3.0 Site-Specific End State Description

The goal of cleanup of the Hanford Site is to protect human health and the environment from hazardous substances that will remain after cleanup for the reasonably anticipated future land uses of the site. This chapter describes DOE's end state vision for the Hanford Site based on consideration of the land uses selected in the CLUP (DOE 1999a) and record of decision (ROD) (64 FR 61615) in order to define a set of actions that will meet this cleanup goal. Thus, the end state vision describes what DOE believes is a protective and regulatory-compliant outcome of the final remedial decisions for cleanup of the Hanford Site. See Section 3.2.3 for a discussion of the current land uses and anticipated future land use.

This end state vision has been modified in response to feedback from stakeholders and regulatory agencies received during the development of the final document. Public and regulator input was solicited through issuance of an April 2004 *Draft Hanford Site Risk-Based End State Vision* document that was made publicly available and through several briefings regarding the April 2004 Draft. In addition, this final document has benefited from feedback received from three Hanford End State Workshops, held in June and August 2004 and May 2005 (see http://www/hanford.gov/docs/rbes). The workshops were held as part of the end state initiative of the Tri-Parties IAMIT. The purpose of this initiative is to develop a clear picture of the Hanford Site when cleanup is complete. These end state workshops did not assume or limit possible future uses of the Hanford Site to the CLUP (DOE 1999a) land uses, so they were not specifically focused on the Hanford Site End State Vision document. However, much of the workshop feedback was relevant in developing assumptions, approaches, and recommendations and influenced the final Hanford End State Vision. This section provides information on these workshops, summarizes the feedback received and indicates how the April 2004 draft document changed based on consideration of this feedback.

This document is not a cleanup decision document, but provides information that may help focus remedial investigations, feasibility studies, work planning, and execution and consultation with the regulatory agencies and the public towards decision making. In particular, DOE believes that this end state vision provides information to form the basis for a reasonable cleanup alternative in the context of the CERCLA remedy decision process. The role of alternatives in this process is recapped in the following paragraphs.

Cleanup actions are selected based upon remedial action objectives for an area and media of concern, and an evaluation of remedial action alternatives to achieve the cleanup goal using criteria specified in the CERCLA implementing regulations, 40 CFR 300.430.[1] The development and selection of alternatives that will be evaluated for a particular area is an iterative process that includes, as appropriate, a screening of potentially effective remedies that will undergo a detailed analysis to provide relevant information regarding cleanup options to the decision maker. Interim remedial actions have been selected based upon an abbreviated alternatives evaluation to accelerate the cleanup process and obtain early reduction of risks in a way that is expected to be consistent with the final remedial actions.

[1] While this discussion focuses on CERCLA remedy selection, the evaluation criteria and remedy selection process under federal and state hazardous waste response action requirements are generally consistent with CERCLA requirements. Hazardous waste and hazardous waste constituents are also hazardous substances under CERCLA.

In the detailed analysis, selected alternatives are evaluated against the "nine CERCLA criteria" at 40 CFR 300.430(e)(9)(iii). In addition to the evaluation of the no action alternative, or no further action alternative if an interim action has been taken, a reasonable number of alternatives should be considered for comparison to the nine CERCLA criteria and to each other to gage their relative performance. This information and identification of a preferred alternative is provided in a proposed plan that is subject to public review and comment before a remedy is selected after consideration of public comments.

In accordance with the CERCLA remedy selection process, the nine evaluation criteria are grouped into *Threshold*, *Balancing,* and *Modifying* categories. The conduct of the alternatives analysis is generally organized based on the nine criteria in three categories as follows:

- Two Threshold Criteria – A remedy must (1) be adequately protective of human health and the environment and (2) must meet applicable or relevant and appropriate requirements (ARARs) unless a requirement is properly waived.

- Five Balancing Criteria – Alternative remedies that meet the Threshold Criteria are further evaluated for overall effectiveness using the following three Balancing Criteria (3) long-term effectiveness and permanence; (4) reduction in toxicity, mobility, or volume through treatment; and (5) short-term effectiveness.

  The overall effectiveness of each alternative is compared to the Balancing Criteria, i.e., cost, to determine overall cost effectiveness of an alternative. Cost-effective alternatives are then evaluated for implementability. Thus, the last two Balancing Criteria are (6) cost and (7) implementability.

- Two Modifying Criteria – Cost-effective, implementable alternatives are balanced against (8) state acceptance and (9) community acceptance.

The end state vision is not a detailed analysis of these criteria, but some consideration was given to each criteria. In developing the end state vision, however, several criteria were more important to determining the risk basis of the end state and were given more weight than others. Key factors in this regard were:

- "Adequate protection" is taken to be within the CERCLA acceptance range of 10^{-6} to 10^{-4} lifetime excess cancer risk for carcinogens and a hazard index below 1 for systemic toxicants for humans and within the range that does not cause unacceptable damage to ecological resources on a population basis, or in the case of protected species on an individual basis.

- While hazardous substances may pose a threat of exposure, adequate protection assumes exposure pathways and exposure models based on the CLUP (DOE 1999a) land uses, while recognizing that land-use controls to preserve this use for very long periods are important in some instances.

- Many ARARs are standards based, but usually provide for some flexibility based upon site-specific circumstances to allow application of "risk based" compliance approaches if adequate protection of human health and the environment will be achieved. While this flexibility is discretionary, reasonable applications include establishing groundwater points of compliance that recognize groundwater is not used as a drinking water or irrigation source.

- While not favored, CERCLA does provide for an ARAR waiver based on a showing of technical impracticability. While not determined at this point, it is assumed that this type of waiver may be relevant not just under the end state vision, but also under other alternatives.

- The protectiveness risk range provides flexibility to balance short-term risks posed by hazards encountered during remedy implementation, such as risks to workers from handling hazardous substances, risks from treatment processes, and risks from transportation. Thus, remedies that achieve adequate protection at the higher end of the risk range, but that avoid short-term risks posed by remedies achieving the lower end of the range, are appropriate to consider.

- Similarly, use of risk range flexibility to avoid short-term risks in determining adequate long-term effectiveness and permanence, and reduction in toxicity, mobility, or volume through treatment is appropriate to consider.

- While the end state vision alternative is believed to provide overall effectiveness, the overall cost effectiveness of the End State Vision alternative is not determined. Areas of possible significant cost savings are recognized and stated where known or estimated at this time. However, a detailed analysis may show that long-term operation and maintenance costs could increase as short-term costs decrease.

- The federal government will own and, therefore, control the land use for the foreseeable future. However, based on consultation with the regulatory agencies and the community, such as through the dialogue and feedback at the three Hanford End State Workshops, the degree of acceptance of the CLUP (DOE 1999a) as the land use end state and DOE's ability to control land use long-term varies for specific areas of the site. While this feedback is discussed in this document, the end state vision assumes adequate institutional controls for as long as necessary to maintain and implement a protective remedy.

The CLUP anticipates multiple uses of the Hanford Site, including anticipated future DOE missions, non-DOE federal missions, and other public and private-sector land uses. DOE's selected land-use alternative includes the following elements:

- *Cleanup Mission* – consolidate waste management operations on 50.1 square kilometers (20 square miles) in the Central Plateau of the Hanford Site

- *Economic Development Mission* – allow industrial development in the eastern and southern portions of Hanford and increase recreational access to the Columbia River

- *Natural Resource Trustee Mission* – expand the existing Saddle Mountain National Wildlife Refuge to include all of the Wahluke Slope, consistent with the 1994 Hanford Reach environmental impact statement (DOI 1994) and 1996 Hanford Reach (DOI 1996); place the ALE Reserve under U.S. Fish and Wildlife Service management by permit so it may be included in the overlay wildlife refuge.

Based on the extensive public comments received on the CLUP, the following changes were also included in the selected alternative:

- All conservation (mining and grazing) was changed to conservation (mining).
- The National Wildlife Refuge designation was extended to include ALE, the Riverlands, and McGee Ranch, and all river islands not in Benton County. The selected alternative clarifies that the refuge will be an overlay wildlife refuge, and that DOE retains the right to mine a portion of ALE for cover materials.
- A railroad right-of-way through the Riverlands portion of the proposed national wildlife refuge was given status as a pre-existing condition and was included in the U.S. Fish and Wildlife Service permit to manage the refuge.
- The White Bluffs town site was added to the selected alternative map as low-intensity recreation to serve as the White Bluffs Memorial.
- The low-intensity recreation comfort stations along the river, which could eventually serve as anchor points for a river trail from Richland to the Vernita Bridge, were moved to ensure that they have both river and road access.
- A high-intensity recreation triangle was added to the selected alternative map near Horn Rapids Park on the Yakima River.

3.1 Physical and Surface Interface

The Hanford Site lies within the semi-arid Pasco Basin of the Columbia Plateau in southeastern Washington State. The site occupies an area of ~1,517 square kilometers (~586 square miles) north of the confluence of the Yakima River with the Columbia River. Within the geographic boundary of the site, there are 36.42 square kilometers (14.1 square miles) of Columbia River surface water, and one section (2.6 square kilometers [1 square mile]) of land owned by the state of Washington.

The Hanford Site is about 50 kilometers (30 miles) north to south and 40 kilometers (24 miles) east to west. The Columbia River flows through the northern part of the site and, turning south, forms part of the 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 site's northern boundary. Two small east-west ridges, Gable Butte and Gable Mountain, rise above the plateau in the central part of the 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. A description of the Hanford Site can be found in the annual environmental report (Poston et al. 2003). Details about Hanford Site groundwater can be found in the annual monitoring report (Hartman et al. 2003).

Figure 3.1a shows the current physical and surface interface on the Hanford Site. Figure 3.1b shows the End State Vision for the Hanford Site.

As discussed in Section 2.1, the Hanford Site lies in the Columbia Plateau. This plateau was formed by a thick sequence of Miocene-Age basalt flows called the Columbia River Basalt Group. In addition to the Columbia River Basalt Group, stratigraphic units underlying the Hanford Site include, in ascending order:

- **Ringold Formation** – a mix of variably cemented and compacted gravel, sand, silt, and clay deposited by the ancestral Columbia and Snake Rivers. The system that deposited the sediment was a braided stream channel with the two rivers joining in the area of the present White Bluffs.

- **Plio-Pleistocene unit and Early Palouse soil** – a sequence of sidestream alluvial deposits and buried soil horizons with significant caliche in some areas. The unit overlies the Ringold Formation and is found only in the western part of the Hanford Site.

- **Hanford Formation and Pre-Missoula gravels** – coarse-grained sediment, ranging from sand to cobble and boulder size gravel, deposited from a series of cataclysmic floods during the Pleistocene Age. The floods occurred when ice dams broke, releasing water from Lake Missoula, a large glacial lake that formed in the Clark Fork River Valley. Pre-Missoula (flood) gravels underlie the Hanford formation gravel deposits in the central part of the Hanford Site. The pre-Missoula deposits are difficult to distinguish from the Hanford gravel, so they are usually grouped together.

- **Holocene surficial deposits** – a discontinuous veneer of alluvium, colluvium, and/or eolian sediment. In the 200 West Area and southern part of the 200 East Area, these deposits consist dominantly of laterally discontinuous sheets of wind-blown silt and fine-grained sand. They are generally found above the water table.

Groundwater within these sediments is present under both unconfined and confined aquifer conditions. The unconfined aquifer is contained in the unconsolidated to semiconsolidated Ringold and Hanford formations that overlie the basalt bedrock. In some areas, low permeability mud layers within the Ringold Formation form aquitards that create locally confined hydraulic conditions within the aquifer system.

The water table lies within the Hanford formation over most of the eastern and northern parts of the Hanford Site (Figure 3.1c). The Hanford formation lies entirely above the water table in the western part of the site and in some other localized areas. Within these areas, the water table is generally found in hydrogeologic units associated with the Ringold Formation. Also shown in Figure 3.1c are areas on the Hanford Site where the basalt bedrock crop out above the water table in the vicinity of Gable Butte and Gable Mountain. Basalt bedrock also extends above the water table in the southwest part of the Hanford Site as an extension of Yakima Ridge below the land surface.

Figure 3.1d shows a geologic cross section of the Hanford Site and the location of the water table between Cold Creek Valley and the Columbia River. This cross section represents A-A' on the map in Figure 3.1c and shows that the saturated sediment of the Hanford formation represents a small portion of the total saturated sediment above basalt when compared to the total saturated thickness of the Ringold Formation.

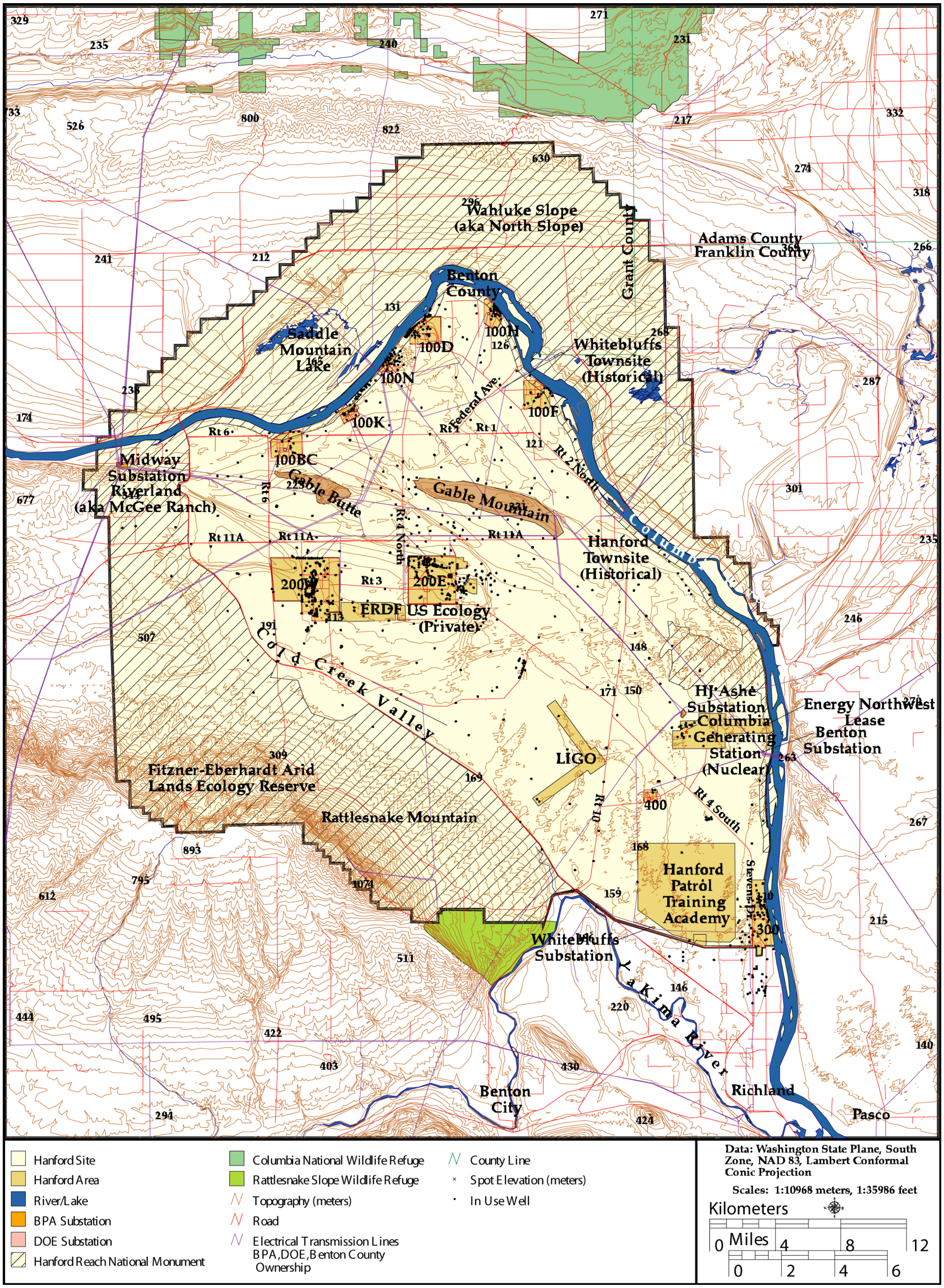


Figure 3.1a. Site Physical and Surface Interface – Current State

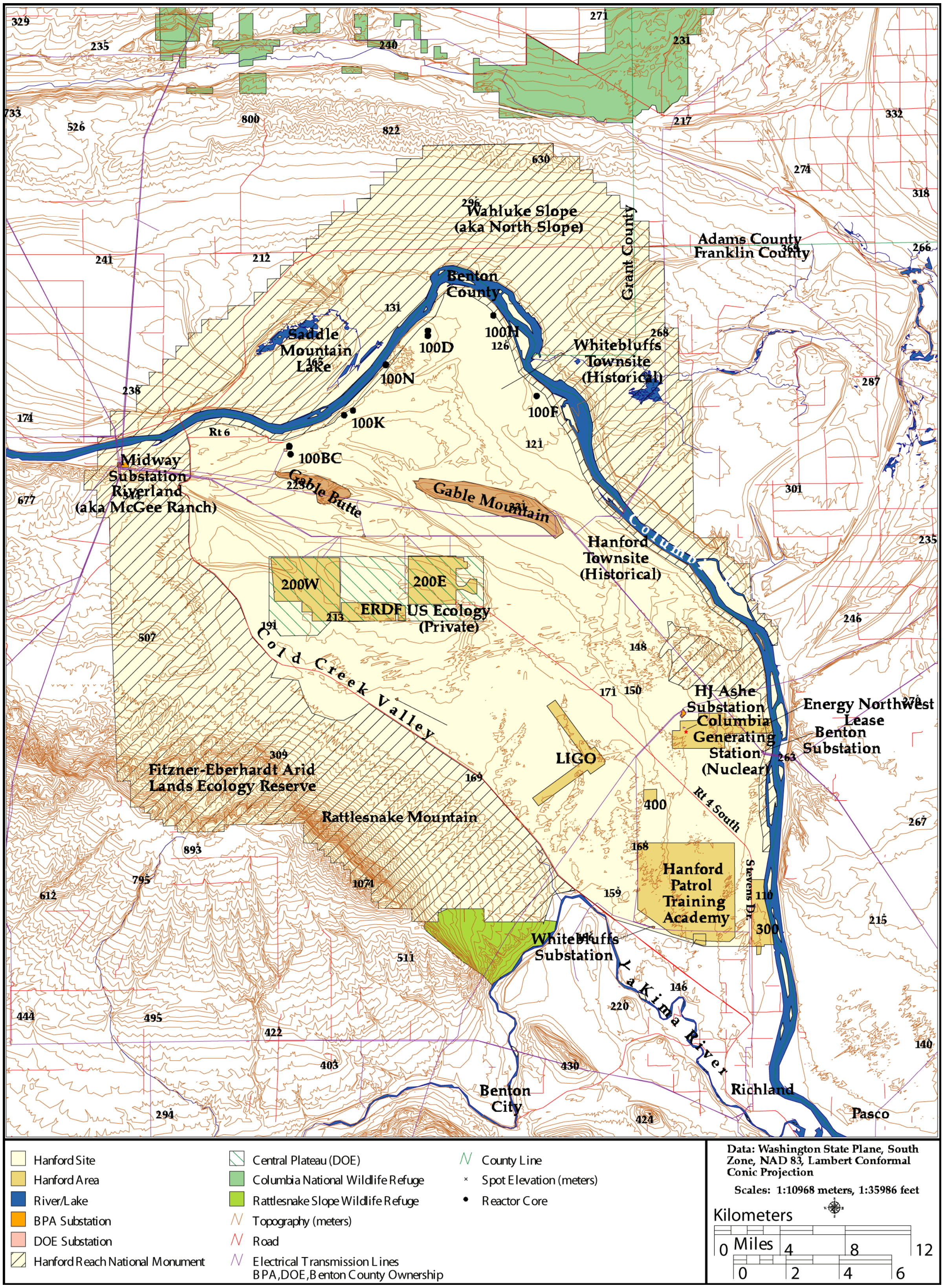


Figure 3.1b. Site Physical and Surface Interface – End State Vision

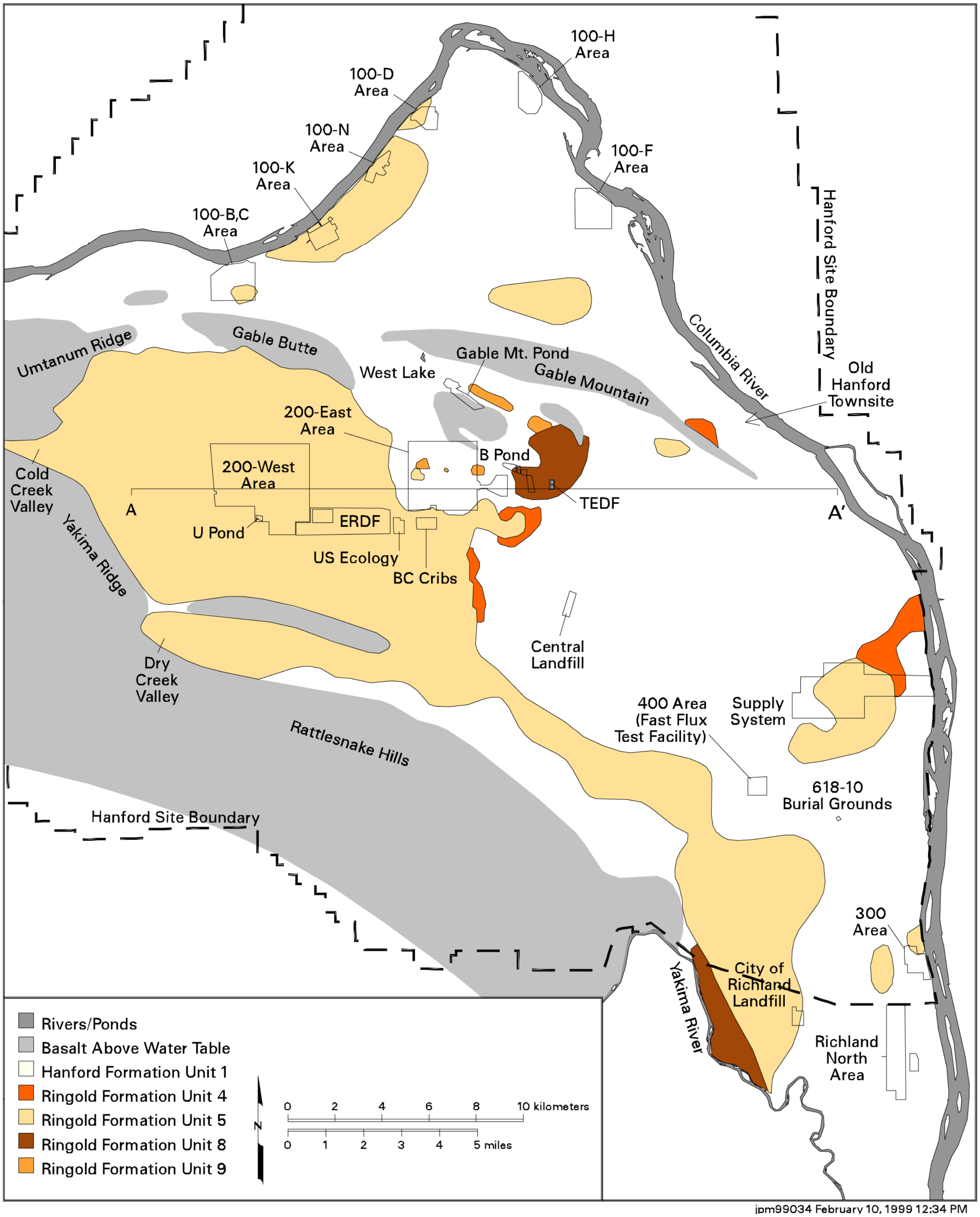


Figure 3.1c. Major Hydrogeologic Units at the Water Table in March 1999

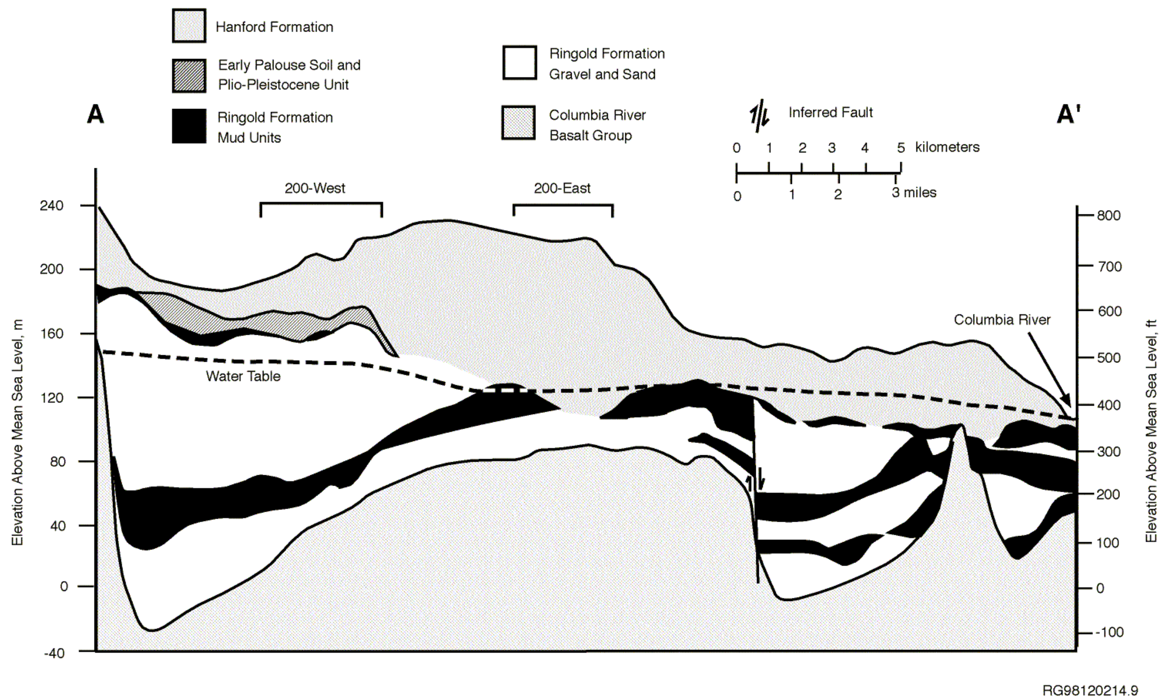


Figure 3.1d. West-East Cross Section Showing Major Hydrogeologic Units at the Hanford Site and the Water Table in 1999

