additional private-sector economic development opportunities.

- Quarry sites will support DOE's remediation construction and infrastructure maintenance needs. No commercial use of the quarries will occur during this planning period.

3.3.3.3 Application of the Land-Use Designations. Alternative One land-use designations include Industrial-Exclusive, Industrial, Research and Development, High-Intensity Recreation, Low-Intensity Recreation, Conservation (Mining), and Preservation. The location, shape, and size of the land-use designations were based on analysis of the existing natural and man-made resources (e.g., infrastructure, topography, and biology, etc.) found in Chapter 4 and land-use projects for economic development, which are also found in Chapter 4.

3.3.3.3.1 The Wahluke Slope. The land-use designation for the Wahluke Slope under Alternative One would be Preservation. The Wahluke Slope is currently administered for wildlife and recreation as the Saddle Mountain NWR and the Wahluke Wildlife Recreation Area under permits granted by DOE to the USFWS and WDFW. Management of the Wahluke Slope would be consolidated under the USFWS as a portion of the Saddle Mountain NWR.

The Saddle Mountain NWR would be designated Preservation, which is consistent with the current administered land use. Preservation would provide a protective safety buffer zone for DOE remedial activities in the 100 Areas. These DOE activities are expected to continue for the planning period, and would continue to provide a sanctuary for shrub-steppe dependent species that inhabit the area. Preservation would also prevent activities within the BoR's Red Zone (an area where irrigation is restricted because it accelerates mud slides along the Columbia River) that could jeopardize stability of the White Bluffs. Preservation would not interfere with the BoR's management of the Columbia Basin Project's irrigation wasteways because they would be considered a pre-existing, nonconforming use. An agreement would be

established by the DOI between its four agencies (i.e., USFWS, BoR, NPS, and BLM) to enable all to fulfill their Congressionally mandated missions on the Wahluke Slope.

Agriculture (cropland) is a feature of some refuges, and was considered for portions of the Wahluke Slope consistent with currently administered wildlife sharecropping programs (see text box, "*Cropland Management on National Wildlife Refuges*"). Currently, there is a significant amount of privately held agricultural lands in the region that the U.S. Department of Agriculture is protecting (i.e., the lands are not being used for agriculture) for either environmental or cultural reasons under the Conservation Reserve Enhancement Program (CREP) (see Table 3-2). In addition, the markets for apples, potatoes, and wheat are currently soft with the apple industry examining the need to take trees out of production (TCH 1998a).

In consideration of the natural resource trustee's Congressional mandate to preserve and protect endangered ecosystems such as the shrub-steppe, expanding the agricultural base in the region -- while possible under a NWR scenario -- is not considered to be an appropriate use of the Wahluke Slope lands and their dependent fisheries resources.

Cropland Management on National Wildlife Refuges

In 1992, estimated cropland in the NWR System was approximately 82,556 ha [204,000 ac] (1.4% of refuge system lands outside of Alaska), down from 8,903 ha (222,000 ac) (1.9% of refuge system lands outside of Alaska) in 1974. Former croplands have been allowed to undergo natural succession, have been planted with desired grasses, trees, or shrubs; or have been converted in some cases to managed moist soil wetland units, according to a USFSW report.

Of the 181 refuges with farming programs in 1989, 129 refuges (and 61,917 ha [153,000 ac]) were farmed by permittees who retained a share of the crop in return for costs incurred to farm the land. On the remaining refuges, USFWS personnel conduct farming operations with government equipment.

Soil preparation, manipulation and treatment practices on refuge croplands are based on sound land-use soil conservation practices. Techniques used include contour farming, cover cropping, windrow planting, sodding waterways, eliminating fall and spring plowing, stubble mulching, and using shallow water retention structures.

On many refuges, crops are systematically rotated and legumes are incorporated with grain crops to improve soil tilth and nutrient content and to reduce weed problems. Biological farming is the preferred farming method on refuges.

3.3.3.3.2 The Columbia River Corridor. Land-use designations for the Columbia River Corridor under Alternative One would include High-Intensity Recreation, Low-Intensity Recreation, Conservation (Mining), and Preservation.

Table 3-2. 1997 Regional Conservation Reserve Enhancement Program (CREP) (USDA 1998).

County	Acres	Rental Payment per Acre in 1997	CREP Cost in 1997
Adams County	91,794.00	$45.45	$4,172,037.00
Benton County	29,703.00	$40.63	$1,206,833.00
Franklin County	32,524.00	$48.95	$1,592,050.00
Grant County	25,891.00	$44.64	$1,155,774.00
Hanford Region	179,912.00	$44.92	$8,126,694.00

The Columbia River islands within the Hanford Site boundary would be designated for Preservation and included in the Saddle Mountain NWR to maintain important areas for wildlife. Wildlife species using these islands include mule deer, American white pelicans, sandhill cranes, waterfowl, and ring-necked pheasant. A significant area of the Upper Columbia River

summer/fall-run chinook salmon spawning habitat is located near these islands, as well as potential juvenile rearing habitat for the federally listed Upper Columbia River spring-run chinook salmon (Endangered listed -3/99), Middle Columbia River steelhead (Threatened listed-3/99), and Upper Columbia River steelhead (Endangered listed-8/97).

The Columbia River Corridor itself includes Low-Intensity Recreation, High-Intensity Recreation, Conservation (Mining), and Preservation land-use designations. The Low-Intensity Recreation areas would include an existing unimproved boat ramp on the Benton County side of the corridor at the White Bluffs. Use of the boat ramp would be restricted to emergency responses to protect suitable bald eagle nesting habitat. Restrictions would be consistent with the *Hanford Site Bald Eagle Management Plan* (DOE-RL 1994b). The High-Intensity Recreation area currently includes an existing highway rest area on the west side of State Highway 240 at Vernita Bridge. The rest area is leased from DOE by the Washington Department of Transportation. A boat ramp facility has been proposed east of the highway across from the rest area on the Benton County side. The Preservation designation would provide protection for ecologically and culturally sensitive areas being considered for protection under the Wild and Scenic Recreational River designation (DOI 1996) and would be consistent with the current management of the Saddle Mountain NWR.

The 100 Areas would include High-Intensity Recreation, Conservation (Mining), and Preservation land-use designations. The B Reactor would be designated High-Intensity Recreation to allow tourism of the federally registered landmark and would be consistent with the B Reactor Museum proposal. Radioactive contamination would remain below 4.6 m (15 ft) in the 100 Areas vadose zone. During the planning period for this document (at least the next 50 years), the spent fuel will be removed from the K Basins. Associated environmental risks were evaluated in the K Basin EIS (DOE 1996b).

3.3.3.3.3 The Central Plateau. The Central Plateau would include Industrial-Exclusive and Preservation land-use designations. The Central Plateau includes undeveloped and uncontaminated land, the majority of which has been designated priority shrub-steppe habitat by the WDFW. Potential future Hanford Site projects include a full-scale, low-level vitrification plant and a burial ground for eight reactor cores (DOE 1992a). The remaining undeveloped areas would be considered sufficient for the preferred regional alternative of DOE's Programmatic Waste Management EIS (DOE 1997a). Under the Programmatic EIS preferred regional alternative, the Central Plateau would be committed to waste management from other DOE sites. Although this land-use designation does not include Research and Development, R&D projects specific to DOE waste management activities would be allowed. Mitigations for impacts from all the previously mentioned, and any unforeseeable projects, would be consistent with the Draft *Hanford Site Biological Resources Management Plan* (BRMaP) (DOE-RL 1996c).

Land west of the currently developed 200 West Area within the Central Plateau geographic area would be designated Preservation. This area contains high-quality mature sagebrush, which provides essential habitat for shrub-steppe dependent species. This designation would prevent additional sprawl to the west and encourage siting of new projects between the 200 East and 200 West Areas.

3.3.3.3.4 The All Other Areas. The All Other Areas geographic area under Alternative One would include Industrial, Research and Development, Low-Intensity Recreation, Conservation (Mining), and Preservation land-use designations. All development (i.e., Industrial, and Research and Development) would occur south of Energy Northwest (formerly known as WPPSS), inclusive. This development would include transition of existing facilities in the 1100, 300, and 400 Areas and the Energy Northwest area to potential uses such as high technology incubators, manufacturing, and medical isotope production. The majority of non-Federal uses

would occur offsite or within a portion of the area identified by the City of Richland's urban growth area (UGA) boundary in the southeast portion of the Site. This reduced UGA would include Industrial and Research and Development. The DOE's industrial needs could also be met within the approximately 5.2 km^2 (4 mi^2) of land identified for industrial use between Energy Northwest and the UGA boundary. This 5.2 km^2 (4 mi^2) area contains low-quality habitat. Just west of the Industrial designation is an extensive tract of seral shrub-steppe habitat which has been designated Conservation (Mining). As the canopy cover increases, this seral shrub-steppe habitat will become more important for shrub-steppe dependent species as additional shrub-steppe habitat is destroyed offsite.

Wildlife corridors designated as Preservation would be located around this industrial development to allow wildlife movements between the ALE Reserve, the Columbia River, and the Saddle Mountain NWR. Between the western boundary and State Highway 240, a wildlife corridor would run north from the ALE Reserve to the Columbia River. This northwestern wildlife corridor would include the areas known as McGee Ranch and the river lands. Within the southeastern wildlife corridor north of the Yakima River, a small area would be designated Conservation (Mining) to allow potential extraction of geologic materials for use in the 200 Areas remedial efforts. Considering this as a quarry site for basalt and soil provides DOE with the option to designate Gable Mountain, Gable Butte, and West Haven as Preservation because of their significant cultural value; and also to designate, as Preservation, the McGee Ranch site (which is DOE land north and west of Highway 24 and south of the Columbia River). This Preservation designation, including the McGee Ranch site as part of the expansion of the Saddle Mountain NWR, would help preserve and protect an important habitat link between the Hanford Site and the Yakima Training Center.

3.3.3.3.5 The Fitzner/Eberhardt Arid Lands Ecology Reserve (ALE Reserve). The ALE Reserve geographic area would be designated Preservation consistent with the management of the expanded Saddle Mountain NWR. Preservation and management of the ALE Reserve as an expansion of the Saddle Mountain NWR would protect the rare and high-quality shrub-steppe plant communities and unique and rare fauna that reside on this portion of the Site. Many of these plant communities and fauna are found nowhere else in the state of Washington or in the Columbia Basin eco-region. Providing an expanded Saddle Mountain NWR for a biological sanctuary of shrub-steppe dependent species would assist agricultural and industrial development in other areas of the Columbia Basin's shrub-steppe community by partially fulfilling the mandate to preserve species under the *Endangered Species Act of 1973.*

3.3.4 Alternative Two

3.3.4.1 Planning Goals, Objectives, and Values (Vision). Alternative Two presents the vision of the Nez Perce Tribe, Department for Environmental Restoration and Waste Management and incorporates their vision of Federal trust responsibility to the Indian Tribes (Figure 3-5). This vision calls for preservation of the natural and cultural resources at the Hanford Site. Traditional Tribal use is consistent with the Preservation land-use designation. Protection of cultural resources at the Hanford Site is the top priority of Alternative Two. Sharing the Nez Perce Tribe's knowledge and point of view about sacred sites and nature with everyone is vitally important. Cultural resources remain important to the Nez Perce Tribe's way of life and are part of the Tribe's tradition.

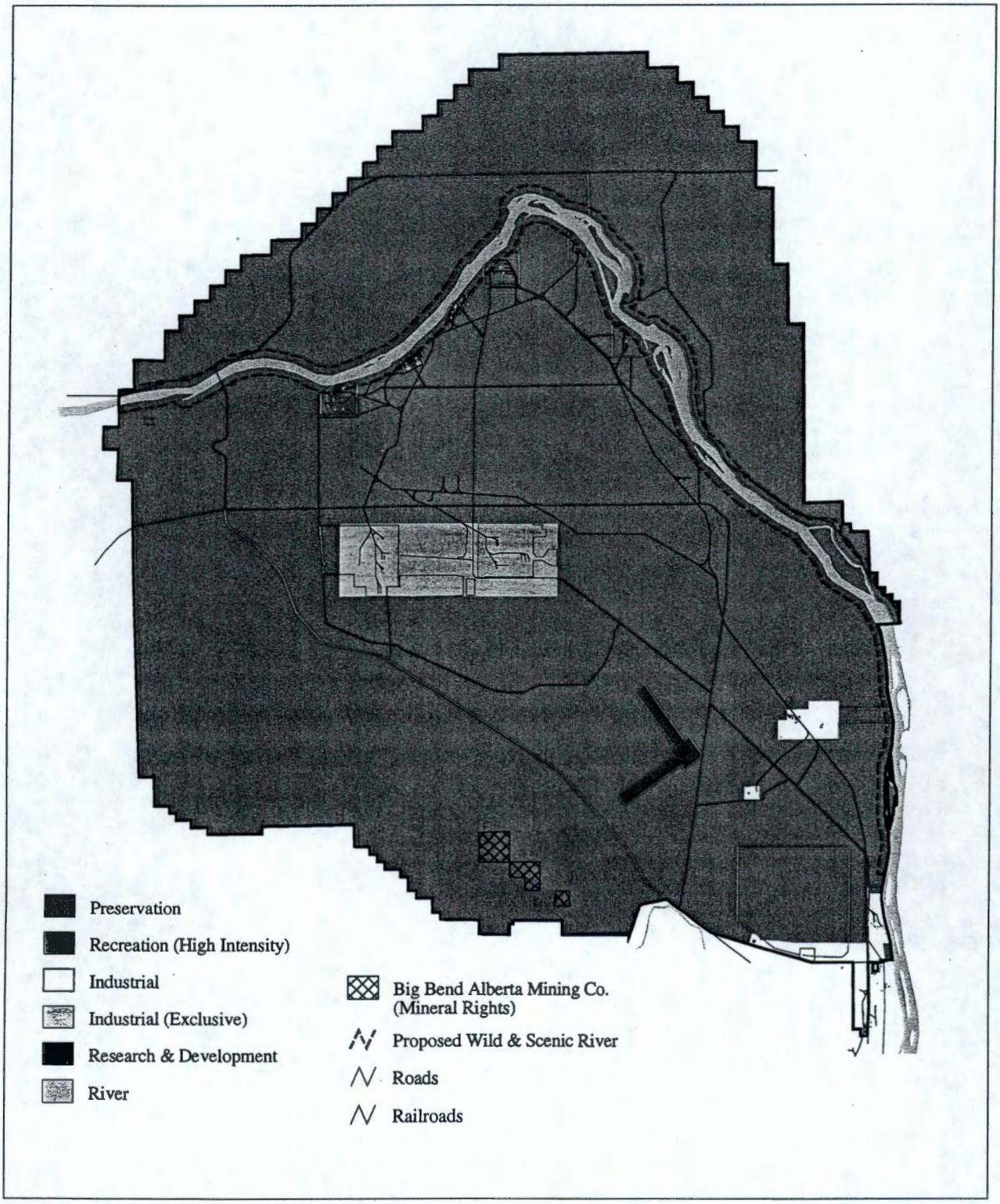
The Hanford Site, including the Columbia River, has a history of serving as a gathering place for Indian Nations to hunt, fish, trade, and feast. The Nez Perce have shared and participated in these known ancient and traditional activities with other Tribes when and where there were no fences, boundary lines, or treaties. The Hanford Site is one of the largest areas of land in the Pacific Northwest region that has not been developed, with agriculture being the principal development on surrounding lands. The Hanford Site contains the last nontidal, unimpounded section of the Columbia River in the United States, and the Hanford Reach is the only remaining area on the Columbia River where Chinook salmon still spawn naturally. The ALE Reserve geographic area contains one of the few resident elk herds in the world that inhabit a semi-arid area, and the ALE Reserve is one of the largest remnants of relatively undisturbed shrub-steppe ecosystem in the State of Washington. Approximately 50 species of animals that are classified as "sensitive species" currently reside at the Hanford Site. The largest population of sage sparrows in Washington State can also be found at Hanford.

The Nez Perce have always considered that the land and its creatures are essential to everyday life. Humans are considered to be only one small part of a much larger circle of life on the earth. Nez Perce stories exemplify this intimate relationship between humans and the earth, and traditional Nez Perce culture weaves an intimate relationship between humanity and nature. In all phases of their daily lives, the Nez Perce recognize the spirits of the forces and objects around them as supernatural guardian forms, which they call in a personal way their *Wyakin.* The Nez Perce identify themselves with all the natural features of the earth. In the Nez Perce's belief, the earth is the ever-nourishing mother, as any mother provides for a child. We must continue to be caretakers of the earth, or life will surely soon end. These values are used in developing Alternative Two.

3.3.4.2 Assumptions Regarding Future Use. The assumptions used to develop Alternative Two are as follows:

- Potential industrial and recreational development of the City of Richland and Benton County will primarily occur outside of the Hanford Site's boundary and close to Benton County's population centers.
- Remediation of the Hanford Site will continue, and the security measures currently in place will continue to be required.
- Plutonium production reactor blocks will remain in the 100 Areas throughout the planning period and will be considered a pre-existing, nonconforming use.
- The last nontidal, unimpounded section of the Columbia River, and the salmon habitat found therein, as well as cultural resources of the indigenous people who pre-date the Federal government will be protected.

Figure 3-5. Alternative Two.



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- The retained rights to the area, as recognized and affirmed by the Federal government in treaties with the affected Native American Tribes, will be protected.
- International treaties concerned with protecting salmon and other wildlife will be honored.
- With DOE's mission change from defense production to environmental restoration, the land needs of future DOE missions could be contained in the Central Plateau, 400 Area, and 300 Area.
- Major portions of the Site could not be conveyed to private ownership due to soil contamination left at depth after remediation.
- Existing contaminated groundwater conditions would not preclude development in any given location but would be considered a constraint to groundwater use and prevent transfer to private ownership, as the private sector would be unable and unwilling to accept the environmental liabilities.

3.3.4.3 Application of the Land-Use Designations. Alternative Two's land-use designations include Industrial-Exclusive, Industrial, Research and Development, High-Intensity Recreation, and Preservation. The location, shape, and size of the land-use designations were influenced by a thorough analysis of the existing cultural resources, the hazards and resources created by humans, and the geology.

3.3.4.3.1 The Wahluke Slope. Alternative Two would designate the entire Wahluke Slope as Preservation. Preservation would prohibit irrigation of the Wahluke Slope because irrigation is accelerating sloughing of the White Bluffs along the Hanford Reach of the Columbia River. Sloughing of the bluffs, or other activities that change the course of the Columbia River such as dredging or mining, could release chemical and radioactive contaminants that have been entombed within the fine sediments of the Hanford Reach.

Preservation would protect the last nontidal, unimpounded section of Columbia River and the salmon habitat found within, as well as the cultural resources of the indigenous people who pre-date the Federal government. Preservation would honor retained Tribal rights as recognized and affirmed by the United States of America in the *Treaties of 1855* with the affected Tribes (Appendix A), as well as complying with international fishing treaties. Preservation would prevent an additional appropriation of water from the Columbia River in order to support development of lands on the Wahluke Slope. The Wahluke Slope is not in acreage that has been appropriated water from the (57 U.S.C. 14). Finally, a Preservation designation would be appropriate because a large portion of the Wahluke Slope is too steep to develop (see Section 4.2).

3.3.4.3.2 The Columbia River Corridor. The Columbia River Corridor would include High-Intensity Recreation, Low-Intensity Recreation, Research and Development, and Preservation land-use designations. The Columbia River (surface water only) would be designated for Low-Intensity Recreation. The Nez Perce Tribe supports a Preservation designation for the islands in the Columbia River and the designation of the Hanford Reach as a "wild and scenic" river under Federal control. The B Reactor and surrounding area, which are located within the Columbia River Corridor, would be designated for High-Intensity Recreation and would allow conversion of the reactor into a museum with museum-related facilities. The B Reactor was the first full-scale nuclear reactor in the world and was critical in the development

of the first nuclear weapons. The K Reactor area would be designated for Research and Development. The K Reactor area could be used by the Tribes and others for fish farming or for aquaculture and aquatic research.

The remainder of land within the 100 Areas would be designated Preservation. Preservation would protect retained rights of American Indian Tribes to the area and would protect sensitive cultural and biological resource areas. Prohibiting further irrigation and other land uses that increase infiltration on both sides of the Hanford Reach would aid in the stabilization of the Columbia River shoreline. Prohibiting irrigation would protect public health and the environment by preventing remobilization of contaminants entombed within the river's sediment and the shoreline's soil column, and would prevent siltation and destruction of salmon spawning beds. Preservation prohibiting irrigation near the reactor areas would mitigate mobilizing contaminants left behind at depth long after cleanup efforts have ceased (see Section 4.11). Because the cleanup efforts in the 100 Area's soil column are limited to a depth of about 6.1 m (20 ft) below ground surface, the contaminants remaining in the soil column below 6.1 m (20 ft) will not be remediated.

3.3.4.3.3 The Central Plateau. The majority of land within the Central Plateau geographic area would be designated Industrial-Exclusive, allowing for continued management of radioactive and hazardous waste. These management activities include collection and disposal of radioactive and hazardous waste materials that remain onsite, contaminated soil and groundwater containment and cleanup, and other related and compatible uses. Deed restrictions or covenants could be applied to this area through the CERCLA and RCRA processes. This designation would allow for expansion of existing facilities or the development of new facilities for Waste Management or other DOE missions.

Land west of the currently developed 200 West Area within the Central Plateau geographic area would be Preservation. This area contains high-quality mature sagebrush, which provides this essential habitat for shrub-steppe dependent species. This designation would prevent additional sprawl to the west and encourage siting of new projects between the 200 East and 200 West Areas.

3.3.4.3.4 The All Other Areas. The All Other Areas geographic area would include Industrial, Research and Development, and Preservation. Alternative Two designates, as Industrial, the City of Richland UGA, the 400 Area (including the Fast Flux Test Facility), and Energy Northwest (formerly known as WPPSS) to allow for future economic development. An Industrial designation would accommodate economic development of the area identified by the City of Richland's UGA boundary at the southeast portion of the Site for at least the next 50 years. An Industrial designation would also reserve the 400 Area for DOE missions and the Energy Northwest (formerly known as WPPSS) area for use by Energy Northwest. The area around LIGO within the All Other Areas geographic area would be designated Research and Development, consistent with current management practices.

The remainder of the All Other Areas geographic area would be designated Preservation. Major constraints identified in the *Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land-Use Plan* (DOE 1996) demonstrated that the majority of the Hanford Site is unsuitable for economic development, and that the best future land use would be Preservation. Designating the majority of the All Other Areas as Preservation is appropriate because, while portions of the All Others Areas geographic area have a well-developed transportation network, these areas are remote from population centers thus limiting their economic potential. A sand dune complex and vegetation-stabilized sand dunes, which extend from the Columbia River westward across the Site to State Highway 240 (see Section 4.5), should not be developed because vegetation-disturbing activity might

reactivate stabilized dune fields. Soil and groundwater contamination remaining at depth after remediation prevents these lands from being exploited for economic reasons due to the difficulties involved in transferring public lands with environmental liabilities to private ownership. For example, the widespread environmental contamination from the 200-BC cribs is approximately 32.1 km^2 (12 mi^2). A Preservation designation also precludes extensive economic development of the All Other Areas geographic area because of the large exclusive-use zones (safety buffers) around the Hanford Site's existing nuclear facilities (see Section 4.11). Additionally, the nature of the research conducted at LIGO requires a substantial seismic buffer zone for operation.

The promontories of Gable Mountain, Gable Butte, Umtanum Ridge, and a large portion of their viewsheds would be designated Preservation, consistent with traditional Tribal use. The *Old Indians* went to high mountains seeking vision sites and to fast for a few days to seek a vision or a *Wyakin* (which is the Nez Perce word for your personal vision spirit that will protect you for the rest of your life). The *Wyakin* could be a bird, four-legged animal, plant, or root, and it will be your personal medicine. During a vision quest, one looks at the big picture or the view as far as the eye can see. This view encompasses the big river, creeks, springs, the various grasses, shrubs, animals, birds, and even insects such as ants. These things and objects all have their place and souls on the mother earth; one prays to the Creator to bless you and ask him to take care of all these things.

To preserve these cultural resources (including wildlife), the large contiguous tract of shrub-steppe habitat in the All Other Areas surrounding the Central Plateau is designated Preservation. The resident elk herd, one of the largest remnants of relatively undisturbed shrub-steppe ecosystem, and viewsheds for American Indian vision sites (e.g., Gable Butte and Gable Mountain) would all be protected by a Preservation land-use designation. The Preservation land-use designation would also ensure that wildlife corridors are maintained.

3.3.4.4 The Fitzner/Eberhardt Arid Lands Ecology Reserve (ALE Reserve). The ALE Reserve geographic area would be designated Preservation in accordance with its management as the Rattlesnake Hills Research Natural Area. Currently, the USFWS manages the ALE Reserve for DOE. Privately owned mineral rights exist on the ALE Reserve that were not conveyed to the Federal government when the Hanford Site was formed. The ALE Reserve contains one of the few resident elk herds in the world that inhabit a semiarid area, and the ALE Reserve is one of the largest remnants of relatively undisturbed shrub-steppe ecosystem in Washington State.

3.3.5 Alternative Three

3.3.5.1 Planning Goals, Objectives, and Values (Vision). Benton, Franklin, Grant, and Adams counties and the City of Richland contain portions of the Hanford Site. Alternative Three represents the individual planning efforts of these local governments. The procedures used by these governments to develop Alternative Three vary by each planning jurisdiction. The designations in Grant County reflect the Wahluke 2000 Plan prepared by farming interests in 1992 and supported by Grant County (NPS 1996). The designations in Franklin County result from a land-use analysis conducted by the Franklin County Planning Department; and designations within Benton County were developed per the procedure outlined below:

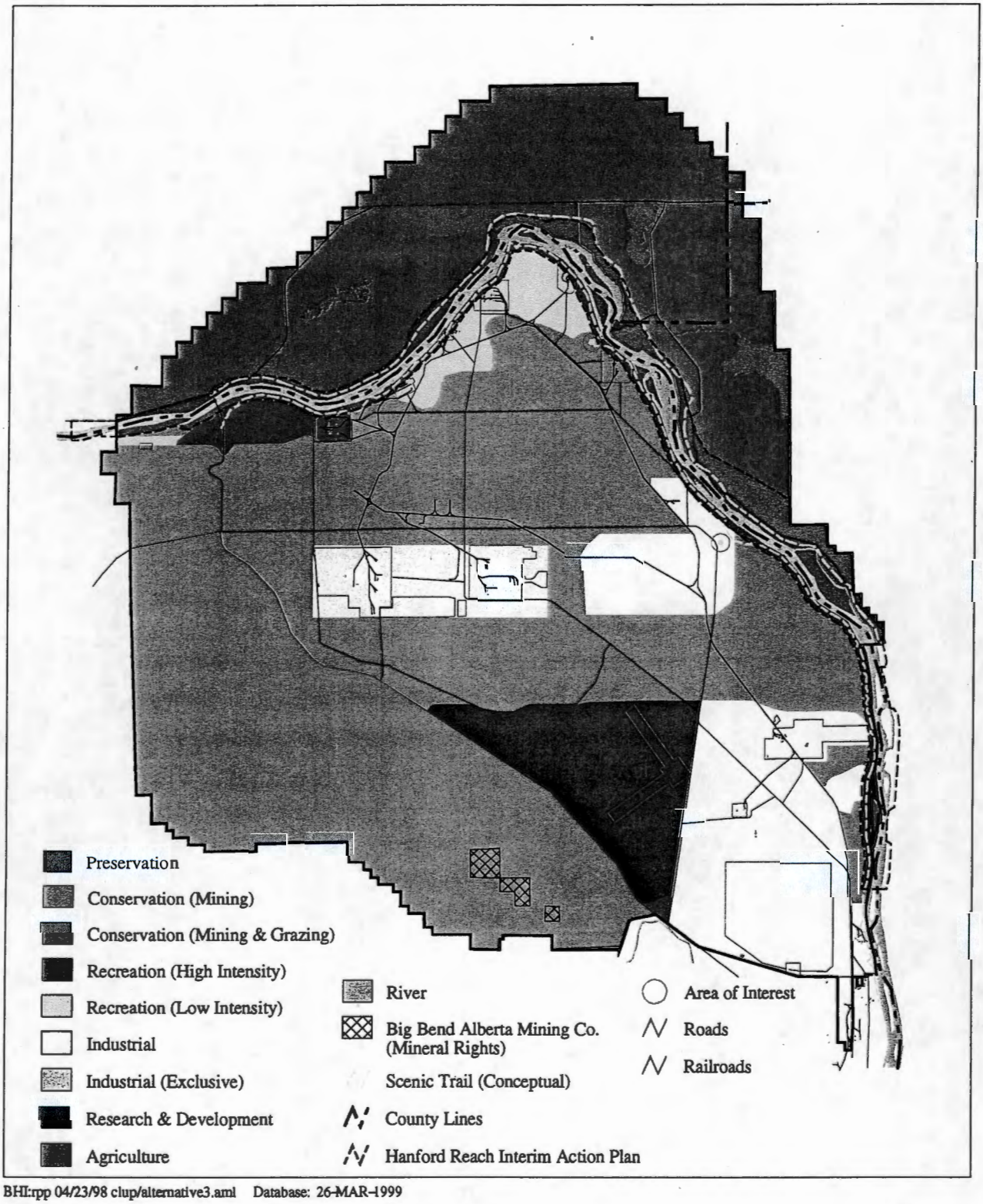
- Existing Hanford Site resources were inventoried, mapped, and characterized.
- Biological resources were identified per the WDFW priority habitat and species data base.
- Natural and biological resources were then translated into five "critical resources," consistent with the GMA, including wetlands, fish and wildlife conservation areas, frequently flooded areas, geologically hazardous areas, and critical aquifer recharge areas.
- An opportunities and constraints analysis was performed using the assembled Hanford Site information.
- Critical resources were placed in a single contiguous designation (i.e., the Conservation land-use designation).
- Areas remaining outside of the Conservation designation were identified as suitable for development and analyzed to determine the appropriate "intensity" of use within the designated area.
- After appropriate intensities were identified for each area suitable for development, land uses were designated consistent with "opportunities and constraints" (e.g., availability of infrastructure, nearness of urban areas, soils capabilities, and current use patterns/future options).

The land-use designations included in Alternative Three are presented in Figure 3-6. The county and city governments believe that the land-use designations for the Hanford Site address identified goals and values of DOE, the City of Richland, Benton County, and the HAB. The goals and values include economic diversification, increased public use for recreation and private enterprise, private-sector utilization of infrastructure, and the protection of biological and cultural resources (see text box, "*Goals and Objectives*").

3.3.5.2 Assumptions Regarding Future Uses. The assumptions used to develop Alternative Three are as follows:

- The Hanford Site will eventually be remediated as recommended by the Working Group.
- Major portions of the Site will be used for multiple private and Federal uses after remediation.

Figure 3-6. Alternative Three.



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- Existing contaminated groundwater conditions will not preclude development in any given location, but will be considered a constraint to groundwater use.

- Plutonium production reactor blocks will remain in the 100 Areas throughout the planning period and will be considered a pre-existing, nonconforming use.

3.3.5.3 Application of the Land-Use Designations. Alternative Three land-use designations include Industrial-Exclusive, Industrial, Agriculture, Research and Development, High-Intensity Recreation, Low-Intensity Recreation, Conservation (Mining), Conservation (Mining and Grazing), and Preservation.

For Site lands within Benton County, the location, shape, and size of the land-use designations were determined by analyzing the existing natural and man-made resources (e.g., infrastructure, topography, and biology) described in Chapter 4 (see text box, "*Allowable and Permitted Uses within the Land-Use Designations of Alternative Three*"). For lands within the Grant County portion of the Site, land-use designations were influenced by the input and analysis resulting from the Benton, Franklin, and Grant County Hanford Reach Citizens Advisory Panel, the Wahluke 2000 Plan, and the Wahluke Slope Element of the Grant County Comprehensive Plan. The lands within the Franklin County portion of the Site went through an analysis similar to that described above. The designations of Preservation, Conservation, Low-Intensity Recreation, and Agriculture on this portion of the Site were developed from onsite analysis and with input from the Benton, Franklin, and Grant County Hanford Reach Citizen's Advisory Panel and the Wahluke 2000 Plan. In addition, the WDFW, the BoR, and the South Columbia Basin Irrigation District provided information.

Goals and Objectives

County and City Objectives (GMA Mandates*)
- Designate city urban growth areas in cooperation with cities.*
- Designate and conserve, by regulation, natural resource lands (i.e., agricultural lands and mineral resources).*
- Designate and conserve, by regulation, critical resources.*
- Protect the environmental, cultural, historical, and economic resources.*
- Maintain functional infrastructure and utilities currently on the Site.
- Provide for Low-Intensity Recreation.

Hanford Advisory Board
- Historic and cultural resources have value. They should not be degraded or destroyed. Appropriate access to those resources is a part of their value.
- The importance of ecological diversity and recreational opportunities should be recognized; these resources should be enhanced as a result of cleanup and Waste Management decisions.
- Cleanup and Waste Management decisions should be coordinated with the efforts of the affected communities to shift toward more private business activity and away from dependence on Federal projects that have adverse environmental or economic impact.
- Cleanup activities should protect to the maximum degree possible the integrity of all biological resources, with specific attention to rare, threatened, and endangered species and their habitats.
- Use the Central Plateau wisely for Waste Management.

Hanford Future Site Uses Working Group (1992)
- Deal realistically and forcefully with groundwater contamination.
- Use the Central Plateau wisely for Waste Management.
- Do no harm with cleanup or new development.

Commonly Identified Goals
- Economic development and diversification
- Protect the Columbia River
- Clean up areas for future use.

Alternative Three would accommodate both future Federal missions and private activities, such as business-related industry and R&D enterprises, in the southeastern portion of the Site (north of the City of Richland). This area would be adjacent to essential services and large-capacity infrastructure. Accommodations for the expansion of public and commercial recreational activities would be focused on the northern portion of the Site (i.e., primarily in the vicinity of the Vernita Bridge). The largest land-use designation would be Conservation (Mining), which would represent a single continuous area that would extend over all geographic areas except the southern portion of the Site. Generally, the shape and extent of this designation

would include sensitive biological, physical, and cultural features on the landscape (e.g., rare, threatened, or endangered flora/fauna and their habitats; unique geologic hazards and features; and wetland and riverine environments), and would be intended to protect these resources over the long term.

Allowable and Permitted Uses within the Land-Use Designations of Alternative Three

Allowable and permitted uses within any land-use designation would correspond to those listed in Table 3-1, except that within the Industrial, Research and Development, and High-Intensity Recreation land-use designations, dryland agricultural and commercial grazing would be considered an allowable use (typically interim). Irrigated agriculture would be considered an interim conditionally permitted use, which would be subject to existing deed restrictions or covenants standards that prohibit activities that impact contaminated soil and groundwater. Basalt outcrops and other culturally significant landscape features would not be available for mining.

In the southern portion of the Site, located north and northwest of Richland, is a large area designated for Industrial, and Research and Development land uses. Within these land-use designations, a large area of seral-stage, shrub-steppe habitat exists. Given the existence of other planning considerations identified in the All Other Areas geographic area, this area was not included with the Conservation (Mining) land-use designation, and would be considered suitable for future development. However, the importance of this habitat would be recognized and impacts to shrub-steppe habitat would require mitigation.

3.3.5.3.1 The Wahluke Slope. The soil, climate, and topography of the Wahluke Slope make it potentially one of the most productive agricultural areas in the Pacific Northwest. Prior to its inclusion in the Hanford control zone, the BoR had purchased over 10,927 ha (27,000 ac) of the Wahluke Slope for agricultural development. Development of land within the Site that is appropriate for agriculture would result in the completion of the vision for agricultural economy benefitting the citizens of the area. The land-use proposal for the Wahluke Slope seeks to provide balanced and compatible economic development, conservation of critical resource lands, and the protection of the Columbia River Corridor. The Wahluke Slope contains expansive critical resource lands not suitable for farming, but these lands are ideally suitable for wildlife habitat and Low-Intensity Recreation. Such areas constitute an ideal buffer providing protection between agricultural land and the Columbia River Corridor.

Hanford's Agricultural Opportunity Cost

In a May 18, 1995, letter response to the Benton County Assessor, the Washington State University Area Extension Horticulturist, John W. Watson, estimated the present value of crops that could be grown on the Benton County portion of the Hanford Site. Watson's report estimated the farm gate income from arable Hanford acreage (79,737 ha [197,035 ac], or 73 percent of the area) under three assumption scenarios:

- **Assumption 1**. Benton County has 26 major crops currently being grown on irrigated land. Growing those crops on the Hanford Site, Hanford agricultural income would equal $121,491,340.
- **Assumption 2**. If the crops that are expanding the fastest in the county are the only crops used to estimate potential income, the lost farm gate income in 1994 would be as follows:
  - 50% apples would be 98,517 acres at $5,000/acre for $492,800,000
  - 25% cherries would be 49,258 acres at $7,000/acre for $344,806,000
  - 25% grapes would be 49,258 acres at $4,000/acre for $197,032,000

  (resulting in a total of $1,034,638,000).
- **Assumption 3**. If the total acreage was planted to high-income-producing apple varieties (e.g., Gala, Fuji, and Braeburn), then Hanford lands could produce an income of $2,955,525,000 (assuming 197,035 ac at $15,000/ac).

The largest land-use designation would be approximately 23,951 ha (59,184 ac), designated as Agriculture. Development of land for agriculture would be based upon an opportunities and constraints analysis. Land designated as Agriculture within the "Red Zone" consists of approximately 10,813 ha (26,720 ac) that would be conserved under a "no-action" scenario pending initiation and completion of geotechnical studies analyzing the impacts of irrigation to the White Bluffs and the Columbia River. Approximately

6,476 ha (16,003 ac) are designated Conservation (Mining and Grazing), including land providing for wildlife refuge and Low-Intensity Recreational activities. Approximately 9,002 ha (22,244 ac) would be designated as Preservation. Generally, the shape and extent of this designation would include sensitive biological, physical, and cultural features on the landscape (e.g., rare, threatened or endangered flora/fauna and their habitats, unique geologic hazards and features, and wetland and riverine environments), and would be intended to protect these resources over the long term. Agriculture designated within the Franklin County portion of the Site is just outside of the BoR's Red Zone.

3.3.5.3.2 The Columbia River Corridor. Land-use designations included in the Columbia River Corridor under Alternative Three would support conservation of the Columbia River, and would maintain and support high-quality aquatic and riparian habitats. These land-use designations within the Columbia River Corridor geographic area are described below.

The Preservation land-use designation follows the boundaries of the locally proposed Hanford Reach Interim Protection Plan, which is an initial phase of the *Hanford Reach Protection And Management Plan* proposed by Benton, Franklin, and Grant counties to protect and manage the Hanford Reach jointly with Federal, state, and local authorities. The second phase of this proposal, which has legislation pending before Congress, is to appoint a Commission consisting of appointees from Federal and state agencies, and local jurisdictions, which would devise and implement the *Hanford Reach Protection and Management Plan*. The Preservation designation would extend upland 400 m (0.25 mi.) from the average high-water line of the river, except in Franklin and Grant counties, where the boundary would extend further inland to include specific sensitive features, such as the White Bluffs and several upland wetlands. Permitted uses would be similar to those within the Conservation land-use designation, except mining would be prohibited by the permitting process. Although Preservation is not a land-use term used under county-wide planning ordinances, Conservation is a recognized land-use term. The Conservation (Mining) land-use designation would include those areas that extend upland of the Preservation land-use designation. Within the Conservation (Mining) land-use designation, Mining would be allowed as a conditionally permitted use. Agriculture uses would be prohibited. The primary purpose would be to protect and manage fish and wildlife.

Areas surrounding the K, N, D, and H Reactor sites would be designated as Low-Intensity Recreation. This area has minimal biological sensitivity and contains unique natural features potentially suitable for public enjoyment. The Low-Intensity Recreation designation would begin 400 m (0.25 mi.) upland from the average high-water line of the river except in small isolated areas such as the former White Bluffs town site, and the existing recreational access corridors to the Columbia River. Environmental restoration activities would continue in the 100 Areas (i.e., 100-BC, 100-KE, 100-KW, 100-N, 100-D, 100-DR, 100-H, and 100-F). These uses would be considered a pre-existing, nonconforming use in the Low-Intensity Recreation land-use designation.

A hiking and biking recreational trail along the entire river corridor would be proposed from North Richland to the Vernita Bridge, which would allow public access along the river corridor and connect important historic and natural resources, such as the former Hanford and White Bluffs townsites, the Bruggerman Warehouse, and the B Reactor Museum, and would connect the rest stop and boat launch area located at the Vernita Bridge. This trail would be sited to avoid impact to, or contact with sensitive biological, cultural, hazardous, and/or natural resource-sensitive areas. This trail would connect to the river shore trails in Richland at the southern boundary.

3.3.5.3.3 The Central Plateau. The DOE would be expected to continue all Waste Management and disposal activities in the Central Plateau. As a result, the Central Plateau

geographic area would be designated for Industrial-Exclusive Use.

3.3.5.3.4 The All Other Areas. The majority of the All Other Areas geographic area would be designated Conservation (Mining). Within the Conservation land-use designation, mining would be allowed as a conditionally permitted use. Agricultural uses would be prohibited. A small area along the southern boundary of the Site near the Yakima River would be designated High-Intensity Recreation. This area, adjacent to the Benton County Horn Rapids Park, is currently "master planned" as a regional park. A High-Intensity Recreation land-use designation would provide commercial use support for the expected increase in recreational and visitor use in the park area (a central feature of the Tapteal Greenway), which would extend along the lower Yakima River from Benton City to Columbia Point. The area adjacent to the Vernita rest stop, east of State Highway 240 (which includes the B Reactor site), would also be designated as High-Intensity Recreation. The Vernita rest stop, the proposed B Reactor Museum, and the proposed boat launch are all expected to increase demand for recreational and visitor use of the Vernita area. The strip designated for the west 135 ha (333 ac) of the Vernita Terrace would be designated Low-Intensity Recreation, primarily for limited activities such as biking, hiking, fishing, hunting, boat launching facilities, primitive day camping, and nature viewing, while maintaining the natural resource values upon which those uses are based.

Areas north of the City of Richland would be designated as Industrial, and Research and Development. This area would be accessible using the State Highway 240 corridor, State Highway 10, and existing railroad infrastructure. Existing municipal water and sewer infrastructure is located nearby within the City of Richland's UGA boundary. Industrial use also would be proposed for the area east of the 200 Area (i.e., May Junction), which contains low-quality biological resources and existing rail and road infrastructure.

3.3.5.3.5 The Fitzner/Eberhardt Arid Lands Ecology Reserve (ALE Reserve). This area would be designated as Conservation (Mining) due to the existing unique and sensitive biological, ecological, and cultural resources.

3.3.6 Alternative Four

3.3.6.1 Planning Goals, Objectives, and Values (Vision). Alternative Four represents the vision of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) for the management of the Hanford Site for the next 50 years (Figure 3-7). The alternative is based on a detailed knowledge of Site resources and upon experience gained from many years participating in a host of Hanford Site planning forums.

In the view of the CTUIR, the greatest value provided to the region and the nation by the Hanford Site is its role as a natural and cultural resource reserve. The CTUIR recognizes, nevertheless, that there are other services provided by the Hanford Site that are not compatible with this primary value, and that a rational land-use plan for Hanford must take into account these other services. In the CTUIR's review of the Hanford Site's resources, and of the current and potential services provided or potentially provided by the Site, we have striven to find the most rationally justifiable balance between these interests.

The result is a land-use plan that protects a significantly greater amount of Hanford resources than is protected under DOE's Preferred Alternative. Nevertheless, Alternative Four provides opportunities for waste management, commercial industry, and recreation that by the CTUIR's estimates would meet or exceed actual demand. In the view of the CTUIR (and consistent with the *Final Report of the Hanford Future Site Uses Working Group* [FSUWG 1992]), all permanent waste disposal sites at Hanford should be located in the Central Plateau waste management area. While Alternative Four provides opportunity for R&D activities, the CTUIR has intentionally provided an area for these activities that may not accommodate all proposals received over the next 50 years. The CTUIR has limited the size of this area because, in its view, the value provided by these activities does not justify the consumption of a large amount of Hanford Site resources. The CTUIR wants to ensure that Hanford lands would only be available to support the most valuable R&D activities, and that any future R&D activities on the Site would make efficient use of Hanford Site resources. Finally, Alternative Four provides no opportunity for agriculture on the Hanford Site. In the view of the CTUIR, agricultural development at Hanford is not justified. Any value that would be added to the region by allowing agricultural development at Hanford is grossly outweighed by the value presently provided by the natural and cultural services of the Site.

3.3.6.2 Assumptions Regarding Future Use

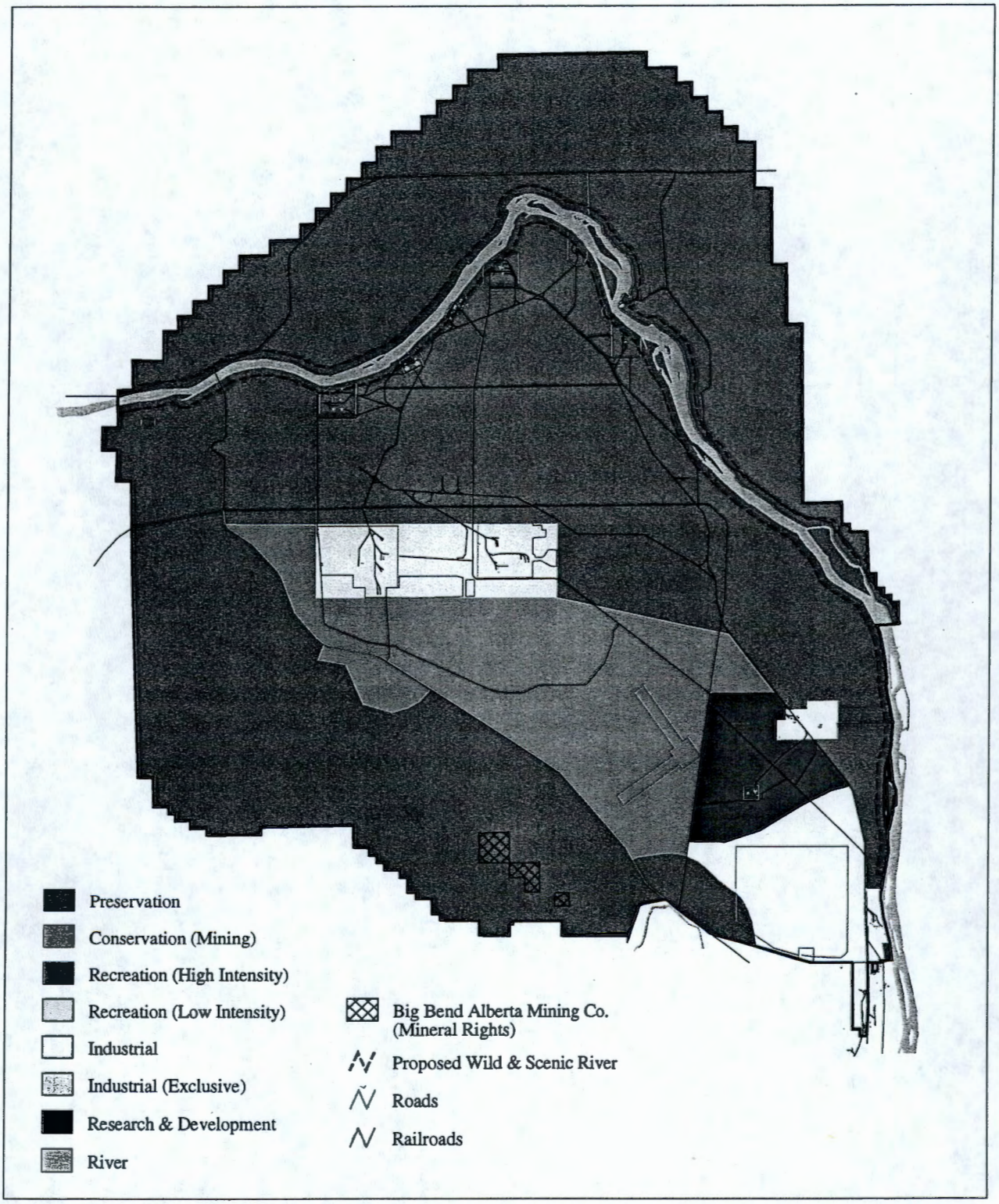
Remediation and Waste Management:

1. Remediation activities on the Hanford Site will continue as planned.

2. The remediation process will generally impose no long-term restrictions on future land use, with the exception of (a) activities that disturb capped permanent waste sites, (b) activities that disturb contaminants which remain in place 4.6 m (15 ft) or more below the ground surface in some areas, and (c) activities that would affect groundwater contaminant plumes.

3. Plutonium production reactor blocks will remain in the 100 Areas throughout the planning period and will be considered a pre-existing, nonconforming use.

Figure 3-7. Alternative Four.



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4. All permanent waste disposal activities (e.g., all capped permanent waste sites) will be located in the Central Plateau.

5. Geologic material will need to be mined onsite for the construction of caps over disposal sites.

Local Economic Transition:

1. The Tri-Cities area will need to develop a stable economic base that is independent of DOE activities and budgets. Economic considerations will cause most of that new development to take place within the City of Richland's UGA. Available projections indicate that, at the most, only 809 ha (2,000 ac) to 1,619 ha (4,000 ac) of the Hanford Site will be needed for private commercial development over the next 50 years.

2. Much development in the Tri-Cities area has made inefficient use of available lands, resulting in sprawl. Future land-use regulation should ensure more efficient use of available lands.

Research and Development Activities:

For practical reasons, DOE will locate the R&D activities needed to assist in Hanford remediation, restoration, and Waste Management in the following manner by one of these actions:

1. In sophisticated laboratory facilities within the City of Richland (e.g., EMSL)

2. In the 300 Area

3. Within the Central Plateau Waste Management area, or

4. As field studies with little environmental impact.

From time to time proposals are advanced for R&D activities at Hanford that are unrelated to remediation, Waste Management, or the restoration of the Site. Some of these proposals are rejected as making poor use of Hanford Site resources, but others are developed on the Site. This trend is likely to continue. The land-use planning process should ensure that only proposals that provide a clear value and make efficient use of available Hanford resources are accepted.

Natural and Cultural Resource Values, Management, and Use:

1. The Hanford Site and the U.S. Department of the Army's Yakima Training Center constitute the only large, relatively undisturbed areas of natural shrub-steppe habitat remaining in Central Washington.

2. The Hanford Reach will be designated as a Recreational River under the *Wild and Scenic Rivers Act* or other analogous legislation. Demand for (and the need to manage) recreational activity on the Reach and associated Hanford lands will steadily increase.

3. A public desire for low-impact recreation (including hunting) on the uplands of the Hanford Site already exists and will increase over time.

4. The gathering, processing, distribution, and use of natural resources, and the cultural and religious laws governing these activities, are at the core of the traditional culture of the CTUIR and other Hanford-affected Tribes. The survival of the CTUIR's culture depends upon the availability of, access to, and traditional use of native natural resources. As a result, protection of native ecosystems and of Tribal member access to such resources is a priority for the CTUIR and other Tribal governments. As areas of the Hanford Site are determined to be clean, and as administrative mechanisms are put in place, members of the CTUIR and other Hanford-affected Tribes will make increasing use of the Hanford Site for the gathering of natural resources. Such activities will include subsistence plant gathering and hunting, as well as subsistence and commercial fishing.

5. The Hanford Site contains numerous places of religious importance to members of the CTUIR who practice traditional Indian religions. These places include the major basalt outcrops, the active dunes area, and other sites. These sites have been used by members of the CTUIR and other Hanford-affected Tribes from time immemorial for a wide variety of religious activities. In addition, the Prophet Smohalla, a founder of the Washat, or Seven Drums, religion, received his principal visions and teachings at places now located within the boundaries of the Hanford Site. Many members of the CTUIR are members of the Washat religion. Protection of these sites, and of Tribal members' access to these sites, is of great importance to the CTUIR and its members (as well as to other Hanford-affected Tribes) and will continue to be an issue of great importance.

6. The area currently occupied by the Hanford Site has been used by American Indian Tribes for at least the past 13,000 years, and likely much longer than that. Cultural resources such as cemeteries, village sites, and archaeologic resources are abundant on the Hanford Site because of the area's abundance of natural resources, its central location on transportation routes, and its climate. The locations of many of these sites are presently unknown. Federal law mandates the protection of these resources. Moreover, the protection of these resources is very important to members of the CTUIR and other Hanford-affected Tribes. Respect for and non-disturbance of these resources is a fundamental religious value of members of the CTUIR who practice traditional religion. These management principles will continue to be defended by the CTUIR and other Hanford-affected Tribes.

3.3.6.3 Application of the Land-Use Designations. Alternative Four land-use designations include Industrial-Exclusive, Industrial, Research and Development, High-Intensity Recreation, Low-Intensity Recreation, Conservation (Mining), and Preservation. Low-Intensity Recreation, while generally not appearing as a separate land use in Alternative Four, would occur in all land-use designations, as long as protected resources are not placed at risk, and so long as incompatible development has not already occurred. Specific planning for support of Low-Intensity Recreation would take place as part of the implementation of the CLUP (see Chapter 6).

3.3.6.3.1 The Wahluke Slope. Alternative Four would manage the entire Wahluke Slope area as Preservation due to the outstanding value of its natural and cultural resources, which would be destroyed by more consumptive land uses. These resources include wetlands, uplands, and the White Bluffs. The White Bluffs are a unique geologic, paleologic, and cultural feature. The Bluffs, in particular, are highly susceptible to collapse due to activities that increase groundwater flow. Such collapses have occurred in recent years and their impacts continue. Aside from causing the loss of this irreplaceable resource, such collapses bury salmon habitat

under tons of silt and alter the course of the Columbia River. The alteration of the river's course causes new erosion which, in turn, destroys cultural resources on the islands and shore of the Columbia River, and potentially mobilizes contaminants that are currently stabilized. Managed, Low-Intensity Recreation (including hunting) and other activities would take place on Preservation lands.

Preservation is the land-use designation which bears the strongest resemblance to the land-use alternative chosen by the *Hanford Reach of the Columbia River, Comprehensive River Conservation Study and Environmental Impact Statement, Record of Decision* (NPS 1996). That Department of the Interior NEPA ROD determined that the best use of the Wahluke Slope is as a NWR. The DOE concurred that the Wahluke Slope should be a NWR. The CTUIR supported that decision, as did other Tribes, governments, and stakeholder groups.

Moreover, as the No-Action Alternative indicates, the Saddle Mountain NWR, which is managed by the USFWS, is currently managed in a manner that is most analogous to Preservation. Likewise, the Wahluke Wildlife Recreation Area is managed in the same manner. In both of these areas, as well as under the Hanford Reach ROD (DOI 1996), grazing is only allowed as a tool to improve wildlife habitat. Grazing solely for commercial production is not allowed anywhere on the Site.

In practice, none of the Saddle Mountain NWR has been grazed for many years. Likewise, the portion of the Wahluke Wildlife Recreation Area south of State Highway 24 is not grazed. Only the portion of the Wahluke State Wildlife Recreation Area north of State Highway 24 has been grazed in order to control cheatgrass. The WDFW lease allowing grazing on the Wahluke State Wildlife Recreation Area was allowed to expire on December 31, 1998 but, under SEPA regulations for up to 10 years after the expiration of the lease, the WDFW can reinstate the grazing lease without public review. Under this Preservation designation, grazing would be barred entirely. This would result in no changes to the current management of 26,000 ha (64,247 ac) or 73 percent of the Wahluke Slope. In the area north of State Highway 24, alternative methods for controlling cheatgrass would be adopted.

