CHAPTER 3
AFFECTED ENVIRONMENT

In Chapter 3, the affected environment descriptions of the Hanford Site and Idaho National Laboratory are presented to provide the context for understanding the environmental consequences described in Chapter 4. As such, they serve as a baseline from which any environmental changes that may be brought about by implementing the proposed actions and alternatives can be identified and evaluated; the baseline conditions are the existing conditions. The affected environment is described for the following impact areas: land resources, infrastructure, noise and vibration, air quality, geology and soils, water resources, ecological resources, cultural and paleontological resources, socioeconomics, existing human health risk, environmental justice, waste management, and spent nuclear fuel.

3.1 APPROACH TO DEFINING THE AFFECTED ENVIRONMENT

This chapter describes the environment at both the Hanford Site (Hanford) and Idaho National Laboratory (INL) that could be affected through actions evaluated in this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)*. For each resource area, this environmental impact statement (EIS) describes first the existing environment of each site as a whole and then that of each site's areas within which the proposed actions would take place.

The U.S. Department of Energy (DOE) evaluated the environmental impacts of the proposed actions within defined regions of influence (ROIs). These ROIs are specific to the resource area evaluated; encompass geographic areas within which any meaningful impact is expected to occur; and can include the areas within which the proposed actions would take place, the sites as a whole, or nearby or distant offsite areas. For example, impacts on historic resources were evaluated at specific facility locations within each site, whereas human health risks to the general public from exposure to airborne radioactive contaminant emissions were assessed for an area within an 80-kilometer (50-mile) radius of the facility locations. Economic effects such as job and income changes were evaluated within a socioeconomic ROI that includes the counties in which each site is located and nearby counties in which a substantial portion of the site's workforce resides. Brief descriptions of the ROIs for each resource area are given in Table 3–1.

Baseline conditions for each environmental resource area were determined from information provided in previous EISs and environmental studies, other government reports and databases, and relevant laws and regulations. The *Hanford Site National Environmental Policy Act (NEPA) Characterization (Hanford NEPA Characterization Report)* (Duncan 2007); *Hanford Site Environmental Report for Calendar Year 2010 (Including Some Early 2011 Information) (Hanford Site Environmental Report)* (Poston, Duncan, and Dirkes 2011); *Idaho High-Level Waste and Facilities Disposition Final Environmental Impact Statement* (DOE 2002a); and *Idaho National Laboratory Site Environmental Report, Calendar Year 2008* (DOE 2009a) were important sources of information on the affected environment at Hanford and INL.

3.2 HANFORD SITE

American Indians used the area along the Columbia River in eastern Washington, including the area occupied by Hanford, for thousands of years for fishing, hunting, and gathering. Following the expedition of Lewis and Clark, which reached the Hanford area in 1805, use of the land began to change as fur traders and settlers populated the area. By the beginning of the twentieth century, much of the area was used for farming and grazing (DOE 1999a:4-1, 4-3). The Hanford Engineer Works was established in 1943 as one of the three original Manhattan Project sites. Hanford occupies approximately 151,775 hectares (375,040 acres) in Washington State, just north of Richland (Duncan 2007:4.1).

Table 3–1. General Regions of Influence for the Affected Environment

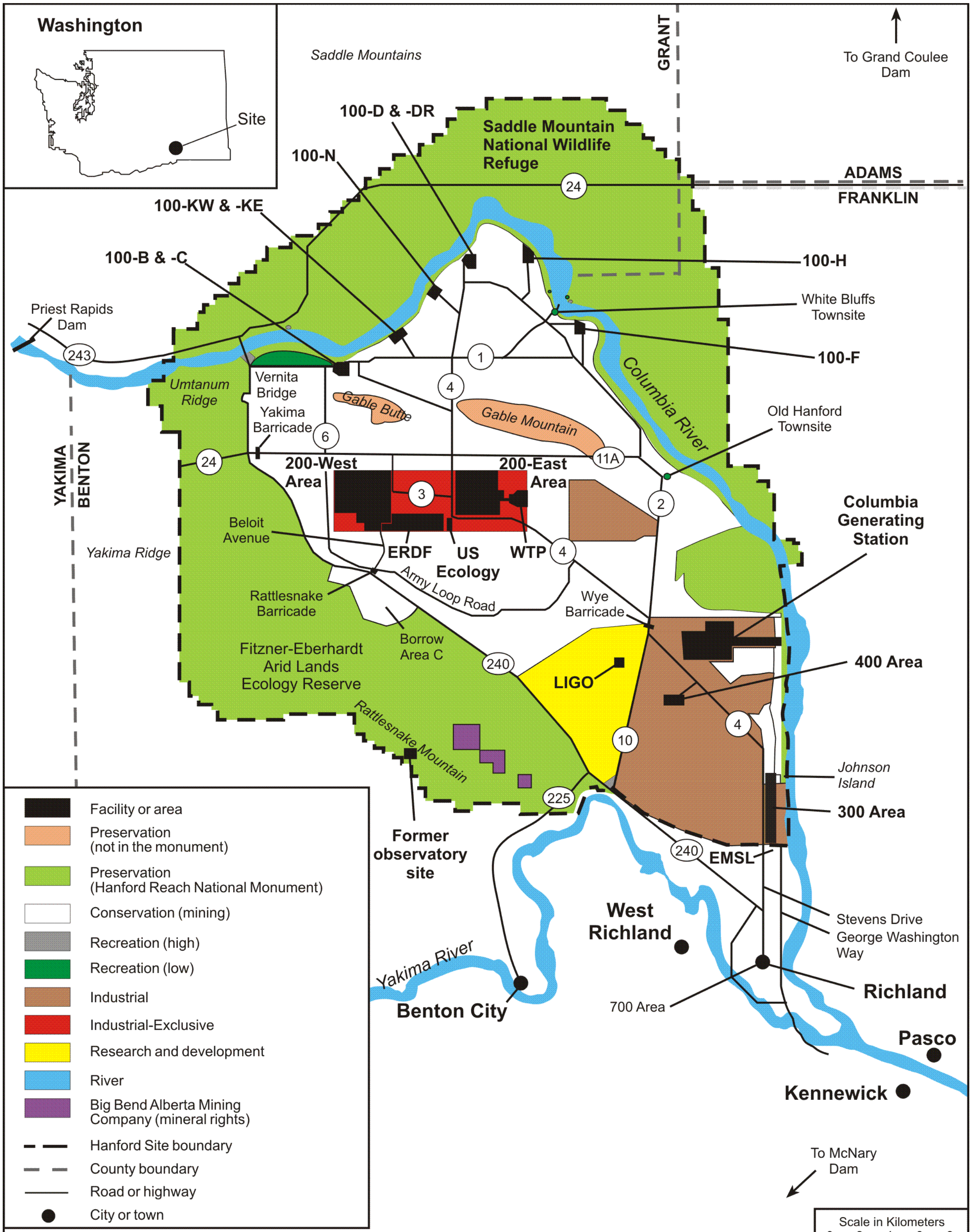
Environmental Resource Area	Region of Influence
Land resources	The proposed-action areas,[a] the site, and areas immediately adjacent to the site
Infrastructure	The proposed-action areas, the site, and local areas supporting the site
Noise and vibration	The proposed-action areas, the site, nearby offsite areas, and access routes to the site
Air quality	The proposed-action areas, the site, and nearby offsite areas within local air quality control regions
Geology and soils	The proposed-action areas, the site, and nearby offsite areas
Water resources	The proposed-action areas, the site, and adjacent surface-water bodies and groundwater
Ecological resources	The proposed-action areas, the site, and nearby offsite areas
Cultural and paleontological resources	The proposed-action areas and the site
Socioeconomics	The counties where at least 90 percent of site employees reside
Existing human health risk	The proposed-action areas, the site, offsite areas within 80 kilometers of the site, and the transportation corridors
Environmental justice	Offsite areas within 80 kilometers of the site and along the transportation corridors between the sites
Waste management	Site waste management facilities

[a] Proposed-action areas are the 200 Areas, 400 Area, and Borrow Area C for the Hanford Site and the Materials and Fuel Complex and Idaho Nuclear Technology and Engineering Center for Idaho National Laboratory.

Note: To convert kilometers to miles, multiply by 0.6214.

The site extends over parts of Adams, Benton, Franklin, and Grant Counties (see Figure 3–1). In the past, Hanford was a U.S. Government defense materials production site that included nuclear reactor operation; uranium and plutonium processing; the storage and processing of spent nuclear fuel (SNF); and the management of radioactive, hazardous, and dangerous wastes. The current mission at Hanford includes managing waste products, cleaning up the site, researching new ideas and technologies for waste disposal and cleanup, and reducing the size of the site (Poston, Duncan, and Dirkes 2011:v, E-3). Present Hanford programs are diversified and include the management of radioactive waste; cleanup of waste sites, soil, and groundwater related to past releases; stabilization and storage of SNF; research into renewable energy and waste disposal technologies; cleanup of contamination; and stabilization and storage of plutonium.

Hanford is owned and used primarily by DOE, but portions of it are owned, leased, or administered by other Government agencies. Public access to the site is limited to travel on the Route 4 and Route 10 access roads as far as the Wye Barricade, State Routes 24 and 240, and the Columbia River. By restriction of access, the public is shielded from portions of the site formerly used for the production of nuclear materials and currently used for waste storage and disposal. Only about 6 percent of the land area has been disturbed and is actively used, leaving mostly vacant land with widely scattered facilities (Neitzel 2005:4.144). Figure 3–1 shows the generalized land use at Hanford as developed in the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement (Hanford Comprehensive Land-Use Plan EIS)* (DOE 1999a) and modified by the designation of the Hanford Reach National Monument (65 FR 37253).



Key: EMSL=Environmental and Molecular Sciences Laboratory; ERDF=Environmental Restoration Disposal Facility; LIGO=Laser Interferometer Gravitational-Wave Observatory; WTP=Waste Treatment Plant.

Source: Modified from DOE 1999a:3-18; 2000a:3-89.

Figure 3–1. Generalized Land Use at the Hanford Site and Vicinity

Hanford includes extensive production, service, and research and development (R&D) areas. Onsite programmatic and general purpose facilities, many of which are inactive, occupy approximately 800,000 square meters (8.6 million square feet) of space. Fifty-one percent (409,000 square meters [4.4 million square feet]) is general purpose space, accommodating offices, laboratories, shops, warehouses, and other support facilities. The remaining 392,000 square meters (4.2 million square feet) of space are committed to programmatic facilities, including processing; evaporation; filtration; and waste recovery, treatment, and storage facilities, as well as R&D laboratories. While more than half of the general purpose and programmatic facilities are more than 30 years old, several new facilities, including the Waste Treatment Plant (WTP) and the privately owned Laser Interferometer Gravitational-Wave Observatory (LIGO), are being or have been constructed. Facilities designed to perform previous missions are being evaluated for reuse in the cleanup mission. The existing facilities are grouped into the numbered operational areas discussed in the following paragraphs (DOE 1996a:3-20, 3-21; Duncan 2007:4.1, 4.3).

The 100 Areas, which cover about 1,100 hectares (2,720 acres), are in the northern part of the site on the southern shore of the Columbia River. Within these areas are eight retired plutonium production reactors and the dual-purpose N Reactor, all of which have been permanently shut down since 1991. Waste sites throughout the 100 Areas are currently undergoing remediation, consisting of the excavation of contaminated soils and structural materials. Additionally, SNF currently stored in indoor basins in the 100 Areas is being moved to the 200 Areas. Contaminated groundwater in the 100 Areas is being treated via both ex situ and in situ methods.

The 200 Areas, which include the 200-East and 200-West Areas, are in the center of Hanford. Together, they cover about 5,100 hectares (12,602 acres) and are, respectively, about 11 and 8 kilometers (6.8 and 5 miles) south and 12 and 20 kilometers (7.5 and 12.4 miles) west of the Columbia River. Historically, these areas were devoted to nuclear fuel processing; plutonium processing, fabrication, and storage; and waste management and disposal. The WTP is currently under construction within the 200-East Area. This plant includes a number of facilities that will pretreat and separate waste recovered from the 200 Area tank farms into high-level radioactive waste (HLW) and low-activity waste (LAW) streams, vitrify the HLW stream, and vitrify or similarly immobilize the LAW stream. In addition to 18 underground tank farms, the 200 Areas contain a number of low-level radioactive waste burial grounds (LLBGs). DOE constructed the Environmental Restoration Disposal Facility (ERDF) in the southeast portion of the 200-West Area for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) cleanup waste. A commercial low-level radioactive waste (LLW) disposal site (the US Ecology Commercial LLW Disposal Site) occupies 40 hectares (100 acres) just southwest of the 200-East Area. The land is leased by the State of Washington from the Federal Government and subleased to US Ecology, Inc. Facilities to be constructed under the Tank Closure alternatives analyzed in this *TC & WM EIS* are proposed to be located in the 200 Areas.

The 300 Area is in the southern part of the site, just north of the city of Richland, and covers 150 hectares (370 acres). From the early 1940s, most R&D activities were conducted in the 300 Area. It was also the location of nuclear fuel fabrication. A few of the facilities continue to support nuclear and nonnuclear R&D activities for the Pacific Northwest National Laboratory. Many of the facilities in the 300 Area are being deactivated. Waste sites in the 300 Area are currently undergoing remediation, consisting of the excavation of contaminated soils and structural materials. The 300 Area is undergoing accelerated remediation of waste sites and inactive buildings to support future non-DOE uses.

The 400 Area, located 8 kilometers (5 miles) northwest of the 300 Area, is the site of the Fast Flux Test Facility (FFTF) and the Fuels and Materials Examination Facility (FMEF). The latter facility, located to the west of FFTF, was constructed in the late 1970s and early 1980s to perform fuel fabrication and development and postirradiation examination of breeder reactor fuels. FMEF never operated and is currently in a layup condition suitable for a future mission. Designed and built as a liquid-metal (sodium)-cooled reactor, FFTF was intended as the Nation's lead reactor for development and testing of materials and equipment for DOE's liquid-metal fast-breeder reactor programs. It operated for about 10 years (1982 to 1992) as a national research test facility, during which time it also produced a wide variety of medical isotopes and made hydrogen-3 (tritium) for the U.S. fusion research program. FFTF was ordered shut down in 1995, but the shutdown process was deferred in 1997 on receipt of DOE direction for the facility to come to a standby condition. Later, in the "Record of Decision for the *Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility*" (66 FR 7877), DOE announced that FFTF would be permanently deactivated. Completion of final decontamination and decommissioning of the facility is addressed in this *TC & WM EIS*.

The 600 Area is the designation for Hanford lands that are not part of any other designation. Thus, it includes all of Hanford not occupied by the 100, 200, 300, and 400 Areas (Duncan 2007:4.133).

Other areas at Hanford include the land occupied by the facilities of Energy Northwest (formerly known as the Washington Public Power Supply System) and an area currently leased by Washington State and used for disposal of hazardous substances. Energy Northwest operates the Columbia Generating Station on land leased from DOE that is located approximately 4 kilometers (2.5 miles) northeast of the 400 Area. The original lease called for the operation of three nuclear power plants; however, construction of two of the plants has been stopped and other industrial options are now being considered. Other facilities include the Volpentest Hazardous Materials Management and Emergency Response Training and Education Center, which is used to train hazardous materials response personnel. It is located in the southeastern portion of the site and covers about 32 hectares (80 acres). The Hanford Patrol Training Academy, a regional law enforcement training facility, provides classrooms, library resources, practice shoot houses, an exercise gym, and an obstacle course. LIGO, a national research facility built by the National Science Foundation for scientific research, is designed to detect cosmic gravitational waves. The facility consists of two optical tube arms, each 4 kilometers (2.5 miles) long and arrayed in an "L" shape, and is extremely sensitive to vibrations (DOE 1999a:4-8, 4-9). The 700 Area is the administrative center in downtown Richland and consists of Government-owned buildings (e.g., the Federal Building) (DOE 2000a:4-90).

In addition, there are DOE-leased facilities and DOE-contractor-owned or -leased facilities that support Hanford operations. These facilities are on private or Port of Benton land south of the 300 Area (DOE 1996a:3-21).

DOE has transferred the Richland North Area—formerly the 1100 Area, an area that served as a procurement, central warehousing, vehicle maintenance, transportation, and distribution center for Hanford—and the smaller 3000 Area to the Port of Benton for use in economic development and diversification (DOE 2000a:3-91).

3.2.1 Land Resources

Land resource areas include land use and visual resources. Land use is defined in terms of the kinds of anthropogenic activities (e.g., agriculture, residential, industrial) for which land is developed (EPA 2006). Natural resource and other environmental characteristic attributes make a site more suitable for some land uses than for others. Changes in land use may have beneficial or adverse effects on other resources—ecological, cultural, geologic, and atmospheric. Visual resources are natural and manmade features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape.

3.2.1.1 Land Use

3.2.1.1.1 General Site Description

The Tri-Cities area southeast of Hanford includes residential, commercial, and industrial land uses. This area, which encompasses the cities of Richland, Kennewick, and Pasco, is the population center closest to Hanford. Additional cities near the southern boundary of Hanford include Benton City, Prosser, and West Richland. Agriculture is a major land use in the remaining areas surrounding Hanford. In 2007, wheat was the largest crop in terms of area planted in Adams, Benton, Franklin, and Grant Counties. Alfalfa, potatoes, corn, vegetables, and fruit are some of the other crops grown in these counties (USDA 2009).

In 1977, DOE designated Hanford as a National Environmental Research Park, an outdoor laboratory for ecological research to study the environmental effects of energy development. The Hanford National Environmental Research Park is a shrub-steppe habitat that contains a wide range of semiarid land ecosystems and offers the opportunity to examine linkages between terrestrial, subsurface, and aquatic environments (DOE 2000a:3-91; Vaughan and Rickard 1977:1, 2). An integral part of the Hanford Reach National Monument is the Fitzner-Eberhardt Arid Lands Ecology Reserve, which includes 31,080 hectares (76,800 acres) of primarily shrub-steppe vegetation to the west of State Route 240 (see Figure 3–1). This area was originally set aside in 1967 for ecological research and educational purposes (O'Connor and Rickard 2003:vi, 1).

Hanford Site Land Use Designations

Preservation – An area managed for the preservation of archaeological, cultural, ecological, and natural resources. No new consumptive uses are allowed within this area. Public access is limited.

Conservation (Mining) – An area reserved for the management and protection of archaeological, cultural, ecological, and natural resources, but where limited and managed mining (e.g., quarrying for governmental purposes) could occur as a permitted special use. Public access is limited.

Recreation (High) – An area allocated for high-intensity, visitor-serving activities and facilities (commercial and governmental), such as golf courses, recreational-vehicle parks, boat-launching facilities, tribal fishing facilities, destination resorts, cultural centers, and museums.

Recreation (Low) – An area allocated for low-intensity, visitor-serving activities and facilities, such as improved recreational trails, primitive boat-launching facilities, and permitted campgrounds.

Industrial – An area suitable and desirable for activities such as reactor operations, rail and barge transport, mining, manufacturing, food processing, assembly, warehouse, and distribution operations.

Industrial-Exclusive – An area suitable and desirable for treatment, storage, and disposal of hazardous, dangerous, radioactive, and nonradioactive wastes.

Research and Development – An area designated for conducting (1) basic or applied research that requires the use of a large-scale or isolated facility, or (2) smaller- scale, time-limited research conducted in the field or within facilities that consume limited resources.

Source: DOE 1999a:3, 4.

Land use designations based on the Hanford Comprehensive Land-Use Plan include Preservation, Conservation (Mining), Recreation, Industrial, Industrial-Exclusive, and Research and Development (see Figure 3–1). Approximately 6 percent of the site has been disturbed and is occupied by DOE facilities (Neitzel 2005:4.144). Hanford contains a variety of widely dispersed facilities, including retired reactors, R&D facilities, and various deactivated production and processing plants. Preservation and Conservation (Mining) are the predominant land uses at Hanford. Borrow Area C (also known as quarry No. 2) located south of State Route 240, falls within the Conservation (Mining) land use designation. The 200 Areas are classified as Industrial-Exclusive. Industrial areas include an area to the east of the 200 Areas and most of the southeast corner of the site, including the 400 Area.

Important areas within the Preservation land use designation include the Hanford Reach National Monument, which incorporates a portion of the Columbia River corridor, as well as the Fitzner-Eberhardt Arid Lands Ecology Reserve to the south and west and portions of Hanford north of the Columbia River (65 FR 37253). Other special status lands in the vicinity of Hanford include the McNary National Wildlife Refuge, which is administered by the U.S. Fish and Wildlife Service (USFWS), as well as the

Columbia River Islands Area of Critical Environmental Concern and McCoy Canyon, both of which are administered by the U.S. Bureau of Land Management (BLM) (DOE 2000a:3-91).

The Columbia River, which is adjacent to and runs through Hanford (see Figure 3–1), is used for numerous purposes, including public boating, waterskiing, fishing, hunting, transportation, irrigation, and municipal water supply. Public access is allowed to certain islands, while other areas are considered sensitive because they include unique habitats and cultural resources. The area known as the Hanford Reach includes the 0.4-kilometer (0.25-mile) strip of public land on either side of the last free-flowing, nontidal segment of the Columbia River in the United States. On June 9, 2000, under the authority of the Antiquities Act of 1906 (16 U.S.C. 431 et seq.), the President issued a proclamation that established the Hanford Reach National Monument (65 FR 37253) on approximately 78,900 hectares (195,000 acres). This proclamation recognizes the unique character and biological diversity of the area, as well as its geologic, paleontological, historic, and archaeological significance. USFWS manages the monument under existing agreements with DOE. DOE manages land within the monument that is not subject to existing agreements; however, DOE consults with the Secretary of the Interior when developing any management plans affecting these lands. In the future, when appropriate cleanup has been completed, USFWS and DOE will extend management agreements to lands in the monument not currently managed by USFWS.

On June 27, 2000, a fire known as the 24 Command Fire was started by a fatal motor vehicle accident on State Route 24 about 3.2 kilometers (2 miles) west of the State Route 240 intersection. As a result of high winds, high temperatures, and low humidity, the fire spread rapidly and eventually consumed 66,322 hectares (163,884 acres) of Federal, state, and private lands. A total of 56,246 hectares (138,986 acres) within Hanford burned, including lands within the Hanford Reach National Monument, most of the Fitzner-Eberhardt Arid Lands Ecology Reserve, and areas near former production sites (see Figure 3–2). The fire was declared controlled on July 2, 2000. Fire suppression impacts included bulldozing 66 kilometers (41 miles) of fire lines, widening dirt roads, and cutting fences (DOI 2000:iii, iv). Vegetation loss due to the firefighting activities exposed the soil to erosion by subsequent wind and rain.

More recently, several major fires burned portions of Hanford in 2007. On July 13, 2007, three lightning-caused wildfires merged and became known as the Overlook Fire; this fire covered 8,527 hectares (21,071 acres) on the east side of the Columbia River on Hanford Reach National Monument lands (see Figure 3–2). The Overlook Fire burned native shrublands and grasslands in areas on the Wahluke Slope. On August 13, 2007, the Milepost 17 Fire started along State Route 240 and burned about 1,905 hectares (4,708 acres) in a crescent-shaped area on the Fitzner-Eberhardt Arid Lands Ecology Reserve. The Wautoma Fire started on August 16, 2007, on private lands and burned across the Fitzner-Eberhardt Arid Lands Ecology Reserve onto central Hanford. These two fires burned approximately 31,161 hectares (77,000 acres) of Federal and private lands. About 26,709 hectares (66,000 acres) burned on the Fitzner-Eberhardt Arid Lands Ecology Reserve, including the northern slope of Rattlesnake Mountain, and approximately 3,116 hectares (7,700 acres) burned on the central portion of Hanford, including land adjacent to the 200-West Area (PNNL 2008a).