The major stratigraphic and the corresponding hydrogeologic units contained within the Hanford and Ringold formations, provided in Figure 3.1e, show key differences in sediment characteristics among the major units. The geologic column on the right defines the lithostratigraphic units, based on mapping and physical properties of the sediment, modified from Lindsey (1995). The hydrogeologic column on the left defines hydrostratigraphic units based on hydraulic properties (Thorne et al. 1993).

A sequence of basalt-confined aquifers is present within the Columbia River Basalt Group beneath the Hanford Site. These aquifers are composed of sedimentary interbeds and the relatively permeable tops of basalt flows. The dense interior sections of the basalt flows form confining layers. The most recent basalt flow underlying the Hanford Site is the Elephant Mountain Member of the Saddle Mountains Basalt. However, the younger Ice Harbor Member is found in the southern part of the site (DOE 1988). The Rattlesnake Ridge interbed is the uppermost laterally extensive hydrogeologic unit of these sedimentary interbeds and this unit represents the uppermost confined aquifer unit.

The local unconfined aquifer flow system is bounded by Yakima River and basalt ridges on the south and west and by the Columbia River on the north and east. The Columbia River represents a point of regional discharge for the unconfined aquifer system. Groundwater in the unconfined aquifer generally flows from upland areas in the west and southwest parts of the Hanford Site either north through the gap between Gable Butte and Gable Mountain or east toward the Columbia River where it eventually discharges into the Columbia River. Groundwater in the basalt-confined aquifers also generally flows from elevated regions at the edge of the Pasco Basin toward the Columbia River (Spane and Webber 1995). However, the discharge zone locations are also influenced by geologic structures that increase the vertical permeability of the confining basalt layers.

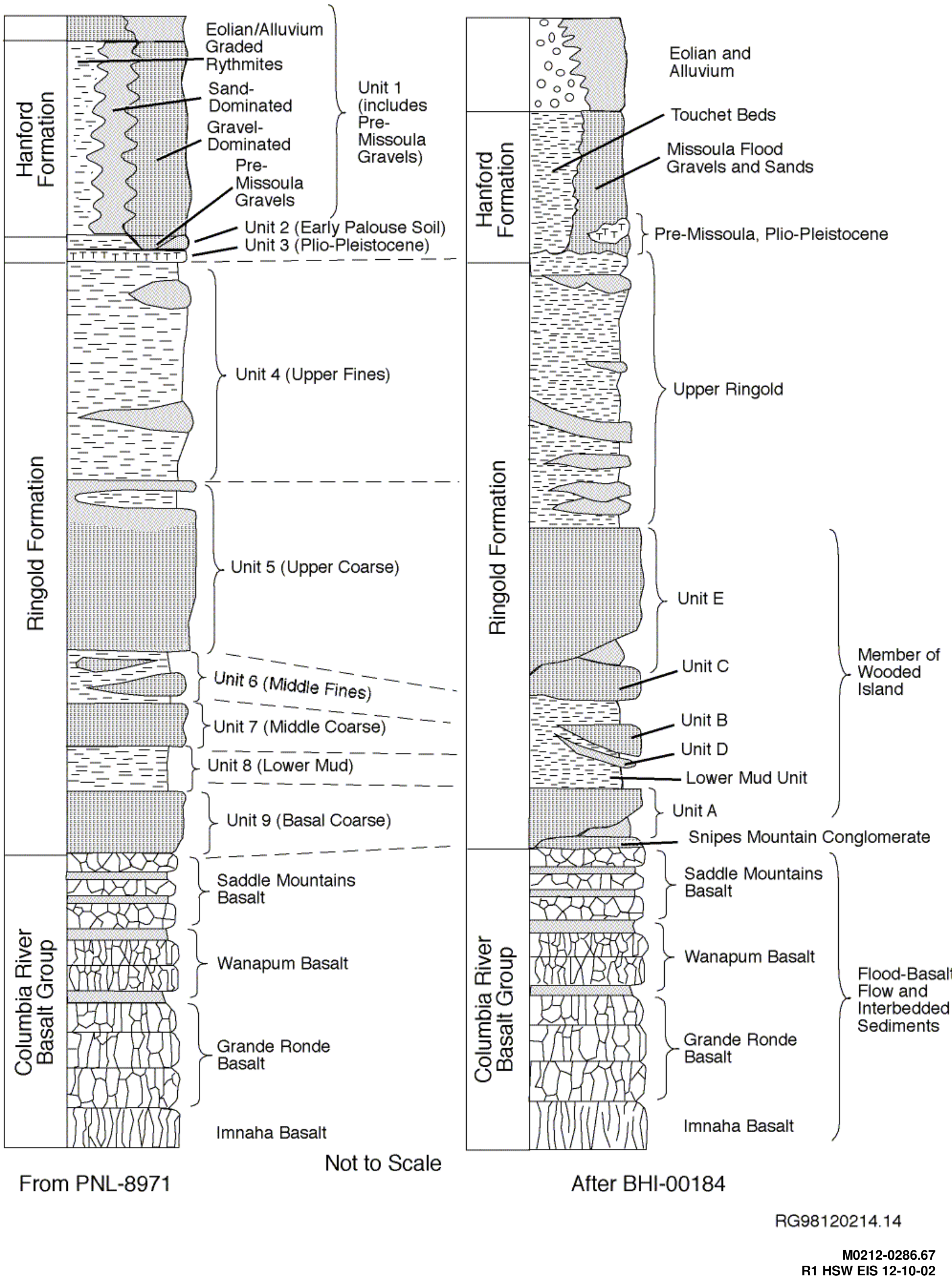


Figure 3.1e. Comparison of Generalized Hydrogeologic and Geologic Stratigraphy (from Thorne et al. 1993 and after Lindsey 1995)

The amount of groundwater within the unconfined and confined aquifers discharging to the Columbia River and the lower reaches of the Yakima River is a function of the local hydraulic gradient between the groundwater elevation adjacent to the river and the river stage elevation. This hydraulic gradient is highly variable because the river stage is affected by releases from upstream dams. Estimates made using the site-wide model indicate that groundwater discharging to the Columbia River from the Hanford side of the river would be less than 0.1 of 1% of the average annual flow in the river of about 2,832 cubic meters (100,000 cubic feet) per second.

Existing plumes of tritium and iodine-129 migrating east from 200 East Area discharge into the Columbia River near the Hanford town site. Plumes of tritium and technetium-99 also migrating north through the gap between Gable Mountain and Gable Butte have reached the river in the 100-B/C Area. Plumes of various constituents also discharge into the river in vicinity in all of the 100 Areas and the 300 Area.

Recharge to the unconfined aquifer system occurs from several sources including

- Infiltration of precipitation falling across the Hanford Site
- Infiltration of runoff from elevated regions along the western and southwest boundary of the Hanford Site
- Infiltration of spring water and upwelling of groundwater that originates from the basalt-confined aquifer system
- Artificial recharge in vicinity of onsite wastewater facilities, offsite irrigation, and nearby municipal city of Richland water supply systems

Recharge from infiltration of precipitation is highly variable, both spatially and temporally, and ranges from near zero to greater than 100 millimeters (3.9 inches) per year, depending on climate, vegetation, and soil texture (Gee et al. 1992; Fayer and Walters 1995). Recharge from precipitation is highest in coarse-textured soil with little or no vegetation, which is the case for most of the industrial areas on the Hanford Site. A recharge distribution applied in the site-wide model, described in Cole et al. (1997, 2001) and shown in Figure 3.1f, is based on distributions of soil and vegetation types.

The majority of runoff from elevated regions along the western and southwest boundary of the Hanford Site infiltrates into the unconfined aquifer system within Cold Creek and Dry Creek Valleys and along the base of Rattlesnake Hills at the west and southwest boundaries of the Hanford Site.

The aquifer also receives recharge from upper reaches of the Yakima River where water level in the river is above the regional water table.

Intercommunication between the unconfined aquifer and the uppermost basalt-confined aquifer occurs from several leakage processes. The major sources of leakage include

- Leakage distributed areally through the uppermost basalt confining layer (that is, the Elephant Mountain Member of the Saddle Mountains Basalt)

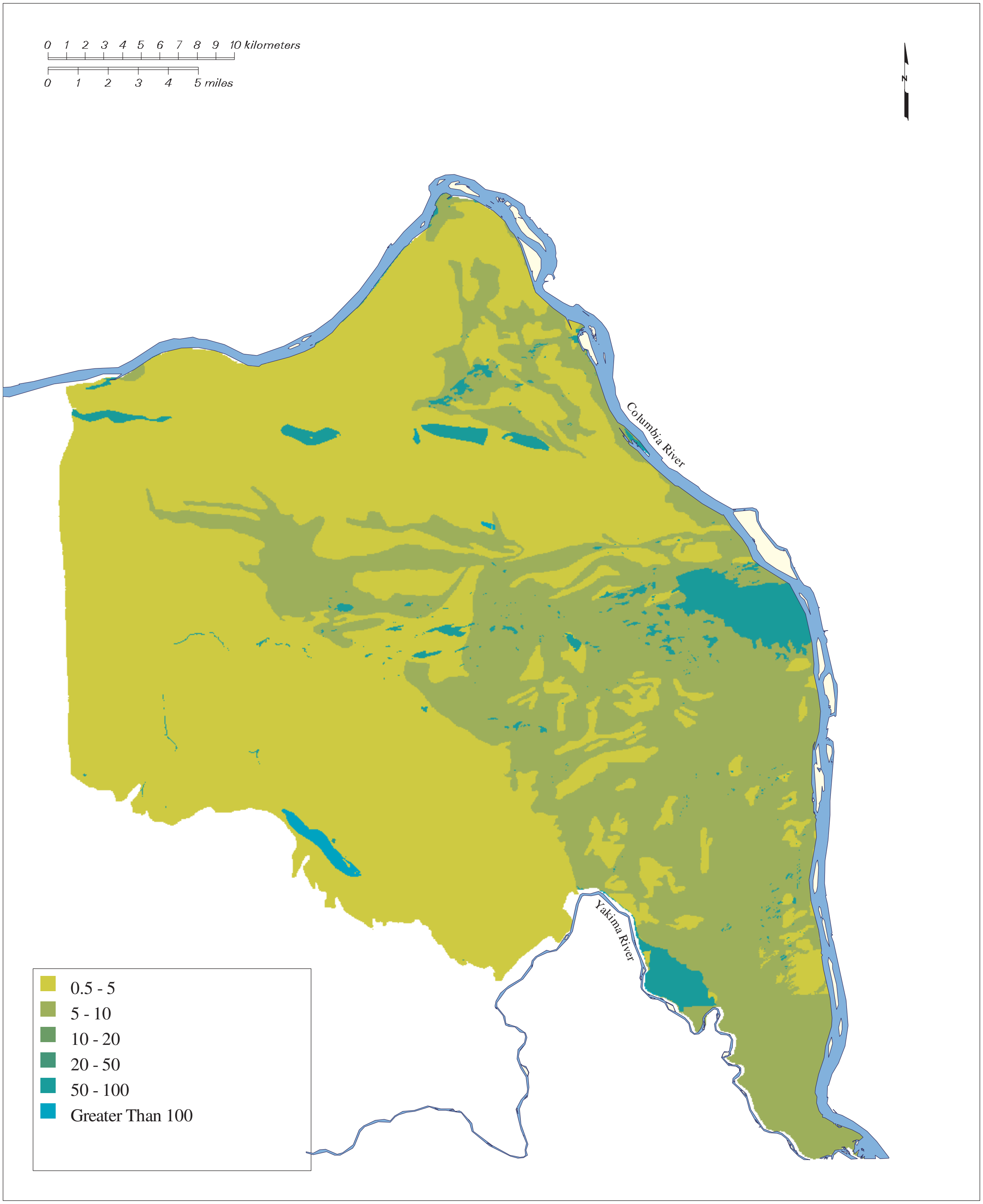


Figure 3.1f. Estimates (in millimeters) of Recharge for 1979 Conditions (Fayer and Walters 1995)

- Leakage at an erosional window through the uppermost confining unit near Gable Mountain/Gable Butte and near B Pond
- Leakage along two thrust fault zones north of Gable Mountain and Gable Butte and north of the Yakima Ridge

Since the start of Hanford Site operations in the mid-1940s, the unconfined aquifer system has also been significantly affected by artificial recharge from onsite wastewater disposal facilities. The artificial recharge has been several times greater than the estimated recharge from natural sources. This caused an increase in the water-table elevation over most of the Hanford Site and the formation of groundwater mounds beneath major wastewater disposal facilities. The regional rise in water table was at its highest historical levels in the early to mid-1980s when the mounds in 200 East and 200 West Areas were about 10 and 22 meters (33 and 66 feet) higher than estimated pre-Hanford water-table conditions, respectively.

Beginning in 1988, plutonium production activities on the Hanford Site ended, which resulted in a decrease of wastewater disposal and subsequent decreases in water-table elevation over much of the site. Remnants of the groundwater mounds that formed during the historical periods of highest wastewater discharge are still evident in the vicinity of major discharge facilities near 200 East and 200 West Areas.

The unconfined aquifer system has also been affected locally by other sources of artificial recharge as a result of irrigation in the upper Cold Creek Valley in the western part of the Hanford Site, in agricultural areas south of the Hanford Site, and in the vicinity of the recharge basin/withdrawal well system used by the city of Richland for municipal water supply.

These past and current hydraulic impacts on the unconfined aquifer system are predicted to subside in the future and the aquifer system is expected return to more natural flow conditions over the next 300 to 400 years. Previous modeling analysis by Cole et al. (1997) suggests that as water levels drop in the central areas of the Hanford Site, where the surface basalt features associated with Gable Butte and Gable Mountain crop out above the water table, the saturated thickness of the unconfined aquifer will decrease and the aquifer may actually dry out in certain areas. This thinning/drying of the aquifer is predicted to occur in the area just north of the 200 East Area between Gable Butte and the outcrop south of Gable Mountain; a potential exists for this northern area of the unconfined aquifer to become hydrologically separated from the area south of Gable Mountain and Gable Butte.

3.2 Human and Ecological Land Use

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. In 1943, the federal government acquired the Hanford Site for production of nuclear materials to be used in development of the atomic bomb.

3.2.1 Land Use Adjoining the Hanford Site

Land use adjoining the Hanford Site includes a low-level radioactive waste decontamination, super-compaction, plasma gasification and vitrification unit (operated by Pacific EcoSolutions) and a commercial nuclear fuel fabrication facility (operated by AREVA).

3.2.2 Hanford Site Land Use

Land-use categories at the Hanford Site include reactor operations, waste operations, administrative support, operations support, sensitive areas, and undeveloped areas (Figure 3.2a). 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.

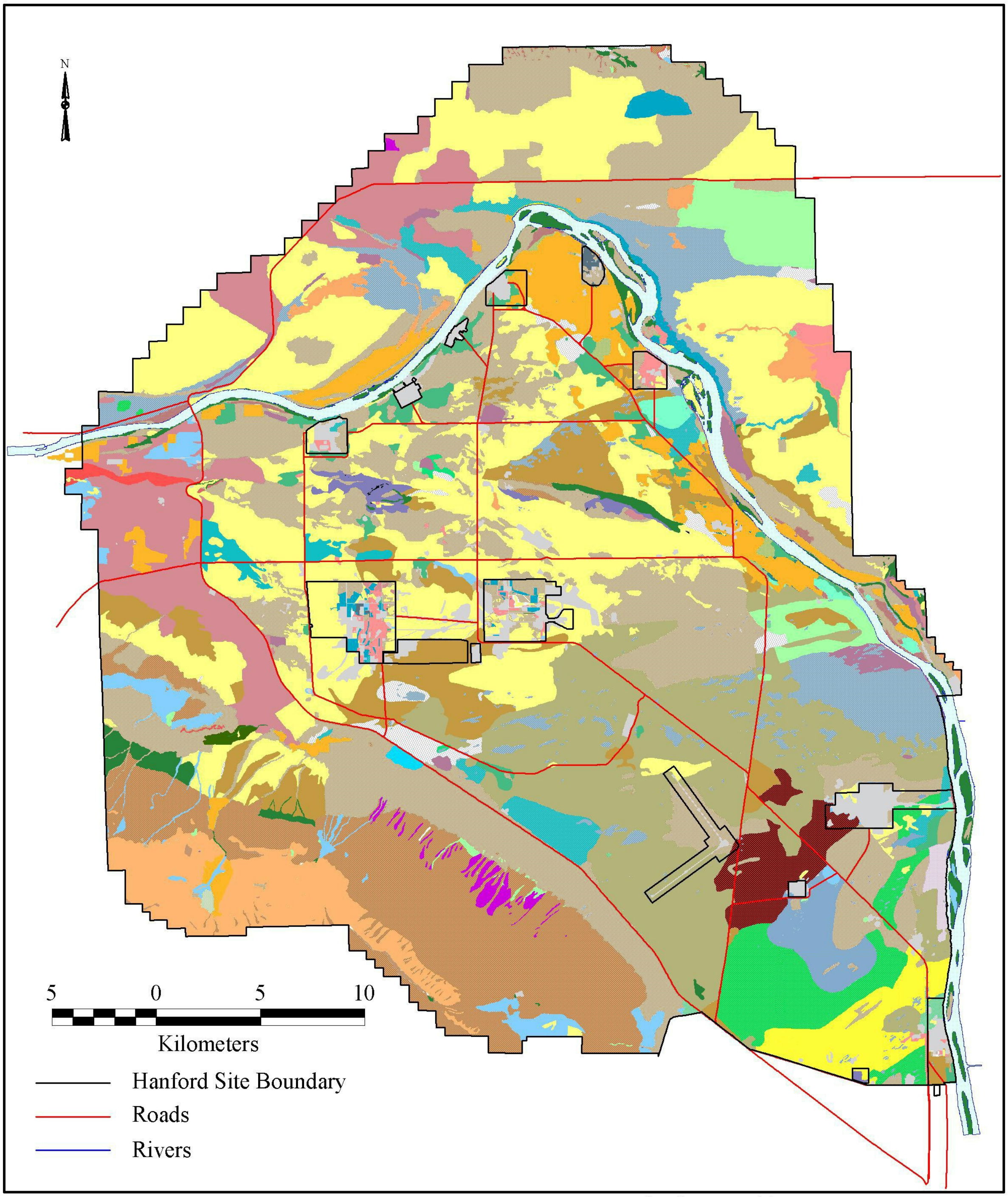
In 2000, the Hanford National Monument Proclamation (65 FR 37253) became the dominant reservation for many of the Wahluke Slope, Columbia River Corridor, McGee/Riverlands, and ALE lands. These lands are still being managed by DOE and its permittees under agreements that follow. DOE is in the process of transitioning the administrative ownership and prime management of monument lands to the U.S. Fish and Wildlife Service.

3.2.2.1 Wahluke Slope

The area north of the Columbia River encompasses ~357 square kilometers (~138 square miles) of relatively undisturbed or recovering shrub-steppe habitat. The northwest portion of the area is managed by the U.S. Fish and Wildlife Service under a permit issued by DOE in 1971 as the Saddle Mountain National Wildlife Refuge. The permit conditions require that the refuge remain closed to the public as a protective perimeter surrounding Hanford operations. The closure has benefited migratory birds, such as curlews, loggerhead shrikes, and waterfowl.

Until recently, in the northeast portion of the Wahluke Slope, the Washington Department of Fish and Wildlife operated the Wahluke State Wildlife Recreation Area, which was established in 1971. In April 1999, the Washington Department of Fish and Wildlife and the U.S. Fish and Wildlife Service notified DOE of their intent to modify their management responsibilities on the Wahluke Slope under the 1971 agreement, leaving only a small portion (~324 hectares [~800 acres]) northwest of the Vernita Bridge under Washington Department of Fish and Wildlife permit. The U.S. Fish and Wildlife Service informed DOE that it intended to allow essentially the same uses permitted by the state of Washington under the Washington Department of Fish and Wildlife's management of the Wahluke Slope. Therefore, transfer of management of the Wahluke Slope from the Washington Department of Fish and Wildlife to the U.S. Fish and Wildlife Service 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 U.S. Fish and Wildlife Service as an overlay wildlife refuge is consistent with the 1996 U.S. Department of Interior (DOI) ROD for the Hanford Reach environmental impact statement (DOI 1996). 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 U.S. Fish and Wildlife Service.