3.3.6.3.2 The Columbia River Corridor. Alternative Four would designate almost the entire Columbia River Corridor as Preservation due to its outstanding natural and cultural resources. The Columbia River Corridor contains a wealth of aquatic and terrestrial natural resources, including salmon, sturgeon, mule deer, bald eagles, and many others. The Columbia River Corridor is also an area where cultural resources such as cemeteries and archaeologic resources are highly concentrated.

The Corridor has historically contained reactors and associated buildings to support Hanford's former defense production and energy research missions. Nevertheless, remediation planning documents, public statements of advisory groups, and planning documents such as the "Record of Decision: Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington, Environmental Impact Statement" (58 FR 48509, dated September 16, 1993), have determined that remediation and restoration of the Columbia River Corridor would return the corridor to a non-developed, natural condition. Restrictions on certain activities may continue to be necessary to prevent the mobilization of contaminants, the most likely example of such restrictions being on activities that discharge water to the soil. Although the Surplus Reactor NEPA ROD calls for the reactor buildings to be demolished and the reactor blocks to be moved to the Central Plateau, this action might not take place until 2068 or a new Tri-Party Agreement milestone is negotiated. As a result, the reactor buildings will remain in the Columbia River Corridor throughout the 50-year planning period addressed by the Final HCP EIS.

The Preservation designation would allow managed recreation within the Corridor. This activity would include the continued operation of the White Bluffs boat launch, managed as Low-Intensity Recreation, on the east side of the river. Other infrastructure to support Low-Intensity Recreation would be identified during implementation of the CLUP.

Alternative Four provides for a High-Intensity Recreation public boat launch located near the Vernita Bridge on the south side of the river. Alternative Four provides another High-Intensity Recreation boat launch, located at the White Bluffs boat launch on the west side of the river. The White Bluffs boat launch would support Tribal treaty-reserved fishing activity throughout the Reach, and would contain appropriate support facilities for that purpose.

Alternative Four does not provide for the creation of a High-Intensity Recreation tourist facility at the B Reactor. The CTUIR prefers to remove all vestiges of nuclear weapons production from the Hanford Reach.

3.3.6.3.3 The Central Plateau. Consistent with the findings of the *Final Report of the Future Site Uses Working Group* (FSUWG 1992), subsequent planning documents, and the general consensus of governments and stakeholders, the Central Plateau would be used for waste management activities, designated in this EIS as Industrial-Exclusive. All permanent waste disposal at the Hanford Site would take place within the Central Plateau. Likewise, R&D activities associated with waste management would take place within this geographic area. Land use within this area would have to be carefully planned during implementation of the CLUP to ensure that DOE would not run short of area for waste management activities. Since the Central Plateau currently contains natural resources of high value, developments that impact these resources would be mitigated using the BRMaP.

3.3.6.3.4 The All Other Areas. The All Other Areas geographic area contains a variety of natural and cultural environments, including large stands of mature sagebrush-steppe, basalt outcrops, an active dune complex, stabilized dunes, a wide variety of archaeologic resources, American Indian cemeteries, former agricultural lands, the remains of former DOE facilities, and the remains of two former small towns. Because of the diversity of the All Other Areas, Alternative Four applies a variety of land-use designations to this area. While Low-Intensity Recreation generally does not appear as a separate land use in this geographic area, it is anticipated that during the implementation of the CLUP (Chapter 6), opportunities for compatible Low-Intensity Recreation would be established throughout much of the All Other Areas geographic region.

Alternative Four recognizes that the area within 3.2 km (2 mi) of the Columbia River (an area much larger than the 400 m [0.25 mi.] area protected by proposed legislation for the Hanford Reach, or considered to be part of the Columbia River Corridor) contains a disproportionately high share of the archaeologic resources and cemeteries on the Hanford Site. This area also has high natural resource value as a wildlife corridor. In recognition of these facts and the importance of protecting these resources, Alternative Four designates this expanded corridor area as Preservation.

Alternative Four also recognizes that the area north of Gable Butte and Gable Mountain (but outside of the expanded corridor area), contains large blocks of mature, relatively undisturbed sagebrush-steppe habitat. Alternative Four places these areas under the Preservation designation because of the increasing rarity of such resources in Central Washington, the need to avoid fragmentation, and the value of these areas as wildlife corridors. Alternative Four differs from Alternative One by including areas of lower quality habitat within this Preservation area. Alternative Four does this in the interest of avoiding fragmentation. Under Alternative Four, these lower quality areas would be prime sites for the location of restoration

projects initiated under BRMaP as mitigation for development in other parts of the Hanford Site. Likewise, such areas would be appropriate for natural resource restoration initiated under the natural resource damage restoration provisions of CERCLA. The area north of the ALE Reserve and south of Umtanum Ridge (also known as McGee Ranch) would be designated Preservation because of its value as a wildlife corridor and in the interest of avoiding fragmentation. This area would also be a suitable location for habitat impact mitigation activities.

Alternative Four recognizes that the basalt outcrops beginning with Gable Mountain in the east and moving west through Gable Butte and Umtanum Ridge have been of great religious and cultural importance to members of the CTUIR, members of other Hanford-affected Tribes, and their ancestors for many millennia. These sites continue to be of great religious importance to many members of the CTUIR and other Hanford-affected Tribes. In addition to religious importance, these sites are of great cultural and archaeologic value to members of the CTUIR in general. These outcrops also have distinct habitat value, such as providing raptor perching area and talus slope habitat. In recognition of the irreplaceable cultural value of these resources and their biological importance, Alternative Four designates these areas as Preservation.

An important part of cultural and religious use of a basalt outcrop such as Gable Mountain is the view such areas provide of the surrounding landscape. When this landscape is damaged by development -- especially when that development occurs relatively near the viewpoint -- the cultural use of the Site is seriously injured. The CTUIR members' use of Gable Mountain and Gable Butte has already been significantly injured by the development of the Central Plateau. To prevent further injuries to the central basalt outcrops' viewshed, Alternative Four designates the area north of the Central Plateau and south of the outcrops, as well as the area east of the Central Plateau (also known as May Junction), as Preservation. Designation of the May Junction area as Preservation is especially critical, due to its close proximity to Gable Mountain (see Chapter 4, Figure 4-33). The designation as Preservation of other portions of the All Other Areas geographic region, mentioned above, also supports the protection of the central basalt outcrops' viewsheds.

Existing structures on Gable Mountain itself also injure CTUIR members' cultural and religious use of the mountain. Under Alternative Four, structures not currently in use would be removed. During implementation (Chapter 6), further steps would be taken to facilitate the relocation of pre-existing, nonconforming structures to more appropriate locations.

Alternative Four recognizes that the area of active dunes, located north of Energy Northwest (formerly known as WPPSS), is similar to the basalt outcrops in being an area of great religious and cultural significance as well as being an area of distinct habitat value. Alternative Four would treat these dunes in a similar manner to the basalt outcrops, designating the dune area as Preservation.

This alternative anticipates that work in the Central Plateau Industrial-Exclusive waste management area may require the consumption of large quantities of sand, gravel, and basalt for capping material. Economic considerations would likely require that these materials come from areas near the Central Plateau. While making it clear that the basalt outcrops and the active dunes area are fundamentally inappropriate for such consumptive uses, Alternative Four does anticipate the need to make such materials available. As a result, Alternative Four designates a large area near the Central Plateau and between the Plateau and the southeastern border of the Hanford Site as Conservation (Mining). This area contains a variety of soil and rock types allowing DOE several options for locating quarries which would meet anticipated waste management specifications and quantities.

While the Conservation (Mining) designation provides DOE with the means to satisfy its need for geologic materials, the designation also reflects the high quality of the habitat in this area. Portions of this area contain some of the largest and highest quality mature sagebrush communities on the Hanford Site. Were it not for the need to supply DOE with geologic material, much of this area would most appropriately be designated Preservation. As a result, DOE would need to make prudent choices regarding the removal of needed material, so as to minimize impacts to this generally high-quality habitat. Such decisions would be made during implementation of the CLUP (Chapter 6). Likewise, the provisions of BRMaP would provide incentive for DOE to minimize these impacts, while also providing the assurance that such impacts would be appropriately mitigated. If these geologic materials are not needed to support the Waste Management and cleanup mission, the land-use designation for this area should revert to Preservation.

The southern portion of the area, which Alternative Four designates Conservation (Mining), contains the existing LIGO facility. Alternative Four treats LIGO as a pre-existing, nonconforming use. The LIGO facility would continue to operate throughout its life span, but its use could not be altered to increase its nonconformity, and similar R&D facilities could not be located in this area. This area also contains the square mile of land owned by the State of Washington, but not currently developed. The State of Washington's reason for purchasing this land was to build a hazardous waste treatment, storage and disposal facility on this site (State of Washington 1980). In the view of the CTUIR, such a facility would be a poorly reasoned use of the land. Because this square mile of land is not owned by DOE, this EIS apparently cannot determine the land use on this land. It appears that such a determination can only be made by Benton County. The CTUIR urges Benton County and the State of Washington to agree to a land-use designation for this square mile which is consistent with the designation for the surrounding land adopted in the ROD for this Final HCP EIS.

Alternative Four designates the portion of the All Other Areas geographic area that is south and east of the Wye Barricade (between State Highway 10 and the Hanford Site rail line) as Research and Development and Industrial in roughly equal amounts. Alternative Four provides 4,388 ha (10,843 ac) for Research and Development. The primary purpose of this land would be to meet any future DOE need for additional research facilities to support the remediation, Waste Management, and restoration mission. Nevertheless, Alternative Four recognizes that from time to time, proposals will be made for the development of R&D facilities on the Hanford Site that are unrelated to the cleanup mission. Alternative Four provides adequate land for the development of facilities that make efficient use of available resources, while screening out facilities that are highly consumptive of Hanford resources. Such facilities could also be located on available land within the Industrial designation.

While current studies (e.g., the *City of Richland's Comprehensive Plan* [CoR 1997] and the Draft *Benton County Comprehensive Plan* [BCPD 1997]) indicate there will be little or no demand for industrial sites in this area in the next 20 years, Alternative Four recognizes that when private commercial industrial development begins onsite, it would most likely occur in the area immediately north of the City of Richland. Length of commute, distance required for the extension of utilities, and similar factors would encourage private commercial development to take place in this area. While the demand for such land is at this point highly speculative, Alternative Four recognizes that the CLUP adopts a 50-year planning horizon, and that such development may occur within that time frame. As a result, Alternative Four provides 6,882 ha (17,006 ac) for Industrial development. Planning concerning the provision of infrastructure to support industrial development in this area, planning determining the sequence of development in this area, and planning aimed at discouraging sprawl would all occur during implementation of the CLUP (see Chapter 6).

Finally, Alternative Four designates a 3.2 km (2 mi) corridor along the Yakima River as Preservation for the same reasons a similar corridor along the Columbia River was designated Preservation (i.e., the density of archaeologic sites combined with the area's value as a wildlife corridor).

3.3.6.3.5 The Fitzner/Eberhardt Arid Lands Ecology Reserve (ALE Reserve). The same cultural and religious values that pertain to the central basalt outcrops apply with equal force to Rattlesnake Ridge, the dominant feature of the ALE Reserve. The ALE Reserve is currently managed by the USFWS. In recognition of the ALE Reserve's outstanding natural and cultural resource value, the ALE Reserve geographic area has been managed for the past 30 years in a manner that is consistent with the Preservation designation. Alternative Four would continue that mode of management, designating this area Preservation. The sole exception is an area of the ALE Reserve bordering State Highway 240 near the 200 West Area that would be designated Conservation (Mining). This area contains large near-surface basalt and soil sources which would provide an adequate and economic source for Central Plateau waste management needs. Since no siting decision has been made, it is not certain that this area would be used as a quarry site. If the site is not used as a source for waste site capping material, the land-use designation should revert to Preservation. This analysis would occur during implementation of the CLUP (see Chapter 6).

The ALE Reserve geographic area contains buildings and structures that are currently not in use. Structures that are nonconforming and which are not in use at the time the CLUP is finalized cannot be used in a nonconforming manner after the adoption of the CLUP in the ROD for this EIS (see Chapter 6). Under Alternative Four, structures not currently in use would be removed. During implementation, further steps would be taken to facilitate the relocation of pre-existing, nonconforming structures to more appropriate locations.

3.4 Summary of Potential Environmental Impacts

The CEQ NEPA implementing procedures (40 CFR 1500-1508) require a comparative summary of potential environmental impacts and mitigation measures be presented in the alternatives chapter. Table 3-3 contains a summary of land-use designation areas by alternative. For ease in understanding, the table is repeated in hectares, acres, square miles, and percentages. Table 3-4 contains a summary of potential cumulative impacts from the land-use alternatives by impacted resource. Detailed analyses of potential environmental impacts for each of the land-use alternatives are given in Chapter 5 of this document.

3.4.1 Comparison of Affected Areas by Alternative

Table 3-3 is a comparative summary of the amount of acreage under each alternative that would be potentially subject to impacts from development. In addition to the 148,080 ha (572 mi^2) of land surface areas, this EIS affects 3,642.3 ha (14.1 mi^2) of surface water, almost all of which is the Columbia River (i.e., a navigable river) where access cannot be controlled. Because access cannot be controlled on the Columbia River, it has no land-use designation. For this EIS, the 1,517 km^2 (586 mi^2) area within the boundary of the Hanford Site includes both the land area and the river area.

3.4.2 Comparison of Affected Environmental Resources and Other NEPA Values

The effects of choosing a land-use alternative are discussed for the following subject areas: (1) geologic resources, (2) water resources, (3) biological resources, (4) cultural resources, (5) aesthetic resources, (6) socioeconomic resources, (7) environmental justice, and (8) human health. Many of the potentially significant adverse impacts would occur as a result of disturbances of relatively pristine natural areas on the Hanford Site.

Natural plant and wildlife communities have flourished, sensitive species have been preserved, and archaeological and cultural resources have been protected because historically large areas of the Hanford Site have been used solely for security buffers. Each alternative uses an unique balance of impact avoidance (i.e., committing the land to preservation or conservation) versus impact mitigation. This balance is based on the planning goals, objectives, and values (i.e., vision) of each alternative. For example, Alternative Two relies almost exclusively on avoidance by designating 95 percent of the Hanford Site as Preservation. Therefore, among the alternatives, Alternative Two provides the highest level of resource protection. But this resource protection is at the sacrifice of multiple-use goals where the Hanford Site's natural and infrastructure resources could be used for economic development. Mitigation of disturbance effects through the use of policies and implementing procedures as an augmentation to the alternative map, is an alternate means of resource protection exemplified best by Alternative Three. Mitigation is the form of resource protection employed by more development-oriented or multiple-use oriented alternatives. Successful mitigation depends on the adopted CLUP map working in concert with the CLUP policies and implementing procedures to protect unique, cultural, or sensitive resources through avoidance of impacts after site-specific considerations or mitigation of the impacts by prescribed mitigation procedures. The Implementing Procedures (e.g., project review, resource management plans (RMPs), AMPs, and NEPA or SEPA reviews) provide mitigation guidelines where avoidance is less desirable than project implementation with mitigation.

The alternatives vary in their reliance on avoidance or mitigation as the principal means of protection. Because it has no land-use designations, policies, or implementing procedures based on a CLUP, the No-Action Alternative relies almost exclusively on mitigation through NEPA. All the other alternatives fall between Alternative Two and the No-Action Alternative with respect to the balance used between impact avoidance and mitigation.

The DOE intends to prepare a Mitigation Action Plan after the ROD for this EIS is issued which would address mitigation commitments made in the ROD. In general, these mitigation commitments can be expected to include updating the existing resource management plans such as the CRMP, BRMaP, and *Hanford Bald Eagle Management Plan*; and committing to a schedule to develop additional resource management plans (e.g., Minerals Resources Management Plan) under the procedures outlined in Chapter 6. The resource impact analyses in Chapter 5 of this Final HCP EIS include ranges of potential mitigation measures for each land-use alternative.

Table 3-3. Comparisons of Affected Areas by Alternative. (4 pages)

	No-Action[a]	Preferred Alt.	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Areas in Hectares						
Agriculture	0	0 (0)[b]	0	0	23,951	0
Conservation (Mining and Grazing)	0	0 (43,857)[b]	0	0	6,476	0
Conservation (Mining)	0	44,183 (1,005)[b]	15,921	0	72,685	19,341
Industrial	22,534	15,335 (15,378)[b]	2,542	1,830	17,860	6,882
Industrial-Exclusive	5,064	5,064	4,593	4,593	5,064	5,064
Preservation	46,366	78,127 (77,449)[b]	124,517	140,767	9,002	112,321
High-Intensity Recreation	0	125 (82)[b]	64	191	1,768	77
Low-Intensity Recreation	1	334	29	0	3,097	7
Research and Development	0	4,912	414	699	8,177	4,388
Open Space Reserved	74,115	0	0	0	0	0
TOTAL[c]	**148,080**	**148,080**	**148,080**	**148,080**	**148,080**	**148,080**

[a] The No-Action Alternative does not have land-use designations. It has areas administered similar to land-use designations (see Figure 3-2).

[b] Areas in Revised Draft EIS.

[c] In addition to the 148,080 ha (572 mi^2) of land surface areas, this EIS affects 3,642.3 ha (14.1 mi^2) of surface water, almost all of which is the Columbia River.

Table 3-3. Comparisons of Affected Areas by Alternative. (4 pages)

	No-Action[a]	Preferred Alt.	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Areas in Acres						
Agriculture	0	0 (0)[b]	0	0	59,184	0
Conservation (Mining and Grazing)	0	0 (108,371)[b]	0	0	16,003	0
Conservation (Mining)	0	109,179 (2,483)[b]	39,342	0	179,609	47,793
Industrial	55,684	37,894 (38,000)[b]	6,281	4,522	44,133	17,006
Industrial-Exclusive	12,513	12,323	11,350	11,350	12,513	12,513
Preservation	114,573	193,056 (191,381)[b]	307,688	347,843	22,244	277,551
High-Intensity Recreation	0	309 (203)[b]	158	472	4,369	190
Low-Intensity Recreation	2	825	72	0	7,653	17
Research and Development	0	12,138	1,023	1,727	20,206	10,843
Open Space Reserved	183,142	0	0	0	0	0
TOTAL[c]	**365,914**	**365,914**	**365,914**	**365,914**	**365,914**	**365,914**

[a] The No-Action Alternative does not have land-use designations. It has areas administered similar to land-use designations (see Figure 3-2).

[b] Areas in Revised Draft EIS.

[c] In addition to the 148,080 ha (572 mi^2) of land surface areas, this EIS affects 3642.3 ha (14.1 mi^2) of surface water, almost all of which is the Columbia River.

Table 3-3. Comparisons of Affected Areas by Alternative. (4 pages)

	No-Action[a]	Preferred Alt.	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Areas in Square Miles						
Agriculture	0	0 (0)[b]	0	0	92	0
Conservation (Mining and Grazing)	0	0 (169)[b]	0	0	25	0
Conservation (Mining)	0	171 (4)[b]	61	0	281	75
Industrial	87	59 (59)[b]	10	7	69	27
Industrial-Exclusive	20	20	18	18	20	20
Preservation	179	302 (299)[b]	481	544	35	434
High-Intensity Recreation	0	0	0	1	7	0
Low-Intensity Recreation	0	1	0	0	12	0
Research and Development	0	19	2	3	32	17
Open Space Reserved	286	0	0	0	0	0
TOTAL[c]	**572**	**572**	**572**	**572**	**572**	**572**

[a] The No-Action Alternative does not have land-use designations. It has areas administered similar to land-use designations (see Figure 3-2).

[b] Areas in Revised Draft EIS.

[c] In addition to the 148,080 ha (572 mi^2) of land surface areas, this EIS affects 3642.3 ha (14.1 mi^2) of surface water, almost all of which is the Columbia River.

Table 3-3. Comparisons of Affected Areas by Alternative. (4 pages)

	No-Action[a]	Preferred Alt.	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Percentage of Area						
Agriculture	0.00%	0.00% (0.00%)[b]	0.00%	0.00%	16.17%	0.00%
Conservation (Mining and Grazing)	0.00%	0.00% (29.62%)[b]	0.00%	0.00%	4.37%	0.00%
Conservation (Mining)	0.00%	29.84% (0.68%)[b]	10.75%	0.00%	49.08%	13.06%
Industrial	15.22%	10.36% (10.38%)[b]	1.72%	1.41%	12.06%	4.65%
Industrial-Exclusive	3.42%	3.42%	3.10%	3.10%	3.42%	3.42%
Preservation	31.31%	52.76% (52.30%)[b]	84.09%	94.89%	6.08%	75.85%
High-Intensity Recreation	0.00%	0.08% (0.06%)[b]	0.04%	0.13%	1.19%	0.05%
Low-Intensity Recreation	0.00%	0.23%	0.02%	0.00%	2.09%	0.00%
Research and Development	0.00%	3.32%	0.28%	0.47%	5.52%	2.96%
Open Space Reserved	50.05%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	**100.00%**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

[a] The No-Action Alternative does not have land-use designations. It has areas administered similar to land-use designations (see Figure 3-2).

[b] Areas in Revised Draft EIS.

[c] In addition to the 148,080 ha (572 mi^2) of land surface areas, this EIS affects 3642.3 ha (14.1 mi^2) of surface water, almost all of which is the Columbia River.

Table 3-4. Summary of Potential Impacts to Hanford Site Resources. (8 pages)

Resource	Preferred Alternative	Alternative One	Alternative Two	Alternative Three	Alternative Four	No-Action Alternative
GEOLOGIC RESOURCES						
Features	Unique geologic features such as Gable Mountain, Gable Butte, the White Bluffs; and active sand dunes would be protected.	Same as the Preferred Alternative.	Same as the Preferred Alternative. Stabilized sand dunes would also be protected.	Unique geologic features could be developed to obtain materials for remediation and economic development.	Same as the Preferred Alternative except stabilized sand dunes would also be protected.	Unique geologic features could be developed.
Missoula Flood Deposits	Missoula Flood features would be protected by Plan Policies and Procedures.	Missoula Flood features would be protected by Plan Policies and Procedures.	Missoula Flood features would be protected by Plan Policies and Procedures.	Missoula Flood features would be protected by Plan Policies and Procedures.	Missoula Flood features would be protected.	Same as Preferred Alternative because of their cultural significance.
Geologic Materials	Viable sources of geologic materials for governmental purposes could be developed.	Geologic materials could be developed only from existing quarries and to support remediation.	Geologic resources to support remediation would need to be obtained from offsite sources.	Same types of impacts as the Preferred Alternative, but applied to 66% more surface area.	Geologic materials could be developed only to support remediation.	Commercial development of geologic resources would not be restricted.
Natural Gas	Existing natural gas claims on the ALE Reserve could be developed, but the Preservation designation surrounding those claims would preclude construction of an access road.	Same as Preferred Alternative.	Same as Preferred Alternative.	Existing natural gas claims could be developed and an access road could be constructed under the Conservation (Mining) designation.	Same as Preferred Alternative.	Existing natural gas claims could be developed and an access road could be constructed.
Soils	Soil compaction and erosion could occur around quarry sites.	Soil compaction and erosion could occur around quarry sites.	The potential for soil erosion and compaction would be minimized by maintaining existing vegetative cover and precluding development.	Soil compaction and erosion could occur around quarry sites. Cultivated agriculture would increase soil erosion through removal of existing cover and tillage.	The potential for soil erosion and compaction would be minimized. Some soil erosion and compaction could occur as a result of mining in support of remediation.	Mining, grazing, and cultivated agriculture could increase soil compaction or erosion.

Table 3-4. Summary of Potential Impacts to Hanford Site Resources. (8 pages)

Resource	Preferred Alternative	Alternative One	Alternative Two	Alternative Three	Alternative Four	No-Action Alternative
WATER RESOURCES						
Surface Water	Runoff from mining operations located close to the Columbia River could lead to water quality degradation.	Mining restricted to upland areas would have little impact on water quality.	Mining, grazing, and agriculture would not be allowed; therefore, there would be no impacts to surface water.	Mining prohibited within 1/4 mile of the Columbia River, would have little impact on water quality.	Same as Alternative One.	Same as the Preferred Alternative.
	Grazing would not be allowed, so no impacts would result from this activity.	Grazing would not be allowed, so no impacts would result from this activity.	Experimental aquaculture could increase the nutrient load in the Columbia River.	Grazing permitted in irrigation flow returns on the Wahluke Slope, potentially leading to increased siltation.	Grazing would not be allowed, so no impacts would result from this activity.	Same as the Preferred Alternative.
	Increased recreational access to the Columbia River could increase shoreline erosion from boating wake and could generate additional pollution, such as oil, gas, and engine exhaust.	Similar to the Preferred Alternative, but fewer access points would be provided and use of the river might not increase as much.	Recreational access to the Columbia River would not be increased.	Same types of impacts as the Preferred Alternative, but applied to 66% more surface area.	Similar to the Preferred Alternative.	Same as Alternative Two.
Groundwater	Mining operations could require groundwater withdrawal for material washing and dust control. Surface water could also collect in quarry sites increasing groundwater recharge locally.	Similar to the Preferred Alternative.	Mining operations would not be allowed.	Same types of impacts as the Preferred Alternative, but applied to 66% more surface area.	Same as the Preferred Alternative.	Same as the Preferred Alternative.
	Groundwater withdrawal for industrial uses could alter flow patterns. Discharges to the soil column could mobilize contaminants in the vadose zone and accidental releases could contaminate groundwater.	New impacts to groundwater from industrial development would be minimal.	New impacts to groundwater from industrial development would be minimal.	Same as the Preferred Alternative. Agricultural chemicals could impact Wahluke groundwater and recharge from Wahluke irrigation could alter flow patterns and lead to slumping in the White Bluffs.	Same as the Preferred Alternative.	Same potential impacts as the Preferred Alternative, but new impacts could be distributed across the Hanford Site. Potential impacts from Agriculture similar to Alternative Three.

Table 3-4. Summary of Potential Impacts to Hanford Site Resources. (8 pages)

Resource	Preferred Alternative	Alternative One	Alternative Two	Alternative Three	Alternative Four	No-Action Alternative
BIOLOGICAL RESOURCES						
Federal Endangered Species	Increased protection of the river from development would ensure salmon and steelhead spawning areas are protected. Increased recreational access to the Columbia River could adversely affect salmonid spawning areas and the proposed Tribal Village and White Bluffs boat launch could impact the Bald Eagle nesting attempts.	Protects all species from development and restricts access to the Columbia River. Does not assume consumptive use of species through treaty-reserved rights. Is the Environmentally Preferable Alternative.	Protects all species from development and restricts access to the Columbia River. Allows consumptive use of species through treaty-reserved rights.	Increased threat to habitat from Wahluke Slope development. Increased protection of the river from development would help protect salmon and steelhead spawning areas. Increased recreational access to the Columbia River could adversely affect salmonid spawning areas. Proposed High Intensity Recreation Area and White Bluffs boat launch could impact the Bald Eagle nesting attempts.	Protects all species from development and restricts access to the Columbia River. Allows consumptive use of species through treaty-reserved rights.	Between Preferred Alternative and Alternative One.
Vegetation	Surface clearing would eliminate vegetation and wildlife habitat in areas designated for development.	Much lower than the Preferred Alternative.	Much lower than the Preferred Alternative.	Greater impacts than the Preferred Alternative. Clearing of vegetation for cultivated agriculture.	Less than the Preferred Alternative.	Greater than the Preferred Alternative.
Habitat	Utility corridors and access roads could fragment habitat within areas designated for industrial development. Generally protected by Plan's Policies that designate development in habitat that is of lower biological value.	Lower than under the Preferred Alternative.	Potential impacts restricted to urban growth area.	Same as the Preferred Alternative, but larger areas designated for development, so potential greater need for new infrastructure.	Less than the Preferred Alternative.	Greater than Preferred Alternative.
Grazing	Grazing would not be allowed under this alternative.	Commercial grazing is not allowed under this alternative.	Commercial grazing would not be allowed under this alternative.	Grazing is a permitted interim use for other than Preservation or Conservation uses under this alternative's Policies.	Grazing is not allowed under this alternative.	Grazing impacts restricted to the Wahluke Slope north of State Highway 24.

Table 3-4. Summary of Potential Impacts to Hanford Site Resources. (8 pages)

Resource	Preferred Alternative	Alternative One	Alternative Two	Alternative Three	Alternative Four	No-Action Alternative
Aquatic Resources	Increased recreational access to the Columbia River could adversely affect salmonid spawning areas, aquatic plant communities, and other resources associated with the river.	Lower than the Preferred Alternative.	No increase in recreational access under this alternative, so no new impacts.	Same impact as the Preferred Alternative.	Similar, but potentially lower, impacts than the Preferred Alternative.	Less than the Preferred Alternative because no new boat ramps.
Wildlife Migration Corridor	The integrity of the wildlife migration corridor associated with McGee Ranch would be maintained.	Same as the Preferred Alternative.	Same as the Preferred Alternative.	McGee Ranch available for development.	Same as the Preferred Alternative.	McGee Ranch available for development.
Preservation of BRMaP Level III and Level IV Resources	Preservation designation would protect 66% of BRMaP Level III, and 85% of BRMaP Level IV resources.	Preservation designation would protect 92% of BRMaP Level III and 85% of BRMaP Level IV resources.	Preservation designation would protect 96% of BRMaP Level III and 85% of BRMaP Level IV resources.	Preservation designation would protect 5% of BRMaP Level III and 13% of BRMaP Level IV resources.	Preservation designation would protect 85% of BRMaP Level III and 85% of BRMaP Level IV resources.	The No-Action Alternative does not specifically designate land for Preservation.
CULTURAL RESOURCES						
Religious Sites	Cultural resources and religious sites associated with basalt outcrops such as Gable Butte and Gable Mountain would be protected.	Same as the Preferred Alternative.	Same as the Preferred Alternative.	Cultural resources and religious sites associated with basalt outcrops such as Gable Butte and Gable Mountain would be protected by Plan Policies and Procedures.	Same as the Preferred Alternative.	Cultural resources and religious sites associated with basalt outcrops such as Gable Butte and Gable Mountain would be protected by CRMP Plan Policies and Procedures.
Viewsheds	Mining and industrial development could occur within viewsheds from high promontories.	Area that could be developed within viewsheds is smaller than for the Preferred Alternative.	Viewsheds would be protected. Impacts would be less than for the Preferred Alternative.	Development could occur within viewsheds to a greater extent than for the Preferred Alternative.	Same as Alternative Two. Less than the Preferred Alternative.	Development not precluded at any location. Greater than for the Preferred Alternative.
Natural Resource Gathering Areas	Damage to natural resource gathering areas from development and increased recreational use of the Columbia River.	Less than the Preferred Alternative.	Impacts to natural resource gathering areas would be minimal.	Damage to natural resource gathering areas from development, increased recreational use of the Columbia River, and grazing.	Less than the Preferred Alternative.	Greater than the Preferred Alternative.

Table 3-4. Summary of Potential Impacts to Hanford Site Resources. (8 pages)

Resource	Preferred Alternative	Alternative One	Alternative Two	Alternative Three	Alternative Four	No-Action Alternative
Cultural Sites	Damage to cultural sites from development. Increased access to the Columbia River could result in damage from artifact collection, vandalism, and erosion.	Less than the Preferred Alternative.	Commercial grazing would not be allowed and impacts to cultural sites from development would be minimal. Access to the Columbia River would not be increased.	Impacts to the Wahluke Slope and White Bluffs only. Damage to cultural sites on the Wahluke Slope from agriculture (including grazing), and could lead to loss of the White Bluffs.	Less than the Preferred Alternative. No grazing would be allowed.	Greater than the Preferred Alternative.
Salmonid Spawning Sites	No impact to salmonid spawning sites.	No impact to salmonid spawning sites.	No impact to salmonid spawning sites.	Increased sediment loading from White Bluffs irrigation sloughing, and grazing could damage salmonid spawning sites.	Same as Alternative Two.	Between Alternative Three and Preferred Alternative.
AESTHETIC RESOURCES						
Viewsheds	Viewing locations associated with Gable Butte and Gable Mountain would be protected. Locations associated with the Columbia River would be disrupted. Viewsheds could be disrupted.	Same as the Preferred Alternative.	Minimal impacts; less than the Preferred Alternative.	Viewing locations associated with basalt outcrops could be adversely impacted, but locations along the river would be protected. Viewsheds could be disrupted.	Viewing locations would be protected. Minimal impacts to viewsheds. Less than the Preferred Alternative.	Viewing locations and viewsheds could be adversely impacted. Greater than the Preferred Alternative.
Ambient Visibility	Visibility could be impacted by releases of fugitive dust from construction sites and pollutants from new industrial sources.	Similar to, but less than, the Preferred Alternative.	Minimal impacts; less than the Preferred Alternative.	Greater than the Preferred Alternative.	Less than the Preferred Alternative.	Greater than the Preferred Alternative.
Ambient Noise	Blasting, industrial sites, and increased use of motorized water craft could increase noise levels, disrupt wildlife, and detract from recreational experiences.	Less than the Preferred Alternative.	Minimal impacts; less than the Preferred Alternative.	Greater than the Preferred Alternative.	Less than the Preferred Alternative.	Same as the Preferred Alternative.

Table 3-4. Summary of Potential Impacts to Hanford Site Resources. (8 pages)

Resource	Preferred Alternative	Alternative One	Alternative Two	Alternative Three	Alternative Four	No-Action Alternative
SOCIOECONOMICS AND INDUSTRIAL DEVELOPMENT	15,335 ha available for industrial development, which would meet the need forecasted by the Benton County Planning Department and provide ample area to support possible future DOE missions. This amount of land would support employment of 1,000 or more.	2,542 ha available for industrial development, which would meet the forecasted need and provide 1,615 ha for possible future DOE missions. This land could support employment of 100 to 1,000.	1,830 ha available for industrial development, but much of the land is already developed. Would not provide sufficient vacant land to meet Benton County's estimated future needs or provide for possible future DOE missions. Employment limited to less than 100.	17,860 ha available for industrial development, which would meet the need forecasted by the Benton County Planning Department and provide ample area to support possible future DOE missions. This amount of land would support employment of 1,000 or more.	6,882 ha available for industrial development, meeting the estimated future need and providing land for future DOE missions. This land could support employment of 100 to 1,000.	Facility planning and siting conducted on a project-by-project basis as guided by the 1996 *Hanford Strategic Plan*. At least 22,534 ha available to support future Industrial or Research and Development DOE missions
RESEARCH AND DEVELOPMENT	4,912 ha designated for Research and Development could support up to 300 employees.	414 ha designated for Research and Development, but limited to previously developed areas.	Research and Development limited to 699 ha of existing uses at LIGO and the K Reactor water supply used for fish rearing.	Greater than the Preferred Alternative 8,177 ha designated for Research and Development could support up to 600 employees	4,388 ha designated for Research and Development could support up to 300 employees	Facility siting conducted on a project-by-project basis. Ample land available. At least 22,534 ha available to support future Industrial or Research and Development DOE missions
GRAZING AND AGRICULTURE	No lands designated for grazing or cultivated agriculture.	No lands designated for commercial grazing or cultivated agriculture.	No lands designated for commercial grazing. Cultivated agriculture would not be allowed.	1,059 AUM with a value of $12,700. Cultivated agriculture could generate from $16 to $88 million in additional revenue depending on the scenario.	No lands designated for grazing or cultivated agriculture.	Lack of a plan may discourage multiple use of Hanford lands and grazing and agriculture would be considered under individual proposals. Lands permitted for grazing could support 1,655 AUM with a value of $19,900. Cultivated agriculture would be allowed.
MINERAL RESOURCES (Privately Held)	Existing natural gas claims could be developed, but the Preservation designation in the surrounding area would preclude construction of an access road.	Same as the Preferred Alternative.	Same as the Preferred Alternative.	Existing claims could be developed and access roads could be constructed. Additional development of natural gas could be encouraged.	Same as the Preferred Alternative.	Existing natural gas claims could be developed and access roads could be constructed.

Table 3-4. Summary of Potential Impacts to Hanford Site Resources. (8 pages)

Resource	Preferred Alternative	Alternative One	Alternative Two	Alternative Three	Alternative Four	No-Action Alternative
RECREATION	Increased recreation could increase revenues generated by tourism.	Less than the Preferred Alternative.	Less than the Preferred Alternative.	A destination resort/conference center at Vernita Terrace could generate up to $2 million to $4 million in payroll.	Less than the Preferred Alternative.	New revenue generating recreational opportunities would be unlikely.
ENVIRONMENTAL JUSTICE	Increased access to the Columbia River would potentially increase exposure and health risk. Minority or low-income populations may be more prone to adopt a subsistence lifestyle, but a particular population would not necessarily be affected.	Because the purpose of a Federal Wildlife Refuge is to conserve native ecological systems, consumption of those systems would be limited and therefore provide better protection from contamination than the Preferred Alternative.	Access to the Columbia River would be limited. No disproportionately high and adverse impacts would occur.	Same as the Preferred Alternative.	Same as the Preferred Alternative.	Same as the Preferred Alternative.
	Areas of cultural value to American Indians would be protected, but development would be allowed within the viewscape of some of those areas.	Same as the Preferred Alternative.	Same as the Preferred Alternative, but viewscapes would also be protected.	Areas of cultural value to American Indian Tribes could be developed and development could occur within culturally significant viewscapes.	Same as Alternative Two.	Same as Alternative Three.
	Economic development of Hanford Site lands would be neutral in low-income and minority communities within the assessment area.	Limitation on development could adversely impact low-income populations. However, local low-income populations are not greatly influenced by Hanford Site spending.	Same as Alternative One.	Same as Preferred Alternative.	Same as Preferred Alternative.	Same as Preferred Alternative.
	Prohibiting agriculture on the Wahluke Slope would not change the current condition.	Same as the Preferred Alternative.	Same as the Preferred Alternative.	Agriculture would be allowed on the Wahluke Slope, potentially benefitting low-income and minority populations..	Same as the Preferred Alternative.	Same as the Preferred Alternative.

Table 3-4. Summary of Potential Impacts to Hanford Site Resources. (8 pages)

Resource	Preferred Alternative	Alternative One	Alternative Two	Alternative Three	Alternative Four	No-Action Alternative
HUMAN HEALTH	Increased access to Hanford Site lands would increase the potential for health risks.	Less than the Preferred Alternative.	Access to Hanford would be limited and the potential for health risks would be minimized.	Greater than the Preferred Alternative because of the intensity of use.	Less than the Preferred Alternative.	Access would be restricted and risks would be less than for the Preferred Alternative.
	New developments on the Hanford Site could lead to an increase in occupational injuries and fatalities associated with mining and industrial activities.	Less than the Preferred Alternative.	Much less than the Preferred Alternative.	Greater than the Preferred Alternative and would have the additional risk of occupational injuries from agriculture.	Less than the Preferred Alternative.	Potentially greater risk than for the Preferred Alternative.
	Increased recreational activities could increase the risk of injury from recreational accidents.	Less than the Preferred Alternative.	No increase in recreational use and the risk of recreational accidents would be minimized.	Greater than the Preferred Alternative.	Less than the Preferred Alternative.	Minimal increase in recreational use. Risk of recreational accidents would not increase.
HUMAN HEALTH	Remediation to an Industrial standard in the 300 and 200 Areas would involve less remediation worker risk from hazardous materials exposure and cumulative equipment operation time than some of the CRCIA scenarios could require for non-industrial uses. Actual remediation scenario will be picked through the CERCLA/RCRA process which could require more or less remediation based on the scenario chosen.	Minimum Industrial development could require more remediation worker risk exposure than Preferred Alternative.	Minimum Industrial development could require the most remediation worker risk exposure.	Maximum Industrial development could require the least remediation worker risk exposure.	Industrial development between Alternative One and the Preferred Alternative.	Minimal increase in changes of land use from open space reserved designation. The validity of an Industrial remediation scenario could be questioned without an integrated GMA Industrial designation. Actual remediation scenario will be picked through the CERCLA/RCRA process which could require more or less remediation based on the scenario chosen.

4.0 Affected Environment

The Hanford Site lies within the semi-arid Pasco Basin of the Columbia Plateau in southeastern Washington State. The Hanford Site occupies an area of approximately 1,517 square kilometers (km^2) (586 square miles [mi^2]) north of the confluence of the Yakima River with the Columbia River. Within the geographic boundary of the Site, there are 36.42 km^2 (14.1 mi^2) of Columbia River surface water, and one section (1 mi^2) of land owned by the State of Washington.

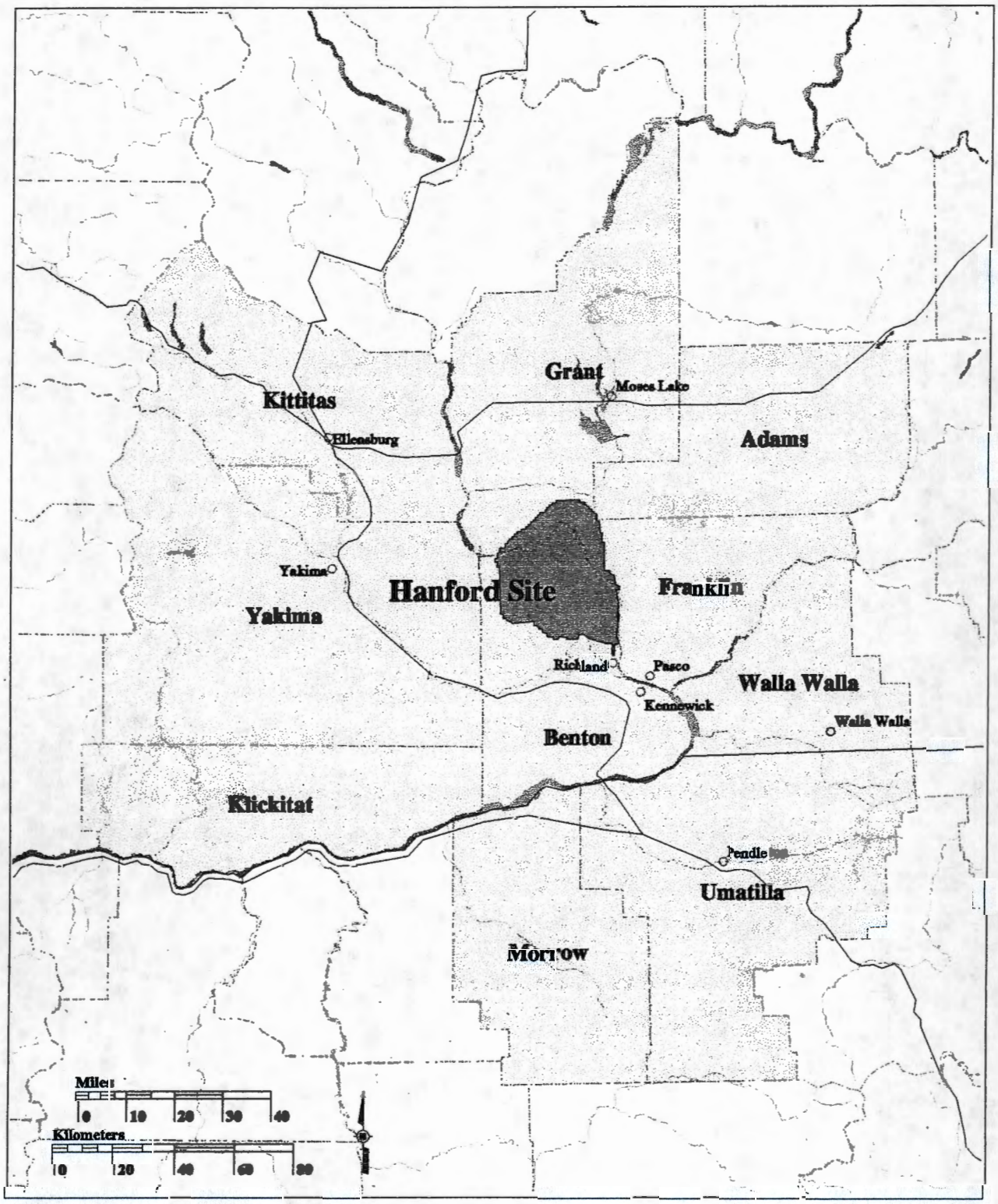
The Hanford Site is about 50 km (30 mi) north to south and 40 km (24 mi) east to west. The Columbia River flows through the northern part of the Hanford Site and, turning south, forms part of the Hanford Site's eastern boundary. The Yakima River runs near the southern boundary and joins the Columbia River below the City of Richland, which bounds the Hanford Site on the southeast. Rattlesnake Mountain, Yakima Ridge, and Umtanum Ridge form the southwestern and western boundaries, and the Saddle Mountains form the Hanford Site's northern boundary. Two small east-west ridges, Gable Butte and Gable Mountain, rise above the plateau of the central part of the Hanford Site. Adjoining lands to the west, north, and east are principally agricultural and range land. The cities of Richland, Kennewick, and Pasco (also referred to as the Tri-Cities) constitute the nearest population center and are located immediately southeast of the Hanford Site. Figure 4-1 depicts the Hanford Site and the surrounding area.

The production of defense nuclear materials at the Hanford Site since the 1940s has necessitated the exclusion of public access and most non-government-related development on the Hanford Site. As a result of its defense-related mission, the Hanford Site has also provided *de facto* protection of the natural environment and cultural resources (NPS 1994); however, the defense nuclear production mission has left the Hanford Site with an extensive waste legacy. Nuclear weapons material production and associated activities at the Hanford Site during the past five decades have generated a variety of radioactive, hazardous, and other wastes that have been disposed of or discharged to the air, soil, and water at the Hanford Site.

4.1 Land Uses

For many years, the area along the Columbia River was used extensively by Tribal members for fishing, hunting, and gathering. Pasturing of livestock became important in pre-contact times. The Cayuse, Umatilla, Walla Walla, and Nez Perce people became very skillful at breeding horses (in the 1700s). When Lewis and Clark first came down the Columbia River, there were great herds of horses grazing the rich hills of southeastern Washington and northeastern Oregon. Although the horse meant greater mobility, these people maintained traditional migratory patterns. The Columbia River supplied an endless cycle of vegetable crops. Most bands gathered at winter sites on or near the Columbia River. Culturally, these sites were used by the same people and their ancestors before them for thousands of years. The routes of migration followed ancient patterns with the band stopping at the same spot it camped the year before. In the early spring, family bands would leave the main encampment on the river and travel to the uplands to dig roots. They timed their returns to utilize the main salmon run in the spring and fall. When they had a sufficient stockpile of dried salmon, they would return to the mountains to gather berries and hunt for game until the snows would push them back to the lowlands near or on islands in the Columbia where they would gather together in the large wintering sites and spend the colder months. Mission, Oregon; Walla Walla, Washington; Pasco, Washington; and Umatilla, Oregon, are just a few of the modern-day names of where some of those old winter camping sites were located.

Figure 4-1. Hanford Site and the Vicinity.



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Land uses at the Hanford Site have changed dramatically over the past 100 years. By the turn of the century, settlers had moved into the area, developing irrigated farmland and practicing extensive grazing (see Figure 1-4). In 1943, the Federal government acquired the Hanford Site for production of nuclear materials to be used in the development of the atomic bomb.

4.1.1 Existing Land Uses in the Vicinity of the Hanford Site

Existing land uses within the vicinity of the Hanford Site include urban and industrial development, wildlife protection areas, recreation, irrigated and dryland farming, and grazing. According to the 1992 Census of Agriculture (USDA-NASS 1992), Benton, Franklin, and Grant counties had a total of 958,626 hectares (ha) (2,396,564 acres [ac]) (9,586 square kilometers [km^2]/3,745 square miles [mi^2]) of land in farms, of which 667,027 ha (1,667,568 ac) (6,670 km^2/ 2,606 mi^2) were in crop land. Approximately 46 percent of crop land was irrigated in 1992, and approximately 40 percent of crop land in 1992 was used as pastureland. According to the 1992 census, the total market value of agricultural products in the three counties was $935 million, including $758 million for crops and $177 million for livestock. In 1994, wheat represented the largest single crop (in terms of area) planted in Benton and Franklin counties. The total area planted in the two counties was 97,490 ha (240,900 ac) (975 km^2/376 mi^2] and 12,020 ha (29,700 ac) (120 km^2/46.4 mi^2) for winter and spring wheat, respectively. Other major crops such as alfalfa, apples, asparagus, cherries, corn, grapes, and potatoes are also produced in Benton and Franklin counties (PNNL 1996a). In 1994, the Conservation Reserve Program of the U.S. Department of Agriculture (USDA)[1] included 10,279.8 ha (25,382.3 ac) [102.8 km^2/ 39.7 mi^2] in Benton County, 9,359.3 ha (23,109.3 ac) [93.6 km^2/ 36.1mi^2] in Franklin County, and 10,116.8 ha (24,979.8 ac) (101.1km^2/39.0 mi^2) in Grant County.[2]

In 1992, the Columbia Basin Project, a major irrigation project to the north of the Tri-Cities, produced gross crop returns of $552 million, representing 12.5 percent of all crops grown in Washington State. Also, in that year, the average gross crop value per irrigated acre was $1,042. The largest percentage of irrigated acres produced alfalfa hay (26.1 percent of irrigated acres), wheat (20.2 percent), and feed-grain corn (5.8 percent). Other significant crops are apples, dry beans, potatoes, and sweet corn (PNNL 1996a).

Other land uses in the vicinity of the Hanford Site include a planned, low-level radioactive waste decontamination, super-compaction, plasma gasification and vitrification unit (operated by Allied Technology Group Corporation); and a commercial nuclear fuel fabrication facility (operated by Siemens Power Corporation).

4.1.2 Existing Hanford Site Land Uses

Land-use categories at the Hanford Site include reactor operations, waste operations, administrative support, operations support, sensitive areas, and undeveloped areas. Remedial activities are currently focused within or near the disturbed areas. Much of the Hanford Site is undeveloped, providing a safety and security buffer for the smaller areas used for operations. Public access to most facility areas is restricted.

4.1.2.1 Wahluke Slope. The area north of the Columbia River encompasses approximately 357 km^2 (138 mi^2) of relatively undisturbed or recovering shrub-steppe habitat. The northwest portion of the area is managed by the U.S. Fish and Wildlife Service (USFWS) under a permit

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1 Agricultural lands at risk for soil erosion set aside to enhance wildlife.

2 Personal conference with Rod Hamilton, Conservation Program Specialist with the USDA, Farm Service Agency, in Spokane, Washington, October 1997.

issued by DOE in 1971 as the Saddle Mountain National Wildlife Refuge (NWR). The permit conditions require that the refuge remain closed to the public as a protective perimeter surrounding Hanford operations. The closure has benefitted migratory birds, such as curlews, loggerhead shrikes, and waterfowl.

Until recently, in the northeast portion of the Wahluke Slope, the Washington State Department of Fish and Wildlife (WDFW) operated the Wahluke State Wildlife Recreation Area, which was established in 1971. In April 1999, the WDFW and the USFWS notified the DOE of their intent to modify their management responsibilities on the Wahluke Slope under the 1971 agreement leaving only a small portion (about 324 ha (800 ac)) northwest of the Vernita bridge under WDFW permit. The USFWS informed the DOE that it intends to allow essentially the same uses permitted by the State of Washington under the WDFW's management of the Wahluke Slope. Therefore, transfer of management of the Wahluke Slope from the WDFW to the USFWS involves only a change in the agency managing the property and does not involve any change in the management activities for the Wahluke Slope. Management of the entire Wahluke Slope by the USFWS as an overlay wildlife refuge is consistent with the 1996 DOI Hanford Reach EIS ROD. The ROD recommended the Wahluke Slope be designated a wildlife refuge and the Hanford Reach a Wild and Scenic River, and that the wildlife refuge be managed by the USFWS.

The WDFW had leased a total of approximately 43 ha (107 ac) of the Wahluke State Wildlife Recreation Area for sharecropping. The purpose of these agricultural leases is to produce food and cover for wildlife and manage the land for continued multi-purpose recreation. In addition, the WDFW issued a grazing permit for approximately 3,756 ha (9,280 ac), allowing up to 750 animal-unit-months to graze the parcel (WDFW Grazing Permit #W5-01, and WDFW Agricultural Leases #R-01, #WB-01, and #WB-02). This WDFW grazing lease was allowed to expire on December 31, 1998 but, under SEPA regulations for up to 10 years after the expiration of the lease, the WDFW can reinstate the grazing lease without public review.

The Wahluke Wildlife Recreation Area is open to the public for recreational uses during daylight hours. According to data published in the *Hanford Reach of the Columbia River, Comprehensive River Conservation Study and Environmental Impact Statement Final - June 1994* (NPS 1994), the Wahluke State Wildlife Recreation Area has more than 40,000 visits per year by recreationists. Most recreational visits are related to sport fishing in the Columbia River.

The Wahluke Slope once contained small, nonradioactively contaminated sites (i.e., landfills). These sites were subject to an expedited response action and were remediated by DOE in 1997. Although remediation took place, the landfills could still have hazardous materials that would cause injury to trust resources. The DOE is not planning to alter the current land uses of the Wahluke Slope and is specifically prohibited from causing any adverse impacts on the values for which the area is under consideration for Wild and Scenic River or NWR status (DOI 1996).

4.1.2.2 Columbia River Corridor. The 111.6 km^2 (43.1 mi^2) Columbia River Corridor, which is adjacent to and runs through the Hanford Site, is used by the public and Tribes for boating, water skiing, fishing, and hunting of upland game birds and migratory waterfowl. While public access is allowed on certain islands, access to other islands and adjacent areas is restricted because of unique habitats and the presence of cultural resources.

The 100 Areas occupy approximately 68 km^2 (26 mi^2) along the southern shoreline of the Columbia River Corridor. The area contains all of the facilities in the 100 Areas, including nine retired plutonium production reactors, associated facilities, and structures. The primary land uses are reactor decommissioning and undeveloped areas. Future use restrictions have been

placed in the vicinity of the 100-H Area, which is associated with the 183-H Solar Evaporation Basins. Additional deed restrictions or covenants for activities that potentially extend beyond 4.6 meters (m) (15 feet [ft]) below ground surface are expected for other *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remediation areas. Additional information is provided in Section 3.3.1.4.2.

The area known as the Hanford Reach includes an average of a 402-m (1,320-ft) strip of public land on either side of the Columbia River. The Hanford Reach is the last unimpounded, nontidal segment of the Columbia River in the United States. In 1988, Congress passed Public Law 100-605, *Comprehensive River Conservation Study*, which required the Secretary of the Interior to prepare an environmental impact study (in consultation with the Secretary of Energy) to evaluate the outstanding features of the Hanford Reach and its immediate environment.