DOE developed the *Hanford Comprehensive Land-Use Plan EIS* to provide the framework for future use of the site's lands and resources (DOE 1999a). Preparation of the plan was consistent with the National Defense Authorization Act (P.L. 104-201), which required the development of a future-use plan for at least the next 50 years. Preparation of the plan involved a number of cooperating agencies and consulting tribal governments, including BLM; the U.S. Bureau of Reclamation; USFWS; the City of Richland; Benton, Franklin, and Grant Counties; the Nez Perce Tribe; and the Confederated Tribes of the Umatilla Indian Reservation. The *Hanford Comprehensive Land-Use Plan EIS* consists of four basic elements: a

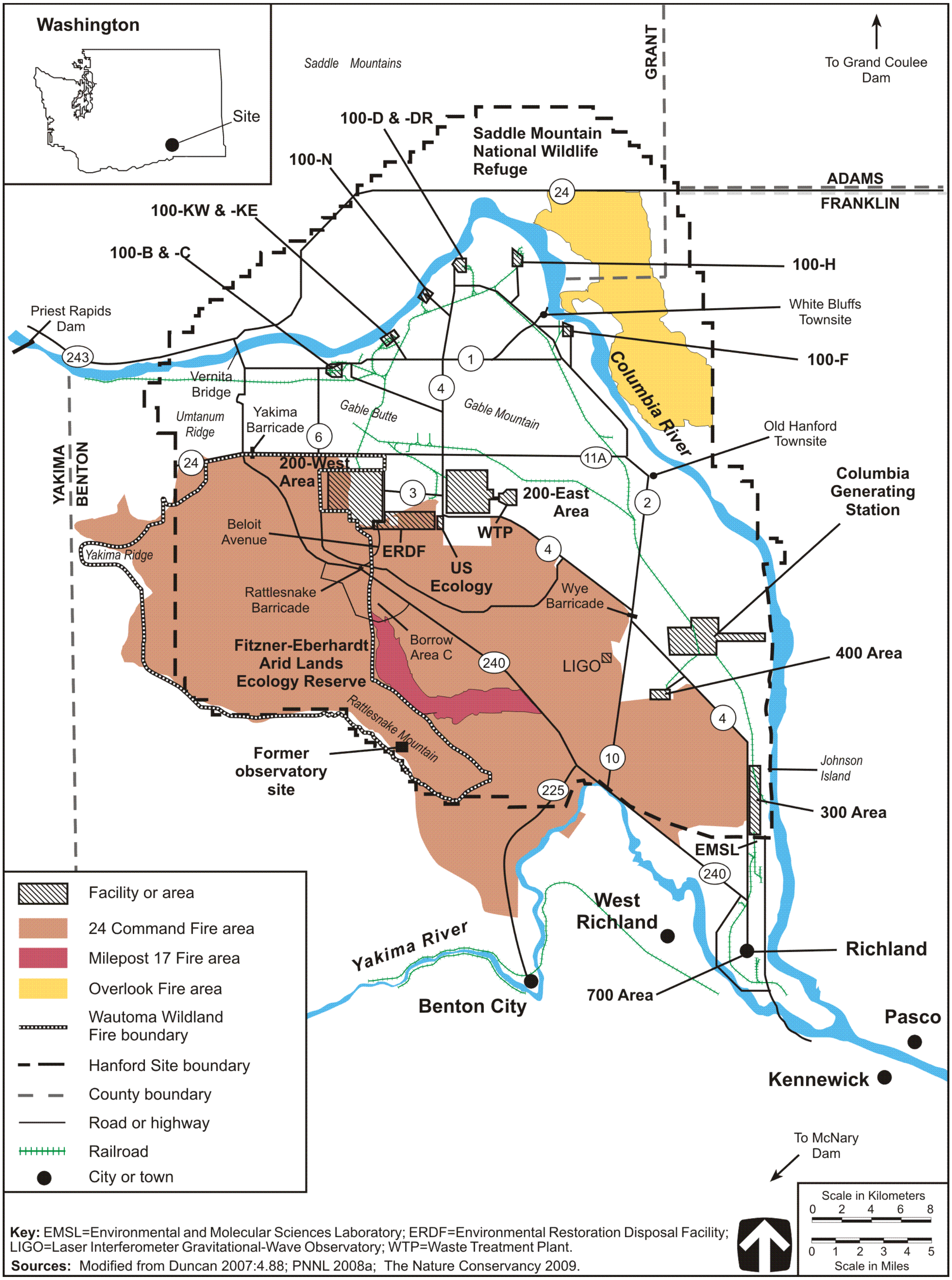


Figure 3–2. Extent of Area Burned During Recent Fires at the Hanford Site

map depicting land uses for the site; description of the purpose, intent, and principal uses of each land use designation; a set of policies governing land use actions; and implementing procedures. Figure 3–1 reflects land use designations developed in the plan. DOE has issued the *Supplement Analysis, Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 2008a) to review information and update the status of activities since the original plan was issued in 1999. An amended Record of Decision (ROD) (73 FR 55824) was issued to clarify and confirm DOE's commitments to the Hanford Comprehensive Land-Use Plan process.

As noted earlier, Hanford lies within Adams, Benton, Franklin, and Grant Counties, each of which developed a comprehensive land use plan in response to Washington's Growth Management Act (RCW 36.70A). This act requires state and local governments to manage Washington's growth by identifying and protecting critical areas and natural resource lands, designating urban growth areas, preparing comprehensive plans, and implementing them through capital investments and development regulations (Washington State 2007). The counties have no jurisdiction over Federal lands.

The *Adams County Comprehensive Plan* (ACPC 2005) does not specifically mention Hanford; however, the small area of the site within the southwestern portion of the county is classified as General Agriculture. That portion of Hanford lying within Benton County is designated as the Hanford Region within the *Benton County Comprehensive Land Use Plan*; however, a subarea plan has not been completed for this area (BCPC 2009). The *Franklin County Growth Management Comprehensive Plan* (Franklin County 2008) identifies Hanford as Federal land and labels it as the Hanford Reach National Monument on its Comprehensive Land Use Plan map. That portion of Hanford lying within Grant County is known as the Wahluke Slope. Within the *Grant County Comprehensive Plan/Environmental Impact Statement*, this area is identified as Hanford Federal Reserve (GCDCD 1999; GCGIS 2002). A subarea plan has yet to be developed for this tract.

Under separate treaties signed in 1855 (see Chapter 8, Section 8.1.7), much of the land in what is now referred to as "eastern Washington, eastern Oregon, and Idaho" was ceded to the United States by a number of regional American Indian tribes. The land area includes land occupied by Hanford. Under these treaties, the tribes retained the right to fish in usual and accustomed places. Tribal fishing rights are recognized on rivers within the ceded lands, including the Columbia River, which flows through Hanford.

In addition to fishing rights, the tribes retained under the treaties the privilege to hunt, gather roots and berries, and pasture horses and cattle on open and unclaimed lands. It is the position of DOE that Hanford, like other ceded lands that were settled or used for specific purposes, is not open and unclaimed land. While reserving all rights to assert their respective positions regarding treaty rights, the tribes are participants in DOE's land use planning process, and DOE considers tribal concerns in that process.

3.2.1.1.2 200 Areas Description

The *Hanford Comprehensive Land-Use Plan EIS* and subsequent supplement analysis (DOE 1999a:3-5, 3-18, 3-53; 2008a) and RODs (64 FR 61615, 73 FR 55824) designated a 5,064-hectare (12,513-acre) area within the Central Plateau of Hanford as Industrial-Exclusive (see Figure 3–1). This area, which includes the 200-East and 200-West Areas, encompasses the location of activities proposed under the various Tank Closure alternatives evaluated in this *TC & WM EIS*. The Industrial-Exclusive designation preserves DOE control of continuing remediation activities and use of the existing compatible infrastructure required to support activities such as dangerous radioactive and mixed waste treatment, storage, and disposal (TSD). Further, under this designation, DOE continues its Federal waste disposal mission, and the Northwest Interstate Compact on Low-Level Radioactive Waste Management allows for continued use of the US Ecology Commercial LLW Disposal Site for the disposal of commercial radioactive waste (Ecology 2011). The Industrial-Exclusive designation also allows for the expansion of existing facilities or the development of new compatible facilities in support of ongoing missions. Research supporting dangerous radioactive and mixed waste TSD facilities is also encouraged, and new uses of radioactive materials, such as food irradiation, could be developed within this land use designation.

3.2.1.1.3 400 Area Description

Under the *Hanford Comprehensive Land-Use Plan EIS* and subsequent supplement analysis (DOE 1999a:3-5, 3-18; 2008a) and RODs (64 FR 61615; 73 FR 55824), land in the 400 Area is designated for industrial use, including reactor operations, manufacturing, warehousing, and related activities. The 400 Area occupies 61 hectares (150 acres) and is 7 kilometers (4.3 miles) to the west of the nearest site boundary. The Property Protected Area, within which FFTF and associated facilities are located, is 18 hectares (44.5 acres) in size.

3.2.1.1.4 Borrow Area C Description

Prior to April 1999, McGee Ranch (in the northwest corner of Hanford north of Route 24 and south of the Columbia River) was identified as the primary suitable source of silt, loam, and basalt rock borrow material. Based on public and tribal input received by DOE during the *Hanford Comprehensive Land-Use Plan EIS* process and as recorded in its RODs (64 FR 61615; 73 FR 55824), DOE decided to protect a wildlife corridor through the McGee Ranch and consolidate the many planned borrow areas at Hanford into one location, identified as Borrow Area C (see Figure 3–1), to keep a primary source of geologic materials available for Hanford remediation activities. Borrow Area C is a large polygonal area 926.3 hectares (2,289 acres) in size bordering State Route 240 on the south. Although the area is contiguous with the Fitzner-Eberhardt Arid Lands Ecology Reserve, it is designated for Conservation (Mining) in the *Hanford Comprehensive Land-Use Plan EIS*. Such areas are typically reserved for management and protection of cultural, ecological, and natural resources; however, they may also be used in limited, managed mining activities (DOE 1999a:3-4, 3-18). Borrow Area C is largely undeveloped, consistent with its land use classification; however, a road was built in 2006 to access a portion of the site that will be used to generate borrow material for environmental remediation activities.

3.2.1.2 Visual Resources

3.2.1.2.1 General Site Description

Hanford lies in the Pasco Basin of the Columbia Plateau northwest of the city of Richland, where the Yakima and Columbia Rivers join. The land in the vicinity of Hanford ranges from generally flat to gently rolling. Rattlesnake Mountain, rising to 1,060 meters (3,480 feet) above mean sea level, forms the southwestern boundary of the site. Gable Mountain and Gable Butte are the highest landforms within the site, rising to a height of 329 meters (1,081 feet) and 238 meters (782 feet), respectively. The Columbia River flows through the northern part of the site, and, turning south, forms part of the eastern site boundary. White Bluffs, steep whitish-brown bluffs adjacent to the river, are a striking feature of the landscape (DOE 2000a:3-93).

Typical of the regional shrub-steppe desert, the site is dominated by widely spaced, low-brush grasslands. A large area of nonvegetated, stabilized sand dunes extends along the east boundary, and nonvegetated blowouts are scattered throughout the site. Hanford is characterized by mostly undeveloped land, with widely spaced clusters of industrial buildings along the southern and western banks of the Columbia River and at several interior locations (DOE 2000a:3-93).

Hanford facilities can be seen from elevated locations such as Gable Mountain, Gable Butte, Rattlesnake Mountain, and other parts of the Rattlesnake Hills along the western perimeter. Site facilities also are visible from State Routes 240 and 24 and the Columbia River. Because of terrain features, distances involved, the size of Hanford, and the size of individual structures, not all facilities are visible from the highways or the Columbia River (DOE and Ecology 1996:4-60).

DOE and its leaseholders operate and maintain buildings and equipment on Gable Mountain and Rattlesnake Mountain that also affect the view from these elevated natural features. The tallest structures, the six communication towers (height 30 meters [100 feet]) are located on Rattlesnake Mountain. Numerous other structures and related activities on these mountains (e.g., communication towers and equipment/structures, research and monitoring equipment/structures, an observatory, fire breaks, access roads) are currently visible from the surrounding area, including State Route 240. In March 2008, the DOE Richland Operations Office (DOE-RL) announced it would not renew existing permits, licenses, and easements on Rattlesnake Mountain and that structures would be removed, returning the land to natural conditions. In 2009, the Rattlesnake Mountain Observatory was removed and communications operations were consolidated. Additionally, excess facilities, infrastructure, and debris were removed (Poston, Duncan, and Dirkes 2010:1.4, 2011:1.4).

State Route 240 provides public access through the southwestern portion of Hanford. Views along this highway include the lands of the Fitzner-Eberhardt Arid Lands Ecology Reserve in the foreground to the west, with the prominent peak of Rattlesnake Mountain and the extended ridgelines of Rattlesnake Hills in the background. Views to the east feature rather flat terrain, with the structures of the 200-West Area visible in the central area and Gable Butte and Gable Mountain in the background. From the highway, the Saddle Mountains can be seen in the distance to the north, and steam plumes from the Energy Northwest reactor cooling towers are often visible in the distance to the east. The views along State Route 240 are expansive due to the flat terrain and the predominantly short, treeless vegetation cover.

The 24 Command Fire burned 66,322 hectares (163,884 acres) of Federal, state, and private lands, including 56,246 hectares (138,986 acres) within Hanford (see Figure 3–2), while firefighting activities resulted in the construction of 66 kilometers (41 miles) of bulldozed fire lines, widened dirt roads, and cut fences (DOI 2000:iii, iv). Thus, both the fire and the activities required to control it resulted in dramatic changes to the visual character of affected portions of the site. Visual resources were also affected by duststorms resulting from exposed soil. The most recent large fires to burn across Hanford were the Overlook, Milepost 17, and Wautoma Fires (PNNL 2008a). The Overlook Fire blackened 8,527 hectares (21,071 acres) on the east side of the Columbia River on Hanford Reach National Monument land. The Milepost 17 and Wautoma Fires burned 31,161 hectares (77,000 acres) of Federal and private lands. These two fires left large areas blackened across the southwestern portion of Hanford, including the slope of Rattlesnake Mountain, which is visible from Richland and other areas in the region. Alterations to the visual character of Hanford resulting from these fires will change over time since the landscape will tend to recover as rains promote the growth of vegetation, fire lines are rehabilitated, and fences are repaired. Because of the slow regeneration of sagebrush, however, it will be years before the visual character of the area will mirror prefire conditions.

The landscape adjacent to Hanford consists primarily of rural rangeland and farms. The city of Richland, part of the Tri-Cities area, is the only adjoining urban area. Viewpoints affected by DOE facilities are primarily associated with the public access roadways, including State Routes 24 and 240, Horn Rapids Road, Route 4 South, and Stevens Drive; the Columbia River bluffs; and the northern edge of the city of Richland. The Energy Northwest nuclear reactor and DOE facilities are brightly lit at night and are highly visible from many areas. Developed areas are consistent with a BLM Visual Resource Management (VRM) Class IV rating, and for the remainder of Hanford VRM ratings range from Class II to Class III (BLM 1986:6, 7). Management activities within Class II and III areas may be seen but should not dominate the view; those in Class IV areas dominate the view and typically are the focus of viewer attention.

3.2.1.2.2 200 Areas Description

The tallest structure within the 200 Areas is the meteorological tower, with a height of 124 meters (408 feet) (Duncan 2007:4.8). Additionally, a number of stacks are around 61 meters (200 feet) in height. Travelers can see some site facilities in the 200-West Area on an 11-kilometer (7-mile) segment of State Route 240 south of the Yakima Barricade (near the junction of State Routes 240 and 24). At the closest approach, these structures are about 3.2 kilometers (2 miles) distant. However, not all facilities are visible, as many (e.g., storage tanks) are situated below ground, and undeveloped areas are present within and adjacent to the 200 Areas. It is within some of these undeveloped areas that a number of proposed project facilities would be located (see Chapter 4, Figures 4–1 and 4–2).

Aboveground structures throughout the 200 Areas are visible from elevated locations such as Gable Mountain, Gable Butte, and Rattlesnake Mountain. They are not visible from the Columbia River. Because the 200-East and 200-West Areas are highly developed industrial areas, they have a VRM Class IV rating. Natural features of visual interest within the vicinity of the 200 Areas include Gable Butte, 6.9 kilometers (4.3 miles) to the northwest; Gable Mountain, 8 kilometers (5 miles) to the northeast; Rattlesnake Mountain, 14 kilometers (8.7 miles) to the south; and the Columbia River, as close as 10 kilometers (6.2 miles) to the northwest.

3.2.1.2.3 400 Area Description

FMEF, the tallest building in the 400 Area, is 30 meters (100 feet) in height and can be seen from State Route 240; however, FFTF is also a prominent feature. Developed areas within the 400 Area are consistent with a VRM Class IV rating. Natural features of visual interest within a 40-kilometer (25-mile) radius include the Columbia River, 6.8 kilometers (4.2 miles) to the east; Rattlesnake Mountain, 18 kilometers (11 miles) to the west-southwest; Gable Mountain, 19 kilometers (12 miles) to the north-northwest; and Gable Butte, 27 kilometers (17 miles) to the northwest (DOE 2000a:3-94).

3.2.1.2.4 Borrow Area C Description

Borrow Area C, except for a roadway completed in 2006, is an undeveloped area on the south side of State Route 240 (see Figure 3–1). It is generally indistinguishable from the Fitzner-Eberhardt Arid Lands Ecology Reserve, which surrounds it on three sides. Since the 24 Command Fire burned the area in 2000, the original vegetation of the area has changed substantially and it now appears as grassland with little shrub component. A large portion of Borrow Area C surface was burned by the recent 2007 Wautoma Fire. Due to the presence of the road across a portion of the site, Borrow Area C is consistent with a BLM VRM Class II rating. It is readily visible from State Route 240, located immediately adjacent to the area, and Rattlesnake Mountain, about 6.4 kilometers (4 miles) to the south. It is also visible in the distance from Gable Mountain, 12.9 kilometers (8 miles) to the northeast, and Gable Butte, 11.3 kilometers (7 miles) to the north.

3.2.2 Infrastructure

As used in this *TC & WM EIS*, infrastructure encompasses the condition, capacity, and usage of ground transportation and utilities (electricity, fuel, and water) at Hanford and in the site vicinity. In addition to the descriptions provided below, a summary of sitewide infrastructure characteristics is presented as Table 3–2. Further information on transportation infrastructure is presented in Section 3.2.9.4, and waste management infrastructure is addressed in Section 3.2.12.

Table 3–2. Hanford Sitewide Infrastructure Characteristics

Resource	Site Usage[a]	Site Capacity
Transportation		
Roads (kilometers)	607[b]	N/A
Railroads (kilometers)	183	N/A
Electricity		
Energy (megawatt-hours per year)	172,585	1,743,240
Peak load (megawatts)	24[c]	199[d]
Fuel		
Natural gas (cubic meters per year)	977,840	N/A
Fuel oil (liters per year)	2,954,000	(e)
Diesel fuel (liters per year)	1,191,900	(e)
Gasoline (liters per year)	150,300	(e)
Propane (liters per year)	551,400	(e)
Water (liters per year)	816,560,000	18,500,000,000[f]

[a] All values are for fiscal year 2006.

[b] Includes asphalt-paved roads only.

[c] Estimated from average sitewide electrical energy usage, assuming peak load is 120 percent of average demand.

[d] Reflects the capacity of the primary substations serving the 100, 200, 300, and 400 Areas but not necessarily the availability of electric power from the Bonneville Power Administration, which can vary (Uecker 2007).

[e] Limited only by the ability to ship resources to the site.

[f] Capacity of the Hanford Export Water System.

Note: To convert cubic meters to cubic feet, multiply by 35.315; kilometers to miles, by 0.6214; liters to gallons, by 0.26417.

Key: N/A=not applicable.

Source: Duncan 2007:4.150, 4.152; Ferns 2003a, 2003b; Fluor Hanford 2006a:Attachments 1 and 2; Uecker 2007.

3.2.2.1 Ground Transportation

3.2.2.1.1 General Site Description

The DOE-maintained road network within Hanford consists of 607 kilometers (377 miles) of asphalt-paved road and provides access to the various work centers (see Figure 3–1). Primary access roads on the site are Routes 1, 2, 3, 4, 6, 10, and 11A and Beloit Avenue. Public access to the 200 Areas and interior locations of Hanford is restricted by guarded gates at the Wye Barricade (at the intersection of Routes 10 and 4), the Yakima Barricade (at the intersection of State Route 240 and Route 11A), and the Rattlesnake Barricade (south of the 200-West Area) (Duncan 2007:4.152).

The Hanford rail system originally consisted of about 209 kilometers (130 miles) of track. It connected to the Union Pacific commercial track at the Richland Junction and to the now-abandoned commercial right-of-way (Chicago, Milwaukee, St. Paul, and Pacific Railroad) near Vernita Bridge in the northwest section of the site (see Figure 3–2). Prior to 1990, annual sitewide railcar movements numbered about 1,400, transporting materials such as coal, fuel, hazardous process chemicals, and radioactive materials and equipment. Coal deliveries ceased with the replacement of site coal-fired steam plants by oil and natural gas package boilers. In October 1998, 26 kilometers (16 miles) of track were transferred to the Port of Benton and are currently operated and maintained by the Tri-City and Olympia Railroad Company. Included were those track segments constituting the Hanford southern rail connection (from Horn Rapids Road to Columbia Center) and those serving the Richland North Area (Duncan 2007:4.150).

3.2.2.1.2 200 Areas Description

The 200-East Area is accessed primarily by Route 4 South from the east, by Route 4 North off Route 11A from the north, and by Route 4 North off Route 11A for vehicles entering the site at the Yakima Barricade. The 200-West Area is accessed from State Route 240 by Beloit Avenue. A network of both improved and semi-improved roads provide access to individual facilities within the 200-East and 200-West Areas and to the WTP site. Inactive rail spurs traverse portions of both the 200-East and 200-West Areas (see Figure 3–2).

3.2.2.1.3 400 Area Description

The 400 Area access road can be reached directly via a roadway off Route 4. An inactive rail spur to the 400 Area originates northeast of the site from the vicinity of the Energy Northwest Columbia Generating Station.

3.2.2.1.4 Borrow Area C Description

Borrow Area C is accessible via a two-lane, 2.0-kilometer-long (1.25-mile-long) asphalt-paved roadway. Completed in 2006, the roadway extends southeast into the interior of Borrow Area C from the intersection of Beloit Avenue and State Route 240 and south of the Rattlesnake Barricade.

3.2.2.2 Electricity

3.2.2.2.1 General Site Description

Electric power for Hanford is purchased wholesale from the Bonneville Power Administration, which provided nearly 90 percent of the electricity consumed on the site in 2006 (Duncan 2007:4.157). Hanford is a Priority Firm customer, and the Bonneville Power Administration is contractually obligated to provide as much power as Hanford requires. Being a Priority Firm customer ensures that, in the event of severe regional power shortages, Hanford (along with other Priority Firm customers) would be the last level of Bonneville Power Administration service to be shut off (Fluor Hanford 2005a:45, 46). Power for the 700 Area and the Richland North Area is provided by the City of Richland (DOE 1999a:4-112). The Richland Energy Services Department and the Benton and Franklin County public utility districts provide electricity to the Tri-Cities and surrounding areas and also purchase nearly all their electric power from the Bonneville Power Administration (Duncan 2007:4.156). Because the transmission line capacity across the site was developed when the nine 100 Area reactors were operating, historically there has been surplus capacity on the Hanford electrical transmission system (Ferns 2003a). In 2006, the sitewide average electric load demand was approximately 19.7 megawatts (172,585 megawatt-hours) for 8,760 hours (see Table 3–2).

Power to the electrical system that serves the 100 and 200 Areas is provided from two sources, the Bonneville Power Administration Midway substation at the northwestern site boundary and a transmission line from the Bonneville Power Administration Ashe substation near Energy Northwest's Columbia Generating Station. The 100/200 Area electrical system consists of about 80 kilometers (50 miles) of 230-kilovolt transmission lines, six primary substations, about 217 kilometers (135 miles) of 13.8-kilovolt distribution lines, and 124 secondary substations. The 100/200 Area transmission and distribution systems, like the Bonneville Power Administration source lines, have redundant routings to ensure electrical service to individual areas and designated facilities within those areas (DOE 1990:3-1, 3-2; 1999b:3-47). The 100/200 Area system had been upgraded in the 1980s with an installed usable electric load capacity of 244 megavolt-amperes (about 195 megawatts) and had a peak load demand of 54.7 megawatts at that time (DOE 1990:3-1–3-3; ICF KH Engineers Hanford 1995:4, 5). Presently, the 100 Areas are served by one primary substation (151-KW substation) that has a usable load capacity of 50 megavolt-amperes (about 40 megawatts) (Uecker 2007). Total electrical energy consumption in the 100 Areas was 23,440 megawatt-hours in fiscal year 2006, reflecting an average electric load demand of 2.7 megawatts (Fluor Hanford 2006a:Attachment 2).

3.2.2.2.2 200 Areas Description

The main 251-W substation that serves the 200 Areas has a current usable load capacity of 33 megavolt-amperes (about 26 megawatts) (Uecker 2007). The 251-W substation also serves as the electrical dispatch center for the 100, 200, and 300 Areas (DOE 1990:3-1–3-2; ICF KH Engineers Hanford 1995:4, 5).

In late 2001, DOE completed construction of a new 62.5-megavolt-ampere-capacity (about 50-megawatt) substation to support future WTP operations. The substation is supplied by 230-kilovolt transmission lines and can receive power directly from the Columbia Generating Station or the Priest Rapids Dam (DOE 2001a).