The Washington Department of Fish and Wildlife had leased a total of ~43 hectares (~107 acres) 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 Washington Department of Fish and Wildlife issued a grazing permit for ~3,756 hectares (~9,280 acres), allowing up to 750 animal-unit-months to graze the parcel. This grazing lease was allowed to expire on December 31, 1998. But under *State Environmental Protection Act* (WAC 365-195-610) regulations, for up to 10 years after the expiration of the lease, the Washington Department of Fish and Wildlife can reinstate the grazing lease without public review.



Data Collected: 1994, 1997/The Nature Conservancy
1991, 1999 Pacific Northwest National Laboratory
Map Created: September 1999/Pacific Northwest National Laboratory

Figure 3.2a. Site Human and Ecological Land Use – Current State Distribution of Vegetation Types and Land Use Areas on the Hanford Site Prior to the 24 Command Fire of 2000 (Neitzel 2001). Legend on following page.

LEGEND

- Abandoned Old Agricultural Fields
- Alkali Saltgrass - Cheatgrass
- Big Sagebrush - Bitterbrush / Bunchgrass
- Big Sagebrush - Bitterbrush / Needle-and-Thread Grass
- Big Sagebrush - Bitterbrush / Sandberg's Bluegrass
- Big Sagebrush - Rigid Sagebrush / Bunchgrass
- Big Sagebrush - Rock Buckwheat / Bunchgrass
- Big Sagebrush - Spiny Hopsage / Bunchgrass
- Big Sagebrush - Spiny Hopsage / Sandberg's Bluegrass - Cheatgrass
- Big Sagebrush / Bluebunch Wheatgrass
- Big Sagebrush / Bunchgrass
- Big Sagebrush / Needle-and-Thread Grass
- Big Sagebrush / Sand Dropseed
- Big Sagebrush / Sandberg's Bluegrass - Cheatgrass
- Bitterbrush / Bunchgrass
- Bitterbrush / Indian Ricegrass
- Bitterbrush / Needle-and-Thread Grass
- Black Greasewood / Alkali Saltgrass
- Bluebunch Wheatgrass - Needle-and-Thread Grass
- Bluebunch Wheatgrass - Sandberg's Bluegrass
- Bunchgrass - Cheatgrass
- Crested Wheatgrass
- Disturbed
- Gray Rabbitbrush - Snow Buckwheat / Bunchgrass
- Gray Rabbitbrush / Bunchgrass
- Gray Rabbitbrush / Cheatgrass
- Gray Rabbitbrush / Needle-and-Thread Grass
- Gray Rabbitbrush / Sand Dropseed
- Gray Rabbitbrush / Sandberg's Bluegrass - Cheatgrass
- Needle-and-Thread Grass - Indian Ricegrass
- Needle-and-Thread Grass -Sandberg's Bluegrass
- Non-Riverine Wetlands and Associated Deepwater Habitats
- Rabbitbrush / Bunchgrass
- Rigid Sagebrush / Sandberg's Bluegrass
- Riparian
- Riverine Wetlands and Associated Deepwater Habitats
- Sand Dropseed - Sandberg's Bluegrass - Cheatgrass
- Sandberg's Bluegrass - Cheatgrass
- Snow Buckwheat - Bitterbrush / Bunchgrass
- Snow Buckwheat / Bunchgrass
- Snow Buckwheat / Sandberg's Bluegrass - Cheatgrass
- Spiny Hopsage / Sandberg's Bluegrass - Cheatgrass
- Talus
- Threetip Sagebrush / Bunchgrass
- Thymeleaf Buckwheat / Sandberg's Bluegrass
- Vernal Pool
- White Bluffs
- Winterfat / Bunchgrass

Figure 3.2a. (contd) Legend for Figure 3.2a

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* (National Park Service 1994), the Wahluke State Wildlife Recreation Area has more than 40,000 visits per year by recreationalists. Most recreational visits are related to sport fishing in the Columbia River.

The Wahluke Slope once contained small, non-radioactively contaminated sites (e.g., military and farmstead landfills). In February 1996, a no further action ROD was signed documenting that previous removal actions done in 1993 and 1994 removed all contaminants to below the WAC 173-340 Washington *Model Toxics Control Act Cleanup Regulation cleanup levels* and that these areas do not pose a threat to human health or the environment. The DOE is not planning to alter the current land uses of the Wahluke Slope and is specifically prohibited from causing any adverse impact on the values for which the area is under consideration for wild and scenic river (DOI 1996).

3.2.2.2 Columbia River Corridor

Portions of the 111.6 square kilometers (43.1 square miles) of the 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 Area NPL site occupies ~68 square kilometers (~26 square miles) 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 CERCLA remedial actions, reactor decommissioning, and undeveloped areas used by wildlife. Future use restrictions will be placed as appropriate on the CERCLA sites, such as institutional controls on activities that potentially extend beyond 4.6 meters (15 feet) below ground surface.

The area known as the Hanford Reach includes an average of a 402-meter (1,320-foot) strip of federally owned land on either side of the Columbia River. The Hanford Reach is the last unimpounded, non-tidal segment of the Columbia River in the United States. In 1988, Congress passed *The Hanford Reach Study Act*, 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 final *Hanford Reach of the Columbia River, Comprehensive River Conservation Study and Environmental Impact Statement Final - June 1994* (National Park Service 1994). The ROD (DOI 1996) issued as a result of this document 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 ~728 hectares (~1,800 acres) of private land located in the Hanford Reach Study Area be included in the recreational river boundary but not the refuge boundary.

On June 9, 2000, the President signed a proclamation creating the Hanford Reach National Monument (65 FR 37253). The monument encompasses 793 square kilometers (306 square miles) of lands already owned by the federal government that were planned for preservation or conservation in the land-use plan (DOE 1999a). No changes have occurred to related land uses since the monument designation.

The U.S. Fish and Wildlife Service is writing a comprehensive conservation plan environmental impact statement for all lands within the monument (with DOE-RL as a cooperating agency), which should be completed in 3 years. DOE-RL is working on a phased approach to transfer most of the monument land to DOI by September 2005. DOE-HQ agrees with DOE-RL and will provide support and direction as needed.

3.2.2.3 Central Plateau

The 200 East and 200 West Areas occupy ~51 square kilometers (~19.5 square miles) 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 non-radioactive waste. The primary land uses are waste operations and operations support. The CLUP (DOE 1999a) indicates that deed or land-use restrictions for activities that potentially may extend beyond 4.6 meters (15 feet) below ground surface are expected for CERCLA and RCRA remediation areas in the Central Plateau geographic study area under the rural residential scenario and down to 3.6 meters (12 feet) in an ecological scenario. In addition, it is anticipated that the Central Plateau will remain a waste management area for the foreseeable future.

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

The Environmental Restoration Disposal Facility is operated on the Central Plateau to provide disposal capacity for environmental remediation waste (e.g., low-level, mixed low-level, and dangerous waste) generated during remediation of the 100, 200, and 300 Areas of the Hanford Site. The facility is currently about 100 hectares (approximately 250 acres) and can be expanded up to 414 hectares (1,023 acres), as additional waste disposal capacity is required.

3.2.2.4 All Other Areas

The All Other Areas geographic area is 689 square kilometers (266 square miles) and contains the 300, 400, 600, and 1100 Areas; Energy Northwest 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 square kilometers (0.6 square mile). The 300 Area is the site of former reactor fuel fabrication facilities and is also the principal location of nuclear research and development facilities serving the Hanford Site. The Environmental Molecular Sciences Laboratory 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 FFTF. 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, 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.

FFTF has been permanently shutdown and is currently being deactivated including removal and washing of fuel and draining of liquid sodium coolant. In May 2003, DOE, EPA, and Ecology signed into agreement the FFTF series of Tri-Party Agreement milestones to govern the deactivation activities currently underway. A small-business solicitation was published in September 2003 seeking offers to achieve a safe and accelerated closure of FFTF by 2012 while reducing risk to the public and workers, streamlining essential operations, minimizing costs, and introducing new and innovative approaches for the deactivation and decommissioning of FFTF facilities. FFTF site tours and one-on-one sessions with interested potential bidders were held in early October 2003. The FFTF Closure Project contract was awarded in September 2004. Following a protest, an amended RFP was issued to the three offerors in the competitive range on April 29, 2005. Proposal revisions are due to DOE on May 31, 2005, and award of the contract is projected for September with transition to begin October 1, 2005.

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 Landfill, which restricts future land uses in the vicinity of the landfill because of asbestos disposal there. The Horn Rapids Landfill was included in the 1100 Area CERCLA cleanup, although it is located on the Hanford Site to the north of Horn Rapids Road; it remains in federal ownership. Also, DOE transferred ~318 hectares (~786 acres) of the former 1100 Area to the Port of Benton. DOE prepared an environmental assessment (DOE 1998) that resulted in a finding of no significant impact on August 27, 1998, for the transfer of this portion of the 1100 Area and the southern rail connection to the Port of Benton. The Port officially took ownership and control of the 1100 Area (consisting of 318 hectares [786 acres], 26 buildings, and 26 kilometers [16 miles] of railroad track) on October 1, 1998. This portion of the 1100 Area is no longer under DOE control.

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 all other geographic areas 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 ~32 hectares (~80 acres).

- Land was leased to Energy Northwest to construct three commercial power reactors in the 1970s. One plant, WNP-2, was completed and is currently operating. Activities on the other two plants were terminated and the plants will not be completed.
- In 1980, the federal government sold a 259-hectare (640-acre) section of land south of the 200 East Area, near State Route 240, to the state of Washington for the purpose of non-radioactive hazardous waste disposal. This parcel is uncontaminated (although the underlying groundwater is contaminated) and undeveloped. The deed requires that if it were used for any purpose other than hazardous waste disposal, ownership would revert to the federal government.
- The Laser Interferometer Gravitational-Wave Observatory, 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 kilometers (2.5 miles) long, arrayed in an “L” shape. The facility is sensitive to vibrations in the vicinity, which can be expected to constrain nearby land uses.

3.2.2.5 Fitzner/Eberhardt Arid Lands Ecology Reserve

The Fitzner/Eberhardt Arid Lands Ecology (ALE) Reserve (also designated as the Rattlesnake Hills Research Natural Area or ALE Reserve) encompasses 308.7 square kilometers (119.2 square miles) 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.

The mineral rights to a 518-hectare (1,280-acre) area on the ALE Reserve are owned by a private company. There are also two ongoing research and development projects under way on the ALE Reserve: gravity experiments in underground Nike bunkers located in the southern portion of the Reserve, and online 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 re-vegetated. There are two landfills on the ALE Reserve, at least one of which was used for disposal of a non-radioactive hazardous waste. Although remediated, one of the landfills may still contain hazardous materials.

DOE granted a permit and entered into an agreement with U.S. Fish and Wildlife Service to manage the ALE Reserve consistent with the existing ALE Facility Management Plan. The U.S. Fish and Wildlife Service is preparing a comprehensive conservation plan pursuant to the *National Wildlife Refuge System Improvement Act of 1997* to identify refuge management actions and to bring the ALE Reserve into the national wildlife refuge system.

3.2.3 Selected Land-Use Alternative

In developing the selected alternative, DOE took into account its role as the long-term caretaker for the Hanford Site for at least the next 50 years. Information considered by DOE includes:

- All surface waste sites, including those remediated
- Groundwater contaminants and flow direction
- Cultural and biological resources
- Exclusive-use zones and emergency planning zones associated with DOE and other Hanford activities (e.g., Energy Northwest's nuclear power reactor; US Ecology, Inc.'s low-level waste disposal site; Laser Interferometer Gravitational-Wave Observatory)

DOE believes that the selected alternative would fulfill the statutory mission and responsibilities of the agency and give adequate consideration to economic, environmental, technical, and other factors. DOE's selected alternative would establish policies and implementing procedures that would place Hanford's land-use planning decisions in a regional context.

DOE's selected alternative is illustrated in Figure 3.2b and 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.

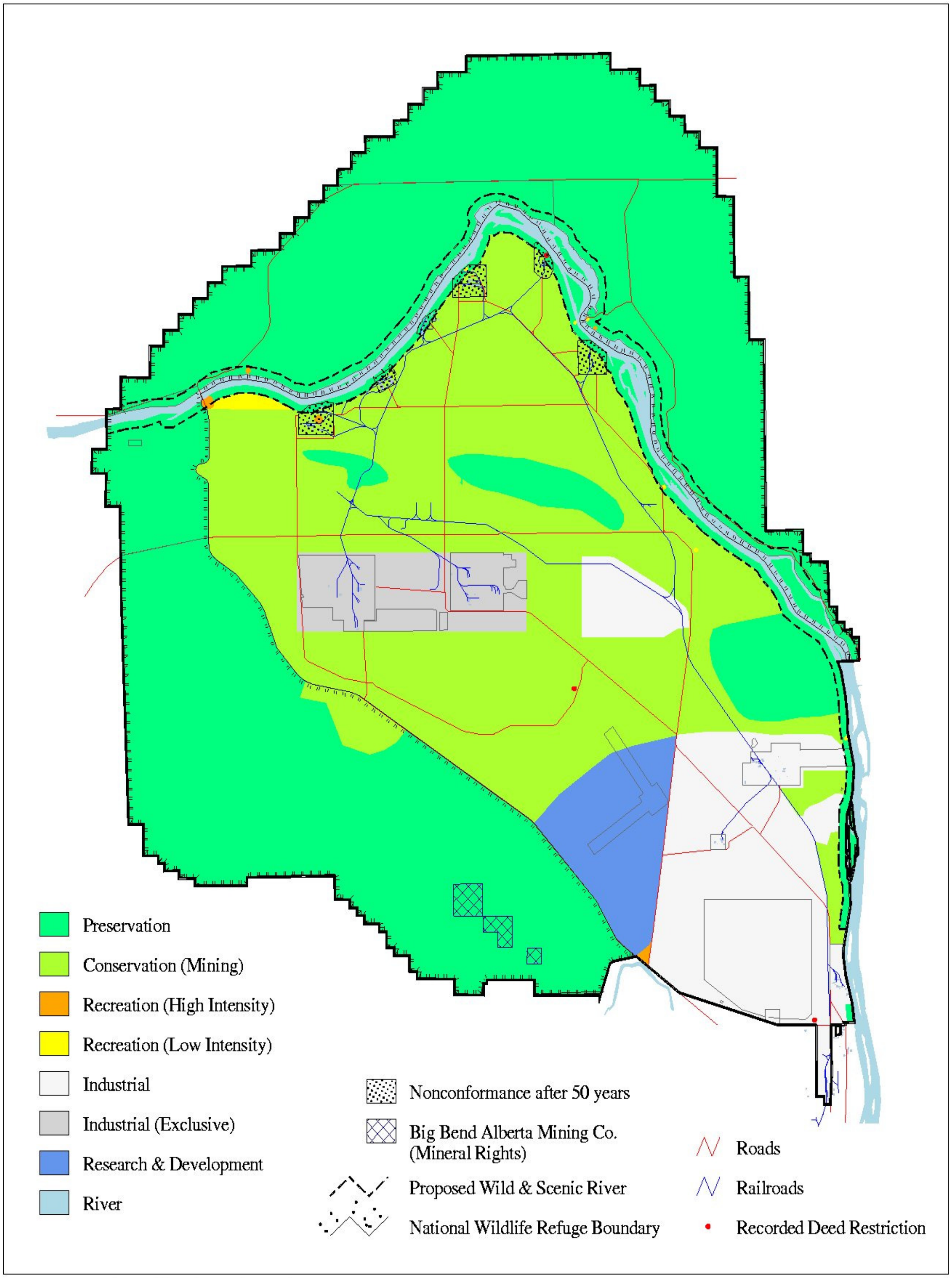
The following paragraphs discuss the End State Vision for specific areas of the Hanford Site.

3.2.3.1 Wahluke Slope

DOE's selected alternative allowed expansion of the existing Saddle Mountain National Wildlife Refuge as an overlay wildlife refuge to include all of the Wahluke Slope and consolidating management of the Wahluke Slope under the U.S. Fish and Wildlife Service, consistent with the Hanford Reach ROD (DOI 1996). An overlay refuge is one where the land belongs to one or more federal agencies, but is managed by the U.S. Fish and Wildlife Service. DOE granted a permit and entered into an agreement with U.S. Fish and Wildlife Service to manage most of the Wahluke Slope.

The entire Wahluke Slope was designated preservation, with the exceptions near the Columbia River. The major reason for designating this area as preservation is to protect sensitive areas or species of concern (e.g., wetlands, sand dunes, steep slopes, or White Bluffs) from any impact associated with intensive land-disturbing activities.

A comprehensive conservation plan for the Wahluke Slope is being developed by U.S. Fish and Wildlife Service 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 U.S. Fish and Wildlife Service is consulting 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.



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

Figure 3.2b. Site Human and Ecological Land Use – DOE's Selected Land-Use Alternative (from DOE 1999a)

3.2.3.2 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 for reactor decommissioning (DOE 1992a) 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 at many remediated waste sites 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 meters (15 feet). Although the surplus reactor ROD (DOE 1993) 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. As a result, the reactor buildings could remain in the Columbia River Corridor throughout the 50-year-plus planning period addressed by the environmental impact statement (64 FR 61615) and would be considered a pre-existing non-conformance 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 0.4-kilometer (0.25-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.

The Hanford CLUP (DOE 1999a, pg. 3.21) indicates that 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 considered for a museum and the surrounding area could be available for museum-support facilities. 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 facilities. Two areas on the Wahluke Slope would be designated as high-intensity recreation for potential exclusive tribal fishing (DOE 1999a).

The plan also indicates that 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. 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 along the Hanford Reach. A sixth site, just north of Energy Northwest, 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 0.4-kilometer (0.25-mile) buffer zone would be designated for conservation (mining). 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). A conservation (mining) designation would allow DOE to provide protection to sensitive cultural and biological resource areas, while allowing access to geologic resources. Activities that use or effect groundwater would continue to be restricted.

A preservation land-use designation for the Columbia River islands would be consistent with the Hanford Reach 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 Areas), and would be considered a pre-existing, non-conforming use in the preservation land-use designation.

DOE is considering whether each of these designations is appropriate under the designation of the Hanford Reach as a National Monument. For land which under the control of the U.S. Fish and Wildlife Service, future uses will be dealt with through the Comprehensive Conservation Plan.

3.2.3.3 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 Future Site Uses Working Group's recommendations, current DOE management practice, other governments' recommendations, and many public stakeholder values throughout the region.

3.2.3.4 All Other Areas

Within all other geographic areas, the selected alternative would include industrial, research and development, high-intensity recreation, low-intensity recreation, conservation, and preservation land-use designations. The majority of all other areas would be designated conservation (mining).

3.2.3.5 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.

3.2.3.6 Fitzner/Eberhardt Arid Lands Ecology 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 U.S. Fish and Wildlife Service 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 surface barriers 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 than the cheat grass in the ALE Reserve quarry site.

3.3 Site Context Legal Ownership

The Hanford Site land holdings consist of three different real property classifications, all currently under DOE jurisdiction (Figure 3.3a):

1. Lands acquired in fee by DOE or its predecessor agencies
2. Bureau of Land Management public domain lands withdrawn from the public domain for use as part of the Hanford Site
3. Lands the Bureau of Reclamation has withdrawn from the public domain or acquired in fee as part of the Columbia Basin Project.

In addition, Figure 2.1b shows the ownership of land on a regional basis, beyond the boundary of the Hanford Site.

The Bureau of Reclamation agreed 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 on February 27, 1957. These lands consisted of a checkerboard pattern of alternating square-mile sections on the Wahluke Slope.

The alternating square-mile sections that would eventually revert to the Bureau of Land Management or Bureau of Reclamation are an important consideration that complicates land-use planning.

Under the end state land management/ownership vision for Hanford, all land except the Central Plateau (200 Areas Core Zone and buffer zone) is transferred to another entity (federal, state, local government or private). The LTS program will be managed by a DOE program secretarial office, other than EM, that is to be defined in the future. DOE will maintain liability for any residual waste left on site and institutional controls unless, as part of a transfer agreement, the receiver has agreed to assume future liability.

More specifically, the Hanford Reach National Monument could potentially be transferred to the U.S. Fish and Wildlife. Other Hanford land could be transferred to other entities as opportunities arise. All land will be managed consistent with the DOE comprehensive land-use plan environmental impact statement (64 FR 61615). Figure 3.3b shows possible land ownership after cleanup is complete.

3.4 Site Context Demographics

This section describes a forecast of local population density in the region surrounding the Hanford Site. In particular, DOE's *Guidance for Developing a Site Specific Risk-Based End State Vision* (September 11, 2003) directs that two maps be prepared: one showing current population density from the 2000 Census and at least one map showing population density at the "Risk-Based End State Vision." For the Hanford Site, the year 2035 was used for the end state.