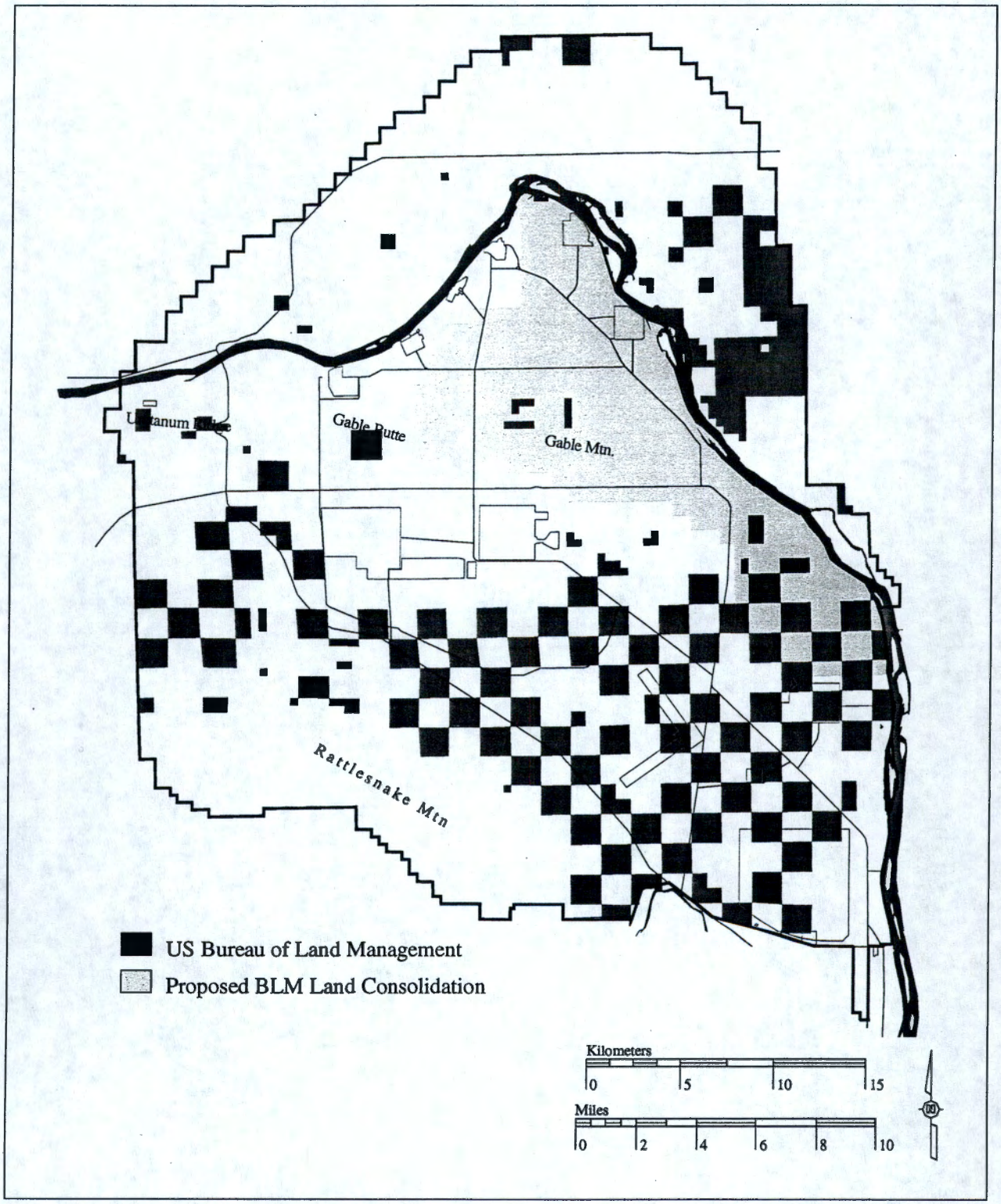
Alternatives for preserving the outstanding features also were examined, including the designation of the Hanford Reach as part of the National Wild and Scenic Rivers system. The results of the study can be found in the *Hanford Reach of the Columbia River, Comprehensive River Conservation Study and Environmental Impact Statement Final - June 1994* (NPS 1994). The Record of Decision (ROD) DOI issued as a result of this EIS in 1996 recommended that the Hanford Reach be designated a "recreational river," as defined by the *National Wild and Scenic Rivers Act of 1968*. The ROD also recommended that the remainder of the Wahluke Slope be established as a National Fish and Wildlife Refuge. Finally, the ROD recommended that the approximately 728 ha (1,800 ac) of private land located in the Hanford Reach Study Area be included in the recreational river boundary, but not the refuge boundary. The final designation will require Congressional legislation.

There are two proposals currently under consideration in Congress. The primary differences between the proposals include the extent of the geographic scope (whether the Wahluke Slope is addressed in addition to the river corridor) and the designation of the land manager (e.g., local vs. Federal control).

In addition to the control and Wahluke Slope issues, the proposed Wild and Scenic legislation contains a provision for transferring administrative jurisdiction over certain parcels of land in the State of Washington from the Secretary of Energy to the Secretary of the Interior, affecting underlying ownership of about 19,943 ha (49,280 ac, 197 km^2, 75 mi^2) of the Hanford Site. This swap would consolidate the scattered Benton County portion of Hanford's Bureau of Land Management (BLM) Public Domain lands, into an area beginning near 100-D, running south and east along the Columbia River shore, to just north of Energy Northwest (formerly known as the Washington Public Power Supply System, or WPPSS) and then west to Gable Mountain (see Figure 4-2). As long as these lands are needed (e.g., still withdrawn from BLM by DOE), this legislative action would not affect DOE's administration of the areas involved. The DOE's use of withdrawn BLM Public Domain lands is consistent with most land-use designations with the exceptions of Industrial Exclusive, Research and Development, or Industrial designations where BLM's multiple-use mandate would be limited by an extensive infrastructure.

4.1.2.3 Central Plateau. The 200 East and 200 West Areas occupy approximately 51 km^2 (19.5 mi^2) in the Central Plateau of the Hanford Site. Facilities located in the Central Plateau were built to process irradiated fuel from the production reactors. The operation of these facilities resulted in the storage, disposal, and unplanned release of radioactive and nonradioactive waste. The primary land uses are waste operations and operations support. Deed restrictions or covenants for activities that potentially may extend beyond 4.6 m (15 ft) below ground surface are expected for CERCLA remediation areas in the Central Plateau geographic study area.

Figure 4-2. Proposed BLM Land Swap.



BHI:rpp 01/13/98 draft_2/landownswap1.aml Database: 06-AUG-1998

In 1964, a 410-ha (1,000-ac) tract was leased to the State of Washington to promote nuclear-related development. A commercial low-level radioactive waste disposal facility, run by U.S. Ecology, Inc., currently operates on 41 ha (100 ac) of the leasehold. The rest of the leasehold was not used by the State, and this portion of the leasehold recently reverted to DOE. The DOE constructed the Environmental Restoration Disposal Facility (ERDF) on this tract.

The ERDF is operated on the Central Plateau to provide disposal capacity for environmental remediation waste (e.g., low-level, mixed low-level, and dangerous wastes) generated during remediation of the 100, 200, and 300 Areas of the Hanford Site. The facility is currently about 65 ha (160 ac) and can be expanded up to 414 ha (1.6 mi^2) as additional waste disposal capacity is required.

4.1.2.4 All Other Areas. The All Other Areas geographic area is 689 km^2 (266 mi^2) and contains the 300, 400 and 1100 Areas, Energy Northwest (formerly known as WPPSS) facilities, and a section of land currently owned by the State of Washington.

The 300 Area is located just north of the City of Richland and covers 1.5 km^2 (0.6 mi^2). The 300 Area is the site of former reactor fuel fabrication facilities and is also the principal location of nuclear research and development (R&D) facilities serving the Hanford Site. Kaiser Aluminum and Chemical Corporation is leasing the 313 Building in the 300 Area to use an extrusion press that was formerly owned by DOE. The Environmental Molecular Sciences Laboratory (EMSL) and associated research programs provide research capability to advance technologies in support of DOE's mission of environmental remediation and Waste Management.

The 400 Area, located southeast of the 200 East Area, is the site of the Fast Flux Test Facility (FFTF). The FFTF is a 400 megawatt thermal, liquid metal (sodium-cooled) nuclear research test reactor that was constructed in the late 1970s and operated from 1982 to 1992. Although not designed nor operated as a breeder reactor, the FFTF operated during these years as a national research facility for the Liquid Metal Fast Breeder Reactor Program to test advanced nuclear fuels, materials, components, systems, nuclear operating and maintenance procedures, and active and passive safety technologies. The reactor was also used to produce a large number of different isotopes for medical and industrial users, generate tritium for the United States fusion research program, and conduct cooperative, international research.

In December 1993, the FFTF was shutdown due largely at that time from determinations that the facility could not continue to operate economically. In April 1995, defueling was completed and usable fuel is stored on site in fuel storage vessels or in the secure vault at the Plutonium Finishing Plant at the Hanford Site. Unusable spent nuclear fuel (SNF) has been thoroughly washed to remove all sodium residuals, dried, and placed in approved, 50-year Interim Storage Casks on the 400 Area Interim Storage Area pad. In November 1995, the reactor was placed in standby mode with the main cooling system operating at approximately 200°C (400°F) to keep the sodium coolant liquid and circulating to maintain DOE's option to restart and operate the reactor in the future. Essential systems, staffing, and support services are being maintained in a manner that will support either timely restart or deactivation of the FFTF. In January 1997, the Secretary of Energy officially directed that the FFTF be maintained in a standby condition while an evaluation was conducted of any future role the facility might have in the DOE's national tritium production strategy. In December 1998, the Secretary determined that the FFTF would not play a role in the nation's tritium production strategy.

In May 1999, the Secretary announced that DOE would ask the Pacific Northwest National Laboratory (PNNL) to complete a 90-day study that would resolve outstanding informational needs for the FFTF. Results of this study were completed and documented in a

program scoping plan presented by PNNL to DOE in early August 1999. As a result of this study, the Secretary decided, on August 18, 1999, that DOE would conduct a programmatic *National Environmental Policy Act* (NEPA) review, including an Environmental Impact Statement (EIS), evaluating the potential environmental impacts associated with proposed expansion of infrastructure, including the possible role of the FFTF, for civilian nuclear energy research and development activities; production of isotopes for medical, research, and industrial uses; and production of plutonium-238 for use in advanced radioisotope power systems for future National Aeronautic and Space Administration (NASA) space missions. The Notice of Intent for this programmatic EIS is planned for publication in the *Federal Register* on September 15, 1999. The Final EIS (FEIS) is planned for completion in the Fall of 2000; a Record of Decision utilizing the NEPA review (including the FEIS), is planned by December 2000.

The 1100 Area, located just north of Richland, served as the central warehousing, vehicle maintenance, and transportation operations center for the Hanford Site. A deed restriction has been filed with Benton County for the Horn Rapids Asbestos Landfill, which restricts future land uses in the vicinity of the landfill. Also, DOE transferred the 1100 Area to the Port of Benton. The DOE prepared an environmental assessment that resulted in a finding of no significant impact on August 27, 1998, for the transfer of the 1100 Area and the Southern rail connection to the Port of Benton (DOE/RL EA-1260). The Port officially took ownership and control of the 1100 Area (consisting of 318 ha [786 ac], 26 buildings, and 26 km [16 mi] of rail tract) on October 1, 1998. Although the 1100 Area is no longer under DOE control, it is included in this EIS to support the local governments with their SEPA EIS analyses of the Hanford sub-area of Benton County under the State of Washington's Growth Management Act.

Together with the Washington State Department of Transportation and Legislature Transportation Committee, the Port of Benton is currently funding a major study ($600,000) to determine the feasibility of reconnecting the Hanford main rail line to Ellensburg, Washington (as it was in the 1970s), as an alternative route for Yakima Valley rail traffic flowing between the Puget Sound and the Tri-Cities. The current Yakima Valley route passes directly through all the cities in the Valley, including the cities of Yakima and Kennewick which have plans to develop their downtown areas to be more people friendly. Specifically, the Port has expressed a desire to use the Hanford rail system and extend the current system upriver where there is currently only an abandoned railroad grade.

Additional land uses in the All Other Areas geographic area include the following:

- The Hazardous Materials Management and Emergency Response (HAMMER) Volpentest Training and Education Center, which is used to train hazardous materials response personnel. The HAMMER Volpentest Training and Education Center is located north of the 1100 Area and covers about 32 ha (80 ac).

- Land was leased to Energy Northwest (formerly known as WPPSS) to construct three commercial power reactors in the 1970s. One plant, Washington Nuclear Plant Number 2 (WNP-2), was completed and is currently operating. Activities on the other two plants were terminated and the plants will not be completed. The DOE is considering a proposal from Energy Northwest to allow a sublease for siting, construction, and operation of an aluminum smelter (see Section 1.3).

- In 1980, the Federal government sold a 259 ha (640 ac) section of land south of the 200 East Area, near State Route (SR) 240, to the State of Washington for the purpose of nonradioactive hazardous waste disposal. This parcel is uncontaminated (although the underlying groundwater is contaminated) and undeveloped. The deed requires that if it is used for any purpose other than hazardous waste disposal, ownership would revert to the Federal government.

- The Laser Interferometer Gravitational-Wave Observatory (LIGO), built by the National Science Foundation on the Hanford Site, detects cosmic gravitational waves for scientific research. The facility consists of two underground optical tube arms, each 4 km (2.5 mi) long, arrayed in an "L" shape. The facility is sensitive to vibrations in the vicinity, which can be expected to constrain nearby land uses.

4.1.2.5 The Fitzner/Eberhardt Arid Lands Ecology Reserve (ALE Reserve). The Fitzner/Eberhardt Arid Lands Ecology Reserve (also designated as the Rattlesnake Hills Research Natural Area, or the ALE Reserve), encompasses 308.7 km^2 (119.2 mi^2) in the southwestern portion of the Hanford Site and is managed as a habitat and wildlife reserve and environmental research center. A "research natural area" is a classification used by Federal land management agencies to designate lands on which various natural features are preserved in an undisturbed state solely for research and educational purposes. The ALE Reserve remains the largest research natural area in the State of Washington (PNL 1993a).

The mineral rights to a 518 ha (1,280 ac) area on the ALE Reserve are owned by a private company. The company has been free to enter this area and explore for oil or gas since 1977. Additional information is provided in Section 4.2.3. There are also two ongoing R&D projects under way on the ALE Reserve: gravity experiments in underground Nike bunkers located in the southern portion of the Reserve, and on-line science education, teacher training, and astronomy research in the observatory on the top of Rattlesnake Mountain. Both are long-term projects using existing facilities.

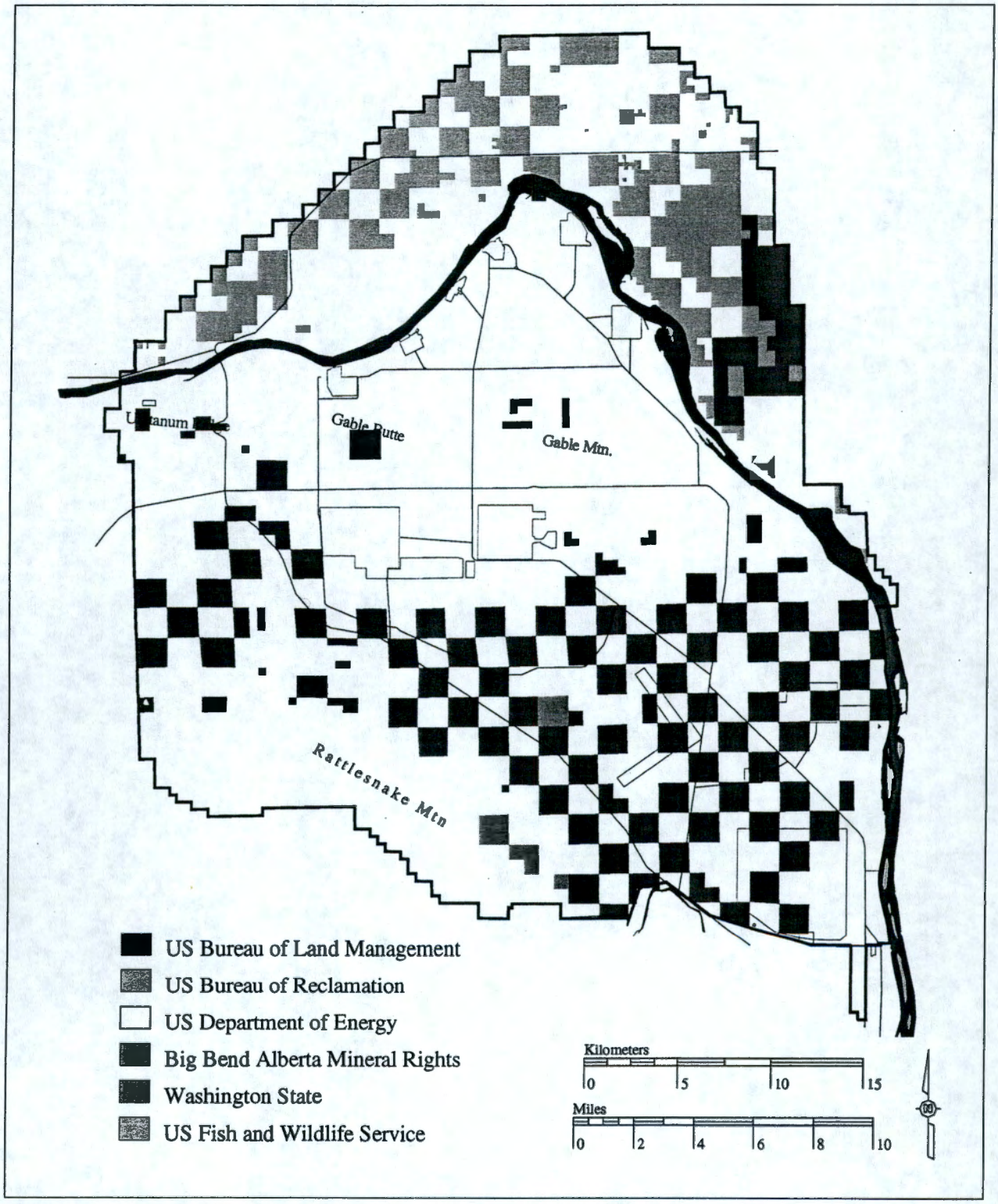
Because public access to the ALE Reserve has been restricted since 1943, the shrub-steppe habitat is virtually undisturbed and is part of a much larger Hanford tract of shrub-steppe vegetation. This geographic area contained a number of small contaminated sites that were remediated in 1994 and 1995 and have been revegetated. There are two landfills on the ALE Reserve, at least one of which was used for disposal of a nonradioactive hazardous waste. Although remediated, one of the landfills may still contain hazardous materials that could cause injury to trust resources.

In 1997, DOE granted a permit and entered into an agreement with USFWS to manage the ALE Reserve consistently with the existing ALE Facility Management Plan. Under this framework, USFWS is preparing a Comprehensive Conservation Plan (CCP) pursuant to the *National Wildlife Refuge Improvement Act of 1997* to identify refuge management actions and to bring the ALE Reserve into the NWR System.

4.1.3 Hanford Site Land Ownership

The Hanford Site land holdings consist of three different real property classifications: (1) lands acquired in fee by DOE or its predecessor agencies, (2) BLM Public Domain lands withdrawn from the Public Domain for use as part of the Hanford Site, and (3) lands the Bureau of Reclamation (BoR) has withdrawn from the Public Domain or acquired in fee as part of the Columbia Basin Project (Figure 4-3). All lands in the Hanford area were ceded to the United States by the Treaties of 1855 (see Appendix A), and these treaties contain

Figure 4-3. Hanford Site Land Ownership.



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reserved rights for perpetuity. All Federal agencies and projects, including the BoR and BLM, have a Federal trust responsibility to protect the rights of the Indian Tribes.

The BoR agreed in a Memorandum of Agreement (MOA) to transfer custody, possession, and use of certain acquired and withdrawn lands situated within the control zone of the Hanford Works to the U.S. Atomic Energy Commission (AEC) on February 27, 1957. These lands consisted of a checkerboard pattern of alternating square-mile sections on the Wahluke Slope. The BoR retained the right to construct, operate, and maintain the Wahluke Canal and related facilities and any necessary wasteways and drainage ways through the Wahluke Slope in connection with irrigation of lands outside of the control zone. These lands were included in the South Columbia Basin Irrigation District and the East Columbia Irrigation District at the time of district formation. In the MOA, the BoR identified a continued interest in development of irrigable lands on the Wahluke Slope as part of the Columbia Basin Project. The AEC acknowledged the interest of the BoR and reaffirmed a policy of keeping DOE land ownership and restrictions of land use on the Wahluke Slope to a minimum.

The BoR continues to retain an interest in the ultimate development of the irrigable lands within the Wahluke Slope as part of the Columbia Basin Project. The interest of the BoR pertains not only to irrigation development, but also to other project purposes (e.g., fish and wildlife protection) and to resource management and environmental concerns. The BoR maintains that the agreement with the AEC assures return of the lands when the lands are no longer necessary to support DOE's mission for the Hanford Site. Furthermore, the BoR would not concur with any change in the present use of the lands until technical and environmental studies were completed.

Withdrawn Public Domain Lands

In addition to the lands acquired by DOE through condemnation during and after World War II (WW II), the Hanford Reservation includes: (1) Bureau of Land Management (BLM) administered lands withdrawn from the Public Domain by DOE during and following WW II, (2) BLM lands withdrawn from the Public Domain by the Bureau of Reclamation (BoR) prior to WW II as part of the Columbia Basin Reclamation Project (CBRP), and (3) lands acquired in fee by the BoR prior to WW II as part of the CBRP. The withdrawn lands and non-withdrawn lands form a checkerboard pattern over large portions of the Hanford Site.

The lands in category (2) (as listed above) were subsequently affected by a second overlapping withdrawal by DOE during and following WW II. When DOE relinquishes its withdrawals on lands that were historically Federal, those lands withdrawn only by DOE would revert to the Public Domain and management by BLM. Those lands withdrawn by the overlapping DOE and BoR withdrawals would remain withdrawn and managed by the BoR.

The BoR's use of the withdrawn Public Domain lands (after the relinquishment of DOE's overlapping withdrawal) must be consistent with the purposes for which they were originally withdrawn from BLM by BoR. If they are not, the BoR could be expected to relinquish or renegotiate its withdrawal notice and the lands could be returned to the Public Domain and management by the BLM, or BoR could negotiate a new withdrawal order with the BLM.

The alternating square-mile sections that would eventually revert to the BLM or BoR are an important consideration that complicates land-use planning. Because the lands are owned by another government agency (i.e., BLM), DOE cannot authorize uses of the property beyond the mission needs of the DOE. Typically, after getting the land back, the BLM evaluates current use(s) of the land, compatibility of uses, and suitability of the land for different uses (i.e., mining, grazing, recreation, and preservation) (see text box, "*Withdrawn Public Domain Lands.*")

4.2 Geological Resources

Geologic considerations for the Hanford Site include physiography, stratigraphy, structural geology, seismic and volcanic hazards, and soil characteristics. The *Hanford Site National Environmental Policy Act (NEPA) Characterization* report (Neitzel 1998) provides the basis for the following discussions.

4.2.1 Landscape

The landscape of the Hanford Site is dominated by the low-relief plains of the Central Plains and the anticlinal ridges of the Yakima Folds physiographic regions. The surface topography has been modified within the past several million years by several geomorphic processes: (1) Pleistocene cataclysmic flooding, (2) Holocene eolian activity, and (3) landsliding. Cataclysmic flooding occurred when ice dams in western Montana and northern Idaho were breached and allowed large volumes of water to spill across eastern and central Washington. This flooding formed the channeled scablands and deposited sediments in the Pasco Basin. The last major flood occurred about 13,000 years ago, during the late Pleistocene Epoch. Braiding flood channels, giant current ripples, and giant flood bars are among the landforms created by the floods. Anastomosing flood channels, giant current ripples, bergmounds, and giant flood bars are among the land forms created by the floods. The 200 Area Waste Management facilities are located on one prominent flood bar, the Cold Creek bar (Figure 4-4).

Since the end of the Pleistocene, winds have locally reworked the flood sediments and have deposited dune sands in the lower elevations and loess (windblown silt) around the margins of the Pasco Basin. Many sand dunes have been stabilized by anchoring vegetation, except where they have been reactivated by human activity disturbing the vegetation.

A series of bluffs occurs for a distance of approximately 56 km (35 mi) along the eastern and northern shores of the Columbia River. In the northern portion of the area, these bluffs are known as the White Bluffs.

Landslides occur along the north limbs of some Yakima Folds and along steep river embankments such as White Bluffs. Landslides on the Yakima Folds occur along contacts between basalt flows or sedimentary units between the basalt, whereas active landslides at White Bluffs occur in sediments above the basalt flows. A study of the Hanford Reach by U. S. Geological Survey geologists (Shuster and Hays 1987) concluded that nearby irrigation has accelerated the rate of landslides occurring in the area. The active landslides at White Bluffs are the result of irrigation activity east of the Columbia River.

4.2.2 Stratigraphy

The stratigraphy of the Hanford Site consists of Miocene-age and younger rocks. Older Cenozoic sedimentary and volcaniclastic rock underlie the Miocene and younger rocks but are not exposed at the surface. The Hanford Site stratigraphy is described in the following subsections and is summarized in Figures 4-5 and 4-6.

4.2.2.1 Columbia River Basalt Group. The Columbia River Basalt Group consists of an assemblage of continental flood basalts of the Miocene age. These basalts cover an area of more than 163,170 km^2 (63,000 mi^2) in Washington, Oregon, and Idaho, and have an estimated volume of about 174,000 km^3 (67,200 mi^3). Isotopic age determinations suggest flows of the Columbia River Basalt Group were erupted during a period from approximately 17 to 6 million years ago, with more than 98 percent by volume being erupted in a 2.5 million-year period (17 to 14.5 million years ago).

Figure 4-4. Topography of the Hanford Site (WHC 1991a).

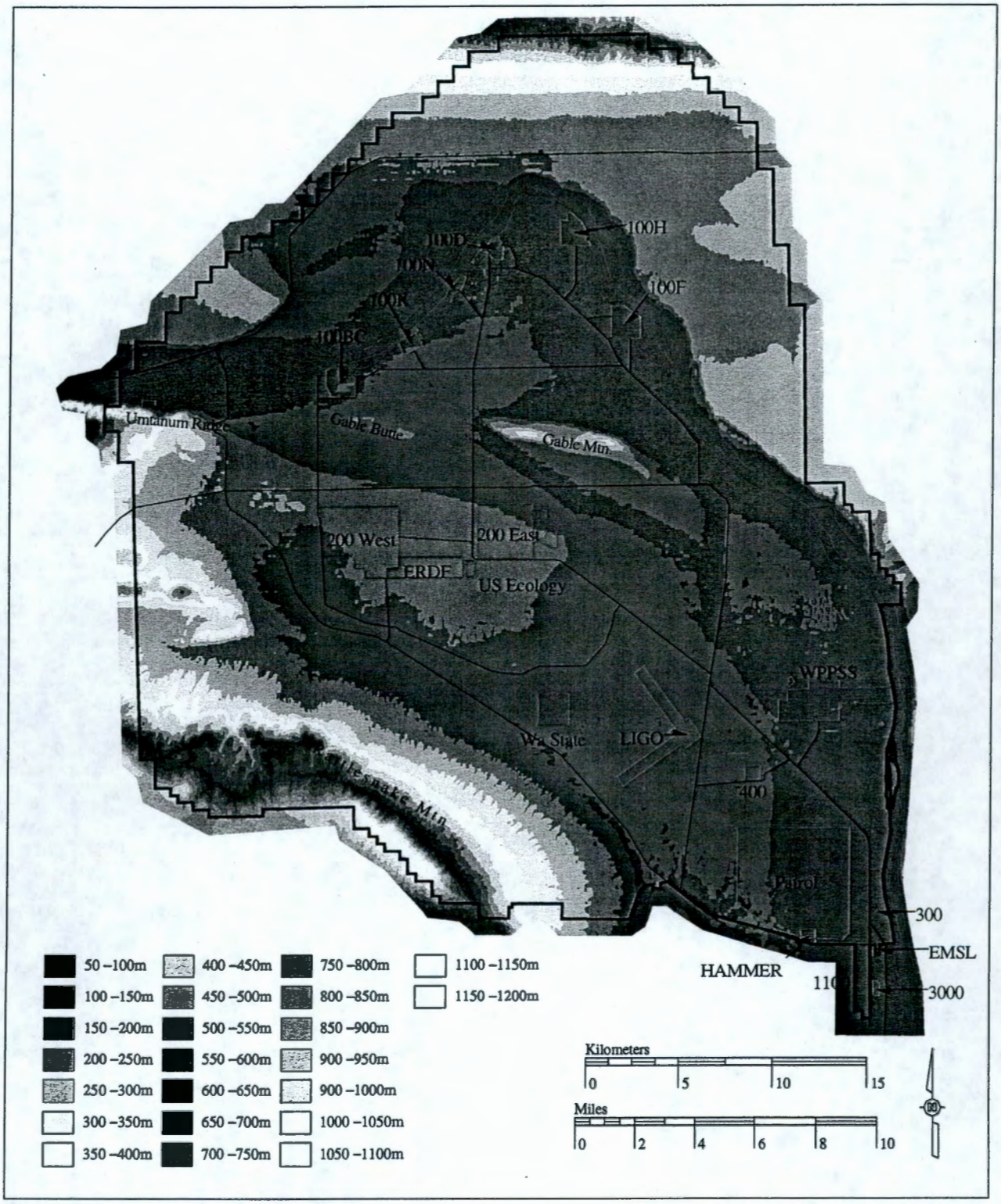

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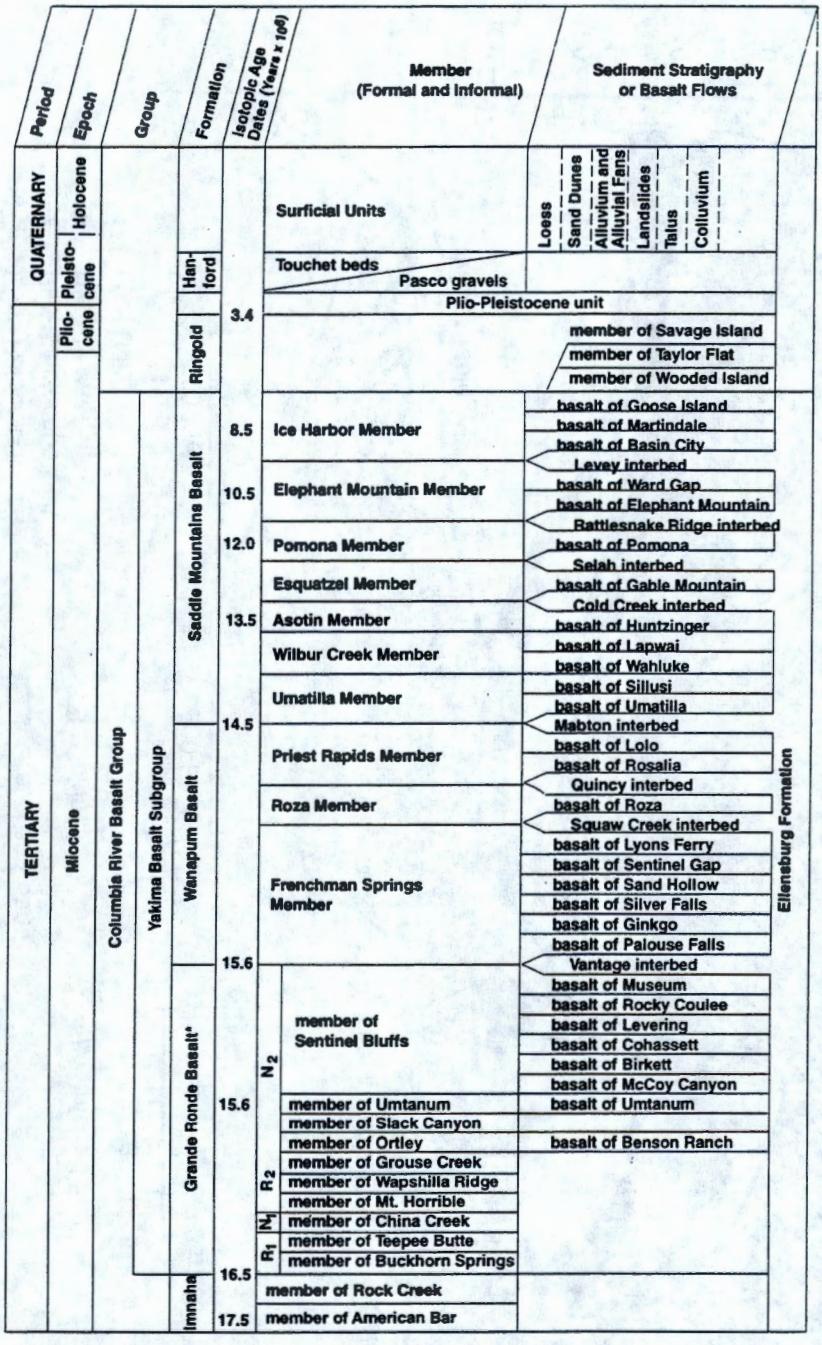
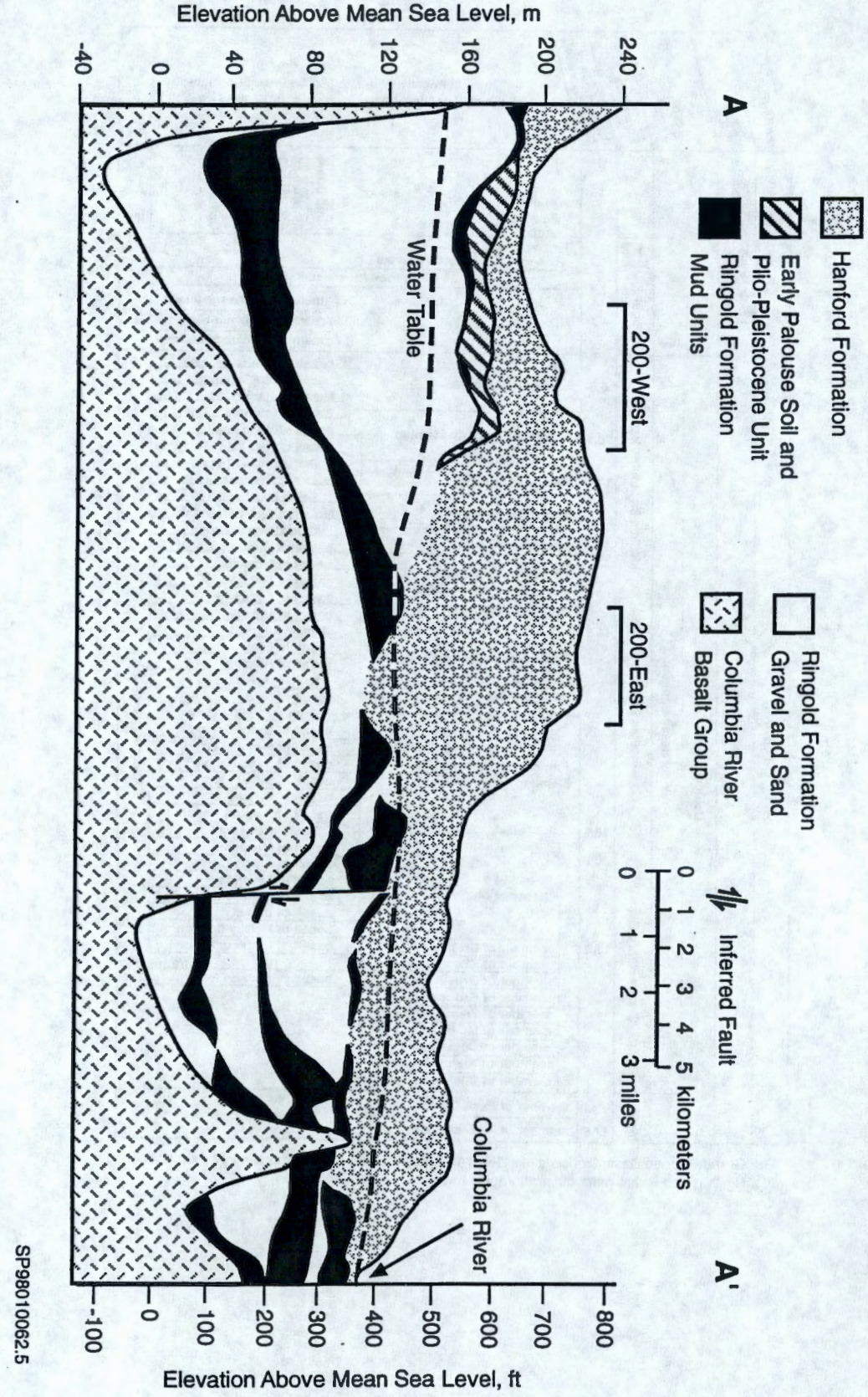
Figure 4-5. A Generalized Stratigraphic Column of the Major Geologic Units of the Hanford Site.



*The Grande Ronde Basalt consists of at least 120 major basalt flows comprising 17 members. N_2, R_2, N_1, and R are magnetostratigraphic units.

Figure 4-6. Geologic Cross-Section of the Hanford Site (PNNL 1996c).



Columbia River basalt flows were erupted from north-northwest-trending fissures (linear vent systems) in north-central and northeastern Oregon, eastern Washington, and western Idaho. The Columbia River Basalt Group is formally divided into five formations (listed in order from the oldest to the youngest): Imnaha Basalt, Picture Gorge Basalt, Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt. Of these, only the Grande Ronde, Wanapum, and Saddle Mountains Basalts are present in the Pasco Basin. The Saddle Mountains Basalt forms the uppermost basalt unit in the Pasco Basin, with the exception that some of the bounding ridges where the Wanapum and Grande Ronde Basalt flows are exposed.

4.2.2.2 Ellensburg Formation. The Ellensburg Formation includes sedimentary rocks interbedded with the Columbia River Basalt Group in the central and western part of the Columbia Plateau. The age of the Ellensburg Formation is principally Miocene, although locally it may be equivalent to early Pliocene. The thickest accumulations of the Ellensburg Formation lie along the western margin of the Columbia Plateau where Cascade Range volcanic materials interbed with the Columbia River Basalt Group. The lateral extent and thickness of interbedded sediments generally increase upward in the section.

4.2.2.3 Suprabasalt Sediments. The suprabasalt (above the basalt) sediments within and adjacent to the Hanford Site are dominated by the Ringold and Hanford formations, with other minor deposits (PNNL 1996a).

4.2.2.3.1 Ringold Formation. Late Miocene to Pliocene deposits, younger than the Columbia River Basalt Group, are represented by the Ringold Formation within the Pasco Basin. The Ringold Formation was deposited in east-west trending valleys by the ancestral Columbia River and its tributaries in response to development of the Yakima Fold Belt. Exposures of the Ringold Formation are limited to the White Bluffs within the central Pasco Basin and to the Smyrna and Taunton Benches located north of the Pasco Basin. Extensive data on the Ringold Formation are available from boreholes on the Hanford Site.

Flood-related deposits of the Ringold Formation can be broken into different associations based on proximity to the ancestral Columbia and/or Snake River channels. Gravel and associated sand and silt represent a migrating channel deposit of the major river systems and generally are confined to the central portion of the Pasco Basin. Overbank sand, silt, and clay reflect occasional deposition and flooding beyond the influence of the main river channels, and generally are found along the margins of the Pasco Basin. Over time, the main river channels moved back and forth across the basin, causing a shift in location of the various facies. Periodically, the river channels were blocked and caused lakes to develop where mud (with minor amounts of sand) was deposited.

4.2.2.3.2 Plio-Pleistocene Unit. A locally derived unit consisting of an alluvium and/or pedogenic calcrete occurs at the unconformity between the Ringold Formation and the Hanford formation. The sidestream alluvial facies are derived from Cold Creek and its tributaries and are characterized by relatively thick zones of unweathered basalt clasts along with wind-blown materials and soil. The calcrete is relatively thick and impermeable in areas of the western Pasco Basin, often forming an aquitard to downward migration of water in the vadose zone where artificial recharge is occurring.

4.2.2.3.3 Early Palouse Soil. Overlying the Plio-Pleistocene unit in the Cold Creek syncline area is a fine-grained sand to silt. It is believed to consist mainly of eolian (derived from wind deposits) origin, derived from either an older reworked Plio-Pleistocene unit or upper Ringold Formation. The early Palouse soil differs from the overlying slackwater flood deposits by a greater calcium-carbonate content, massive structure in core samples, and a high natural gamma response in geophysical logs.

4.2.2.3.4 Quaternary Deposits. Repositioning of sediments resumed during the Quaternary Period, following the period of late-Pliocene to early-Pleistocene erosion. In the Columbia Plateau, the Quaternary record is dominated by cataclysmic flood deposits with lesser amounts of sediments deposited by water and wind lying below, between, and above flood deposits.

Sand and gravel river sediments, referred to informally as the pre-Missoula gravels, were deposited after incision of the Ringold Formation and before deposition of the cataclysmic flood deposits. The pre-Missoula gravels are similar to the Ringold Formation main-channel gravel facies, consisting of dominantly nonbasaltic clasts. These sediments occur in a swath that runs from the old Hanford townsite on the eastern side of the Hanford Site, across the Site toward Horn Rapids on the Yakima River.

Cataclysmic floods inundated the Pasco Basin a number of times during the Pleistocene, beginning as early as one million years ago. The last major flood sequence is dated at about 13,000 years ago by the presence of erupted material from Mount Mazama interbedded with the flood deposits. The number and timing of cataclysmic floods continues to be debated. As many as 10 flood events have been documented during the last ice age. The largest and most frequent floods came from glacial Lake Missoula in northwestern Montana; however, smaller floods may have escaped down valley from glacial Lakes Clark and Columbia along the northern margin of the Columbia Plateau, or down the Snake River from glacial Lake Bonneville. The flood deposits, informally called the Hanford formation, blanket low-lying areas over most of the central Pasco Basin (Neitzel 1997).

Cataclysmic floodwaters entering the Pasco Basin quickly became impounded behind Wallula Gap (located about 32 km [20 mi] downstream from the Hanford Site), which was too restrictive for the volume of water involved. Floodwaters formed temporary lakes with a shoreline up to 381 m (1,250 ft) in elevation, which lasted only a few weeks or less. Two types of flood deposits predominate: (1) a sand-and-gravel main-channel facies, and (2) a mud-and-sand slackwater facies. Within the Pasco Basin, these deposits are referred to as the Pasco Gravels and slackwater deposits of the Hanford formation. Sediments with intermediate grain sizes (e.g., sand-dominated facies) also are present in areas throughout the Pasco Basin, particularly on the south, protected half of Cold Creek Bar.

Landslide deposits in the Pasco Basin are of variable age and genesis. Most of these deposits occur within the basalt outcrops along the ridges (e.g., on the north side of Rattlesnake Mountain) or steep river embankments (e.g., White Bluffs), where the Upper Unit Ringold Formation crops out in the Pasco Basin.

4.2.3 Structure

The Hanford Site is located near the junction of the Yakima Fold Belt and the Palouse structural subprovinces (DOE 1988a). These structural subprovinces are defined on the basis of their structural fabric, unlike the physiographic provinces that are defined on the basis of landforms. The Palouse subprovince is a regional paleoslope that dips gently toward the Columbia Plateau and exhibits only relatively mild structural deformation. The Palouse Slope is underlain by a wedge of Columbia River basalt that thins gradually toward the east and north, and laps onto the adjacent highlands.

The principal characteristics of the Yakima Fold Belt are a series of segmented, narrow, asymmetric anticlines. These anticlinal ridges are separated by broad synclines or basins that, in many cases, contain thick accumulations of Eocene- to Quaternary-age sediments. The deformation of the Yakima Folds occurred under north-south compression. The fold belt was growing during the eruption of the Columbia River Basalt Group and continued to grow into the

Pleistocene and probably into the present. Thrust or high-angle reverse faults with fault planes that strike parallel or subparallel to the axial trends are found principally along the limbs of the anticlines (Figure 4-7) (PNNL 1996a). The amount of vertical stratigraphic offset associated with these faults varies but commonly exceeds hundreds of meters.

4.2.3.1 Mineral Development. Directly after the discovery of gold in British Columbia and Oregon in the 1850s, gold was discovered in eastern Washington. In 1862, the first very successful strike in Washington was made near the mouth of the Methow River. Strikes were also made on the Clearwater River near present-day Orofino, Idaho, in 1860 and in the Boise Basin ("Treasure Valley") in 1862. These discoveries caused prospectors to explore the mid-Columbia region in the 1860s, upstream from the Dalles to the Canadian border. Between Vantage and Alderdale, Washington, at least seven sites along the Columbia River have had past placer mining activity and gold production. The Chinaman's Bar Placer (located on the south side of the river directly upstream of the Vernita Bridge, partially on the Hanford Site) supported a small operation from 1939 to 1941 with an unknown amount of production (NPS 1994).

In addition to gold mining along the Columbia River, natural gas was discovered on Rattlesnake Mountain in 1913. The small, shallow field was developed in 1929 and produced until it was closed in 1941, yielding a total of approximately 0.07 billion m^3 (2.5 billion ft^3) of gas (NPS 1994). Twenty-four wells were drilled, with the main gas field located on the ALE Reserve. Although intensive exploration occurred, deposits proved to be small.

Oil exploration was also conducted in the Rattlesnake Mountain and Rattlesnake Hills area in the 1920s and 1930s, but useful deposits were not found (Gerber 1997). The mineral rights to a 518 ha (1,280 ac) area are still owned by a private company, the Big Bend Alberta Mining Company. The surface title to this acreage was acquired by the AEC by condemnation in 1952. At that time, the final judgment of the court revested in the owners (at that time, the Big Bend Land Company) the gas and oil rights in the land providing, however, that all rights of ingress and egress over the surface of the land for exploration or exploitation of such rights were prohibited for 25 years from the date of the judgment (January 14, 1952). Presently, the Big Bend Alberta Mining Company is free to enter on the lands at will to explore for oil or gas. The company holds all the oil and mineral rights on one section, the oil and mineral rights on three-quarters of a second section, and the soil and mineral rights on one-quarter of a third section.

4.2.4 Geologic Hazards

The White Bluffs represent a geologic hazard resulting from certain types of land uses, such as irrigated farming and other forms of intensive development (Figure 4-8). The White Bluffs are composed of claystones and siltstones that are relatively strong when dry but lose considerable strength when wet. Visual evidence of recent, suspected human-induced landslide activity has developed over the past two decades. Irrigation water applied to croplands immediately east of the White Bluffs has raised the water table significantly, resulting in local saturation, increased pore pressures, reduced shear strength, and instability of slopes above the river. Leaks in local irrigation canals and irrigation waste water are believed to be contributing groundwater to the slide area, but a regional aquifer may also be responsible (NPS 1994).

Based on studies in the early 1970s, the BoR determined that irrigation would increase the potential for landslide activity along the White Bluffs. Also, a detailed drainage investigation completed in 1967 found a large portion of "red zone" area infeasible to drain based on economic criteria. As part of its effort to restrict irrigation in this area, the BoR rescinded the plats for two irrigation blocks (blocks 36 and 55) and acquired private lands on a "willing seller" basis (NPS 1994).

Figure 4-7. Map of the Hanford Site Region Showing Known Faults.

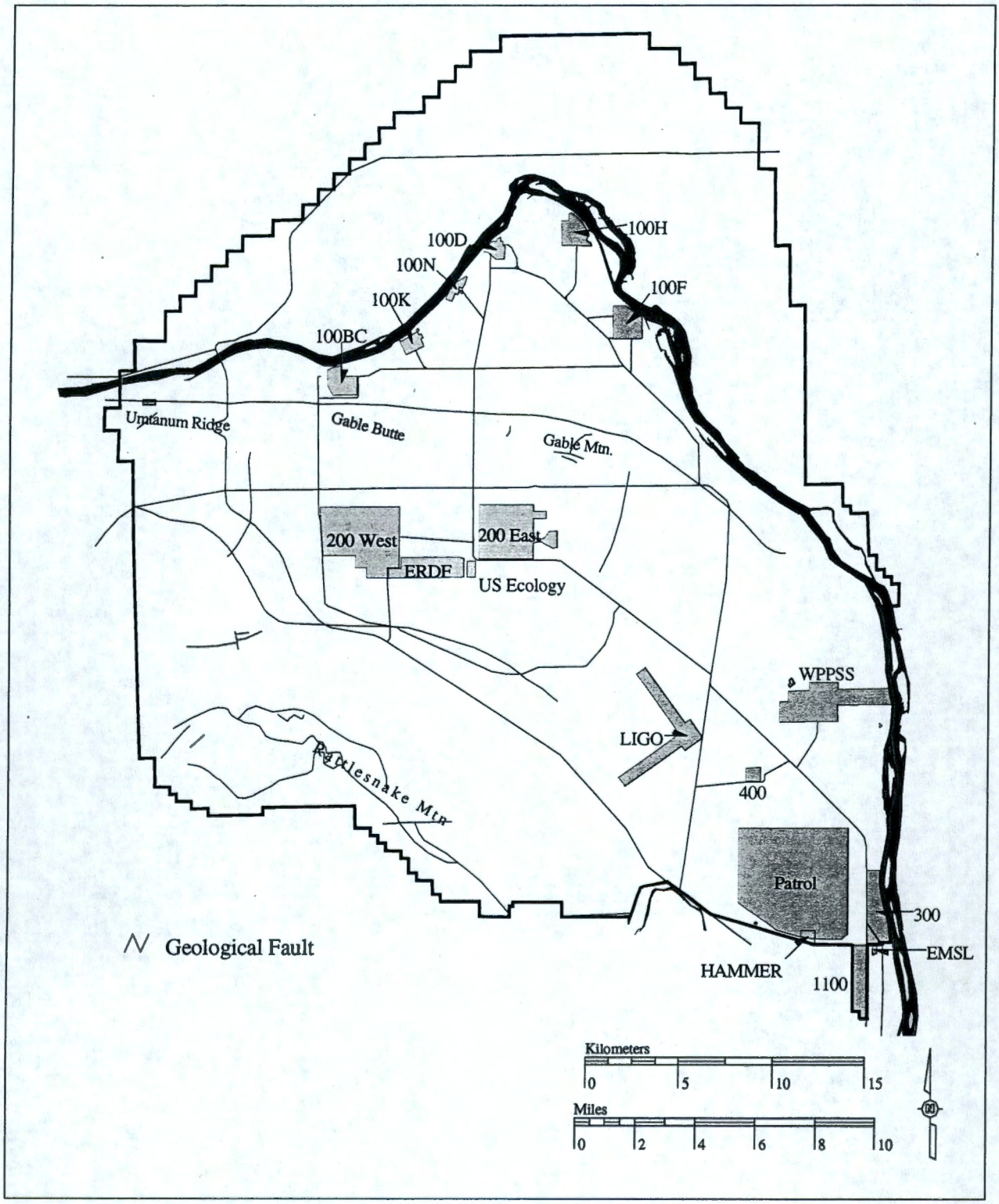


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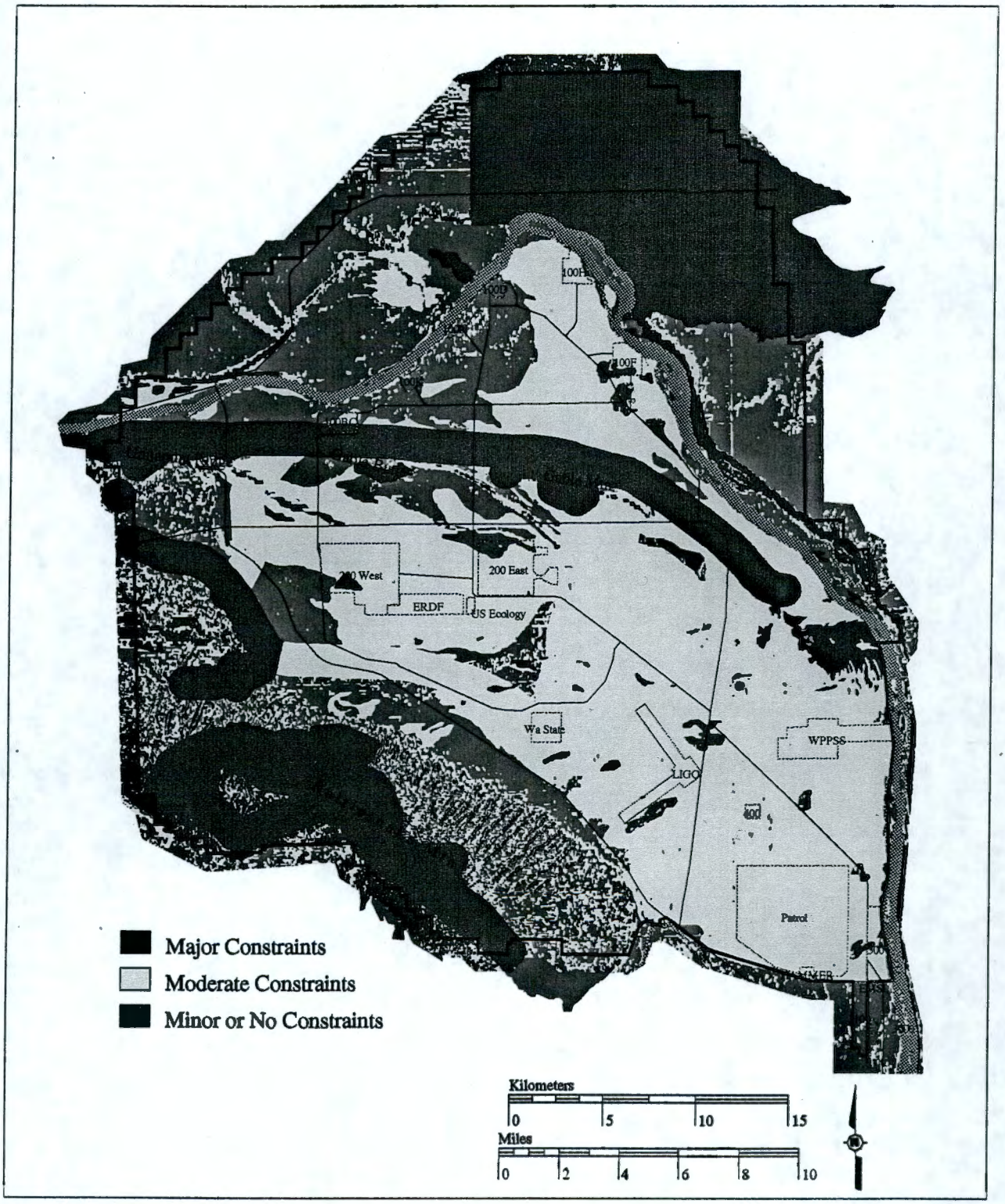
Figure 4-8. Geologic Hazards Related to Economic Land Uses.



Ringold Formation sediments that make up a large portion of the White Bluffs are largely unconsolidated and uncemented (BHI 1995a). These sediments were deposited between 6 and 3.5 million years ago. During and following deposition of Ringold sediment, the floor of the Pasco Basin was subsiding while the surrounding highlands were rising. Consequently, the Ringold sediment layers dip toward the center of the Pasco Basin, which lies in the east-central part of the Hanford Site. The angle of dip of these layers is less than 2 degrees. Ringold sediment layers dip down from the northern and eastern edges of the basin toward the Columbia River. Ringold sediments found in the bluffs consist predominantly of layers of river-deposited sand, ancient soils (paleosols), and sand, silt, and clay deposited in lakes (BHI 1995a).

Throughout the Hanford Site, a series of catastrophic flood deposits, informally known as the Hanford formation, lies atop the Ringold Formation sediments. The Hanford formation consists of fine-grained sediments know as Touchet beds and gravel beds known as the Pasco ravels. The sediments of the Hanford formation are unconsolidated, uncemented, and highly transmissive for the flow of water.