In fiscal year 2006, total electrical energy consumption was 53,915 megawatt-hours in the 200-East Area and 43,888 megawatt-hours in the 200-West Area, for a 200 Area total of 97,803 megawatt-hours (Fluor Hanford 2006a:Attachment 2). This consumption reflects an average electric load demand of about 11.2 megawatts for activities in the 200 Areas.

3.2.2.2.3 400 Area Description

For the 300 and 400 Areas, electric power is supplied via two separate 115-kilovolt Bonneville Power Administration transmission lines. The first originates from the Bonneville Power Administration Benton switch station south of the Columbia Generation Station; the second, from the Bonneville Power Administration White Bluffs substation in the southeast portion of Hanford (DOE 1990:3-6). The primary 300 Area substation (351 substation) currently has a usable electric load capacity of 20 megavolt-amperes (about 16 megawatts) (Uecker 2007). Total electrical energy consumption in the 300 Area was 18,117 megawatt-hours in fiscal year 2006, reflecting an average electric load demand of 2.1 megawatts (Fluor Hanford 2006a:Attachment 2).

There is one 13.8-kilovolt tie line from the 300 Area to the 400 Area emergency power system that also provides alternate power for maintenance outages. Redundancy in the distribution lines to designated facilities ensures continuity of service and the rerouting of power for the maintenance of system components. There are two substations in the 400 Area: Building 451A (FFTF substation), which serves the FFTF reactor complex, and Building 451B (FMEF substation), serving FMEF and associated buildings (DOE 1990:3-8, 3-9; 1999b:3-47; Fluor Hanford 2005a:16). The FFTF substation has a usable load capacity of 50 megavolt-amperes (about 40 megawatts); the FMEF substation, a usable capacity of 33.3 megavolt-amperes (about 27 megawatts) (Uecker 2007).

Electrical energy usage for FFTF averaged approximately 55,000 megawatt-hours annually during standby, reflecting an average electric power demand of about 6 megawatts (Fluor Hanford 2005a:46). The total electrical energy consumption for the 400 Area as a whole during fiscal year 2006 was 20,385 megawatt-hours, reflecting an average electric load demand of 2.3 megawatts (Fluor Hanford 2006a:Attachment 2).

3.2.2.2.4 Borrow Area C Description

No electric power distribution lines serve Borrow Area C at present. Overhead electrical distribution lines could be extended to the site from the vicinity of Beloit Avenue and State Route 240 to support borrow area operations as needed.

3.2.2.3 Fuel

3.2.2.3.1 General Site Description

Both fuel oil and natural gas are used as energy sources at Hanford facilities. A commercial vendor supplies fuel oil to the site, including the 200 Areas. The primary fuel for the 300 Area is natural gas, which is supplied by the Cascade Natural Gas Corporation (Duncan 2007:4.157; Ferns 2003a).

Liquefied petroleum gas (propane) is the primary facility fuel source in the 100 Areas. In addition, diesel fuel, gasoline, and propane are consumed to operate vehicles and other equipment at Hanford (Fluor Hanford 2006a:Attachment 1:4, Attachment 2).

Individual package boilers supply heat and process steam to specific facilities in the 200-East, 200-West, and 300 Areas. Oil-fired package boilers produce steam in the 200 Areas, while natural-gas-fired package boilers produce steam in the 300 Area. A new underground natural gas line was installed from south of Richland to the 300 Area to supply natural gas to the new package boilers (DOE 1999a:4-112).

Hanford sitewide fuel oil consumption, reflecting demands in the 200 Areas, was 2,954,000 liters (780,400 gallons) in fiscal year 2006. Total natural gas consumption by 300 Area facilities was about 977,840 cubic meters (34,530,000 cubic feet) during the same time period (see Table 3–2). Total diesel fuel consumption was 1,191,880 liters (314,860 gallons); total gasoline consumption, 150,300 liters (39,700 gallons); and total propane consumption, 551,400 liters (145,670 gallons). Fuel consumption by nonfleet vehicles and equipment was substantially lower in fiscal year 2006 than in previous years due to the slowdown in WTP construction (Fluor Hanford 2006a:Attachment 1:4, Attachment 2).

3.2.2.3.2 200 Areas Description

As indicated above, individual package boilers supply heat and process steam to facilities in the 200-East and 200-West Areas. When complete and operational, a dedicated fuel-oil-fired central utilities plant will supply heat and process steam to the WTP complex within the 200-East Area.

3.2.2.3.3 400 Area Description

At FFTF, fuel oil was required to operate the emergency fire pumps, emergency diesel generators, and the sodium preheaters in the main heat transport system dump heat exchangers. Fuel oil usage during operations averaged 76,000 liters (20,000 gallons) annually (Fluor Hanford 2005a:46). No fuel oil consumption was recorded for the 400 Area in fiscal year 2006 (Fluor Hanford 2006a:Attachment 2).

3.2.2.3.4 Borrow Area C Description

There is no liquid fuel storage or consumption in Borrow Area C.

3.2.2.4 Water

3.2.2.4.1 General Site Description

The Hanford water system includes numerous buildings, pumps, valve houses, reservoirs, and wells, in addition to a distribution piping system that delivers water to all areas of the site. The Export Water System, the largest system at Hanford, delivers water from the Columbia River to the 100 and 200 Areas and parts of the 600 Area (DOE 1999a:4-112). The Hanford water system is further divided into nine DOE-owned, contractor-operated, regulated drinking water systems. Only one of the nine systems (the 400 Area system) uses groundwater from the unconfined aquifer instead of water from the Columbia River. The 400 Area used emergency backup well 499-SO-8 (P-14) as a source of drinking water for the first 6 months of 2010. Primary supply well 499-S1-8J (P-16) supplied the system for the remaining 6 months. Backup well 499-S0-7 (P-15) did not supply water to the 400 Area during 2010 (Poston, Duncan, and Dirkes 2011:8.53–8.55).

In the 300 Area, the water system distributes water supplied by the City of Richland. The Richland water supply system provides drinking water to the 300 Area, the Richland North Area, and the Volpentest Hazardous Materials Management and Emergency Response Training and Education Center (Poston, Duncan, and Dirkes 2011:8.53). This system obtains about 82 percent of its water directly from the Columbia River, while the remainder is split between a well field in north Richland (recharged from the river) and groundwater wells. In 2006, the city of Richland's total water use was approximately 20.1 billion liters (5.3 billion gallons). The city of Pasco water system draws from the Columbia River and used about 15.3 billion liters (4.0 billion gallons) in 2006. While the Kennewick water system partly depends on the Columbia River for its supply, two groundwater wells serve as the sole source of water between November and March. The total water usage by the city of Kennewick was 13.4 billion liters (3.5 billion gallons) in 2006. A significant number of Kennewick's residents (about 22,000 residential customers) also draw irrigation water from the Kennewick Irrigation District, which has the Yakima River as its source (Duncan 2007:4.155).

3.2.2.4.2 200 Areas Description

Water for the 200-East and 200-West Areas is filtered and chlorinated at the 283-W Water Treatment Plant (Ferns 2003b; Fluor Hanford 2006a:Attachment 1:8). Construction of an additional 4.8 kilometers (3 miles) of pipeline was completed by DOE in late 2001 to deliver water to the WTP site for drinking, fire protection, and future WTP operations (DOE 2001a). The total raw water capacity of the Export Water System is currently rated at approximately 35,200 liters (9,300 gallons) per minute, or about 18.5 billion liters (4.89 billion gallons) per year. However, the potable water capacity of the treatment plant is about 5,680 liters (1,500 gallons) per minute, or about 2.98 billion liters (0.788 billion gallons) per year, which is limited by the plant's chlorination capacity (Ferns 2003b). The original Export Water System was designed to supply raw water to the 100-B, 100-D, 100-F, and 100-H Area reactor operations in addition to the 200 Areas. Since reactor shutdown, it has been reconfigured to mainly furnish water to the 200 Areas and has undergone further modification. Prior to 1990, the system had a daily average pumping demand of about 72 million liters (19 million gallons) per day, with the 200 Areas consuming over 22,700 million liters (6 billion gallons) annually (DOE 1990:5-3, 5-9). Hanford sitewide water production and usage totaled approximately 816.6 million liters (215.7 million gallons) in fiscal year 2006, including groundwater withdrawals in the 400 Area. Of this total, the amount of water produced and used in the 200 Areas was 303.1 million liters (80.1 million gallons) (Fluor Hanford 2006a:Attachment 1:8).

3.2.2.4.3 400 Area Description

In the 400 Area, the primary and two backup groundwater supply wells each have a production capacity of 833 liters (220 gallons) per minute (DOE 2000a:3-113). Groundwater is chlorinated at the well as it is pumped into one of three 1,140-cubic-meter (300,000-gallon) storage tanks. Approximately 4,540 liters (1,200 gallons) of sodium hypochlorite were consumed annually in water treatment (Fluor Hanford 2005a:46). Annual groundwater withdrawals during operations averaged about 197 million liters (52 million gallons) (DOE 2000a:3-113; Fluor Hanford 2005a:46). Groundwater production and usage in the 400 Area was measured at approximately 116 million liters (30.6 million gallons) in fiscal year 2006 (Fluor Hanford 2006a:Attachment 1:8).

3.2.2.4.4 Borrow Area C Description

No utility systems serve Borrow Area C at present. Development plans call for a new waterline to be extended down Beloit Avenue from the 200-West Area distribution system to provide water in support of future borrow area operations.

3.2.3 Noise and Vibration

Noise is unwanted sound that interferes or interacts negatively with the human or natural environment. Noise may disrupt normal activities or diminish the quality of the environment. Noise sources, existing noise levels at Hanford, and noise standards are described in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a:3-29–3-31, F-31, F-32) and in the *Hanford NEPA Characterization Report* (Duncan 2007:4.161–4.165).

3.2.3.1 General Site Description

Background noise levels at Hanford were measured during two surveys in 1996 and 2007. Data from a survey of 15 sites at Hanford found that background noise levels (measured as the 24-hour equivalent sound level) ranged from 30 to 60.5 decibels A-weighted (dBA) (a unit of measurement that accounts for the frequency response of the human ear). A second survey of 5 isolated areas concluded that background sound levels in undeveloped areas could best be described as a mean 24-hour equivalent sound level of 24 to 36 dBA. Wind was identified as the primary contributor to background sound levels at Hanford (Duncan 2007: 4.162, 4.164).

Major noise sources within Hanford include various facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and material handling equipment, vehicles). However, most Hanford industrial facilities are far enough from the site boundary that noise levels from these sources at the boundary are either unmeasurable or barely distinguishable from background noise levels. It can reasonably be assumed that Hanford is currently in compliance with state noise regulations (DOE 1996a: 3-29, 3-31; Neitzel 2005:4.149–4.153).

The primary source of noise at the site and nearby residences is traffic. The potential impact of traffic noise resulting from activities at Hanford was evaluated for a draft EIS addressing the siting of the proposed New Production Reactor (Duncan 2007:4.164). Estimates were made of baseline traffic noise along two major access routes: State Route 24, from Hanford west to Yakima, and State Route 240, south of the site and west of Richland, where it handles maximum traffic volume. About 9 percent of the employees at Hanford commute by vanpool or bus. Modeled traffic noise levels (equivalent sound level [1 hour]) at 15 meters (50 feet) from State Route 24 for both peak and offpeak periods were 62 dBA. Traffic noise levels from State Route 240 for both peak and offpeak periods were 70 dBA. These traffic noise levels were projections based on employment levels about 30 percent higher than actual levels at Hanford in 1997. Existing traffic noise levels may be different due to changes in site employment and ridesharing activities (DOE 1999b:3-8; Duncan 2007:4.161–4.165).

Washington State has established noise standards for different source and receiving areas. Hanford belongs to source area Class C (industrial). The maximum allowable noise level for residential, commercial, and industrial areas is 50 to 70 dBA (WAC 173-60). For industrial areas impacting a residential area, the limit is 60 dBA during daylight hours and 50 dBA at night. U.S. Environmental Protection Agency (EPA) guidelines for environmental noise protection include a day-night average sound level of no more than 55 dBA to protect the public from the effects of broadband environmental noise in typically quiet outdoor residential areas (EPA 1974:29). Land use compatibility guidelines adopted by the Federal Aviation Administration and the Federal Interagency Committee on Urban Noise indicate that yearly day-night average sound levels less than 65 dBA are compatible with residential land uses (14 CFR 150). These guidelines further indicate that noise levels up to 75 dBA are compatible with residential uses if suitable noise reduction features are incorporated into structures. It is expected that, for most residences near Hanford, the day-night average sound level is less than 65 dBA and thus compatible with residential land use, although noise levels may be higher for some residences along major roadways. Truck traffic, especially on State Routes 240 and 10; excavation activity at various projects at Hanford, such as the WTP and the Integrated Disposal Facility (IDF) in the 200-East Area (IDF-East); and roadwork on State Route 240 have resulted in ground vibration sufficient to interfere with operation of the LIGO (Raab 1996; SAIC 2006a).

3.2.3.2 200 Areas Description

No distinguishing noise characteristics in the 200 Areas have been identified. The 200 Areas are far enough away from the nearest site boundary (10 kilometers [6.2 miles]) that industrial noises emanating from those areas are either unmeasurable or barely distinguishable from background levels at the site boundary. The 200-West Area is about 2.3 kilometers (1.4 miles) from the closest part of the Hanford Reach National Monument.

3.2.3.3 400 Area Description

No distinguishing noise characteristics in the 400 Area have been identified. The 400 Area is far enough away from the site boundary (6.9 kilometers [4.3 miles]) that industry-related noise levels at that boundary are unmeasurable or barely distinguishable from background levels. The 400 Area is about 6.9 kilometers (4.3 miles) from the closest part of the Hanford Reach National Monument.

3.2.3.4 Borrow Area C Description

There are currently no quarry activities in Borrow Area C that would produce audible noise in the area of the Hanford Reach National Monument immediately adjacent to the quarry (SAIC 2006b). The major noise source in this area is traffic along State Route 240.

3.2.4 Air Quality

Air pollution refers to the direct or indirect introduction of any substance into the air that could endanger human health; harm living resources, ecosystems, or material property (e.g., buildings); or impair or interfere with the comfortable enjoyment of life or other legitimate uses of the environment. Air pollutants are transported, dispersed, and concentrated by meteorological and topographical conditions. Air quality is affected by air pollutant emission characteristics, meteorology, and topography. This section primarily discusses criteria and toxic air pollutants. Radioactive air pollutants are discussed further in Section 3.2.10.

3.2.4.1 General Site Description

The climate at Hanford and the surrounding region is characterized as that of a semiarid steppe. The humidity is low, and winters are mild. According to data collected from 1946 through 2004, the average monthly temperatures at the Hanford Meteorological Station (located between the 200-East and 200-West Areas) range from a low of –0.7 degrees Celsius (°C) (31 degrees Fahrenheit [°F]) in January to a high of 24.7 °C (76 °F) in July. Annual average relative humidity is 55 percent. While the average annual precipitation is 17 centimeters (6.8 inches), most precipitation occurs during the late autumn and winter, with more than half of the annual amount occurring from November through February. The monthly average windspeeds are lower during the winter, averaging 2.7 to 3.1 meters per second (6 to 7 miles per hour); during the summer they average 3.6 to 4.0 meters per second (8 to 9 miles per hour). Prevailing winds are from the northwest (Duncan 2007:4.5–4.13). Figures 3–3 and 3–4 show wind roses for the Hanford Meteorological Station at the 200 Area for the 9-meter (30-foot) and 61-meter (200-foot) elevations, respectively, for the period 1997 through 2006. Figures 3–5 and 3–6 show wind roses for the meteorological station at the 400 Area for the 9-meter (30-foot) and 61-meter (200-foot) elevations, respectively, for the period 1997 through 2006.

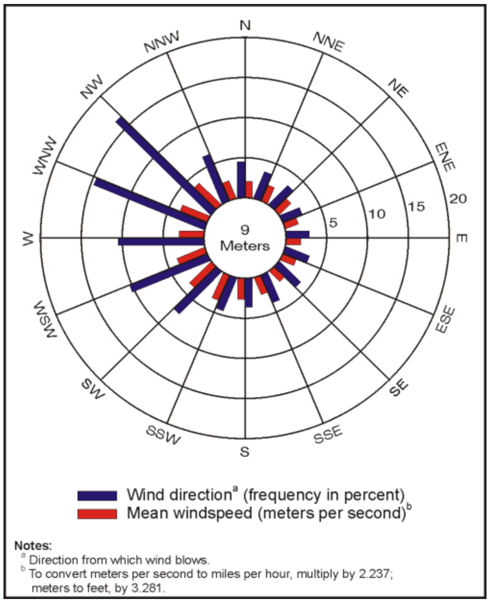


Figure 3–3. Wind Rose for the Hanford Meteorological Station at the 200 Area, 1997–2006 (9-Meter Elevation)

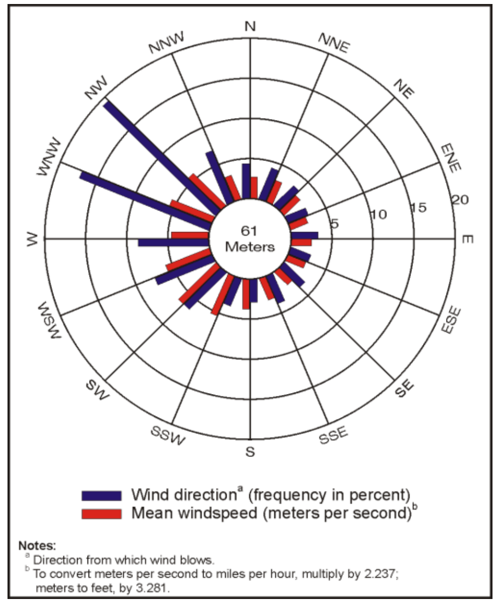


Figure 3–4. Wind Rose for the Hanford Meteorological Station at the 200 Area, 1997–2006 (61-Meter Elevation)

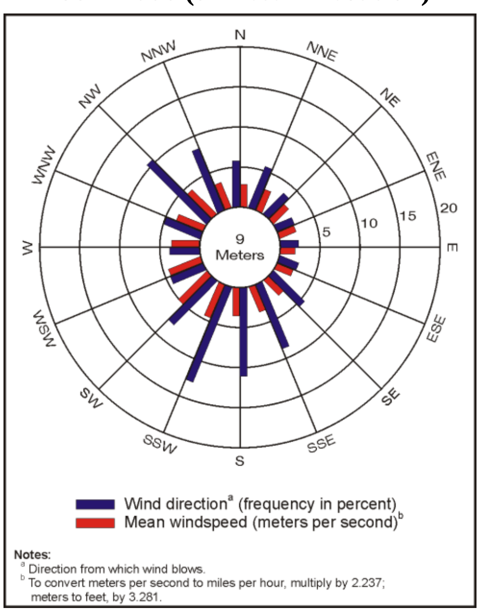


Figure 3–5. Wind Rose for the Fast Flux Test Facility Meteorological Station at the 400 Area, 1997–2006 (9-Meter Elevation)

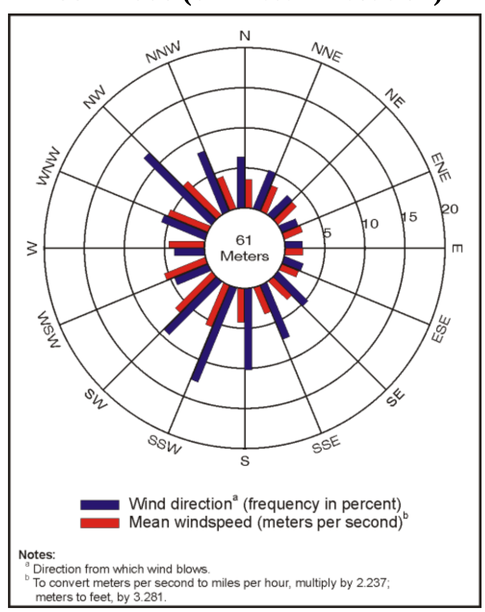


Figure 3–6. Wind Rose for the Fast Flux Test Facility Meteorological Station at the 400 Area, 1997–2006 (61-Meter Elevation)

Tornadoes are infrequent and generally small in the northwestern portion of the United States. In the 10 counties closest to Hanford (Benton, Franklin, Grant, Adams, Yakima, Klickitat, Kittitas, and Walla Walla Counties in Washington, and Umatilla and Morrow Counties in Oregon), only 28 tornadoes have been recorded for the period from 1950 through 2006. The average occurrence of thunderstorms in the vicinity of the Hanford Meteorological Station is 10 per year, with about 1.9 percent considered severe (Duncan 2007:4.13, 4:14).

Most of Hanford is within the South-Central Washington Intrastate Air Quality Control Region No. 230, but a small portion of the site is in the Eastern Washington-Northern Idaho Interstate Air Quality Control Region No. 62. None of the areas within Hanford and its surrounding counties are designated as nonattainment areas with respect to National Ambient Air Quality Standards (NAAQS) for criteria air pollutants (40 CFR 81.348). Particulate matter (PM) concentrations can reach relatively high levels in eastern Washington State because of extreme natural events such as duststorms and large brush fires. Duststorms are treated as uncontrollable natural events under EPA policy (Nichols 1996). Accordingly, the air quality impact of such storms can be disregarded in determining whether an area is in nonattainment for atmospheric particulates. However, states are required to develop and implement a natural-events action plan (Duncan 2007:4.19). Applicable NAAQS and Washington State ambient air quality standards are presented in Table 3–3.

The primary sources of criteria and toxic air pollutants at Hanford include emissions from power generation and chemical processing (Duncan 2007:4.19). Other sources include vehicular emissions and construction, environmental remediation, and waste management activities (Wisness 2000). The tank farms in the 200 Areas produced reportable quantities of ammonia emissions in 2010 (Poston, Duncan, and Dirkes 2011:8.10). Modeled ambient air pollutant concentrations at the site boundary attributable to existing sources at Hanford are presented in Table 3–3.

These ambient air pollution concentrations are based on dispersion modeling using year 2005 emissions for Hanford, which are presented in Table 3–4. Only those pollutants that would be emitted under any of the alternatives evaluated in this *TC & WM EIS* are presented. Emissions from carbon tetrachloride vapor extraction work in the 200-West Area are included among the toxic pollutant emissions shown. Emissions from tank vents other than ammonia and criteria pollutants are included among the composite toxic air pollutants. These emissions include 1,3-butadiene, 2-hexanone, 2-pentanone, acetone, acetonitrile, benzene, heptane, hexane, methyl amyl ketone, nonane, octane, phosphoric acid tributyl ester, and toluene (DOE and Ecology 1996:G-36–G-38). The concentrations at the site were calculated from 2000–2004 meteorological data using the AERMOD [American Meteorological Society/U.S. Environmental Protection Agency Regulatory Model] dispersion model.

Background concentrations of criteria pollutants are well below ambient standards. As shown in Table 3–3, these modeled concentrations from Hanford sources represent a small percentage of the ambient air quality standards. Hanford emissions should not result in air pollutant concentrations that violate the ambient air quality standards for criteria pollutants. Detailed information on emissions of other pollutants at Hanford is discussed in the *Hanford Site Environmental Report* (Poston, Duncan, and Dirkes 2011:8.10–8.12).

The principal sources of radioactive emissions at Hanford are facilities in the 100, 200, 300, 400, and 600 Areas. Source emissions in the 600 Area are reported with those from the 200-West Area due to the proximity of the emitting facility to the 200-West Area. Emission sources are discussed in the *Hanford Site Environmental Report* (Poston, Duncan, and Dirkes 2011:8.10). Radioactive airborne emissions in 2010 are summarized in Table 3–5. Emissions data are provided as a baseline and are the basis for the human health baseline information discussed in Section 3.2.10, but are not used in the modeling for this *TC & WM EIS*.

Table 3–3. Modeled Nonradioactive Ambient Air Pollutant Concentrations from Hanford Site Sources and Ambient Air Quality Standards

Pollutant	Averaging Period	Most Stringent Standard or Guideline[a]	Maximum Hanford Concentration[b]
		(micrograms per cubic meter)	
Criteria Pollutants			
Carbon monoxide	8 hours 1 hour	10,000[c] 40,000[c]	39.5 162
Nitrogen dioxide	Annual 1 hour	100[c] 188[d]	0.237 13.2
Ozone	8 hours 1 hour	147[d] 235[f]	(e) (e)
PM_{10}	Annual 24 hours	50[f, g] 150[c]	0.134 0.926
$PM_{2.5}$	Annual 24 hours	15[d] 35[d]	0.113[h] 1.09[h]
Sulfur dioxide	Annual 24 hours 3 hours 1 hour 1 hour 1 hour	50[f] 260[f] 1,300[c] 1,000[f] 660[f, i] 197[d]	0.00577 0.52 2.01 5.0 5.0 2.19
Other Regulated Pollutants			
Total suspended particulates	Annual 24 hours	60[f] 150[f]	0.134[h] 0.926[h]
Ammonia	24 hours	70.8[j]	1.91

[a] The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (40 CFR 50), other than those for ozone, particulate matter, and lead, and those standards based on annual averages, are not to be exceeded more than once per year. The annual arithmetic mean $PM_{2.5}$ standard is attained when the weighted annual arithmetic mean concentration (3-year average) does not exceed the standard value. The 24-hour $PM_{2.5}$ standard is met when the 98th percentile over 3 years of 24-hour average concentrations is less than or equal to the standard value. The 24-hour PM_{10} standard is met when the standard value is not exceeded more than once per year over a 3-year period. The annual arithmetic mean PM_{10} standard is attained when the weighted annual arithmetic mean concentration (3-year average) is less than or equal to the standard value. The 1-hour nitrogen dioxide standard is met when the 3-year average 98th percentile of the daily maximum 1-hour average does not exceed the standard value. The Federal 1-hour sulfur dioxide standard is met when the 3-year average 99th percentile of the daily maximum 1-hour average does not exceed the standard value.