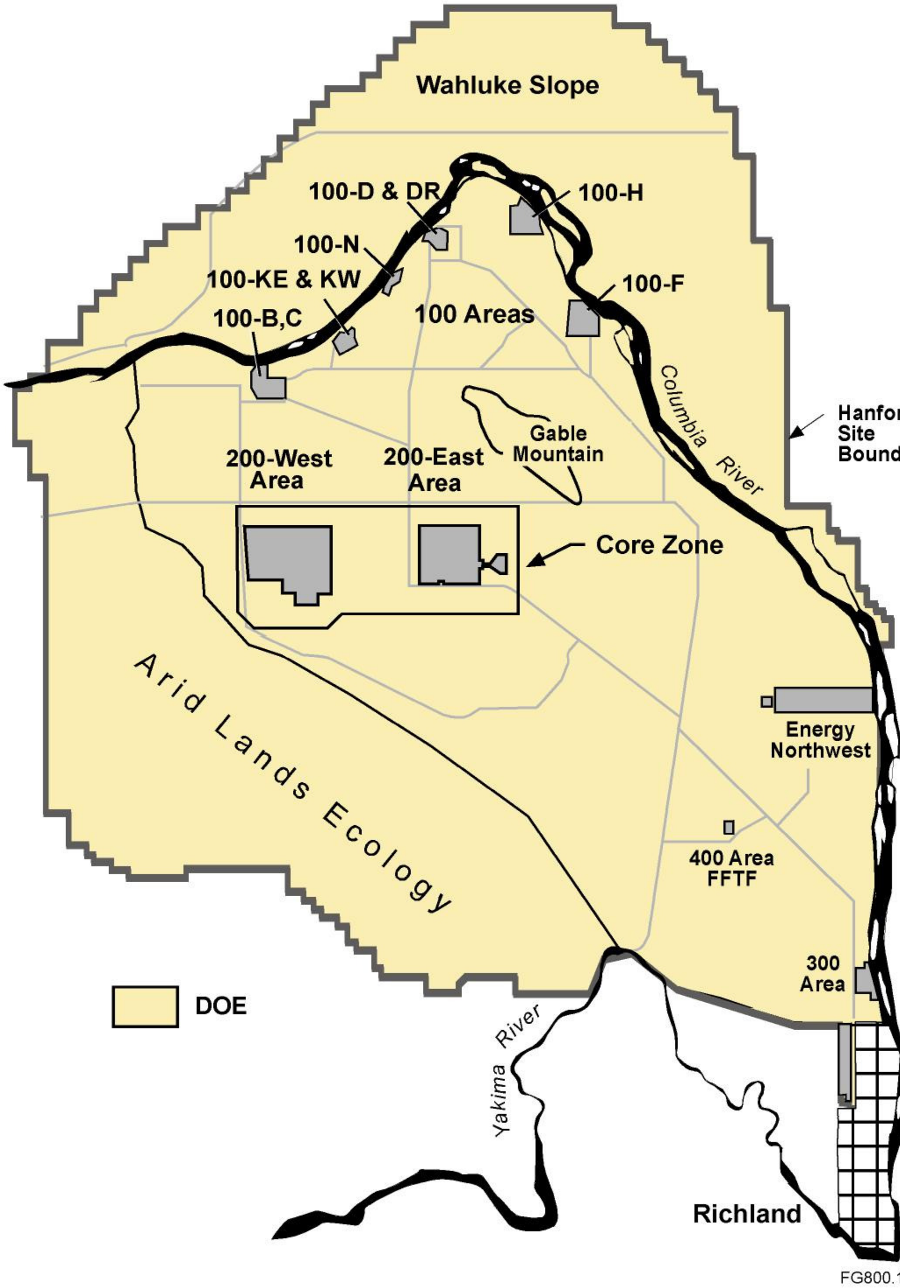


Figure 3.3a. Site Context Legal Ownership – Current State

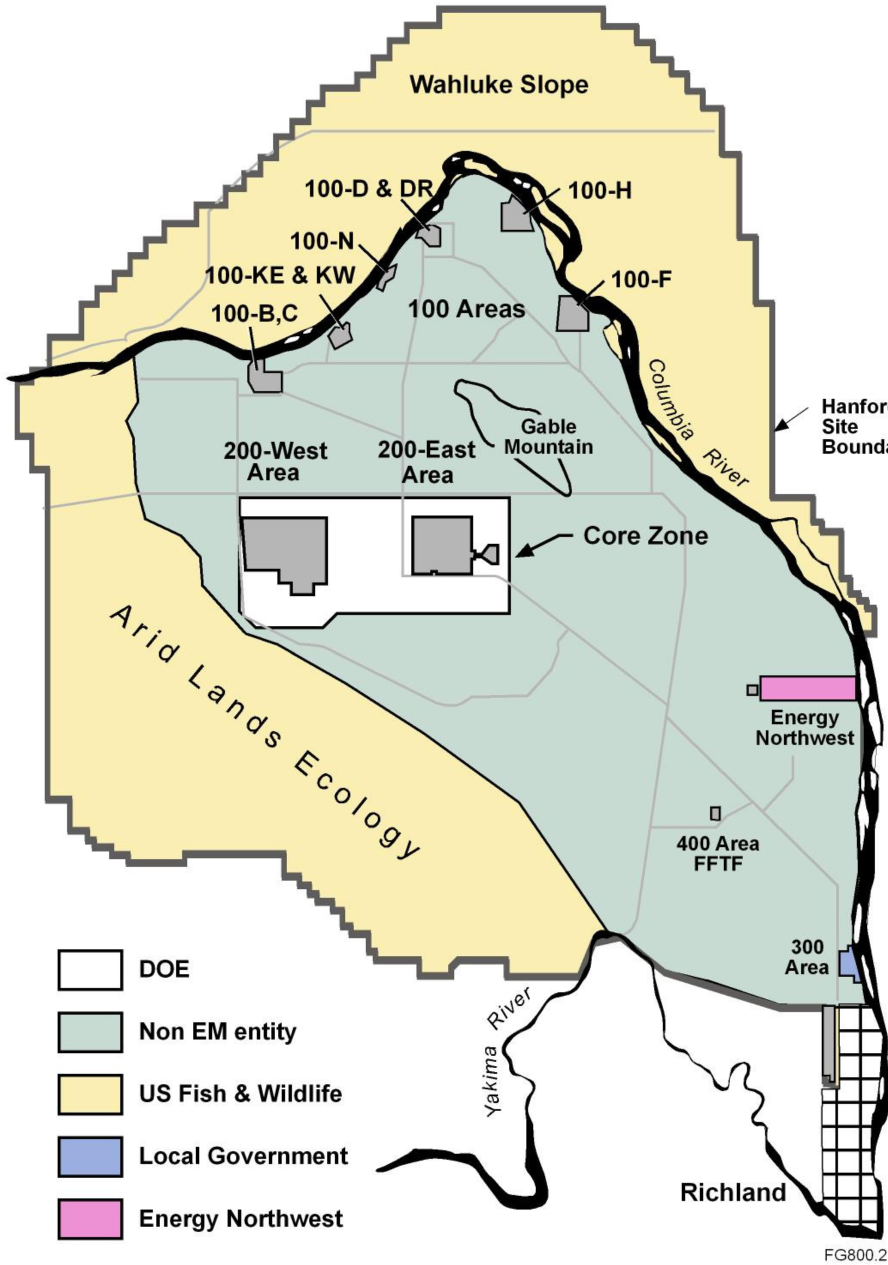


Figure 3.3b. Site Context Legal Ownership – End State Vision

3.4.1 Method

Current population density was calculated and mapped (Figure 3.4a) by using the 2000 Census of Population (Census 2003) 100-percent count data and the Arc View geographic information system. The 2000 Census provided the most recent available count of total population at the Census block level. The Census block is the smallest geographical unit for which the Census provides population counts. The Census also provided the geographic area encompassed by each Census block, allowing an accurate estimate of population density for the year 2000.

Internally consistent detailed population forecasts at the county level are provided online by the Washington State Office of Financial Management (OFM)[2] and the Oregon Office of Economic Analysis, Department of Administrative Services[3] using widely recognized and used cohort-component projection procedures. These two organizations are the demographic analysis arms of their state governments and provide long-term population forecasts for long-term planning in their respective states. Each county population is subjected to projected age-sex-specific birth and death rates to determine the number of births and deaths during a given period, allowing for changes in the vital rates over time. A separate assumption is made for the net migration estimates and the migrants are subjected to the same vital rates. OFM provides both a high and a low demographic forecast for each county in the state through the year 2025. Year 2035 county populations for the Washington counties were calculated by using a straight-line extrapolation of the OFM forecasts. Oregon provides only a single long-range population forecast for each county through the year 2040. The year 2035 Oregon forecasts for each county were used directly.

The 2000 Census provides the most recent available count of total population at the Census block level and can be used to calculate the future population that is resident in each Census block. This year 2000 geographical population distribution was assumed to apply to each Census block in each county. The forecasted county population growth in each state forecasts was used to calculate county-level population growth factors, which are shown in Table 3.1. These county level factors were multiplied times the block-level year 2000 Census populations for each county to produce block-level population forecasts for each Census block in year 2035. Forecasted block level populations were divided by the area in each Census to calculate forecasted population densities.

3.4.2 Results

The population forecast method provides an estimate of population density (Figures 3.4b and 3.4c) that increases sharply by the year 2035 summarized in Table 3.2. The forecast densities are partly a consequence of populations that are forecasted by the states of Washington and Oregon to as much as double during the forecast period. It is also a consequence of the relatively simple method used for small-area forecasting. In reality, because land is readily available in the area to accommodate additional low-density population growth, it is not very likely that already developed areas will become much more densely populated than they already are, even if the population doubles. Instead, relatively undeveloped

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[2] Washington State Office of Financial Management, *Washington State County Population Projections for Growth Management by Age and Sex: 2000-2025*. Released January 2002. Available at http://www.ofm.wa.gov/pop/gma/countypop.pdf. (Last accessed August 23, 2004).

[3] Oregon Department of Administrative Services, Office of Economic Analysis, *State and County Population Forecasts by Age and Sex*. Released April 2004. Available at http://www.oea.das.state.or.us/DAS/OEA/demographic.shtml#Long-term%20County%20Forecast. (Last accessed August 23, 2004).

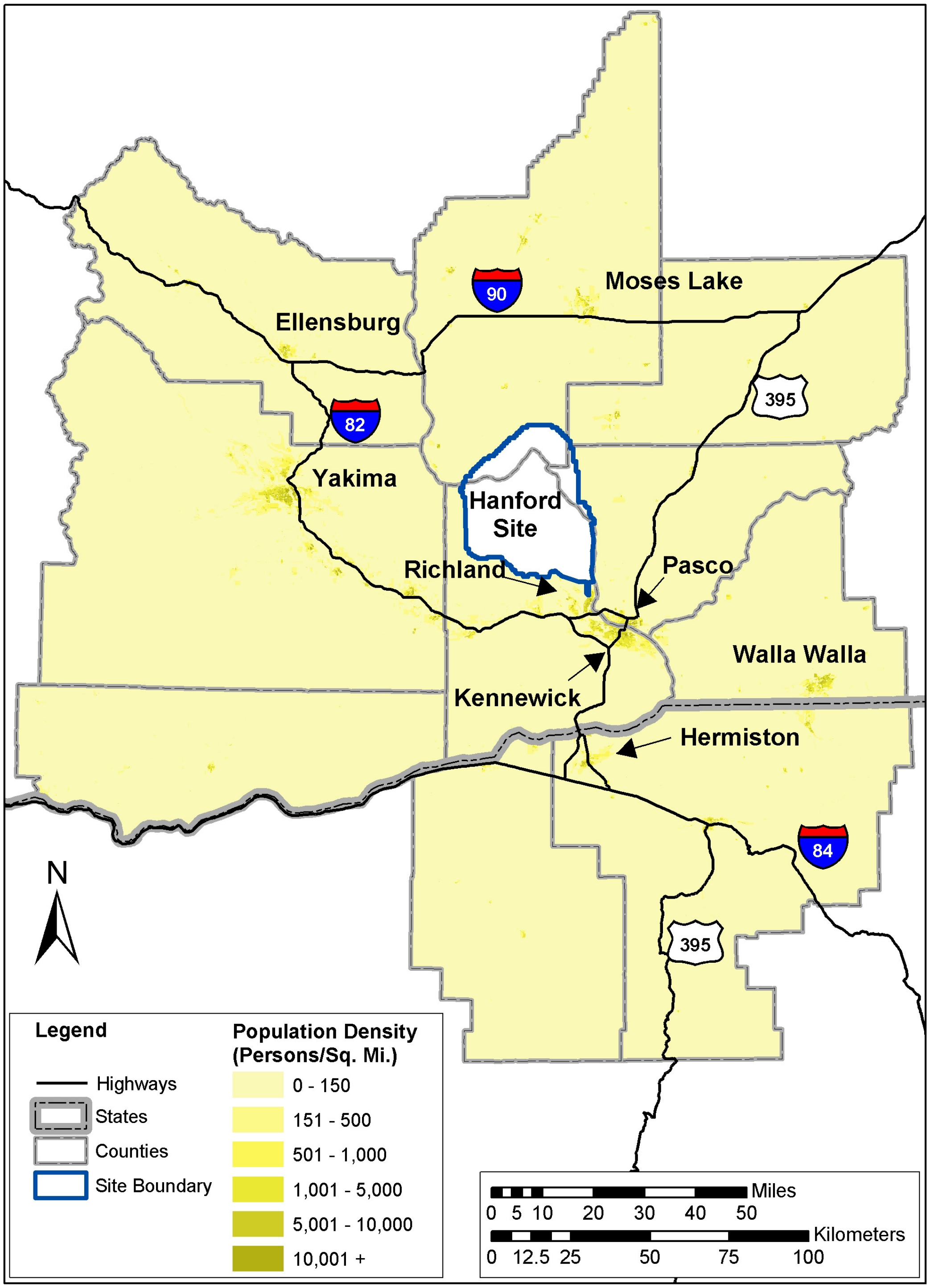

Figure 3.4a. Site Demographics – Current State

Table 3.1. County Level Population Growth Factors, 2000-2035

County	Year 2000 Population Total	2035 Forecast Population High	2035 Forecast Population Low	2035 Population Growth Factor High	2035 Population Growth Factor Low
Washington Counties					
Adams	16,428	28,379	21,850	1.73	1.33
Benton	142,475	258,159	161,347	1.81	1.13
Franklin	49,347	97,338	63,913	1.97	1.30
Grant	74,698	131,458	78,990	1.76	1.06
Kittitas	33,362	61,861	38,074	1.85	1.14
Klickitat	19,161	35,692	23,170	1.86	1.21
Walla Walla	55,180	88,660	59,147	1.61	1.07
Yakima	222,581	378,063	254,871	1.70	1.15
Oregon Counties					
Morrow	11,100	21,358		1.92	
Umatilla	70,850	101,001		1.43	

areas adjacent to currently developed areas will also be developed for housing. Thus, actual population density in 2035 is likely to be higher than shown in some of the areas with very low current densities and lower than shown in some of the areas with higher densities. What is not available is a simple and plausible rule that makes these adjustments. The driving factors will be such factors as zoning and future availability of infrastructure, both of which are results of detailed and dynamic institutional and economic processes that cannot be forecasted. The densities shown likely will overestimate the risks to future populations because higher densities are shown close to the Hanford Site than are likely to exist in 2035, at least in the high forecast.

3.5 Hanford Current/End State Vision Descriptions

The purpose of this section is to describe the current cleanup plans reflected in the Integrated Hanford Baseline and to describe each End State Vision cleanup alternative. It is anticipated that the End State Vision alternatives may be analyzed further along with other alternatives in the remedy selection process. Based on a conceptual model of the hazards and exposure pathways being developed and analyzed in various risk assessments across Hanford, DOE believes the end state vision alternatives would result in interim and final remedies that are adequately protective of human health and the environment for the land uses identified in the CLUP (DOE 1999a). It also provides a basis to re-evaluate DOE’s current cleanup activities and strategic approaches to determine if it is appropriate to change site baseline documents and renegotiate agreements if required for such changes. Changes will be proposed and reviewed for approval as required by law, regulation, or current agreements.

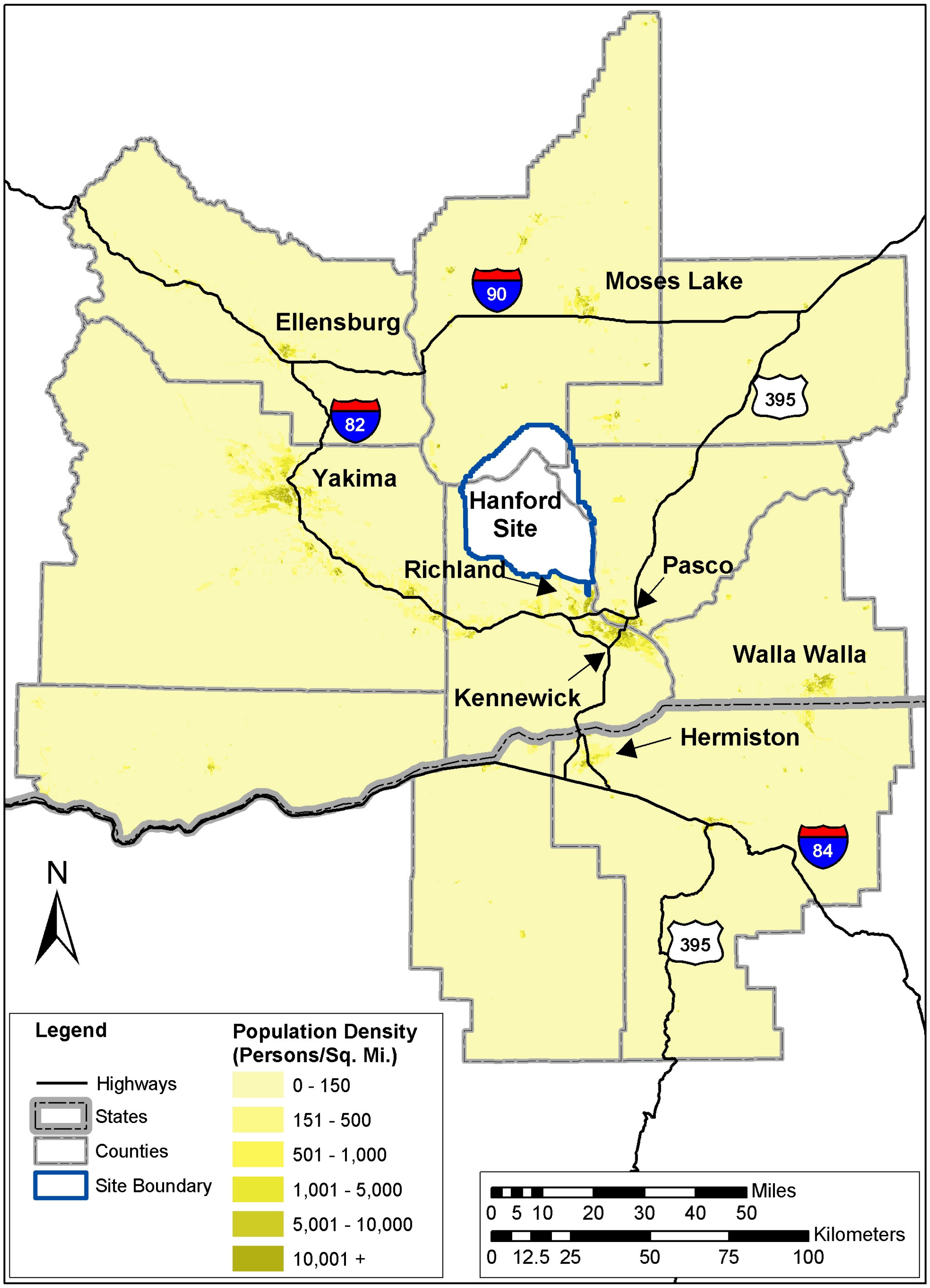

Figure 3.4b. Site Demographics – End State Vision, High Estimate

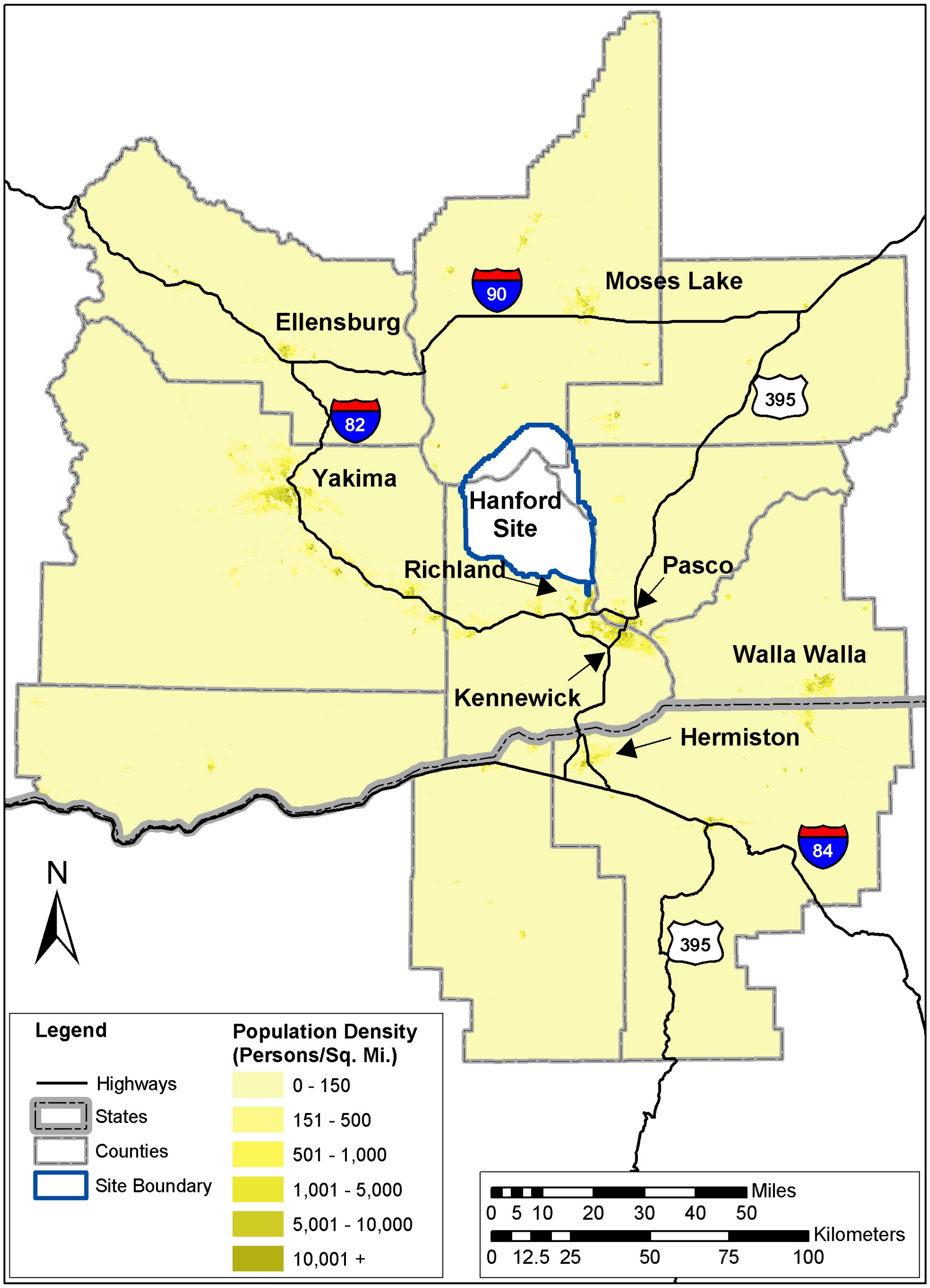

Figure 3.4c. Site Demographics – End State Vision, Low Estimate

Table 3.2. Summary of the Current (2000) and Forecasted (2035) Population Densities in the Counties Surrounding the Hanford Site

			Number of Census Blocks by Population Densities in Persons per Square Mile					
	Total Blocks	Scenario	≤150	>150 and ≤500	>500 and ≤1000	>1000 and ≤5000	>5000 and ≤10000	>10000
Washington Counties								
Adams	1,728	Year 2000	1,344	53	27	179	95	30
		2035, High	1,328	42	34	117	113	94
		2035, Low	1,336	47	31	142	117	55
Benton	4,276	Year 2000	2,155	240	163	884	710	124
		2035, High	2,061	219	144	513	638	701
		2035, Low	2,133	234	165	773	786	185
Franklin	1,856	Year 2000	1,039	68	73	296	236	144
		2035, High	1,018	47	44	195	176	376
		2035, Low	1,032	58	62	234	226	244
Grant	4,368	Year 2000	2,879	195	138	614	420	122
		2035, High	2,819	159	131	439	368	452
		2035, Low	2,872	190	138	602	429	137
Kittitas	4,407	Year 2000	3,526	212	124	361	156	28
		2035, High	3,404	231	120	287	212	153
		2035, Low	3,502	211	126	342	183	43
Klickitat	3,132	Year 2000	2,694	92	45	183	99	19
		2035, High	2,647	87	57	122	110	109
		2035, Low	2,680	89	51	167	108	37
Walla Walla	2,683	Year 2000	1,509	126	97	507	366	78
		2035, High	1,479	108	77	351	341	327
		2035, Low	1,501	125	99	467	388	103
Yakima	9,063	Year 2000	5,502	737	292	1,035	988	509
		2035, High	5,146	781	381	759	750	1,246
		2035, Low	5,406	757	324	929	951	696
Oregon Counties								
Morrow	1,576	Year 2000	1,315	54	40	133	19	15
		2035	1,303	35	32	116	59	31
Umatilla	5,219	Year 2000	3,707	241	152	581	378	160
		2035	3,653	225	141	477	412	311

3.5.1 Hanford End State Public Workshops

Facilitated public workshops were held in Richland, Washington, to discuss end state issues related to the 100 Area on June 23 and 24, 2004, the Central Plateau on August 10 and 11, 2004, and the 300 Area on May 19, 2005. Environmental Protection Agency, Washington Department of Ecology staff and members of the Hanford Advisory Board actively collaborated with DOE to prepare the format and topics for discussion and jointly participated in and supported the conduct of the workshops. Key members from each of these organizations met weekly, months in advance of the workshops to help prepare for success. In addition, DOE, regulatory agencies and Hanford contractor staff gave briefings to educate attendees on operational history of the Hanford Site and on the new DOE Office of Legacy Management. The specific topics and questions for discussion are shown in Tables 3.3, 3.4, and 3.5.