Shuster and Hays (1987) concluded that the entire area of the bluffs along the northern and eastern shores of the Columbia River is susceptible to landslides. Recent landslides have occurred in four areas along the bluffs; these areas are the Locke Island, Savage Island, Homestead Island, and Johnson Island slide areas. The length of the slide areas parallel to the river shoreline ranges from more than a mile at Locke Island to about 0.4 km (0.25 mi) of a mile near Homestead Island.

The Hanford powerline area shows evidence of Late Pleistocene landslides, and the area coincides with lack of irrigation adjacent to the bluffs (Shuster and Hays 1987). The landslides, both active and inactive, total about 11.2 km^2 (4.3 mi^2) in area, and the total landslide susceptible area is about 15.1 km^2 (5.8 mi^2) (Shuster and Hays 1987). These slide areas are characterized by major cracks about two-thirds of the way up the bluff face, surface areas on the slopes below the cracks with an irregular ground surface, and mud flows at the base of the slope. The irregular surface forms as the bluff face slides away and begins to break up. The mud flows occur as a result of a process known as liquefaction, which is water-saturated soil that flows similar to a liquid. Some of the slide areas, such as Savage Island and Locke Island slides, are rimmed by a scarp or cliff. Surface cracks located upland of the bluff face can be found, which indicate the slopes behind the bluffs are very unstable and prone to future landslides.

Examination of slide areas reveals the universal presence of water seeping from the bluffs in springs and marshes. Observation of these springs, saturated cliff faces, and mud flows indicates that water plays a role in producing landslides along the bluffs. The water found in the bluffs reduces the strength, decreases frictional resistance, and adds weight to the unconsolidated Ringold Formation. Because the transmissivity of the Ringold layers varies, water accumulates in certain sediment layers within the bluffs. This wet layer is the plane on which the slide begins. The bluff above a wet layer will slide when the water-laden and lubricated layer fails under the weight of the overburden.

Sources of water on the bluffs are natural precipitation, irrigated farmlands, irrigation and wastewater canals, and irrigation wastewater ponds located up-slope and east of the bluffs and on the Wahluke Slope. Water from these activities percolates through the soil to the Ringold Formation. Some of the layers within the formation resist the downward flow of water, forcing the water to flow laterally. Ringold Formation layers dip toward the Columbia River and the water that collects above less transmissive Ringold Formation layers moves downslope toward the bluffs. Eventually, this water reaches the bluffs and increases the potential for a landslide.

Shuster and Hays (1987) concluded, "In the present climate, most of these bluffs are very stable under natural conditions, but irrigation of the upland surface to the east, which began

in the 1950s and has been greatly expanded, led to increased and more widespread seepage in the bluffs and to a spectacular increase in slope failures since 1970. With continuing irrigation, areas of the bluff wetted by seepage will be subject to landslides wherever slopes exceed about 15 degrees and, on lesser slopes, wherever the surficial material is old landslide debris."

The hazards posed by landslides in bluffs range from minor to catastrophic. Economic loss from landslides in the bluffs has not been large because the area is relatively undeveloped. Road closures have occurred. A concrete flume, part of the Ringold wasteway, was destroyed by the Homestead Island slide in the late 1960s (Shuster and Hays 1987). Encroachment upslope by the Savage Island slide destroyed the riverward margins of irrigated fields along the top of the bluffs (Shuster and Hays 1987).

Perhaps the most unlikely occurrence would be an earthquake-triggered, massive slope failure caused by liquefaction of the White Bluffs, which would temporally block the Columbia River. Hanford facilities on the west side of the river could be endangered, as well as citizens and property located downstream of this temporary dam. Also, contaminants left at depth in the soil column would be further mobilized by the subsequent rise in groundwater levels on the Hanford facilities side of the river.

The Locke Island slide caused the loss of cultural artifacts on the island by changing the channel of the river and causing erosion to occur on Locke Island. Since its beginning in the mid-1970s, the Locke Island slide has extended 150 m (492 ft) into the channel of the Columbia River (Neitzel 1997). Since November 1995, Locke Island has an actively eroding cut bank that is 400 m (1,312 ft) in length, with a horizontal loss of 16 m (53 ft) (Neitzel 1997). These slides can disturb and destroy salmon spawning beds by siltation, and the increase in sediment load in the Hanford Reach could potentially adversely affect the Energy Northwest (formerly known as WPPSS) reactor cooling-water intake systems (Shuster and Hays 1987).

The Hanford Dune Field, located north of the Energy Northwest (formerly known as WPPSS) reactor, also represents a hazard to certain types of land uses. The Hanford Dune Field is one of three great dune fields in the Columbia River Basin. It is an active area of migrating barchan dunes and partially stabilized transverse dunes derived from alluvium, with bare rock-rubbled areas between dunes. In the late 1970s, a study performed by the Heritage Conservation and Recreation Service determined this dune field to be of national significance and proposed a 2,560 ha (6,320 ac) protected area for inclusion in the National Natural Landmark system. For security purposes and other reasons, DOE requested that the site not be designated as such, and the request was honored (NPS 1994).

There is also an extensive dune system that is stabilized with vegetation, located south of the 200 Areas, trending to the northeast toward the Columbia River. This stabilized dune system, which forms hummocky terraces and dune-like ridges, also represents a potential geologic hazard to development. Should the vegetation on the dune system be altered, cleared, or otherwise disturbed, the dunes might remobilize, resulting in dune sand movement and blowing sand during windy weather.

4.2.4.1 Seismic and Volcanic Hazards. The historic record of earthquakes in the Pacific Northwest dates from about 1840. The early part of this record is based on newspaper reports of structural damage and human perception of the shaking and structural damage as classified by the Modified Mercalli Intensity (MMI) scale and is probably incomplete because the region was sparsely populated. Seismograph networks did not start providing earthquake locations and magnitudes in the Pacific Northwest until about 1960. A comprehensive network of seismic stations, which provide accurate locating information for most earthquakes greater than a magnitude of 2.5 on the Richter scale, was installed in eastern Washington in 1969.

Seismicity of the Columbia Plateau, as determined by the rate of earthquakes per area and the historical magnitude of these events, is relatively low when compared to other regions of the Pacific Northwest, the Puget Sound area, and western Montana/eastern Idaho. The largest known earthquake in the Columbia Plateau occurred in 1936 near Milton-Freewater, Oregon. This earthquake had a Richter scale magnitude of 5.75 and a maximum MMI of VII and was followed by a number of aftershocks that, when analyzed, indicated a northeast-trending fault plane. Other earthquakes with Richter scale magnitudes greater than 5.0 and/or MMIs of VI have occurred along the boundaries of the Columbia Plateau in a cluster near Lake Chelan extending into the northern Cascade Range, in northern Idaho and Washington, and along the boundary between the western Columbia Plateau and the Casade Range.. Three MMI VI earthquakes have occurred within the Columbia Plateau, including one in the Milton-Freewater region in 1921; one near Yakima, Washington, in 1892; and one near Umatilla, Oregon, in 1893. In the central portion of the Columbia Plateau, the largest earthquakes near the Hanford Site are two that occurred in 1918 and 1973. These two events were at Richter scale magnitude of 4.4 and MM of V, and were located north of the Hanford Site, near Othello, Washington.

Earthquakes often occur in spatial and temporal clusters in the Columbia Plateau and are termed "earthquake swarms." The region north and east of the Hanford Site is concentrated with earthquake swarm activity; however, earthquake swarms also have occurred in several locations within the Hanford Site. Earthquakes in a swarm tend to gradually increase and decay in frequency of events, and usually no outstanding large event is present within the sequence. These earthquake swarms occur at shallow depths, with 75 percent of the events located at depths less than 4 km (2.5 mi). Each earthquake swarm typically lasts several weeks to months, may consist of anywhere from several to more than 100 earthquakes, and is clustered in an area 5 to 10 km (3 to 6 mi) in lateral dimension. Often, the longest dimension of the swarm area is elongated in an east-west direction.

Earthquakes in the Columbia Plateau also occur to depths of approximately 30 km (18 mi). These deeper earthquakes are less clustered and occur more often as single, isolated events. Based on epicenter studies and refraction surveys in the region, the shallow earthquake swarms occur in the Columbia River Basalts and the deeper earthquakes occur in crustal layers below the basalts.

Several major volcanoes are located in the Cascade Range west of the Hanford Site. The nearest volcano, Mount Adams, is about 165 km (102 mi) from the Hanford Site. The most active volcano, Mount St. Helens, is located approximately 220 km (136 mi) west-southwest of the Hanford Site.

Because of their close proximity, the volcanic mountains of the Cascades are the principal volcanic hazard at the Hanford Site. The major concern is that ash fall could affect Hanford Site communications equipment and electronic devices, as well as the movement of truck and automobile traffic in and out of the area.

4.2.5 Soils

The *Soil Survey Hanford Project in Benton County Washington*, BNWL-243 (PNL 1966), describes 15 different soil types on the Hanford Site, varying from sand to silty and sandy loam. The soil classifications given in BNWL-243 have not been updated to reflect current reinterpretations of soil classifications (see text box, *"Hanford Site Quick Facts: Soils"*). Until soils on the Hanford Site are

Hanford Site Quick Facts: Soils

- Fifteen types of soils identified
- Textures range from sand to silty and sandy loam
- Most common soil type: Quincy Sand

resurveyed, the descriptions presented in BNWL-243 will continue to be used (see Table 4-1 and Figure 4-9). No soils on the Hanford Site are currently classified as prime farmlands because (1) there are no current soil surveys, and (2) the only prime farmland soils in the region are irrigated (August 1996 Draft HRA-EIS).

The parent material for predominant soil types at the Hanford Site consists of the Hanford formation and Holocene surficial deposits (Cushing 1992). Soils with well-developed profiles occur only where fine and poorly-drained sediments have been deposited and typically are low in organic matter (PNL 1991a).

Wind and water erosion have been key factors in modifying developed soil profiles on the Hanford Site, and have resulted in the loss of soil down to parent material in some areas and the creation of large active sand dunes in other areas. Currently stabilized dune complexes can potentially be reactivated as a result of surface disturbances.

4.3 Water Resources

This section provides an overview of the Hanford Site hydrologic setting, which includes surface water and groundwater resources, and a discussion of existing water rights.

In 1980, Congress enacted the *Northwest Power Act* (NPA) (16 U.S.C. 839-839h), which "marked an important shift in Federal policy." Continually declining fish runs had revealed the failures of previous legislative efforts requiring that "equal consideration" be given to fish and wildlife affected by resource exploitation. The NPA created "a pluralistic intergovernmental and public review process." At the hub of this process, Congress established the Pacific Northwest Electric Power and Conservation Planning Council (Council), directing it to create "a program to protect, mitigate, and enhance" the Columbia River Basin's fish and wildlife "to the extent affected by the development and operation of the Basin's hydropower system." The Council's authority with respect to fish and wildlife measures is contained; the Council "can guide, but not command, Federal river management."

In addition, Canada and the United States signed the Pacific Salmon Treaty in 1985. The Pacific Salmon Treaty has provided for improved conservation and management of the resource. The Treaty covers five species of Pacific salmon and steelhead (two of which -- the Upper Columbia steelhead and the Redfish Lake sockeye salmon -- are now also covered by the *Endangered Species Act of 1973)*, and applies to fisheries in Southeast Alaska, British Columbia, Washington, and Oregon.

There is no single "law of the river" on the Columbia River. Instead, there is a maze of overlapping treaties, laws, and regulations, which together attempt to balance the varied interests on the river. (See text box, "*Columbia River Flow – Who Controls It?*")

4.3.1 Surface Water

The Pasco Basin occupies about 4,900 km^2 (1,900 mi^2) and is located centrally within the Columbia Basin. Elevations within the Pasco Basin generally are lower than other parts of the Columbia Plateau, and surface drainage enters the Pasco Basin from other basins. Within the Pasco Basin, the Columbia River is joined by three major tributaries: the Yakima River, the Snake River, and the Walla Walla River.

Table 4-1. Soil Types on the Hanford Site (adapted from PNNL 1996a).

Name (Symbol)	Description
Ritzville silt loam (Ri)	Dark-colored silt loam soils midway up the slopes of the Rattlesnake Hills. Developed under bunchgrass from silty wind-laid deposits mixed with small amounts of volcanic ash. Characteristically greater than 150-cm (59-in.) deep; bedrock may occur at less than 150 cm (59 in.) but greater than 75 cm (30 in.).
Quincy (Rupert) sand (Rp)	One of the most extensive soils on the Hanford Site. Brown to grayish-brown coarse sand grading to dark grayish-brown at approximately 90 cm (35 in.). Developed under grass, sagebrush, and hopsage in coarse, sandy, alluvial deposits that were mantled by wind-blown sand. Hummocky terraces and dune-like ridges.
Hezel sand (He)	Similar to Rupert sands; however, a laminated grayish-brown strongly calcareous silt loam subsoil usually is encountered within 100 cm (39 in.) of the surface. Surface soil is very dark brown, and was formed in wind-blown sands that mantled lake-laid sediments.
Koehler sand (Kf)	Similar to other sandy soils on the Hanford Site. Developed in a wind-blown sand mantle. Differs from other sands because the sand mantles a lime-silica-cemented layer "hardpan." Very dark grayish-brown surface layer is somewhat darker than Rupert Sand. Calcareous subsoil usually is dark grayish-brown at approximately 45 cm (18 in.).
Burbank loamy sand (Ba)	Dark, coarse-textured soil underlain by gravel. Surface soil usually is 40-cm (16-in.) thick, but can be 75-cm (30-in.) thick. Gravel content of subsoil ranges from 20 to 80 percent.
Kiona silt loam (Ki)	Located on steep slopes and ridges. Surface soil is very dark grayish-brown and approximately 10-cm (4-in.) thick. Dark brown subsoil contains basalt fragments 30 cm (12 in.) and larger in diameter. Many basalt fragments found in surface layer. Basalt rock outcrops present. A shallow stony soil normally occurring in association with Ritzville and Warden soils.
Warden silt loam (Wa)	Dark grayish-brown soil with a surface layer usually 23-cm (9-in.) thick. Silt loam subsoil becomes strongly calcareous at approximately 50 cm (20 in.) and becomes lighter in color. Granitic boulders are found in many areas. Usually greater than 150-cm (59-in.) deep.
Ephrata sandy loam (El)	Surface is dark colored, and subsoil is dark grayish-brown medium-textured soil underlain by gravelly material, which may continue for many meters (feet). Level topography.
Ephrata stony loam (Eb)	Similar to Ephrata sandy loam. Differs in that many large hummocky ridges presently are made up of debris released from melting glaciers. Areas between hummocks contain many boulders several meters (feet) in diameter.
Scooteney stony silt loam (Sc)	Developed along the north slope of Rattlesnake Hills; usually confined to floors of narrow draws or small fan-shaped areas where draws open onto plains. Severely eroded with numerous basaltic boulders and fragments exposed. Surface soil usually is dark grayish-brown, grading to grayish-brown in the subsoil.
Pasco silt loam (P)	Poorly drained, very dark grayish-brown soil formed in recent alluvial material. Subsoil is variable, consisting of stratified layers. Only small areas found on the Hanford Site, located in low areas adjacent to the Columbia River.
Esquatzel silt loam (Qu)	Deep dark-brown soil formed in recent alluvium derived from loess and lake sediments. Subsoil grades to dark grayish-brown in many areas, but color and texture of the subsoil vary because of the stratified nature of the alluvial deposits.
Riverwash (Rv)	Wet, periodically flooded areas of sand, gravel, and boulder deposits that make up overflowed islands in the Columbia River and adjacent land.
Dune sand (D)	Miscellaneous land type that consists of hills or ridges of sand-sized particles drifted and piled up by wind, and are either actively shifted or so recently fixed or stabilized that no soil horizons have developed.
Lickskillet silt loam (Ls)	Located on ridge slopes of Rattlesnake Hills and slopes greater than 765 m (2,509 ft) in elevation. Similar to Kiona series except surface soils are darker. Shallow over basalt bedrock, with numerous basalt fragments throughout the profile.

Figure 4-9. Soil Map of the Hanford Site (adapted from PNNL 1996a).

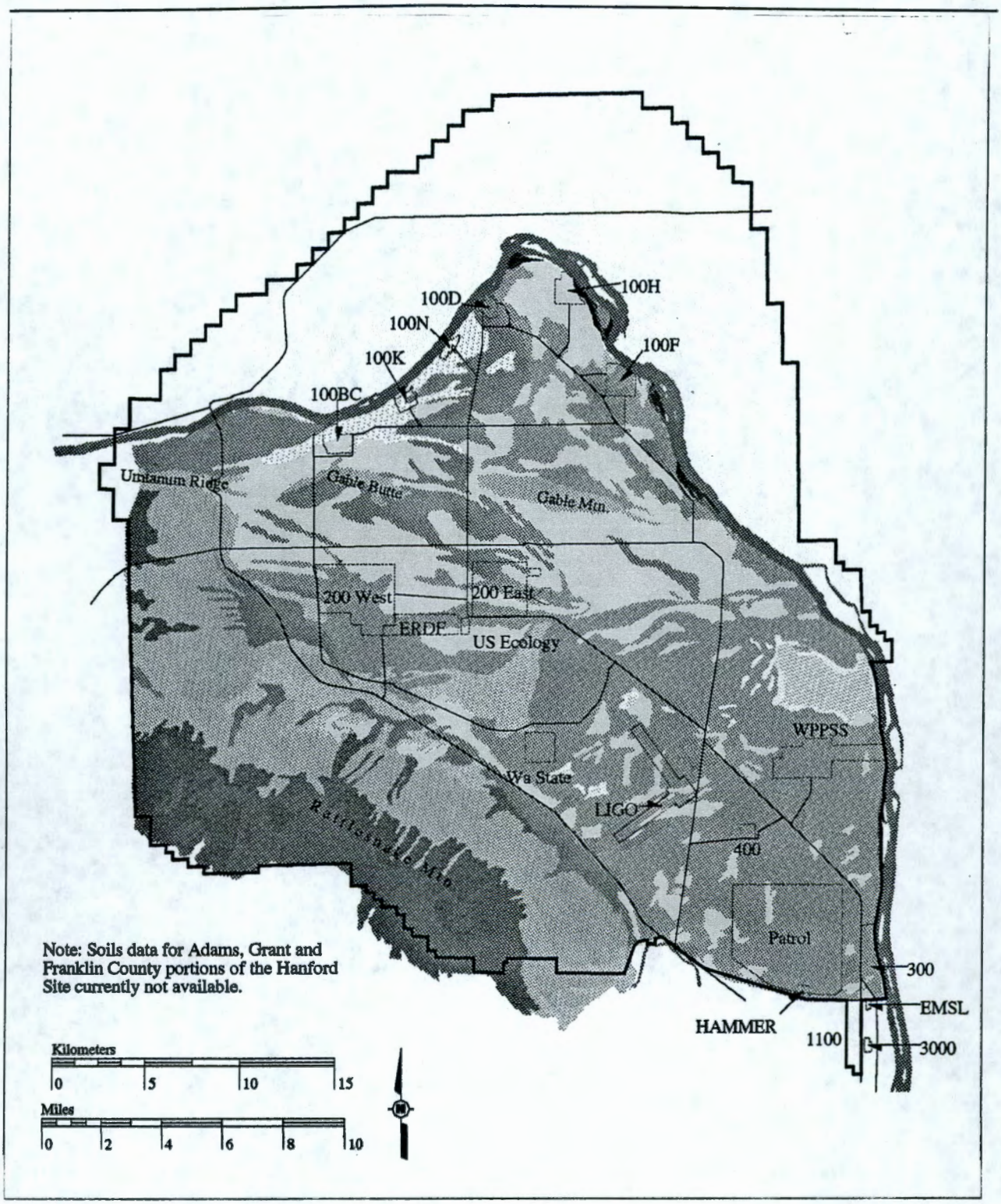
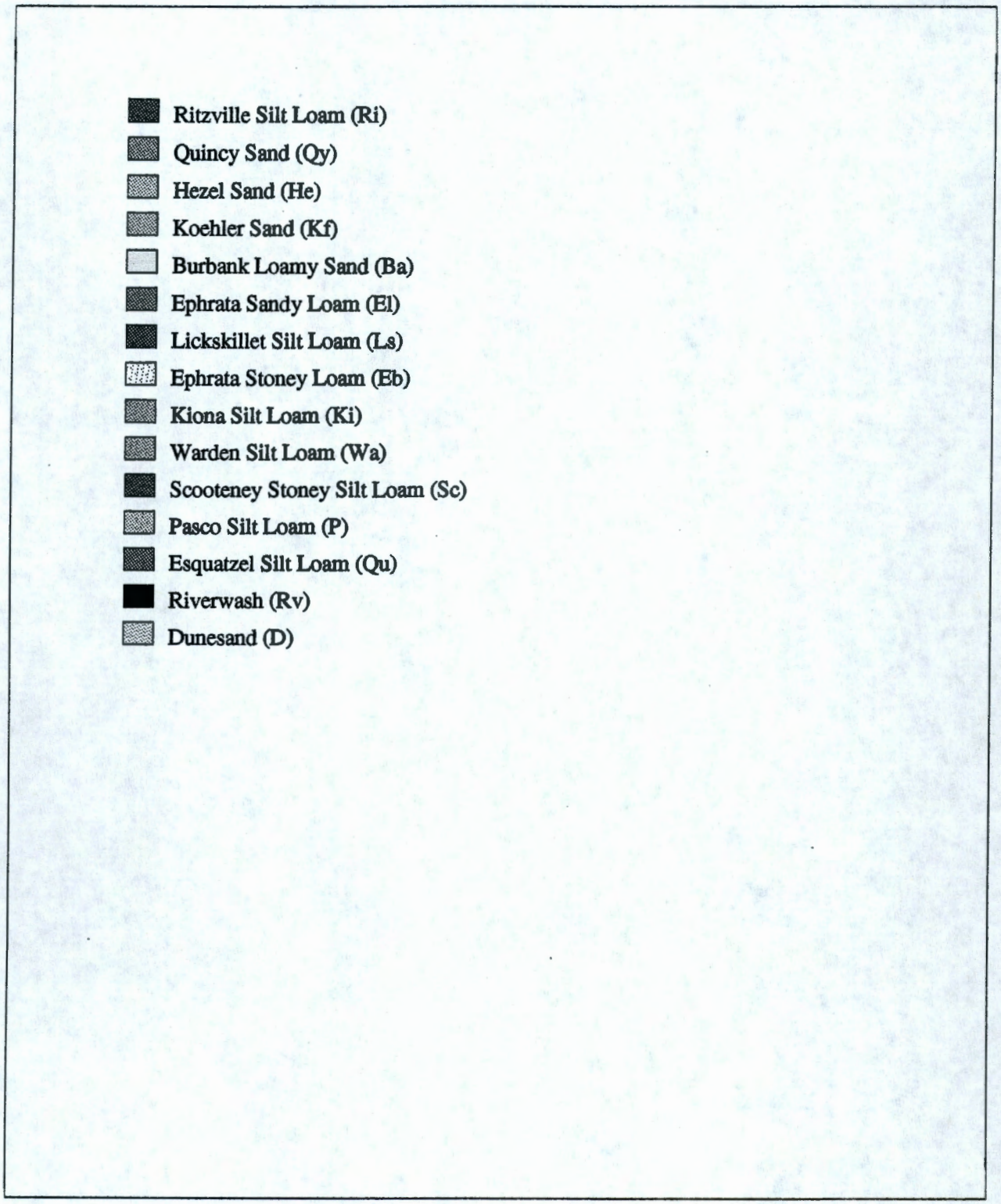


Figure 4-9. Soil Map of the Hanford Site (Legend).



The Hanford Site occupies approximately one-third of the land area within the Pasco Basin. Primary surface-water features associated with the Hanford Site are the Columbia and Yakima rivers (see text box, *"Hanford Site Quick Facts: Surface Water"*). Several surface ponds and ditches in the 200 Areas, which were generally associated with fuel- and waste-processing activities, are shown in their historical locations (Figure 4-10). In the 100 Area and 300 Area, historical Hanford irrigation canals are shown. Other active irrigation wasteways (i.e., canals or ditches that carry excess irrigation water back to the Columbia River) that belong to the BoR are shown on the Wahluke Slope. In addition, several small spring-fed streams occur on the ALE Reserve in the southwestern portion of the Hanford Site.

A network of dams and multi-purpose water resource projects is located along the course of the Columbia River. Water storage behind Grand Coulee Dam, combined with storage upstream in Canada, totals 3.1×10^{10} m^3 (1.1×10^{12} ft^3) of usable storage to regulate the Columbia River for power, flood control, and irrigation.

The flow of the Columbia River has been inventoried and described in detail by the U.S. Army Corps of Engineers (USACE) (DOE, DOA, and DOI 1995). Flows through the Hanford Reach fluctuate significantly and are controlled primarily by releases from the Priest Rapids Dam. Recorded flow rates in the Hanford Reach have ranged from 4,500 to 18,000 m^3/s (approximately 158,900 to 635,600 ft^3/s) during the runoff in spring and early summer, and from 1,000 to 4,500 m^3/s (35,300 to 158,900 ft^3/s) during the low-flow period of late summer and winter.

Annual flows near Priest Rapids during the 68 years prior to 1985 averaged nearly 3,360 m^3/s (120,000 ft^3/s) (McGavock et al. 1987). Daily average flows during this period ranged from 1,000 to 7,000 m^3/s (36,000 to 250,000 ft^3/s). During the last 10 years, the average daily flow was also about 3,360 m^3/s (120,000 ft^3/s). However, larger than normal snowpacks resulted in exceptionally high spring runoff during 1996 and 1997. The peak flow rate during 1997 was nearly 11,750 m^3/s (415,000 ft^3/s) (DART 1998). Normal river elevations range from 120 m (394 ft) above mean sea level where the river enters the Hanford Site near Vernita, to 104 m (341 ft) where the river

Columbia River Flow — Who Controls It?

On the Columbia River above the Hanford Site, there are dams such as the Grant County Public Utility District (PUD) Rock Island Dam and Rocky Reach Dam; the Douglas County PUD Wells Dam; the U.S. Army Corps of Engineers Chief Joseph Dam; the BoR Grand Coulee Dam; and the British Columbia Hydro Keenleyside Dam, Revelstoke Dam, and Mica Dam.

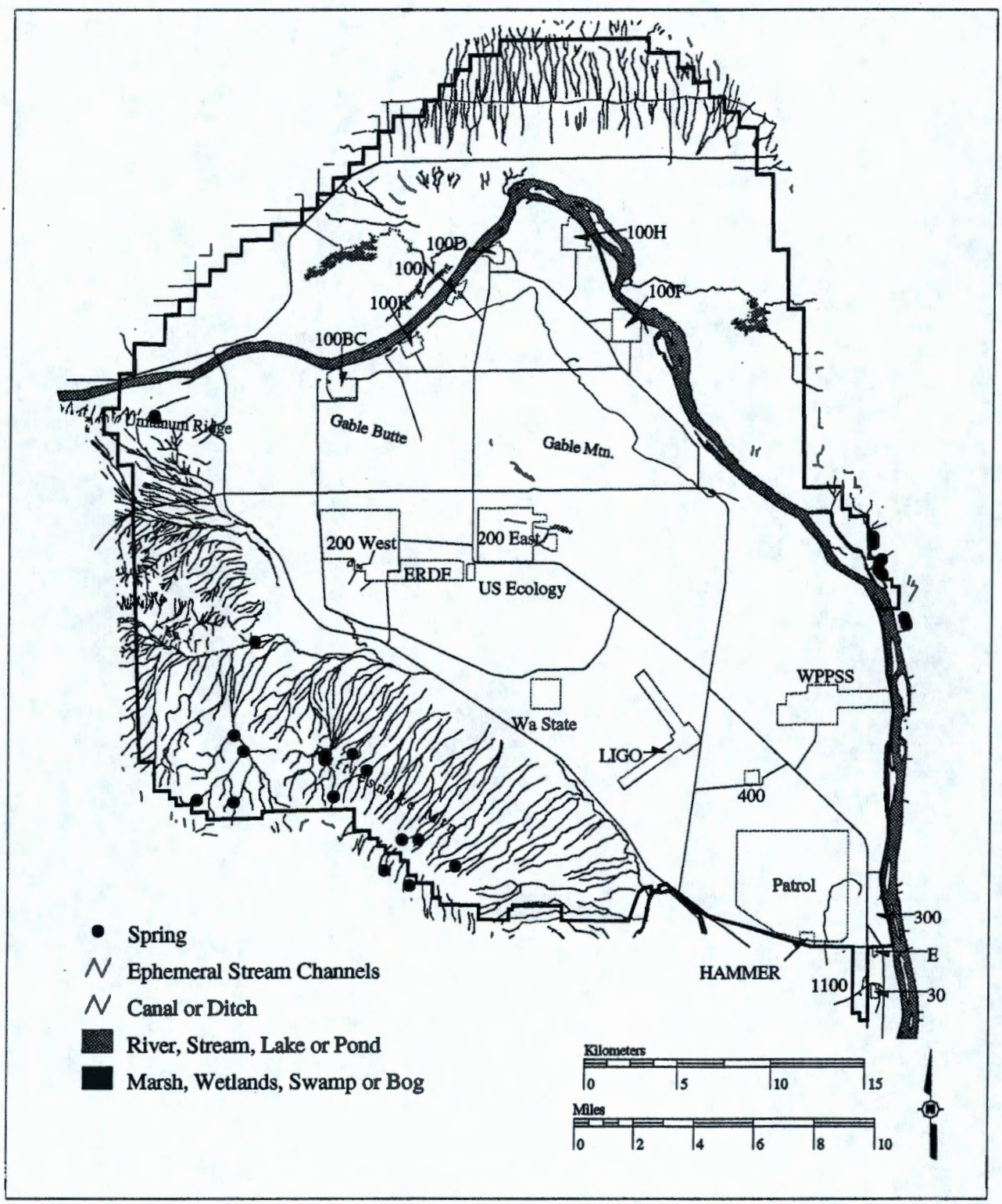
The 1964 Columbia River Treaty between the United States and Canada provided for building four storage reservoirs: three in Canada (Mica, Kennleyside, and Duncan) and one in the United States (Libby). The reservoirs that were built and operated under the Treaty represent almost half the water storage on the Columbia River System. The Treaty required over 15.5 million acre-feet of Canadian storage, but reservoirs actually built contained storage capacity of 20.5 million acre-feet. The excess storage capacity, most of which is behind Mica Dam, is referred to as non-Treaty storage. The Non-Treaty Storage Agreements made by DOE's BPA were necessary to govern the rights to this additional storage capacity. Nothing in the Treaty prevented Canada from using all of the non-Treaty storage unilaterally, although the United States argued it had the right to compensation if use of the non-Treaty storage resulted in reduced Columbia River flows into the United States.

The three dams in British Columbia were developed to provide water storage for power generation in the United States. Mica Dam has the highest "head" at 200 m (656.2 ft) and is the only installation of the three to have a powerhouse. In return for building the three dams (Mica, Keenleyside, and Duncan), B.C. Hydro was entitled to half the additional power generated in the United States that resulted from storage operations in Canada. These "downstream benefits" were sold to a group of American utilities for 30 years. This share, known as the "Canadian Entitlement," is owned by B.C. Hydro. In September 1994, British Columbia and the United States signed a Memorandum of Agreement which outlines new arrangements for the return of the Canadian Entitlement, beginning in 1998.

The Vernita Bar Agreement (signed June 16, 1988, by the U.S. Department of Energy, Federal and state agencies, Tribal governments, and public utility districts in Grant, Chelan, and Douglas counties) was entered into by the dam owners to prevent salmon eggs from being left high and dry when river flows fluctuate to meet peak power demands.

The overall water flow in the Columbia River is precisely controlled with cooperation from all dam owners from the U.S. Army Corps of Engineers Operations Center in Portland, Oregon.

Figure 4-10. Surface Water on the Hanford Site.



leaves the Hanford Site near the 300 Area. Vertical fluctuations of approximately 1.5 m (greater than 5 vertical ft) are not uncommon along the Hanford Reach (Dirkes 1993). The width of the river varies from approximately 300 m (1,000 ft) to 1,000 m (3,300 ft) within the Hanford Site.

Hanford Site Quick Facts: Surface Water

- Columbia River average annual flow: 3,400 m^3 (120,100 ft^3) per second
- Yakima River average annual flow: 104 m^3 (3,673 ft^3) per second

Several drains and intakes are present along the Hanford Reach. These include irrigation outfalls from the Columbia Basin Irrigation Project, Hanford Site intakes for the onsite water export system, and Energy Northwest (formerly known as WPPSS) water intakes.

The primary uses of the Columbia River include the production of hydroelectric power, irrigation of cropland in the Columbia Basin, and transportation of materials by barge. The Hanford Reach is the upstream limit of barge traffic on the main stem of the Columbia River. Barges are used to transport reactor vessels from decommissioned nuclear submarines to Hanford for disposal. Several communities located on the Columbia River rely on the river as their source of drinking water. The Columbia River is also used as a source of both drinking water and industrial water for several Hanford Site facilities (Dirkes 1993). In addition, the Columbia River is used extensively for recreation, which includes fishing, hunting, boating, sailboarding, waterskiing, diving, and swimming.

The Yakima River, bordering the southern portion of the Hanford Site, has a low annual flow compared to the Columbia River. The average flow, based on nearly 60 years of records, is about 104 m^3/s (3,712 ft^3/s), with an average monthly maximum of 490 m^3/s (17,500 ft^3/s) and minimum of 4.6 m^3/s (165 ft^3/s). Exceptionally high flows were observed during 1996 and 1997. The peak average daily flow rate during 1997 was nearly 1,300 m^3/s (45,900 ft^3/s). Approximately one-third of the Hanford Site is drained by the Yakima River system.

An alkaline spring at the east end of Umtanum Ridge was documented by The Nature Conservancy in *Biodiversity Inventory and Analysis of the Hanford Site* (TNC 1998). Several springs are also found on the slopes of the Rattlesnake Hills, along the western edge of the Hanford Site. Cold Creek and its tributary, Dry Creek, are ephemeral streams within the Yakima River drainage system that roughly parallel SR 240 through the Hanford Site. Both streams drain areas to the west of Hanford Site. Surface flow, when it occurs, infiltrates and disappears into the surface sediments in the western portion of the Hanford Site. Rattlesnake Springs, located on the western portion of the Hanford Site, forms a small surface stream that flows for approximately 3 km (1.9 mi) before disappearing into the ground.

There are no currently active ditches on the Hanford Site. The only active pond in Benton County's portion of the Hanford Site is West Lake. West Lake is located north of the 200 East Area and is a natural feature recharged from groundwater (PNNL 1996a). West Lake has not received direct effluent discharges from Hanford Site facilities; rather, its existence is caused by the intersection of the elevated water table with the land surface in the topographically low area south of Gable Mountain (and north of the 200 East Area). The artificially elevated water table occurs under much of the Hanford Site and reflects the artificial recharge from past Hanford Site operations. This elevated water table is dropping and so is the size of West Lake.

The seepage of groundwater into the Columbia River has been known to occur for many years. The riverbank seep discharges were documented along the Hanford Reach long before Hanford Site operations began during World War II (PNNL 1996a). These relatively small seeps flow intermittently, apparently influenced primarily by changes in river level. Hanford-origin contaminants have been documented in these groundwater discharges along the Hanford Reach (PNNL 1996a).

In the 200 West Area, the West Powerhouse Pond, 216-T-1 Ditch, 216-T-4-2 Ditch, and 216-Z-21 Basin are active. In the 200 East Area, only the East Powerhouse Ditch and the 216-B-3C Pond are active. The 216-B-3C Pond originally was excavated in the mid-1950s for disposal of process cooling water and other liquid wastes occasionally containing low levels of Radionuclides. The FFTF pond is located near the 400 Area and was excavated in 1978 for the disposal of cooling and sanitary water from various facilities in the 400 Area (PNNL 1996a). The ponds are not accessible to the public and do not constitute a direct offsite environmental impact (PNNL 1996a). However, the ponds are accessible to migratory waterfowl, creating a potential pathway for the dispersion of contaminants. Periodic sampling provides an independent check on effluent control and monitoring systems (PNNL 1996a).

Among the most interesting discoveries of the 1997 field season were three previously undocumented clusters of approximately 20 vernal pools. Vernal pools are associated more typically with arid areas in California and Oregon. Vernal pools in Washington are little known or studied; therefore, their occurrence on the Hanford Site is significant (TNC 1998). The Hanford Site pools were located on the eastern end of Umtanum Ridge, in the central part of Gable Butte, and at the eastern end of Gable Mountain. Each cluster of pools was situated on top of an impermeable basalt layer that enabled water to pond in shallow depressions during wetter winter seasons. The pools often were characterized by a distinct zonation of species from the bottom of the pool, which might be barren throughout the growing season, to the upper pool edge, which was occupied by various annual plant species. The vernal pools also showed wide variation in their degree of development (i.e., some appeared to be pools that filled intermittently and were invaded by sagebrush during extended dry periods). Most pools apparently filled with water most years.

Vernal pools on the Hanford Site showed wide variation in regard to a number of traits, including pool size, species composition, dominant species, degree of invasion by weedy (mostly non-native) species, and presence of rare plant species. Pools averaged about 60 by 60 ft (18 by 18 m) in size, but ranged from 20 by 20 ft (6 by 6 m) to 150 by 100 ft (46 by 30 m). Dominant species were typically annuals. Some vernal pools had a high cover of moss and lichen species. In addition to their botanical resources, there was ample evidence of avian and other wildlife use of these vernal pools as they often provided water during dry times of the year (TNC 1998).

The cluster of 10 to 11 vernal pools on the eastern end of Umtanum Ridge were of relatively high quality and appeared to be the most undisturbed (pristine) pools on the Site. Large and vigorous subpopulations of *Mimulus suksdorfii* (Suksdorf's Monkey-flower) were found in almost all of these pools. *Myosurus* x *clavicaulis* (Tiny mousetail) was located in one of the vernal pools. The pools were spread out over an area of about 1,000 by 3,000 ft (305 by 915 m). The lower, middle portion of Gable Butte supported a cluster of six or seven vernal pools. These pools supported healthy populations of several thousand *Mimulus suksdorfii* (Suksdorf's Monkey-flower) and *Loeflingia squarrosa* var. *squarrosa* (Sagebrush loeflingia) plants. The area was far from current development; however, an old road did cross through the largest vernal pool. The cluster of three pools on the eastern end of Gable Mountain was the least pristine of the three sets of vernal pools. These weedy, intermittently filled pools supported a population of several hundred *Mimulus suksdorfii* (Suksdorf's Monkey-flower) plants. The aggressive weed *Centaurea solstitialis* (Yellow Starthistle) posed a serious threat to the native plants at these pools (TNC 1998). Because these vernal pools are systems of significant quality, good management practices would include careful monitoring for invasive species. Immediate management action would be needed to stop invasive plants, if detected.

An alkaline spring and marshy area was found in a large shallow basin at the east end of Umtanum Ridge. This previously unknown spring did not appear to have been significantly damaged by past grazing. It is perhaps the only spring of its kind on the Hanford Site. This spring supports a population of *Castilleja exilis* (Foothill Indian Paintbrush) and other alkali-

tolerant plant species. There also were a number of weedy species present that could threaten the persistence of native plant species at the spring. The alkaline spring, as well as the vernal pool clusters, are considered to be special habitat areas (TNC 1998).

West Lake and its adjacent wetlands also were surveyed during the 1997 field season. A highly alkaline lake, West Lake results from an artificially elevated rise in the water table due to historic waste management practices on Hanford's central plateau (Cushing 1994). There also was evidence of significant groundwater changes in the area, probably due to recent changes in waste management activities that have reduced groundwater discharges on the central plateau. Native plant communities at West Lake appeared to be substantially degraded (TNC 1998). A historic siting of *Castilleja exilis* and many other species for the Hanford Site that had been documented at West Lake in the past (Sackschewsky et al. 1992) were not located during the 1997 survey. Much of the lake basin was invested with weedy species, primarily Bassia hyssopifolia (smotherweed).

Other than rivers and springs, there are no naturally occurring bodies of surface water adjacent to the Hanford Site. However, there are artificial wetlands (caused by irrigation) exist on the east and west sides of the Wahluke Slope portion of the Hanford Site, which lies north of the Columbia River. Hatcheries and canals associated with the Columbia Basin Irrigation Project constitute the only other artificial surface water expressions in the area. The Ringold Hatchery, located just south of the Hanford Site boundary on the east side of the Columbia River (northeast of the 300 Area), is the only local fish hatchery. In addition to the public hatchery, the Yakama Nation raised several species of fish in settling pools in the 100-K Area as part of an experimental program.

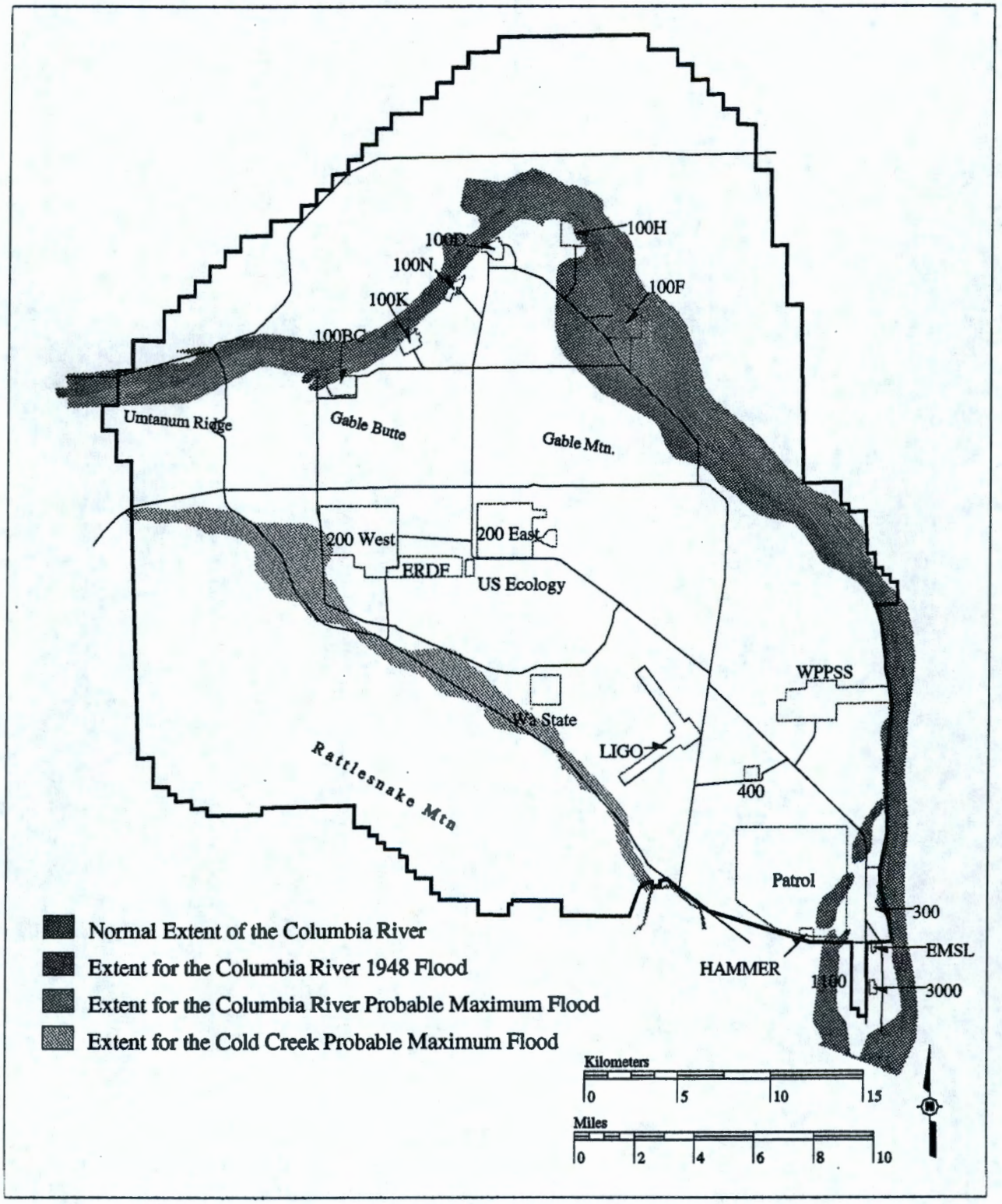
Total estimated precipitation over the Pasco Basin is about 9×10^8 m^3 (3.2×10^{10} ft^3) annually, averaging less than 20 cm/yr (approximately 8 in./yr). Mean annual runoff from the Pasco Basin is estimated at less than 3.1×10^7 m^3/yr (1.1×10 ft^3/yr), or approximately 3 percent of the total precipitation. The basin-wide runoff coefficient is zero for all practical purposes. The remaining precipitation is assumed to be lost through evapotranspiration, with less than 1 percent recharging the groundwater system. Precipitation contributes recharge to the groundwater in areas where soils are coarse-textured and bare of vegetation (PNNL 1996a).

4.3.1.1 Flooding. Large Columbia River floods have occurred in the past, but the likelihood of recurrence of large-scale flooding has been reduced by the construction of several flood control and water storage dams upstream of the Hanford Site. Major floods on the Columbia River typically result from rapid melting of the winter snowpack over a wide area, augmented by above-normal precipitation. The maximum historical flood on record occurred June 7, 1894, with a peak discharge at the Hanford Site of 21,000 m^3/s (742,000 ft^3/s). The largest recent flood took place in 1948, with an observed peak discharge of 20,000 m^3/s (706,280 ft^3/s) at the Hanford Site (PNNL 1996a). The exceptionally high runoff during the spring of 1996 resulted in a maximum discharge of nearly 11,750 m^3/s (415,000 ft^3/s) (DART 1998). The floodplain associated with the 1948 flood is shown in Figure 4-11 (see text box, *"Hanford Site Quick Facts: Columbia River Floods"*).

Hanford Site Quick Facts: Columbia River Floods

- Largest flood on record: 1894 at 21,000 m^3/s
- Largest recent flood: 1948 at 20,000 m^3/s
- Probable maximum flood: 40,000 m^3/s

Figure 4-11. Probable Maximum Flood of the Columbia River and Cold Creek, and the Actual 1948 Flood of the Columbia River (adapted from PNNL 1996a).



The Federal Emergency Management Agency has not prepared floodplain maps for the Hanford Reach because they only prepare maps for areas that are being developed (a criterion that specifically excludes the Hanford Reach).

Evaluation of flood potential is conducted, in part, through the concept of the probable maximum flood, which is determined from the upper limit of precipitation falling on a drainage area and other hydrologic factors (e.g., antecedent moisture conditions, snowmelt, and tributary conditions) that could result in maximum runoff. The probable maximum flood for the Columbia River below the Priest Rapids Dam has been calculated at 40,000 m^3/s (1.4 million ft^3/s) (see Figure 4-11) and is greater than the 500-year flood. This flood would inundate some portions of the 100 Area that are located adjacent to the Columbia River; but the central portion of the Hanford Site would remain unaffected (PNNL 1996a). Floodplain issues are further discussed in Appendix C.

The USACE has derived the Standard Project Flood with both dam-regulated and unregulated peak discharges given for the Columbia River below Priest Rapids Dam (PNNL 1996a). The regulated Standard Project Flood for this portion of the river is given as 15,200 m^3/s (540,000 ft^3/s), and the 100-year regulated flood as 12,400 m^3/s (440,000 ft^3/s).

Potential dam failures on the Columbia River have been evaluated (PNNL 1996a). Upstream failures could arise from a number of causes, with the magnitude of the resulting flood depending on the degree of breaching at the dam. The USACE evaluated a number of scenarios for failure of the Grand Coulee Dam, assuming flow conditions of 11,000 m^3/s (400,000 ft^3/s). For purposes of emergency planning, they hypothesized that 25 and 50 percent breaches (the instantaneous disappearance of 25 or 50 percent of the center section of the dam) would result from the detonation of nuclear explosives in sabotage or war. The discharge or floodwave from such an instantaneous 50 percent breach at the outfall of the Grand Coulee Dam was determined to be 600,000 m^3/s (21 million ft^3/s). In addition to the areas inundated by the probable maximum flood, the remainder of the 100 Areas, the 300 Area, and nearly all of Richland, Washington, would be flooded (PNNL 1996).

Determinations were not made for (1) failures of dams upstream, (2) associated failures downstream of Grand Coulee, or (3) breaches greater than 50 percent of Grand Coulee, because the 50 percent scenario was believed to represent the largest realistically conceivable flow that could result from a natural or human-induced breach; that is, it was not considered credible that a structure as large as the Grand Coulee Dam would be 100 percent destroyed instantaneously. The analysis also assumed that the 50 percent breach would occur only as the result of direct explosive detonation, not because of a natural event (i.e., an earthquake), and that even a 50 percent breach under these conditions would indicate an emergency situation in which other overriding major concerns might be present.

The possibility of a landslide resulting in river blockage and flooding along the Columbia River also has been examined for an area bordering the east side of the river upstream from the City of Richland (PNNL 1996a). The possible landslide area considered was the 75-m (250-ft)-high bluff (generally known as White Bluffs). Calculations were made for an 8×10^5 m^3 (1×10^6 yd^3) landslide volume with a concurrent flood flow of 17,000 m^3/s (600,000 ft^3/s) (a 200-year flood) that results in a flood wave crest elevation of 122 m (400 ft) above mean sea level. Areas inundated upstream from such a landslide event would be similar to a 50 percent breach of the Grand Coulee Dam. A flood-risk analysis of Cold Creek was conducted in 1980 as part of the characterization of a geologic repository for high-level radioactive waste. This design work evaluated the probable maximum flood rather than the worst-case and/or 100-year flood scenarios. Therefore, in lieu of 100- and 500-year floodplain studies, a probable maximum flood

evaluation was made for a reference repository located directly west of the 200 East Area that encompasses the 200 West Area (PNNL 1996a). Figure 4-11 identifies the extent of this probable maximum flood.

4.3.1.2 Surface Water Quality. The Washington State Department of Ecology (Ecology) classifies the Columbia River, from Grand Coulee to the Washington-Oregon border, which includes the Hanford Reach, as Class A (excellent) (PNNL 1996a). Class A waters are suitable for essentially all uses, including raw drinking water, recreation, and wildlife habitat. Federal and state drinking water standards, as well as DOE Order 5400.5 (DOE 1993a), apply to the Columbia River and are currently being met.

Pacific Northwest National Laboratory (PNNL) conducts routine monitoring (for both radiological and nonradiological water quality parameters) of the Columbia River. A yearly summary of these monitoring results has been published since 1973 (PNNL 1996b). Numerous water quality studies have been conducted on the Columbia River during the past 37 years. Three outfalls, located in the 100-K, 100-N, and 300 Areas of the Hanford Site, are covered by a National Pollutant Discharge Elimination System Permit (Permit No. WA-000374-3). These discharge locations are monitored for various measures of water quality, including nonradioactive and radioactive pollutants. The estimated dose from radionuclide releases is presented in environmental reports such as the *Hanford Site Environmental Report for Calendar Year 1996* (PNNL 1997a). In 1994, monitored liquid discharges resulted in a dose of 0.016 mrem to the downstream maximally exposed individual (PNL 1995).

Radiological monitoring of the Columbia River continues to show low levels of radionuclides. Although radionuclides associated with Hanford Site operations continued to be identified in Columbia River water in 1994, concentrations remained well below applicable standards at all monitored locations (PNL 1995). In 1995, tritium, iodine-129, and uranium concentrations downstream of the Hanford Site were found to be slightly higher than upstream concentrations, but these concentrations were well below guidelines established by DOE through DOE Order 5400.5 (DOE 1993a) and the U.S. Environmental Protection Agency (EPA) drinking water standards (Table 4-2). In 1995, the average annual strontium-90 and technetium-99 concentrations were essentially the same at Priest Rapids Dam (upstream of the Hanford Site) and at the Richland pump house (PNNL 1996b).

Total alpha and beta measurements are useful indicators of the general radiological quality of the river that provide an early indication of changes in radioactive contamination levels because results are obtained quickly. Total alpha and beta measurements for 1996 were similar to the previous year, and were approximately 5 percent or less of the applicable drinking water standards of 15 and 50 pCi/L, respectively. Tritium measured at the Richland pump house was significantly higher than at Vernita Bridge, but continued to be well beyond the state and Federal drinking water standards (Dirkes 1997). The presence of a ^{3}H concentration gradient at the Richland pump house supports previous conclusions made by Backman (1962) and Dirkes (1993) that contaminants in the 200 Area groundwater plume entering the Columbia River at and upstream of the 300 Area are not completely mixed by the time the river reaches the Richland pump house.

Table 4-2. Annual (1995) Average Concentrations of Radionuclides in the Columbia River (adapted from PNNL 1996b).

Radionuclides	Water Concentrations (pCi/L)			Downstream Concentration as Percentage of Drinking Water Standard
	Upstream Concentration (Priest Rapids Dam)	Downstream Concentration (Richland Pump House)	EPA Drinking Water Standard	
H-3	34	79	20,000	0.40
Sr-90	0.08	0.09	8.0	1.1
U	0.40	0.50	20.0 (ug/L)[a]	2.5
Tc-99	ND	0.06	900	--
I-129	3.6×10^{-6}	5.7×10^{-5}	0.48	0.01

[a] Proposed
ND = Not *Detected.*

For nonradiological water quality parameters measured in Columbia River water during 1995, concentrations of metals and anions were similar upstream and downstream and were found to be in compliance with applicable primary drinking water standards. Concentrations of volatile organic compounds (VOCs) also were below regulatory standards (PNNL 1996b).

4.3.2 Groundwater

The following sections describe the groundwater resources at the Hanford Site. Groundwater under the Hanford Site occurs under unconfined and confined conditions. The uppermost aquifer beneath most of the Hanford Site is unconfined and is composed of unconsolidated to semi-consolidated sediments deposited on the basalt bedrock. In some areas, deeper parts of the aquifer are locally confined by layers of silt and clay. Groundwater in the unconfined aquifer systems generally moves from recharge areas along the western boundary of the Hanford Site to the east and north toward the Columbia River, which is the major discharge area. This natural flow pattern was altered by the formation of groundwater mounds created by the discharge of large volumes of wastewater at disposal facilities. These mounds are declining, however, and groundwater flow is gradually returning to earlier patterns.

The confined aquifers consist of sedimentary interbeds and/or interflow zones that occur between dense basalt flows in the Columbia River Basalt group. The main water-bearing portions of the interflow zones occur within a network of interconnecting vesicles and fractures of the basalt flow tops or flow bottoms. Figure 4-6 presents a generalized subsurface cross-section of the Hanford Site.

4.3.2.1 Groundwater Hydrology. The multi-aquifer system within the Pasco Basin has been conceptualized as consisting of four geohydrologic units: (1) Grande Ronde Basalt, (2) Wanapum Basalt, (3) Saddle Mountain Basalt, and (4) Hanford and Ringold formation sediments lying above the basalt units (see Figure 4-5). Geohydrologic units older than the Grande Ronde Basalt probably are of minor importance to the regional hydrologic dynamics and system. Together, the Grande Ronde, Wanapum, Saddle Mountains, and Imnaha Basalts compose the Columbia River Basalt group.