[b] Site contributions based on a 2005 emissions inventory, including emissions from the 200 Areas.

[c] Federal and state standard.

[d] Federal standard.

[e] Not directly emitted or monitored by the site.

[f] State standard.

[g] The U.S. Environmental Protection Agency recently revoked the annual PM_{10} standard.

[h] Assumed to be the same as the concentration of PM_{10} because there are no specific emissions data for total suspended particulates or $PM_{2.5}$.

[i] Not to be exceeded more than twice in any 7 consecutive days.

[j] State acceptable source impact level.

Note: The National Ambient Air Quality Standards include standards for lead. Lead emissions identified at the site are small (less than 1 kilogram per year) and were not modeled. The State of Washington also has ambient standards for fluorides. No emissions of fluorides have been reported at Hanford. To convert cubic meters to cubic feet, multiply by 35.315; kilograms to pounds, by 2.2046.

Key: PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

Source: 40 CFR 50; 71 FR 61144; Johnson 2006; Poston et al. 2006:10.12; WAC 173-460, 173-470, 173-474, 173-475, 173-481, 173-490.

Table 3–4. Nonradioactive Constituents Emitted to the Atmosphere at the Hanford Site, 2005

Constituent	Emissions (kilograms)
Carbon monoxide	14,000
Nitrogen oxides	12,000
Particulate matter PM_{10} $PM_{2.5}$	6,500 2,800 1,000
Sulfur oxides	3,000
Lead	0.47
Volatile organic compounds[a]	14,000[b]
Ammonia	12,000[c]
Other toxic air pollutants	6,600[d]

[a] Produced from burning fossil fuels for steam generation and electrical generators and calculated from estimates of emissions from the 200-East and 200-West Area tank farms; evaporation losses from fuel dispensing; and emissions from operation of the 242-A Evaporator and the 200 Area Effluent Treatment Facility, Central Waste Complex, T Plant complex, and Waste Receiving and Processing Facility.

[b] Estimate does not include emissions from certain laboratory operations and mobile sources.

[c] Calculated estimates of releases from the 200-East and 200-West Area tank farms, operation of the 242-A Evaporator, and the 200 Area Effluent Treatment Facility.

[d] A composite of calculated estimates of toxic air pollutants, excluding ammonia.

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

Source: Poston et al. 2006:10.12.

Table 3–5. Radionuclides Discharged to the Atmosphere at the Hanford Site, 2010

Radionuclide	Release Location					
	100 Areas	200-East Area	200-West Area	300 Area	400 Area	Total
	(curies)					
Hydrogen-3 (tritium) (as elemental tritium)	NM	NM	NM	7.3×10^{1}	NM	7.3×10^{1}
Hydrogen-3 (tritium) (as tritiated water vapor)	NM	NM	NM	2.8×10^{2}	1.8×10^{-3}	2.8×10^{2}
Krypton-85	NM	NM	NM	4.4×10^{-1}	NM	4.4×10^{-1}
Strontium-90	1.0×10^{-4}[a]	1.6×10^{-4}[a]	2.8×10^{-5}[a]	5.5×10^{-6}[a]	NM	2.9×10^{-4}
Iodine-129	NM	1.7×10^{-3}	NM	NM	NM	1.7×10^{-3}
Xenon-131m	NM	NM	NM	1.0×10^{-8}	NM	1.0×10^{-8}
Xenon-133	NM	NM	NM	3.0×10^{-9}	NM	3.0×10^{-9}
Cesium-137	2.5×10^{-5}	1.5×10^{-5}	1.8×10^{-5}	4.1×10^{-9}	4.1×10^{-7}[b]	5.8×10^{-5}
Radon-220	NM	NM	NM	9.0×10^{1}	NM	9.0×10^{1}
Radon-222	NM	NM	NM	1.4×10^{-8}	NM	1.4×10^{-8}
Plutonium-238	3.0×10^{-6}	2.0×10^{-9}	3.9×10^{-8}	4.4×10^{-7}	NM	3.5×10^{-6}
Plutonium-239 and -240	5.1×10^{-5}	1.7×10^{-6}	3.5×10^{-5}	5.8×10^{-7}	9.1×10^{-15}	8.8×10^{-5}

Table 3–5. Radionuclides Discharged to the Atmosphere at the Hanford Site, 2010 *(continued)*

Radionuclide	Release Location					
	100 Areas	200-East Area	200-West Area	300 Area	400 Area	Total
	(curies)					
Plutonium-241	1.2×10^{-4}	ND	1.5×10^{-5}	4.3×10^{-7}	NM	1.4×10^{-4}
Americium-241	1.7×10^{-5}	1.4×10^{-7}	3.1×10^{-6}	7.4×10^{-9}	NM	2.0×10^{-5}
Americium-243	NM	NM	NM	1.4×10^{-7}	NM	1.4×10^{-7}
Total releases	$\mathbf{3.2\times10^{-4}}$	$\mathbf{1.9\times10^{-3}}$	$\mathbf{9.9\times10^{-5}}$	$\mathbf{4.4\times10^{2}}$	$\mathbf{1.8\times10^{-3}}$	$\mathbf{4.4\times10^{2}}$

[a] This value includes gross beta release data, treated as strontium-90 in dose calculations.

[b] This value is derived entirely from data on gross beta emissions from 400 Area stacks.

Key: ND=not detected; NM=not measured.

Source: Poston, Duncan, and Dirkes 2011:8.11.

The nearest Prevention of Significant Deterioration (PSD) Class I areas to Hanford are Mount Rainier National Park, 160 kilometers (100 miles) to the west; Goat Rocks Wilderness Area, about 145 kilometers (90 miles) to the west; Mount Adams Wilderness Area, about 153 kilometers (95 miles) to the southwest; and Alpine Lakes Wilderness Area, about 177 kilometers (110 miles) to the northwest (40 CFR 81.434; Ecology 2005; Duncan 2007:4.19). A Class I area is one in which very little increase in pollution is allowed owing to the pristine nature of the area. Hanford and its vicinity are classified as a Class II area, in which more-moderate increases in pollution are allowed. The PUREX [Plutonium-Uranium Extraction] and Uranium Trioxide Plants were issued a PSD permit for nitrogen oxide emissions in 1980. These facilities were permanently shut down in the late 1980s and deactivated in the 1990s. None of the currently operating Hanford facilities have nonradioactive emissions of sufficient magnitude to warrant consideration under PSD regulations (Duncan 2007:4.17). DOE has applied for and received a PSD permit for the WTP, which includes the Pretreatment Facility, HLW Vitrification Facility, LAW Vitrification Facility, six steam-generating boilers, two diesel fire pumps, and three emergency diesel generators (Ecology 2001, 2005; Hibbard 2003). New emission sources may require a PSD increment consumption analysis if they have significant emissions and air quality impacts. The PSD increments are shown in Table 3–6.

Table 3–6. Prevention of Significant Deterioration Increments for the Hanford Site

Emission	Class I Areas	Class II Areas
	(micrograms per cubic meter)	
Sulfur Dioxide		
Annual	2	20
24-hour	5	91
3-hour	25	512
PM_{10}		
Annual	4	17
24-hour	8	30
Nitrogen Dioxide		
Annual	2.5	25

Note: To convert cubic meters to cubic feet, multiply by 35.315.

Key: PM_{10}=particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.

Source: 40 CFR 52.21.

A sitewide air operating permit for Hanford (permit No. 00-05-006) became effective in July 2001 and was renewed in December 2006 (Duncan 2007:6.23) in accordance with Title V of the Clean Air Act and Amendments of 1990, the Federal and state programs under "State Operating Permit Programs" (40 CFR 70), and the *Washington Administrative Code (WAC)* (WAC 173-401). The Hanford Site Air Operating Permit (Ecology 2001, 2006) includes a compilation of requirements for both radioactive emissions covered by the existing state license and nonradioactive emissions. It entails emission and reporting requirements for various sources in the 200 Areas, including oil-fired boilers, large internal-combustion engines, tank exhausters, waste retrieval systems, rotary-mode core sampling systems, tank sluicing, emergency fire pump generators, the 200 Area Effluent Treatment Facility (ETF), tank waste retrieval, tank farm ventilation systems, storage of vented waste containers at the Central Waste Complex (CWC), the Waste Receiving and Processing Facility (WRAP), IDF-East, the Bulk Vitrification Facilities, the WTP, the WTP's Concrete Batch Plant, the T Plant complex, and the Plutonium Finishing Plant. The requirements include a limitation of 0.05 percent sulfur distillate fuel oil for larger boilers in the 200 Areas. The primary effects of the permit are to consolidate approval orders and applicable requirements into one permit, require the permitted party to conduct periodic monitoring to show continuous compliance with permit conditions and applicable requirements, and require biannual reporting and annual certification of continuous compliance. A final PSD permit for the WTP was issued by the Washington State Department of Ecology (Ecology) in November 2003. That permit applies to two HLW melters, two LAW melters, and six boilers and requires the use of ultralow-sulfur (maximum 0.003 percent sulfur) fuel in the boilers, diesel fire pump, and diesel generators (Ecology 2005, 2006; Hibbard 2003). The revised application for this permit indicates that concentrations of the pollutants for which the PSD analysis was required (nitrogen dioxide and PM) would be below significant levels for Class II areas and nearby Class I areas when the required best-available control technology was applied. The maximum contributions to ambient air concentrations from these sources are shown in Table 3–7 (Ecology 2005; Su-Coker and Curn 2003).

Table 3–7. Maximum Waste Treatment Plant Contributions to Ambient Air Concentrations as Analyzed for the Revised Prevention of Significant Deterioration Permit Application

Emission	Class I Areas	Class II Areas
	(micrograms per cubic meter)	
PM_{10}		
Annual	0.0008	0.11
24-hour	0.058	1.93
Nitrogen Dioxide		
Annual	0.00505	0.61

Key: PM_{10}=particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.
Source: Ecology 2005; Su-Coker and Curn 2003.

As determined in 2004 monitoring conducted off site by the Benton County Clean Air Authority, the maximum and annual average concentrations of PM with an aerodynamic diameter less than or equal to 2.5 micrometers ($PM_{2.5}$) or 10 micrometers (PM_{10}) were below EPA and Washington State standards (Duncan 2007:4.19). Ambient air quality at Hanford is discussed in more detail in the *Hanford Site Environmental Report* (Poston, Duncan, and Dirkes 2011:8.13–8.24). The air operating permit indicates that toxic air pollutants from tank farm activities in the 200 Areas have been demonstrated to be below the acceptable source impact levels and are required to remain below these levels (Ecology 2001, 2006).

Routine monitoring of most nonradioactive pollutants is not conducted at the site. Monitoring of nitrogen oxides and total suspended particulates at Hanford has been discontinued as a result of the phasing out of those programs that required the monitoring. Carbon monoxide, sulfur dioxide, and nitrogen dioxide have been monitored periodically in communities and commercial areas southeast of Hanford (Duncan 2007:4.19). In 1995, moreover, air samples of semivolatile organic compounds were collected on the site and at an offsite location, and results are discussed in the site's annual environmental report. All concentrations of these compounds were below the applicable risk-based concentrations (Dirkes and Hanf 1996:95–108). Continuous monitoring of PM_{10} and $PM_{2.5}$ was initiated at the Hanford Meteorological Station and the 300 Area in 2001. Values reported for PM_{10} exceeded the 24-hour standard value only once during 2005 on a windy day. The PM monitors involved in this effort are not used to determine compliance with ambient standards (Poston et al. 2006:10.26, 10.27). Ambient monitoring of ammonia and other toxic pollutants is not routinely conducted at Hanford.

Continuous monitoring is performed for radioactive airborne emissions from Hanford activities that have the potential to exceed 1 percent of the 10-millirem-per-year standard for offsite doses specified in the "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities" (40 CFR 61, Subpart H) and in the state "Ambient Air Quality Standards and Emission Limits for Radionuclides," subsection "Ambient Standard" (WAC 173-480-040). These emissions are primarily from ventilation stacks in the 100, 200, 300, 400, and 600 Areas. Radioactivity in the ambient air is routinely monitored in the area near Hanford. The radiological monitoring network includes downwind air samplers near the sites and facilities and in distant offsite communities. Monitoring in 2010 consistently detected concentrations of uranium-234 and -238 at most of the locations in the 100 Areas, in the 200-East Area, in the 200-West Area, and within the 300 Area. Occasional detection of other radionuclides varied by area: americium-241 and cesium-137 at the 100 Areas and plutonium-239 and -240 at the 100 Areas and the 200-West Area. Average concentrations in near-facility air samples are compared with those in distant communities in the *Hanford Site Environmental Report* (Poston, Duncan, and Dirkes 2011:8.9, 8.10, 8.16, 8.17).

Radionuclides are also regulated under the Washington State "Radiation Protection Standards" (WAC 246-221), which limit the maximum total effective dose equivalent for any member of the public to 100 millirem per year.

3.2.4.2 200 Areas Description

Prevailing winds in the 200 Areas are from the west-northwest to northwest (Duncan 2007:4.8, 4.9). The 200 Areas emit various nonradioactive air pollutants. The sources of criteria and toxic air pollutant emissions in the 200 Areas include generators; tank farm exhausters; evaporators; boilers; vehicles; and construction, environmental remediation, and waste management activities (Hebdon 2003; Johnson 2006; Wisness 2000). The tank farms in the 200 Areas produced reportable ammonia emissions in 2010 (Poston, Duncan, and Dirkes 2011:8.10). Year 2005 emissions for the 200 Areas are included in the sitewide emissions presented in Table 3–4. Emissions from carbon tetrachloride vapor extraction work in the 200-West Area are included in the toxic pollutant emissions shown. Emissions from tank vents other than ammonia and criteria pollutants are included in the composite toxic air pollutants. These emissions include 1,3-butadiene, 2-hexanone, 2-pentanone, acetone, acetonitrile, benzene, heptane, hexane, methyl amyl ketone, nonane, octane, phosphoric acid tributyl ester, and toluene (DOE and Ecology 1996:G-36–G-38).

The primary sources of radioactive emissions to the air from the 200 Areas are the storage and treatment of radioactive waste. In 2010, emissions from the 200 Areas originated from the PUREX Plant, Waste Encapsulation and Storage Facility, Plutonium Finishing Plant, T Plant, underground storage tanks, WRAP, and waste evaporators (Poston, Duncan, and Dirkes 2011:8.10). Radioactive airborne emissions from the 200 Areas in 2010 are summarized in Table 3–5.

The Hanford Site Air Operating Permit (Ecology 2006) includes emission and reporting requirements for various sources in the 200 Areas, including oil-fired boilers, large internal-combustion engines, tank exhausters, waste retrieval systems, rotary-mode core sampling systems, tank sluicing, emergency fire pump generators, the 200 Area ETF, tank waste retrieval, tank farm ventilation systems, storage of vented waste containers at the CWC, and WRAP.

3.2.4.3 400 Area Description

Prevailing winds in the 400 Area are from the south-southwest, with a secondary maximum from the northwest (Duncan 2007:4.9). The 400 Area emits no nonradioactive air pollutants of regulatory concern. Operations and support activities at FFTF and the Maintenance and Storage Facility release small quantities of radioactive material to the environment (Poston, Duncan, and Dirkes 2011:8.10, 8.11).

3.2.4.4 Borrow Area C Description

Prevailing winds in the area around Borrow Area C are likely from the west-northwest to northwest, although farther to the west, under the influence of Yakima Ridge, they are from the west-southwest (Duncan 2007:4.9). There are currently no quarry activities in Borrow Area C that would produce emissions of air pollutants.

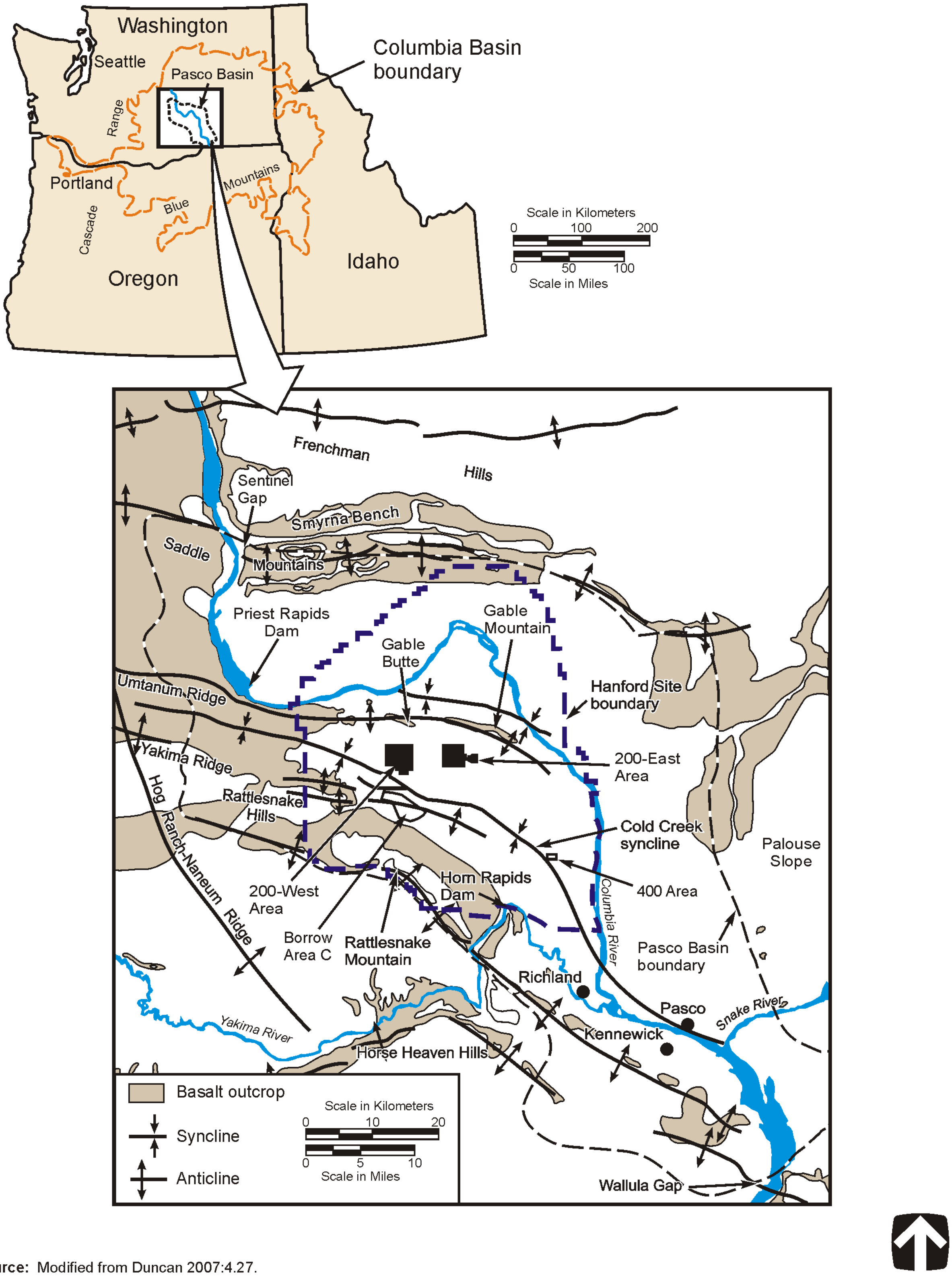
3.2.5 Geology and Soils

The geologic and soil resources of Hanford and the vicinity are described below with respect to regional physiography and geologic structure; site stratigraphy; rock and mineral resources; geologic hazards, including regional seismicity; and soil attributes. The geologic and soil characteristics of the 200 Areas, 400 Area, and Borrow Area C are specifically described.

3.2.5.1 General Site Description

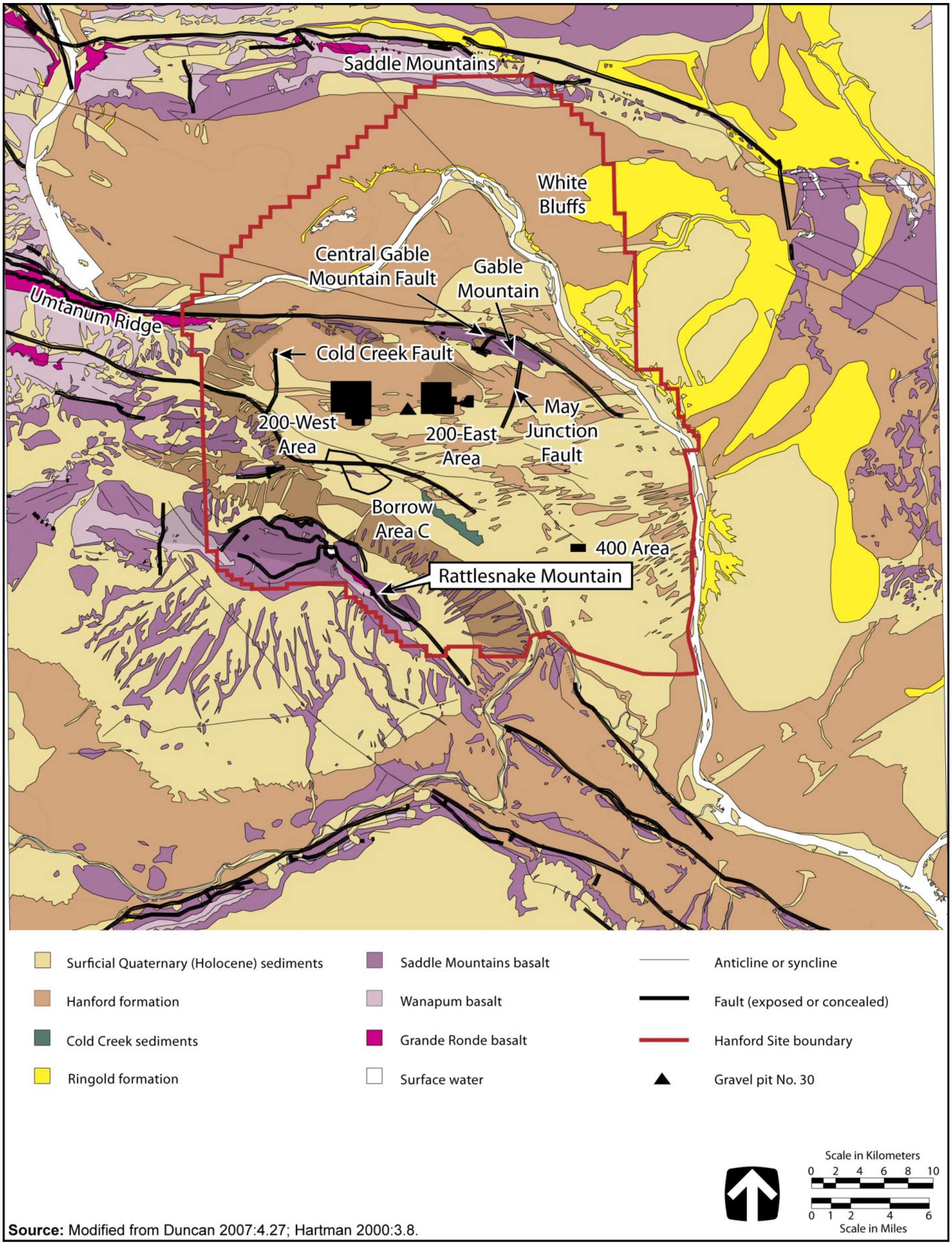
3.2.5.1.1 Physiography and Structural Geology

Hanford lies within the Columbia Basin, which comprises the northern part of the Columbia Plateau physiographic province and the Columbia River flood-basalt geologic province (Duncan 2007:4.25; Reidel et al. 1994:1, 2). Thus, the extent of the Columbia Basin is generally defined as that area underlain by the Columbia River Basalt Group. Within this region, Hanford lies within the Pasco Basin, a structural and topographic depression of generally lower-relief plains and anticlinal ridges (Duncan 2007:4.25, 4.26). Elevations across the central portion of the basin and Hanford range from about 119 meters (390 feet) above mean sea level at the Columbia River to 229 meters (750 feet) above mean sea level across the 200 Areas. The Pasco Basin is bounded on the north by the Saddle Mountains; on the west by Hog Ranch–Naneum Ridge and the eastern extension of Umtanum and Yakima Ridges; on the south by Rattlesnake Mountain and the Rattlesnake Hills; and on the east by the Palouse Slope. Two east-west trending ridges, Gable Butte and Gable Mountain, lie in the central portion of Hanford between the 100 and 200 Areas. These features reflect the eastern extension of Umtanum Ridge into Hanford. Rattlesnake Mountain, the highest of the Rattlesnake Hills, reaches an elevation of 1,060 meters (3,480 feet) above mean sea level, the highest elevation in the area. A geologic fault is typically present on the north side of the folded ridges where the strata fractured as the ridges were folded (see Figures 3–7 and 3–8) (DOE 1999a:4.12, 4.13; Duncan 2007:4.25, 4.26, 4.29, 4.159).