Table 3.3. 100 Area Workshop, June 23 and 24, 2004

Topics	Questions for Discussion
100 Area Land-Use Activities	A final regulatory decision must be made for the 100 Area cleanup. Given the National Monument designation and the U.S. Department of Energy Record of Decision on land use, what post-cleanup activities do you see for the 100 Areas?
Reactors	Should the reactor blocks be moved to the Central Plateau? If so, now or at the end of an interim storage period? (B Reactor was considered separately because it may become a museum and resulting need for public access is a possibility.)
River Pipelines, Groundwater and Riparian Zone	Are the remedies completed at waste sites in the 100 Area sufficient to be considered final remedies? Should the pipelines from the reactors into and under the Columbia River be removed or should they be left in place? Groundwater in the 100 Area is expected to meet applicable standards by the end of the cleanup mission with the exception of the strontium-90 plume at 100 N. Is it acceptable to rely on radioactive decay to remediate this plume or are extensive efforts required to perform further treatment?

Following the briefings, the participants were divided into discussion groups. Each topic and the related questions were discussed by each group. Technical and regulatory subject matter experts representing each of the Tri-Parties also provided information to assist these discussions. Key Hanford Advisory Board members facilitated the discussion groups. The comments and questions generated during each group session were captured, and a draft list of common themes and, as appropriate, a draft list of significant conflicting or opposing views were also developed. These draft lists were then reviewed, modified after discussion, and agreed to by all participants as a single group to capture the main feedback for the Tri-Parties in developing end states for the Hanford Site. However, all individual questions and comments gathered during these sessions, or submitted shortly thereafter to expand or clarify a point, have been retained by the Tri-Parties for consideration.

Table 3.4. Central Plateau Workshop, August 10 and 11, 2004

Topics	Questions for Discussion
Central Plateau Uses and Activities (Exposure Scenario Development)	Based on the possible post-cleanup land uses (primarily focused on the time frame of 50 years into the future and beyond) • What range of activities could workers and/or visitors be involved in within the Core Zone? • Outside the Core Zone? • Should other alternative activities (beyond those consistent with the assumed land uses) be considered for comparison or other purposes? • Based on the desired land-use and exposure scenarios, what types of institutional controls are appropriate, and over what time frames?
Buried Waste and Contaminated Soil	For solid and liquid waste sites end states, CERCLA requires that decisions be made using nine criteria. In weighing these criteria: • If waste is left in place under an engineered barrier, what factors affecting public acceptance must the Tri-Parties consider? • If waste must be removed for treatment and disposal, what factors affecting public acceptance must the Tri-Parties consider? • What other options should be considered by the Tri-Parties and when is it appropriate to consider them? • How would these considerations change depending on location inside or outside the Core Zone and could these decisions affect how the Core Zone is defined? • If data collection activities are purposely focused on defining the highest levels of contamination, how important is additional detailed characterization information in making these decisions? How does this change for different end states or hazards?
Processing Facilities, Buildings, and Structures	In order to develop some very specific tools and perspectives to assist in risk-balancing considerations associated with future risk assessments and remedial/closure decisions: • What end state do you envision for the various classes of facilities (e.g., canyons, plutonium processing facilities, ancillary facilities, waste storage/treatment facilities) on the Central Plateau? • How do you feel about leaving facilities in place (i.e., fully standing) versus demolishing them? • Under what situations would you think it appropriate to remove, treat, and dispose of some or all of the waste within and/or under the facility or is consolidation and isolation of waste within the facility a viable option? • If a canyon facility is left in place or is partially demolished, can additional waste be placed in it? • How would the potentially high dose rates and hazards to workers encountered during cleanup activities affect these decisions? • If data collection activities are purposely focused on defining the highest levels of contamination, how important is additional detailed characterization information in making these decisions? How does this change for different end states or hazards?

Table 3.5. 300 Area Workshop, May 19, 2005

Topics	Questions for Discussion
300 Area Land-Use Activities	Based on the possible post-cleanup land uses (primarily focused on the time frame of 20 years into the future and beyond) • What range of activities could the public, workers, and/or visitors be involved in within the region now known as the (industrialized) 300 Area? • Outside the industrialized 300 Area? • Should other alternative activities (beyond those consistent with the assumed land uses) be considered for comparison or other purposes? • Based on the desired land-use and exposure scenarios, what types of institutional controls are appropriate, and over what time frames?
Groundwater Remediation Alternatives and Technologies	Are the alternatives we are considering for the groundwater feasibility study appropriate? Are you aware of any other potential groundwater technologies which should be considered? Are there other considerations that should be evaluated?
Groundwater Remedy Selection Considerations	Given the possible types of surface uses and the potential groundwater remediation alternatives, what considerations are important for groundwater remedy selection? (For example, what is an acceptable period of time to achieve groundwater goals, and under what surface end states would it make sense to continue with monitored natural attenuation or be necessary to pursue alternative approaches?)

The agreed-to themes and conflicting or opposing views that were developed are discussed in this section. All of the comments generated during the workshops, as well as the materials used for presentations during the workshops are posted at the following website: www.hanford.gov/docs/rbes. A summary of each of the workshops can also be found at that site.

In addition to the public and stakeholder workshops, DOE recognized the importance of Tribal Consultation in obtaining input to the end state vision development process. Shirley Olinger, Deputy Manager for the Office of River Protection met with representatives of the affected Tribes in April 2004 to initiate that process. Tribes were encouraged to participate in the workshops and representatives or technical staff from each of the Tribes participated in one or more of the workshops. To obtain additional Tribal input following the workshops, Shirley Olinger and several staff members met with each of the federally recognized Tribes separately (the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe and the Yakama Nation) at the conclusion of the workshops to solicit end state comments. To initiate the discussion, comments from the workshop related to Tribal use and protection of cultural resources were compiled and shared with the Tribal representatives. The discussions held are summarized in Section 3.5.5.

3.5.2 Groundwater Baseline and End State Descriptions

Other than key facility surface source terms, the primary pathway for Hanford contaminants to reach the reasonably maximally exposed (RME) individual and the environment for current, future, and end state scenarios is through the groundwater pathway. The locations where such exposure might occur will vary for current, future, and end state scenarios. Protection of Columbia River water quality and return of groundwater to beneficial use are the primary objectives of groundwater remediation actions.

The current cleanup plans are reflected in the groundwater ROD for interim action (DOE 1999a) and Hanford's Groundwater Management Plan (DOE 2003). Where current or planned in situ or ex situ treatment has been shown to work effectively, the current plan and end state vision are essentially the same. However, alternate concentration limits and points of compliance and technical impracticability waivers for ARARs that may be needed during the remediation period will be identified following the CERCLA/RCRA past practice regulatory cleanup approach. Under current and end state vision scenarios, groundwater use for consumption and irrigation will be restricted through institutional controls for as long as necessary to maintain adequate protection. Where it is believed to be technically impracticable to achieve aquifer restoration to its highest beneficial use as a source of drinking water, plume control and the need for further risk reduction is considered.

3.5.2.1 Current Baseline End-State for Groundwater

Goals for Hanford groundwater cleanup have been defined in Hanford's Groundwater Management Plan (DOE 2003) and include protection of the groundwater from further degradation, remediation of existing groundwater plumes to reduce risk and restore groundwater resources, and monitoring the groundwater conditions to support cleanup and management decisions. Remediation of existing groundwater plumes is performed to protect the Columbia River and to meet specific interim goals such as to stop further spreading of plumes in the Central Plateau, use currently available technologies to reduce immediate risk to human health and the environment. The overall strategy is to restore the aquifer to its highest beneficial use within a reasonable time frame if practicable.

There have been no final RODs written for Hanford groundwater cleanup. The Tri-Parties are using interim remedial actions to protect human health and the environment from existing threat in the short term, while final remedial solutions are being developed. There are five interim remedial action RODs (ROD 1995, 1996a, 1996b, 1997, 1999a).

Four of the interim action RODs (ROD 1995, 1996a, 1997, 1999a) call for active remediation to address hexavalent chromium that exceeds ambient water quality criteria at 100-H, 100-D, and 100-K Areas; strontium-90 that exceeds drinking water standards at 100-N Area; uranium and technetium-99 in the southern half of 200 West Area; and carbon tetrachloride underlying the 200 West Area. In all these sites, pump and treat is used as an active remediation system. In addition, an in situ geochemical barrier is used for chromium treatment in the 100-D Area. In the 100 and 300 Areas, a soil excavation/removal technique was used to address source control/removal, while in the 200 West Area, soil vapor extraction is continuing as a part of the source remediation in the vadose zone. There is a ROD (ROD 1996b) for natural attenuation and continued monitoring of the uranium plume at the 300 Area that is being reassessed on the basis of effectiveness. The 300 Area uranium plume is not attenuating as envisioned in the ROD (ROD 1996b), and a focused feasibility study has been initiated to evaluate remedial alternatives. The uranium plume was expected to attenuate within 10 years from 1996. This has not occurred. Recent geochemical investigations have lead to a revised conceptual model that can be used to better evaluate active remedial alternatives.

The 100 and 300 Areas groundwater contaminant plumes will be assessed through CERCLA 5-year ROD review, the related CERCLA regulatory processes, and a planned risk assessment covering the River Corridor. Environmental risk from chromium, uranium, and strontium-90 plumes currently reaching the Columbia River may drive cleanup actions rather than attainment of drinking water standards. The remedial actions addressing chromium in the 100-H, 100-D, and 100-K Areas appear to be successful in meeting their remedial action goals and will be terminated in a reasonable time frame. The pump-and-treat system for strontium-90 at 100-N Area has failed in meeting remedial action goals. The primary objective of the 100-N interim action is to reduce the flux of strontium-90 going to the river. Evaluation of the past performance and the effectiveness of the pump-and-treat system is currently going on. As far as the reduction of mass of strontium-90 is concerned, natural decay is found to be more effective than pump and treat. It is expected that natural attenuation will restore the groundwater to drinking water concentrations sooner than will pump and treat. Other technologies are being evaluated including geochemical sequestration and bioremediation. In summary, the current understanding and performance of various remedial actions shows that except for the 100-N Area groundwater, the rest of the 100 Area groundwater will be remediated to drinking water standards in a reasonable and acceptable time frame.

Accelerated removal of irradiated lithium-aluminum materials that are suspected to be the source of tritium (from the few burial grounds where they are suspected to be buried) will also decrease the risk of further contamination of 300 Area groundwater.

Active remedial measures are underway for the carbon tetrachloride plume underlying the 200 West Area and for a plume containing technetium-99 and uranium in the 200-UP-01 Operable Unit within the 200 West Area. The remedial actions for carbon tetrachloride in 200 West Area have removed 87 metric tons (96 tons) of the contaminant. However, further characterization is needed to design more effective technologies. The pump-and-treat system for technetium-99 and uranium in the 200-UP-01 Operable Unit may reach interim remedial action objectives in the next several years. It is unlikely that aquifer restoration can be fully achieved in the 200 West Area in the foreseeable future.

In addition to the interim action RODs, one pump-and-treat system, located in the 200 East Area, was terminated on the basis of a demonstration of minimal risk and technical impracticability. Two plumes in the 200 Area are candidates for technical impracticability waivers because there is currently no cost-effective technology to remediate them; these are the tritium and iodine-129 plumes. The plumes will attenuate to less than drinking water standards in less than 150 years. Tritium has a relatively short half-life (12.5 years) and radioactive decay will attenuate the concentrations. Iodine-129 has a much longer half-life and concentrations are expected to decline through dispersion and diffusion.

The end state vision identifies proposed alternatives from the baseline for Hanford cleanup (see Chapter 5). These proposed alternatives are not expected to result in additional contribution of contaminants to the underlying groundwater in concentrations that would degrade the aquifer. Therefore, these actions should not affect groundwater cleanup plans. In February 2004, the Tri-Parties concurred on the *Hanford Site Groundwater Strategy: Protection, Monitoring and Remediation* (DOE 2004a). The end state vision for groundwater is intended to be consistent with this strategy.

3.5.2.2 100 Area End State Workshop Feedback Related to Groundwater

While those in attendance expressed strong public acceptance for continued full implementation of all approved interim remedial actions in the 100 Area, there was a fairly equal split of opinion on the need to continue to perform the interim remediation for the strontium-90 plume in 100 N Area. Some felt it is acceptable to devote the resources to other cleanup if the risk from strontium-90 contamination is low and if it is not practicable to cleanup by active means as described by DOE. For others, attenuation is not an acceptable remedy and DOE should continue actions to return the water to pristine conditions by developing and deploying an innovative technology approach. All expressed interest in more information that an engineering evaluation might provide.

3.5.2.3 Central Plateau End State Workshop Feedback Related to Groundwater

Participants agreed that protecting groundwater is first and foremost consideration. The key messages were as follows:

- Remediate groundwater to highest beneficial use. It was reiterated that remedies must be protective of groundwater and current contaminant plumes will require some form of treatment, in or outside of the Core Zone, to be restored for beneficial use. Aggressive technology development should be done to remediate contamination that could get into the groundwater (particularly for technetium-99). In some instances, nature may do the job, but institutional controls must be established based on the risks if the controls fail.

- Address highest risks first.

- Consider potential future influences on groundwater. Future conditions that could alter current assumptions about groundwater flow, including the potential for nearby agriculture/irrigation or an upgradient water reservoir (e.g., proposed Blackrock Reservoir), should be considered.

3.5.2.4 300 Area End State Workshop Feedback Related to Groundwater

The 300 Area End State Workshop focused on two questions related to groundwater. The first asked participants to review the technologies currently being considered and offer any suggestions for additional technologies that should be considered. The second question asked the participants to identify considerations important for groundwater remedy selection.

Those in attendance identified a number of technologies to be considered. They suggested installation of a physical barrier (a grout curtain) up gradient of the uranium contamination, or a chemical barrier that would change the chemistry of the water moving through the contaminated part of the aquifer that would reduce the mobility of uranium. They also suggested that Hanford look at the technologies implemented at other DOE sites (such as Fernald) to control uranium. One of the workshop participants was involved in the groundwater remediation at Fernald and was able to brief the group on the technologies used at that site and indicated that those technologies had been considered for the 300 Area. Another alternative discussed involved mobilizing the uranium so that it could be readily removed through a pump and treat system.

Workshop participants identified a number of considerations important to groundwater remedy selection. They noted the need to think long term. They believe the uses of the land in and around the 300 Area will change with time and cleanup needs to allow for a spectrum of potential future uses. Given uranium's long half life and hazard as a metal contaminant as well as a radionuclide cleanup decisions need to recognize this.

They asked DOE and the regulatory agencies to consider the effects of uranium on aquatic organisms as well as human health and said that implementing an effective solution is more important than meeting an accelerated cleanup schedule. Participants said that understanding the problem through adequate characterization was important so that the solution could consider the distribution of the contaminant in the environment as well as how future land uses might impact the chemical form and mobility of the material.

Additional detail on the workshop input can be found online at http://www/hanford.gov/docs/rbes.

3.5.2.5 Final Groundwater End State Based on Feedback from Workshops

Under the current implementation of the various active remedial actions, except for the N-Area groundwater, the rest of the entire 100 Area groundwater will be remediated to drinking water standards in a reasonable, acceptable time frame. The pump-and-treat system at the 100-N Area for strontium-90, which has a 30-year half-life, is not effective at reducing the strontium-90 inventory or the overall flux of strontium-90 reaching the river. The strontium-90 groundwater plume at 100-N Area will attenuate through radioactive decay within approximately 250 years. DOE is planning tests for assessing alternative technologies designed to reduce the flux of strontium-90 to the river and reduce the concentration of strontium-90 in groundwater at the river. Under the end state vision, institutional controls are expected to prevent the use of groundwater in this area. While public and regulator acceptance of protection afforded by institutional controls as a long-term remedy is low, drinking water quality will be achieved by decay in about 250 years. The plume concentrations do not negatively impact river water quality, except that the drinking water standard can be assumed to be exceeded for the very small flow of contaminated groundwater at the point that it enters the river. The end state vision for the strontium-90 plume is to sequester the near shore source of strontium-90 that could reach the Columbia River and address the remainder through natural attenuation. Regulatory agencies and DOE are looking at innovative technologies to address the riparian zone contamination that is directly feeding the river. Alternate technologies, in situ semi-permeable barrier and phytoremediation are planned to be tested to determine if they are effective for reducing the flux of strontium-90 to the river. Preliminary evaluation of the effectiveness of pump and treat of the strontium-90 plume inland to the riparian zone shows that pump and treat is not a viable alternative.

For the Central Plateau groundwater, the end state vision is the same as the baseline goals. These are protection of the groundwater from further degradation, remediation of existing groundwater plumes to reduce risk and restore groundwater resources to highest beneficial use, and monitoring the groundwater conditions to support cleanup and management decisions. In general, DOE will strive to contain the groundwater contamination from the 200 Areas in the Central Plateau to the extent practicable.

For the 300 Area the end state vision for groundwater is to re-evaluate the natural attenuation decision for the uranium plume at the 300 Area and develop a proposed plan/focused feasibility study to determine if other more effective groundwater remedial alternatives are available to meet cleanup goals. Work to meet the goals of no further degradation of groundwater above drinking water standards and restore groundwater to beneficial drinking water use when practicable. DOE's ability to achieve drinking water standards will impact the type of activities that can be allowed on the land surface in the future. A final remedy for groundwater will be arrived at through the RI/FS process that is currently underway. DOE will follow process outlined in state and federal regulations to establish protective clean up goals if groundwater cannot be restored in a reasonable time frame.

3.5.3 River Corridor – Background, Baseline, and End State Descriptions

The geographic area referred to as the River Corridor consists of over 544 square kilometers (210 square miles) of the Hanford Site adjacent to the Columbia River. The area includes a 0.4 kilometer (0.25 mile) strip of land along the entire length of the Columbia River shore within the Hanford Site that is included in the Hanford Reach National Monument. The River Corridor is divided into three major sub areas: (1) the 100 Areas, comprised of deactivated plutonium production reactors and support facilities; (2) the 300 Area, comprised of former reactor fuel fabrication, research, and support facilities; and (3) the vacant land between the 100 and 300 Areas, extending from the Columbia River to the Central Plateau in the middle of the Hanford Site.

3.5.3.1 100 Areas

The 100 Areas lie on the south bank of the Columbia River and consist of six noncontiguous reactor areas (100-B/C, 100-D, 100-F, 100-H, 100-K, and 100-N Areas). Nine nuclear reactors (B, C, D, DR, F, H, KE, KW, and N) are located in these areas. They are large, graphite moderated, plutonium production reactors that used slightly enriched uranium metal as fuel. The first eight reactors, which were constructed between 1943 and 1955, used Columbia River water in a single-pass process for cooling the reactor core. There are 14 large pipelines ranging in size from 107 to 259 centimeters (42 to 102 inches) in diameter that extend into the river for reactor cooling water supply and discharge. The lengths range from 91 to 564 meters (300 to 1,850 feet), for a total of nearly 4,267 meters (14,000 feet). The elevation is from 0.6 to 0.9 meter (2 to 3 feet) above to 2.4 to 3 meters (8 to 10 feet) below the river bed. Water that was not discharged back to the river was diverted to onshore liquid waste disposal sites, such as cribs or trenches, which contaminated the soil and groundwater with CERCLA hazardous substances. The N Reactor differed from the other eight reactors because it had the dual purpose of producing electricity as well as special nuclear material. The process of using the heat produced by the reactor to generate electricity required the reactor coolant to be re-circulated rather than discharged after a single-pass, as was the case for the other eight reactors. This recirculation process, however, caused much higher concentrations of radionuclides to accumulate in the reactor coolant system. Moreover, N Reactor operated over a longer period of time than most of the other reactors. Therefore, the soil receiving discharges from the reactor has a much higher concentration of contaminants.

Soil contamination in the 100 Areas, in general, is related to the liquid waste (process water) disposal sites, leaking pipelines, and burial grounds used to dispose of solid waste from each reactor, such as contaminated and uncontaminated construction debris and trash. The 100 Areas contain a total of 550 waste sites of which 45 are burial grounds. As of April 2005, 217 waste sites have been remediated including 7 burial grounds. The average depth of burial grounds is ~6.1 meters (~20 feet). Over 4.2 million metric tons (4.7 million U.S. tons; over 247,750 truckloads) have been excavated from the

100 Area waste disposal sites and transported to ERDF. The estimated transportation risk, based on statistical fatal accident rates per mile of travel for this campaign was $2x10^{-2}$. No fatalities have occurred as a result of the 100 and 300 Area cleanup campaigns to date; however, there has been one transportation incident involving movement of material and equipment from the 100 and 300 Areas.

In 1998, C Reactor was the first reactor placed into interim safe storage, or "cocooned," pursuant the 1993 environmental impact statement, *Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington* (58 FR 4690) and the ROD (58 FR 48509; surplus reactor environmental impact statement). The D, F, and DR Reactors are also now cocooned, and H Reactor interim safe storage will be completed in 2005. Cocooning involves fuel and equipment removal and demolition of the facility down to the reactor biological shield walls. The graphite core block is left in place within the shield walls. A new 75-year design life roof is then installed to stabilize these facilities to allow for natural decay of the 5-year half-life cobalt-60 activation product within the graphite core, to reduce the worker radiation hazards before further removal, if any, of the core takes place. An inspection of D Reactor after 5 years in interim safe storage showed no problems with the integrity of the cocoon or any deterioration of the core block. The N Reactor core has the highest inventory of radionuclides among Hanford reactors. N Reactor's radiological inventory was estimated to be almost 262,000 curies (about 96% cobalt-60 and 4% carbon-14) in 1985. If N Reactor were to decay an additional 75 years from 2004, it would have an inventory of just over 10,000 curies (carbon-14) (2079).