The Grande Ronde Basalt is the most voluminous and widely spread formation within the Columbia River Basalt group and has a thickness of at least 2,745 m (9,000 ft). The Grande Ronde Basalt is composed of the basalt flows and minor intercalated sediments that are equivalent to or part of the Ellensburg Formation (DOE 1988a). More than 50 flows of Grande

Ronde Basalt underlie the Pasco Basin, but little is known of the lower 2,200 to 2,500 m (7,216 to 8,200 ft). Groundwater in these basalts is confined to semi-confined and is recharged along the margins of the Columbia Plateau where the basalt is at, or close to, the land surface and by surface-water and groundwater inflow from lands adjoining the plateau. Vertical movement into and out of this system is known to occur. Groundwater within the Grande Ronde Basalt in the eastern Pasco Basin is believed to originate from groundwater inflow from the east and the northeast.

The Wanapum Basalt consists of basalt flows intercalated with minor and discontinuous sedimentary interbeds of the Ellensburg Formation or equivalent sediments. In the Pasco Basin, the Wanapum Basalt consists of three members, each consisting of multiple flows. The Wanapum Basalt underlies the entire Pasco Basin and has a maximum thickness of 370 m (1,215 ft). Groundwater within the Wanapum Basalt is confined to semi-confined.

The Saddle Mountain Basalt is composed of the youngest formation of the Columbia River Basalt group and several thick sedimentary beds of the Ellensburg Formation or equivalent sediments, which comprise up to 25 percent of the unit. Within the Pasco Basin, the Saddle Mountain Basalt contains seven members, each with one or more flows. This Saddle Mountain Basalt underlies most of the Pasco Basin, attaining a thickness of about 290 m (950 ft), but is absent along the northwest part of the basin and along some anticlinal ridges. Groundwater in the Saddle Mountain Basalt is confined to semi-confined, with recharge and discharge believed to be local (PNL 1991a).

The rock materials that overlie the basalts in the structural and topographic basins within the Columbia Plateau generally consist of Miocene-Pliocene sediments, volcanics, Pleistocene sediments (including those from catastrophic flooding), and Holocene sediments consisting mainly of alluvium and eolian deposits. The suprabasalt sediment (referred to as the Hanford/Ringold unit) consists principally of the Miocene-Pliocene Ringold Formation stream, lake, and alluvial materials, and the Pleistocene catastrophic flood deposits informally called the Hanford formation. Groundwater within the suprabasalt sediment is unconfined, with recharge and discharge usually coincident with topographic highs and lows (PNL 1991a). The Hanford/Ringold unit is restricted to the Pasco Basin; principal recharge occurs (along the periphery of the basin) from precipitation and ephemeral streams.

4.3.2.2 Groundwater Recharge. Little, if any, natural recharge occurs within the Hanford Site, but artificial recharge occurs from liquid waste disposal activities (PNNL 1996b) (Figure 4-12). Recharge from irrigation occurs east and north of the Columbia River and in the synclinal valleys west of the Hanford Site. Within the Pasco Basin, recharge occurs along the anticlinal ridges to the north and west and from groundwater inflow from the east and northeast. Sources of natural recharge to the unconfined aquifer are rainfall and runoff from the higher bordering elevations, water infiltrating from small ephemeral streams, and river water along influent reaches of the Yakima and Columbia rivers. To define the movement of water in the unsaturated (vadose) zone, the movement of precipitation through the vadose zone has been studied at several locations on the Hanford Site. Conclusions from these studies vary depending on the location studied.

From the recharge areas to the west, groundwater flows downgradient to the discharge areas, primarily along the Columbia River (Figure 4-13a and 4-13b). This general west-to-east flow pattern is interrupted locally by the groundwater mounds in the 200 East and 200 West Areas. From the 200 East and 200 West Areas, a component of groundwater also flows to the north, between Gable Mountain and Gable Butte. These flow directions represent current conditions; the aquifer is dynamic, and responds to changes in natural and artificial recharge (see Figures 4-14 and 4-15, respectively).

Figure 4-12. Estimated Recharge from Infiltration of Precipitation and Irrigation on the Hanford Site.

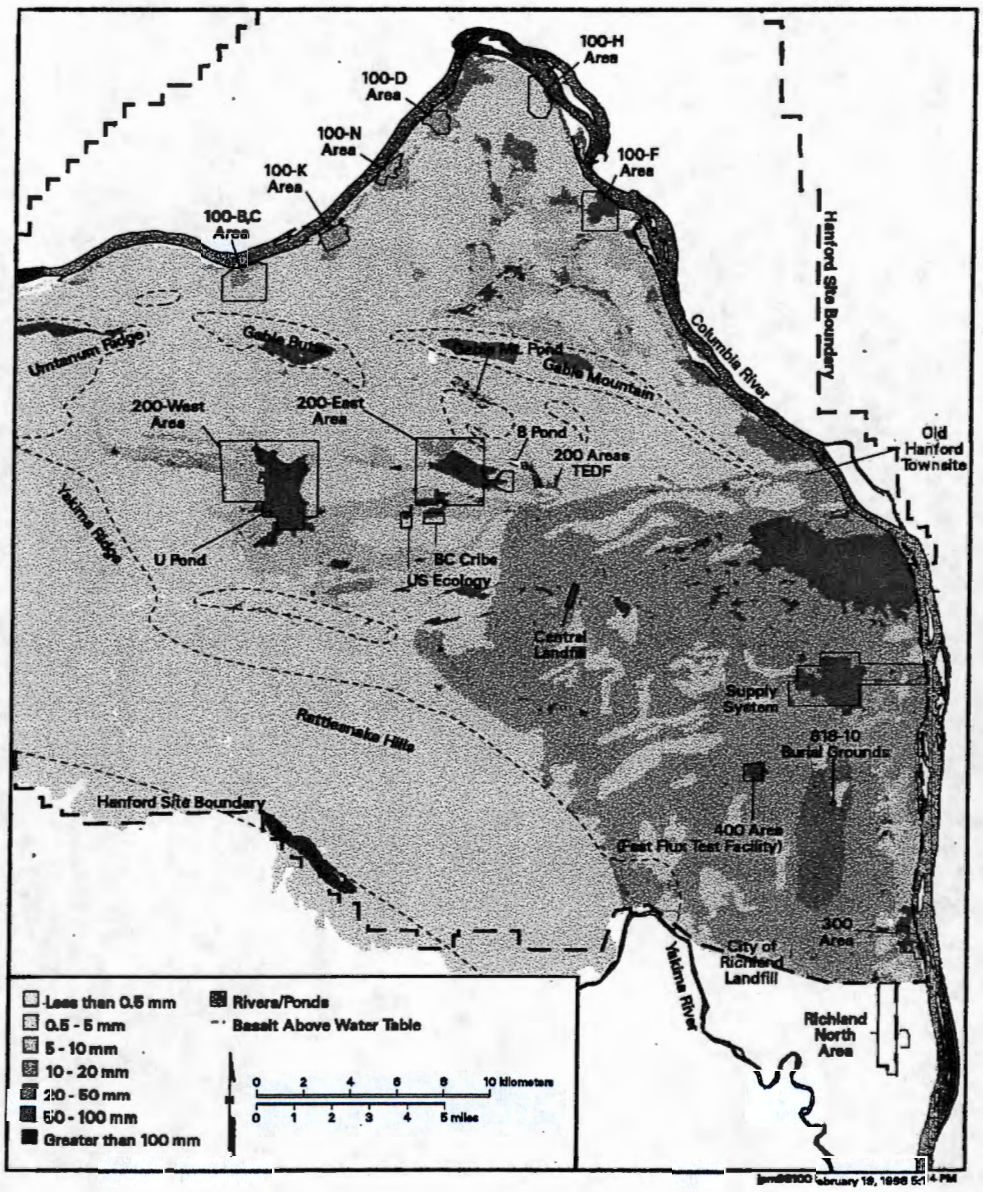


Figure 4-13a. Hanford Site and Outlying Areas Water Table Map -- June 1998 (PNNL 1998).

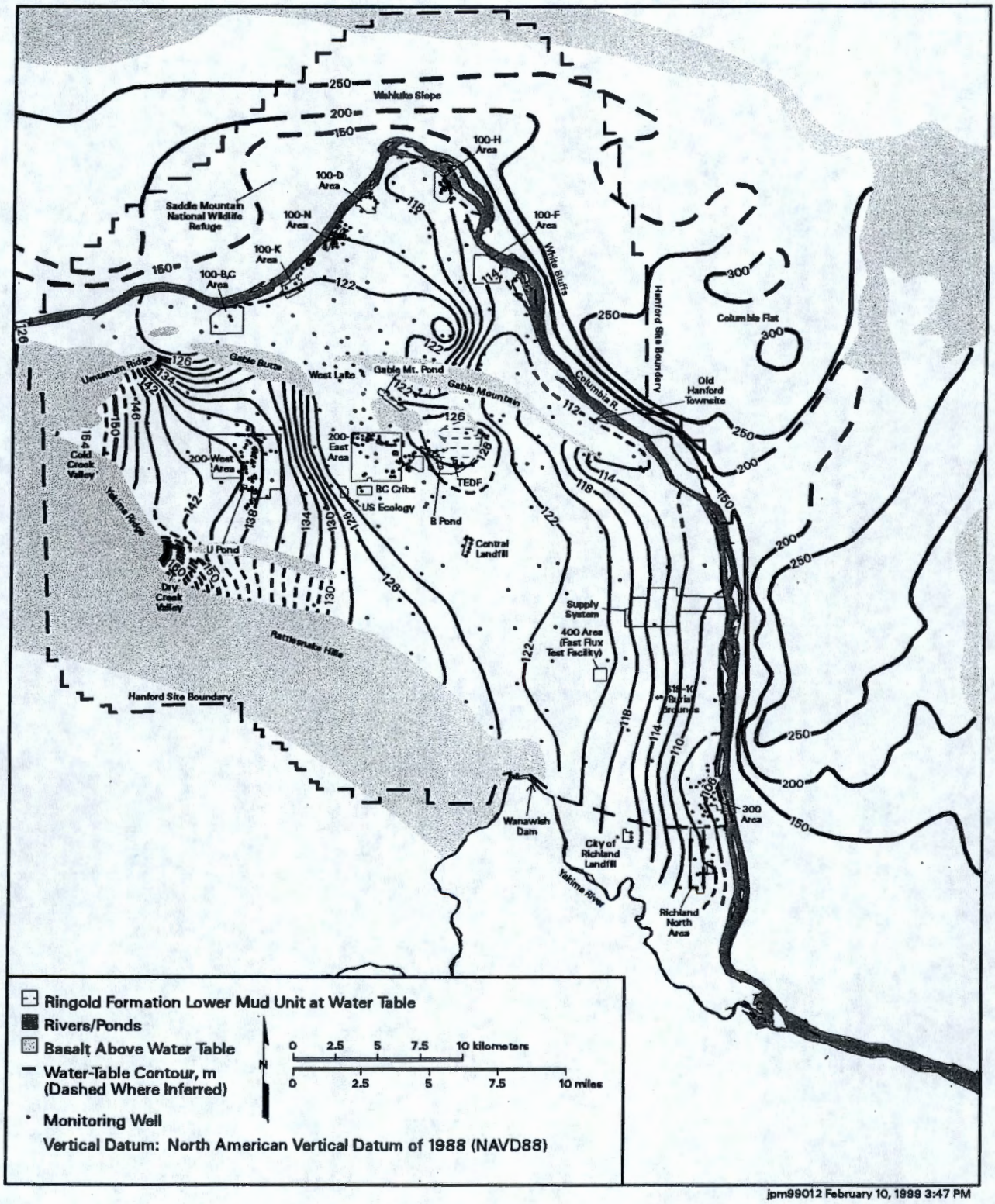


Figure 4-13b. Potentiometric Map of Upper Basalt-Confined Aquifer System -- June 1998 (PNNL 1998).

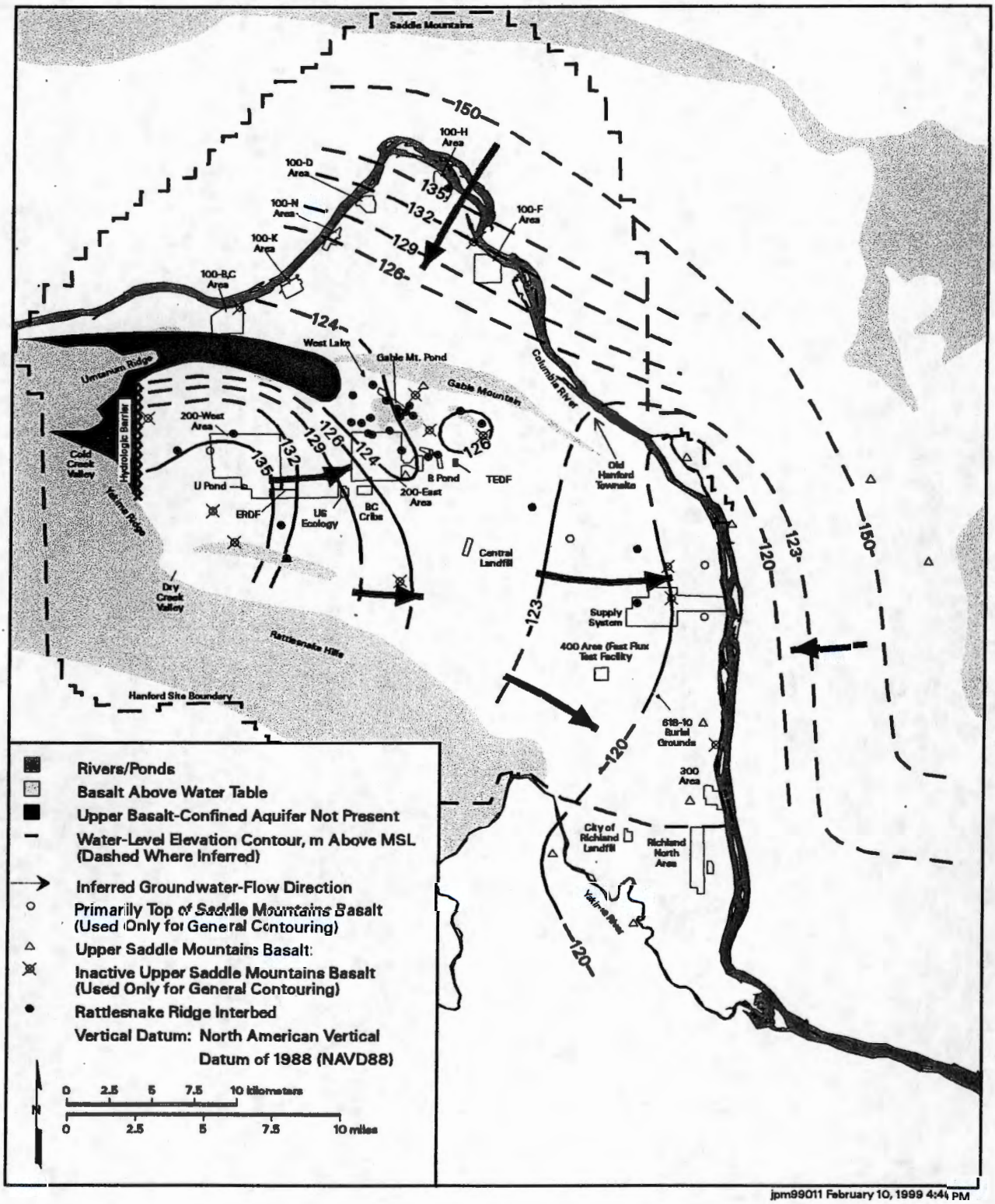


Figure 4-14. Water Table Change Map for 1944 - 1979.

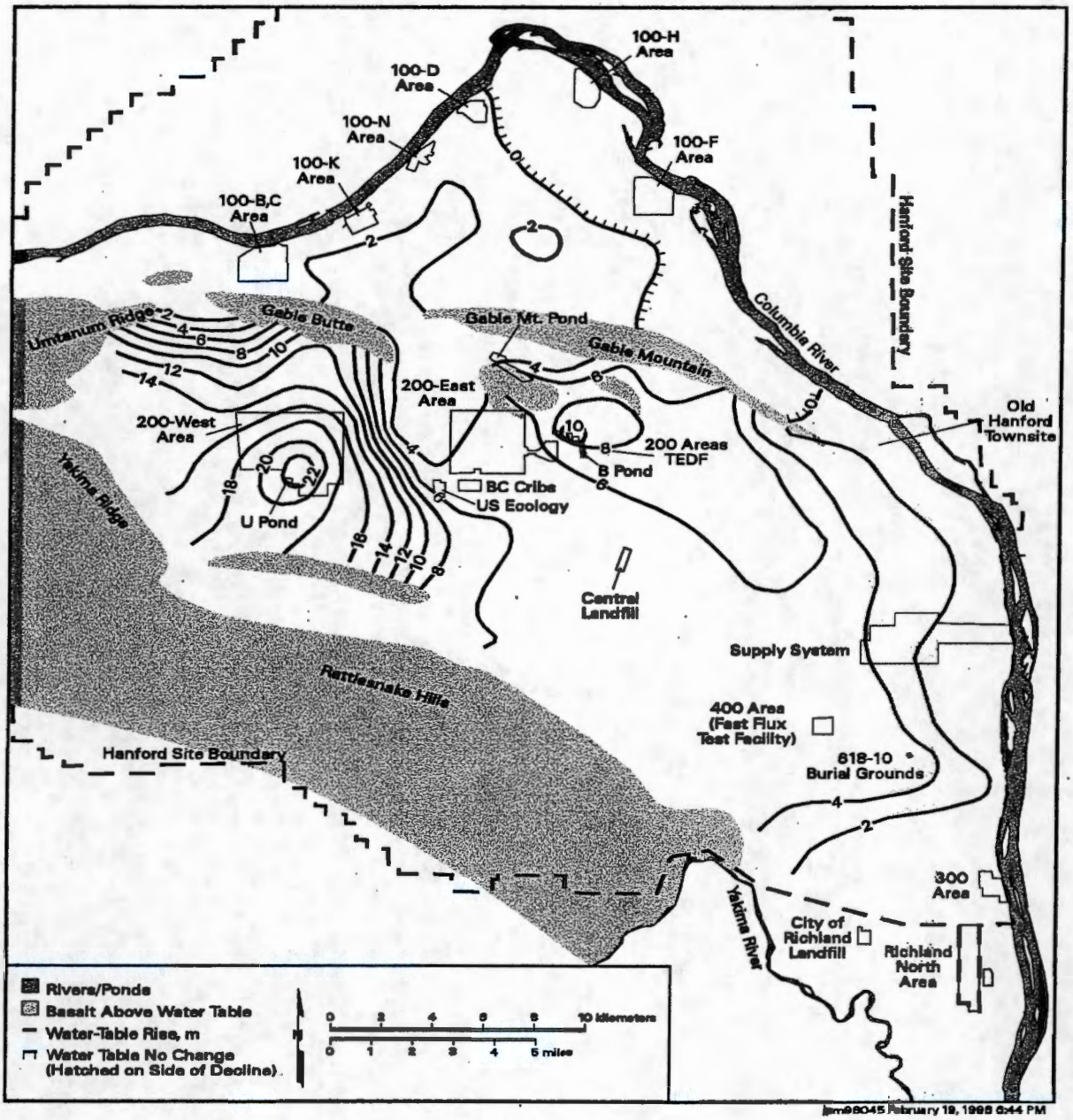
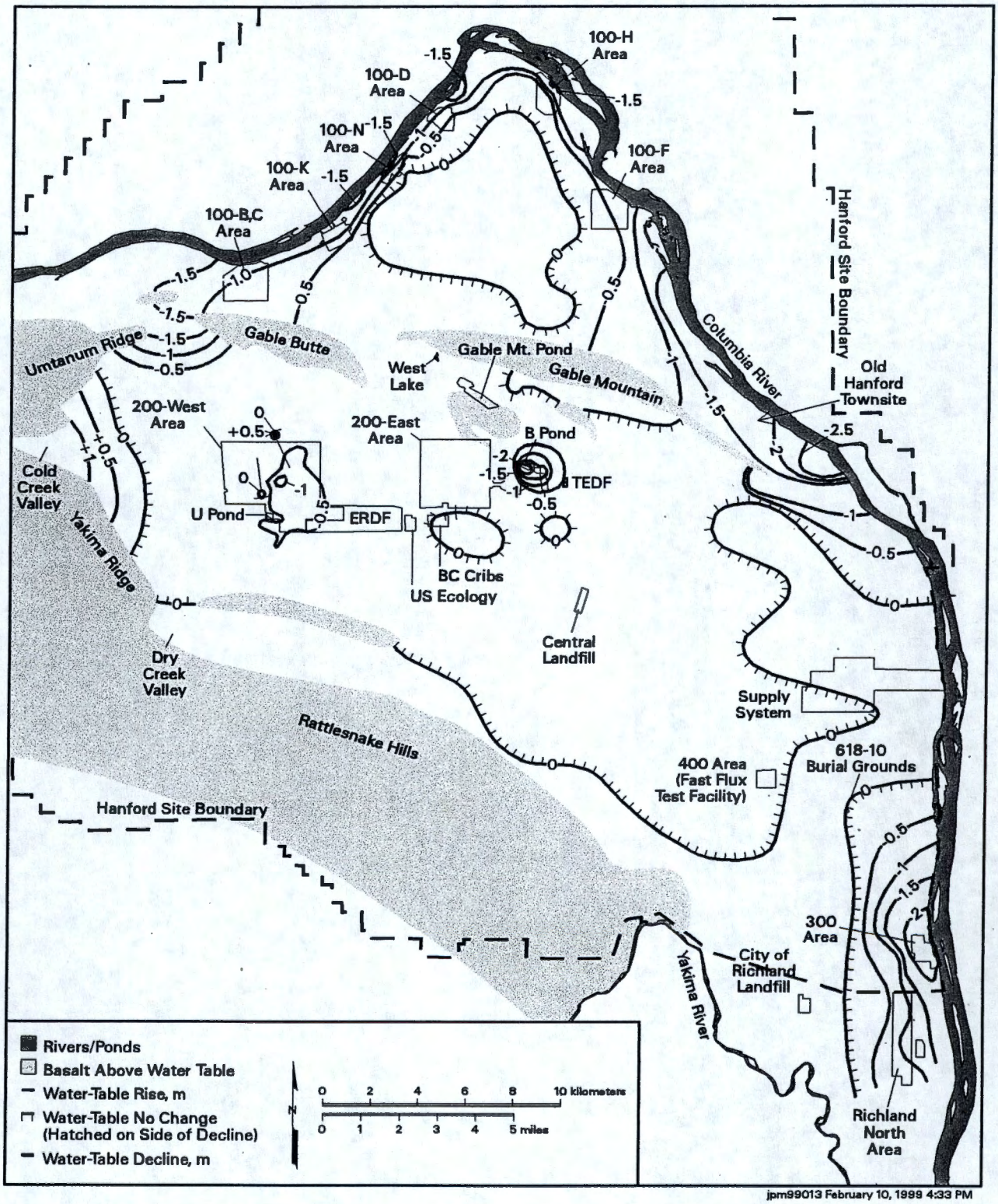


Figure 4-15. Water Table Change Map for 1997 - 1998.



Studies indicate that local recharge to the shallow basalts results from infiltration of precipitation and runoff along the margins of the Pasco Basin. Regional recharge of the deep basalts is thought to result from interbasin groundwater movement that originates northeast and northwest of the Pasco Basin in areas where the Wanapum and Grande Ronde Basalt outcrops are extensive (Neitzel 1997). Groundwater is discharged from the shallow basalt to the overlying unconfined aquifer and the Columbia River. In some cases, well bores may have allowed water movement between the unconfined aquifer and the confined aquifer.

The major recharge sources of the Hanford and Ringold formations are as follows: inflow from Dry Creek, which average 0.035 cm/s; inflow from Cold Creek, which averages 0.028 cm/s; and inflow around Rattlesnake Hills, which averages 0.032 cm/s.

4.3.2.3 Groundwater Quality. The quality of the groundwater at the Hanford Site has been affected by many of the activities related to the production of nuclear materials. Due to the arid climate, natural recharge of the groundwater on the Hanford Site is low. Artificial recharge has occurred in the past from the disposal of liquid waste associated with processing operations in the 100, 200, and 300 Areas, which created mounds of water underlying discharge points. Large areas underlying the Hanford Site have elevated levels of both radiological and nonradiological constituents. The liquid effluents discharged into the ground have carried with them a variety of radionuclides and chemicals that move through the soil column at differing rates, eventually entering the groundwater and forming plumes of contamination (see text box, *"Hanford Site Quick Facts: Principal Groundwater Contaminants"*).

Hanford Site Quick Facts: Principal Groundwater Contaminants

- chromium
- nitrate
- trichloroethylene
- fluoride
- carbon tetrachloride
- cyanide
- tetrachloroethylene
- chloroform
- cis-1, 2-dichloroethylene
- cobalt-60
- strontium-90
- tritium
- uranium
- cesium-137
- carbon-14
- iodine-129
- plutonium
- technetium-99

4.3.2.3.1 Unconfined Aquifer. As part of the continuing environmental monitoring program at the Hanford Site, groundwater monitoring reports are published in the *Hanford Site Environmental Report* (PNNL 1996b), and in the *Hanford Site Groundwater Monitoring Report* (PNNL 1998), which are issued each calendar year. The shallow, unconfined aquifer in the Pasco Basin and on the Hanford Site contains waters of a dilute (less than or approximately 350 mg/L total dissolved solids) calcium bicarbonate chemical type. Other principal constituents include sulfate, silica, magnesium, and nitrate. Variability in chemical composition exists within the unconfined aquifer because of natural variation in the composition of the geologic strata, and irrigation and other agricultural practices north, east, and west of the Hanford Site, and on the Hanford Site, because of liquid waste disposal.

The uppermost aquifer beneath most of the Hanford Site is unconfined and is composed of unconsolidated to semi-consolidated sediments deposited on the basalt bedrock. In some areas, deeper parts of the aquifer are locally confined by layers of silt and clay. Confined aquifers occur within the underlying basalt flows and associated sedimentary interbeds. Groundwater in the unconfined aquifer system generally moves from recharge areas along the western boundary of the Site to the east and north toward the Columbia River, which is the major discharge area. This natural flow pattern was altered by the formation of groundwater mounds created by the discharge of large volumes of wastewater at disposal facilities. These mounds are declining, and groundwater flow is gradually returning to earlier patterns.

Water levels are monitored across the Hanford Site and to the east and north of the Columbia River. The purpose of these measurements is to monitor changes in the water table elevations that affect the direction and velocity of groundwater flow and transport of contaminants, and to assess impacts of the changes on monitoring networks. A Site water table

map for June 1998 was constructed and used to infer groundwater-flow directions (see Figure 4-13). Water levels over most of the Site declined during fiscal year 1998, continuing the trend caused by reduction in liquid effluent disposal. Water levels are also measured in wells completed in the upper basalt-confined aquifer. Several areas showed declines in the confined-aquifer potentiometric surface associated with declines in the water table of the overlying unconfined aquifer (PNNL 1998).

Radioactive and nonradioactive liquid effluents were discharged to the environment from facilities in the 100 and 300 Areas, as well as facilities in the Central Plateau (PNNL 1996b). Contamination of the groundwater exceeds drinking water standards in more than 220 km^2 (85 mi^2) of the Hanford Site. The U.S. Department of Energy, Richland Operations Office (RL) has committed to implement the best available technology and all known and reasonable methods of prevention, control, and treatment for several of the effluent streams, and to obtain permits for the waste streams under the "State Waste Water Discharge Permit Program," *Washington Administrative Code* (WAC) 173-216. The goal associated with the use of best available technology is to eliminate, minimize, or treat effluents discharged to the ground.

4.3.2.3.2 Confined Aquifer. The uppermost confined aquifer (Rattlesnake Ridge) was sampled to determine what extent of groundwater contamination occurred from interaction between the confined and unconfined aquifers. Groundwater samples from selected confined aquifer wells were analyzed for a variety of radionuclides and hazardous chemicals. In most cases, no indication of contamination was observed. Detection of radionuclides in well 299-E33-12 (the Central Plateau) was attributed to contamination by high-salt waste that migrated by density flow into the borehole when it was open to both the unconfined and the confined aquifer during drilling (PNNL 1996b). The 1995 samples from well 299-E33-12 contained up to 458 pCi/L of tritium, similar to levels detected since 1982. The 1995 samples from this well also contained cobalt-60 at levels up to 31.4 pCi/L, nitrate at levels up to 11 mg/L, technetium-99 at levels up to 1,560 pCi/L, and cyanide at levels up to 20.7 µg/L. Although all of these constituents are indicators of contamination, only nitrate and technetium-99 were detected at levels greater than drinking water standards.

The upper basalt-confined aquifer system is defined as the groundwater occurring within basalt fractures and joints, interflow contacts, and intercalated sedimentary interbeds within the upper Saddle Mountains Basalt. The thickest and most widespread sedimentary unit is the Rattlesnake Ridge Interbed. Groundwater is confined by the dense, low-permeability, interior portions of basalt flows and by Ringold Formation silt and clay units overlying the basalts.

In 1993, hydraulic head distribution and flow dynamics of the upper basalt-confined aquifer system were evaluated and reported in PNL-8869, which identified the following prominent hydrologic features:

- A broad recharge mound extending northeastward from Yakima Ridge in the 200 West Area
- A small recharge mound (now subsiding) immediately east of the 200 East Area in the vicinity of B Pond
- A subsurface hydrogeologic barrier (i.e., an impediment to groundwater flow), believed to be related to faulting, near the mouth of Cold Creek Valley
- A region of low hydraulic head (potential discharge) in the Umtanum Ridge-Gable Mountain structural area

- A region of high hydraulic head to the north and east of the Columbia River associated with recharge attributed to agricultural activities.

Recharge to the upper basalt-confined aquifer system is believed to result from precipitation and surface water infiltration where the basalt and interbeds are exposed at ground surface. Recharge also may occur through the unconfined aquifer system where a downward hydraulic gradient exists between the unconfined and upper basalt-confined aquifers. Hydraulic communication with overlying and underlying aquifers is believed to cause the region of low hydraulic head found in the Umtanum Ridge-Gable Mountain structural area (these relationships are given in more detail in PNL-8869). Maps of the upper basalt-confined and unconfined aquifer potentiometric surfaces indicate that a downward hydraulic gradient from the unconfined aquifer to the upper basalt-confined aquifer occurs in the western portion of the Hanford Site, in the vicinity of the B Pond recharge mound, as well as in the regions north and east of the Columbia River (see PNL-6313, PNL-8869, PNL-10082, PNNL-11470, PNNL-12067, WHC-EP-0142-3, WHC-EP-0142-4, and WHC-EP-0394-3). In the vicinity of B Pond, however, a recent acceleration in head decline within the unconfined aquifer system may soon lead to a reversal in the vertical hydraulic gradient between the unconfined and upper basalt-confined aquifer systems in this region. In other areas of the Hanford Site, the hydraulic gradient is upward from the upper basalt-confined aquifer to the unconfined aquifer system.

Figure 4-13b, constructed by manual contouring, presents a regional approximation of the potentiometric surface for the upper basalt-confined aquifer system based on water-level measurements taken during June 1998. Measurements in the Rattlesnake Ridge Interbed were primarily used to construct this map, though additional measurements in the upper Saddle Mountains Basalt were used for general contouring. The datum used was NAVD88, which is approximately 1 m higher than the NGVD29 datum used in previous versions of this map (e.g., PNL-8869, PNL-10817, and PNNL-11793).

With some exceptions, the major potentiometric map features shown in Figure 4-13b are nearly the same as those exhibited for 1996, as reported in Section 5.5 of PNNL-11470 and Section 3.10 of PNNL-11793. The potentiometric map indicates that, south of the Umtanum Ridge-Gable Mountain structural area, groundwater flows from west to east across the Site toward the Columbia River, which represents the regional discharge area for groundwater-flow systems. In the region northeast of Gable Mountain, the potentiometric contours suggest that groundwater flows southwest and discharges primarily to underlying confined aquifer systems in the Umtanum Ridge-Gable Mountain structural area (PNL-8869). This increased hydraulic head region is associated with recharge from agricultural activities north and east of the Columbia River and has been observed for deeper, confined aquifer systems. Therefore, the Columbia River does not represent a major discharge area for upper basalt-confined groundwater in the northern portion of the Hanford Site.

Water levels in almost all wells monitoring the upper basalt-confined aquifer system declined from June 1997 to June 1998. The greatest declines occurred near the B Pond (well 699-42-40C) and in the eastern portion of the site (wells 699-26-15C and 699-42-E9B). However, water levels in well 699-42-E9B are known to be affected by stage fluctuations in the Columbia River. The river stage was higher than normal during 1996 and 1997 but returned to normal during 1998, thus accounting for the water-level decline in well 699-42-E9B. For this reason, short-term water-level fluctuations in this well and in other wells near the river (i.e., wells 199-H4-2 and 399-5-2) mask long-term trends in the upper basalt-confined aquifer system. Water levels in confined aquifer wells near the northern boundary of the 200 East Area and immediately east of the 200 East Area near B Pond continue to show a decline, falling in the range of approximately 0.1 to 0.7 m from June 1997 to June 1998. Water levels in confined aquifer wells near the 200 West Area also continue to show a decline of approximately 0.1 to 0.4 m/yr. Water levels in wells located between Gable Mountain and the northern boundary of

the 200 East Area fell approximately 0.1 to 0.3 m from June 1997 to June 1998. These declines are a response to curtailed effluent-disposal activities in the 200 Areas and are consistent with water-level declines in the overlying unconfined aquifer system.

4.3.2.4 Vadose Zone. The vadose zone is the area between the land surface and the top of the groundwater table. The vadose zone represents the pathway for contaminants to the groundwater for surface and near-surface releases, leaks, and spills of contaminated liquids. The length of time it takes contaminated material to travel through the vadose zone depends on a number of factors including: (1) the depth to the groundwater, (2) characteristics of vadose zone sediment, and (3) chemical interaction of the contaminated material with the soil and subsoil.

Historically, radioactive contamination was released into the vadose zone sediment (the unsaturated sediment between the ground surface and the top of the unconfined groundwater aquifer) at Hanford from several hundred effluent discharge sites (e.g., cribs and ditches) and from leaks and spills from single-shell radioactive waste tanks. These releases, leaks, and spills represent the largest quantity of radioactive contamination released to the environment from Hanford operations (Dirkes and Hanf 1997).

Soil vapor extraction continued in the 200-ZP-2 Operable Unit as a CERCLA expedited response action to remove the carbon tetrachloride source from the vadose zone. The mix of extraction wells was changed periodically during fiscal year 1998 to improve performance based on a 1997 rebound study. In fiscal year 1998, 777 kg (1,717 lbs.) of carbon tetrachloride were removed, resulting in a total of 75,490 kg (166,455 lbs) since remediation began in 1992 (PNNL1998).

In 1998, results from 1997 spectral gamma logging of boreholes surrounding the B-BX-BY single-shell tank farm in the 200 East Area became available. The logging was to detect changes in the distribution of man-made radionuclides in the sediments associated with liquid waste disposal facilities adjacent to the tank farm. Spectral gamma logging also was performed at boreholes around the Plutonium Finishing Plant liquid disposal facilities to ascertain any changes in subsurface radionuclide distribution since last logging. Also, baseline characterization logging of all drywells in the BX, C, S, and TY tank farms was completed and the results reported in 1998. In addition, 10 new groundwater-monitoring wells were installed and logged by spectral gamma-ray methods. Historical gross gamma logs from boreholes near the SX, BX, BY, and TY tank farms were analyzed to locate mobile radionuclides.

Directional well drilling was tested at two sites. The holes were completed, but boulder gravels at one site presented difficulties in drilling and sampling. Control of drilling fluids also presented an obstacle that must be overcome before using this technique to address vadose zone contamination.

Sediment samples from new vadose-zone or groundwater wells were collected and analyzed for contaminants and physical properties. A vadose-zone borehole near the SX tank farm was extended to groundwater and sediments were analyzed for radionuclides. Cesium-137 contamination decreased with depth and was undetectable at the water table (PNNL 1998).

4.3.2.4.1 Surface Disposal. Radioactive and hazardous waste disposed to the soil column have been the dominant contributor to groundwater contamination at Hanford. Even though disposal of untreated waste water stopped in 1995, movement of contaminant in the soil column beneath historical effluent disposal sites still occurs. Large volumes (1,600 billion L [426 billion gal]) of low-level liquid waste were discharged to surface ponds and ditches. In addition 53 billion L (14 billion gal) of low- and intermediate-level liquid waste were discharged to the subsurface in reverse wells, french drains, cribs, and tile fields (PNNL 1997b).

Early in the Hanford Site's production history, when the bismuth phosphate process was used, the radioactive supernatant from the tanks was discharged directly to soil-column disposal sites. As a result, over 450 million L (120 million gal) of high-level radioactive liquid wastes were discharged to the vadose zone via cribs, trenches, and french drains. Although this disposal practice was terminated over 30 years ago, the residual liquid held in the soil-pore spaces can continue to be a long-term source of groundwater contamination, especially if a source of moisture is available to transport the mobile waste constituents. Some of these sources of moisture include enhanced infiltration from the coarse gravel covering, removal of vegetation, and leaking water lines (Dirkes and Hanf 1998).

4.3.2.4.2 Tank Farms. Contamination was released to the near-surface and subsurface sediment at Hanford Site tank farms as the result of tank leaks, spills, or radioactive effluents on the ground surface, as well as pipe leaks and airborne releases of particulate matter through tank ventilation and access ports. Of the 149 single-shell, and 28 double-shell tanks, 67 single-shell tanks are known or assumed to leak. The estimated volume to date of radioactive waste leakage from single-shell tanks is 2.3 million to 3.5 million L (600,000 to 900,000 gal). A Los Alamos study in 1998 used historical information and new leak models to better define the volume, chemical composition, and radioactive components of leaks from tanks SX-108, SX-109, SX-111, and SX-112. The study estimated that past leaks from the four single-shell tanks likely total between 757,000 and 1,514,00 L (200,000 and 400,000 gal)– about six times more that previous estimates. has recently been reassessed. Airborne releases and surface spills created contaminated plumes in the vadose zone that are generally confined to the near-surface regime, but in some cases surface contamination is known to have migrated deeper into the vadose zone. Pipeline leaks have also occurred either near the ground surface or at a maximum depth of 6 m (20 ft). In some cases, contamination from pipeline leaks has also migrated into the vadose zone; however, tank leaks created the deepest contamination plumes (Dirkes and Hanf 1998).

Spectral gamma log data show that cesium-137 is the most abundant and highly concentrated man-made radionuclide in the vadose zone of several of the tank farms. It was previously believed the cesium-137 was relatively immobile in the sediment and was not expected to migrate more than a few meters from the base of the tanks. In 1996, cesium-137 contamination was detected at relatively high concentrations deeper than expected (as deep as 73 m [240 ft]).

Cobalt-60 has also been detected but at a much lower concentration than cesium-137. Cobalt-60 has been found at depths of between 15 and 50 m (50 to 165 ft) and as trace amounts at depths close to the water table at 69 and 71 m (225 to 234 ft). Cobalt-60 was detected at a depth of 65 m (213 ft), immediately above the water table and within the capillary fringe. Some of the cobalt-60 contamination was detected below the Early Palouse/Plio-Pleistocene interval, which has been considered a barrier to downwardly migrating fluids and groundwater. Additional contaminants detected in the vadose zone as detected in monitoring wells include europium-154, antimony-125, uranium-235, uranium-238, potassium-40, and thorium-232 (Dirkes and Hanf 1998).

4.3.2.4.3 Plutonium Finishing Plant. The spent-process solutions from the Plutonium Finishing Plant contained carbon tetrachloride, nitric acid, and isotopes of plutonium and americium (transuranic waste). Liquid waste discharges to cribs and trenches in the Plutonium Finishing Plant area resulted in the accumulation of an estimated 20,000 Ci of plutonium-239 and americium-241 in the underlying soil column. Based on relative hazard, the Plutonium Finishing Plant's cribs are some the most significant sources of radioactive contamination in the vadose zone at the Hanford Site.

Transuranic concentration in the soil of >100,000 pCi/g were found immediately beneath the tile fields to a depth of 6 m (20 ft). Transuranics were also found in sediment at depths of 20 to 30 m (66 to 98 ft). Although transuranics are normally expected to be retained in the first few meters of surface sediment, the combination of high acidity and the presence of complexants apparently allowed the transuranics at these sites to penetrate deeper into the soil column.

In addition to transuranics, between 1955 and 1973, the 200 West Area's cribs also received 570,000 to 920,000 kg (1.2 million to 2 million lb) of carbon tetrachloride. Carbon tetrachloride was discovered in the groundwater near the plant in the mid-1980s and was later found to be widespread in the 200 West Area. If left unchecked, the carbon-tetrachloride would significantly increase the extent of groundwater contamination because of vapor-phase transport through soil-pore space or by downward migration through the vadose zone as a dense nonaqueous-phase liquid or dissolved in natural recharge water.

Soil vapor extraction is being used to remove the carbon tetrachloride source from the vadose zone as part of the 200 West Area carbon tetrachloride expedited response action. Approximately 75,000 kg (165,000 lb) of carbon tetrachloride have been removed from the subsurface since extraction operations started in 1992 (Dirkes and Hanf 1998).

4.3.2.4.3 Other Liquid Waste Disposal Sites. Along the Columbia River in the vicinity of the now inactive and closed reactors, once-through cooling waters were routinely disposed into cribs and trenches. The disposed cooling water contained low levels of fission and neutron activation products and very low level of some chemicals and actinides. The biggest concern is the impacts of chromate, nitrate, strontium-90, and tritium to groundwater. Leakage from fuel-storage basins in the 100-K Area also contributes potentially significant inventories of fission products and transuranics to the soil column. Thus both historical waste disposal sites and fuel-storage basin leakage are potential vadose-zone sources (Dirkes and Hanf 1998).

4.3.2.4.4 Vadose Zone Monitoring. Two programs currently under way at Hanford characterize and monitor radionuclides in the vadose zone. One program focuses on vadose zone monitoring near single-shell radioactive waste tanks and the other involves monitoring near historical effluent disposal sites, which include cribs, ponds, ditches, injection wells, and french drains. Both programs were designed to characterize and monitor gamma-emitting radionuclides in the vadose zone and focused on establishing existing baseline conditions. Once a baseline is established for a particular tank or effluent discharge site, the facility can be monitored for either long-term or short-term changes. The intent of long-term monitoring is to detect changes over a 5- to 10-year period than can be used for predictive risk assessment. Short-term monitoring is used to identify recent changes in the vadose zone caused by current operations and tank leaks (PNNL 1997b).

In 1994, the tank farms vadose zone baseline characterization project was begun to perform an initial baseline characterization of the vadose zone gamma-emitting contamination at Hanford Site tank farms. Under the baseline characterization program, approximately 800 pre-existing monitoring boreholes surrounding the single-shell tanks are being logged with gamma-ray logging methods. Borehole logging is used to identify the locations and sizes of the contamination plumes. Once the baseline is established for a particular tank, that tank can be monitored over time (PNNL 1997b).

4.3.3 Water Use

Water use in the Pasco Basin is primarily from surface diversion, with groundwater diversions accounting for less than 10 percent of the total use (DOE 1988a). Historically, industrial, agricultural, and municipal usage represented about 32, 50, and 9 percent, respectively. Until recently, the Hanford Site used about 81 percent of the water withdrawn for industrial purposes. However, because of the N Reactor shutdown, and considering other data (PNL 1991a), these percentages now approximate 13 percent for industrial, 75 percent for agricultural, and 12 percent for municipal uses, with the Hanford Site accounting for about 41 percent of the water withdrawn for industrial use (DOE 1995e). The first downstream drinking water intake below the Hanford Site is the City of Richland intake.

The largest categories of wells in the Pasco Basin are those used for domestic purposes (approximately 50 percent). Agricultural wells, used for irrigation and stock supply, constitute the second-largest category of well use (about 24 percent for the Pasco Basin). Industrial users account for only about 3 percent of the wells (DOE 1995e).

Most of the water used by the Hanford Site is withdrawn from the Columbia River. The water distribution systems supplying river water are located at the 100-B, 100-D, 200, and 300 Areas at Energy Northwest (formerly known as WPPSS). In addition, wells supply water to the 400 Area and a variety of low-use facilities at remote locations. The 700 and 1100 Areas are supplied with water by the City of Richland.

Regional effects of water-use activities are apparent in some areas where the local water tables have declined because of withdrawals from wells. In other areas, water levels in the shallow aquifers have risen because of artificial recharge mechanisms, such as excessive application of imported irrigation water or impoundment of streams. Waste water ponds on the Hanford Site have artificially recharged the unconfined aquifer below the 200 East and 200 West Areas. The increase in water table elevations was most rapid from 1950 to 1960 and slowed down substantially between 1970 and 1980, when only small increases in water table elevations occurred. Waste water discharges from the 200 West Area were reduced significantly in 1984, with an accompanying decline in water table elevations.

The Vernita Bar Settlement Agreement, executed June 16, 1988, established a minimum Columbia River flow below Priest Rapids Dam to protect salmon spawning habitat. This Agreement was signed by the Washington Public Utility Districts in Chelan, Grant, and Douglas counties; the Bonneville Power Administration (BPA); National Marine Fisheries Service; WDFW; Oregon Department of Fish and Wildlife; Yakama Nation; the Confederated Tribes of the Umatilla Indian Reservation; and the Colville Confederated Tribes. The Agreement was then approved by the Federal Energy Regulatory Commission as a condition of the license for the Priest Rapids Dam. This minimum flow is in effect from about December 15 to May 31 each year to hold flows down during the fall (which would limit the area of fall chinook salmon spawning to the lower elevations of the Vernita Bar), and then to provide sufficient flows during the winter and spring to assure the survival of the eggs and newly hatched fish. The Vernita Bar Agreement limits river flow in the fall to 1,960 m^3/s (70,000 ft^3/s). The post-spawning flows are determined annually, based on field surveys that identify when, where, and to what extent spawning has occurred (NPS 1994).

4.3.3.1 Water Rights. Water rights in the state of Washington are determined by the Washington State Superior Courts and regulated by Ecology. Water sources relevant to the discussion in this document include the Columbia River and underground aquifers on the Hanford Site.

The DOE's past and present water withdrawals at the Hanford Site are based on the

"Federal Reserved Water Rights" doctrine. This doctrine, developed as case law from U.S. Supreme Court rulings, holds that the Federal government, when it withdraws public domain lands for the purpose of the creation of a Federal reservation, necessarily withdraws unappropriated water rights sufficient to meet the needs for which the reservation was created. The date of priority of these rights is the date of creation of the reservation. In the case of the Hanford Site, this date is 1943. It is the general rule that Federal reserved water rights cease to exist when the Federal reservation ceases to be used for the purposes for which it was created. The limited exception to the rule is reflected in the *U.S. v. Powers*, 305 U.S. 527 (1939), wherein the Court allowed that a purchaser of agricultural land on an Indian reservation may be entitled to a portion of Federal reserved water rights where the use of the property did not change.

The Federal government has not established its own water rights regulation. Instead, it uses the regulatory procedures outlined in the State water rights laws to document the extent of its rights. There has been no general adjudication in the State of Washington of the water rights in the Columbia River and, therefore, the reserved water right of the Hanford Site has not been documented. The quantity of that right, however, would be equal to the maximum amounts used at Hanford during its operation, up to the amount of unappropriated water in the Columbia River as of 1943.

In a report titled, *Hanford Land Transfer* (Ecology 1993), Ecology indicated that if water rights were attached to privately owned parcels of land acquired in fee by the Federal government for the creation of Hanford in 1943, those water rights may continue to be attached to these parcels of land. Ecology has indicated that it has not taken action to extinguish these rights, although under Washington law appropriative water rights are subject to be extinguished if unused for a period of five years.

Further complications exist regarding non-Federal water rights claims at the Hanford Site. The first is the issue of groundwater contamination at Hanford. The second is that the date for filing a water rights claim in the Hanford sub-basin, for both Columbia River water and groundwater, expired in 1992. No claims for water rights under state law appear to have been filed within the required time period (NPS 1994).

4.4 Air Resources

This section addresses the general air resources at the Hanford Site and the surrounding region. Included in this section are discussions on climate and meteorology, ambient air quality, and atmospheric dispersion.

4.4.1 Climate and Meteorology

The Hanford Site climate is classified as mid-latitude semiarid or mid-latitude desert, depending on the climatological classification scheme used. Summers are warm and dry, with abundant sunshine. Large diurnal temperature variations result from intense solar heating during the day and radiational cooling at night. Daytime high temperatures in June, July, and August periodically exceed 38°C (100°F). Winters are cool, with occasional precipitation. Outbreaks of cold air associated with modified arctic air masses can reach the area and cause temperatures to drop below -18°C (0°F). Overcast skies and fog occur periodically (PNNL 1996a).

Topographic features have a significant impact on the climate of the Hanford Site. All air masses that reach the region undergo some modification during their passage over the complex topography of the Pacific Northwest. The climate of the region is strongly influenced by the Pacific Ocean and the Cascade Range to the west. The relatively low annual average rainfall of

16.1 cm (6.3 in.) at the Hanford Meteorological Station (HMS) is caused largely by the rain shadow created by the Cascade Range. These mountains limit much of the maritime influence of the Pacific Ocean, resulting in a more continental-type climate than would exist if the mountains were not present. Maritime influences are experienced in the region during the passage of frontal systems and as a result of movement through gaps in the Cascade Range (e.g., the Columbia River Gorge).

The Rocky Mountains to the east and the north also influence the climate of the region. These mountains play a key role in protecting the region from the more severe winter storms and the extremely low temperatures associated with the modified arctic air masses that move southward through Canada. Local and regional topographical features (e.g., the Yakima Ridge and the Rattlesnake Hills) also impact meteorological conditions across the Hanford Site (PNNL 1996a). In particular, these features have a significant impact on wind directions, wind speeds, and precipitation levels.

Climatological data are available for the HMS, which is located between the 200 East and 200 West Areas. Data collected at this location since 1945 (PNL 1994b) are representative of the general climatic conditions for the region and describe the specific climate of the Central Plateau. Local variations in the topography of the Hanford Site may cause some aspects of the climate to differ significantly from those of the HMS (see text box, *"Hanford Site Quick Facts: Meteorology"*). For example, winds near the Columbia River are different from those at the HMS. Similarly, precipitation along the slopes of the Rattlesnake Hills differs from that at the HMS.

Hanford Site Quick Facts: Meteorology

- Average annual precipitation: 16.1 cm (6.3 in.)
- Prevailing wind direction: Northwest
- Average monthly temperature: January - 0.9°C (30°F); July - 24.6°C (76°F)

4.4.1.1 Wind. Prevailing wind directions on the 200 Area Plateau are from the northwest during all months of the year; southwesterly winds occur less frequently. Summaries of wind direction indicate that winds from the northwest quadrant occur most often during the winter and summer. During the spring and fall, the frequency of southwesterly winds increases with a corresponding decrease in northwest flow. Winds blowing from other directions (e.g., the northeast) display minimal variation from month to month. Monthly average wind speeds are lowest during the winter months, averaging 10 to 11 km/hr (6 to 7 mi/hr), and highest during the summer, averaging 13 to 15 km/h (8 to 9 mi/hr). Wind speeds that are well above average are usually associated with southwesterly winds. However, the summertime drainage winds generally are northwesterly and can frequently gust to 50 km/hr (30 mi/hr). These winds are most prevalent over the northern portion of the Hanford Site (PNNL 1996a).

4.4.1.2 Temperature and Humidity. Nine separate temperature measurements are made at the 125-m (410-ft) tower at the HMS. Temperatures also are measured at the 2-m (6.5-ft) level on the twenty-six 9.1-m (30-ft) towers located on and around the Hanford Site. The three 60-m (200-ft) towers have temperature-measuring instrumentation at the 2-, 10-, and 60-m (6.5-, 33-, and 200-ft) levels. The temperature data from the 9.1- and 61-m (30- and 200-ft) towers are telemetered to the HMS.

Ranges of daily maximum and minimum temperatures vary from normal maxima of 2°C (35°F) in late December to 35°C (95°F) in late July (PNL 1994b). On the average, 52 days during the summer months have maximum temperatures greater than or equal to 32°C (90°F), and 12 days have maxima greater than or equal to 38°C (100°F). From mid-November through early March, minimum temperatures average less than or equal to 0 °C (32°F), with the minima in late December and early January averaging -6°C (21°F). During the winter, on average, three days have minimum temperatures less than or equal to -18°C (0°F); however, only about

one winter in two experiences such temperatures. The record maximum temperature is 45°C (113°F), and the record minimum temperature is -31°C (-23°F). For the period of 1946 through 1998, the average monthly temperatures ranged from a low of -0.9°C (30°F) in January to a high of 24.6°C (76°F) in July. During the winter, the highest monthly average temperature at the HMS was 6.9°C (44°F) in February 1958, and the record average lowest temperature was -11.1°C (12°F) during January 1950. During the summer, the record highest monthly average temperature was 27.9°C (82°F) in July 1985, and the record lowest temperature was 17.2°C (63°F) in June 1953.

Relative humidity and dew-point temperature measurements are made at the HMS and at the three 60-m (200-ft) tower locations. The annual average relative humidity at the HMS is 54 percent. It is highest during the winter months, averaging about 75 percent, and lowest during the summer, averaging about 35 percent. Fog reduces the visibility to 9.6 km (6 mi) during an average of 47 days/yr and to less than 0.4 km (0.25 mi) during an average of 25 days/yr. Other phenomena causing restrictions to visibility (i.e., visibility less than or equal to 9.6 km [6 mi]) include dust, blowing dust, and smoke from field burning. There are few such days; an average of 5 days/yr have dust or blowing dust and less than 1 day/yr has reduced visibility from smoke (Neitzel 1998).

4.4.1.3 Precipitation. The average annual precipitation at the HMS is 16 cm (6.3 in). Winter monthly average snowfall ranges from 0.8 cm (0.32 in) in March to 13.7 cm (5 in) in December. The seasonal record snowfall of 142 cm (56 in.) occurred in the winter of 1992-1993. During the months of December, January, and February, snowfall accounts for about 38 percent of all precipitation (PNNL 1996a). Days with greater than 1.3 cm (0.50 in) precipitation occur on average less than one time each year. Rainfall intensities of 1.3 cm/hr (0.50 in./hr) persisting for 1 hour are expected once every 50 years (Neitzel 1998).

4.4.1.4 Severe Weather. Severe weather on the Hanford Site may include a variety of meteorological events, which include severe winds, blowing dust, hail, fog, ash falls, extreme temperatures, temperature inversions, and blowing and drifting snow. The HMS climatological summary and the National Severe Storms Forecast Center database list only 24 separate tornado occurrences within 161 km (100 mi) of the Hanford Site from 1916 to 1995 (PNNL 1996a). Only one of these tornadoes was observed within the boundaries of the Hanford Site (on the extreme western edge), and no damage resulted. The estimated probability of a tornado striking a point at the Hanford Site is 9.6×10^{-6}/yr (PNNL 1996a). Because tornadoes are infrequent and generally small in the Pacific Northwest (and hurricanes do not reach this area), risk from severe winds normally are associated with thunderstorms or the passage of strong cold fronts. The greatest peak wind gust was 130 km/hr (81 mi/hr), recorded at 15 m (50 ft) above ground level at the HMS. Extrapolations based on 35 years of observations indicate a return period of about 200 years for a peak gust in excess of 145 km/hr (90 mi/hr) at 15 m (50 ft) above ground level.