Source: Modified from Duncan 2007:4.27.

Figure 3–7. Physiographic Setting and General Structural Geology of the Pasco Basin and Hanford Site



Source: Modified from Duncan 2007:4.27; Hartman 2000:3.8.

Figure 3–8. Surface Geology and Structural Features of the Pasco Basin and Hanford Site

Several geologic processes, acting over millions of years, have shaped the surface topography of the Columbia Basin and specifically formed the rocks, sediments, and soils found across Hanford. The area was covered with numerous basaltic lava flows (now represented by the Columbia River Basalt Group) between 6 million and 17 million years ago. This was followed by tectonic forces that folded the basalt. In this landscape, the ancestral Columbia River meandered across the area, leaving behind layers of sediment called the Ringold Formation. Beginning as early as 1.8 million years ago and extending through much of the Pleistocene epoch (i.e., until 15,000 years ago), the region was inundated by a series of Ice Age floods that deposited sediments that are informally referred to as the "Hanford formation." During the freezes and thaws that occurred in the Ice Age, an ice dam across the Clark Fork River and glacial Lake Missoula in Montana formed and failed many times, each time releasing a wall of water that surged southwest through the Columbia Basin, inundating the area that is now Hanford. The most recent major glacial flood cycle is thought to have occurred between 15,000 and 30,000 years ago. Fine-grained deposits associated with the last floods commonly contain Mount St. Helens volcanic ash, dated approximately 15,000 years ago (Duncan 2007:4.25, 4.29, 4.30, 4.33, 4.35).

Current interpretations suggest that as many as 40 individual flooding events occurred during the most recent glacial cycle, as ice dams holding back glacial Lake Missoula repeatedly formed and burst. In addition to flood episodes from Lake Missoula, there was also at least one flood from glacial Lake Bonneville in Utah, and possibly floods from other ice-dammed lakes in northern Washington and Idaho. Temporary lakes were created when flood waters were dammed, resulting in the formation of the short-lived glacial Lake Lewis behind Wallula Gap. Evidence for these temporary lakes includes high-water marks inferred from ice-rafted boulders and sediments along the basin margins at elevations between 370 and 385 meters (1,214 to 1,261 feet) above sea level, far above the present Pasco Basin bottom. As the water moved across eastern Washington, it eroded the basalt, forming channels of barren rocky land referred to as the "scablands." At other localities, away from the main flood channels, the water deposited bars of gravel and sand. Branching flood channels, giant current ripples, ice-rafted erratics (i.e., rocks and boulders remaining after the melting of the ice), and giant flood bars are among the landforms created by the floods and readily seen at Hanford (Duncan 2007:4.33; USGS 2002).

Since the end of the Pleistocene epoch, winds have locally reworked the flood sediments, depositing dune sands in the lower elevations and loess (windblown fine sand and silt) around the margins of the Pasco Basin. Anchoring vegetation has stabilized many sand dunes. Active dunes exist north of the 300 Area in the Hanford Reach National Monument. Some dunes were temporarily reactivated by the removal of vegetation resulting from the 24 Command Fire of June–July 2000 (Duncan 2007:4.25, 4.34).

Structurally, Hanford is near the junction of the Yakima Fold Belt and the Palouse Slope. The underlying basalt of the Palouse Slope dips gently toward the central Columbia Basin and exhibits mild structural deformation. A wedge of Columbia River basalt underlies the Palouse Slope (see Figure 3–7) and thins gradually toward the east and north. The Yakima Fold Belt consists of all the generally east-west-trending, long, narrow ridges (anticlines) and intervening valleys (synclines) that arose as tectonic forces buckled and folded the basalt and associated sediments in the western Columbia Basin. The fold belt was growing during the eruption of the Columbia River basalts and continued to grow into the Pleistocene epoch and probably into the present from north-south compression. A fault is typically present on the north side of the ridges where the rock broke as it was folded (Duncan 2007:4.25-4.27, 4.30, 4.35, 4.36).

Mapped faults in the Hanford area include reverse or thrust faults on the north side of the Saddle Mountains on the northern Hanford boundary and in association with Rattlesnake Mountain and the Rattlesnake Hills in the southwestern portion of the site (part of the Rattlesnake-Wallula alignment, which passes along the southwest boundary of Hanford) (see Figure 3–8) (Duncan 2007:4.35, 4.37). Other faults include the Cold Creek Fault, on the west end of the Cold Creek syncline, and the May Junction Fault, located nearly 4.8 kilometers (3 miles) east of the 200-East Area. Moreover, a potential for Quaternary-age (Holocene) faulting has been identified on the Gable Butte–Gable Mountain Segment of the Umtanum Ridge–Gable Mountain anticline—specifically, on Gable Mountain where the Central Gable Mountain Fault has offset sediments 13,000 years old (Reidel et al. 1994:12-14).

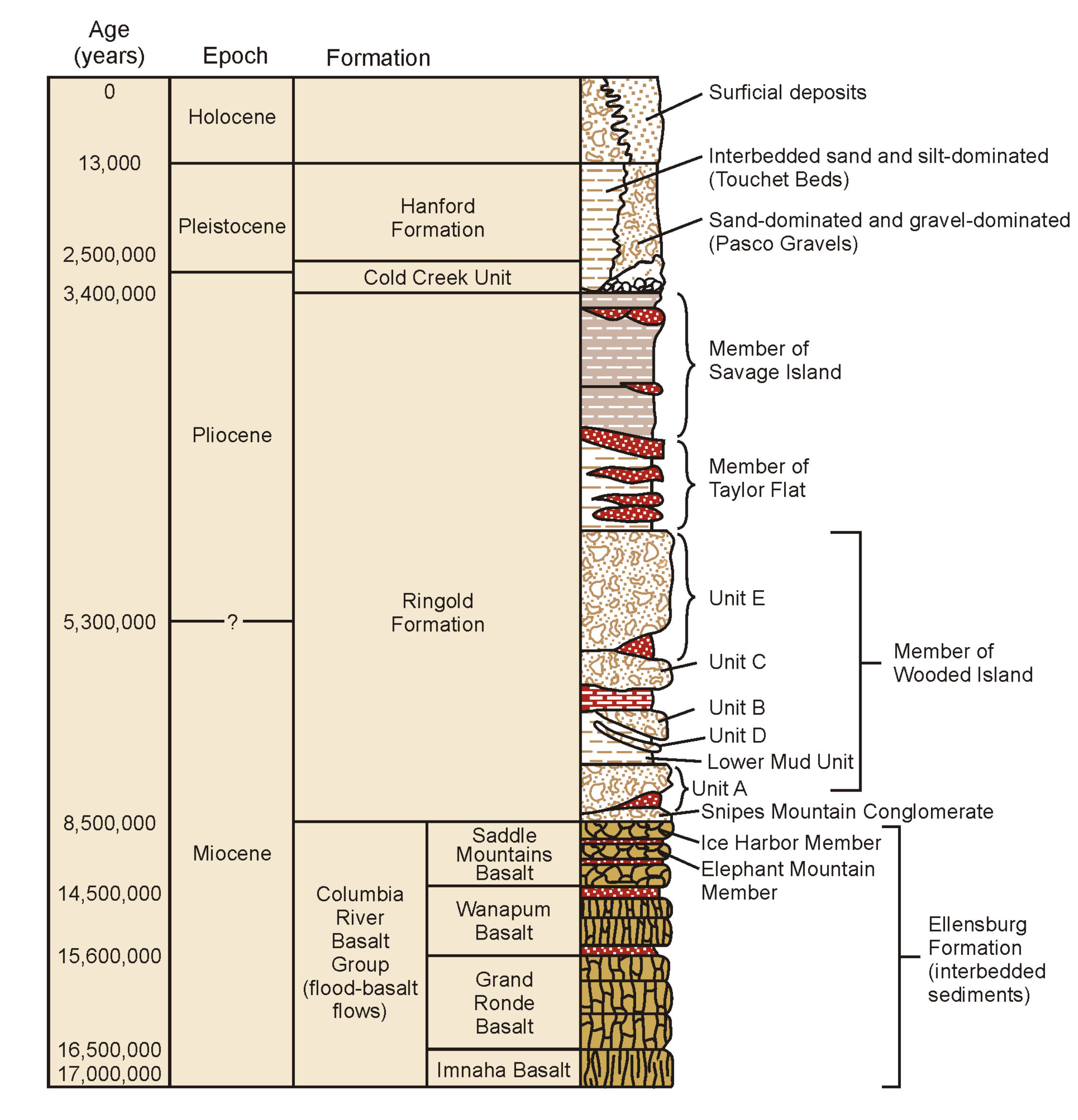
3.2.5.1.2 Stratigraphy

The unconsolidated sediments and rocks beneath Hanford consist of Miocene-age (5 million to 24 million years old) and younger strata that overlie older Cenozoic sedimentary and volcanic basement rocks (DOE 1999a:4-12, 4-16; Duncan 2007:4.26, 4.28). The major geologic units immediately underlying Hanford are, in ascending order, (1) the Columbia River Basalt Group and interbedded Ellensburg Formation and (2) the Ringold Formation, Cold Creek Unit, and Hanford formation, collectively known as the suprabasalt sediments. The surficial occurrence and distribution of these units is shown in Figure 3–8. Figure 3–9 presents a stratigraphic profile of Hanford.

The Columbia River Basalt Group consists of sequences of Miocene-age continental flood basalts that cover an extensive area across Washington, Oregon, and Idaho. These basalts erupted over a period ranging from approximately 6 million to 17 million years ago. Columbia River basalt flows erupted from north-northwest trending fissures or linear vent systems mostly in north-central and northeastern Oregon, eastern Washington, and western Idaho. Beneath Hanford is a minimum of 50 basalt flows with a combined thickness greater than 3,000 meters (9,800 feet). Basalt outcrops are exposed on ridges at Gable Mountain, Gable Butte, and the Saddle Mountains in the northern part of Hanford, and on Rattlesnake Hills and Yakima Ridge on the western and southwestern edges of the site (see Figure 3–7). Basalt flows at Hanford have eroded to various degrees in localized areas. Interbedded with, and in some places overlying the Columbia River Basalt Group, are the volcaniclastic (volcanic-sedimentary) and fluvial (stream-deposited) sedimentary materials of the Ellensburg Formation. In the western Columbia Basin, the Ellensburg Formation is mostly volcaniclastic sediment; in the central and eastern basin, fluvial mainstream and overbank sediments of the ancestral Clearwater-Salmon and Columbia Rivers form the dominant lithologies (Duncan 2007:4.29; Reidel et al. 1994:2-4).

The Ringold Formation consists of a mix of variably cemented gravel, sand, silt, and clay deposited by the ancestral Columbia River system (Duncan 2007:4.31; Hartman 2000:32). Ringold Formation deposits represent an eastward shift of the Columbia River across Hanford. The Columbia River first flowed across the west side of Hanford (where Dry Creek is now), crossing through Rattlesnake Hills. The river eventually shifted to a course that took it through Gable Mountain–Gable Butte Gap (Gable Gap) and south across the present 200-East Area (Hartman 2000:3.2). In summary, about 8.5 million years ago, the river meandered across a gravelly braided plain, depositing the extensive gravel and interbedded sand of the oldest Ringold sediments, Unit A, Member of Wooded Island (see Figure 3–9). Between 5 and 7 million years ago, the Columbia River abandoned the Yakima River water gap (near present-day Benton City) and began to exit the Pasco Basin through Wallula Gap. Around 6.7 million years ago, the Columbia River became a sandy alluvial system, depositing extensive lake and stream overbank sediments known as the Ringold Formation Lower Mud Unit. The Lower Mud Unit was covered by another extensive sequence of mainstream gravels and sands in the central Pasco Basin and fine-grained overbank deposits near the 100 Areas. The most extensive of the coarse sediments, Unit E, Member of Wooded Island, underlies much of the 200 Areas. The Columbia River sediments became more sand-dominated about 5 million years ago when over 90 meters (295 feet) of interbedded fluvial sand and overbank deposits accumulated at Hanford. These deposits are collectively called the Member of Taylor Flat. The fluvial sands of the Member of Taylor Flat dominate the lower cliffs of the White Bluffs but have been subsequently eroded from most of Hanford. The last Ringold unit (Member of Savage Island) was deposited between 3.4 and 4.8 million years ago in the form of lake deposits. A series of three successive lakes are recognized along the White Bluffs and elsewhere along the margin of the Pasco Basin. Then, regional uplift associated with the Cascade Mountains marked a change from sedimental disposition to removal and caused the river to cut through its own earlier deposits (the Ringold

Formation), exposing the White Bluffs (Duncan 2007:4.31). The Ringold Formation at Hanford is as much as 185 meters (607 feet) thick and attains a thickness of about 285 meters (935 feet) along White Bluffs (see Figure 3–8) (Neitzel 2005:4.32; Reidel et al. 1994:3).



Source: Duncan 2007:4.28; Hartman 2000:3.9.

Figure 3–9. Stratigraphic Column of the Hanford Site

The Plio-Pleistocene Cold Creek Unit includes all alluvial and eolian (wind-deposited) sediments, as well as a series of extensively weathered, carbonate-rich, buried soil profiles called paleosols. These sediments and paleosols overlie the Ringold Formation and underlie the Hanford formation in the vicinity of the 200-West Area, and may extend over most of the central Pasco Basin. The Cold Creek Unit, which is also locally prevalent in the subsurface within the Cold Creek syncline, includes deposits referred to in older Hanford literature as the "Plio-Pleistocene Unit" and "pre-Missoula gravels," as well as the 200-West Area's "early Palouse soils" and "caliche layer" (DOE 2002b:3-1, 3-2). Because the Plio-Pleistocene Cold Creek Unit was formed when the Ringold Formation was eroding and relatively little was being deposited, the distribution of the unit depends in part on erosion and weathering of the underlying Ringold Formation and postdepositional erosion by the Ice Age floods. As such, the

Cold Creek Unit is discontinuous, with a thickness ranging from 0 to 20 meters (0 to 66 feet) (Neitzel 2005:4.32). Cold Creek Unit paleosols and small-stream drainages were developing in the 200-West Area while the Columbia River was still eroding the 200-East Area. The paleosols and side-stream sediments, which are referred to as the "Lower Cold Creek Unit," are consequently more numerous and heavily cemented, forming layers known as caliches or hardpans in the 200-West Area. Eolian and minor fine-grained stream sediments were deposited on the Lower Cold Creek Unit, resulting in a wide variety of sediments that are referred to as the "Upper Cold Creek Unit." The thickness and type of sediment are highly variable due to several localized environments. Because of their fine-grained or cemented nature, the Upper and Lower Cold Creek Units play important roles in the movement of water and contaminants through the vadose zone. Cold Creek Unit gravels of mixed lithologies in a sand matrix reflect deposition by the Columbia River as it flowed through Gable Gap. These mainstream gravel deposits, which are informally called the pre-Missoula gravels, immediately overlie the Ringold Formation. They are often difficult to differentiate from similar gravel deposits in the Ringold Formation and Hanford formation (Duncan 2007:4.32, 4.33; Hartman 2000:3.3).

The gravel, sand, and silt deposits composing the strata informally called the Hanford formation are products of Ice Age floods that inundated the Pasco Basin and Hanford during the Pleistocene epoch as previously described in this section. The Hanford formation sediments were left after the floodwater receded and now blanket low-lying areas over most of Hanford. Associated deposits occur in three distinct assemblages, dominated by coarse sand and gravel, sand, and interbedded sand and silt (Duncan 2007:4.33). The sediments range up to boulder size, with the lithofacies (sediment types) grading or interfingering with one another in both the horizontal and vertical directions (DOE 2002b:3-9). The gravel-dominated flood deposits are generally confined to tracts within or adjacent to flood channels and reflect higher-energy depositional environments. A major depositional feature called the Cold Creek bar underlies the 200 Areas at Hanford and was deposited just south of one such channel. Gravel-dominated flood sediments deposited on the north side of the bar grade into sand-dominated sediments on the south side. Gravel- and sand-dominated sediments compose most of the vadose zone beneath Hanford. Coarse- to fine-sand deposits represent a transitional depositional environment between the fluvial gravel-dominated deposits and the interbedded sands and silts. The interbedded sand- and silt-dominated sediments were deposited in low-energy slackwater areas around the margins of the Pasco Basin, and they are rarely encountered during Hanford operations. They specifically consist of rhythmically bedded silt and sand (referred to as "rhythmite deposits") and have been named the "Touchet Beds" at Hanford (see Figure 3–9) (Duncan 2007:4.33; Hartman 2000:3.3).

Clastic dikes are vertical to subvertical tabular structures that crosscut normal sedimentary layers and are usually filled with multiple layers of unconsolidated sediments. They are common in Hanford vadose zone sediments (Duncan 2007:4.34). (See Appendix N, Section N.5.5, for additional information on clastic dikes.)

Surficial Quaternary-age (Holocene) deposits (gravel, sand, and silt), with a total thickness of generally less than 5 meters (16 feet), span much of Hanford. Eolian deposits of fine-grained sand and silt also occur, particularly in the southern part of the 200-East Area and in the 200-West Area (Hartman 2000:3.4). An extensive, stabilized field of sand dunes extends from the southern boundary of the 200-East Area to the south across the 300 Area and east to the Columbia River. An active dune field is located just north of Energy Northwest in Hanford Reach National Monument (DOE 1999a:4-22; Duncan 2007:4.33).

3.2.5.1.3 Rock and Mineral Resources

Geologic resources, including relatively large volumes of gravel, sand, and silt, are available from the suprabasalt sediments and associated soils on Hanford. Basalt is also plentiful. As discussed in the *Environmental Assessment, Use of Existing Borrow Areas, Hanford Site, Richland, Washington*

(DOE 2001b), a number of active gravel and sand pits and two rock quarries at Hanford have been identified for use as a continuing source of borrow materials for new facility construction and the maintenance of existing facilities and transportation corridors, as well as fill and capping material for remediation and other sites. Specifically addressed in the environmental assessment was the provision of an additional 7.6 million cubic meters (10 million cubic yards) of materials over a 10-year period (beginning in fiscal year 2001), including 692,000 cubic meters (905,000 cubic yards) to support WTP project activities.

Of the two designated quarries on the site, Borrow Area C, located due south of the 200-West Area and just south of State Route 240, is described as having large volumes of basalt and sand (DOE 1999a:D-7; 2001b:2-2, 3-1–3-4). Borrow Area C is a 926.3-hectare (2,289-acre) area that would be operated to provide necessary rock riprap (basalt), aggregate (gravel and sand), and soil (silt and loam) to support facility construction and tank closure activities as described in this *TC & WM EIS* (DOE 2003a:5-3, 6-15, 6-21, 6-46, 6-73). This borrow site would be developed using modern open-pit excavation techniques, with excavations averaging 4.6 meters (15 feet) in depth and provision for cut-slope maintenance, haul roads, and stockpile and buffer areas. It is estimated that Borrow Area C could yield 42.6 million cubic meters (55.7 million cubic yards) of borrow material (SAIC 2006b). The other quarry, gravel pit No. 30, located between the 200-East and 200-West Areas, is an approximately 54-hectare (134-acre) borrow site containing a large quantity of aggregate suitable for multiple uses (DOE 2001b:3-4, A-3). Aggregate reserves at pit No. 30 are estimated at 15.3 million cubic meters (20 million cubic yards) of material (DOE 1999a:D-4). This pit continues to provide aggregate (sand and gravel) for onsite concrete batch plants in support of the construction of new facilities, including those at the WTP adjacent to the 200-East Area.

As for other geologic resources on the site, placer gold was historically extracted along the Columbia River on and near Hanford, and small volumes of natural gas were produced from wells developed on Rattlesnake Mountain from about 1929 to 1941 (DOE 1999a:4-18).

3.2.5.1.4 Seismicity and Geologic Hazards

The seismicity of the Columbia Plateau, as determined by the rate of earthquakes per area and the magnitude of these events, is lower than that of other regions in the Pacific Northwest. Nevertheless, Hanford has been affected by earthquakes within and beyond the Columbia Plateau. The largest known earthquake in the Columbia Plateau occurred in 1936 near Milton Freewater, Oregon. This moderate earthquake had a magnitude of 5.75 and a maximum Modified Mercalli Intensity (MMI) of VII, and it featured a number of aftershocks (Duncan 2007:4.43). Appendix F, Table F–7, summarizes and compares the parameters cited in this *TC & WM EIS* to describe earthquakes and their effects. Other moderate-to-major earthquakes with magnitudes greater than 5 or MMIs of VI have occurred along the boundaries of the Columbia Plateau northwest of Hanford and extending into the northern Cascade Range. A strong-to-major earthquake of uncertain location occurred in north-central Washington in 1872. This event had an estimated magnitude of 7.4 and an estimated maximum MMI ranging from VIII to IX (Duncan 2007:4.43; USGS 2003). Evidence of landslides near Lake Chelan, Washington, suggests a location near there. A more recent study of this event indicates a magnitude of 6.8, a maximum MMI of VIII, and a location at the south end of Lake Chelan (Duncan 2007:4.43). Nevertheless, it was reportedly felt over a wide area from British Columbia, Canada, to Oregon and from the Pacific Ocean to Montana. Near Lake Chelan, huge landslides, massive fissures in the ground, and a 9-meter-high (30-foot-high) geyser were reported. Shaking-intensity maps produced for the event indicate that MMI VI shaking extended southeast across the Columbia Plateau and beyond Hanford (USGS 2003).

Major earthquakes have also occurred east of the Columbia Plateau in the Rocky Mountains. These include the 1959 Hebgen Lake earthquake in western Montana, which had a magnitude of 7.5 and an MMI of X, and the 1983 Borah Peak earthquake in central Idaho, which had a magnitude of 7.3 and an

MMI of IX. A number of strong-to-major earthquakes (magnitude 6 to greater than 7) have occurred in western Washington in and around the Puget Sound area in association with the subducting Juan de Fuca tectonic plate. Most recently, a magnitude-6.8 earthquake (termed the "Nisqually earthquake") occurred on February 28, 2001, near Olympia, Washington. It produced ground shaking that reached an MMI of VIII. This event was similar to other events recorded in 1949 and 1965 (Duncan 2007:4.42, 4.43).

The two largest earthquakes near Hanford occurred in 1918 and 1973; each had an approximate magnitude of 4.4 and an MMI of V. They occurred in the central portion of the Columbia Plateau north of Hanford near Othello, Washington (Duncan 2007:4.43). The epicenter of the December 20, 1973, event was instrumentally located approximately 49 kilometers (30 miles) northeast of the 200 Areas. This earthquake occurred at a rather shallow depth of about 1 kilometer (0.6 miles) (USGS 2010a). Earthquakes in eastern Washington generally originate at shallow depths, most at depths of less than 6 kilometers (3.7 miles). The Saddle Mountains region in which the December 20, 1973, earthquake occurred is one of the most active earthquake areas in eastern Washington; earthquakes there tend to occur in clusters or "swarms" (i.e., the earthquakes are concentrated in an area and occur in a series over a short period of time) (Noson, Qamar, and Thorsen 1988). Earthquake swarms have also occurred in several locations within Hanford. Deeper earthquakes in the central Columbia Plateau occur up to depths of about 30 kilometers (18.6 miles). These deeper earthquakes are less clustered and generally occur as isolated events. Survey data indicate that the shallow earthquake swarms are occurring in the Columbia River Basalts and the deeper earthquakes in deeper, crustal layers (Duncan 2007:4.43, 4.45). A total of 126 small earthquakes (generally ranging in magnitude from 2.5 to 4.3) have been recorded within a radius of 100 kilometers (62 miles) of the Central Plateau of Hanford (200 Areas) since the December 1973 earthquake. The closest of these was a magnitude-3.3 event on November 13, 1994; it had an epicenter about 4 kilometers (2.5 miles) north of the 200 Areas (USGS 2010a).