Estimates of worker exposure and cost were evaluated in the surplus reactor environmental impact statement (58 FR 4690). Worker exposures were estimated to be 159 person rem for immediate one piece removal, 28 person rem for deferred (75 year) one piece removal, and 509 person rem for deferred dismantlement. Deferred dismantlement has higher doses due to working inside the reactor block where dose rates are higher than in the work area for one piece removal. Robotic advances would lessen the dose for dismantlement.

The cost in 1990 dollars was estimated to be $228 million for immediate one piece removal, $235 million for deferred one piece removal, and $311 million for deferred dismantlement. The time to execute each alternative was estimated to be 2.5 years per reactor for immediate or deferred one piece removal and 6.5 years per reactor for deferred dismantlement.

B Reactor is listed in the National Register of Historic Places and the facility has been sufficiently decommissioned so that safe, limited public access through escorted tours is currently conducted. An initiative to maintain this facility as a museum is being pursued. Resources are being provided for maintenance and continued public access rather than conducting interim safe storage at this time. Resources for establishing a museum are uncertain.

Reactor fuel from the final runs of N Reactor has been stored in the fuel storage basins in the 100-K Area. The material in the K Basins contained 55 million curies of radioactivity, ~54.8 million curies in fuel and 200,000 curies in the sludge, water, and debris. Loadable fuel has been stabilized and repackaged into a safe storage configuration and is being stored in the Canister Storage Building awaiting final disposal at a geological repository. Approximately 386 multi-purpose canister overpacks are stored in the Canister Storage Building (plus 2 potential containers for any found fuel elements). Fuel removal was successfully completed in October 2004. Approximately 50 cubic meters (65.4 cubic yards) of sludge remain in the fuel storage basins. Approximately 1300 drums may be generated as a result of treating and packaging the sludge for disposal at WIPP or in the 200 Area Core Zone in accordance with waste acceptance criteria and CERCLA decision documents.

3.5.3.2 100 Area Current Baseline End State

RODs for interim actions (ROD 1996a, 1999a, 1999b) are in place to excavate and remove contaminated soil to ~4.6-meter (~15-foot) depth where contaminated reactor cooling water, and other liquid waste were discharged to the soil in lieu of direct discharge to the Columbia River. The RODs also require excavation to remove the contaminated contents and soil from solid waste burial grounds and the removal of the reactor pipelines to the river. The current Tri-Party Agreement milestone for completing cleanup required by the 100 Area RODs for interim remedial action is 2012.

Waste site and burial ground excavation may extend deeper than 4.6 meters (15 feet), determined on a site-specific performance assessment, for residual contamination as a source removal action to prevent further degradation of groundwater (4 mrem/year drinking water standard). It also may be terminated based on an analysis of technical feasibility. Remedial action objectives for these activities are designed so that hypothetical future site users do not exceed an approximate 3×10^{-4} increased cancer risk for a rural resident (15 mrem/year for radionuclide contamination) for an unlimited surface use of the land. Institutional controls are still required to prevent digging below 4.6 meters (15 feet). Remediation of waste sites is reducing risk from contaminated soils from greater than 1×10^{-3} to $\sim 3 \times 10^{-4}$ for radio-nuclides and from greater than 1×10^{-3} to $\sim 1 \times 10^{-6}$ for metals and organics based on protection of a hypothetical rural resident farmer.

The exposure scenario consists of a resident farmer who spends 80% of his life for 30 years on the waste site (60% indoors, 20% outdoors, and 20% offsite) and eats plants, fish, milk, and meat raised on the waste site. The farmer irrigates with 0.9 meter (3 feet) of water per year that can drive residual contamination toward the groundwater. For these calculations, groundwater was considered only as a clean future drinking water source to isolate the effect of the individual waste site on the groundwater and evaluate the non-degradation requirement. The key contaminants that contribute to this risk scenario are cobalt-60, tritium, and silver-108. The scenario applied did not consider the time period this scenario would be applicable and did not apply any radioactive decay of these contaminants. The exposure scenario was selected because it is inclusive of a range of potential uses including tribal uses, recreational uses, and others. In these early decisions, it was assumed that the environmental risk would be bounded by the risk to human health. This assumption is being evaluated in the River Corridor ecological risk assessments due to be completed by the end of 2007.

Current plans call for KE, KW, and N Reactors to be placed in interim safe storage before the end of 2012. Based on initiatives to preserve B Reactor as a museum, it has not been decided whether to cocoon the core or leave the facility in place. The surplus reactor environmental impact statement considered transporting the cocooned reactor graphite cores either in a single piece as a block or in pieces after dismantling to the Central Plateau for permanent burial. The surplus reactor environmental impact state-ment ROD (58 FR 48509) selected decommissioning by safe storage followed by one-piece removal, with a commitment to reevaluate on an area-by-area basis considering the CERCLA RODs for the surrounding waste sites. A single piece move would require special lifting and transport mechanisms for the 7,250- to 10,866-metric ton (8,000- to 12,000-ton) core blocks and building sufficient haul roads for the move. Dismantling would present worker risks and pose a release hazard from the remaining carbon-14 activity.

Pursuant to Tri-Party Agreement milestones, an evaluation of final disposition of the reactor cores must be submitted to EPA by DOE by September 30, 2005, and a decision regarding removal of the cocooned reactors made by July 2006.

All above-ground structures in the 100 Areas, except the cocooned reactors, will be demolished. Contamination below structures will be remediated similar to other waste sites in the 100 Area. Uncontaminated structures are demolished and excavated to 0.9 meter (3 feet) below grade.

Detailed ecological evaluations were not made for the RODs for interim action. It was generally assumed that the remedy, based on a qualitative risk assessment for the protection of human health, would also be protective of the environment because a conservative exposure scenario was used. However, the RODs (ROD 1996a, 1999c) for the remediation of chromium-contaminated groundwater are based on exceedence of ambient water quality criteria (protection of biota) for hexavalent chromium in the localized area where such plumes up well into Columbia River gravel beds.

Final CERCLA RODs have not been written for 100 Areas soil and groundwater cleanup. A baseline risk assessment of the River Corridor has been initiated and will assess potential impact on human health and the environment to support final RODs. Multiple exposure scenarios are being developed and evaluated in the River Corridor baseline risk assessment. A reasonable tribal land-use scenario will also be included to ensure the decision makers and Tribal Nations can compare cleanup levels and the level of protectiveness. The risk assessment will be a transparent and open CERCLA process and it will serve as the basis for final remedy decisions in the 100 Areas. Actions under the RODs for interim action will continue during the development of the final remedial decisions.

The K Basin current end state specifies all fuel, sludge, debris, and water be removed from the K Basins. The fuel has been stabilized and repackaged for interim storage in the Canister Storage Building within the Central Plateau with final disposition at a geologic repository. The sludge will be consolidated in the K West basin and interim stored until treatment occurs at the 100 K Area. Sludge treatment is scheduled to start in fiscal year 2007. Treated sludge will be stored at T Plant pending disposal. Debris from the facility will be removed during decommissioning of the basins and disposed of in burial grounds on the Central Plateau or through the Central Waste Complex. Water from the basins would be treated and disposed of in the 200 Area.

3.5.3.3 100 Areas End State Workshop Feedback

In addition to groundwater in the 100 Area, discussed above in Section 3.5.1, the range of activities for the 100 Area land uses, the reactor cores and pipelines disposition, and cleanup of waste disposal sites were also discussed during the June 23 to 24, 2004, 100 Area End States Public Workshop. Again, the end state vision was not specifically discussed, but the public and regulator input regarding end state issues and preferences is helpful in gauging the level of state and community acceptance for particular aspects of the end state vision.

Reactor Cores (for all cores except B Reactor). The current interim safe storage approach was acceptable to all so long as safety is assured. Interim safe storage performance should be evaluated using the 5-year review process. The safety analysis should include risks for incidents such as an impact from an airplane, perhaps as an act of terrorism. All participants believe a final disposition remedy is required, but were split on whether the cores should be moved to the Central Plateau after decay or left in place.

While it may prove safe to leave them in place, other factors, such as aesthetics, consolidation for more cost-effective institutional controls and possible interference with/by anticipated 100 Area uses may drive a decision to move. But, cores left in place may also provide a “reminder” of the Hanford Site legacy for future generations and provide an institutional control in and of itself.

Native American participants were comfortable with leaving cocooned cores in place for a while, but strongly want them ultimately moved. All agreed time should be allowed for further radioactive decay before final disposition decision, but disposition should be done most preferably before DOE closes the Hanford Site (e.g., 2035 – which still allows significant cobalt-60 decay). All cautioned against presuming final disposition or technology now and wanted to make and execute the decision in the future. DOE should make future removal possible and given funding concerns, a trust fund may be required for this assurance. Moving each reactor as an intact block should be avoided if possible because road building and removal for a transporter that can perform the task will impact the environment. Also, the potential for release of carbon-14 during the move or dismantlement could complicate the decision. Participants favored evaluating new technologies that become available during periodic (e.g., 5-year) reviews.

B Reactor. There was very strong support for the historically significant B Reactor to be preserved for display as a museum if it can be maintained in a safe configuration, which is assumed possible for 10 years with appropriate maintenance. The roof will need replacement in 10 years. The reactor may require use restrictions given possible other uses in the 100 Area and development of national monument plans. The B Reactor should be considered in the evaluation for disposition of the other reactors. The resources for establishing a museum still need to be assured, but the 2006 Tri-Party Agreement milestone to decide final core disposition could come before funding is secured. There was no strong opposition to a milestone extension for B Reactor while funding is sought.

100 Area Post-Cleanup Activities. For the next 50 years, or as long as a federal entity is controlling the lands, activities will be consistent with the Hanford Reach National Monument designation and conservation/preservation land uses. Near-term activities will include preservation of the last native shrub-steppe habitat in Columbia Basin and protection of cultural and historical resources and use as a National Wildlife Refuge.

Recreational and tourism uses are expected to be boating (motorized and non-motorized), fishing, camping, hunting, swimming, hiking, and photography.

Tribal Nations expect to use the area for traditional fishing, hunting, gathering, and sweathouses. While traditional farming will more likely not occur, restoration of plant species important to Native Americans may be pursued.

There could also be Hanford Reach boat tours and B Reactor Museum tours with bus tours during daylight hours, with a park area between Vernita Bridge and B Reactor. A resident ranger and family in the 100 Area is possible for the Hanford Reach National Monument (but not near former waste sites).

For post-cleanup long-term activities (after 50 years), a broader range of possible activities/exposures is envisioned. Beside the continuation of near-term activities, many other activities are seen to be possible and perhaps reasonable:

- Individual residences
- Possible resurrection of the Hanford town site
- Hotel with swimming pool near National Monument
- Commercial activities (e.g., restaurant, souvenir shop)
- Agricultural uses (e.g., fruit orchards, tree farms for wood pulp)
- Industrial activities (e.g., gravel mining, manufacturing)
- Reinstated railroad access to 100 Areas
- Wildfire protection and law enforcement personnel housing in 100 Areas
- Oil and gas leasing

Reactor Pipelines in the Columbia River. Many participants in the workshops strongly believed that the pipelines are trash that should be removed from the Columbia River, unless worker risk and ecological damage during removal can be shown to be significant. If the pipes are left in place, they must be stabilized to minimize physical hazard in the long term.

Disposal Sites and Burial Grounds. All remedy decisions need to provide a good presentation on the science to support the decision, the risk associated with the options and the engineering incorporated in solution. The Tri-Parties need to explain risks from contaminants and risks associated with engineering options. Some concern with the strength of the science and the need to validate with monitoring was expressed. Tribal members pointed out the need for government-to-government discussions on these topics.

3.5.3.4 Final 100 Area End State Based on Feedback from Workshops

Cleanup objectives for an end state vision would be based on adequate protection of human health and environmental resources based on the CLUP (DOE 1999a) identified conservation and preservation land use and compliance with ARARs. The applicable range of exposure scenarios to determine how clean is clean for conservation and preservation activities are envisioned to include the avid recreationalist, resident park ranger, and tribal fisherman for the next 50 years. Beyond 50 years unlimited use is anticipated.

The groundwater end state will be similar to the baseline (see Section 3.5.2). The groundwater remediation goal is to return groundwater to its highest beneficial use within a reasonable time frame. The strontium-90 plume is the only 100 Area groundwater plume that will not be remediated during cleanup. The end state vision for the strontium-90 plume is natural attenuation and monitoring for meeting aquifer restoration goals while reducing strontium-90 concentrations at the river by installing a permeable reactive zone that sequesters the contaminant in place. The plume will meet drinking water standards in approximately 250 years. Alternative technologies are planned to be evaluated to meet the goal of reducing the flux of strontium-90 to the Columbia River.

Cocoon eight of nine reactors and leave in place to decay for up to 75 years. DOE will make a final decision on whether to cut up and move reactor cores to Central Plateau after sufficient decay has occurred. The decision will be made prior to cleanup completion. This delay will require a commitment of future funds toward the final decision.

Keep the B Reactor in its current configuration until funding is secured to support a museum. Should the support not materialize, B Reactor will follow the path described for the other reactors. Cocooning of B Reactor would be finished with the remainder of the 100 Area cleanup completions and no later than the end of the River Corridor Contract period.

The end state vision for 14 pipelines that extend into the Columbia River is to leave them in place, if risk levels are protective and ARARs are complied with and removal results in additional impact. Stabilize the pipelines if required. This evaluation will be part of the final ROD (2008) via the CERCLA process with removal and disposal if any section of the pipelines should wash up on shore. While small concentrations of radionuclides and metals, such as mercury and chromium, are in scale and sludge, they are not in a form that is hazardous to fish that may enter the pipelines, nor do the contaminants pose a risk to the public warranting remediation while the pipelines remain in the river. There are a number of hazardous conditions with potentially significant adverse consequences associated with the pipeline removal option. The receptors that appear to be potentially at greatest risk are onsite workers (injury and exposure), salmon (river habitat disturbance), bald eagles (mating and nesting disturbance), and riparian and shrub-steppe biota (construction impact). As such, significant measures would need to be undertaken during work performance to seek to prevent or mitigate these hazardous conditions wherever possible.

The end state vision for underground pipelines between the reactors and the liquid effluent disposal facilities may remain in place in a stabilized condition as determined by the final ROD.

The end state vision for the approximately 250 above-ground structures in the 100 Areas is the same as the current baseline end state, to demolish and excavate to 0.9 meter (3 feet) below grade.

The end state for the K Basins is also modified from the baseline. The fuel has been stabilized and repackaged for interim storage in the Canister Storage Building within the Central Plateau awaiting final disposition at a geological repository. In addition, water from the basins will be treated and disposed of in the 200 Areas. Fuel pieces make up approximately 0.4 cubic meters (0.5 cubic yards) of the 50 cubic meters (65.4 cubic yards) of the sludge. The fuel pieces will be removed with the sludge and disposed of with the fuel. The sludge will not be stored in T Plant but instead stabilized using in-container solidification processes, similar to those used by commercial nuclear power plants. Dispose the sludge at WIPP or in a 200 Area Core Zone (if less than 100 nCi/g) in accordance with waste acceptance criteria and CERCLA decision documents. Grout remaining equipment and material in place and then cut up and move to a disposal facility in the 200 Area. The basins will then be cut into pieces and transported to an onsite disposal facility.

The end state vision for the land in the 100 Areas is that it remains in federal control well beyond the EM cleanup mission. The Hanford Reach National Monument is currently being managed by the U.S. Fish and Wildlife. A management plan is currently under development by the U.S. Fish and Wildlife for the next 15 years for the monument. The vision for the remainder of the 100 Area would be to fold the land into the refuge system. DOE will maintain its legacy management responsibilities required by the final remedy decisions including continued surveillance and maintenance of the reactor cores and the strontium-90 plume in 100-N Area and continued groundwater monitoring.

3.5.3.5 300 Area

The 300 Area is located in the southeast portion of the Hanford Site, along the west bank of the Columbia River, 2.4 kilometers (1.5 miles) north of the city of Richland. Some of the facilities in the 300 Area are still in use. Starting in 1943, the 300 Area was the location of uranium fuel fabrication facilities and provided fuel for reactors in the 100 Area. It also was the center for much of the Hanford Site's research and development activities. Facilities in the 300 Area include chemical processing laboratories, test reactors, and numerous ancillary/support structures. Later work included research for energy, waste management, biological, and environmental sciences. Over the years, each contributed to liquid and solid waste streams, contaminated buildings, and unplanned releases to the environment. The 300 Area contains a total of 165 waste sites of which 13 are burial grounds (includes 618-7, -10, and -11). Eight of these sites are outside of the 300 Area industrial complex in remote locations. They are the 300 vitrification test site, 316-4 crib at 618-10 burial ground, 600-47 dumping area north of 300 Area, 600-63 a 300-N lysimeter facility, 600-259 a lysimeter site, 618-7 drums of pyrophoric zircaloy chips, 618-13 contaminated soil mound, 618-10 transuranic contaminated waste. Thirty-nine of the 165 waste sites have been remediated of which 5 are burial grounds. As of April 2005, over 643,000 metric tons (709,000 U.S. tons; over 38,160 truckloads) have been excavated from the 300 Area and transported to ERDF. The transportation risk of this campaign was 6.6 x 10^{-3} fatalities. No fatalities have occurred as a result of the 100 and 300 Area cleanup campaigns to date; however there was one significant transportation incident involving movement of material and equipment from the 100 and 300 Areas.

The primary source of groundwater contamination is from waste discharge to engineered facilities such as trenches. The primary environmental concern is uranium; a plume of uranium approximately one mile long currently reaches the Columbia River.

3.5.3.6 300 Area Current Baseline End State

The land use for the 300 Area is industrial restricted surface use. The 300 Area has one final ROD (ROD 1996b). The remedial action objectives in this ROD are based on the default *Model Toxics Control Act Cleanup Regulation* (WAC 173-340) industrial land-use scenario for soil. Direct exposure, inhalation, and ingestion are the primary pathways of concern. Direct exposure is based on an 8-hour-per-day worker that is both indoors (4.6 meters [15 feet] below grade) and outdoors. There is also the assumption that contamination from waste sites and burial grounds is at the surface. According to the ROD (ROD 1996b), human health risk is being reduced for the industrial worker from greater than 10^{-2} to 10^{-5} probability of additional cancer incidence for metals and organics and from ~10^{-2} to ~10^{-4} probability of additional cancer incidence or 15 mrem per year for radionuclides based on EPA guidance on dose rate to risk conversion.

Remedial actions at the 300-FF-1 Operable Unit that removed contaminated soil down to 4.6 meters (15 feet) from 16 waste sites including the major liquid/process waste disposal sites, one burial ground, and 3 small landfills are complete. To date, surface exposure rates meet unlimited surface use at many site because whenever possible sites have been backfilled first with excavated material that is below the standard for industrial use (267 pCi/g uranium if there was any). Backfilling is completed with clean fill from a borrow site. Remedial actions at the 300-FF-2 Operable Unit are underway to excavate solid waste burial grounds and haul the contaminated contents and soil to the Environmental Restoration Disposal Facility. As of April 2005, excavation of 69 waste sites including 5 burial grounds has been completed. Final RODs have not been written for the entire 300 Area soil and groundwater cleanup. A baseline risk assessment for the River Corridor has been started that will assess human health and the environment to support final RODs.

Remedial actions will strive to prevent further degradation of groundwater through the leaching of residual contaminants to the extent practicable. Groundwater use will be restricted because of residual groundwater contamination. Contaminant discharges to the Columbia River will be below levels resulting in unacceptable risk to the environment or groundwater control actions will be put in place.

Eight waste sites/burial grounds are outside of the 300 Area industrial complex in remote locations. They are surrounded by undisturbed desert habitat. In May 2004, an explanation of significant differences (ESD) was issued for the 300-FF-2 ROD (EPA et al. 2004) documenting that these waste sites/ burial grounds will be cleaned up to unrestricted surface use standards for a residential non-farmer scenario, even though the land use remains industrial. This scenario is identical to current scenarios in the 100 Area RODs (ROD 1996a, 1999a, 1999b, 1999c), including use of irrigation. Excavation of these outlying waste sites/burial grounds is believed to be a cost-effective way to shrink the contaminated footprint along the River Corridor. The additional cost to remediate the eight waste sites/burial grounds to meet the unrestricted surface use criteria has been estimated to be $750,000 (or just over 1%). Approximately $500,000 of the extra cost is attributable to the 618-10 burial ground.

Relatively few facilities in the 300 Area have CERCLA decision documents associated with them. However, ~150 buildings and structures need to be removed to expose the 40 soil contamination areas within the 300 Area industrial complex that need to be cleaned up pursuant to the ROD. About 220 facilities are slated to come down in the 300 Area.

3.5.3.7 300 Area End State Workshop Feedback

A broad range of activities are envisioned for the area currently known as the industrialized 300 Area and the surrounding region. The proximity to the Columbia River and the City of Richland makes this area attractive to many people for a broad range of uses. Current land-use plans identify this region for industrial reuse, but a study recently completed by the City of Richland suggests that industry is not interested in reoccupying this land. The City of Richland study did not involve input from the Tribal Nations. Future land use identified during the workshop included a number of industrial uses, as well as recreational uses and a range of other ideas. The thought was expressed that an effort should be made to encourage industrial reuse to avoid continued sprawl of industrial development to currently undisturbed land. Table 3.6 summarized the potential future uses identified.

Workshop participants also identified a number of considerations for future land-use decisions. Proactive steps will need to be taken to successfully reindustrialize the 300 Area. Work at other sites in the United States with contamination remaining has shown that the new user's liability must be capped so they are not taking the risk of being responsible for preexisting contamination. Additional incentives must also be provided to encourage the use of previously contaminated land when lots of clean land is available – tax reduction or other incentives.

Workshop participants identified the protection of cultural resources as an important consideration during land-use decisions. A number of Native American burials were disturbed at the original site identified for the Environmental Molecular Sciences Laboratory before the site was abandoned in favor of one farther south and away from the river. Workshop participants also indicated a preference for non irrigated uses over irrigated uses to minimize mobilization of any uranium that remains in the vadose zone or groundwater.

Representatives of the Native Americans or their technical staff indicated that the land should be cleaned up so that Tribes to could safely exercise their Treaty Rights and held in federal control so that they could continue to exercise those rights.

Reuse of the area will lead to better protection of any contamination that remains. People living and working in a region with remaining contamination and institutional controls will pay attention to these controls which will lead to better protection. An example given was the desecration of Civil War battle fields that are not set aside and maintained. Isolated locations in the woods are much more often looted than those that are identified and maintained.

As with workshops for the other areas on the site, participants expressed the concern that institutional controls will fail. As a result, the consequence of the failure of institutional controls needs to be understood. If an obvious action needs to be taken, for example a large hole dug, to violate the institutional control and cause harm it will be much easier to prevent than if minor actions result in exposure. Participants also indicated that development should not preclude further cleanup actions if monitoring identifies the need to do more or new technologies are developed that could reduce the remaining contamination. A complete listing of the notes taken at the workshop can be found online at http://www/hanford.gov/docs/rbes.