4.4.1.5 Atmospheric Stability. Atmospheric dispersion is a function of wind speed, duration and direction of wind, atmospheric stability, and mixing depth. Dispersion conditions generally are good if winds are moderate to strong, if the atmosphere is of neutral or unstable stratification, and if there is a deep mixing layer. Good dispersion conditions associated with neutral and unstable stratification exist about 56 percent of the time. Less favorable dispersion conditions might occur when the wind speed is light and the mixing layer is shallow. These conditions are most common during the winter when moderately to extremely stable stratification exists about 66 percent of the time. Less favorable conditions also occur periodically for surface and low-level releases in all seasons from about sunset to about 1 hour after sunrise, as a result of ground-based temperature inversions and shallow mixing layers (PNNL 1996a).

4.4.2 Air Quality

The EPA has set National Ambient Air Quality Standards (NAAQS) that define levels of air quality that are necessary to protect the public health (primary standards) and the public welfare (secondary standards). Regional air quality is generally good, with the occasional exception due to blowing dust.

4.4.2.1 Regional Air Quality. Air quality in the Hanford region is well within the state and Federal standards for criteria pollutants, except that short-term particulate concentrations occasionally exceed the 24-hour "particulate matter nominally 10 microns or less" (PM_{10}) standard. Because the highest concentrations of airborne particulate material are generally a result of natural events, the area has not been designated nonattainment[1] with respect to the PM_{10} standard.

Particulate concentrations can reach relatively high levels in eastern Washington State because of extreme natural events (e.g., dust storms, volcanic eruptions, and large brushfires) that occur in the region. "Rural fugitive dust" from extreme natural events was not considered when estimating the maximum background concentrations of particulates in the area east of the Cascade Mountain crest and when determining Washington State ambient air quality standards. In the past, the EPA has exempted the rural fugitive dust component of background concentrations when considering permit applications and enforcement of air quality standards. However, the EPA is now investigating the prospect of designating parts of Benton, Franklin, and Walla Walla counties as a nonattainment area for PM_{10}. Windblown dust has been identified as a particularly large problem in this area.

Ecology has been working with the EPA and the Benton County Clean Air Authority under a MOA to characterize and document the sources of PM_{10} emissions and develop appropriate control techniques in the absence of formally designating the area nonattainment. At this time, the parties are characterizing the sources of PM_{10} emissions and working through other items in the MOA. A final decision on this issue will be made by the EPA, when the final results of the PM_{10} characterization analysis are received (PNNL 1996a).

Ecology conducted the only offsite monitoring (for PM_{10}) near the Hanford Site in 1996. PM_{10} was monitored at one location in Benton County – at Columbia Center – located approximately 17 km (10.5 mi) south-southwest of the 300 Area, in Kennewick, Washington. During 1996, the 24-hour PM_{10} standard established by the State of Washington, 150 $\mu g/m^3$, was not exceeded. The Site did not exceed the annual primary standard, 50 $\mu g/m^3$, during 1996. The arithmetic mean for 1996 was 21 $\mu g/m^3$ at Columbia Center (Neitzel 1998).

During the past 10 years, carbon monoxide, sulfur dioxide, and nitrogen dioxide have been monitored periodically in communities and commercial areas southeast of the Hanford Site. These urban measurements are used to estimate the maximum background pollutant concentrations for the Hanford Site. Because these measurements were made in the vicinity of local sources of pollution, they might overestimate maximum background concentrations for the Hanford Site or at the Hanford Site boundaries. Concentrations of toxic chemicals, as listed in 40 CFR 60.1, are not measured and, therefore, are not available for the Hanford Site.

4.4.2.2 Hanford Site Nonradiological Air Quality. The *Clean Air Act* (CAA) requires that Federal activities may not cause or contribute to new violations of air quality standards, exacerbate existing violations, or interfere with timely attainment or required interim emission reductions towards attainment (40 CFR 93.150). A determination of conformity of general

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[1] A nonattainment area is an area where measured concentrations of a pollutant are above the primary or secondary NAAQS.

Federal actions to state or Federal implementation plans must accompany any major Federal action where air quality might be impacted. Because of the administrative nature of this EIS, and the absence of any on-site nonattainment area, this EIS is exempt from a conformity determination (40 CFR 93.153).

The NAAQS, set by EPA, must be met at the Hanford Site boundary or other publicly accessible locations (i.e., highways on the Hanford Site). The standards define levels of air quality that are necessary, with an adequate margin of safety, to protect the public health and welfare. Standards exist for sulfur oxides (measured as sulfur dioxide), nitrogen dioxide, carbon monoxide, total suspended particulates (TSP), PM_{10}, lead, and ozone. The standards specify the maximum pollutant concentrations and frequencies of occurrence that are allowed for specific averaging periods (e.g., the concentration of carbon monoxide when averaged over 1 hour is allowed to exceed 40 mg/m^3 only once a year). The averaging periods vary from 1 hour to 1 year, depending on the pollutant.

An exception to the rule for using the Hanford Site boundary as the point of compliance for air pollution can occur if a nonattainment area occurs within 100 km (62 mi) of any significant new source that could be built or any revision to an operating source. As a requirement for new sources in attainment or unclassifiable areas, WAC 173-400-113 mandates that "allowable emissions from the proposed new source or modification will not delay the attainment date for an area not in attainment nor cause or contribute to a violation of any ambient air quality standard." The Wallula PM_{10} nonattainment area is within 100 km (62 mi) of all parts of the Hanford Site (62 FR 3800).

Because the Hanford Site is in an attainment area, this type of action is exempt from conformity determinations for Federal actions. Federal conformity rules (40 CFR 93) require agencies to determine that the proposed Federal action is in conformity with the specific requirements pursuant to the agency's affirmative obligation under Section 176(c) of the CAA.

In addition to ambient air quality standards, the EPA has established standards for the Prevention of Significant Deterioration (PSD) of air quality. PSD standards provide maximum allowable increases in concentrations of pollutants for areas already in compliance with NAAQS. The PSD standards are expressed as allowable increments in atmospheric concentrations of specific pollutants (nitrogen dioxide, sulfur dioxide, and PM_{10}) (40 CFR 52). Different PSD standards exist for Class I areas (where degradation of ambient air quality is restricted) and Class II areas (where moderate degradation of air quality is allowed).

The closest Class I areas to the Hanford Site are as follows:

- Mount Rainier National Park, approximately 160 km (100 mi) west of the Hanford Site
- Goat Rocks Wilderness Area, approximately 145 km (90 mi) west of the Hanford Site
- Mount Adams Wilderness Area, approximately 150 km (95 mi) southwest of the Hanford Site
- Alpine Lakes Wilderness Area, approximately 175 km (110 mi) northwest of the Hanford Site.

If the Hanford Reach is given Congressional status as a Wild and Scenic River with the Wahluke Slope added as a wildlife refuge, then it would be eligible for Class 1 air shed status.

The PSD standards are presented in Table 4-3. The Hanford Site, which is located in a Class II area, operates under a PSD permit (Permit No. PSD-X80-14) issued by the EPA

in 1980. This permit provides specific limits for emissions of nitrogen oxide from the Plutonium-Uranium Extraction (PUREX) and the Uranium-Trioxide plants, which are now closed and are being decommissioned.

Table 4-3. Maximum Allowable Increases for Prevention of Significant Deterioration of Air Quality (40 CFR 52).

Pollutant	Averaging Time	Class I	Class II
Particulate matter[a] (PM_{10}) ($\mu g/m^3$)	Annual	4	17
	24 hours	8	30
Sulfur dioxide ($\mu g/m^3$)	Annual	2	20
	24 hours	5	91
	3 hours	25	512
Nitrogen dioxide ($\mu g/m^3$)	Annual	2.5	25

[a] PM_{10} is defined as particulate matter nominally 10 microns or less.

State and local governments have the authority to impose standards for ambient air quality that are more stringent than the national standards. Washington State has established more stringent standards for sulfur dioxide and TSP. In addition, Washington State has established standards for other pollutants, such as fluoride, that are not covered by national standards. The state standards for carbon monoxide, nitrogen dioxide, ozone, PM_{10}, and lead are identical to the national standards. Table 4-4 summarizes the relevant air quality standards (Federal and supplemental state standards).

Emission inventories for permitted pollution sources in Benton County are routinely compiled by the Benton County Clean Air Authority. The annual emission rates for Hanford Site sources are reported to Ecology by DOE (Table 4-5).

Monitoring of nitrogen oxides was discontinued after 1990, mostly because of the end of operations at the PUREX facility. Monitoring of TSP was discontinued in early 1988 when the Basalt Waste Isolation Project ended (for which those measurements were required).

4.5 *Biological Resources*

As a Federal land manager, DOE is responsible for conserving fish, wildlife, and plant populations and their habitats on the Hanford Site. Information about these natural resources is presented below.

Figures 4-16, 4-17, and 4-18 show priority habitats and priority species within Washington State as identified by the WDFW. Because biological resources are temporal, they may not be found in the same place from year to year or require the same mitigation steps at different times of the year. Also, because many of the siting data used to develop these maps were obtained from incidental sightings (e.g., driving [road] surveys) as opposed to thorough surveying, areas with no record sighting are not necessarily devoid of the species. For these reasons, biological resources are generally inventoried prior to the undertaking of specific projects.

Table 4-4. National and Washington State Ambient Air Quality Standards.

Pollutant[a]	National Primary	National Secondary	Washington State
Total suspended particulates			
Annual geometric mean	NS	NS	60 µg/m^3
24-hour average	NS	NS	150 µg/m^3
PM_{10} (fine particulates)			
Annual arithmetic mean	50 µg/m^3	50 µg/m^3	50 µg/m^3
24-hour average	150 µg/m^3	150 µg/m^3	150 µg/m^3
$PM_{2.5}$			
Annual arithmetic mean	15 µg/m^3	–	–
24-hour average	65 µg/m^3	–	–
Sulfur dioxide			
Annual average	0.03 ppm	NS	0.02 ppm
24-hour average	0.14 ppm	NS	0.10 ppm
3-hour average	NS	0.50 ppm	NS
1-hour average	NS	NS	0.40 ppm[b]
Carbon monoxide			
8-hour average	9 ppm	9 ppm	9 ppm
1-hour average	35 ppm	35 ppm	35 ppm
Ozone			
1-hour average	—	0.12 ppm	0.12 ppm
8-hour average	0.08 ppm[c]	—	—
Nitrogen dioxide			
Annual average	0.05 ppm	0.05 ppm	0.05 ppm
Lead			
Quarterly average	1.5 µg/m^3	1.5 µg/m^3	1.5 µg/m^3
Fluoride			
30-day average			0.84 mg/m^3
7-day average			1.7 mg/m^3
24-hour average			2.9 mg/m^3
12-hour average			3.7 mg/m^3
VOCs			Source-specific standards

[a] Annual standards are never to be exceeded; short-term standards are not to be exceeded more than once per year unless otherwise noted (Ecology 1994).

[b] 0.25 ppm not to be exceeded more than twice in any 7 consecutive days; not to be exceeded more than 1 day per calendar year.

[c] Based on a 3-year average of the annual fourth highest daily maximum 8-hour average.

NS = no standard
ppm = parts per million
µg/m^3 = micrograms per cubic meter
VOC = volatile organic compound

Table 4-5. Nonradioactive Constituents Discharged to the Atmosphere, 1995[a] (Dirkes and Hanf 1996).

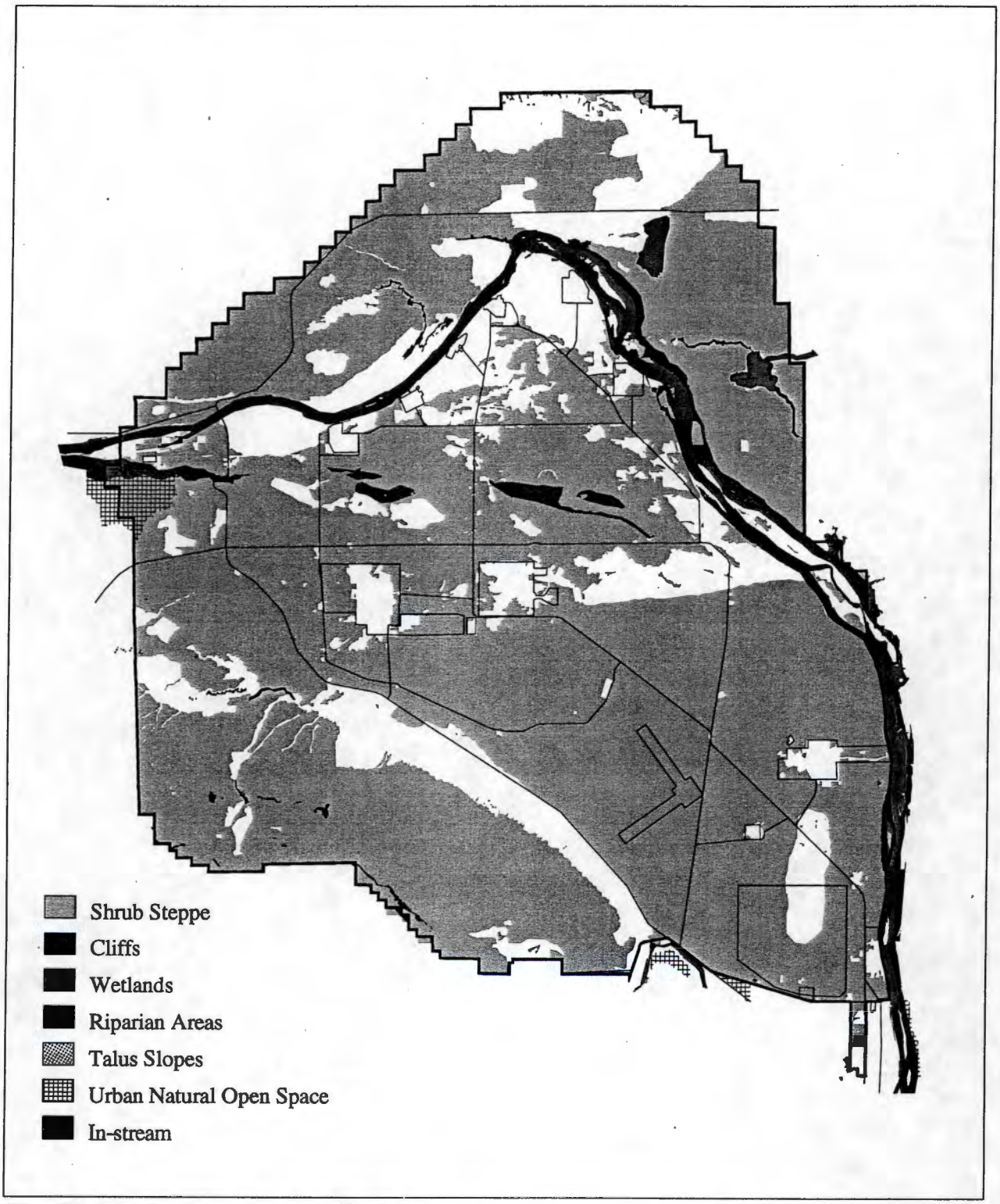
Constituent	Release (kg)		
	200 East Area	200 West Area	300 Area
Particulate matter	3.40×10^{2}	8.02×10^{1}	1.43×10^{4}
Nitrogen oxides	1.77×10^{5}	2.82×10^{4}	4.69×10^{4}
Sulfur oxides	2.25×10^{5}	3.53×10^{4}	2.34×10^{5}
Carbon monoxide	6.43×10^{4}	1.01×10^{4}	4.25×10^{3}
Lead	1.62×10^{2}	2.53×10^{1}	2.52×10^{1}
Volatile organic compounds[b]	6.43×10^{2}	1.00×10^{2}	2.38×10^{2}
Ammonia[c]	6.18×10^{3}	1.53×10^{3}	NM
Arsenic	1.73×10^{2}	2.70×10^{1}	1.48×10^{1}
Beryllium	2.33×10^{1}	3.64×10^{0}	5.46×10^{1}
Cadmium	1.37×10^{1}	2.18×10^{0}	2.74×10^{1}
Carbon tetrachloride[d]	NM	NE	NM
Chromium	5.01×10^{2}	7.83×10^{1}	1.67×10^{1}
Cobalt	NE	NE	1.57×10^{1}
Copper	3.15×10^{2}	5.02×10^{2}	3.62×10^{1}
Formaldehyde	7.05×10^{1}	1.25×10^{1}	5.27×10^{1}
Manganese	6.93×10^{2}	1.08×10^{2}	9.63×10^{0}
Mercury	5.11×10^{0}	8.08×10^{1}	4.16×10^{0}
Nickel	4.12×10^{2}	6.43×10^{1}	3.03×10^{2}
Polycyclic organic matter	NE	6.00×10^{2}	7.14×10^{3}
Selenium	6.26×10^{1}	9.84×10^{0}	4.94×10^{0}
Vanadium	4.31×10^{1}	7.79×10^{0}	3.93×10^{2}

[a] The estimate of volatile organic compound emissions do not include emissions from certain laboratory operations; NM = not measured; NE = no emissions.
[b] Produced from burning fossil fuels for steam generation.
[c] Ammonia releases are from the 200 East Area tank farms, 200 West Area tank farms, and the operation of the 242-A Evaporator.
[d] Does not include carbon tetrachloride Vapor Extraction Project releases from passively ventilated wells.

The block of habitat directly south of the 200 East and West Areas contains high-quality habitat and some of the Hanford Site's best sage sparrow and loggerhead shrike habitat. However, since some of these areas have never been officially surveyed for these species, the species frequently do not show up on maps even though they most likely occur there. Figure 4-17 shows some, but not all, historic bald eagle nesting sites but does not include current or recent bald eagle nest locations which can't be shown because of their sensitivity to disturbance. Similarly, Figure 4-18 shows some, but not all, great blue heron occurrences.

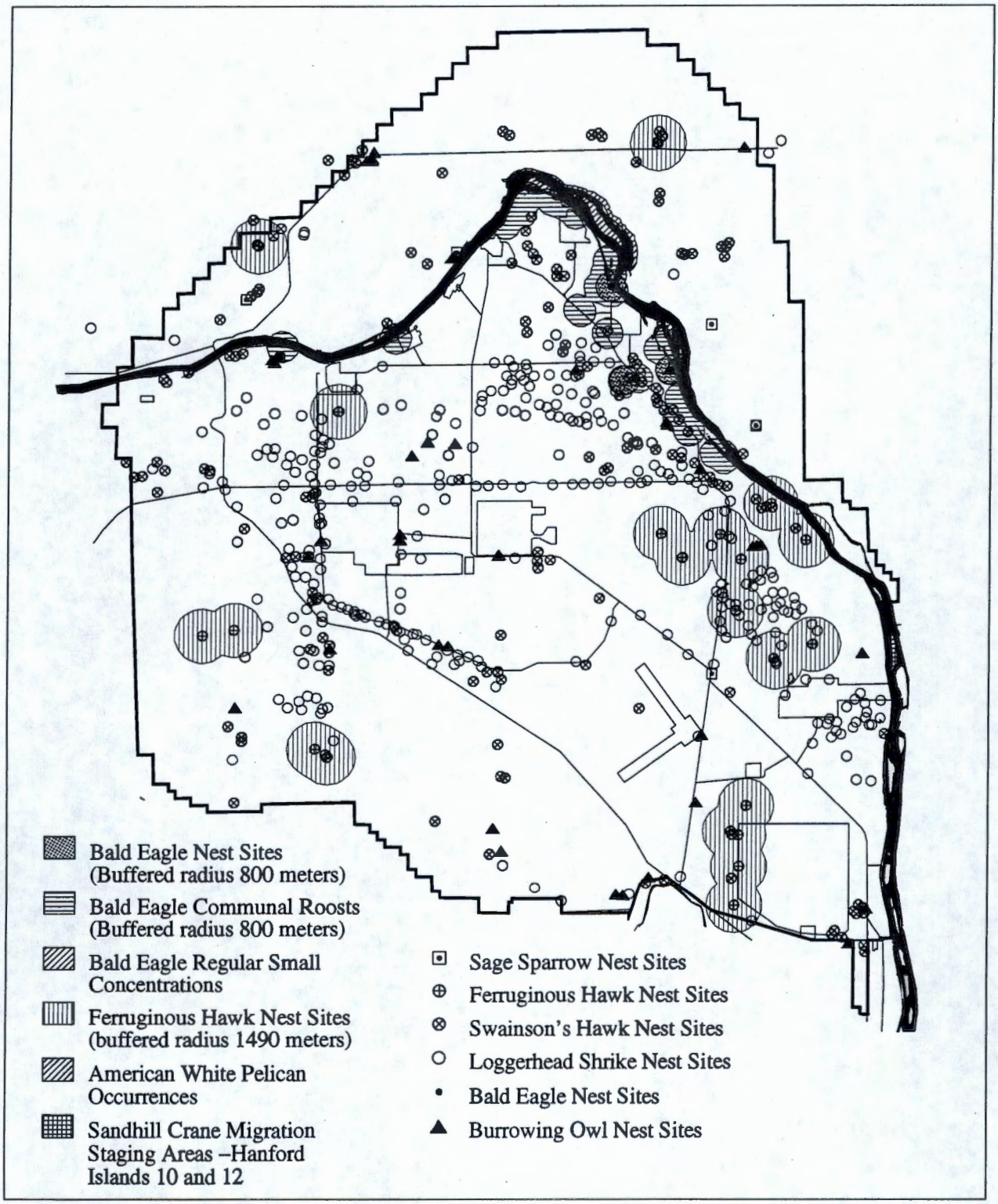
Counties and cities may use information prepared by the WDFW to classify and designate locally important habitats and species. While these priorities are those of the Department, they and the data on which they are based may be considered by counties and cities when developing their land-use plans under the *Growth Management Act* (GMA) (WAC 365-180-080).

Figure 4-16. WDFW Priority Habitats on the Hanford Site.



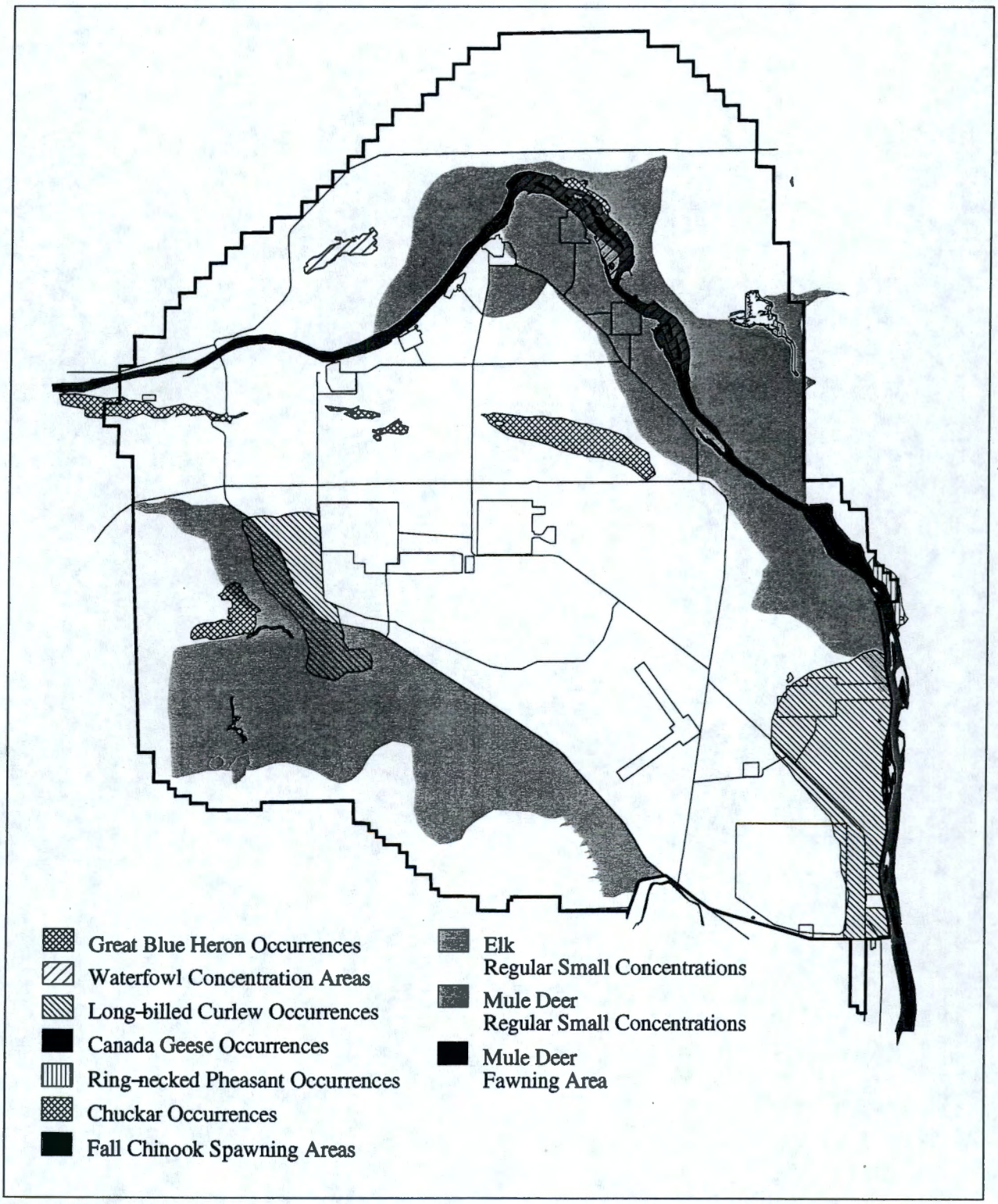
BHI:rpp 07/06/98 draft_2/wadfw1.aml Database: 03-AUG-1998

Figure 4-17. WDFW Priority Species: State Listed and Candidates.



BHI:rpp 07/06/98 draft_2/wadfw2.aml Database: 03-AUG-1998

Figure 4-18. WDFW Priority Species: Vulnerable Aggregations and Species of Recreation, Commercial, and/or Tribal Importance.



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The Hanford Site is located within a region known as the Columbia Basin ecoregion, which occupies an extensive area south of the Columbia River between the Cascade Range and Blue Mountains in Oregon and roughly two-thirds of the area of Eastern Washington. This region has been botanically characterized as a shrub-steppe ecosystem, with various shrub and bunchgrass associations playing dominant roles. The region is often referred to as high desert, northern desert shrub, or desert scrub (Franklin and Dyrness 1973).

Settlement during the late 19th and early 20th century has resulted in significant changes to vegetation patterns through activities such as farming, dam development, and regional settlement. The State of Washington is rapidly losing much of its remaining steppe habitat and losses are projected to be high for the next 50 years. It has been estimated that approximately 60 percent of the original acreage (4.2 million ha/10.4 million ac) (42,000 km^2/ 16,250 mi^2) of shrub-steppe vegetation in Washington has been lost, primarily to agriculture (DOE-RL 1996c) (see text box, *"What is Shrub-Steppe?"*).

What is Shrub-Steppe?

The shrub-steppe ecosystem is a vegetation zone occupying most of central and southeastern Washington, part of northeastern Oregon, and portions of Idaho, Utah, and Nevada. It is a region whose native, pre-settlement vegetation consisted primarily of shrubs, perennial bunchgrasses, and a variety of forbs. Typical shrubs include several sagebrush species, rabbitbrush, and bitterbrush. Dominant grasses were bluebunch wheatgrass, Idaho fescue, needle-and-thread grass, and Sandberg's bluegrass. Before European settlement, at least 4.2 million hectares (10.4 million acres) of unaltered shrub-steppe habitat covered much of central and southeastern Washington. With the advent of dryland wheat farming, intensive livestock grazing, irrigation, and altered fire regimes, the landscape is changed to such an extent that the amount of natural shrub-steppe remaining is a small fraction of the original acreage. The average cover of big sagebrush was about 10 percent prior to the introduction of livestock into Washington. Because livestock do not eat it, sagebrush often increases in density in grazed areas, replacing most other plants in badly degraded ranges. Hanford is unique in that it contains large expanses of relatively undisturbed shrub-steppe vegetation and has become a refuge for the native species and habitats comprising the shrub-steppe.

An illustration of this habitat alteration can be seen through the use of satellite-based remote sensing data, which can provide images of land surfaces and existing vegetation cover. Using these data, the WDFW has developed land cover classification maps (historic and current) of a portion of the Columbia Basin ecoregion (Figures 4-19 and 4-20, respectively). As indicated in Figure 4-20, the Hanford Site and the Department of Defense Yakima Training Center (located to the west of the Hanford Site) contain the largest remaining remnant of shrub-steppe vegetation in the Columbia Basin.

The Hanford Site is a relatively large, undisturbed area of shrub-steppe habitat that contains numerous plant and animal species adapted to the semi-arid environment in the region. The Hanford Site consists of mostly undeveloped land, with widely spaced clusters of industrial buildings located along the western shoreline of the Columbia River and at several locations in the interior of the Hanford Site. The industrial buildings are interconnected by roads, railroads, and electrical transmission lines. The major facilities and activities occupy about 6 percent of the total available land area, and their impact on the surrounding ecosystems is minimal from direct discharges or releases attributable to DOE. Most of the Hanford Site has not experienced tillage or livestock grazing since the early 1940s. The Columbia River flows through the Hanford Site, and although the river flow is not directly impeded by dams within the Hanford Site, the historical daily and seasonal water fluctuations have been changed by dams upstream and downstream of the Hanford Site (Cushing 1995).

The Columbia River and other water bodies on the Hanford Site provide valuable habitat for aquatic organisms. Several large portions of the Site are administered in a manner to protect and preserve biological resources, such as the ALE Reserve and the Wahluke Slope (Figure 4-21).

Figure 4-19. Historic Distribution and Extent of Land Cover Classes within a Portion of the Columbia Basin Ecoregion (DOE-RL 1996c).

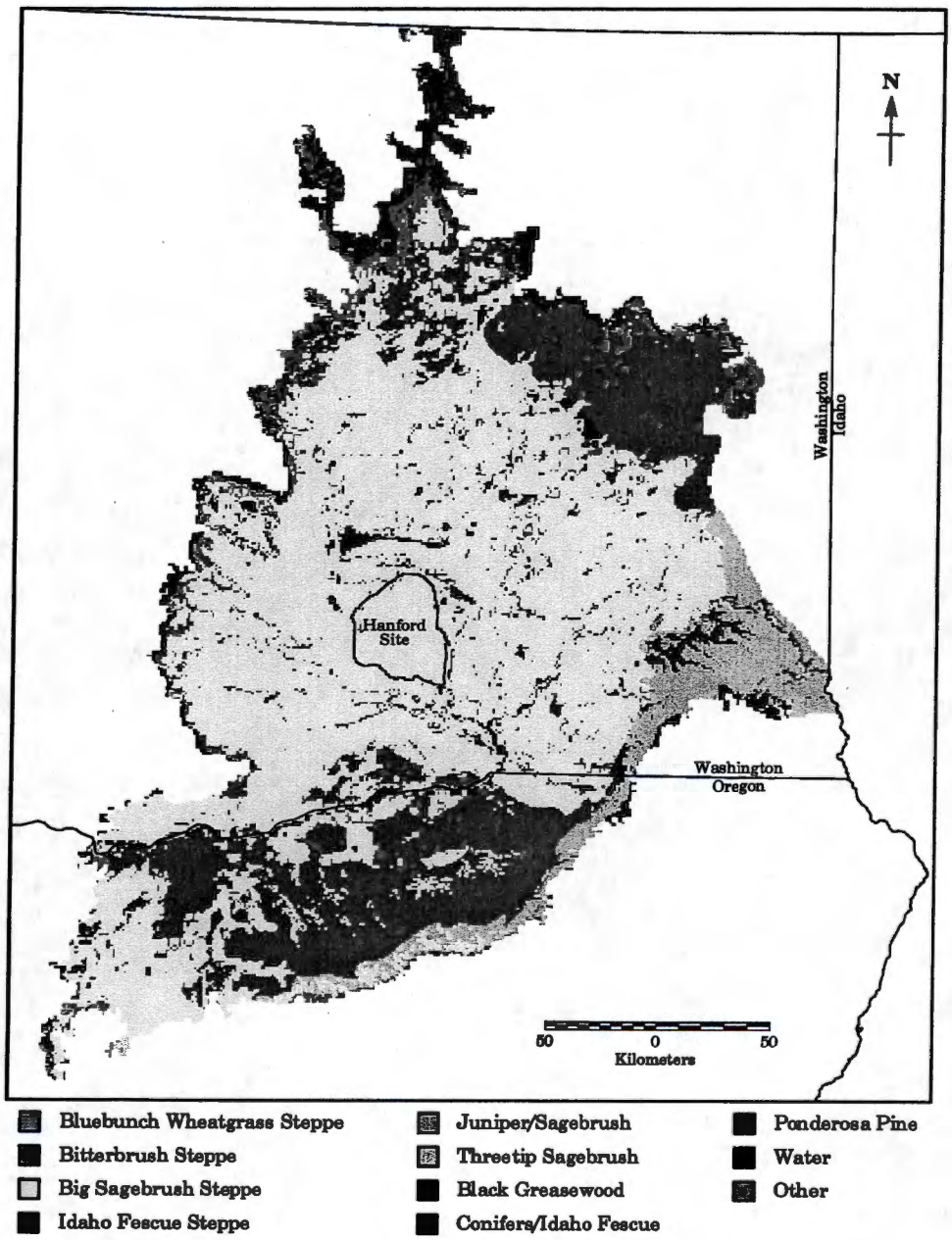


Figure 4-20. Current Distribution and Extent of Land Cover Classes within a Portion of the Columbia Basin Ecoregion (DOE-RL 1996c).

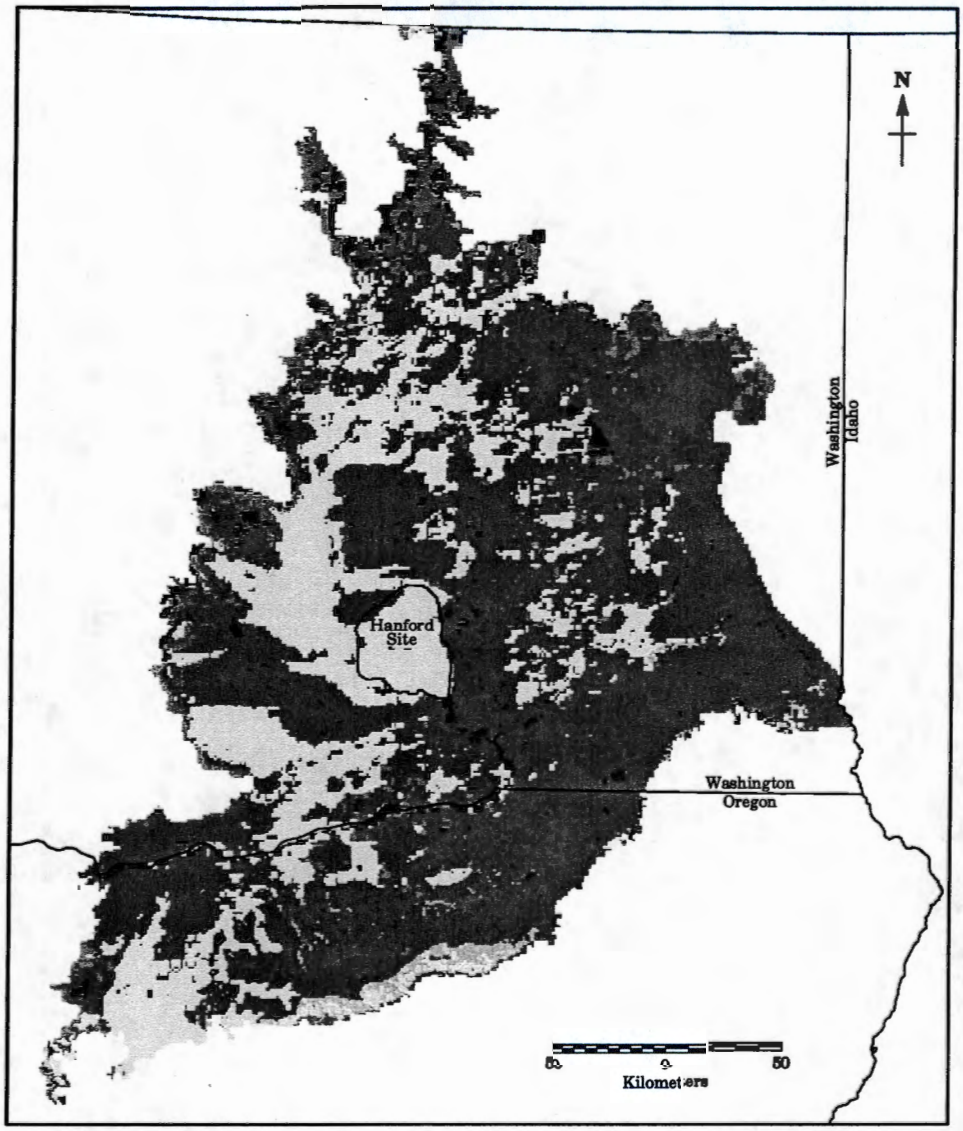
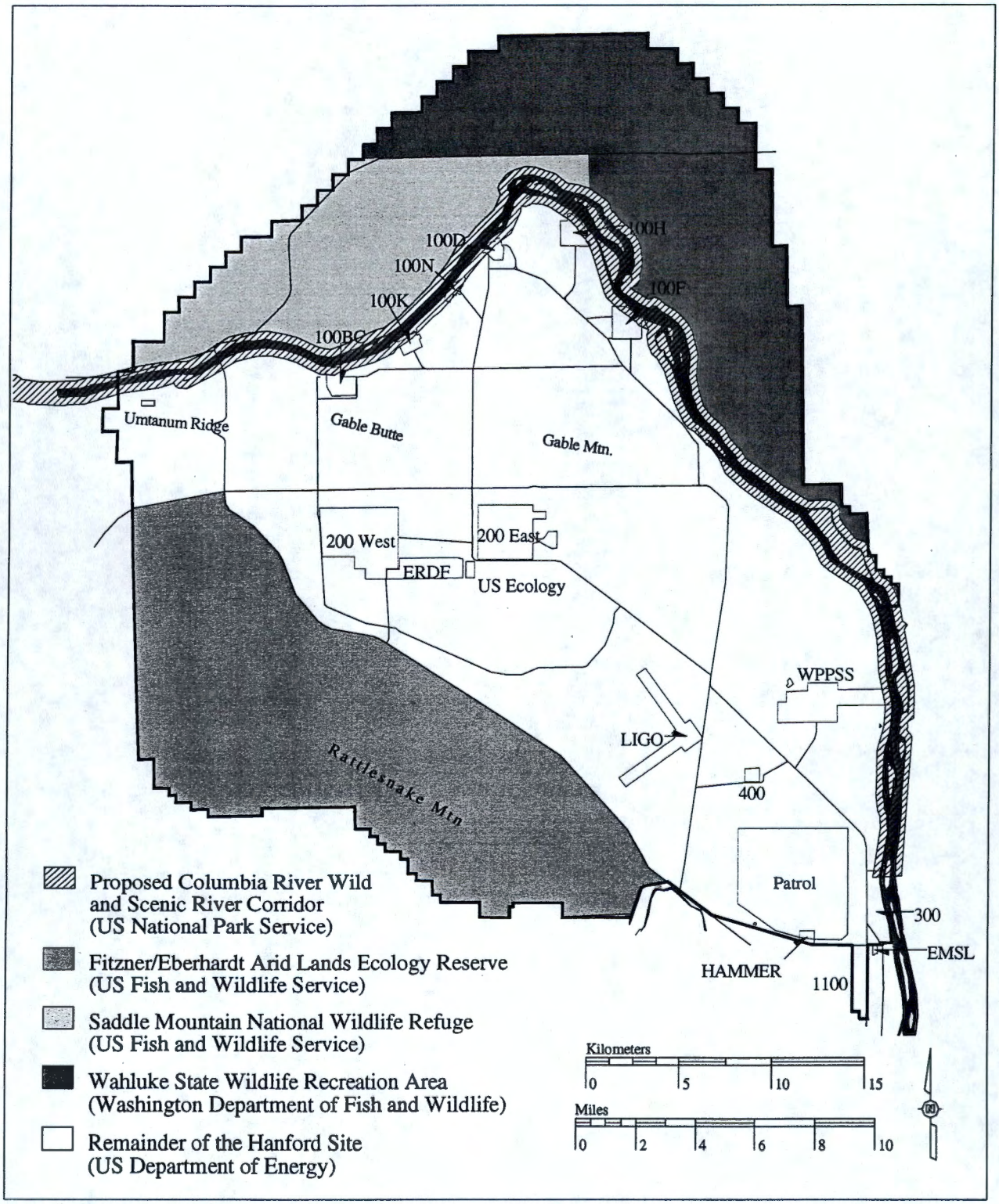


Figure 4-21. Designated Administrative Areas for the Hanford Site.



BHI:rpp 04/22/96 clup/brmap_d24.aml Database: 03-AUG-1998

4.5.1 Administrative Designations for Natural Resource Protection

In 1977, the U.S. Energy Research and Development Agency (a predecessor to DOE) designated the entire Hanford Site as one of seven National Environmental Research Park (NERP) sites located in the United States. In addition, two other portions of the Hanford Site are administered under special designations.

The Wahluke Slope encompasses approximately 365 km^2 (140 mi^2) and is administered as two wildlife areas known as the Saddle Mountain NWR and the Wahluke Wildlife Recreation Area. Under an agreement made between the WDFW and the USFWS in April 1999, the Wahluke State Wildlife Recreation Area will be combined with the Saddle Mountain NWR and managed as a unit by the USFWS. These areas are operated under the terms of a permit issued by the AEC on November 30, 1971, to provide for management of Hanford lands north and east of the Columbia River.

According to the terms of the permit, the USFWS is required to keep the lands managed as the Saddle Mountain NWR closed to all public access. The closure ensured a security zone for the N Reactor and encompassed an area within a 8.8-km (5.5-mi) radius of the reactor (NPS 1994). Although N Reactor is being decommissioned and doesn't require an extensive buffer, the K Basins still require an exclusion zone until the spent nuclear fuel is removed from the basins.

The ALE Reserve has been used for ecological research dating back to 1952, but it was not until 1967 that the Richland Office of the AEC established the ALE Reserve by administrative order (PNL 1993b). As a result of a Federal interagency cooperative agreement, the ALE Reserve was designated as the Rattlesnake Hills Research Natural Area in 1971. The ALE Reserve currently retains its status as an administratively protected environment and as a valuable ecological study site. Through a MOA with DOE, the USFWS is responsible for management and protection of the ALE Reserve.

4.5.2 Terrestrial Vegetation and Habitats

The Hanford Site has been botanically characterized as a shrub-steppe ecosystem. In the early 1800s, the dominant plant in the area was big sagebrush with an understory of perennial bunchgrasses, especially Sandberg's bluegrass and bluebunch wheatgrass. With the advent of horses in the 1700s and settlement in the 1800s that brought livestock grazing and crop raising, the natural vegetation mosaic was opened to a persistent invasion by non-native annual species, especially cheatgrass. Of the 590 species of vascular plants recorded for the Hanford Site, approximately 20 percent of all species are considered nonnative. Cheatgrass is the dominant nonnative species. It is an aggressive colonizer and has become well established across the site (Neitzel 1998). Today, cheatgrass is the dominant plant on fields that were cultivated 50 years ago. Cheatgrass is also well established on rangelands at elevations less than 244 m (800 ft) (Cushing 1995).

The dryland areas of the Hanford Site were treeless in the years before land settlement; however, for several decades before 1943, trees were planted and irrigated on most of the farms to provide windbreaks and shade. Some of the trees died when the farms were abandoned in 1943, but others have persisted, presumably because their roots are deep enough to contact groundwater. Today these trees serve as nesting platforms for several species of birds (e.g., hawks, owls, ravens, magpies, and great blue herons), and as night roosts for wintering bald eagles (Cushing 1995). The vegetation mosaic of the Hanford Site currently consists of a variety of diverse plant communities.

The State of Washington has designated large and small blocks of shrub-steppe as priority habitat because these areas possess unique or significant value to many species. The State identifies priority habitats based on the quality of the habitat with respect to the following attributes: comparatively high fish and wildlife density; comparatively high fish and wildlife species diversity; important fish and wildlife breeding habitat; important fish and wildlife seasonal ranges; important fish and wildlife movement corridors; limited availability; high vulnerability to habitat alteration; and unique or dependent species (WDFW 1995). Although Washington State priority habitat designations have no associated legal requirements for habitat protection, DOE Order 430.1 (DOE 1995c) requires that DOE consider ecosystem management and preservation values during all phases of Hanford Site operations.

The DOI National Biological Service identifies native shrub and grassland steppe in Washington and Oregon as an endangered ecosystem (with an 85 to 98 percent decline) (DOI 1995). Almost 600 species of plants have been identified on the Hanford Site (PNNL 1996a). The dominant plants are big sagebrush, rabbitbrush, cheatgrass, and Sandberg's bluegrass, with cheatgrass providing half of the total plant cover on much of the Hanford Site. Cheatgrass and Russian thistle, annuals introduced to the United States from Eurasia in the late 1800s, invade areas where the ground surface has been disturbed. Mosses and lichens appear on undisturbed soil surface; lichens commonly grow on the shrub stems and on basalt outcrops. The important desert shrubs, big sagebrush and bitterbrush, are widely spaced and usually provide less than 20 percent canopy cover. The important native understory plants are grasses, especially Sandberg's bluegrass, Indian ricegrass, June grass, and needle-and-thread grass.

As compared to other semi-arid regions in North America, primary productivity is relatively low and the number of vascular plant species also is low. This situation is attributed to the low annual precipitation (16 cm [6 in.]), the low water-holding capacity of the rooting substrate (sand), and the hot, dry summers and occasionally very cold winters.

The 100 Areas are located in the vicinity of the Columbia River and encompass both riparian and upland habitats. Riparian habitats are found along the shoreline, slack water, and slough areas. Riparian vegetarian includes both woody and herbaceous species. Common plant species occurring in the riparian zone include black cottonwood, mulberry, willow, dogbane, and a variety of grasses and forbs (Cushing 1992). Scattered groves of white mulberry, black locust, Siberian elm, apricot, juniper, and willow were noted in an ecological investigation within the 100-BC-5 and 100-HR-3 operable units (WHC 1992c). The upland vegetation within the 100 Areas is dominated by the non-native annuals, cheatgrass, and tumble mustard on former agricultural lands that were abandoned in 1943 (DOI 1995).

More than 100 species of plants have been identified on the Central Plateau (Cushing 1992). Common plant species include sagebrush, rabbitbrush, cheatgrass, and Sandberg's bluegrass. The dominant vegetation type consists of big sagebrush with an understory of cheatgrass and Sandberg's bluegrass (PNNL 1996a). Cheatgrass provides approximately 50 percent of total plant cover. Most of the waste disposal and storage sites are covered by non-native vegetation or are kept in a vegetation-free condition.

In recent years, a die-off of big sagebrush has been noted on the Hanford Site. A preliminary investigation of the nature and extent of die-off has been conducted. Although the cause remains unknown, early indications focus on the possibility that the die-off might be the result of disease or weather-related stress. The die-off area is estimated to be 1,776 ha (4,390 ac) (Cushing 1992).

Other vegetation within the Central Plateau includes wetland species associated with man-made ditches and ponds on the Central Plateau and introduced perennial grasses (e.g.,

Siberian wheatgrass) that were planted to revegetate disturbed areas. Wetland species (e.g., cattail and reeds) and trees (e.g., willow, cottonwood, and Russian olive) are established around some of these ponds (PNNL 1996a). However, several of the ponds have been decommissioned, resulting in the elimination of wetland habitat as the supply of industrial waste water feeding the ponds was terminated.

Sixteen different plant community types have been identified on the Wahluke Slope. Cheatgrass and other nonnative species dominate, most likely because of disturbances caused by military training activities, historical livestock grazing, dry soil, and multiple fires. However, the Wahluke Slope still possesses extensive remnants of the original shrub-steppe ecosystem. For example, the most extensive and highest quality antelope bitterbrush and Indian ricegrass plant community in the State of Washington is found on the Wahluke Slope (TNC and Pabst 1995). In 1994, The Nature Conservancy discovered a new plant species of the genus *Lesquerella*. In 1997 field surveys, eight new populations of four taxa were located on the Wahluke Unit Columbia Basin Wildlife Area. All of these populations were located on the White Bluffs. One of the new *Gilia leptomeria* populations is the largest currently known in Washington. Also, the remainder of the only known occurrence of *Lesquerella tuplashensis* was mapped and counted. These discoveries, along with its high habitat quality, illustrate the potential ecological value of the Wahluke Slope.

4.5.2.1 Newly Documented Plant Species. During a 1997 rare plant survey of the Hanford Site conducted by The Nature Conservancy, a total of 35 new populations were found of 14 rare plant taxa identified in Washington as either endangered, threatened, sensitive, or Review Group 1 by the State of Washington. (Review Group 1 includes taxa for which more field work is needed to assess their rarity and the degree to which they are threatened.) One species was newly documented at the Hanford Site, and 10 occurrences of eight taxa were revisited and remapped. Finally, a population of an unlisted plant species, previously unknown from Washington, was discovered. A brief review of significant findings from the 1997 survey in regard to individual species is provided below.

- ***Eriogonum codium*** – Previous to biodiversity surveys, this species was undescribed. It is listed as endangered by the state of Washington and identified as a species of concern by the USFWS. Originally discovered during 1995, the only known occurrence of *Eriogonum codium* was resurveyed, remapped, and recounted during 1997. A total of 5200 plants was estimated to be present. Long-term demographic monitoring was initiated on this species in 1997.

- ***Lesquerella tuplashensis*** – Previous to biodiversity surveys, this species also was undescribed, and is listed as endangered by the state of Washington and identified as a species of concern by the USFWS. During 1997 the remainder of the only known occurrence of *Lesquerella tuplashensis* was mapped and counted. The total count of adult plants was estimated to be 50,000 plants. Infestations of a noxious weed, *Centaurea solstitialis* (yellow starthistle), were located within the middle portion of the *Lesquerella* population. Long-term demographic monitoring was initiated on this species in 1997.

Hanford Site populations of two previously undocumented plant species were identified during 1997 field surveys. The two species are described below:

- ***Camissonia minor*** – This annual species has a scattered distribution within the Columbia Basin. Its range includes most western states. In Washington, it is at the northern end of its range and is known from only Benton and Kittitas Counties. *Camissonia minor* generally occurs on very dry, often barren, and sometimes disturbed sites. Six relatively small populations were documented.

On the Hanford Site, *Camissonia minor* occurred in conjunction with a number of other rare plant species. In Washington State, it is currently placed in Review Group 1.

- ***Myosurus* x *clavicaulis*** – This annual species (little mousetail; an "x" before the species name indicated that the species evolved as a hybrid of two other species) was previously unknown in the State of Washington. Its assumed range included Baja California, California, and Oregon. *Myosurus* x *clavicaulis* typically inhabits vernal pools. It occurred on the Hanford Site at a single vernal pool location (see Section 4.3.1). The species also was located during the 1997 field season at five additional vernal pool sites in northeastern Washington. At some locales in the Central Valley of California, the taxonomic status of *Myosurus* x *clavicaulis* is complicated by the presence of other species of *Myosurus*, whose hybrids produce progeny identical to *Myosurus* x *clavicaulis*. At Hanford, however, the *Myosurus* x *clavicaulis* population was self-sustaining and did not occur in the presence of its parental species. The species has no current conservation status in Washington; however, *Myosurus* x *clavicaulis* will be recommended for future tracking by the Washington Natural Heritage Program.

The two major vegetation types occurring along the Hanford Reach of the Columbia River are riparian and upland (NPS 1994). Riparian habitats are found along the shoreline, slack water and slough areas, and on islands in the river. Riparian vegetation at these locations includes both woody and herbaceous species maintained by the high water table immediately adjacent to the river. Common plant species occurring in the riparian zone include black cottonwood, mulberry, willow, dogbane, and a variety of grasses and forbs (Cushing 1992). Sensitive habitats within the riparian zone include islands and cobbled shorelines occurring as a narrow band along the Hanford Reach. Plant species occurring in these areas include perennial summer-blooming forbs adapted to seasonal changes in water levels (NPS 1994). Upland habitats along the Hanford Reach are composed of shrub-steppe vegetation similar to that found on the rest of the Hanford Site.

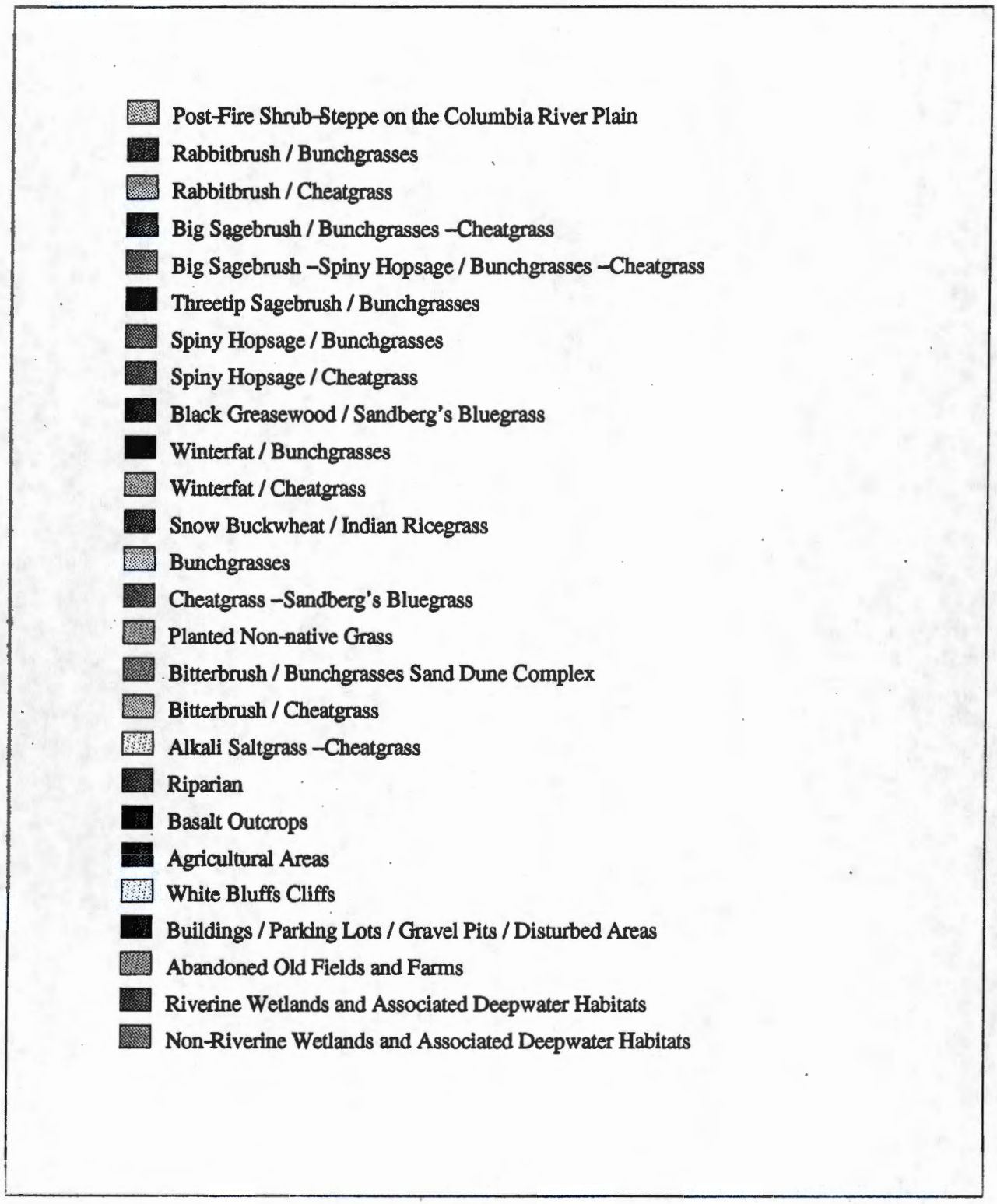
The ALE Reserve supports one of the largest remnants of relatively undisturbed shrub-steppe ecosystem in the State of Washington. Vegetation on the ALE Reserve includes largely undisturbed stands of several plant communities (e.g., sagebrush-bluebunch wheatgrass, blue bunch wheatgrass, sagebrush-Sandberg's bluegrass, sagebrush-bitterbrush-needle-and-thread grass, cheatgrass, and cottonwoods and willows) (PNL 1993c). Extensive wildfires have removed the shrub component from large areas of the ALE Reserve. These areas now support stands of perennial bunchgrasses at the upper elevations and cheatgrass and bunchgrasses at the lower elevations (PNL 1993c).