As part of the operating license review for Energy Northwest, the U.S. Nuclear Regulatory Commission (NRC) concluded that four Hanford earthquake sources should be considered for seismic design: the Rattlesnake-Wallula alignment, Gable Mountain, a "floating" earthquake in the tectonic province, and a swarm area. The NRC estimated a maximum earthquake magnitude of 6.5 for the Rattlesnake-Wallula alignment and 5.0 for Gable Mountain. The floating-earthquake design criterion was developed from the largest event located in the Columbia Plateau, the magnitude-5.75 Milton-Freewater earthquake. The maximum-swarm earthquake for the purposes of seismic design was a magnitude-4.0 event based on the December 1973 earthquake (Duncan 2007:4.45, 4.46).

Earthquake-produced ground motion is expressed in units of percent *g* (force of acceleration relative to that of the Earth's gravity). Two differing measures of this motion are peak horizontal (ground) acceleration and response spectral acceleration. Seismic hazard metrics and maps developed by the U.S. Geological Survey (USGS) and adapted for use in the *International Building Code* depict maximum considered earthquake ground motions of 0.2- and 1.0-second spectral accelerations based on a 2 percent probability of exceedance in 50 years. This corresponds to an annual probability (chance) of occurrence of about 1 in 2,500. Appendix F, Section F.5.2, of this *TC & WM EIS* provides a more detailed explanation of these map parameters and their use. For the 200 Areas, the calculated maximum considered earthquake ground motion is approximately 0.41 *g* for a 0.2-second spectral acceleration and 0.15 *g* for a 1.0-second spectral acceleration. The calculated peak ground acceleration for the given probability of exceedance at the site is approximately 0.18 *g* (USGS 2008). For comparison, the aforementioned 2001 Nisqually earthquake produced peak horizontal (ground) accelerations ranging from 0.0016 to 0.0055 *g*, as measured across Hanford (Duncan 2007:4.43). The USGS earthquake ground motion values are cited to provide the reader with a general understanding of seismic hazard. However, for the design of moderate- or high-hazard nuclear facilities, DOE prescribes seismic criteria that are more rigorous and thus provide a greater margin of safety than the values cited here (see Appendix F, Section F.5.2).

Probabilistic seismic hazard analyses are used to determine ground motions expected from multiple earthquake sources, which are then used to design or evaluate facilities at Hanford. On the basis of the most recent site-specific seismic analyses, it is estimated that an earthquake producing a horizontal (ground) acceleration of 0.10 *g* at Hanford would be experienced on average every 500 years (annual probability of occurrence of 1 in 500). An earthquake producing a peak horizontal (ground) acceleration of 0.2 *g* is calculated to have an annual probability of occurrence of 1 in 2,500, which is in approximate agreement with the national seismic hazard maps produced by USGS (Duncan 2007:4.46). As stated in DOE Order 420.1B, Change 1, DOE requires nuclear and nonnuclear facilities to be designed, constructed, and operated so that the public, workers, and environment are protected from adverse impacts of natural phenomena hazards, including earthquakes. A site-specific ground response model developed for the WTP being constructed at Hanford stipulated increased ground motions for the design basis of this facility by up to 40 percent to be more conservative (Duncan 2007:4.46).

Several major volcanoes are in the Cascade Range west of Hanford, including Mount Adams and Mount St. Helens, 165 kilometers (102 miles) and 220 kilometers (137 miles), respectively, from the site. Ashfalls from at least three Cascade volcanoes have blanketed the central Columbia Plateau since the late Pleistocene epoch. Generally, ashfall layers have not exceeded more than a few centimeters (less than 1.5 inches) in thickness, except for the Mount Mazama (Crater Lake, Oregon) eruption, when as much as 10 centimeters (3.9 inches) of ash fell over eastern Washington (Barghusen and Feit 1995:2.2–2.14).

Slope failure is also a potential concern at Hanford, although only the slopes of Gable Mountain and White Bluffs are steep enough to warrant landslide concern. White Bluffs, east of the Columbia River, poses the greatest concern. This risk is in part attributable to the largely unconsolidated and uncemented nature of the Ringold sediments composing much of the bluffs, the discharge of irrigation water atop the bluffs and subsequent percolation thereof through the sediments, and the general dip of the sediments toward the Columbia River (DOE 1999a:4-18, 4-21; Duncan 2007:4.39, 4.40).

3.2.5.1.5 Soils

Fifteen different soil types occur at Hanford. These soils vary from sand to silty and sandy loam. The dominant soil types are Quincy (Rupert) sand, Burbank loamy sand, Ephrata sandy loam, and Warden silt loam (Duncan 2007:4.39, 4.40). No soils at Hanford are currently classified as prime or unique farmland soils because there are no current soil surveys, and the only prime or unique farmland soils in the region are irrigated (DOE 1999a:4-23, 4-24). The parent material for the predominant soil types at Hanford includes Hanford formation and Holocene-age surficial deposits, as discussed Section 3.2.5.1.2. Quincy (Rupert) sand is the most widespread soil type at Hanford and makes up much of the southeast and east-central portions of the site. However, it is also found across portions of the 200-East Area and the majority of the western portion of the 200-West Area. It developed from sandy alluvial deposits mantled by windblown sand. The soils are deep to moderately deep—51 to 76 centimeters (20 to 30 inches). Burbank loamy sand occurs mainly north of the 200 Areas and south of the Columbia River, along with Ephrata sandy loam. The Burbank soil is moderately deep overall, but grades to a gravelly subsoil. The surface soil may be up to 76 centimeters (30 inches) thick, with the subsoil containing up to 80 percent gravel. While this soil intermingles with Quincy (Rupert) sand and Ephrata sandy loam in the 200-East Area, it composes the balance (eastern portion) of the 200-West Area. Warden silt loam occurs in a broad band in the south and southwestern portions of the site, running from the south boundary of the site and downslope of Rattlesnake Mountain (DOE 1999a:4-23–4-27; Duncan 2007:4.40–4.42).

3.2.5.2 200 Areas Description

The Central Gable Mountain Fault is the nearest potentially active fault to the 200 Areas; it is 4 kilometers (2.5 miles) northeast of the 200-East Area (see Figure 3–8). The geology of the 200-West Area is notably different from that of the 200-East Area, despite the fact that they are separated by a distance of only 6.4 kilometers (4 miles). The 200-West Area has one of the most complete suprabasalt stratigraphic sections on Hanford, including the Cold Creek Unit, with a stratigraphic thickness of up to 168 meters (550 feet) (Hartman 2000:3.11).

The Hanford formation is the main geologic unit at the surface for both the 200-East Area and 200-West Area. The Hanford formation is thickest in the vicinity of the 200-East Area, where it is over 100 meters (330 feet) thick. Gravel-dominated sediments make up most of the Hanford formation in the northern part of the 200-East Area and across the 200-West Area. Also in the northern part of the 200-East Area, the Hanford formation generally rests directly on basalt, and an erosional window through the Elephant Mountain Member is suspected near the northeast corner of the 200-East Area. Regardless, gravel-dominated Hanford sediments were deposited by high-energy water in or immediately adjacent to the main cataclysmic flood channels. The sand-dominated sediments are most common in the central to southern parts of the 200 Areas and were deposited adjacent to the main flood channels during the waning stages of flooding. Finer rhythmite deposits (also called Touchet Beds) are primarily found south and west of the 200 Areas (Duncan 2007:4.38, 4.39).

The Cold Creek Unit in the 200-East Area may be represented by the mainstream pre-Missoula gravels. Beneath some of the 200-East Area tank farms, two suspected Cold Creek Unit sediment types have been encountered between the Hanford formation and underlying Columbia River Basalt that include fine-grained silt up to 10 meters (33 feet) thick and sandy gravel to gravelly sand. Beneath the 200-West Area, the Cold Creek Unit overlies the tilted and eroded Ringold Formation where both the lower and upper portions of the unit have been identified. The Lower Cold Creek Unit mainly consists of basaltic to quartzitic gravels, sands, silt, and clay that are cemented with one or more layers of calcium carbonate and other assemblages. The Upper Cold Creek Unit primarily consists of a distinctive silt-rich interval representing eolian deposits in the 200-West Area. Locally, interbedded layers of fine sand and silt, more characteristic of stream deposits, are found with the eolian deposits. The silt-dominated deposits can be correlated across most of the 200-West Area (Duncan 2007:4.38, 4.39).

Sediments of the Ringold Formation are generally not present across much of the northern part of the 200-East Area, while some units are present in the southern part. The Lower Mud Unit is present under much of Hanford and is a nearly continuous feature beneath the 200-West Area and the southern half of the 200-East Area. The Lower Mud Unit consists primarily of lake bed silt and clay deposits, with at least one well-developed paleosol at the top of the sequence in the 200-West Area. Where present, the Lower Mud Unit forms the base of the unconfined aquifer at Hanford and acts as an aquitard, separating groundwater in the underlying Ringold Unit A from the unconfined aquifer (Duncan 2007:4.31, 4.38).

Unit E of the Member of Wooded Island is by far the thickest of the Ringold Formation units present beneath the 200 Areas and consists of well-rounded gravel in a sand and silt matrix. Erosion by the Columbia River during Cold Creek Unit deposition and flooding during Hanford formation deposition have removed Unit E from most of the northeastern part of the 200-East Area. The Ringold Formation Member of Taylor Flat consists of a sequence of fluvial sands and overbank deposits. Erosional remnants of the Member of Taylor Flat are found beneath parts of the 200-West Area, but it has been eroded from beneath all of the 200-East Area (Duncan 2007:4.38). As described in Section 3.2.5.1.5, the predominant soil types across the 200 Areas developed from the surficial sediments are Quincy (Rupert) sand and Burbank loamy sand.

3.2.5.3 400 Area Description

The nearest potentially active fault to the 400 Area (Central Gable Mountain Fault) is 19 kilometers (12 miles) away (see Figure 3–8). Surficial stratigraphy in the 400 Area consists of sand-dominated sediments of the Hanford formation, which attain a thickness of about 37 to 55 meters (120 to 180 feet) beneath the area. These glaciofluvial sediments are specifically composed of poorly graded, fine-to-medium, dense sands that are locally silty and gravelly. The sands grade downward to dense gravelly sands. Reworked gravelly sands and the sandy gravel of the Ringold Formation immediately underlie the Hanford formation sediments, which transition into silty sand, silts, and clays. Ringold Formation sediments extend to a depth of 181 meters (594 feet) beneath the 400 Area, where they contact the Elephant Mountain Member of the Saddle Mountain Basalt Formation. Eolian deposits overlie the Hanford formation sediments across the 400 Area. These deposits consist of 1.5 to 4.6 meters (5 to 15 feet) of fine-to-medium sand dunes that have been stabilized by sagebrush and grasses (WHC 1992:30–33). The predominant soil type in the 400 Area is Quincy (Rupert) sand (DOE 1999a:4.25; Duncan 2007:4.40).

3.2.5.4 Borrow Area C Description

The surficial geology of Borrow Area C is mainly dominated by the gravelly, sandy, and silty Quaternary-age sediments that cover much of the southern half of Hanford. The deposits also include even younger alluvium deposited by the Cold Creek drainage that traverses Borrow Area C. Pockets of older Hanford formation sediments and of Saddle Mountain Basalt also occur at the surface, and at depth, across the area (see Figure 3–8). This assemblage of fine- to coarse-grained sediments and basalt provides a wide range of borrow materials for multiple uses as described in Section 3.2.5.1.3. Mapped soils across Borrow Area C mainly include the Hezel sand interlaced with Esquatzel silt loam. Hezel sand is similar to Quincy (Rupert) sand. Hezel sand soils developed in wind-blown sands that mantled lake-laid sediment. Esquatzel silt loam is a deep soil that formed in recent alluvium derived from loess and lake sediment (Duncan 2007:4.40–4.42).

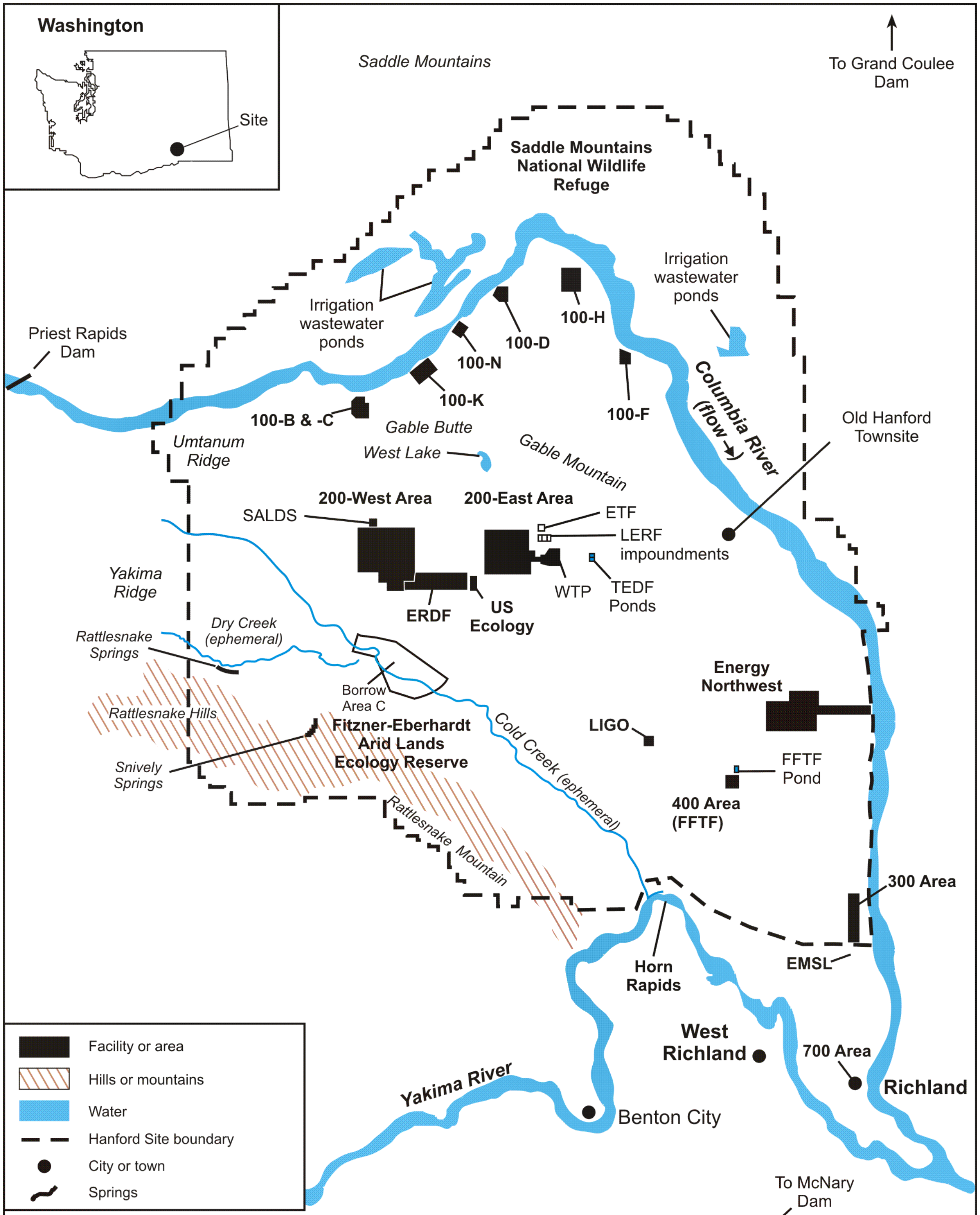
3.2.6 Water Resources

Water resources include all forms of surface water and groundwater, as well as the content of the so-called vadose zone. Surface water is defined as all water bodies that occur above the ground surface, including rivers, streams, lakes, and ponds, and other features. The vadose zone is the unsaturated or partially saturated region between the ground surface and the groundwater-saturated zone (the top of the water table). Groundwater refers to water within the saturated zone—i.e., water that, as at Hanford, typically originates as natural recharge from rain and snowmelt or artificially as recharge from activities such as irrigation, industrial processing, and wastewater disposal, and water destined to return to the surface through discharge to springs and seepage into rivers and streams, evaporation from shallow water table areas, or human activity involving wells or excavations.

3.2.6.1 Surface Water

3.2.6.1.1 General Site Description

Major surface-water features at Hanford include the Columbia River; Columbia riverbank seepage; springs; and ponds, including those constructed for effluent management (see Figure 3–10). In addition, the Yakima River flows along a short section of the southern boundary of the site. The Columbia River is the second-largest river in the contiguous United States in terms of total flow and the dominant surface-water feature on the site. Flow of the Columbia River is regulated by several dams, seven upstream and four downstream from the site. The nearest dam upstream from Hanford is the Priest Rapids Dam, and the nearest one downstream is the McNary Dam (Duncan 2007:4.49).



Key: EMSL=Environmental and Molecular Sciences Laboratory; ERDF=Environmental Restoration Disposal Facility; ETF=Effluent Treatment Facility; FFTF=Fast Flux Test Facility; LERF=Liquid Effluent Retention Facility; LIGO=Laser Interferometer Gravitational-Wave Observatory; SALDS=State-Approved Land Disposal Site; TEDF=Treated Effluent Disposal Facility; WTP=Waste Treatment Plant.

Sources: DOE 2000a:3-99; Duncan 2007:4.50, 4.65.

Figure 3–10. Major Surface-Water Features on the Hanford Site

The 82-kilometer (51-mile) Hanford Reach, which is the last free-flowing, nontidal section of the river in the United States, extends from the Priest Rapids Dam to the upstream edge of Lake Wallula behind the McNary Dam. Because the flows are regulated, flow rates in the Hanford Reach can vary considerably. Columbia River flow rates near the Priest Rapids Dam during the 90-year period from 1917 to 2007 averaged nearly 3,330 cubic meters (117,600 cubic feet) per second; however, daily average flows during this period ranged from 570 to 19,500 cubic meters (20,100 to 689,000 cubic feet) per second (Duncan 2007:4.49, 4.51). In 2010, the Columbia River had below-normal flows; the average daily flow rate downstream of Priest Rapids Dam was 2,670 cubic meters (94,200 cubic feet) per second. Columbia River flows typically peak from April through June during spring runoff from snowmelt and are lowest from September through October. As a result of daily fluctuations in discharges from the Priest Rapids Dam, the depth of the river varies widely over a short time period, with stage changes of up to 3 meters (10 feet) during a 24-hour period along the Hanford Reach. The width of the river varies from approximately 300 to 1,000 meters (980 to 3,300 feet) along the Hanford Reach. This variation also occurs with changes in flow rate, which cause repeated wetting and drying of an area along the shoreline (Duncan 2007:4.51; Poston, Duncan, and Dirkes 2011:8.27–8.29).

Primary uses of the Columbia River include hydroelectric power generation, irrigation of crops in the Columbia Basin, and materials transport by barge. The Hanford Reach is the upstream navigable limit of barge traffic. Barges are used to transport reactor vessels from decommissioned nuclear vessels to Hanford for disposal. The Columbia River is also used extensively for recreation, including fishing, hunting, boating, sailboarding, water skiing, diving, and swimming. In addition to its use as a water supply source for Hanford, the river is a source of drinking water for several communities (Duncan 2007:4.52).

Ecology has designated that segment of the Columbia River extending from the Grand Coulee Dam to the Washington Oregon border, and encompassing the Hanford Reach, for the following uses: salmon and trout spawning and rearing; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting, commerce, and navigation; boating; and aesthetic values (WAC 173-201A).

No federally designated wild and scenic rivers exist in the Hanford vicinity. In 1996, the National Park Service proposed designation of the Hanford Reach as a "recreational river" under the National Wild and Scenic Rivers System as part of broader resource conservation initiatives (DOE 1999a:4-5). The Hanford Reach was proclaimed a national monument in 2000 (see Section 3.2.1.1.1). Creation of the national monument did not convey with it full protection of the river's eligibility as a wild and scenic river. Section 404 of the Omnibus Parks and Public Lands Management Act of 1996 (P.L. 104-333) amended the original study legislation (P.L. 100-605) to mandate that no Federal agency may construct any dam, channel, or navigation project. Under the Wild and Scenic Rivers Act and U.S. Department of the Interior practices, USFWS manages the river as if it were a wild and scenic river and will take no actions that would change its status. This protection only partially extends to other Federal agencies. Those agencies are obliged to take all reasonable care to protect the river's free flow and "outstandingly remarkable resources" as defined by the Wild and Scenic Rivers Act, but they are not obliged to forego projects if no reasonable alternative exists (USFWS 2008:3-2012).

DOE continues to assert a federally reserved water withdrawal right for the Columbia River (DOE 1999a:4-49, 4-50). In fiscal year 2006, total sitewide water consumption was about 817 million liters (215.7 million gallons). Ten of the 11 DOE-owned, contractor-operated water treatment and distribution systems, as well as the City of Richland system that serves the 300 Area, use water pumped from the Columbia River. The 400 Area continued to use a groundwater supply well in 2009 (see Section 3.2.2.4).

Rattlesnake Springs and Snively Springs are in the western portion of the site and flow into intermittent streams that infiltrate rapidly into the surface sediments (see Figure 3–10). Water discharged from Rattlesnake Springs flows down Dry Creek, a tributary to Cold Creek, for about 3 kilometers (1.9 miles) before infiltrating into the ground. An alkaline spring has been documented at the east end of Umtanum Ridge. Several springs are also found on the slopes of Rattlesnake Mountain along the western and southwestern edges of the site. The seepage of groundwater into the Columbia River was documented along the Hanford Reach long before Hanford operations began. This seepage occurs both below the river surface and on the exposed riverbank. Seepage flows are rather small and intermittent, influenced primarily by changes in the river level. Contaminants originating at Hanford have been documented in some of these discharges along the Hanford Reach (DOE 1999a:4-29–4-32; Duncan 2007:4.55, 4:56).

Other naturally occurring surface-water features at Hanford include West Lake and, in three clusters, approximately 20 vernal ponds or pools. The clusters are located on the eastern end of Umtanum Ridge, in the central part of Gable Butte, and at the eastern end of Gable Mountain. The ponds appear to form during the wetter winter periods in shallow depressions underlain by a layer of basalt (DOE 1999a:4-31, 4-32; Duncan 2007:4.64).

West Lake is a natural pond located north of the 200 Areas that is sustained by limited groundwater discharge in a topographic depression. Historically, the lake benefited from an artificially elevated water table beneath much of Hanford attributable to waste management activities in the 200 Areas. With the cessation of production activities at Hanford, the amount of water discharged to the ground in the 200 Area plateau has substantially decreased. Accordingly, over the past 10 years, West Lake has decreased in size to the point that it currently consists of a group of small isolated pools and mudflats. Artificial ponds primarily associated with waste management activities also exist on the site. These include two Treated Effluent Disposal Facility (TEDF) disposal ponds, three Liquid Effluent Retention Facility (LERF) impoundments adjacent to the 200-East Area, and the FFTF Ponds in the 400 Area that are used by FFTF and other facilities (see Figure 3–10) (Duncan 2007:4.50, 4.64; Poston, Duncan, and Dirkes 2011:6.23, 6.24, 8.40). In addition, there are irrigation ponds and wetlands in the northwest portion of the site and north of the Columbia River (Duncan 2007:4.50, 4.73).

Hanford has one EPA-issued National Pollutant Discharge Elimination System (NPDES) Permit—No. WA-002591-7. This permit covers two active outfalls in the 100-K Area. CH2M HILL Plateau Remediation Company is the holder of this permit. The outfall for the 300 Area TEDF was removed from the permit during 2009 because the facility was shut down (Poston, Duncan, and Dirkes 2011:5.25, D.2). CH2M HILL Plateau Remediation Company held an NPDES Construction General Permit in early 2010 that began on June 3, 2009. This permit established the terms and conditions under which stormwater discharges associated with construction activity were authorized. CH2M HILL Plateau Remediation Company filed a notice of termination for its coverage under this permit on March 18, 2010. Discharges from the TEDF Ponds, ETF, and LERF in the 200-East Area; the FFTF Ponds; the 100-N Area sewage lagoon; and consolidated industrial activities are covered by state waste discharge permits issued by Ecology. Ecology-issued NPDES general permits for mining activities are also in place, including a General Sand and Gravel permit for operation of the Concrete Batch Plant and for gravel pit No. 30, located between the 200-East and 200-West Areas. There were four permit violations during 2010. Numerous sanitary waste discharges to the ground from sanitary systems serving facility personnel in the 100 and 200 Areas are permitted by the Washington State Department of Health. Sanitary waste discharges from the 400 Area are conveyed to Energy Northwest's treatment facility. Sanitary waste from the 300 Area and from other facilities in and north of Richland discharges to the City of Richland wastewater treatment facility. Wastewater from the Environmental Molecular Sciences Laboratory, located in the Richland North Area, also discharges to the city's wastewater treatment facility under pretreatment permit No. CR-IU005. This permit was most recently reissued in 2001 (Poston, Duncan, and Dirkes 2011:5.25, 5.26, D.2).