3.5.3.8 Final 300 Area End State Based on Feedback from Workshops

Until final records of decision are produced, the existing cleanup standards under the interim action Record of Decision for the source operable unit will continue to be utilized. Remediated sites will be backfilled to support unlimited surface use (irrigation and groundwater use may be restricted, based on success of future groundwater cleanup activities) where practicable. To date, this has been accomplished whenever possible by backfilling the excavated waste sites first with excavated material that is below the standard for industrial use (267 pCi/g uranium if there was any) and finishing with clean fill from a borrow site. DOE will continue this practice in the future where practicable.

The risk assessment for the River Corridor will be completed to support final remedial decisions. The outcome of the River Corridor risk assessment, the final remedy for groundwater, the 5-year review of land-use decisions, and the data gathered during the early stages of cleanup will be considered along with public input before final 300 Area site remedies are identified.

3.5.4 Central Plateau – Background, Baseline, and End State Descriptions

The Central Plateau consists of ~194 square kilometers (~75 square miles) near the middle of the Hanford Site. The plateau contains about 900 excess facilities formerly used in the plutonium production process including five massive chemical processing facilities (i.e., canyons) and Plutonium Finishing Plant (PFP) as well as about 1,000 individual waste sites including both buried solid waste and contaminated soil.

The Central Plateau Core Zone of 64.7 square kilometers (25 square miles) will be an industrial exclusion zone land use for ongoing waste disposal operations and infrastructure services, which are needed for continued use to support the cleanup mission. This collection of facilities, waste sites, canyons, and ongoing waste disposal operations is spread across the plateau. The rest of the Central Plateau, ~129.5 square kilometers (~50 square miles), will be designated conservation/preservation land use with restricted surface use; the majority will be designated as conservation use. The receptors are the industrial nuclear workers, non-nuclear workers, and authorized visitors.

Table 3.6. Potential Future Land Uses for the 300 Area Identified During the End State Workshop

Use Category	Envisioned Uses
Industrial	• Industrial business uses by DOE or Department of Defense, such as biological and chemical research, high-tech engineering, and research on how to get uranium out of the environment. • Agricultural uses (e.g., wineries) • Passive Energy Generation • Office Complex Development • Energy Development • Sustainable research and development for "green" energy development. • Redevelop the area with facilities for educational use • Redevelop with light industry – especially those that could make use of the Treated Effluent Disposal Facility. • Develop the area into a transportation hub because of the proximity to rail lines, barge dock and major highways. • The area could be used for future government missions.
Recreational	• Retirement area (unconstrained uses similar to those identified for the 100-Area during the 100 Area End State Vision Workshop, such as a golf course, swimming pools, walking path along the river) • Recreation, especially along the River – biking, boating, walking • Entry to National Monument
Other	• Any land with a river view should be unrestricted (because of its high value). • Leave the 300 Area as an open area with natural vegetation – no irrigation will be required resulting in less uranium being released to groundwater, protect cultural and historical resources • The area could be developed for a variety of uses like the Columbia Point area in Richland • One large marina (Excavating all the uranium contamination and using the large hole that remains as a marina) • Bridge to Pasco

3.5.4.1 Central Plateau Current Baseline End State

Most of the contaminant inventory from the Hanford production era is stored or disposed in the 200 Areas within the Central Plateau. The 200 Areas also receive waste from cleanup operations from the rest of the Hanford Site as well as offsite waste from other DOE sites as allowed by law. The end state for the Central Plateau, under current plans, is described in the following paragraphs.

The *200 Areas Remedial Investigation/Feasibility Study Implementation Plan* (DOE 1999c) proposes a standard dose of 15 mrem/year or a risk of 10^{-4} to 10^{-6} for risk evaluations. Current baseline remediation goals for all waste sites incorporate a cleanup dose rate standard of 15 mrem/year for industrial workers under an industrial-use scenario. This is based on an industrial scenario for all remedial actions inside the Central Plateau Core Zone. Outside the Core Zone, land use is identified as conservation (mining). The baseline remediation goals are based on the risk range of 10^{-4} to 10^{-6} under CERCLA using an industrial scenario as a conservative estimate for the conservation (mining) land use. Other scenarios (residential, recreational, tribal) are also evaluated to provide the DOE, regulatory agencies, Tribal Nations, and stakeholders a comparison for evaluating ultimate cleanup objectives.

The 200 Areas will continue to receive waste from Hanford cleanup activities and from offsite sources. DOE has committed to the state of Washington that future radioactive low-level waste will be disposed of in burial grounds equipped with liner/leachate collection systems equivalent to RCRA requirements. This is supported by some stakeholders based on the presumption that such systems provide an increased environmental benefit at Hanford. Liner/leachate systems are used to collect precipitation and dust control water during active waste disposal operations. They have very short design lives (~30 years) and are not relied on for post-closure performance, although they will collect leachate if generated for some period. After waste operations cease, containment of the waste site is controlled by the surface barrier. Liner/leachate systems are not required in the commercial low-level burial grounds licensed by the U.S. Nuclear Regulatory Commission located at Hanford. DOE estimates a need for up to three more burial ground cells that will cost ~$9.5 million each for the liner and leachate system.

The five canyon facilities will be disposed in place with a suitable surface barrier to prevent infiltration of water and/or to prevent intrusion by human or ecological receptors. Existing contaminated equipment from the canyon deck will be reduced in size and placed in the canyon process cells and grouted. Additional wastes may be considered for disposal in the canyons, however, no specific waste streams have been identified at this time. The upper part of the canyon building will then be demolished to approximately the level of the canyon deck. Debris from this partial demolition will be placed on or adjacent to the canyon deck and then filled with grout to minimize voids. The partially demolished building and debris will be covered with a surface barrier. The PUREX tunnels will be filled with grout and covered with a surface barrier.

The PFP had ~17 metric tons (18.7 tons) of bulk plutonium-bearing material that has been stabilized and repackaged into ~2,200 Specification 3013 cans awaiting final disposition offsite and ~2,400 pipe overpack containers stored at PFP and the Central Waste Complex awaiting shipment to WIPP. In addition, there is less than 0.1 metric ton (0.11 ton) of plutonium hold-up that will be packaged as transuranic waste, for disposal at WIPP, or low-level waste, for disposal at an onsite disposal facility. PFP and other 200 Area ancillary facilities will be removed to ground level and disposed in an approved facility (currently the Environmental Restoration Disposal Facility or WIPP, as required). Potential sub-surface contaminants will be disposed in a manner consistent with waste site remedial alternatives discussed below.

Approximately 15,000 cubic meters (19,619 cubic yards) of suspect transuranic waste were placed in retrievable storage trenches in four low-level burial grounds starting in 1970. The waste is being retrieved from the trenches and characterized to determine if it is transuranic or low-level waste. Two additional waste sites located outside the 200 Areas (618-10 and 618-11 burial grounds) contain ~10,000 cubic meters (~13,079 cubic yards) of suspect transuranic waste. The low-level fraction will be treated and disposed onsite as mixed low-level waste in a permitted disposal facility, and the transuranic fraction will be shipped to WIPP. This could require an estimated 3,000 shipments to WIPP. All retrieval actions will be completed by 2018.

The Central Plateau includes ~1,000 waste sites including 132 burial grounds/landfills/dumps. Sixty-nine of these waste sites including 29 landfills/dumps are outside the Core Zone. There are 33 burial grounds inside the Core Zone.

No action is proposed for 17 of the 69 waste sites outside the Core Zone. Three of the waste sites outside the Core Zone are landfills containing solid waste or dangerous non-radioactive waste. Only one soil waste site (the 200-B-57 crib) has been remediated; however, the CERCLA final ROD covering that waste site has not been approved. This waste site was covered with the Hanford prototype surface barrier in 1994.

The cribs, trenches, ponds, and burial grounds, i.e., waste sites, will be generally addressed by one of four alternatives: (1) removed, treated, and disposed to an approved disposal facility; (2) existing soil covers maintained under institutional controls and natural attenuation; (3) capped with a suitable surface barrier; or (4) no action. Other actions may be needed for site-specific remediations. Some cases may call for a combination of remove, treatment and disposal of waste site contents followed by installation of a surface barrier. Surface barriers will be designed to limit the infiltration of water and thereby slow the movement of contaminants currently in the vadose zone into the underlying groundwater. Barriers will be designed to reduce infiltration and prevent intrusion by plants and animals so that the underlying contamination is not dispersed. Smaller 200 Area waste sites may be consolidated if cost efficiencies can be gained and worker risk associated with moving the contaminated material is acceptable. Current baseline cost estimates assume 32% of the waste sites or ~570 hectares (1400 acres) will receive a suitable surface barrier, 40% of the waste sites will be removed and disposed, and 28% will be under natural attenuation with appropriate monitoring or no action.

Disposition of over 643.7 kilometers (400 miles) of buried pipelines in the Central Plateau has not been resolved. However CERCLA-based work plan development efforts are underway to delineate remedial investigation needs and remedial alternative evaluations in support of future remedial action decision making. One possible remedial alternative is that limited sections may be removed, treated, and disposed to ERDF, WIPP, or other approved disposal facilities.

Institutional controls under federal control will be integral to appropriate remedies. Controls may include restrictions to prevent intrusion or modifications to the surface barrier, environmental monitoring, and/or deed restrictions.

An extensive inventory of radionuclides exists in two other forms that require disposition; the German logs and the cesium and strontium capsules. An agreement between an agency of the Federal Republic of Germany (FRG) and DOE resulted in the production of 34 isotopic heat sources ("German logs") in the mid-1980s. Stainless steel canisters were filled with radioactive borosilicate glass. The logs contain a total of approximately 8.3 million curies consisting mainly of cesium-137 and strontium-90, but also containing transuranic contamination. Originally the logs were intended to be transported to Germany for use in experimental programs associated with the development of underground storage facilities. Currently the German logs are managed as remote-handled transuranic waste (approximately 6 cubic meters) and are stored at the 2420-W cask storage pad at the Central Waste Complex. They are stored in casks that provide the needed shielding to meet facility operational limits of 100 mrem/hr. The storage pad has a roof but is not enclosed. They will be processed for certification for disposal at WIPP sometime after 2012 when plans show that the remote-handled transuranic processing capability will become available. If at that time the German logs do not meet acceptance criteria for disposal at WIPP, other alternatives will be evaluated.

Approximately 2,000 cesium and strontium capsules stored at Hanford contain ~130 million curies of radioactivity, which amounts to ~37% of the total radioactivity at the Hanford Site. Currently, the capsules are stored under shielding water in a basin within the Central Plateau. DOE manages the capsules as high-level mixed waste subject to regulation under RCRA. The previous planning assumption was that the capsules would be transferred to the Waste Treatment Plant for vitrification and subsequent disposal offsite. Because the present storage configuration for the capsules presents challenges including vulnerability to accidents, security threats, and high annual surveillance and maintenance costs (~$5 million per year), DOE is considering placing the capsules in dry storage and believes they could be directly disposed at a national geologic repository.

The main challenges for managing and disposing of the capsules are well described by the National Research Council, Board of Radioactive Waste Management, in *Improving the Scientific Basis for Managing DOE's Excess Nuclear Materials and Spent Nuclear Fuel* (NRC 2003). The Board identified the main challenges as intense radiation and the relatively large amount of heat that the capsules produce. Dose rates range from 8,600 to 18,000 rem/hour for the cesium-137 capsules and from 20 to 420 rem/hour for the strontium-90 capsules. Compared to other nuclear materials in DOE's inventory, cesium-137 and strontium-90 have relatively short half-lives, 30 years and 29 years, respectively. Cesium and strontium have limited mobility in the environment due to adsorption on clays and other aluminosilicates. The capsules are considered in good condition; however, 23 capsules have been overpacked, i.e., sealed in a larger stainless steel container.

In addition to the cesium and strontium capsules, transuranic waste and spent fuel from 100-N Area will be packaged and disposed offsite in a selected high-level waste or spent fuel geologic repository (i.e. Yucca Mountain Nuclear Waste Repository or WIPP), for permanent disposal.

3.5.4.2 Central Plateau End State Workshop Feedback

The three discussion topics were each focused on one aspect of cleanup and the recognition of the risks posed by the waste likely to remain following cleanup to ensure remedies are protective. However, there was a good deal of inter-relation between the topics. This inter-relatedness can be readily observed in the feedback summaries presented here and the applicability of the various themes and opinions for one topic could, and in several cases did, easily extend to the rest of the topics. This resulted in the following overarching common themes, which appeared to have widespread participant support:

- Remedial decision-making should include consideration of potential worker exposure. However, maintaining worker safety was not viewed as a barrier to an aggressive cleanup. In other words, potential worker exposures are not an 'excuse' to reduce cleanup efforts. Several participants noted the skilled Hanford workforce that safely performs dangerous work on a daily basis. Moreover, the principles of integrated safety management ensure that, if a job cannot be performed safely, it will not be performed.

- Institutional controls are unreliable and should be used only as a last resort. The bias in cleanup decision-making should be for remedial action. If remedies are not feasible, engineered controls should be pursued as a second priority with institutional controls utilized only as a last resort.

- Consistency in remedial decisions and treatment of waste is important. This issue arose during discussions of transuranic waste. Of primary concern was DOE's policy distinguishing between pre-1970 and post-1970 transuranic waste. Many workshop participants cited this as an artificial designation that was inappropriate—particularly in any end state cleanup approach.

- Tradeoff decisions rely heavily on site-specific data. For example, although Gable Pond is outside the Core Zone, the risk posed by the pond does not appear to warrant aggressive remedial action. On the surface, this input appears to conflict with participants' desire to limit the size of the Core Zone and ensure unrestricted use outside the Core Zone. However, the specifics of Gable Pond make this a reasonable conclusion.

- Site-specific decisions should consider holistic impacts. The site needs to perform a cumulative impact assessment to put site specific decisions in the context of Hanford's total impact.

- Waste left in place requires long-term federal commitment and attention. Waste left in place must be monitored to ensure surface barriers or other engineered/institutional controls are performing as designed. Further, monitoring plans should include 'trigger points' and action plans for remedial actions in the event engineered controls fail.

- High risk waste sites and facilities should be addressed first.

- Bias for cleanup action. Increased cleanup
  - increases potential future land-use option.
  - decreases the likelihood additional cleanup work will be required in the future.
  - decreases DOE's obligations to restore injured natural resources.
  - decreases reliance on institutional controls.

Feedback from each workshop topic is summarized in the following paragraphs.

Land Uses and Exposure Scenarios. Several key messages for future land uses and timelines are important in exposure scenario development for the Central Plateau.

<u>The Core Zone</u>

- Active remediation and waste management should be expected for the next ~50 years. The Core Zone will continue to accommodate continuing waste management activities such as US Ecology, Inc. (through 2064), nuclear submarine reactor compartment disposal, other permitted disposal facilities (e.g., Integrated Disposal Facility), tank waste vitrification, and probably residual materials from existing waste sites, facilities, and tank farm closures.

- Remedies should be robust. Remedies, including intrusion barriers and markers, should be sufficiently robust to prevent intrusion by "realistic" future intruders in the event that institutional controls fail. In addition, development of remedies and development of institutional controls should not be "decoupled" in time as they are today. Remedies and institutional controls should be integrated and mutually supportive.

- Shrink the Core Zone. DOE should consider shrinking the Core Zone perhaps into smaller sub-zones that would release areas such as the land between the 200 East and 200 West Areas to less restrictive uses. The Core Zone should be defined by those areas with active waste management functions.

<u>Outside of the Core Zone</u>

- A buffer zone should be retained, but should shrink with time. A portion of the area outside of the Core Zone should be used to establish a "buffer zone" that restricts access in recognition of ongoing Core Zone activities and to prevent exposure to remaining contamination within the buffer zone. It is expected that this "buffer zone" will shrink and be eliminated over time. This buffer zone could be compatible with "monitored natural attenuation" remedies, if applied, at lower risk sites such as Gable Mountain Pond.

- Beyond a buffer zone, a broad range of uses similar to the 100 Areas should be considered. This area may see "conservation/preservation" uses that are similar in nature to those under consideration for the 100 Areas. Tribal use scenarios should also be considered and expected in the area outside of the Core Zone.

<u>Institutional Controls</u>

- Institutional controls will not last forever. Institutional controls can reasonably be expected to remain intact for about 100 years beyond the period of active waste management activities (perhaps the next 50 years). Beyond that time, institutional controls would be much less reliable and a broader range of potential uses should be considered.

- Encourage compatible industrial uses to improve the viability of institutional controls. One means to strengthen the viability of long-term institutional controls on the Central Plateau would be to encourage compatible industrial uses that would be motivated to retain knowledge of the disposal locations that remain. A variety of potential compatible uses was discussed including energy production, environmental cleanup technology firms, uses requiring the remoteness of the Plateau (e.g., low-light astronomy, bio-chemical research, etc.), continued waste management, and historical preservation of Manhattan Project facilities.

- Actively seek to preserve relevant information now. We should seek ways to actively capture and preserve current information to make it accessible to future generations and users of the Central Plateau. This step would include actively interviewing retired workers.

Processing Facilities, Buildings, and Structures. The feedback for this topic was consistent in many respects to that for the land use and exposure scenario topic. Additional key messages for facilities, buildings, and structures include the following:

- Minimize the size of the Core Zone. The Core Zone should be used for consolidating site-wide contamination.

- Deal with the highest risk facilities first and base decisions regarding whether to leave or demolish facilities on risk. "Robust" facilities (e.g., the canyons) might be left in place if the contamination is contained to a similar degree as it would be in an engineered waste disposal facility. It makes little sense to demolish facilities and move them to the Environmental Restoration Disposal Facility if they can be made safe where they are.

- Remove "less robust" facilities. For example, PFP is a high-risk facility and its construction makes demolition relatively easy (use lessons learned from 233-S demolition) so get rid of the building and the equipment inside it now.

- Dispose of additional waste in the canyon facilities. Canyons could be as protective as, or even more protective than, the Environmental Restoration Disposal Facility. Waste acceptance criteria must first be developed for any waste left inside or imported into a canyon building.

- Compare current risks to workers to risks posed to future generations and the environment. Consider worker radiation/chemical exposure, industrial accidents, and maintenance activities for specific remedial alternatives.

- Develop a comprehensive remedial action work plan for the Central Plateau. Integrate all components in a logical, cost-effective, and protective manner and includes life-cycle costs as well as the pros and cons of remedial alternatives.

- Take advantage of vast process knowledge of retired workers. Conduct comprehensive interviews of retired workers to capitalize on this information resource. It could result in more economical and more reliable characterization.

- Develop monitoring systems for surface barriers and mitigation action plans to ensure barrier performance and prepare for potential future problems – This is needed to address serious doubts about the effectiveness and duration of institutional controls. (The unreliable nature of institutional controls was recognized as a general theme, but it was not heavily discussed for this topic, probably because the Core Zone concept assumes institutional controls will be a remedy component for quite some time.)

Diverse opinions were also expressed about the following issues:

- Surface barriers. Participants generally accepted the idea that surface barriers will work for canyon facilities and are protective, but some felt that surface barriers are not necessary, and some felt that we would be better off without them. The reasons for not capping included (1) the large facilities would serve as a reminder of what has been left in the area, and (2) we would cause more environmental damage digging up the huge volumes of borrow source materials needed for these surface barriers.

- Pipelines. Discussions included a request to use a consistent, logical approach for all pipelines. Some participants felt that pipelines should be closely associated with the facilities they served, and others felt that they should be considered separate entities and not tied to any specific facilities.

- Worker safety. Some participants felt high-risk work should be avoided by closing facilities in place. Others felt that the Hanford workers have the expertise to do the high-risk work and that we should do it now while we have the funding and the historical knowledge. There is a difference between informed workers accepting risks today and unknowing members of the public being exposed to risks in the future. To some, moving the waste to reduce the footprint in the Core Zone was a much greater concern than the concern over the potential future human health, environmental, and ecological risks/impacts from leaving waste on-site and capping in-place.

- Canyons. Some participants said to leave the canyon buildings without surface barriers to remind people of the hazards. Others said to leave the canyons as is for 200 to 300 years so the beta and gamma can decay, then go back and perform the final remedy, which may include surface barriers. The benefits of waiting include reduced worker risk and the possibility of better decontamination and demolition technologies in the future.

- Future weather patterns. One participant felt that global climate change may increase precipitation, which should be considered for remedial actions.

Buried Waste and Contaminated Soil. The key messages centered on protecting the groundwater as a first and foremost consideration, which is also described above in Section 3.5.2.

- High risks waste sites should be addressed first.

- Aggressive technology development is needed. Must address the contamination that could get to the groundwater (particularly the technetium-99).

- Allow for "nature doing its job." May not need to reduce the footprint in certain cases (Gable Mountain as an example of active and healthy ecosystem. Presents low risk if there is a failure in institutional controls.

- Maintain the appropriate institutional controls. During a predetermined time period, need to emphasize certainty of controls. To accomplish this, need good data and characterization. Also need to consider human and ecological risk, and look holistically.

3.5.4.3 Final Central Plateau End State Based on Feedback from Workshop

In addition to the views expressed in the end state workshop, stakeholders, as articulated in *The Future for Hanford: Uses and Cleanup – The Final Report of the Hanford Future Site Uses Working Group* (DOE 1992b) and consensus advice from the Hanford Advisory Board (ADVICE # 132; http://www/hanford.gov/docs/rbes), have recognized for many years that waste will remain in the 200 Areas post cleanup. This view is captured in the CLUP (DOE 1999a) by giving the Central Plateau an industrial-exclusive land-use designation, i.e., an area suitable and desirable for treatment, storage, and disposal of hazardous, dangerous, radioactive, non-radioactive waste, and related activities. Adjacent areas will be conservation areas, i.e., areas reserved for the management and protection of archeological, cultural, ecological, and natural resources with possible limited and managed mining within appropriate areas.

Because the Central Plateau will remain an industrial area to be used exclusively for waste management operations (nuclear and non-nuclear) for the foreseeable future, CERCLA RODs for the 200 Area will define cleanup and future exposure levels to be compatible with an industrial-exclusive land use. Cleanup will be designed so that workers under industrial nuclear and non-nuclear worker scenarios are at acceptable exposure levels. A reasonable industrial exposure scenario will be used that includes direct exposure to surface soil, exposure during limited excavation, inhalation, absorption, and ingestion of contaminants. This scenario assumes no groundwater use. Waste sites containing contaminated soil will be remediated through the use of a surface barrier or will be clean enough to not further degrade the groundwater through leaching of residual contaminants (>4 mrem/year drinking water standard) from natural recharge, protect the environment, and protect human health within the acceptable CERCLA risk range for restricted surface use as allowed by industrial exclusive land use.