Special topographic features of the Hanford Site include Gable Butte and Gable Mountain north of the Central Plateau and an extensive series of active sand dunes in the southeast portion of the Site. Vegetation occurring on scree slopes, outcrops, and scarps on Gable Butte and Gable Mountain is limited to scattered individuals or groups of plants. Plant species include squaw currant, bluebunch wheatgrass, rock buckwheat, and thyme buckwheat. Rigid sagebrush occurs at the Hanford Site only on Gable Mountain and Umtanum Ridge (PNL 1993c).

4.5.2.2 Fire. Plant communities within the shrub-steppe have evolved in the presence of natural wildfires. Typically, shrubs are killed by fire, but the perennial bunchgrasses are not killed. The severity of the damage depends upon the intensity and extent of the fire. Hot fires incinerate entire shrubs and damage grass crowns. Less intensive fires leave dead shrub stems standing with prompt recovery of grasses and forbs. The most recent and extensive wildfire on

Figure 4-22. Distribution of Vegetation Types and Cover Classes on the Hanford Site.

Figure 4-22. Distribution of Vegetation Types and Cover Classes on the Hanford Site (Legend).



the Hanford Site occurred in the summer of 1998 and burned approximately 4,047 ha (10,000 ac). Previous fires occurred in 1957, 1973, and 1981, and 1984 (see Figure 4-22). The presence of non-native plant species and changing land-use practices have altered the frequency and severity of wildfires. Less frequent and more severe fires have reduced the ability of the native habitat to recover from fire, as well as the development of late successional shrub-steppe habitat.

4.5.2.3 Weeds. Non-native weedy species have invaded many areas on the Hanford Site. In particular, weeds have invaded areas that have been disturbed by natural (e.g., fire) and human factors (e.g., pre-Hanford agricultural activities, road and facility construction, etc.). The weed species include, but are not limited to, cheatgrass; Russian thistle; Russian, spotted, and diffuse knapweed; yellow star thistle; Rush skeletonweed; and puncture vines. Cheatgrass and Russian thistle, annuals introduced from Eurasia in the late 1800s, invade areas where the ground surface has been disturbed.

4.5.3 Wildlife

Major habitat types occurring on the Hanford Site include basalt outcrops, scarps and screes, riparian and riverine areas, shrub-steppe, sand dunes and blowouts, and abandoned fields (PNL 1993c). These habitat types support a variety of wildlife.

4.5.3.1 Mammals. Approximately 40 species of mammals have been identified on the Hanford Site (PNNL 1996a). The major predator inhabiting the Hanford Site is the coyote, which ranges all across the Hanford Site. Coyotes have been a major cause of destruction for the nests of Canadian geese on Columbia River islands, especially islands upstream from the abandoned Hanford townsite. Bobcats, cougars, and badgers also inhabit the Hanford Site in low numbers.

Black-tailed jackrabbits are common on the Hanford Site and are mostly associated with mature stands of sagebrush. Cottontail rabbits also are common but appear to be more closely associated with the buildings, debris piles, and equipment laydown areas associated with the onsite laboratory and industrial facilities.

Townsend's ground squirrels occur in colonies of various sizes scattered across the Hanford Site. The most abundant mammal inhabiting the Site is the Great Basin pocket mouse. The mouse occurs all across the Columbia River plain and on the slopes of the surrounding ridges. Other small mammals include the deer mouse, harvest mouse, grasshopper mouse, montane vole, vagrant shrew, and Merriam's shrew.

The Hanford Site has 14 species of bats that are known to be or are potential inhabitants, most of which may be present year-round (PNL 1993d). The pallid bat frequents deserted buildings and is thought to be the most abundant. Other species include the hoary bat, silver-haired bat, California brown bat, little brown bat, Yuma brown bat, and Pacific western big-eared bat.

A herd of Rocky Mountain elk is present on the ALE Reserve. It is believed these animals migrated to the reserve from the Cascade Mountains in the early 1970s. This herd grew from approximately eight animals in 1975 to approximately 420 animals in December 1996 (after the hunting season).[1] Current projections indicate that the elk herd is composed of approximately 800 animals and is still growing. The herd tends to congregate on the ALE Reserve in the winter and disperses during the summer months onto the Site proper, private land to the west of the ALE Reserve, and the Yakima Firing Center. Although lack of water and the high level of human

[1] Personal communication with Brett Tiller, Pacific Northwest National Laboratory, September 22, 1997.

activity presumably inhibit the elk from using other areas of the Hanford Site, the elk are occasionally seen on the 200 Area Plateau and have been sighted at the White Bluffs boat launch. Despite the arid climate, these elk appear to be very healthy; antler and body size for some age classes are among the highest recorded for this species (Neitzel 1997). In addition, reproductive output of this species is also among the highest recorded.

Mule deer are found throughout the Hanford Site, although areas of highest concentrations are on the ALE Reserve and along the Columbia River. Deer populations on the Hanford Site appear to be relatively stable. Islands in the Hanford Reach are used extensively as fawning sites by the deer (Neitzel 1997) and are a very important habitat for this species. Hanford Site deer frequently move offsite and are killed by hunters on adjacent public and private lands (Neitzel 1997).

4.5.3.2 Birds. In general, bird species on the Hanford Site include a variety of raptors, songbirds, and other species associated with riparian, riverine, and upland habitats. The Nature Conservancy recently summarized its findings for birds and mammal surveys. These surveys fall short of the number of species that have been documented on site historically. For example, 178 species were observed in the bird surveys in 1997. This number falls short of the 246 species identified historically (Neitzel 1998). Species of birds found at or near the Hanford Site include common species and accidental species.

Twenty-six species of raptors have been sighted on the Hanford Site, 11 of which are known to nest on the Hanford Site (PNL 1981). The nesting species include the great horned owl, long-eared owl, short-eared owl, barn owl, burrowing owl, northern harrier, ferruginous hawk, Swainson's hawk, red-tailed hawk, prairie falcon, and American kestrel. In 1994, nesting by red-tailed, Swainson's, and ferruginous hawks included 41 nests located across the Hanford Site in relation to high voltage transmission towers, trees, cliffs, and basalt outcrops. In recent years the number of nesting ferruginous hawks on the Hanford Site has increased, as a result in part to their acceptance of steel powerline towers in the open grass and shrubland habitats (Neitzel 1998).

Raptors that may occur year-round on the Hanford Site are the northern harrier, red-tailed hawk, golden eagle, prairie falcon, American kestrel, barn owl, great horned owl, long-eared owl, and burrowing owl (Fitzner and Gray 1991). Raptors use a variety of habitats for nesting and foraging at the Hanford Site. Depending on raptor size and species, prey may include small mammals, birds, reptiles (e.g., snakes), and insects.

Passerine species known to occur in the shrub-steppe vegetation on the Hanford Site include the loggerhead shrike, sage sparrow, western meadowlark, grasshopper sparrow, horned lark, and sage thrasher. The western meadowlark, sage sparrow, and horned lark are the most abundant shrub-steppe passerine bird species that breed on the Hanford Site (Rickard and Poole 1989). The western meadowlark and horned lark nest on the ground in the open, while shrub-steppe species (e.g., the sage sparrow, sage thrasher, and loggerhead shrike) require sagebrush or bitterbrush for nesting habitat.

Common upland game species that occur in shrub and grassland habitat include the chukar partridge, California quail, and Chinese ring-necked pheasant. Chukars are most numerous in the Rattlesnake Hills, Yakima Ridge, Umtanum Ridge, Saddle Mountains, and Gable Mountain areas of the Hanford Site. Less common species include western sage grouse, Hungarian partridge, and scaled quail. Western sage grouse were historically abundant on the Hanford Site; however, populations have declined since the early 1800s because of the conversion of sagebrush-steppe habitat. Surveys conducted by the WDFW and PNNL during late winter and early spring 1993, and biodiversity inventories conducted by The Nature Conservancy in 1997 did not reveal presence of western sage grouse in sagebrush-steppe

habitat at ALE (Neitzel 1998). The McGee Ranch area is viewed by the WDFW as habitat critical to the natural re-establishment of sage grouse populations on the ALE Reserve by providing a habitat corridor to the U.S. Army's Yakima Training Center.

In addition to upland bird species, numerous species associated with wetlands and riparian habitats are found along the Columbia River and at isolated wetlands on the Hanford Site. Ring-billed and California gulls, Forster's terns, and Canadian geese all form nesting colonies on islands in the Hanford Reach. Large numbers of swallows depend on the Columbia River riparian areas during the summer months, eating flying aquatic insects such as caddis flies and collecting mud from wetted areas to build their nests. The Hanford Site is located in the Pacific flyway and, during the spring and fall months, the Hanford Reach serves as a resting area for neotropical migrants, migratory waterfowl, and shorebirds. During the fall and winter months, large numbers of migratory ducks and geese find refuge along the Hanford Reach. Other species observed during winter months include white pelicans, double-crested cormorants, and common loons.

4.5.3.3 Reptiles and Amphibians. Fifteen species of reptiles and amphibians are known to occur on the Hanford Site (PNNL 1996a). The side-blotched lizard is the most abundant reptile and can be found throughout the Hanford Site. Short-horned and sagebrush lizards are also common in selected habitats. The most common snakes are the gopher snake, the yellow-bellied racer, and the Pacific rattlesnake, all of which are found throughout the Hanford Site. Striped whipsnakes and desert night snakes are rarely found, but some sightings have been recorded for the Site. Toads and frogs (e.g., Great Basin spadefoot toad, Woodhouse's toad, bullfrog, and the Pacific tree frog) are found near the permanent water bodies and along the Columbia River.

4.5.3.4 Insects. Many species of insects occur throughout all habitats on the Hanford Site. Butterflies, grasshoppers, and darkling beetles are among the more conspicuous of the approximately 1,500 species of insects that have been identified from specimens collected on the Hanford Site. The actual number of insect species occurring on the Hanford site may reach as high as 15,000. The recent surveys performed by The Nature Conservancy included the collection of 30,000 specimens and have resulted in the identification of 42 new taxa and 172 new findings in the State of Washington (Neitzel 1998). Insects are more readily observed during the warmer months of the year (see text box, *"Hanford Site Quick Facts: Wildlife"*).

Hanford Site Quick Facts: Wildlife

- 44 species of fish
- 40 species of mammals
- Approximately 238 species of birds
- 15 species of reptiles and amphibians
- Approximately 1,500 species of insects

4.5.4 Terrestrial Wildlife and Habitat

Terrestrial wildlife species use both shoreline riparian and shrub-steppe habitats occurring along the Columbia River and on the islands occurring in the Hanford Reach. Wildlife reported to use the Hanford Reach include 184 species of birds, 36 species of mammals, nine species of reptiles, and four species of amphibians (NPS 1994). Canada geese use the islands along the Hanford Reach extensively for nesting. Studies on the nesting habits of geese that use the Hanford Site have been ongoing since 1953. These studies indicate a general decline over the years in the number of nests on the islands in the Hanford Reach because of heavy predation by coyotes (PNNL 1996a). Mule deer use the islands and other riparian areas for fawning habitat. Wildlife occurring on the shoreline habitat includes 46 species that use willow communities and 49 species that use grass areas (NPS 1994).

Terrestrial wildlife species found in the 100 Areas generally are the same species found across the Hanford Site (Cushing 1992). Coyotes occurring along the Columbia River reportedly

feed on carp and small mammals such as the Great Basin pocket mouse, northern pocket gopher, Nuttall's cottontail, and black-tailed jack rabbit (Fitzner and Gray 1991). Mule deer may occur almost anywhere on the Hanford Site but prefer habitats along the Columbia River where riparian areas provide abundant food and cover. Mule deer forage on mulberry, Russian olive, and cottonwood trees, and shrubs such as willow (WHC 1992c).

Wildlife likely to occur in riparian habitat adjacent to the Columbia River includes a variety of birds, mammals, reptiles, and amphibians (Fitzner and Gray 1991). The three known species of amphibians at the Hanford Site use riparian habitat along permanent water bodies and the Columbia River. Medium-size mammals using riparian habitat are the muskrat, raccoon, beaver, weasel, skunk, otter, and porcupine; small mammals include the vagrant shrew and montane meadow mouse. Upland birds likely to occur in habitats in the 100 Areas along the Columbia River are the California quail and ring-necked pheasant (Cushing 1992). Trees along the river, including those found in the 100 Areas, provide habitat for several species of birds. These include the great blue heron, which has colonial nest sites (rookeries) near the White Bluffs ferry landing, and the bald eagle, which uses selected trees for perching and night roosts during the winter (PNNL 1996a).

Terrestrial wildlife species common to the Hanford Site also can be found in the Central Plateau (Cushing 1992). A characterization study of small mammals that occur near the 100-B/C cribs (located south of the 200 East Area) resulted in five species being trapped: Great Basin pocket mouse, deer mouse, northern grasshopper mouse, sagebrush vole, and western harvest mouse (PNL 1977). The Great Basin pocket mouse represented more than 90 percent of the mammals caught. Medium and large-size mammals that may occur in the Central Plateau include rabbits, coyotes, badgers, and mule deer (PNL 1977). Mammals potentially using areas associated with ponds and ditches in the 200 East and 200 West Areas include muskrats, porcupines, and raccoons.

Many common bird species, such as the western meadowlark and sage sparrow, are likely to occur on the Central Plateau where suitable habitats exist. Thirty-seven species of terrestrial birds were recorded during surveys conducted in the 200 East and 200 West Areas of the Hanford Site in 1986 (Schuller et al. 1993). Bird studies associated with waste water ponds in the Central Plateau reveal that a large number of species, particularly waterfowl, use these ponds during migration (PNL 1977).

Unique habitats can be found on Columbia River islands, sand dunes, the cliffs of White Bluffs, and on Gable Butte and Gable Mountain situated north of the Central Plateau (Figure 4-23). The Gable Butte and Gable Mountain unique habitats include basalt outcrops, scarps, and scree slopes. Birds likely to occur in these habitats are the prairie falcon, rock wren, poorwill, and chukar; small mammals include the yellow-bellied marmot and wood rat; reptiles include rattlesnakes, gopher snakes, and horned lizards (PNL 1993c).

4.5.5 Species of Concern on the Hanford Site

Species of concern on the Hanford Site include federally listed threatened or endangered species, state-listed threatened or endangered species, and state candidate species (see text box, *"Hanford's Federal Threatened and Endangered Species"*).

Hanford's Federal Threatened and Endangered Species

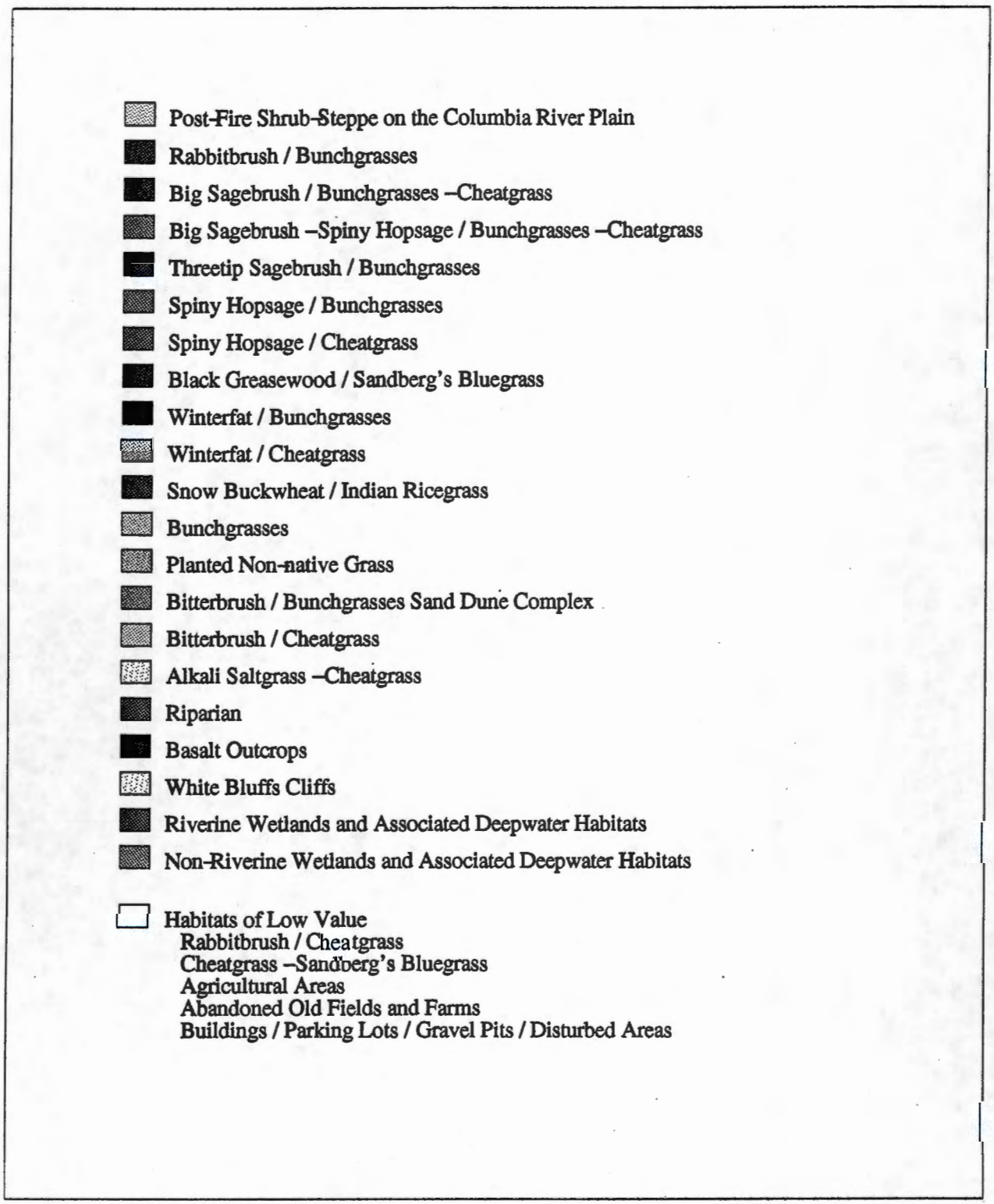
Several federally threatened or endangered species might be found at the Hanford Site, including the following:

- Steelhead (Upper Columbia River run)
- Chinook salmon (Upper Columbia River spring-run)
- Steelhead (Middle Columbia River run)
- Aleutian Canada goose*
- Bald eagle*
- Peregrine falcon†
- Ute Ladies'-tresses

*To be delisted within two years.
†Was delisted August 25, 1999.

Figure 4-23. Plant Communities of Concern on the Hanford Site.

Figure 4-23. Plant Communities of Concern on the Hanford Site (Legend).



No plants or mammals listed in "Federal List of Endangered and Threatened Wildlife and Plants" (50 CFR 17) are known to occur on the Hanford Site. There are, however, two species of birds, two fish species (two ESU for steelhead) and one suspected plant that are federally listed, and several species of plants and animals are under consideration for formal listing by the State of Washington.

Candidate species occurring on the Hanford Site are considered in the preparation of DOE NEPA documentation. Species of concern occurring on the Hanford Site are listed in Tables 4-6 and 4-7; the tables also include definitions of each category of species of concern.

No federally listed threatened or endangered plant species occur on the Hanford Reach. Nine species of Hanford Site plants are included in the Washington State listing as threatened or endangered (see Table 4-6). Columbia milk-vetch occurs on dry-land benches along the Columbia River near Priest Rapids Dam, Midway, and Vernita; it also has been found atop Umtanum Ridge and in Cold Creek Valley near the ALE Reserve. Dwarf evening primrose has been found north of Gable Mountain, near the Vernita Bridge, Ringold, and on steep talus slopes near Priest Rapid Dam, Midway, and Vernita. Yellowcress occurs in the wetted zone of the water's edge along the Hanford Reach. Northern wormwood is known to occur near Beverly and could inhabit the northern shoreline of the Columbia River across from the 100 Areas. Umtanum desert buckwheat and White Bluffs bladderpod occur on the Hanford Site and no where else in the world. Leoflingia occurs north of Gable Mountain (Neitzel et al. 1998).

Wildlife species of concern that may occur along the Hanford Reach include several species of birds associated with riparian and aquatic habitat (PNL 1993c), the Upper Columbia River spring-run chinook salmon and the Upper and Middle Columbia River runs of steelhead from the confluence of the Yakima River and upstream. The Federal government lists the Aleutian Canada goose, the bald eagle, and Middle Columbia River steelhead as threatened, and the Upper Columbia River steelhead, and Upper Columbia River spring-run chinook salmon as endangered. The State of Washington lists, in addition to the peregrine falcon and Aleutian Canada goose, include the white pelican, sandhill crane, and pygmy rabbit as endangered, and the ferruginous hawk and the bald eagle as threatened. The peregrine falcon is a casual migrant to the Hanford Site and does not nest there. The bald eagle is a regular winter resident and forages on dead salmon and waterfowl along the Columbia River; it does not nest on the Hanford Site although it has attempted to for the past several years (see Table 4-7) (Neitzel et al. 1998).

The bald eagle, a Federal and Washington State threatened species, is the only federally listed wildlife species known to regularly use the 100 Areas. Bald eagles use groves of trees (e.g., black locust, white poplar, and Siberian elm) along the Hanford Reach for winter perching, night roosts, and nesting sites (DOE-RL 1994b). Buffer zones around primary night roosts and nest sites have been established in consultation with the USFWS. While the night-roost locations are consistent from year to year, the nesting sites have varied and are readjusted in consultation with the USFWS each year (see Figure 4-24).

Steelhead and salmon are regulated as evolutionary significant units (ESUs) by the National Marine Fisheries Service based on their historic geographic spawning areas. The Upper Columbia River steelhead ESU was listed as threatened in August 1997. Adult steelhead migrate upstream through the Hanford Reach to spawn in upriver tributaries and juvenile pass through the Hanford Reach on their outward migration to the sea. In March 1999, Upper Columbia River spring run chinook salmon ESU were added as endangered, and the Middle Columbia River steelhead ESU were added as threatened. These races of salmonids utilize habitat in the mid-Columbia River and its tributaries.

Table 4-6. Plant Species of Concern Occurring on the Hanford Site (adapted from PNNL 1996a). (2 pages)

Common Name	Scientific Name	Federal Status	State Status
Ammania	*Ammania robusta*		R1
Annual Paintbrush	*Castilleja exilis*		R1
Bristly Combseed	*Pectocarya setosa*		W
Bristly cryptantha	*Cryptantha spiculifera (= C. interrupta)*		S
Brittle prickly-pear	*Opuntia fragilis*		R1
Canadian St. John wort	*Hypericum majus*		S
Chaffweed	*Centunculus minimus*		R1
Columbia milk-vetch	*Astragalus columbianus*		T
Columbia river mugwort	*Artemisia lindleyana*		E
Columbia yellowcress	*Rorippa columbiae*		E
Coyote tobaco[a]	*Nicotiana attenuata*		S
Crouching milkvetch	*Astragalus succumbens*		W
Dense sedge[a]	*Carex densa*		S
Desert Cryptantha	*Cryptantha scoparia*		R1
Desert dodder	*Cuscuta denticulata*		S
Desert evening primrose	*Oenothera caespitosa*		S
Dr. Bill's Locoweed	*Astragalus conjunctus var. novum*		R1
Dwarf evening primrose	*Oenothera pygmaea*		T
False pimpernel	*Lindernia dubia anagallidea*		R2
Few-flowered collinsia[a]	*Collinsia sparsiflora var. bruciae*		S
Fuzzy beardtongue	*Penstemon eriantherus whitedii*		R1
Geyer's milkvetch	*Astragalus geyeri*		S
Gray cryptantha	*Cryptantha leucophaea*		S
Great Basin Gilia	*Gilia leptomeria*		R1
Hedge Hog Cactus	*Pediocactus sempsonii var. robustior (=P. nigrispinus)*		R1
Hoover's desert parsley	*Lomatium tuberosum*		T
Kittitas Larkspur	*Delphinium multiplex*		W
Loeflingia	*Loeflingia squarrosa var. squarrosa*		T
Medic milkvetch[a]	*Astragalus speirocarpus*		W
Northern wormwood[b]	*Artemisia campestris borealis var. wormskioldii*		E

Table 4-6. Plant Species of Concern Occurring on the Hanford Site (adapted from PNNL 1996a). (2 pages)

	Common Name	Scientific Name	Federal Status	State Status
1	Palouse milkvetch[a]	*Astragalus arrectus*		S
2	Palouse thistle	*Cirsium brevifolium*		W
3	Piper's daisy	*Erigeron piperianus*		S
4	Purple Mat	*Nama densum var. parviflorum*		R1
5	Robinson's onion	*Allium robinsonii*		W
6	Rosy balsamroot	*Balsamorhiza rosea*		W
7	Rosy calyptridium	*Calyptridium roseum*		S
8	Scilla onion	*Allium scillioides*		W
9	Shining flatsedge	*Cyperus bipartitus (rivularis)*		S
10 11	Small-flowered evening primrose	*Camissonia (Oenothera) minor*		R1
12	Small-flowered Hemicarpha	*Lipocarpha (=Hemicarpha) aristulata*		R1
13	Smooth cliffbrake	*Pellaea glabella simplex*		W
14	Southern mudwort	*Limosella acaulis*		W
15	Stalked-pod milkvetch	*Astragalus sclerocarpus*		W
16	Suksdorf's monkeyflower	*Mimulus suksdorfii*		S
17	Thompson's sandwort[a]	*Arenaria franklinii thompsonii*		R2
18	Toothcup	*Rotala ramosior*		R1
19	Umtanum desert buckwheat	*Eriogonum codium*		E
20	Ute ladies'-tresses[a]	*Spiranthes diluvialis*	T	
21	White Bluffs bladderpod	*Lesquerella tuplashensis*		E
22	White eatonella	*Eatonella nivea*		T
23	Winged combseed	*Pectocarya linearis*		R1

24 [a] May inhabit the Hanford Site but have not been recently collected, or the known collections are questionable in
25 terms of location and/or identification.
26 [b] Likely not currently occurring on the Hanford Site.
27 R1 = Review Group 1. Taxa for which there are insufficient data to support listing as threatened, endangered, or
28 sensitive.
29 R2 = Review Group 2. Taxa with unresolved taxonomic questions; once resolved these taxa could qualify for
30 listing as endangered, threatened, sensitive.
31 S = Sensitive. Taxa that are vulnerable or declining, and could become threatened or endangered without active
32 management or removal of threats.
33 T = Threatened; a species native to Washington State likely to become endangered within the foreseeable future
34 throughout significant portions of its range within the state without cooperative management or the removal
35 of threats. Threatened species are designated in WAC 232-12-011.
36 E = Endangered; a species native to Washington State that is seriously threatened with extinction throughout all
37 or a significant portion of its range within the state. Endangered species are designated in WAC 232-12-014.
38

Table 4-7. Wildlife Species of Concern Occurring on the Hanford Site (adapted from Cushing 1995).

Common Name	Scientific Name	Federal Status	State Status
Molluscs			
Columbia pebble snail	*Fluminicola (= Lithoglyphus) columbiana*		C
Shortfaced lanx	*Fisherola (= Lanx) nuttalli*		C
Fish			
Steelhead (Upper Columbia River run)	*Onchorhynchus mykiss*	E	
Steelhead (Middle Columbia River run)	*Onchorhynchus mykiss*	T	
Chinook salmon (Upper Columbia spring run)	*Onchorynchus tshawytscha*	E	
Birds			
Aleutian Canada goose[b]	*Branta canadensis leucopareia*	T	E
American white pelican	*Pelecanus erythrorhynchos*		E
Bald eagle	*Haliaeetus leucocephalus*	T	T
Ferruginous hawk	*Buteo regalis*		T
Peregrine falcon[b]	*Falco peregrinus*		E
Sandhill crane[b]	*Grus canadensis*		E
Burrowing owl	*Athene cunicularia*		C
Common loon	*Gavia immer*		C
Flammulated owl[b]	*Otus flammeolus*		C
Golden eagle	*Aquila chrysaetos*		C
Lewis' woodpecker[b]	*Melanerpes lewis*		C
Loggerhead shrike	*Lanius ludovicianus*		C
Northern goshawk[b]	*Accipiter gentilis*		C
Sage sparrow	*Amphispiza belli*		C
Sage thrasher	*Oreoscoptes montanus*		C
Western sage grouse[b]	*Centrocercus urophasianus*		C
Insects			
Columbia River tiger beetle[b]	*Cicindela columbica*		C
Juniper hairstreak	*Mitoura siva*		C
Silver-bordered bog fritillary	*Boloria selene atrocastalis*		C
Reptiles			
Striped whipsnake	*Masticophis taeniatus*		C
Mammals			
Merriam's shrew	*Sorex merriami*		C
Pacific (Townsend's) western big-eared bat[b]	*Corynorhinus townsendii* (also known as		C
Pygmy rabbit[a]	*Plecotus townsendii)*		
Washington ground squirrel	*Brachylagus idahoensis*		E
	Spermophilus washingtoni		C

[a] Likely not occurring on the Hanford Site.
[b] Reported as possibly occurring on the Hanford Site.
C = Candidate; a native species that the state or Federal Departments of Fish and Wildlife has enough substantial information on biological vulnerability to support proposals to list them as endangered or threatened species.
E = Endangered; a species that is seriously threatened with extinction throughout all or a significant portion of its range. Endangered species are designated in WAC 232-12-014 or 50 CFR 17.
T = Threatened; a species that is likely to become endangered within the foreseeable future throughout significant portions of its range without cooperative management or the removal of threats. Threatened species are designated in WAC 232-12-011 or 50 CFR 17.

4.5.6 Aquatic Species and Habitat

There are two primary types of natural aquatic habitats on the Hanford Site: (1) the Columbia River, which flows along the northern and eastern edges of the Hanford Site; and (2) the small spring-streams and seeps located mainly in the Rattlesnake Hills. Several artificial water bodies, both ponds and ditches, have been formed as a result of waste water disposal practices associated with the operation of the reactors and separation facilities. These bodies of water are temporary and will vanish with cessation of activities, but while present, the ponds form established aquatic ecosystems (except the West Pond), complete with representative flora and fauna. The West Pond, also known as West Lake, is created by a rise in the water table in the Central Plateau and is not fed by surface flow; thus, the pond is alkaline and has low species diversity.

Forty-four species of fish representing 13 families are known to occur in the Hanford Reach (PNNL 1996a). Of these species, chinook salmon, sockeye salmon, coho salmon, steelhead, and Pacific lamprey use the Columbia River as a migration route to upstream spawning areas. Other fish of importance to sport fishermen are whitefish, sturgeon, small-mouth bass, catfish, walleye, and perch. Large populations of rough fish also are present, including carp, shiners, suckers, and squawfish (PNNL 1996a).

The Hanford Reach represents the only remaining significant mainstream Columbia River spawning habitat for stocks of Upper Columbia River summer/fall-run chinook salmon and white sturgeon (PNL 1990a). Since 1948, an annual census of salmon spawning on the Hanford Reach indicates that over 60 percent of fall chinook spawning occurs at Vernita Bar and the Locke Island area near White Bluffs (PNL 1993c). The numbers of fall chinook spawning sites (redds) in the Hanford Reach increased between the late 1940s and the 1980s. In 1988, the Hanford Reach served as the spawning area for 50 to 60 percent of the total fall chinook salmon runs in the Columbia River (Figure 4-25) (PNNL 1996a).

The Upper Columbia River run of steelhead has been federally listed as endangered. These fish spawn in and migrate through the Hanford Reach. Recent population estimates indicate that Upper Columbia River steelhead run has declined to fewer than 1,400 fish, prompting listing by the National Marine Fisheries Service (62 FR 43974). On March 16, 1999, the Upper Columbia River spring-run chinook salmon was added as endangered, and the Middle Columbia River steelhead was added as threatened.

Figure 4-24. Bald Eagle Primary Night Roosts and Nest Sites (PNNL database).

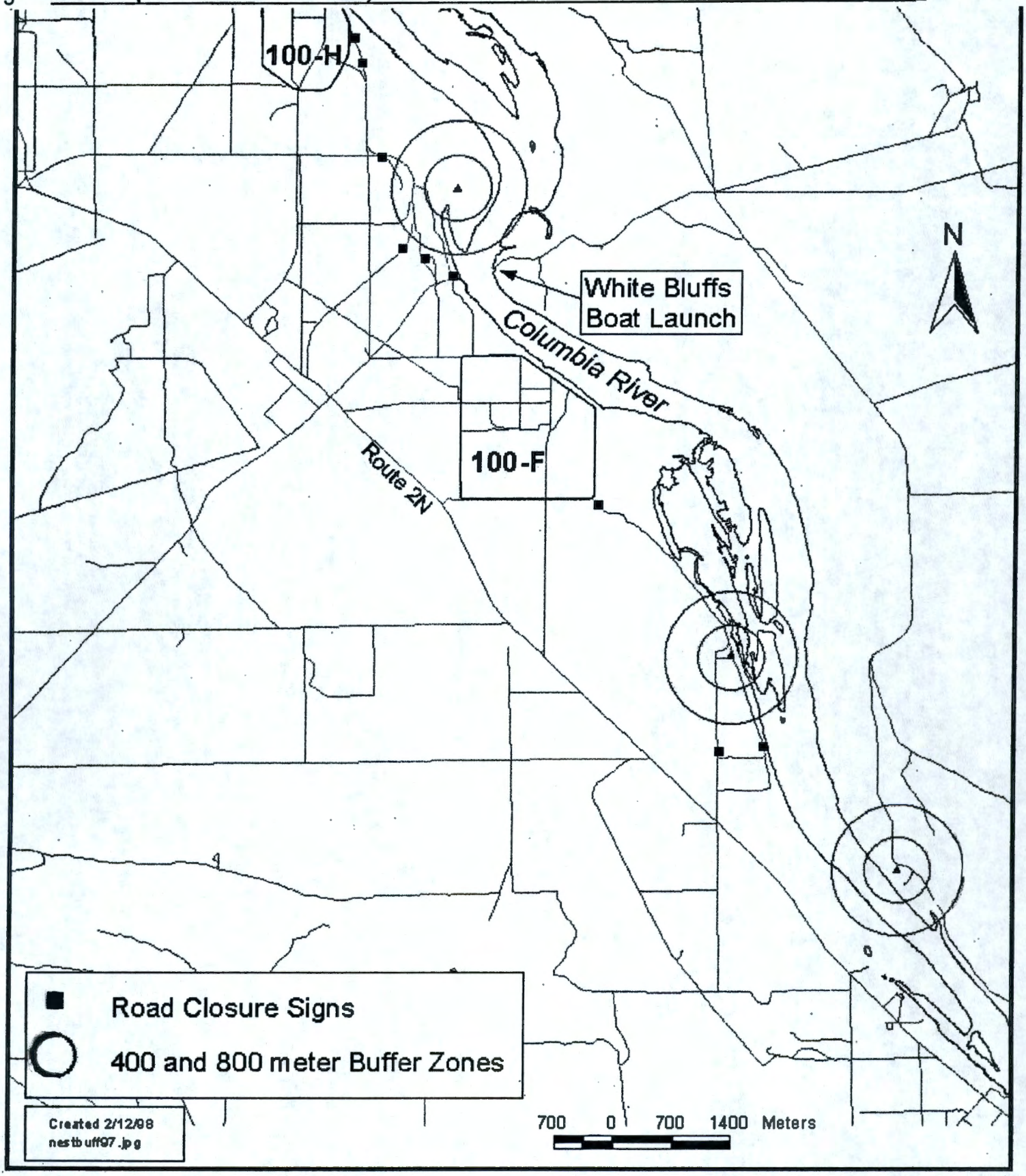
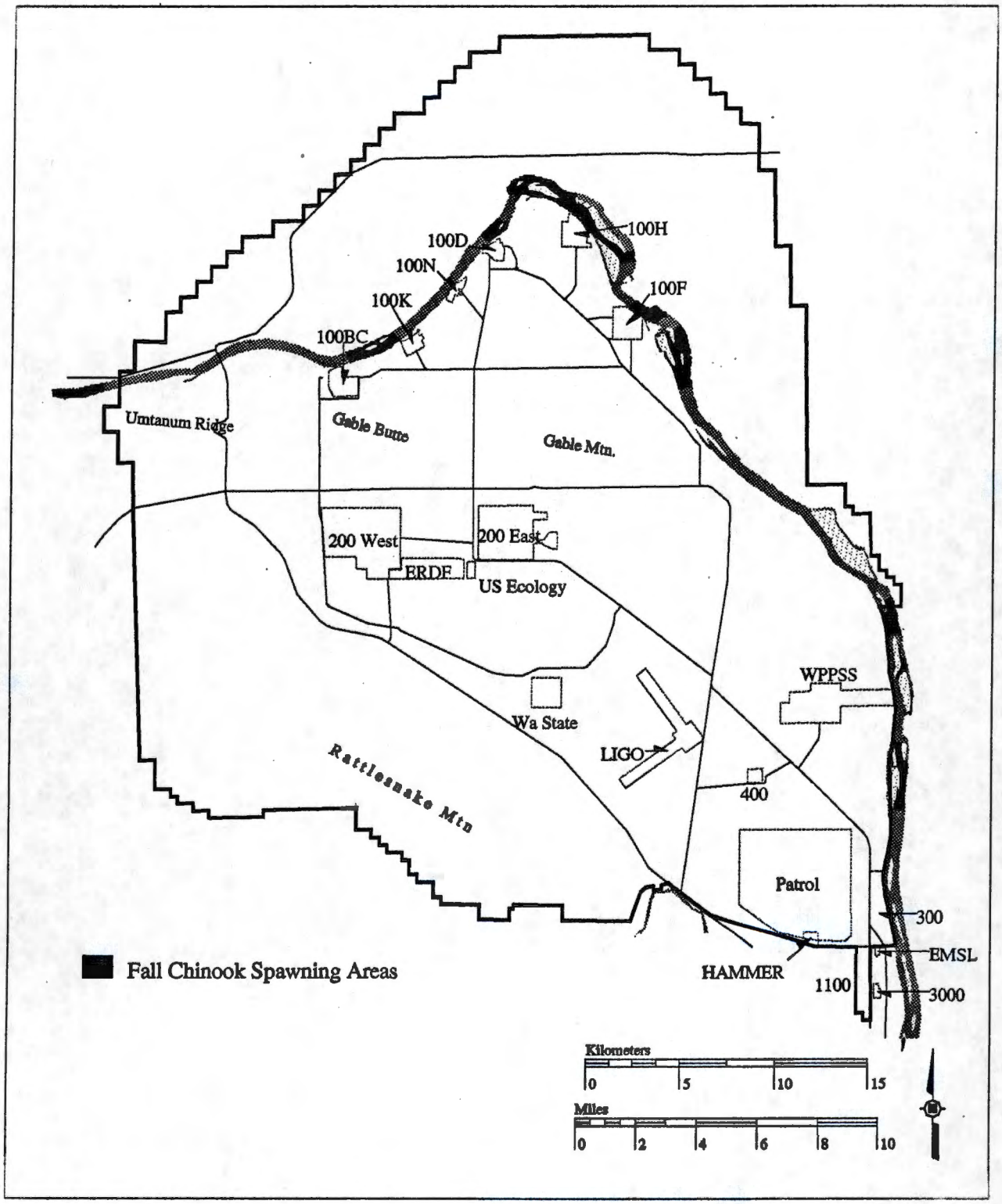


Figure 4-25. Key Fall Chinook Salmon Spawning Areas.



Steelhead follow a life cycle similar to salmon, but with one distinct difference; salmon die after spawning, but steelhead migrate back to the ocean and a small percentage return in subsequent years to spawn again. Little is known about the quality and quantity of steelhead spawning, rearing, and adult holding habitat in the Hanford Reach. Counts from 1972 and 1988 indicate that about 20,000 steelhead passed McNary Dam but did not pass Priest Rapids or Ice Harbor Dam. Some of these fish would enter the Yakima River while others would be caught in the Hanford Reach sport fishery. The remainder represent potential spawners. A substantial number of steelhead do terminate their migration in the Hanford Reach.

Aquatic plants in the Hanford Reach include water milfoil, waterweed, pondweed, Columbia yellowcress, watercress, and duckweed (PNNL 1996a). Aquatic plants generally are more prevalent where currents are less swift (e.g., in slack water areas like sloughs) (WHC 1992c). Aquatic plants are important to resident fish because they provide food, cover, and spawning areas for a variety of species. Water milfoil, an aggressive introduced aquatic plant, is becoming a nuisance in the Columbia River because of its rapid growth and lack of natural control.

Other aquatic species found in the Hanford Reach include a variety of microflora, zooplankton, and benthic invertebrates. Microflora include both sessile types (periphyton) and free-floating types (phytoplankton). Microflora species include diatoms, golden or yellow-brown algae, green algae, blue-green algae, red algae, and dinoflagellates. Dominant zooplankton taxa include *Bosmina*, *Diaptomus*, and *Cyclops*. Benthic invertebrate taxa occurring in the Hanford Reach include insect larvae such as caddis flies, midge flies, black flies, snails, freshwater sponges, limpets, and crayfish (PNNL 1996a).

The small spring-streams, such as Rattlesnake and Snively Springs, contain diverse biotic communities and are extremely productive (PNNL 1996a). Dense blooms of watercress occur and are not lost until a major flash flood occurs. The aquatic insect production is fairly high as compared to that in mountain streams (PNNL 1996a). The macrobenthic biota varies from site to site and is related to the proximity of colonizing insects and other factors.

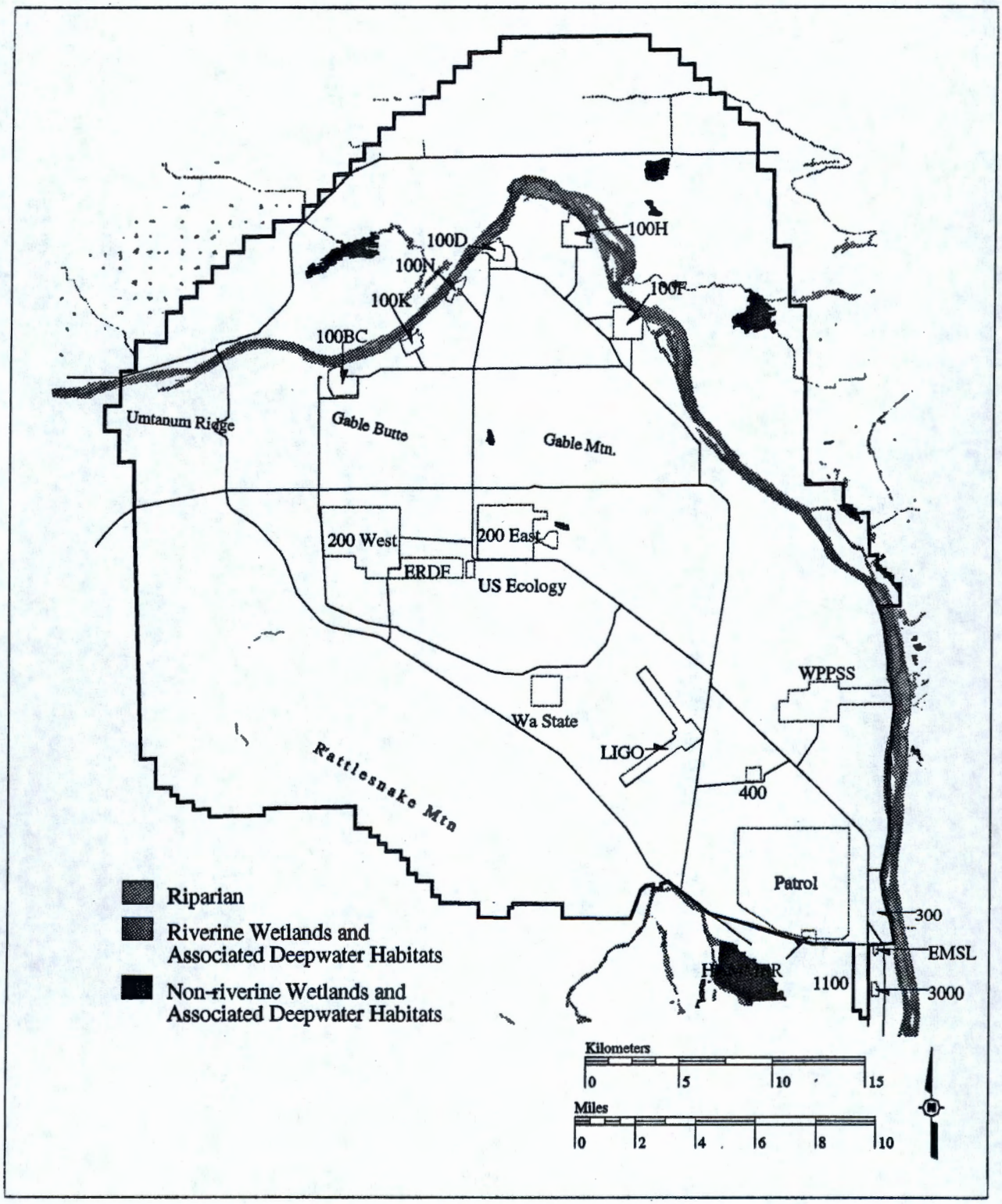
4.5.7 Wetland Habitat

Wetlands include transitional lands occurring between terrestrial and aquatic ecosystems (Figure 4-26) where the water table usually is close to the surface or where shallow water covers the surface. The primary jurisdictional wetlands found on the Hanford Site occur along the Hanford Reach and include the riparian and riverine habitats located along the river shoreline. Riparian habitat includes the uplands immediately adjacent to the Hanford Reach or its backwater sloughs and supports vegetation typical of a high water table (NPS 1994). Common riparian species found along the Hanford Reach include a variety of woody and herbaceous plant species.

Other wetland habitats found on the Hanford Site are associated with man-made ponds and ditches occurring on the Hanford Site, including the B Pond Complex located near the 200 East Area and a small cooling and waste water pond in the 400 Area. The B Pond complex was constructed in 1945 to receive cooling water from facilities in that area. Since that time, effluent flow to the B Pond has halted. One lobe of the pond received cooling water until very recently; the rest of the B Pond complex is slowly reverting to a shrub-steppe ecosystem.

The West Lake, a shallow, highly saline, and alkaline pond located southwest of Gable Mountain, fluctuates in size with changes in the water table (PNL 1991b) and is currently less than 2 ha (5 ac) in size. Unlike other ponds on the Hanford Site, West Lake does not receive direct effluent discharges from Hanford Site facilities (PNL 1993a). Wetland vegetation found at West Lake is limited to scattered patches of emergent macrophytes, such as cattails and bulrushes.

Figure 4-26. Wetlands on the Hanford Site.



4.5.8 *Biological Resources Management*

The DOE is currently in the process of developing and implementing an overall management strategy for the conservation of fish, wildlife, and plant populations and their habitats on the Hanford Site. The Draft *Hanford Site Biological Resources Management Plan* (BRMaP) (DOE-RL 1996c) was developed to provide DOE and its contractors with a consistent approach to protect biological resources and to monitor, assess, and mitigate impacts from Hanford Site development, and environmental cleanup and restoration activities. The primary purposes of the BRMaP are (1) to support DOE Hanford missions; (2) to provide a mechanism for ensuring compliance with laws that relate to the management of potential impacts to biological resources; (3) to provide a framework for ensuring appropriate biological resource goals, objectives, and tools are in place to make DOE an effective steward of the Hanford Site biological resources; and (4) to implement an ecosystem management approach for biological resources on the Site.

Plant communities of concern have been identified for the Hanford Site using classifications from BRMaP. These classifications associate different management actions (i.e., monitoring, impact assessment, mitigation, and preservation) with particular sets of biological resources. The BRMaP classifies Hanford Site biological resources into four levels of management concern (Figure 4-27), which can be summarized as follows:

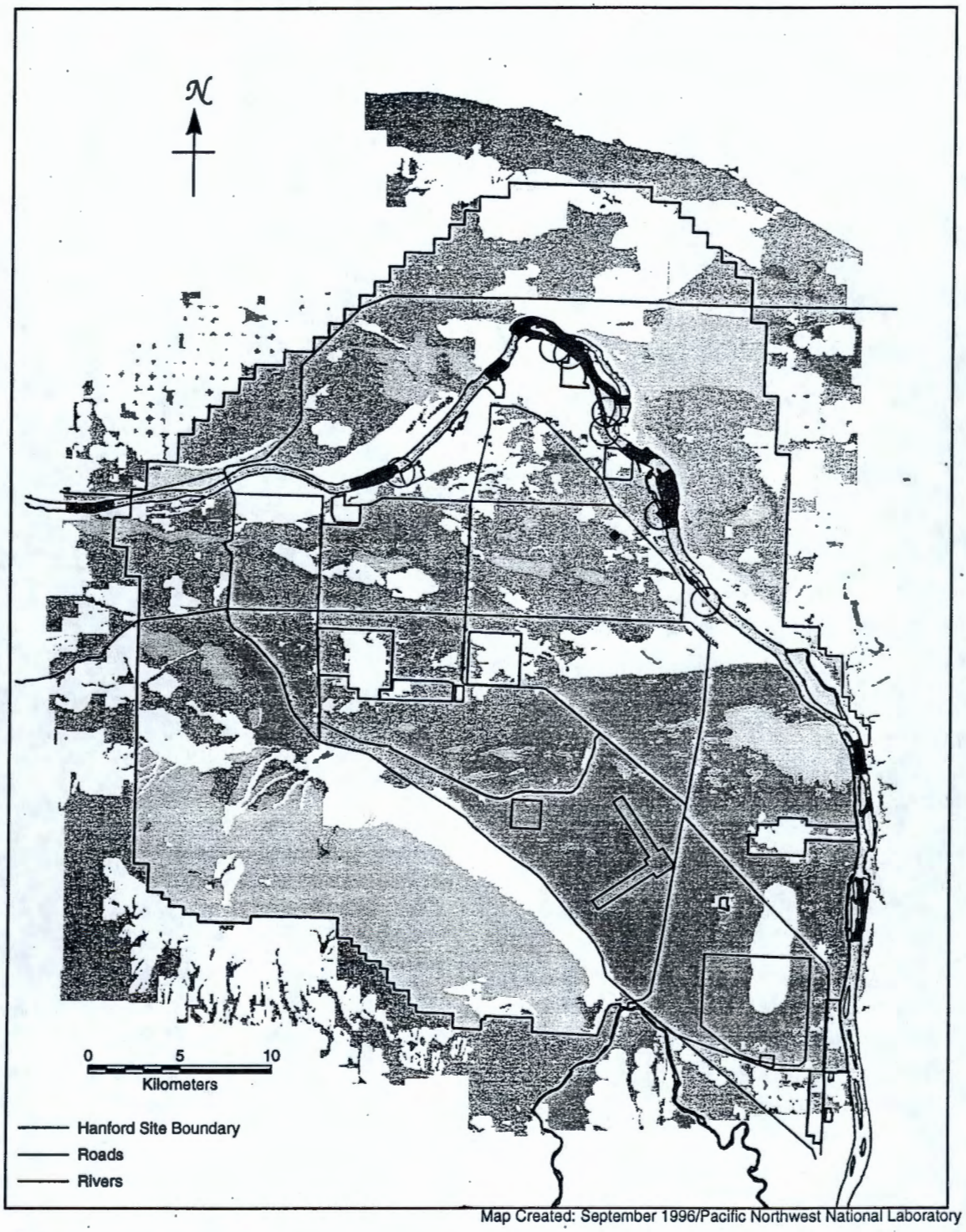
- **Level I** biological resources are resources that require some level of status monitoring because of the recreational, commercial, or ecological role or previous protection status of the resources. Level I includes Washington State Monitor 3 species (DOE-RL 1996).

- **Level II** biological resources require consideration of potential adverse impacts from planned or unplanned Hanford Site actions for compliance with procedural and substantive laws such as NEPA, CERCLA, and the *Migratory Bird Treaty Act of 1918*. Mitigation of potential impacts by avoidance and/or minimization is appropriate for this level; however, additional mitigation actions are not required. Level II resources include Washington State Monitor 1 and 2 species and early successional habitats.

- **Level III** biological resources require mitigation because the resource is listed by the State of Washington; is a candidate for Federal or state listing; is a plant, fish, or wildlife species with unique or significant value; has a special administrative designation (e.g., the ALE Reserve); or is environmentally sensitive. When avoidance and minimization are not possible, or application of these measures still results in adverse residual impacts above a specified threshold value, mitigation by rectification and/or compensation is required. Maintenance of Level III resource values may prevent more restrictive and costly management prescriptions in the future. Level III resources include Washington State candidate and sensitive species, threatened and endangered species, Federal candidate species, wetlands and deep-water habitats, and late-successional habitats.

- **Level IV** biological resources that justify preservation as the primary management option because these resources are federally protected or have regional and national significance. The plant communities and habitats that are defined as belonging to this level are of such high quality and/or rarity that damages to these resources cannot be mitigated except through compensatory mitigation by acquiring and protecting in-kind resources. The legally protected species that are included in Level IV cannot be impacted without the concurrence of the USFWS, so these types of impacts do not jeopardize the continued existence of the

Figure 4-27. Composite Map of Level II, Level III, and Level IV Biological Resources.



species. Level IV resources include Federal threatened and endangered species and those species proposed for listing, rare habitats such as the White Bluffs, active and stabilized sand dunes, and basalt outcrops.

The BRMaP provides a broad, but comprehensive, direction that specifies DOE biological resource policies, goals, and objectives and prescribes how they would be met. Two subordinate implementing documents outline specific management actions necessary to meet the policies, goals, and objectives, as described below:

- The *Ecological Compliance Assessment Management Plan* (DOE-RL 1995a) outlines the methods to be used to evaluate and quantify environmental impacts.

- The Draft *Hanford Site Biological Resources Mitigation Strategy Plan* (BRMiS) (DOE-RL 1996) is designed to aid DOE in balancing its primary missions of environmental restoration, technology development, and economic diversification with its stewardship responsibilities for the biological resources it administers. The BRMiS would (1) ensure consistent and effective implementation of mitigation recommendations and requirements; (2) ensure that mitigation measures for biological resources meet the responsibilities of DOE under both the *National Environmental Policy Act of 1969* (NEPA) and the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA); (3) enable Hanford Site development and cleanup projects to anticipate and plan for mitigation needs through early identification of mitigation requirements; (4) provide guidance to Hanford personnel in implementing mitigation in a cost-effective and timely manner; and (5) preserve Hanford biological resources while facilitating balanced development and Site restoration activities.