During 2010, Columbia River samples were collected and analyzed to compile data on radiological, chemical, and physical water quality parameters. Water samples were collected from fixed monitoring stations at the Priest Rapids Dam and Richland, Washington, and from cross-river transects and nearshore locations. Samples were also collected upstream from Hanford facilities at the Priest Rapids Dam and the Vernita Bridge to provide background data from locations unaffected by site operations, as well as from other locations to identify any increase in contaminant concentrations attributable to such operations. During the 2010 study, tritium, uranium-234 and -238, and naturally occurring beryllium-7 and potassium-40 were consistently measured in river water at levels greater than their reported minimum detectable concentrations. Concentrations of all other radionuclides were typically below the minimum detectable concentrations. Most of these radionuclides derive from worldwide fallout from historical nuclear weapons testing and effluent from Hanford facilities. Tritium and uranium occur naturally in the environment, in addition to being present in Hanford effluent. Nevertheless, all radioactive contaminant concentrations measured in the Columbia River in 2010 were lower than applicable DOE-derived concentration guides for ingested water (DOE Order 458.1, Change 2) and Washington State ambient surface-water-quality criteria. During 2010, there was no indication of any deterioration of Columbia River water or sediment quality resulting from operations at Hanford (Poston, Duncan, and Dirkes 2011:xv, 8.32, 8.37, C.9–C.12).

DOE also conducts sampling of groundwater seeps (also referred to as "riverbank springs") along the Columbia River nearshore during periods of low flow. Water samples were collected from eight shoreline spring areas in 2010. The majority of samples were analyzed for gamma-emitting radionuclides, gross alpha and gross beta concentrations, and tritium. Samples from selected springs were analyzed for strontium-90; technetium-99; and uranium-234, -235, and -238. Most samples were also analyzed for metals and anions, and selected samples for volatile organic compounds as well. Contaminants of Hanford origin continued to be detected in water from shoreline springs entering the Columbia River in 2010; included were gross alpha; gross beta; tritium; strontium-90; technetium-99; and uranium-234, -235, and -238. Concentrations of radionuclides in shoreline springwater have varied over the years with changes in the degree of river water and groundwater mixing (i.e., the bank storage effect). All radioactive contaminant concentrations measured in riverbank springs in 2010 were lower than the applicable DOE-derived concentration guides, although other exceedances were observed. Gross alpha activity exceeded the ambient surface-water quality and EPA maximum contaminant level (MCL) of 8.2 picocuries per liter in riverbank springwater at the 300 Area, with a maximum value of 86 ± 11 picocuries per liter. Total uranium levels exceeded the EPA primary drinking water standard of 30 micrograms per liter (equivalent to 27 picocuries per liter) in 300 Area springwater, with a maximum total uranium concentration of 107 ± 10.6 micrograms per liter (71 ± 10 picocuries per liter). This chemical toxicity standard, which became effective December 8, 2003, is deemed more protective of human health than the radiation dose standard (65 FR 76708). Elevated uranium concentrations exist in the unconfined aquifer beneath the 300 Area as a result of past Hanford operations. The gross alpha and gross beta concentrations observed in 300 Area riverbank springwater parallel those of uranium and are likely associated with its presence. In 2010, the maximum observed tritium concentration was $37{,}000 \pm 7{,}200$ picocuries per liter at the Old Hanford Townsite riverbank spring as compared with the ambient surface-water-quality criterion of 20,000 picocuries per liter (Poston, Duncan, and Dirkes 2011:8.46–8.50, D.6).

Concentrations of almost all nonradioactive contaminants measured in riverbank springs on the Hanford shoreline from 2005 through 2010 were below the applicable Washington State ambient surface-water-quality criteria. The only exception was chromium, whose concentrations in springwater in the 100-B, -K, -N, -D, -H, and -F Areas were above state ambient surface-water acute-toxicity levels. Volatile organic compounds were near or below detection limits for most samples (Poston, Duncan, and Dirkes 2011:8.50).

West Lake and the FFTF Ponds were sampled periodically during 2010 for water quality. The ponds remained inaccessible to the public and, therefore, did not constitute a direct offsite environmental impact during 2010. However, they were accessible to migratory waterfowl and deer, creating a potential biological pathway for the dispersion of contaminants, and they are near facilities undergoing remediation. Grab samples were collected quarterly from the FFTF Ponds (water) and from West Lake (water and sediment). All water samples were analyzed for tritium. Water samples from the FFTF Ponds were also analyzed for gross alpha and gross beta concentrations, as well as gamma-emitting radionuclides. All radionuclide concentrations in onsite pond water samples were lower than applicable values in the DOE-derived concentration guides (DOE Order 458.1, Change 2) and the Washington State ambient surface-water-quality criteria. The median tritium concentration in FFTF Pond water during 2010 was 33 percent of the Washington State ambient surface-water-quality criterion of 20,000 picocuries per liter. The sources of contaminants in the pond water are groundwater contaminant plumes from the 200 Areas that have migrated to water supply wells near the 400 Area. Tritium concentrations in West Lake water during 2010 were similar to those observed in the past. All results for 2010 were below the laboratory-reported detection limits (Poston, Duncan, and Dirkes 2011:8.40–8.42).

Flooding of the site has occurred along the Columbia River, but the likelihood of a recurrence of large-scale flooding has been greatly reduced by the upstream construction of several flood control/water storage dams. Major floods are typically due to melting of the winter snowpack combined with above-normal precipitation. No maps of flood-prone areas have been produced by the Federal Emergency Management Agency, as these maps are produced only for areas that could be developed and are not under Federal control. However, analyses have been completed to determine the potential for the probable maximum flood. This is determined through hydrologic factors such as precipitation within the drainage basin, snowmelt, and tributary conditions. The probable maximum flood for the Columbia River below the Priest Rapids Dam has been calculated at 40,000 cubic meters (1.4 million cubic feet) per second, which is greater than the 500-year flood (DOE 1999a:4-34; Duncan 2007:4.58). The extents of the 1894 and 1948 floods and of the probable maximum flood are shown in Figure 3–11.

In addition, potential dam failures on the Columbia River have been evaluated by the U.S. Army Corps of Engineers. A number of hypothetical scenarios were evaluated, including the destruction of 25 percent and 50 percent of the center section of Grand Coulee Dam by explosives. The 50 percent breach scenario, which was believed to represent the largest realistically conceivable flow resulting from either a natural or manmade breach, would result in a discharge rate of 600,000 cubic meters (21 million cubic feet) per second. In addition to the areas of Hanford that would be inundated by the probable maximum flood, as illustrated in Figure 3–11, the remainder of the 100 Areas, the 300 Area, and nearly all of the city of Richland, Washington, would be flooded. However, the 200 Areas and the 400 Area would be above the resulting flood level (Duncan 2007:4.62).

3.2.6.1.2 200 Areas Description

The 200 Areas are located in the Central Plateau of Hanford approximately 10 kilometers (6.2 miles) southeast of the Columbia River. Neither the 200-East nor 200-West Area lies within the probable maximum flood area of the Columbia or Yakima River (see Figure 3–11). However, the southwest corner of the 200-West Area is within the probable maximum flood area of Cold Creek. This portion of the 200-West Area is largely undeveloped, and the 200-West Area tank farms are east of the delineated probable maximum flood area boundary.

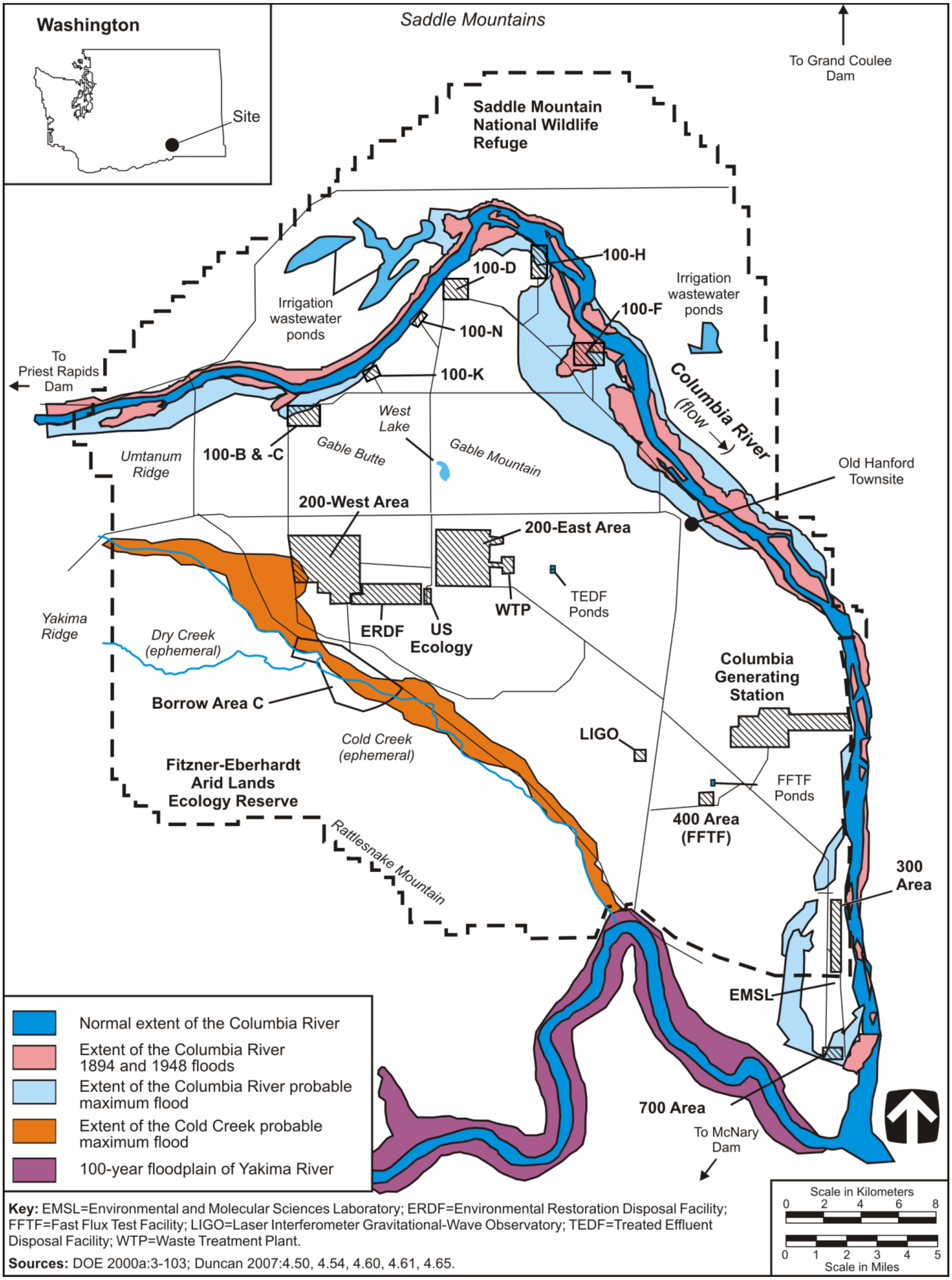


Figure 3–11. Floodplains on the Hanford Site

West Lake, located north of the 200-East Area, is a natural feature recharged from groundwater. The lake has not received direct effluent discharges from Hanford facilities; rather, its existence is attributable to intersection of the elevated water table with the land surface in the topographically low area. West Lake water levels fluctuate with water table elevation, which is influenced by wastewater discharge in the 200 Areas. The water level and size of the lake have been decreasing over the past several years because of reduced wastewater discharge (Duncan 2007:4.64). The 200 Area TEDF consists of two disposal ponds from which wastewater percolates into the subsurface. These ponds, each 2 hectares (5 acres) in size, receive industrial wastewater under Ecology-issued State Waste Discharge Permit No. ST-4502, issued in accordance with WAC 173-216. The 200 Area TEDF received 1,170 million liters (310 million gallons) of unregulated effluent for disposal in 2010. The major source of this effluent was uncontaminated cooling water and steam condensate from the 242-A Evaporator with a variety of other uncontaminated waste streams from other Hanford facilities. Sanitary wastewater in the 200 Areas is primarily treated in a series of onsite sewage systems (Poston, Duncan, and Dirkes 2011:6.24, 6.25, D.2).

Water for the 200 Areas is provided by the 283-W Water Treatment Plant (see Section 3.2.2.4.2). The water source for this filtration and chlorination plant is the Columbia River.

3.2.6.1.3 400 Area Description

The 400 Area is 6.3 kilometers (3.9 miles) from the west bank of the Columbia River. No specific flooding analyses have been completed for the 400 Area, but analyses have been completed for the site as a whole. According to the sitewide data, the elevation of the ground surface in the 400 Area is higher than that of the probable maximum flood of the Columbia River. It is also higher than the elevations of the maximum historical floods of 1894 and 1948 (see Figure 3–11) (DOE 2000a:3-105).

The only surface-water bodies in the vicinity of the 400 Area are the FFTF Ponds (i.e., the 4608 B/C ponds) located just north of the 400 Area (DOE 1999a:4-31; Duncan 2007:4.50; Poston, Duncan, and Dirkes 2011:8.28). The ponds receive nonradioactive industrial process wastewater discharge collected by the process sewer system from four 400 Area facilities, including FFTF, FMEF, the Maintenance and Storage Facility, and the water pumphouse. The pond system consists of two cells that measure 15 by 30 meters (50 by 100 feet) and have 1.2-meter (4-foot) walls. Most of the wastewater discharged to the pond system was cooling-tower blowdown from eight FFTF auxiliary cooling towers and three FMEF cooling towers. Individual effluent streams were collected at a central drain line that runs to the pond, and the effluent was monitored before discharge. Approximately 76 million liters (20 million gallons) per year of process wastewater were historically discharged to the FFTF Ponds. Discharged wastewater rapidly percolates into the ground, leaving the ponds dry under normal conditions (DOE 2000a:3-105, 3-106). Discharges to the ponds continue to be regulated under State Waste Discharge Permit No. ST-4501, and the effluent is periodically sampled and analyzed for permit compliance. During 2010, grab samples for selected radionuclides were collected from the FFTF Ponds and analyzed quarterly. In general, average levels of gross beta and tritium have declined in recent years; however, both did increase in 2010. The average tritium concentration in the FFTF Pond water during 2010 was 33 percent of the Washington State ambient surface-water-quality criterion of 20,000 picocuries per liter. The sources of contaminants in the pond water are groundwater contaminant plumes from the 200 Areas that have migrated to wells within the 400 Area that supply water to facility operations (Poston, Duncan, and Dirkes 2011:8.41, 8.42, D.2).

About 3.8 million liters (1 million gallons) of sanitary wastewater also were discharged annually from 400 Area facilities to the Energy Northwest system for treatment. Moreover, liquid LLW from equipment washing was generated during standby operations at a maximum rate of about 3,785 liters (1,000 gallons) per year. It was collected in tanks and transported to the 200 Area ETF for treatment and disposal (DOE 2000a:3–106).

Waste management activities and facilities are discussed in greater detail in Section 3.2.12.

3.2.6.1.4 Borrow Area C Description

No perennial surface-water features, including streams and ponds, have been documented within the boundaries of Borrow Area C. However, portions of the area lie within the probable maximum flood zone associated with Cold Creek (see Figure 3–11). This ephemeral stream may only contain water after large precipitation or snowmelt events before the water rapidly infiltrates into the subsurface (Duncan 2007:4.49).

3.2.6.2 Vadose Zone

3.2.6.2.1 General Site Description

Unconsolidated sands and gravels of the Hanford formation make up most of the vadose zone. In some areas, however, such as most of the 200-West Area and in some of the 100 Areas, the sediments of the Ringold Formation make up the lower part of the vadose zone. The Cold Creek Unit also composes part of the vadose zone in the western portion of the site. Where sediments are present, the thickness of the vadose zone ranges from less than 1 meter (3.3 feet) at the Columbia River to more than 100 meters (328 feet) near the center of Hanford (Duncan 2007:4.66).

Moisture movement through the vadose zone is important at Hanford because it is the driving force for migration of most contaminants to the groundwater. Radioactive and hazardous wastes in the soil column from past intentional liquid waste disposals, unplanned leaks, solid waste burial grounds, and underground tanks are potential sources of continuing and future vadose zone and groundwater contamination. Contaminants may continue to move downward for long periods (tens to hundreds of years, depending on recharge rates) after termination of liquid waste disposal. Except for the State-Approved Land Disposal Site (SALDS), the 200 Area TEDF, and septic drain fields, substantial artificial recharge to the vadose zone ended in the mid-1990s. Currently, the major source of recharge is natural precipitation. Natural infiltration in the vadose zone causes preexisting water to be displaced downward by newly infiltrated water. The amount of recharge at any particular site highly depends on the soil type and the presence of vegetation. Usually vegetation reduces the amount of infiltration through the biological process of transpiration (Duncan 2007:4.66).

The stratigraphy of the vadose zone influences the movement of liquid through the soil column. Where conditions are favorable, liquid effluent may be spread laterally or local perched water zones may develop. Perched water zones form where downward-moving moisture accumulates on top of low-permeability soil lenses or highly cemented horizons. Preferential flow may also occur along discontinuities such as clastic dikes and fractures. Clastic dikes are a common geologic feature in the suprabasalt sediments at Hanford (see Section 3.2.5.1.2). Their most important feature is their potential to either enhance or inhibit vertical and lateral movement of contaminants in the subsurface, depending on the textural relationships of the strata involved (Duncan 2007:4.66).

Hanford has more than 800 past-practice liquid disposal facilities. Radiochemical- and hazardous-chemical-bearing liquid wastes were discharged to the vadose zone through reverse (injection) wells, French drains, ponds, cribs, and trenches (ditches). From 1944 through the late 1980s, 1.5 billion to 1.7 billion cubic meters (396 billion to 449 billion gallons) of effluent were disposed of in the soils. Most effluent was released in the 200 Areas. The major groundwater contaminant plumes emanating from the 200 Areas are tritium and nitrate. The major sources for both were discharges resulting from the chemical processing of irradiated nuclear fuel rods. Also of concern are technetium-99 and iodine-129, which, like tritium and nitrate, are mobile in the vadose zone and groundwater. The major sources of technetium-99 and iodine-129 were discharges to liquid disposal facilities. Vadose zone sources for these contaminants remain beneath many past-practice disposal facilities. However, other than physical sampling and laboratory analysis, there are no currently available monitoring techniques for tritium, nitrate, technetium-99, and iodine-129 in the vadose zone (Duncan 2007:4.67).

Approximately 280 unplanned releases in the 200 Areas also contributed contaminants to the vadose zone. Many of these were from underground tanks. In addition, approximately 50 active and inactive septic tanks and drain fields and numerous radioactive and nonradioactive landfills and dumps have impacted the vadose zone (Duncan 2007:4.67).

In the 200 Areas, 149 single-shell tanks (SSTs) and 28 double-shell tanks (DSTs) have been used to store HLW and mixed waste. The waste resulted from uranium and plutonium recovery processes and, to a lesser extent, from strontium and cesium recovery processes (Duncan 2007:4.67). Sixty-seven of the SSTs are known or suspected to have leaked liquid waste to the vadose zone between the 1950s and the present, although it is likely that some of the tanks have not actually leaked. Nevertheless, estimates of the total leak loss range from less than 2,840 million liters (750 million gallons) to as much as 3,970 million liters (1,050 million gallons). The three largest tank leaks were 435,000 liters (115,000 gallons), 37,900 to 1,049,000 liters (10,000 to 277,000 gallons), and 265,000 liters (70,000 gallons) (Hanlon 2003:B-13–B-16). The average tank leak was between 41,600 and 60,565 liters (11,000 and 16,000 gallons) (Duncan 2007:4.67). However, these estimates were compiled in the late 1980s and early 1990s from information sources of varying quality. While leak volumes for some tanks are well documented, including tank 241-T-106, which from liquid-level measurements is known to have leaked 435,000 liters (115,000 gallons) of waste, documentation of past leaks for 19 of the 67 tanks that are known or suspected "leakers" is less certain (Hanlon 2003:B-13–B-16). Much effort has been expended to improve SST leak volume estimates using information gathered from extensive tank farm vadose zone investigations. This effort has included an extensive program of field drilling, sampling, and soil analysis in multiple SST farms, as well as directed fundamental research and extensive review of historical process records and gamma logging data (DOE 2003b:6-19–6-22).

In addition to removing pumpable liquids from the SSTs, interim measures have been taken to reduce the movement of tank farm contaminants in the vadose zone. Infiltration of water has been identified as the primary means by which contaminants are displaced beneath the farms. Surface-water controls have been constructed to reduce surface-water run-on from major meteorological events and from breaks in waterlines. Also, waterlines that were determined to be unnecessary have been isolated, cut, and capped. Waterlines that were found to be necessary for continued operations are being leak tested, and any lines found to be leaking will be replaced (Duncan 2007:4.67, 4.68).

Other sources of vadose zone contamination include reactor cooling-water releases from cracked retention basins and direct discharges of cooling water to trenches (ditches) from the 100-KE, -KW, and -N Reactors. The released cooling waters contained fission and neutron activation products and some chemicals and actinides. Of greatest concern are the impacts of tritium, strontium-90, nitrate, and chromium migrating through the vadose zone to groundwater and, ultimately, to the Columbia River. Leakage from fuel storage basins in the 100-K Area also contributed potentially large inventories of fission products, transuranics, and carbon-14 to the soil column. Thus, both past-practice sites and fuel storage basin leakage are potential sources of vadose zone contaminants in the 100 Areas (Duncan 2007:4.68). DOE, with the concurrence of Ecology and EPA, issued the *Hanford Site Groundwater Strategy: Protection, Monitoring, and Remediation* in February 2004 (DOE 2004a). The document focuses on three key areas: groundwater protection, groundwater monitoring, and remediation of contaminated groundwater. All three of these strategic areas are implemented through the Soil and Groundwater Remediation Project. Activities performed by the project include an ongoing monitoring and assessment program to determine the distribution and movement of existing radioactive and chemical contamination in the soil and groundwater beneath Hanford. Information on these remediation efforts is detailed in the annual site environmental report (Poston, Duncan, and Dirkes 2011:8.6, 8.60, 8.62).

Several compilations of vadose zone contamination have been formulated through the years. A series of reports have been issued in recent years by the Hanford Tank Farm Vadose Zone Project that estimate the curies of gamma-emitting radionuclides and the volumes of contaminated soil associated within each

SST farm. The results were compiled from the baseline spectral gamma logging project and are summarized in 12 spectral gamma logging tank farm reports issued by MACTEC-Environmental Remediation Services between 1996 and 2000 (DOE 2003b:6-20, 6-21; Duncan 2007:4.68).

3.2.6.2.2 200 Areas Description

The thickness of the vadose zone across the 200 Areas ranges from approximately 50 meters (164 feet) in the 200-West Area to approximately 100 meters (328 feet) beneath portions of the 200-East Area (Hartman 2000:4.9, 4.16), as illustrated in Figure 3–12. The geologic and groundwater environments of the 200 Areas are further described in Sections 3.2.5.2 and 3.2.6.3.2, respectively.