Fluor Hanford, Inc. has developed a plan for closure of the Central Plateau that adopts a regional or "zone" approach to optimize and prioritize the cleanup of facilities, waste sites, and structures to achieve closure. The end state vision is to continue development of and to finalize this approach for implementation. The 200 Area will continue to receive waste (radioactive and mixed) from Hanford cleanup activities and from offsite sources. These materials will continue to be disposed in trenches, and resources will focus on measures to reduce infiltration at closed Hanford burial grounds. One alternative that was considered, but will not be pursued, is to reconsider the commitment that was made to dispose all future low-level radioactive waste in lined trenches with leachate collection systems; DOE-EM-1 has committed to the state of Washington that all future solid waste disposed at Hanford will be in lined trenches. Liners will provide limited additional risk benefit because waste for new cells must meet waste acceptance criteria that will minimize probability of liquid generation. Long-term protection, including groundwater protection, can be adequately provided by surface barriers. Putting waste in lined trenches is not expected to result in significant risk reduction and increases costs for construction and operation. An estimated three more burial ground cells are needed in the Central Plateau Core Zone. RCRA Subtitle C liners and leachate systems will cost ~$9.5 million for each cell. The end state vision proposes to focus resources on improving surface barriers at the many existing closed low-level waste burial grounds at Hanford where minimal operational covers have been constructed.

Several options have been considered to dispose of the cesium and strontium capsules. These options include continued storage in the pools at the Waste Encapsulation and Storage Facility, passive storage in air at a new facility, overpacking and disposal of the capsules at a geologic repository, and vitrification into a glass or calcination into an oxide followed by disposal at a geologic repository.

DOE's current vision is to continue storage of cesium and strontium capsules in wet storage in the Waste Encapsulation and Storage Facility in the 200 Area in the near term (up to 5 years). Onsite dry storage for up to 50 years in the Central Plateau of the Hanford Site should be considered as a potential cost effective risk-based option until the cesium capsules can be sent to a geological repository and strontium capsules can be disposed of in the Central Plateau in accordance with waste acceptance criteria and CERCLA decision documents. There are regulatory issues and Ecology has serious concerns with this on-site disposal alternative. The National Research Council (2003) states that:

> "Intermediate or long-term storage on site has the advantages of allowing monitoring and surveillance, providing physical protection, saving the material as a potential resource,

and maintaining the material in disposal-ready condition while avoiding interstate transportation issues. Given their ~30-year half-lives, the isotopes could decay significantly during storage thus reducing their hazard and difficulty of eventual disposal. Issues for long-term storage include the commitment to maintain the storage facility and the capsule failure risk due to a lack of understanding of the processes occurring in the capsules. For dry storage, the capsules would be moved using robotics and stored in air in a special facility designed to convectively exhaust the heat generated."

The April 2004 draft end state document described an approach for the five canyon facilities to be disposed in place with a suitable surface barrier to prevent infiltration of water and/or to prevent intrusion by human or ecological receptors. Additional waste may be disposed along with existing contaminated material and equipment from the canyon deck in the canyon process cells, and/or on the canyon deck, and then all voids filled with grout. The upper part of the canyon building would then be demolished to approximately the level of the canyon deck. Debris from this partial demolition would be placed on or adjacent to, the canyon deck and then filled with grout to minimize voids. The partially demolished building and debris would be covered with a surface barrier. Grout in place the contaminated equipment in Plutonium-Uranium Extraction (PUREX) Plant tunnels and cover with a surface barrier.

However, for some canyons an alternative is to use the canyon as an engineered disposal facility that would not be demolished or capped. Waste inside the facility and waste from facilities associated with the canyon would be disposed of in the canyon. This approach could reduce worker risks and potential environmental harm because demolition would not be needed and surface barrier construction would not be needed. This approach could be as protective, or perhaps more protective, than demolition and capping. Facilities that are not robust canyons (including portions of canyon facilities that are not robust) would follow the demolition and engineered barrier approach.

The surface barrier for each partially demolished canyon will require considerable material for construction. An estimated 460,000 cubic meters (601,657 cubic yards) of borrow source material will be needed for the U Plant canyon. Other canyons may require greater volumes so substantially more than 2.3 million cubic meters (3 million cubic yards) of material or ~200,000 truck trips at 11.5 cubic meters (15 cubic yards) per truck will be needed to construct barriers over all five canyons. Due to this magnitude of material and the potential ecological impact to the borrow source area and industrial risks, an alternative to leave the canyon structure intact without a surface barrier may be considered. This will be carried as an alternative to the baseline pending further trade-off studies and evaluation.

Ancillary facilities in the 200 Areas will be removed to ground level and disposed under the surface barrier of the nearest canyon facility. Potential sub-surface contaminants will be disposed of consistent with waste site remedial alternatives.

PFP and Plutonium Reclamation Facility will be demolished to slab-on-grade. Remove equipment, debris and plutonium hold-up material from PFP and disposed at WIPP or onsite in accordance with waste acceptance criteria and CERCLA decision documents.

More than 1,000 waste sites such as cribs, trenches, and ponds, including 132 burial grounds, landfills, and dumps will still be generally addressed by one of four baseline alternatives:

1. Capped with a suitable surface barrier

2. Removed, treated, and disposed to an approved disposal facility
3. Maintain existing soil covers under institutional controls and natural attenuation
4. No action

Other actions may be needed for site-specific conditions, such as the presence of organic constituents. Surface barriers will be designed to limit the infiltration of water and thereby slow the movement of contaminants currently in the vadose zone into the underlying groundwater. Barriers will be designed to reduce infiltration and prevent intrusion by plants and animals so that the underlying contamination is not dispersed. The CERCLA process will be used to determine which of the four options is most appropriate for each waste sites. Consolidation of smaller 200 Area waste sites will be considered to optimize placement and minimize the number of surface barriers if cost efficiencies can be gained.

One of the reasons for pursuing this approach is that worker risks associated with the remove, treat, and dispose activities are greater than those associated with surface barriers. The risks to the worker are greater based on the multiple stages of operation in remove, treat, and dispose remediation activities. The potential for both common industrial accidents and accidents associated with exposure to radiological contamination are increased. There is also a cost risk associated with implementing the remove, treat, and dispose alternative, which is the cost of protecting the workers from potential exposure during various stages of operation.

Approximately 15,000 cubic meters (19,619 cubic yards) of suspect transuranic waste that was placed in four burial grounds after 1970 remain in place with a surface barrier. The baseline assumes removal and offsite disposition of the transuranic waste component (~1,000 shipments to WIPP) and treatment and on or off site disposal of any low-level waste component resulting from removal activities. The current cost estimate to complete waste retrieval in burial grounds 218-E-12B and 218-W-3A is about $355 million. Estimated treatment costs for the non-transuranic waste retrieved from the low-level burial grounds are about $340 million and for thermally treating 600 cubic meters (784 cubic yards) of mixed low-level waste about $36 million. Under the end state vision, retrievably stored suspect TRU waste will be retrieved treated, and the TRU portion shipped to the Waste Isolation Pilot Plant (WIPP). The low-level portion of the retrieved waste will be treated and disposed of on-site. Wastes containing transuranic materials buried pre-1970 will be managed per CERCLA decisions.

Disposition the miles of buried pipelines in place in the Central Plateau using the Resource Conservation and Recovery Act (RCRA) and CERCLA processes, by remove-treat-dispose, or stabilize in place.

Institutional controls under federal control will be an integral component for appropriate remedies. Controls may include restrictions to prevent intrusion or modifications to the surface barrier environmental monitoring and/or deed restrictions.

Future 200 Area waste management and disposal operations will be designed, in concert with non-degradation policies, to minimize the contamination of underlying groundwater to the extent practicable. Current and future groundwater remediation will focus on contaminant plumes that are currently contained within the Central Plateau but have the potential to migrate outside the plateau. CERCLA processes under the Tri-Party Agreement will be used to reach final RODs for the 200 Area groundwater plumes. It is expected that remediation efforts in this region will focus on carbon tetrachloride, uranium, and technetium-99. It is also expected that natural attenuation processes will be used to address the tritium, iodine-129, and nitrate plumes that have migrated from the 200 East Area.

3.5.4.4 Tank Farms

Tank Farm Background. DOE and its predecessor agencies, dating back to the Manhattan Project, created a variety of radioactive and chemical waste as by-products of producing fissile materials for defense purposes. Today, ~2E+008 liters (>53 million gallons) of liquid, sludge, and saltcake waste containing ~200 million curies of radioactive material are stored in 149 single-shell tanks and 28 double-shell tanks. Those tanks are distributed among 18 tank farms within the 200 East and 200 West Areas on the Central Plateau. DOE-ORP was created to execute cleanup of the Hanford tank farms. Its responsibilities include retrieving wastes from the tanks in accordance with the Tri-Party Agreement (Ecology et al. 1989), treating and disposing the waste to authorized disposal locations, executing targeted remediation actions when necessary if soil and/or ancillary equipment contamination levels so warrant, and closing the tank farms in a manner that will protect human health and the environment for extremely long times (hundreds or thousands of years) into the future.

DOE-ORP's cleanup approach integrates its commitments under the Tri-Party Agreement with its responsibilities under the *Atomic Energy Act of 1954*, the *National Environmental Policy Act* (NEPA), and applicable DOE Orders and environmental regulations that flow from those acts. While the Tri-Party Agreement cleanup and closure requirements are relatively prescriptive, the Tri-Party Agreement and the regulations it encompasses do include moderate levels of flexibility to deploy risk-based solutions for cleanup and closure actions. Examples include Appendix H to the Tri-Party Agreement (Ecology et al. 1989), which provides for alternative retrieval levels if the 99% goal cannot be reasonably attained. Under Appendix H, a balance can be struck between long-term risk, risk to workers, technical practicality, and cost to arrive at alternate levels. Similarly, while Tri-Party Agreement's RCRA roots tend to focus on achieving clean closures, provisions exist that can lead to landfill closures based on similar tradeoffs considered under Appendix H. The result is that while some cleanup actions will be taken to meet prescriptive objectives, exercising the flexibilities within Tri-Party Agreement will result in protective conditions existing at the completion of cleanup and closure with risk analyses being a factor in determining the final end states. The tank farm end states are within the final closure of the Hanford Site and groundwater protection that are regulated under the CERCLA using risk-based principles.

Tank Farm End State Vision. The end state envisioned by DOE-ORP for the tank farms is that the bulk of the radionuclides will be disposed of offsite as high-level waste, and the bulk of the contaminated chemical waste equipment (e.g., pumps, piping, and tanks) will be disposed of onsite in a protective manner that complies with Tri-Party Agreement and appropriate laws, regulations, and DOE Orders. This end state is the current baseline and requires completion of the tank closure environmental impact statement. The baseline is premised on the expectation that RCRA landfill closure will be adopted following tank waste retrieval to levels specified by the Tri-Party Agreement. By this method, residuals and ancillary equipment would be stabilized in place. Implementation of this path requires a ROD from the environmental impact statement that specifies landfill closure as the path forward. Further details regarding the end state are as follows:

1. Waste will be retrieved at, near, or beyond the goals established by Tri-Party Agreement barring currently unforeseen obstacles. This should result in ~99% of the waste volume being retrieved and treated.

2. High-level waste, containing >90% of the current total tank radioactive material inventory, will be vitrified and disposed of at the national high-level waste and spent nuclear fuel repository.

3. Transuranic waste retrieved from the tanks will be treated, packaged, and characterized in a manner that should enable disposal offsite at the WIPP transuranic geologic repository.

4. Low-activity waste and secondary low-level mixed waste will be treated and put into stabilized forms that enable disposal onsite within the Central Plateau in DOE-authorized and Ecology-permitted (RCRA) mixed waste disposal facilities.

5. Residual materials that cannot be removed from the tanks will be stabilized with grout formulations and/or other materials engineered to isolate and contain any radioactive and hazardous constituents associated with the residuals. The tank void space will be back-filled with natural and/or engineered materials selected to both contribute to the defense-in-depth containment and isolation of the waste and to stabilize the tank against structural failure, e.g., dome collapse.

6. Above grade structures within the tank farms will be decommissioned and brought to grade level. Contaminated rubble and other materials will be disposed of in RCRA and/or CERCLA compliant facilities. Ancillary equipment, pits, and piping will have any liquid removed to the extent it is possible and be backfilled to fill major void spaces prior to final closure (pending the single-shell tank closure plan and single-shell closure environmental impact statement).

7. Engineered barriers will be placed over the tank farms to divert precipitation from contacting residual waste in the tanks, ancillary equipment, and soil column underlying the tank farms. The surface barriers will also provide protection against plants, animals, and certain forms of possible human intrusion, e.g., shallow excavations.

8. Tanks and tank farms will be landfill closed under the Tri-Party Agreement, which integrates the RCRA and CERCLA processes and provides for end state analyses. Active and passive institutional controls (guards; fences; permanent surface and embedded markers; government held land, water, and mineral rights; extensive public records delineating the location and content of the closed tank farms) will be used to reduce the risk of inadvertent intrusion, e.g., major excavation or drilling to obtain groundwater for irrigation or potable purposes. Monitoring systems will be put into place and maintained for an indefinite period of time in the future (hundreds of years) to measure parameters that affect contaminant transport and determine whether any waste migration may be occurring. Specific approaches will be determined nearer the time when final closure of the Hanford Site occurs using appropriate information/technology available at that time.

3.5.5 Summary of Tribal Discussions

As mentioned in Section 3.5.1 DOE recognize the importance of Tribal Consultation in obtaining input to the end state vision development process. The following is a summary of the discussions between DOE and Tribal representatives following the final End State Workshop in June 2005

3.5.5.1 Confederated Tribes of the Umatilla Indian Reservation

The CTUIR provided a detailed written response to DOE's request for clarification on their endstate vision for Hanford as a whole and for individual areas. The memo can be found in it's entirety on the end states web page (http://www/hanford.gov/docs/rbes). The portions of the memo that responded to the topics discussed at the end state workshops are included here.

Each of the areas of the Hanford Site discussed in this document is very important to the CTUIR for natural resource and cultural reasons. The Central Plateau, river, River Corridor, and adjacent lands are locations included in the Treaty as locations where the CTUIR have reserved rights of access and use. Additionally, the CTUIR have natural resource trustee responsibilities pertaining to the Hanford Site. The CTUIR land use for all locations at Hanford is the same year-round lifestyle, with fishing, hunting/livestock, gathering/gardening, pasturing, and participating in sweatlodge ceremonies that is described in the CTUIR exposure scenario (Harris and Harper 2004). The CTUIR scenario should be used to evaluate risk and set cumulative (multi-pathway, multi-media, and multi-contaminant) health-based remedial goals. If the risks are reduced to acceptable levels as confirmed by the use of this scenario, there will be no further lost or restricted use.

The CTUIR emphasized that all cleanup decisions factor-in natural resource trustee obligations.

100 Area Summary Statement. The CTUIR consider the 100 Area and the River Corridor to be part of the same unit. The CTUIR also consider groundwater and soil sites to be linked, and believe that soil and groundwater cannot be closed independently even if, for practical reasons, they have been designated as separate operable units and are on separate schedules.

It makes sense to allow the entombed the reactor cores to remain where they are for several decades in order that radioactive decay can occur and make subsequent removal less risky and less ecological damaging. The CTUIR are concerned about the assurance of future funding and have suggested that a bond be posted to ensure that future removal will occur.

The CTUIR prefer that the reactor outfall pipelines be removed from the bed of the Columbia River if the environmental damage is not too great, but that all options should be explored for removal (such as during a time when the river is lowered by the dam operations) before simply deciding to leave them in place.

The N-Area groundwater plume must be addressed. The CTUIR exposure scenario includes access and use of groundwater.

The 100 Area should be transferred to another federal agency, and the preferred agencies to the CTUIR are the Bureau of Indian Affairs and the U.S. Fish and Wildlife Service jointly.

200 Area Summary Statement. The 200 Area and Central Plateau are very important to the CTUIR for natural resource and cultural reasons. The CTUIR endstate vision and land use in the Central Plateau, including the Core Zone, is full traditional use. The CTUIR never agreed to a permanent disposal and sacrifice zone in this area, despite the CLUP.

The best closure of the U-Plant (the first canyon building) is clearly full removal, which is one of the cheapest in short-term project costs, is by far the cheapest in terms of lifecycle costs (monitoring, barrier replacement), allows adjacent waste to be excavated, is most permanent, uses by far the least amount of clean fill (with its associated natural resource injury and associated costs), and protects the tribes and public the most.

The tanks should not be filled with grout. We strongly support full removal so that the tanks and associated soil contamination can be removed. If they cannot be removed in the short term, then DOE should not take irreversible interim actions such as filling the tanks with grout. We strongly oppose the reclassification of residual high level waste as low activity waste, which would result in leaving high level waste in near-surface disposal or storage sites, which is prohibited by law.

Contamination from tank leaks has clearly reached groundwater and is moving toward the Columbia River. We may have only decades until it begins to affect the last salmon spawning area in the mainstem Columbia River. The contamination that is in the vadose zone should be excavated to a depth that needs to be negotiated. If residual soil uranium is fairly immobile for the present, this makes it easier to excavate; and immobility is not a valid reason to leave it in place, but fortuitously aids in removal. Associated pipes, trenches, cribs, ditches, electrical lines and other waste should be removed.

300 Area Summary Statement. The 300 Area should remain under federal control, preferably jointly BIA and USFWS.

In the 300 Area, there may be uncontaminated buildings that could be reused. This is to be encouraged, as long as there is not soil contamination beneath them, and as long as no irrigation or landscaping is added, since this could mobilize the uranium in the soil.

The uranium in the soil and groundwater needs to be addressed. If a remedy such as soil flushing is proposed, it must be accompanied by catch-systems (such as a freeze barrier) so that the uranium does not simply get flushed into the river.

3.5.5.2 Nez Perce Tribe

Discussions with the Nez Perce Tribal staff began with a review of information gathered at the workshop on the 300 Area held on May 19, 2005. The staff pointed out that no water quality criteria exist for uranium that can be used to assess whether biota are being protected by the cleanup achieved. The Nez Perce would like to see additional work done to identify the concentration at which uranium is harmful to aquatic and riparian species so that water quality criteria can be established for uranium similar to the criteria that have been established for chromium in the 100 Areas.

There is a concern that moving the 300 Area from federal ownership to private ownership and development will exclude the Tribes from having access to the area for their uses and will put cultural and archaeological resources at risk. They would like to see the area remediated to allow unrestricted surface use, vegetated in native vegetation and protected to preserve the ecological, cultural and archaeological resources.

The cleanup of waste sites in the 300 Area is being done independently of the cleanup of the uranium contamination in groundwater. The Nez Perce technical staff commented that the cleanup of these two problems should be done in a more integrated fashion.

There has been discussion of turning the 300 Area over to local county or city governments following cleanup such as was done with the 1100 Area. The Tribe asked that consideration be given to transferring this land to the Tribes once cleanup is completed.

During the workshop on the 200 Areas there was considerable discussion on the canyon facilities such as U Plant. An alternative that had a lot of support during the workshop was to take the buildings down and cover them in place. The Nez Perce agreed with that approach for the U Plant pilot; however as DOE looks at other canyons (e.g. PUREX Plant and the PUREX tunnels) will need to consider each one individually with the aim of keeping the contaminated footprint left in the Central Plateau as small as is reasonable and feasible. They support moving as many sites including buildings to ERDF as possible so that more of the Central Plateau is available for future use.

In a discussion of the disposition of the reactor blocks in the 100 Areas, Tribal staff said it is acceptable to leave them in place for 75 years to allow radioactive decay to reduce the risk to workers and the environment before they are moved to the Central Plateau. They also indicated that it would be preferable to cut the blocks up prior to removal to lessen the environmental impact of transporting them to the Central Plateau for burial.

The Nez Perce are concerned about not just the contaminants remaining at the end of cleanup but the appearance of the land. Large surface barriers and cocooned buildings that remain in the future will disrupt the appearance of the landscape – which is an important aspect of the Hanford Site from a cultural point of view

Many of the discussions about cleanup options at Hanford include extensive discussions about the cost of cleanup. The United States spent a great deal of money on the plutonium production mission that created the waste sites and should spend what it takes to restore the site so that Tribal uses can be safely carried out at the site. The staff also mentioned that their ultimate goal is to see the Hanford footprint entirely removed but they recognize that the technology is not yet available to protect the environment or the workers. They asked that DOE recognize that cleanup does not end with the EM mission, but that as new technologies become available in the future additional cleanup should occur.

In reflecting on the workshop discussion on removing the pipelines from the river the Nez Perce staff are concerned that removing the pipelines will stir up sediment in the river that will move downstream into important salmon spawning beds and may disrupt salmon spawning for years. Disrupting spawning for several years may result in decimating the population in the Hanford Reach forever and that would be unacceptable.

3.5.5.3 Yakama Nation

The Yakama Nation provided a written response to DOE's request for clarification on their endstate vision for Hanford. The memo can be found in it's entirety on the end states web page (http://www/hanford.gov/docs/rbes). The representatives of the Yakama Nation strongly made the point that the final end state alternatives proposed for the Hanford Site end state must comply with the terms of the Treaty of 1855 between the Yakama Nation and the United States. The Yakama Nation has agreed to cooperate with and assist DOE in achieving an end state which complies with the treaty.

Tribal representatives pointed out that Yakama Tribal members are documented to be the highest risk population affected by Hanford contaminants. They identified two reports to be referenced in end state analysis as documentation of significant exposure pathways and risk factors for Yakama Nation Tribal members:

- Columbia River Basin Fish Contaminant Survey, 1996-1998, United States Environmental Protection Agency, Office of Environmental Assessment, EPA 910/R-02-006, July 2002
- A Risk-Based Screening Analysis for Radionuclides to the Columbia River from Past Activities at the U.S. Department of Energy Nuclear Weapons Site in Hanford, Washington, Department of Health and Human Services, Centers for Disease Control and Prevention, RAC Report No. 3-CDC – Task Order 7 – Final, John E. Till, November, 2002.

The ensuing discussion pointed out that the contaminants contributing to the risk identified in the EPA study are heavy metal and organic contaminants. The study does not identify Hanford as a significant contributor of these contaminants. This study also indicates that the potential cancer risks from consuming fish collected from the Hanford Reach due to radionuclide content were similar to cancer risks from consuming fish collected from the upper Snake River outside of the region influenced by Hanford. However, the EPA study included only limited measurements of a few radionuclides in Columbia River fish. The Yakama Nation supports a comprehensive analysis of radionuclides in Columbia River sediments from Hanford operations.

Tribal representatives also stated that a defensible end state requires a credible Yakama Tribal risk scenario. To date, no risk scenario which can be applied to Yakima Nation Tribal members has been developed. Development of such a scenario is a complex undertaking, as evidenced by the risk studies cited, each of which were multi-million dollar, multi-year efforts conducted by specialists in the appropriate disciplines.

The Yakama Nation proposes a cooperative approach with DOE to arrive at the Hanford end states which complies with Treaty rights and protects Tribal members at risk levels no greater than those established for other populations (1×10^{-4} to 1×10^{-6} lifetime risk).

The discussion also touched on removing the reactor discharge pipelines from the river. The Yakama are concerned that removing the pipelines will impact salmon spawning and other aspects of the ecology of the river. As such they would like to understand the risks associated with leaving the pipelines in place and unless they are significant they would like to see them left in place to reduce disturbance of the river ecosystem. They also agreed that the reactors could stay in place to allow for decay of radionuclides that remain in the cores. At some point though, they need to be removed from the River Corridor for disposal.

In the end the Yakamas reiterated that if DOE honors the Tribes treaty rights and applies a meaningful risk scenario for the Yakama lifestyle they will support the DOE end states.