These draft management plans are currently in trial use at the Hanford Site for a one-year period. The plans are presented as guidance, not requirements. The plans have been issued to various resource agencies, organizations, and stakeholders for review and comment, and it is expected that once comments are received and on-the-ground implementation experience is gained, the plans would be revised and issued as Hanford Site requirements.

4.5.9 Biodiversity

The principles of ecosystem management and sustainable development are the foundation upon which DOE manages its lands and facilities. Comprehensive plans guide land- and facility-use decisions by addressing ecological, social, and cultural factors, as well as Site mission and economics. This DOE policy would result in land and facility uses that support DOE's mission at Hanford, while stimulating the economy and protecting the environment (CEQ 1993).

Biodiversity, a critical component of comprehensive land-use planning, has been defined as the diversity of ecosystems, species, and genes, and the variety and variability of life (CEQ 1993). Major components of biodiversity are plant and animal species, micro-organisms, ecosystems and ecological processes, and the inter-relationships between and among these components. Biodiversity also is a qualitative measure of the richness and abundance of ecosystems and species in a given area (NPS 1994).

Features contributing to biodiversity on the Hanford Site include one of the largest undisturbed tracts of native shrub-steppe habitat left in Washington State and the Hanford Reach, which is the last free-flowing nontidal stretch of the Columbia River in the United States (PNNL 1996a). Other influencing factors include topographic features such as Rattlesnake Mountain, Gable Butte, and Gable Mountain; a variety of soil textures ranging from sand to silty

and sandy loam; and most importantly, the lack of human use and development over much of the Hanford Site. Specialized terrestrial habitats contributing to the biodiversity of the Hanford Site include areas of sagebrush-steppe, basalt outcrops, scarps (cliffs), scree slopes, and sand dunes. Aquatic components of biodiversity are mainly associated with the Columbia River and include aquatic habitat, wetland and riparian areas, and riverine habitat along Hanford Reach shoreline and islands in the Columbia River. Ecologically important plant and animal species on the Hanford Site include species of concern; commercial and recreational wildlife species (e.g., anadromous fish, mule deer, and upland game birds); and plant species used as a source of food, medicine, fiber, and dye by native peoples of the Columbia Basin (WHC 1992d).

In 1992, DOE and The Nature Conservancy entered into a Memorandum of Understanding that called for a cooperative and coordinated inventory of plants, animals, and ecologically significant areas at the Hanford Site. In 1994, DOE awarded The Nature Conservancy a grant to conduct a partial inventory of the Hanford Site on the ALE Reserve and the Wahluke Slope. The inventory, which was conducted from March 1994 to March 1995, showed that the Hanford Site supports a rich mosaic of relatively unaltered and increasingly uncommon native habitats, the quality and extent of which are unequaled within the Columbia Basin (TNC and Pabst 1995). Significant numbers of plant, bird, and insect species, many of which are rare or in declined numbers in Washington State, were found to be associated with or dependent on these habitats. The Hanford Site serves as a genetic bank for both the common and unusual plants and animals that comprise the shrub-steppe ecosystem. This initial inventory can provide only a rough indication of the quality of biodiversity that is to be found on the main part of the Hanford Site, which is more extensively disturbed than the ALE Reserve or the Wahluke Slope. Additional inventories are being performed of the main part of the Hanford Site and may include studies of small mammals, reptiles and amphibians, and nonvascular plants.

The central portion of the Hanford Site has not been farmed or grazed by livestock for over 50 years, allowing the Hanford Site to serve as a refuge for various plant and animal species (PNNL 1996a). However, the invasion and spread of non-native plant species into previously disturbed areas represents a potential threat to biodiversity through displacement of native species, simplification of plant communities, and fragmentation of habitat. Introduced plant species account for approximately 21 percent of the vascular plants found on the Hanford Site and include species such as cheatgrass, Russian thistle, and most of the tree species found on the Hanford Site (WHC 1992f). Most of the disturbed areas on the Hanford Site, including abandoned farmland and areas burned by wildfire, are dominated by nearly pure stands of cheatgrass where the native shrub component has been modified severely or replaced altogether (Cushing 1992).

Human activities may have profound effects on the biodiversity of an ecosystem or community. Among other factors, these human activities include habitat modification or destruction and habitat fragmentation. Destruction or modification of a habitat can occur when undisturbed areas are harvested or converted to other uses, such as agriculture or industrial facilities. Habitat fragmentation occurs when disturbed areas break up a large community into smaller isolated undisturbed areas. When fragmentation occurs, biodiversity is impacted because the smaller undisturbed areas may not be capable of supporting the same number of species. The edges of the undisturbed area also may be strongly affected by proximity to the disturbed area, further reducing the size of the area that is truly undisturbed. Furthermore, the disturbed areas may serve as migration barriers for some species, effectively blocking recolonization of areas where small localized extinctions have occurred. Areas such as the Hanford Site serve to preserve regional biodiversity by providing refuges for species that have been eliminated by human activities in the surrounding region.

4.6 Cultural Resources

The Hanford Site is known to be rich in cultural resources, with numerous, well-preserved archaeological sites representing the period since American Indian contact with Euro-Americans, and the period prior to that contact. These periods are often referred to as "prehistoric" and "historic," but these terms do not recognize the fact that members of Tribal Nations have maintained an active oral history for a long period of time that predates the contact with Euro-Americans. For this reason, the EIS will use the terms "post-contact" and "pre-contact" to describe these periods when appropriate. Management of the Hanford Site cultural resources follows the Draft *Hanford Cultural Resources Management Plan* (CRMP) (DOE-RL 1999) and is conducted for DOE by the Cultural Resources staff of the Environmental Restoration Contractor team, in partnership with the Fluor Daniel Hanford, Inc., staff historian and the Hanford Cultural Resources Laboratory (HCRL) of PNNL (see text box, *"Hanford Site Quick Facts: Cultural Resources"*).

Hanford Site Quick Facts: Cultural Resources

About 8 percent of the Hanford Site has been surveyed. From those surveys, 964 cultural resource sites and isolated finds have been recorded to date. Each find of one or more features (nonportable, nondiscrete artifacts), or of three or more artifacts within 10 m (33 ft) of each other, will be designated as a site and duly recorded in the files of the Washington State Office of Archaeology and Historic Preservation. All other objects are isolated finds (i.e., isolates). Forty-nine properties are listed on the National Register.

The CRMP, which was approved by the State Historic Preservation Office (SHPO) in 1989, was developed to establish guidance for the identification, evaluation, recordation, curation, and management of archaeological, historic, and traditional cultural resources as individual entities or as contributing properties within a district. The plan specifies methods of consultation with affected Tribes and Tribal Historic Preservation Officers, government agencies, and interested parties, and includes strategies for the preservation and/or curation of representative properties, archives, and objects.

Cultural resources are defined as any district, Site, building, structure, or object considered to be important to a culture, subculture, or community for scientific, traditional, religious or other reasons. For the purpose of this Final HCP EIS, these resources are divided into several categories: pre-contact and post-contact archaeological resources, architectural resources, and traditional (American Indian) cultural resources. Significant cultural resources are those that are eligible or potentially eligible for listing in *The National Register of Historic Places* (National Register) (NPS 1988).

Consultation is required to identify the traditional cultural properties that are important to maintaining the cultural heritage of American Indian Tribes. Under separate treaties signed in 1855, the Confederated Tribes and Bands of the Yakama Nation and the Confederated Tribes of the Umatilla Indian Reservation ceded lands to the United States that include the present Hanford Site. Under the treaties, the Tribes reserved the right to fish at usual and accustomed places in common with the citizens of the territory, and retained the privilege of hunting, gathering roots and berries, and pasturing horses and cattle upon open unclaimed land. The Tribes also reserved the right to erect temporary buildings at usual and accustomed places. The Treaty of 1855 with the Nez Perce Tribe includes similar reservations of rights, and the Hanford Reach is identified as the location of usual and accustomed places. The Wanapum People are not signatory to any treaty with the United States and are not a federally recognized Tribe; however, the Wanapum People were historical residents of the Hanford Site, and their interests in the area have been acknowledged.

The methodology for identifying, evaluating, and mitigating impacts to cultural resources is defined by Federal laws and regulations including the *National Historic Preservation Act of 1966*, the *Archaeological Resources Protection Act of 1979*, the *Native American Graves Protection and*

Repatriation Act of 1990, and the *American Indian Religious Freedom Act of 1978*. A project affects a significant resource when it alters the characteristics of the property, including relevant features of its environment or use, that qualify it as significant according to the National Register criteria. These effects may include those listed in 36 CFR 800.9. Impacts to traditional American Indian properties can be determined only through consultation with the affected American Indian groups.

In 1995, 964 cultural resource sites and isolated finds were recorded in the files of the Hanford Cultural Resources Laboratory (HCRL) (PNNL 1996a). Forty-eight archaeological sites and one building are included on the National Register. National Register nominations have been prepared for several archaeological districts and sites considered to be eligible for listing on the National Register. While many significant cultural resources have been identified, only a small portion of the Hanford Site has been surveyed by cultural resource specialists and few of the known sites have been evaluated for their eligibility for listing in the National Register. Many additional cultural resources may remain unidentified. Cultural resource reviews are conducted when projects are proposed in areas that have not been previously surveyed. About 100 to 120 reviews were conducted annually through 1991; this figure rose to more than 360 reviews during 1995 (PNNL 1996a).

4.6.1 Pre-Contact Archaeological Resources

People have inhabited the middle Columbia River region since the end of the glacial period. More than 8,000 years of precontact human activity in this largely arid environment have left extensive archaeological deposits. Certain areas inland from the river show evidence of concentrated human activity, and recent surveys indicate extensive, although dispersed, use of arid lowlands for hunting. Graves are common in various settings, as are spirit quest monuments (Neitzel et al. 1998). Throughout most of the region outside of Hanford, hydroelectric development, agricultural activities, and domestic and industrial construction have destroyed or covered the majority of these deposits. Amateur artifact collectors have had an immeasurable impact on the remainder of the resources. Within the Hanford Site, from which the public is restricted, archaeological resources found in the Hanford Reach and on adjacent plateaus and mountains have been spared some of the disturbances that have befallen other sites. The Hanford Site is, thus, a *de facto* reserve of archaeological information of the kind and quality that has been lost elsewhere in the region.

Currently, about 320 prehistoric archaeological sites have been recorded on the Hanford Site. Forty eight of these sites are included on the National Register of Historic Places; two are single sites and the remainder are located in seven archaeological districts. In addition, several National Register nominations are pending and nine individual archaeological sites have been determined to be eligible for listing. Archaeological sites include the remains of numerous pithouse villages, campsites and graves, spirit quest monuments, hunting camps, game drive complexes, quarries, hunting and kill sites, and small temporary camps (Neitzel et al. 1998).

Recorded sites were found during archaeological reconnaissance projects conducted between 1926 and 1968. Systematic archaeological surveys conducted from the middle 1980s through 1995 are responsible for the remainder. The 100 Areas were surveyed in the early 1990s, revealing other archaeological sites (DOI 1995a).

4.6.2 American Indian Cultural Resources

In pre-contact and early contact periods, the Hanford Reach was populated by American Indians of various Tribal affiliations. The Wanapum People and the Chamnapum Band lived along the Columbia River from south of Richland upstream to Vantage (DOI 1995a). Some of their descendants still live nearby at Priest Rapids, and others have been incorporated into the Yakama and Umatilla Reservations. Palus People, who lived on the lower Snake River, joined the Wanapum, Nez Perce, and Chamnapum to fish the Hanford Reach, and some inhabited the east bank of the river (DOI 1995a). Walla Walla and Umatilla People also made periodic visits to fish in the area. These people retain traditional secular and religious ties to the region, and many have knowledge of the ceremonies and lifeways of their culture. The Washani, or Seven Drums religion, which originated among the Wanapum on what is now the Hanford Site, is still practiced by many people on the Yakama, Umatilla, Warm Springs, and Nez Perce Reservations. Native plant and animal foods, many of which are abundant on the Hanford Site, are used in the ceremonies performed by sect members of this religion, as well as other American Indians who conduct traditional activities (Neitzel et al. 1998).

During public scoping of this EIS, Tribal governments emphatically expressed an interest in renewing their use of these resources in accordance with the Treaties of 1855. The DOE is attempting to address the Tribal governments' concerns by allowing access for the purposes of religious activities and gathering foods and medicines to the extent that these activities are consistent with DOE missions. From a traditional American Indian viewpoint, nature is intrinsically spiritual, as sacredness is embedded in natural phenomena, landforms, plants, and animals. People are one of the thousands of species in a single interconnected system of species relationships. This system of relationships is considered to be based on a sense of reciprocity, and a threat to the land or environment can be perceived as a threat to the entire culture. Impacts to the natural landscape also might be considered impacts to the self-identity of a Tribal community.

Spirituality is expressly interwoven in the Tribal community's way of life. This attachment to land and water means that sacred sites are not always confined or precisely located and are numerous and diverse in form (DOI 1995a).

The Hanford Site possesses traditional cultural significance for many members of Columbia Plateau Tribes. Certain sites demonstrate traditional cultural significance for the following reasons:

- American Indians associate certain locations with traditional beliefs about their origin, their cultural history, or the nature of the world.

- American Indian religious practitioners historically have gone, and continue to go, to these locations to perform ceremonial activities in accordance with traditional cultural rules.

- American Indians make use of natural resources in the conduct of traditional activities. Use can be as food, medicine, barter and exchange items (currency), and for artistic and religious purposes. The act and method of gathering, processing, and exchange and use can all carry important cultural significance.

4.6.3 Post-Contact Archaeological and Architectural Resources

The first Euro-Americans who came to this region were Lewis and Clark, who traveled along the Columbia and Snake rivers during their 1803 to 1806 exploration of the Louisiana Territory. Lewis and Clark were followed by fur trappers, military units, and miners who also

passed through on their way to more productive lands upriver and downstream and across the Columbia Basin. It was not until the 1860s that merchants set up stores, a freight depot, and the White Bluffs Ferry on the Hanford Reach. Chinese miners began to work the gravel bars for gold. Cattle ranches opened in the 1880s and farmers soon followed. Several small, thriving towns, including Hanford, White Bluffs, and Ringold, were established along the riverbanks in the early 20th century. Other ferries were established at Wahluke and Richland. The towns and nearly all other structures were razed after the U.S. government acquired the land for the original Hanford Engineer Works in the early 1940s (Neitzel 1997).

A total of 390 post-contact archaeological sites, 89 post-contact isolated finds, and numerous post-contact properties have been recorded by the HCRL on the Hanford Site. Of these sites, one is included in the National Register. Properties from the pre-Hanford Site era include semi-subterranean structures near McGee Ranch; the Hanford Irrigation and Power Company pumping plant at Coyote Rapids; the Hanford Irrigation Ditch; the old Hanford townsite, pumping plant, and high school; Wahluke Ferry; the White Bluffs townsite and bank; the Richland Ferry; Arrowsmith townsite; a cabin at East White Bluffs ferry landing; the White Bluffs road; the Chicago, Milwaukee, St. Paul, and Pacific Railroad (Priest Rapids-Hanford Line) and associated whistle stops; and the Bruggerman fruit warehouse (Cushing 1995). Historic archaeological sites, including the East White Bluffs townsite and associated ferry landings and an assortment of trash scatters, homesteads, corrals, and dumps, have been recorded by the HCRL since 1987. Minor test excavations have been conducted at some of the historic sites, including the Hanford townsite locality. In addition to the recorded sites, numerous unrecorded areas of gold mine tailings along the river bank and the remains of homesteads, farm fields, ranches, and abandoned U.S. Army installations are scattered over the entire Hanford Site.

More recent historic structures are the defense reactors and associated materials processing facilities that are present on the Hanford Site. The first reactors (B, D, and F) were constructed in 1943 as part of the Manhattan Project. Plutonium for the first atomic explosion and the bomb that destroyed Nagasaki to end World War II was produced at the B Reactor. Additional reactors and processing facilities were constructed after World War II during the Cold War. All reactor containment buildings still stand, although many ancillary structures have been removed. The B Reactor is listed on the National Register and was given the National Historic Landmark Award (Cushing 1995). About 45 other buildings have been evaluated for National Register eligibility by the SHPO.

A Historic Buildings Task Force was established to coordinate future evaluations among DOE and the Hanford Site contractors. This task force established the Hanford Site Historic District, identified all contributing and noncontributing buildings and structures within the District, and prepared an Historic Buildings Programmatic Agreement to direct the documentation of the contributing properties.

After negotiation, the Programmatic Agreement was approved by the Advisory Council on Historic Preservation, the SHPO, and DOE in August 1996. The Programmatic Agreement outlines the methods agreed to by these parties to preserve and protect significant historical resources on the Hanford Site. The Programmatic Agreement stipulates that DOE will document the contributing historic buildings and structures identified in Appendix C of the Programmatic Agreement, which includes about 190 buildings considered to be historically significant. These buildings will require mitigation (i.e., to document the historical character of the building) prior to activities that might adversely affect historic characteristics. The Programmatic Agreement also identifies the form of mitigation required and exemptions to the requirement for mitigation. Evaluation and mitigation will proceed for the identified buildings in accordance with the Programmatic Agreement.

The Programmatic Agreement allows for: the exemption of property types from review and documentation requirements; the exemption of classes of action from review; the designation of an Historic District; the mitigation of all actions on Site, up to and including demolition of properties, through production of a Site-wide process/events history. Provisions in the Programmatic Agreement are implemented through the "Hanford Site Manhattan Project and Cold War Era Historic District Treatment Plan."

For the purpose of this discussion, the cultural resources present along the Columbia River and in the 100 Areas are considered together. This allows a discussion of sensitive cultural resources, without providing information sufficient to allow the discovery and/or adverse impact of these resources by unauthorized personnel. Much of the following information has been obtained from the *Hanford Site National Environmental Policy Act (NEPA) Characterization* (PNNL 1996a).

Intensive field surveys were completed in the 100 Areas from 1991 to 1993. Much of the surface area within and near the 100 Areas fencelines has been disturbed by the industrial activities that have taken place during the past 50 years. Numerous archaeological sites have been encountered, and many are potentially eligible for the National Register. A complete inventory of 100 Area buildings and structures was completed during fiscal year 1996. The former community of Wahluke, which was at the landing of a ferry of the same name, is situated on the north bank of the river.

The principal post-contact site in the vicinity is the East White Bluffs ferry landing and former townsite, which has been considered for nomination to the National Register. The site was the upriver terminus of shipping during the early and mid-19th century. It was at this point that supplies for trappers, traders, and miners were off-loaded, and commodities from the interior were transferred from pack trains and wagons to river boats. The first store and ferry of the mid-Columbia region were located at this site. A log cabin, thought by some to have been a blacksmith shop in the mid-19th century, still stands. The structure has been recorded according to standards of the Historic American Buildings Survey. The only remaining structure associated with the White Bluffs townsite (near the railroad) is the White Bluffs Bank. A revised historic property inventory form for the bank was completed in 1995. Two Manhattan Project buildings, 105-F and 108-F, remain in the 100-F Area. The 108-F Biology Laboratory, originally a chemical pump house, has been determined eligible for the National Register.

In the vicinity of 100-F, post-contact sites were recorded during 1992, 1993, and 1995 and include 20th century farmsteads, household dumps, and military encampments. None of the sites have been evaluated for eligibility to the National Register. Only three buildings associated with the Cold War era remain in this area. These buildings were inventoried and evaluated in 1996.

In the 100-K Area, historic sites containing the remains of farms are found in the nearby area; four historic sites and three isolated finds have been recorded as of 1994. Two important linear features, the Hanford Irrigation Ditch and the former Priest Rapids-Hanford railroad, also are present in the 100-K Area. Remnants of the Allard community and the Allard pump house at Coyote Rapids are located west of the K Reactor compound. The Historic Buildings Task Force has recommended that the 105-KW Reactor and the 1706-KE and 1706-KER water recirculation study facilities be listed in the National Register.

Knowledge about the archaeology of the 100-N Area is based largely on reconnaissance-level archaeological surveys conducted within the last 30 years (PNNL 1996a). These surveys are not complete inventories of the areas covered. Intensive surveys of surrounding areas were conducted during 1991. The Hanford Generating Plant vicinity also has been surveyed intensively for archaeological resources.

The most common evidence of activities now found near the 100-N Area consists of gold mine tailings on riverbanks and archaeological sites where farmsteads once stood. The significance of the 100-N buildings, their role in the Cold War, and their eligibility for listing in the National Register, have been documented through *The Hanford Site N Reactor Buildings Task Identification and Evaluation of Historic Properties* (BHI 1996a), which was conducted during fiscal year 1995. Buildings 105-N, 109-N, 155-N, 185-N, and 1112-N have been determined eligible for the National Register by DOE and the SHPO. Additional determinations for contributing buildings have been submitted to the SHPO, as well as a mitigation plan for the 100-N Reactor complex.

An archaeological survey conducted of all undeveloped portions of the 200 East Area and a 50 percent random sample conducted of undeveloped portions of the 200 West Area have indicated no findings of archaeological sites (PNL 1990b). However, some small sites are known to exist within the boundaries of the 200 East and 200 West Area (PNL 1990b). The only evaluated historic site is the old White Bluffs freight road that crosses diagonally through the 200 West Area. The road, which was originally an American Indian trail, has been in continuous use as a transportation route since pre-contact history and has played a role in Euro-American immigration, regional development, agriculture, and the recent Hanford Site operations. As such, the property has been determined to be eligible for the National Register, although the segment that passes through the 200 West Area is considered to be a noncontributing element. A 100-m (328-ft) restricted zone has been created to protect the road from uncontrolled disturbance. In addition, 49 buildings in the 200 East and 200 West Areas have been evaluated; nine of these buildings have been determined as eligible for the National Register.

Most of the 300 Area has been highly disturbed by industrial activities. Five recorded archaeological sites including campsites, house pits, and a historic trash scatter are recorded at least partially within the 300 Area; any more may be located in subsurface deposits. The historic site contains debris scatter and road beds associated with farmsteads. One archaeological site is recognized as eligible for listing in the National Register. The majority of the buildings in the 300 Area were constructed in the Manhattan Project and Cold War eras (1943 through 1989). A total of 158 buildings/structures in the 300 Area have been inventoried on historic property inventory forms. Of that number, 47 buildings/structures have been determined eligible for the National Register as contributing properties within the Historic District recommended for mitigation (Neitzel et al. 1998).

Most of the 400 Area has been subjected to intensive development-related construction activities. Archaeologists surveying the site in 1978 were able to find only 12 ha (30 ac) that were undisturbed. No cultural resources were found within that small area and no sites have been recorded or are known to exist within 2 km (1.2 mi) of the 400 Area (Cushing 1995). The FFTF and its associated structures have been evaluated by the Historic Buildings Task Force. Buildings 405, 4703, and 4710 have been recommended as contributing properties to the Hanford Site Historic District.

The 600 Area contains diverse cultural resource sites and traditional cultural properties. Project-driven surveys have been conducted throughout the area, but much of the 600 Area remains unsurveyed.

Five anti-aircraft artillery sites have been determined eligible for the National Register. Because of the proposed remediation of these sites, mitigation to reduce the adverse effects will be carried out. The Central Shops Complex, in the 600 Area, was determined to be ineligible for the National Register in 1995 (Cushing 1995).

Historic cultural resources have been identified in or near the 1100 Area. These resources include remnants of homesteads and agricultural structures predating the establishment of the Hanford Site.

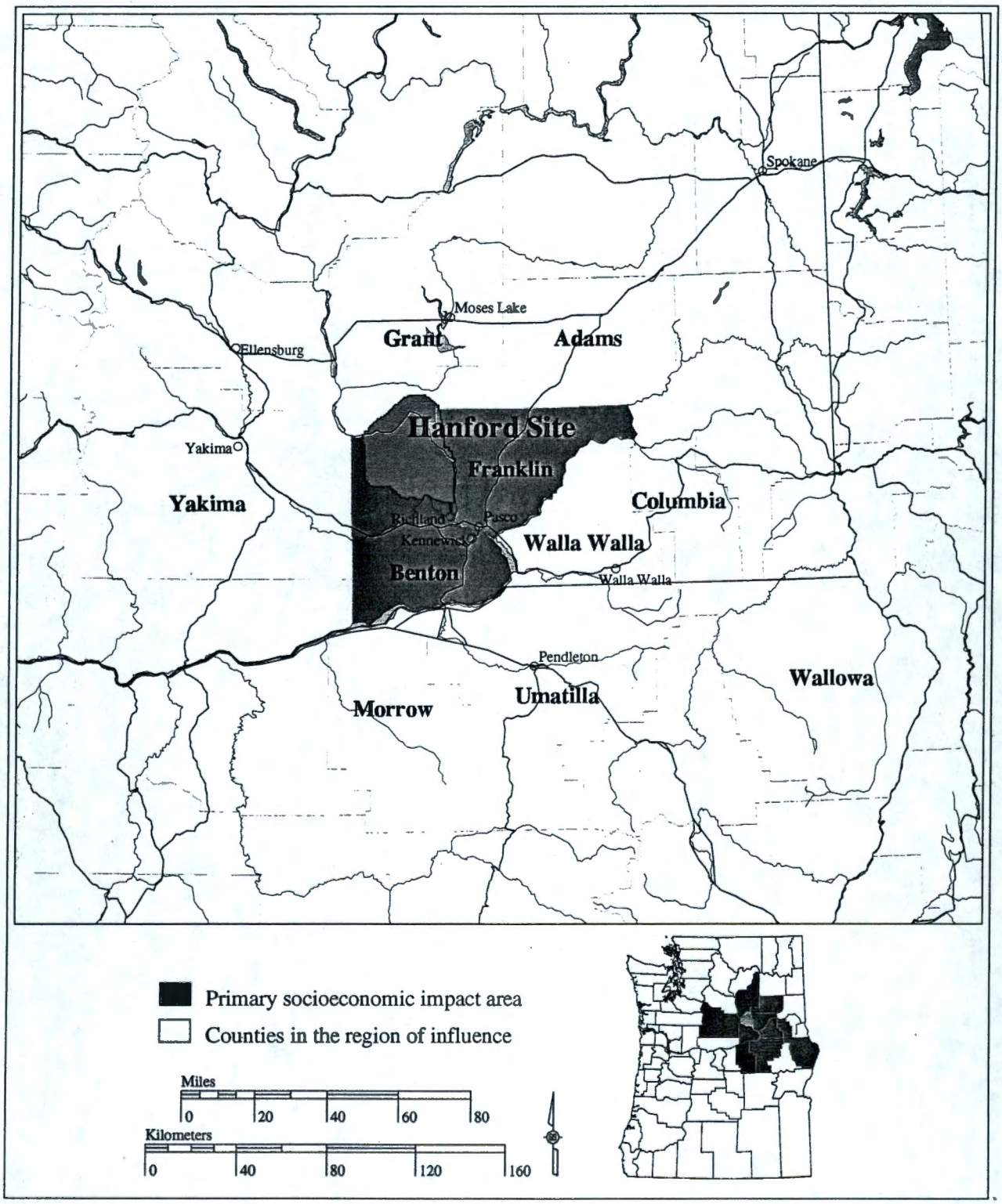
4.7 Socioeconomic Environment

Activity on the Hanford Site plays a dominant role in the socioeconomics of the Tri-Cities and other parts of Benton and Franklin counties. The Tri-Cities serves as a market center for a much broader area of eastern Washington, including Adams, Columbia, Grant, Walla Walla, and Yakima counties. The Tri-Cities also serves parts of northeastern Oregon, including Morrow, Umatilla, and Wallowa counties. Socioeconomic impacts of changes at Hanford are mostly confined to the immediate Tri-Cities community and Benton and Franklin counties (and Yakima County, to a lesser extent) (PNL 1984; PNL 1987). However, because of the significance of the wider agricultural region and surrounding communities in the Tri-Cities economic base, this section briefly discusses the wider region as well (Figure 4-28). Table 4-8 summarizes the regional (Benton and Franklin counties) jobs from 1995 to 1996.

Due to the changing Hanford mission, it has been necessary to develop a facility transition plan. The first step would be conversion, which transitions the process from facilities that were developed to support DOE's nuclear production mission to either new Federal or private development. There have been many obstacles to the successful implementation of a facility reuse plan. The objectives of a successful conversion are as follows:

- Retraining and re-employment of those who have lost jobs, directly or indirectly, as a result of the Federal mission change
- Creation of jobs to replace the revenue lost directly through reductions in payroll taxes and property taxes, as well as through indirect impacts, such as lost sales tax revenue
- Reuse of the facilities on the Hanford Site so the local government might generate revenue to cover the costs involved in its newly acquired responsibilities of maintaining and servicing those facilities, such as the provision of police and fire services and municipal utilities (e.g., water service)
- Using the closure as an opportunity to revitalize the local community
- Mitigating the impacts on the community at large, both from the business and social service perspectives.

Figure 4-28. Areas of Washington and Oregon Where Socioeconomic Resources Might Be Affected (DOE 1995b).



BHI:rpp 02/11/98 clup/socioecon1.aml Database: 03-AUG-1998

Table 4-8. Nonagricultural Workers in Benton and Franklin Counties, 1996 to 1997 (Neitzel et al. 1998).

Industry	1996 Annual Average	1997 Annual Average	% Change 1996-1997
Nonagricultural wage laborers	70,200	70,100	-0.1
Manufacturing	5,800	5,700	-1.7
Construction	4,100	4,100	-0.0
Public utilities	2,900	9000	[b]
Wholesale and retail trade	15,600	16,100	3.2
Finance, insurance, and real estate	2,200	2,200	0.0
Services	26,100	19,600	[b]
Government	13,400	13,500	0.7
Agricultural[a]	5,500		

[a] Source: TRIDEC Tri-City demographics.
[b] Reflects change in reporting.

There are several steps that a community may have to take to achieve the objectives of a successful conversion, including some of those outlined below:

- Improvement of marketing of facilities (i.e., buildings, transportation, and utilities) to new employers
- Training of potential employees
- Negotiation of property transfer and leases
- Negotiation of care and custody agreements
- Supporting environmental remediation to enable the transfer of property
- Acquisition of funding for continued conversion efforts (e.g., planning and implementation)
- Conducting feasibility studies to assist in the successful implementation of specific components of the reuse plan, such as the creation of a historic district or educational programs.

The Hanford Community is working on the Hanford facilities reuse problem through a collation of local cities, port districts, and counties, with assistance from DOE's Office of Worker and Community Transition.

4.7.1 Demographics

Estimates for 1996 placed population totals for Benton and Franklin counties at 134,100 and 43,900, respectively (Neitzel et al. 1998). When compared to the 1990 census data in which Benton County had 112,560 residents and Franklin County population totaled 37,473, the current population totals reflect the continued growth occurring in these two counties.

The 1997 estimates distributed the Tri-Cities population as follows: Richland, 36,500;

Pasco, 35,300; and Kennewick, 49,090. The combined populations of Benton City, Prosser, and West Richland totaled 13,905 in 1997 (see text box, *"Hanford Site Quick Facts: Populations [1996 Estimates]"*). The unincorporated population of Benton County was 34,555. In Franklin County, incorporated areas other than Pasco have a total population of 3,385. The unincorporated population of Franklin County was 15,215 (Neitzel et al. 1998).

Hanford Site Quick Facts: Populations (1996 Estimates)

- Kennewick: 48,010
- Richland: 35,990
- Pasco: 22,370

Benton and Franklin counties accounted for 2.4 percent of the population in Washington State (Neitzel et al. 1998). In 1997, the population demographics of Benton and Franklin counties were quite similar to those found within the State of Washington. In 1997, 54.1 percent of the population of Benton and Franklin counties was under the age of 35, compared to 50.3 percent for the State of Washington. In general, the population of Benton and Franklin counties is somewhat younger than that of Washington State. The 0- to 14-year-old age group accounts for 26.5 percent of the total bi-county population as compared to 22.6 percent for Washington State. In 1996, the 65-year-old and older age group constituted 9.6 percent of the population of Benton and Franklin counties compared to 11.5 percent for the State of Washington.

4.7.1.1 Demographics of Minority Populations. Demographic information obtained from the U.S. Bureau of Census was used to identify minority populations and low-income communities within an 80-km (50-mi) radius surrounding the Hanford Site. For the evaluation of environmental justice impacts, the area defined by this 80-km (50-mi) radius is considered the zone of potential impact.

4.7.1.1.1 Definitions. The demographic analysis used the following definitions to develop community characteristics:

- Census tract -- An area defined for the purpose of monitoring census data that is usually comprised of between 2,500 and 8,000 persons, with 4,000 persons being ideal. When first delineated, census tracts are designed to be homogeneous with respect to population characteristics, economic status, and living conditions. Census tracts do not cross county boundaries. Spatial census tract size varies widely depending on the density of settlement. Census tract boundaries are delineated with the intention of being maintained over a long period of time so statistical comparisons can be made from census to census.

- Census block group -- An area defined for the purpose of monitoring census data that generally consists of between 250 and 550 housing units.

- Minority populations -- A group of people and/or communities experiencing common conditions of exposures or impact that consists of persons classified by the U.S. Bureau of Census as Negro/Black/African American, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, and other non-White persons, based on self-classification by the people according to the race with which they most closely identify. For the purposes of analysis, minority populations are defined as those census tracts within the zone of impact where the percent minority population exceeds the percentage minority population within the entire zone of impact. Census tracts where the percent minority population exceeds 50 percent are also considered minority populations. In the case of migrant or dispersed populations, a minority population consists of a group that is greater than a 50 percent minority.

- Low-income community -- An area where the median household income is 80 percent or more below the median household income for the metropolitan statistical area (urban) or county (rural). The 80 percent threshold was used based on definitions used by the U.S. Department of Housing and Urban Development.

- Population base -- Census tracts were included in the analysis if 50 percent of the geographic area of the tract fell within the 80-km (50-mi) radius of the Hanford Site.

4.7.1.1.2 Minority and Low-Income Populations Near Hanford. Demographic maps were prepared using 1990 census data resolved to the census group tract level (USBC 1992).

A total population of approximately 384,000 people reside within an 80-km (50-mi) radius of the Hanford Site. The minority population within the area consists of approximately 95,000 people and represents approximately 25 percent of the population in the assessment area. The ethnic composition of the minority population is primarily Hispanic (approximately 80 percent) and American Indian (8 percent). Census tracts where the percentage of minority persons within the population exceeds 20 percent are located to the southwest and northeast of the Hanford Site and within the City of Pasco, Washington (Neitzel et al. 1998).

The low-income population within the 80-km (50-mi) area of impact represents approximately 42 percent of the households in the area of impact. Census tracts where the percentage of the population consisting of low-income households exceeds 25 percent are principally located to the southwest and north of the Hanford Site and within the City of Pasco, Washington (Neitzel et al. 1998). Considerable overlap between low-income populations and minority populations exists in the vicinity of the Hanford Site.

4.7.1.1.3 Limitations of Demographic Data. Characterization of minority and low-income populations residing within a geographical area is sensitive to the basic definitions and assumptions used to identify those populations. Consequently, the number of individuals identified as minority and/or low-income individuals within the population around a particular site may vary from analysis to analysis. Several different approaches to identification of minority and low-income populations have been used in recent DOE EISs. The approach presented in this EIS is consistent with the approach used in the *Hanford Site National Environmental Policy Act (NEPA) Characterization* (Neitzel et al. 1998). Other demographic studies may use different assumptions and, consequently, report a different total population, minority population, or low-income population depending on the assumptions used to identify each population.

4.7.2 Economics

This section summarizes pertinent economic activity within the region of interest, including information on the general economy, employment, income, and impact of the Hanford Site. Historically, the primary industries within the region have been related to agriculture — a multitude of crops encompassing many fruits, vegetables, and grains are grown each year.

4.7.2.1 Employment in the Tri-Cities. Three major sectors have been the principal driving forces of the economy in the Tri-Cities since the early 1970s: (1) DOE and Hanford Site contractors; (2) Energy Northwest (formerly known as WPPSS) in its construction and operation of nuclear power plants; and (3) agriculture, including a substantial food-processing industry. With the exception of a minor amount of agricultural commodities sold to local area consumers, the goods and services produced by these sectors are exported from the Tri-Cities. In addition to direct employment and payrolls, these major sectors also support a sizable number of jobs in the local economy through the procurement of equipment, supplies, and business services.

- ***DOE and Hanford Contractors*** -- An average of 11,104 employees worked for

DOE and its Hanford contractors in 1997. This number is down from over 19,000 in 1994 due to downsizing activities, which has reduced employment at Hanford by 7,700 through FY 1996 (source: Hanford Site Internet homepage). In addition to downsizing by Hanford contractors in 1996, DOE created a new Project Hanford Team in an effort to produce cleanup results more cost effectively over a shorter time period, and to help diversify and stabilize the Tri-Cities economy. This team is made up of the overall management contractor Fluor Daniel Hanford Company, Fluor's six major subcontractors, and six newly created "enterprise companies." Fluor Daniel Hanford Company is responsible for integrating and directing cleanup tasks. The actual cleanup work is conducted by the six subcontractors. The "enterprise companies" provide services to the six major subcontractors.

As of December 31, 1997, the official employment count for Hanford was 10,690, which includes Fluor Daniel Hanford Company; Fluor's six major subcontractors, Pacific Northwest National Laboratory, Bechtel Hanford, Inc., Hanford Environmental Health Foundation, ICF Kaiser; and local DOE employees. The "enterprise companies," which have a combined employment of just over 2,200, were not included in this count. The Hanford payroll has a widespread impact on the Tri-Cities and state economies, in addition to providing direct employment.

- ***Energy Northwest (formerly known as WPPSS)*** – Although activity related to nuclear power plant construction ceased with the completion of the WNP-2 reactor in 1983, Energy Northwest (formerly known as WPPSS) continues to be a major employer in the Tri-Cities area. Headquarters personnel based in Richland oversee the operation of one generating facility and perform a variety of functions related to two mothballed nuclear plants and one generating facility. In 1995 and 1996, downsizing activities at Energy Northwest headquarters decreased employment to about 1,164 workers (down from more than 1,900 in 1994). Energy Northwest activities generated a payroll of approximately $81 million in the Tri-Cities during 1996. Alternate uses or decommissioning of the two mothballed Washington Nuclear Plants (WNP-1 and WNP-4) are expected to begin in the next few years. These activities are expected to reduce the number of employees necessary to maintain these facilities (PNNL 1996a).

- ***Agriculture*** -- In 1996, agricultural activities in Benton and Franklin counties were responsible for approximately 10,446 jobs, or 13 percent of the total employment in the area. According to the U.S. Department of Commerce Regional Economic Information System, about 2,317 people were classified as farm proprietors in 1995. Farm proprietors' income, according to this same source, was estimated to be $69 million (Neitzel et al. 1998).

In 1997, the counties of Benton, Franklin, and Walla Walla counties averaged 7,448 seasonal farm workers, ranging from 1,809 workers during the winter pruning season to 17,221 workers at the peak of harvest. An estimated average of 6,553 seasonal workers were classified as local (ranging from 1,251 to 14,388); an average of 64 were classified as intrastate (ranging from 0 to 355); and an average of 832 were classified as interstate (ranging from 122 to 2,830). Most intrastate workers resided elsewhere in Benton, Franklin, Walla Walla, and Yakima counties, although the peak harvest season saw an influx of workers from around eastern and central Washington.

Area farms and ranches generate a sizable number of jobs in supporting sectors, such as agricultural services (e.g., application of pesticides and fertilizers or irrigation system development) and sales of farm supplies and equipment. Although formally classified as a manufacturing activity, food processing is a natural extension of the farm sector. More than 20 food processors

in Benton and Franklin counties produce items such as potato products, canned fruits and vegetables, wine, and animal feed.

In addition to the three major employment sectors (Hanford-related, power marketing, and agricultural), five other employers in 1996 were readily identified as contributors to the economic base of the Tri-Cities economy: (1) Iowa Beef Processing Inc., which employed 1,500 workers (this company lies outside of Benton and Franklin counties, but most of the workforce resides in the Tri-Cities); (2) Lamb Weston, which employed 1,700 workers; (3) Siemens Nuclear Power Corporation, which employed 730 workers; (4) Boise Cascade/Paper Group, which employed 511 workers (like Iowa Beef Processors, Boise Cascade's Wallula mill lies outside both Benton and Franklin counties, but most of its workforce resides in the area); and (5) Burlington Northern Santa Fe Railroad, which employed 350 workers. Approximately 4791 workers were employed by these businesses in Benton and Franklin counties in 1997 (Neitzel et al. 1998).

4.7.2.1.1 Tourism. The Tri-Cities Visitors and Convention Bureau reported that approximately 214 conventions were held in the Tri-Cities in 1997, with 66,150 attending visitors spending an estimated $22 million.

Overall tourism expenditures in the Tri-Cities were roughly $184 million in 1995, with travel-generated employment of about 3,220 and an estimated $34 million in payroll in Benton and Franklin counties.

4.7.2.1.2 Retirees. Although Benton and Franklin counties have a relatively young population (approximately 54 percent under the age of 35), 17,141 people over the age of 65 resided in Benton and Franklin counties in 1997. The portion of the total population 65 years and older in Benton and Franklin counties accounts for 9.6 percent of the total population, slightly below that of the State of Washington (11.5 percent). This segment of the population supports the local economy on the basis of income received from government transfer payments and pensions, private pension benefits, and individual savings.

Although information on private pensions and savings is not available, data is available regarding the magnitude of government transfer payments. The U.S. Department of Commerce Regional Economic Information System has estimated transfer payments by various programs at the county level. A summary of estimated major government pension benefits received by the residents of Benton and Franklin counties in 1995 is shown in Table 4-9.

Table 4-9. Government Retirement Payments in Benton and Franklin Counties in 1995 ($ million) (Neitzel et al. 1998).

Source	Benton County	Franklin County	Total
Social security (including survivors and disability)	139.3	41.5	180.8
Railroad retirement	4.1	4.6	8.7
Federal civilian retirement	13.4	2.9	16.3
Veterans pension and military retirement	20.8	4.2	25.0
State and local employee retirement	33.2	6.5	39.7
Total	210.8	60.2	269.5

About two-thirds of the social security payments go to retired workers; the remainder of the

payments are for disability and other types of payments. The historical importance of government activity in the Tri-Cities area is reflected in the relative magnitude of the government employee pension benefits as compared to total payments (Neitzel et al. 1998).

4.7.2.2 Income Sources. Total personal income is comprised of all forms of income received by the populace, including wages, dividends, and other revenues. Per capita income is roughly equivalent to total personal income divided by the number of people residing in the area. Median household income is the point at which half of the households have an income greater than the median and half of the households have less. The source for total personal income and per capita income was the U.S. Department of Commerce Regional Economic Information System, while median income figures for Washington State were provided by the Office of Financial Management (PNNL 1996a).

In 1995, the total personal income for Benton County was $2,952 million, Franklin County was $747 million, and the State of Washington was $129.1 billion. Per capita income in 1995 for Benton County was $22,072, Franklin County was $16,356, and Washington State was $23,709. Median household income in 1995 for Benton County was estimated to be $43,562, Franklin County was estimated $31,141, and the State of Washington was estimated at $39,206 (Neitzel et al. 1998).

4.7.2.3 Hanford Site Employment. An average of 11,140 employees worked for DOE and its Hanford contractors in 1997 (Neitzel et al. 1998). Future downsizing in Hanford Site employment is anticipated, although the extent of this downsizing is unknown at this time.

In 1996, Hanford employment accounted directly for 20 percent of total nonagricultural employment in Benton and Franklin counties and about 0.7 percent of all statewide nonagricultural jobs. In 1997, the Hanford Site total wage payroll was $537 million and accounted for a significant percentage of the payroll dollars earned in the area (Neitzel et al. 1998) (see text box on next page, *"Hanford Site Quick Facts: Economic Multipliers"*).

Previous studies have revealed that each Hanford job supports about 1.2 additional jobs in the local service sector of Benton and Franklin counties (about 2.2 total jobs) and about 1.5 additional jobs in the state service sector. Similarly, each dollar of Hanford income supports about 2.1 dollars of total local incomes and about 2.4 dollars of total statewide incomes. Based on these multipliers, Hanford directly or indirectly accounts for more than 40 percent of all jobs in Benton and Franklin counties (Neitzel et al. 1998).

Hanford Site Quick Facts: Economic Multipliers

Each Site job supports:

- 1.2 jobs in the local service sector
- 1.5 jobs in the state service sector

Each Site dollar supports:

- 2.1 dollars in total local incomes
- 2.4 dollars in total state incomes

Based on employee residence records as of December 1997, 93 percent of the direct employment of Hanford is comprised of residents of Benton and Franklin counties. Approximately 76 percent of the employment is comprised of residents who reside in one of the Tri-Cities. More than 37 percent of the employment is comprised of Richland residents, 30 percent of Kennewick residents, and 9 percent of Pasco residents. West Richland, Benton City, Prosser, and other areas in Benton and Franklin counties account for 17 percent of total employment. Table 4-10 contains the estimated percent of Hanford employees residing in each of the counties within the region of influence.

Table 4-10. Hanford Employee Residences by County.

County	Percent of Employees in Residence (%)
Adams	0.18
Benton	84.16
Columbia	0.01
Franklin	9.07
Grant	0.25
Walla Walla	0.21
Yakima	5.08
Morrow	0.01
Umatilla	0.01

The DOE and Hanford Site contractors procured nearly $298 million of goods and services (45.6 percent of total procurements of $653 million) from Washington firms in 1993. About 18 percent of Hanford Site orders were filled by Tri-Cities firms.

The DOE and Hanford Site contractors paid a total of $10.9 million in state taxes on operations and purchases during fiscal year 1988 (the most recent year available). Estimates show that Hanford employees paid $27.0 million in state sales tax, use taxes, and other taxes and fees in fiscal year 1988. In addition, the Hanford Site paid $0.9 million to local governments in Benton, Franklin, and Yakima counties in local taxes and fees (PNNL 1996a).

4.7.3 Emergency Services

Police protection in Benton and Franklin counties is provided by county sheriff departments, local municipal police departments, and the Washington State Patrol Division, which is headquartered in Kennewick. Table 4-11 shows the number of commissioned officers and patrol cars in each department in April 1997. The Kennewick, Richland, and Pasco municipal departments maintain the largest staffs of commissioned officers with 73, 50, and 44, respectively.

Table 4-11. Police Personnel in the Tri-Cities for 1998 (Neitzel et al. 1998).

Area	Commissioned Officers	Reserve Officers	Patrol Cars
Kennewick Municipal	73	15	45
Pasco Municipal	44	33	15
Richland Municipal	50	13	13
West Richland Municipal	12	10	11
Benton County Sheriff	47	15	55
Franklin County Sheriff	19	17	22

Table 4-12 indicates the number of firefighting personnel, both paid and unpaid, on the staffs of fire districts in the area.

Table 4-12. Fire Protection in the Tri-Cities for 1998 (Neitzel et al. 1998).

Station	Firefighting Personnel	Volunteers	Total	Service Area
Kennewick	63	0	63	City of Kennewick
Pasco	30	0	30	City of Pasco
Richland	48	0	48	City of Richland
BCRFD 1	9	94	103	Kennewick Area
BCRFD 2	3	37	40	Benton City
BCRFD 4	5	30	35	West Richland

BCRFD = Benton County Rural Fire Department

The Hanford Fire Department, operated by Hanford Site contractors for DOE, has 93 firefighters who are trained to dispose of hazardous waste and to fight chemical fires, in addition to their regular firefighting duties. During a 24-hour duty period, the 1100 and 300 Areas have seven firefighters; the 200 East and 200 West Areas have eight firefighters; the 100 Areas have five firefighters; and the 400 Area, which includes Energy Northwest (formerly known as WPPSS), has six firefighters (Neitzel et al. 1997). To perform their responsibilities, each station has access to a hazardous material response vehicle that is equipped with chemical fire-extinguishing equipment, an attack truck that carries foam and Purple-K dry chemical, a mobile air truck that provides air for respirators, and a transport tanker that supplies water to six brushfire trucks. The Hanford Fire Department owns five ambulances and maintains contact with local hospitals.

4.7.4 Health Care

The Tri-Cities have three major hospitals, all of which offer general medical services and include a 24-hour emergency room, basic surgical services, intensive care, and neonatal care.

Kadlec Medical Center, located in Richland, has 124 beds and functioned at 54 percent capacity (6,055 admissions) in 1997. Non-Medicare and Medicaid patients accounted for 60 percent of their annual admissions in 1997. An average stay of 4.04 days per admission was reported for 1997.

Kennewick General Hospital maintains a 46.7 percent occupancy rate of its 70 beds with 4,670 admissions in 1995. Non-Medicare and Medicaid patients in 1997 represented 45.6 percent of its total admissions. An average stay of 3.2 days per admission was reported in 1997.

Our Lady of Lourdes Health Center, a 132-bed medical facility located in Pasco, provides acute, sub-acute, skilled nursing and rehabilitation, and alcohol and chemical dependency services. Our Lady of Lourdes also operates the Carondolet Psychiatric Care Center, a 32-bed psychiatric hospital located in Richland, which provides a significant amount of outpatient and home health services. For calender year 1997, Our Lady of Lourdes had a total of 4,528 admissions, of which 35 percent were non-Medicare and Medicaid admissions. An average acute care length of stay of 3.0 days was reported (Neitzel et al. 1998).

4.7.5 Housing

In 1996, 91 percent of all housing (44,488 total units) in the Tri-Cities was occupied. Single-unit housing, which represents nearly 58 percent of the total units, has a 95 percent occupancy rate throughout the Tri-Cities. Multiple-unit housing, defined as housing with two or more units, has an occupancy rate of 85 percent. Pasco had the lowest occupancy rate in all categories of housing with 89 percent, followed by Kennewick with 90 percent, and Richland with 92 percent. Mobile homes, which represent 11 percent of the housing-unit types, have the lowest occupancy rate at 84 percent. Table 4-13 shows a detailed listing of total units and occupancy rate by type in the Tri-Cities.

Table 4-13. Total Units and Occupancy Rates, 1996 Estimates (Neitzel et al. 1998).

City	All Units	Rate (%)	Single Units	Rate (%)	Multiple Units	Rate (%)	Manufactured Homes	Rate (%)
Richland	15,859	92	10,722	96	4,284	84	853	88
Pasco	8,419	89	4,104	95	2,956	85	1,359	83
Kennewick	20,210	90	10,887	95	6,660	85	2,241	84
Total for Tri-Cities	44,488	91	27,213	95	13,900	85	4,875	84

Recent Hanford Site downsizing has resulted in occupancy rates lower than in the recent past throughout the Tri-Cities. Statistics from February 1996 indicated that the Tri-Cities apartment occupancy rates are significantly lower: Richland apartment occupancy was 80.2 percent, Kennewick apartment occupancy was 85.4 percent, and Pasco apartment occupancy was 83.7 percent (TCH 1996a).

4.7.6 Human Services

The Tri-Cities offers a broad range of social services. State human service offices in the Tri-Cities include the job services office of the Employment Security Department, food stamp offices, the Division of Developmental Disabilities, financial and medical assistance, Child Protective Services, emergency medical service, a senior companion program, and vocational rehabilitation.

The Tri-Cities also are served by a large number of private agencies and voluntary human services organizations. The United Way, which is an umbrella fund-raising organization, incorporates 22 participating agencies offering more than 46 programs. These member agencies had a cumulative budget total of $23 million in 1997. In addition, there were 488 organizations that received funds as part of the United Way-Franklin County donor designation program (Neitzel et al. 1998).

4.7.7 Educational Services

Primary and secondary education are served by the Tri-Cities and Kiona-Benton School Districts. The combined 1997 fall enrollment for all districts was approximately 32,500 students, an increase 1.7 percent from the 1996 total of 31,970 students. The 1997 total includes 8,974 from the Richland School District, 8,066 students from the Pasco School District, 13,745 students from the Kennewick School District, and 1,715 from Kiona-Benton. Private schools total approximately 3,000 students. In 1997, Richland was operating over capacity at the elementary level, at capacity at their middle schools, and slightly under capacity at the high school level.

A bond issue was recently passed to build a new elementary school, which should open in 1999. Pasco was at capacity for primary education but has room for more students at the secondary level. Pasco also passed an elementary school bond issue, and currently has three buildings under construction. Kennewick and Kiona-Benton schools are operating at capacity (Neitzel et al. 1998).

Post-secondary education in the Tri-Cities area is provided by a junior college, Columbia Basin College (CBC), and the Tri-Cities branch campus of Washington State University (WSU-TC). WSU-TC offers a variety of upper-division, undergraduate, and graduate degree programs. The 1997 fall/winter enrollment was approximately 6,869 at CBC and 1,334 at WSU-TC. Many of the programs offered by these two institutions are geared toward the vocational and technical needs of the area. Currently, 27 associate degree programs are available at CBC, and WSU-TC offers 10 undergraduate and 16 graduate programs, as well as access to eight additional graduate programs via satellite (Neitzel et al 1998).

4.7.8 Transportation

The Tri-Cities serve as a regional transportation and distribution center with major air, land, and river connections (Figure 4-29). The Tri-Cities have direct rail service, provided by Burlington Northern Santa Fe and Union Pacific, which connects the area to more than 35 states. Union Pacific operates the largest fleet of refrigerated rail cars in the United States and is essential to food processors that ship frozen food from this area. Passenger rail service is provided by Amtrak, which has a station in Pasco (Neitzel et al. 1997).

Docking facilities at the Ports of Benton, Kennewick, and Pasco are important aspects of the regional infrastructure. These facilities are located on the 525-km (325.5-mi)-long commercial waterway, which includes the Snake and Columbia rivers and extends from the Ports of Lewiston-Clarkston in Idaho to the deep-water ports of Portland, Oregon, and Vancouver, Washington. The average shipping time from the Tri-Cities to these deep-water ports by barge is 36 hours (PNNL 1996a).

Daily air passenger and freight services connect the area with most major cities through the Tri-Cities Airport, which is located in Pasco. The airport is currently served by one national and three commuter-regional airlines. There are two runways: a main and minor crosswind. The main runway is equipped for precision instrumentation landings and takeoffs. Each runway can accommodate landings and takeoffs by medium-range commercial aircraft, such as the Boeing 727-200 and Douglas DC-9. The Tri-Cities Airport handled approximately 182,978 passengers in 1997, which is up 4.3 percent from 1996. Projections indicate that the terminal can serve nearly 300,000 passengers annually. Two additional airports, located in Richland and Kennewick, are limited to serving private and airfreight aircraft (Neitzel et al. 1998).

The regional transportation network in the Hanford vicinity (Figure 4-29) includes the areas in Benton and Franklin counties from which most of the commuter traffic associated with the Hanford Site originates. Interstate highways that serve the area are I-82, I-182, I-84, and I-90. Interstate-82 is 8 km (5 mi) south-southwest of the Hanford Site. Interstate-182, a 24-km (15-mi)-long urban connector route, located 8 km (5 mi) south-southeast of the Hanford Site, provides an east-west corridor linking I-82 to the Tri-Cities area. Interstate-90, located north of the Hanford Site, is the major link to Seattle and Spokane and extends to the east coast; I-82 serves as a primary link between Hanford and I-90 and I-84. I-84, located south of the Hanford Site in Oregon, is the major link to Portland and extends eastward. SR 224, south of the Hanford Site, serves as a 16-km (10-mi) link between I-82 and SR 240.