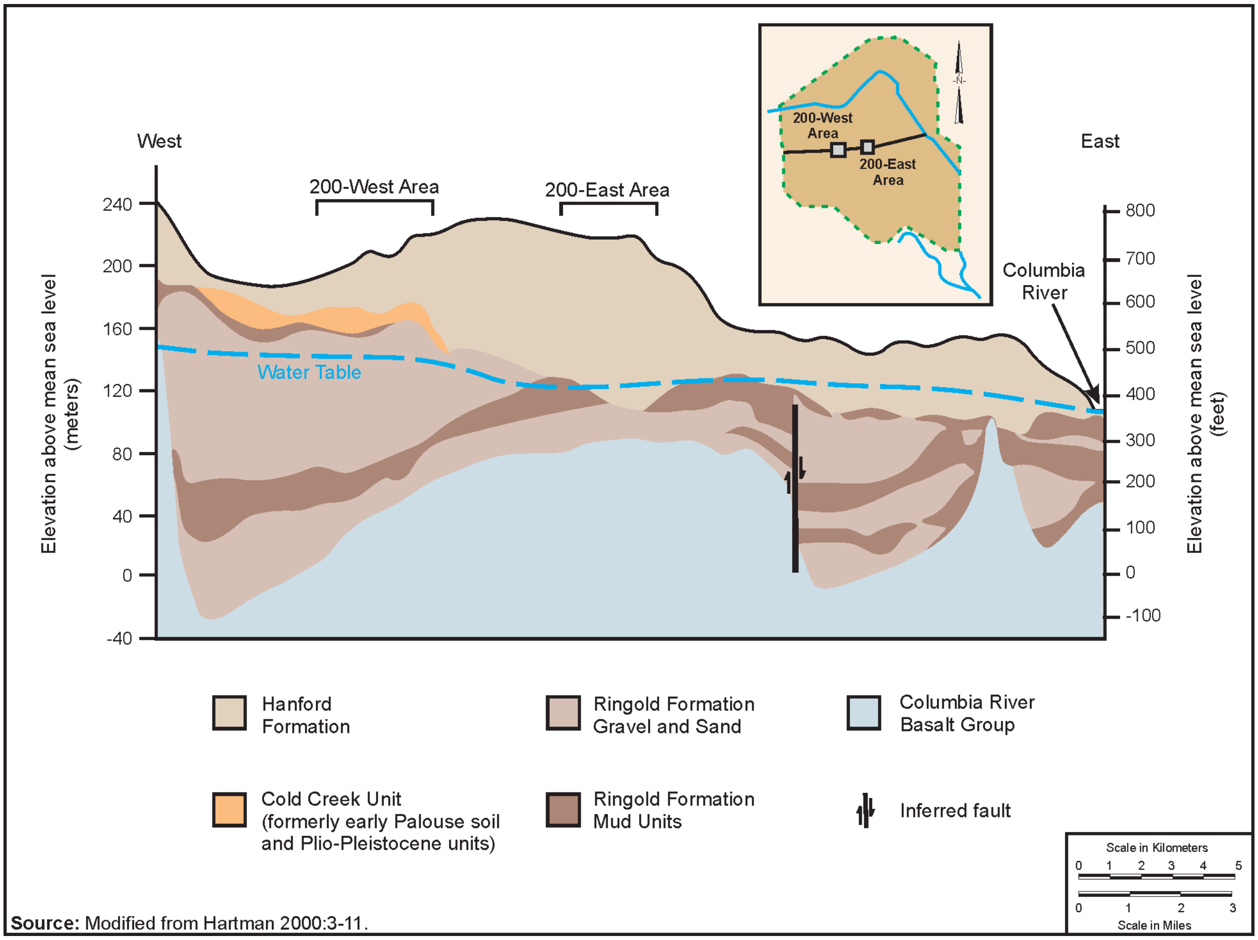


Figure 3–12. Hydrogeologic Cross Section Through the 200 Areas

3.2.6.2.3 400 Area Description

The thickness of the vadose zone in the 400 Area is approximately 50 meters (164 feet). The geologic and groundwater environments of the 400 Area are further described in Sections 3.2.5.3 and 3.2.6.3.3, respectively.

3.2.6.2.4 Borrow Area C Description

The thickness of the vadose zone across Borrow Area C, estimated to average approximately 50 meters (164 feet), similar to that of the 200-West Area, particularly in areas where basalt does not occur at or near the surface. Accordingly, thinning of the vadose zone is expected to the west and south across the area.

3.2.6.3 Groundwater

3.2.6.3.1 General Site Description

Groundwater under Hanford occurs in confined and unconfined aquifer systems. The hydrostratigraphic (water-bearing) units composing these systems are illustrated in the cross section shown as Figure 3–12.

The unconfined aquifer system, also referred to as the "suprabasalt aquifer system" or Hanford/Ringold aquifer system, lies within the sands and gravels of the Hanford formation and, to a greater degree, the sediments of the Ringold Formation. Portions of the suprabasalt aquifer system are locally confined because major sand and gravel units of the Ringold Formation (e.g., Units A, B, C, D, and E) (see Figure 3–9) are separated by fine-grained (e.g., silt- and clay-dominated) units. In some places, the fine-grained units act as aquitards that locally confine groundwater in deeper permeable sediments. Nevertheless, groundwater generally flows eastward across the site from recharge areas in the higher elevations on the western site boundary and discharges primarily to the Columbia River (see Figure 3–13). The Yakima River is also considered a source of recharge. Since the beginning of Hanford operations in 1943, the water table has risen about 9.1 meters (30 feet) under disposal ponds near the 200-East Area and as much as 27 meters (89 feet) in the 200-West Area. This has caused groundwater mounding with radial and northward flow components in the 200 Areas, although groundwater elevations have declined since 1984 with decreased wastewater disposal.

However, a groundwater mound beneath the 200-West Area still exists, as do small groundwater mounds near the 200 Area TEDF and the SALDS (Duncan 2007:4.68–4.71; Hartman 2000:3.4, 3.5). The 200 Area TEDF is a collection and disposal system for pretreated non–Resource Conservation and Recovery Act (RCRA) (42 U.S.C. 6901 et seq.)–permitted waste streams that began operations in April 1995. Effluent is conveyed to the facility through 18 kilometers (11 miles) of buried pipelines connecting three pumping stations, one disposal sample station (Building 6653), and two 2-hectare (5-acre) disposal ponds east of the 200-East Area.

Discharges from the 200 Area TEDF are regulated by State Waste Discharge Permit No. ST 4502 (see Section 3.2.6.1.2). The TEDF has a capacity of 12,900 liters (3,400 gallons) per minute. In 2010, the 200 Area TEDF disposed of 1,170 million liters (310 million gallons) of wastewater to the subsurface. The major sources of this effluent were uncontaminated cooling water and steam condensate from the 242-A Evaporator, as well as a variety of other uncontaminated waste streams received from other Hanford facilities. The SALDS (also known as the 616-A Crib), located north of the 200-West Area, is the ultimate discharge point for liquid waste treated in the 200-East Area ETF, which first passes through the LERF impoundments. The 200-East Area ETF treats liquid effluent to remove toxic metals, radionuclides, and ammonia, and to destroy organic compounds. It began operations in December 1995. The treated effluent is stored in tanks, sampled, and analyzed prior to being discharged to the SALDS. The disposal site is an underground drain field located just north of the 200-West Area. The treatment process constitutes the best-available technology; it includes pH adjustment, filtration, ultraviolet light and peroxide destruction of organic compounds, reverse osmosis to remove dissolved solids, and ion exchange to remove the last traces of contaminants. Discharges are regulated by State Waste Discharge Permit No. ST 4500. The ETF has a maximum treatment capacity of 570 liters (150 gallons) per minute of effluent. In 2010, the volume of wastewater treated and disposed of was approximately 69.7 million liters (18.4 million gallons). This was primarily CERCLA-regulated wastewater (groundwater from the 200-UP-1 and 200-ZP-1 Operable Units in the 200-West Area) (Poston, Duncan, and Dirkes 2011:6.23–6.25, D.2).

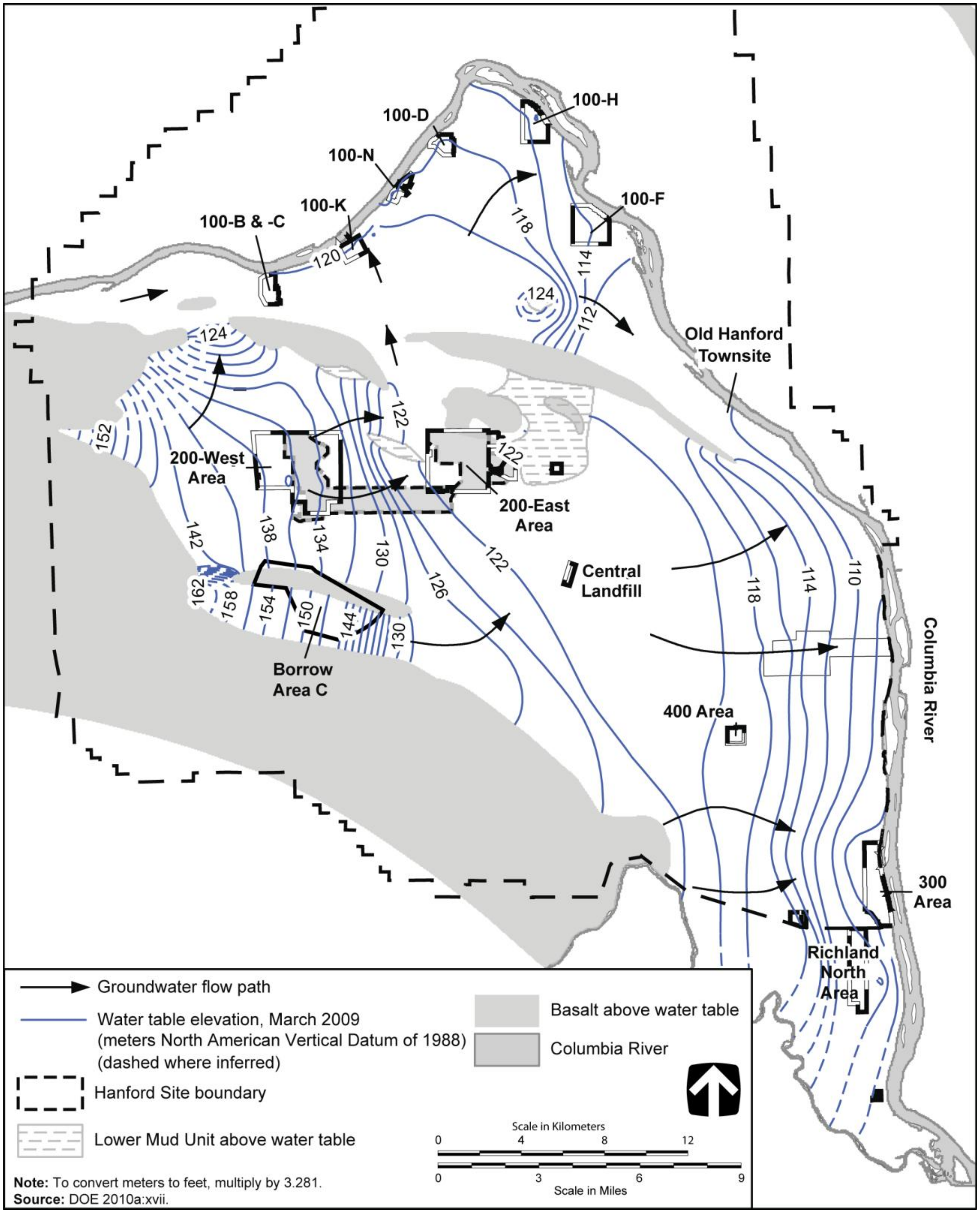


Figure 3–13. Water Table Elevations and Inferred Groundwater Flow for the Unconfined Aquifer System

The generally more consolidated and partially cemented sands and gravels within the Ringold Formation are 10 to 100 times less permeable than the sediments of the overlying Hanford formation, which results in significantly lower hydraulic conductivities. Before wastewater disposal operations at Hanford, the uppermost aquifer was mainly within the Ringold Formation, and the water table extended into the Hanford formation at only a few locations. However, wastewater discharges raised the water table elevation across the site. The general increase in groundwater elevation caused the unconfined aquifer to extend upward into the Hanford formation over a larger area, particularly near the 200-East Area. This increased the groundwater velocity because of both the greater volume of groundwater and the higher permeability of the newly saturated Hanford sediments (Duncan 2007:4.71, 4.72).

The saturated thickness of the unconfined aquifer system is greater than 180 meters (590 feet) in areas near the Central Landfill and in areas west of the 200-West Area and north of Gable Butte near the 100-B, -C, and -K Areas, but the aquifer pinches out along the flanks of the basalt ridges. Perched water table conditions have been encountered in sediment above the unconfined aquifer system in the 200-West Area. Depth to the water table across the site ranges from less than 1 meter (3.3 feet) along the Columbia River to more than 100 meters (328 feet) near the center of the site (see Figure 3–12). Daily river-level fluctuations may result in changes in the water table of up to 3 meters (10 feet) near the Columbia River during periods of high-river stage. As the river stage rises, a pressure wave is transmitted inland through the groundwater. The longer the duration of the higher-river stage, the farther inland the effect is propagated. The pressure wave is observed farther inland than the water actually moves. For the river water to flow inland, the river level must be higher than the groundwater surface and must remain high long enough for the water to flow through the sediments. Typically, this inland flow of river water is restricted to within several hundred meters of the shoreline (Duncan 2007:4.69).

The confined aquifer system at Hanford consists of a sequence of basalt-confined aquifers within the Columbia River Basalt Group. Individual aquifers consist of the relatively permeable sedimentary interbeds and the more porous tops and bottoms of basalt flows that compose the group (see Figure 3–9). Saturated but fairly impermeable, dense interior sections of the basalt flows have horizontal hydraulic conductivities (i.e., ability of the rock to transmit water) that are about five orders of magnitude lower than some of the confined aquifers that lie between these basalt flows. The upper basalt-confined aquifer is believed to be recharged from upland areas along the margins of the Pasco Basin as a result of the infiltration of precipitation and surface water where the basalt and interbeds are exposed at or near the ground surface. Hydraulic head information indicates that groundwater in the basalt-confined aquifers generally flows toward the Columbia River and, in some places, toward areas of enhanced vertical interflow with the unconfined aquifer system. Limited water chemistry data indicate that interaquifer flow has taken place in an area near the Gable Mountain anticlinal structure north of the 200-East Area (Duncan 2007:4.69; Hartman 2000:3.4, 3.5). Recharge may also occur through the Hanford/Ringold aquifer system in areas where the hydraulic gradient is downward and from deeper basalt aquifers where an upward gradient is present. The Yakima River may also be a source of recharge. The Columbia River is a discharge area for this aquifer system in the southern portion of the site, but not the northern portion. Discharge also occurs to the overlying Hanford/Ringold aquifer system in areas where the hydraulic gradient is upward. Discharge to overlying or underlying aquifers in the vicinity of the Gable Butte/Gable Mountain structural area may occur through erosional windows in the basalt (DOE 2010a:8.0-5).

Tritium and carbon-14 measurements indicate that groundwater residence or recharge time (the length of time that groundwater has been in the subsurface) is up to thousands of years for the unconfined aquifer and more than 10,000 years for groundwater in the shallow confined aquifer. Chlorine-36 and noble gas isotope data suggest groundwater ages greater than 100,000 years in the deeper confined systems. These rather long residence times are consistent with semiarid-site recharge conditions. However, groundwater travel time from the 200-East Area to the Columbia River has been shown to be much faster, in the range of 10 to 30 years. This is because of the large volumes of recharge from wastewater disposed of in the

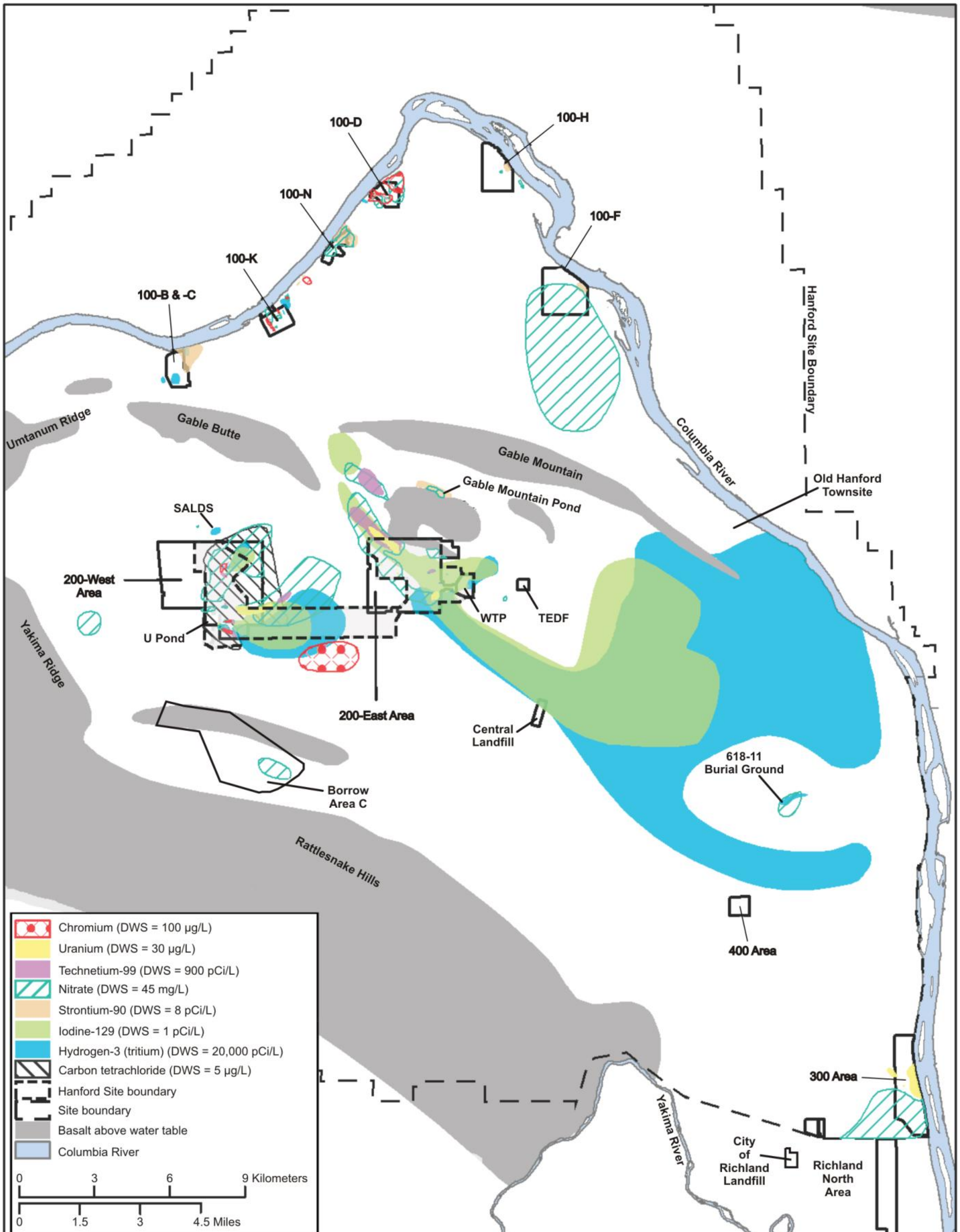
200 Areas between 1944 and the mid-1990s and the rather high permeability of Hanford formation sediments, which are below the water table between the 200 Areas and the Columbia River. Residence times in this portion of the aquifer are expected to increase because of the reduction in wastewater recharge in the 200 Areas. Travel time from the 200-West Area is greater because of the lower permeability of Ringold Formation sediments. Plume monitoring indicates that groundwater from the 200-West Area has moved about 6 kilometers (3.7 miles) during the past 50 years (Duncan 2007:4.72).

Water use in the Pasco Basin, which includes Hanford, is primarily via surface-water diversion; groundwater accounts for less than 10 percent of water use (DOE 1999a:4-49). While most of the water used by Hanford is surface water withdrawn from the Columbia River, some groundwater is used. One of the principal users of groundwater was FFTF in the 400 Area, which used about 697,000 liters (184,000 gallons) per day when it operated (DOE 2000a:3-109). The 400 Area continued to use groundwater supply wells for drinking water in 2010 (see Section 3.2.2.4.1).

Groundwater quality beneath large portions of Hanford has been affected by past liquid waste discharges, primarily to ponds, cribs, and trenches (ditches) and from spills, injection wells, and leaks from waste storage tanks. Additional contaminants from spills, leaking waste tanks, and burial grounds (landfills) have also impacted groundwater in some areas. Contaminant concentrations in the existing groundwater plumes are expected to decline through radioactive decay, chemical degradation, and dispersion. However, contaminants also exist within the vadose zone beneath waste sites (see Section 3.2.6.2), as well as in waste storage and disposal facilities. These contaminants could continue to move downward into the unconfined aquifer system. Some contaminants, such as tritium, move with the groundwater, while movement of other contaminants (e.g., strontium, cesium, plutonium) is slower because they react with or are sorbed on the surface of minerals within the aquifer or the vadose zone (Duncan 2007:4.73, 4.74). Groundwater contamination is monitored and is being actively remediated in several areas through pump-and-treat operations. The unconfined aquifer system contains radioactive and nonradioactive contaminants at levels that exceed water quality criteria and standards. During reporting period 2009 (i.e., October 1, 2008, through December 31, 2009), 922 wells and 326 aquifer tubes were sampled for radioactive and/or chemical constituents. Overall, tritium, nitrate, and iodine-129 continue to be the most widespread groundwater contaminants associated with past Hanford operations (DOE 2010a:1.0-3, 1.0-4).

Figure 3–14 depicts the distribution of major radionuclides and hazardous chemicals in the unconfined aquifer system, including those concentrations above applicable MCL or drinking water standards, during reporting period 2009. The figure depicts groundwater quality on a regional scale. Discussion of additional, smaller-scale contaminant plumes can be found in Appendices L, N, and O. The figure also depicts the locations of former waste management sites (e.g., Gable Mountain Pond, U Pond, B Pond, effluent disposal cribs) and burial grounds. Also shown are locations of active waste management and treatment facilities such as the SALDS, the 200 Area TEDF, and the ERDF.

The areas of the tritium and iodine-129 plumes are the largest areas in which contaminant concentrations exceed drinking water standards. These dominant plumes have sources in the 200-East Area and extend toward the east and southeast. Less-extensive tritium and iodine-129 plumes are also present in the 200-West Area. Technetium-99 exceeds standards in plumes within both the 200-East and 200-West Areas. One technetium-99 plume has moved to the northwest beyond the 200-East Area. Uranium is less mobile than tritium, iodine-129, or technetium-99; isolated plumes are found in the 200-East, 200-West, and 300 Areas. Strontium-90 exceeds standards in the 100 Areas, the 200-East Area, and beneath the former Gable Mountain Pond. Other radionuclides, including cesium-137, cobalt-60, and plutonium, are even less mobile in the subsurface and exceed drinking water standards in only a few wells in the 200-East Area (DOE 2010a:xx).



Key: μg/L=micrograms per liter; DWS=drinking water standard; mg/L=milligrams per liter; pCi/L=picocuries per liter; SALDS=State-Approved Land Disposal Site; TEDF=Treated Effluent Disposal Facility; WTP=Waste Treatment Plant.
Source: Modified from DOE 2010a:xxii.

Figure 3–14. Distribution of Major Radionuclides and Hazardous Chemicals in the Unconfined Aquifer System During Reporting Period 2009

Nitrate is a widespread nonradioactive contaminant in Hanford groundwater, with plumes originating from the 100 and 200 Areas and from offsite industry and agriculture. Carbon tetrachloride, the most widespread organic contaminant on Hanford, forms a large plume beneath the 200-West Area. Other organic contaminants include chloroform, found in the 200-West Area, and trichloroethene. Trichloroethene plumes that approach or exceed the drinking water standard are found in the 100-K and 100-F Areas. Chromium contamination underlies portions of 100-B, -C, -D, -F, -H, and -K Areas; the 600 Area; and the 200-West Area in exceedance of standards (DOE 2010a:xx, xxi). Information on groundwater monitoring and chemical analysis is further summarized in the annual site environmental report, and detailed results are provided in the Hanford annual groundwater monitoring report (DOE 2010a; Hartman, Rediker, and Richie 2009; Poston, Duncan, and Dirkes 2011). Vertical gradients between the basalt-confined aquifer and the unconfined aquifer systems are upward on most of Hanford. Downward gradients are measured in the west portion of Hanford, near B Pond, and north and east of the Columbia River (DOE 2010a:xiii). No aquifers have been designated sole-source aquifers in the Columbia Plateau (EPA 2009).

3.2.6.3.2 200 Areas Description

Along the southern edge of the 200-East Area and in the 200-West Area, the water table occurs almost entirely in the upper gravel layers (Unit E) of the Ringold Formation, while in most of the 200-East Area, it occurs primarily in the Hanford formation and in the lower gravel layers (Unit A) of the Ringold Formation. The upper Ringold strata across most of the 200-East Area were eroded by the ancestral Columbia River and, in some places, by the Missoula floods that subsequently deposited Hanford gravels and sand on what was left of the Ringold Formation. Because the Hanford formation and Cold Creek Unit sand and gravel deposits are much more permeable than the Ringold gravels, the water table is rather flat in the 200-East Area, but groundwater flow velocities are higher. On the north side of the 200-East Area, there is evidence of erosion channels that may allow interaquifer flow between the unconfined and uppermost basalt-confined aquifer systems (Duncan 2007:4.75).

The subsurface hydrology of the 200 Areas has been strongly influenced by the discharge of large quantities of wastewater to the ground for more than 50 years. Those discharges have caused elevated water levels across much of Hanford, resulting in a groundwater mound beneath the former B Pond east of the 200-East Area and a larger groundwater mound beneath the former U Pond in the 200-West Area. Water table changes beneath the 200-West Area have been greatest because of the lower transmissivity of the aquifer in this area. In recent years, discharges of water to the ground have been greatly reduced, and corresponding decreases in the water table elevation have been measured. The decline in part of the 200-West Area has been more than 8 meters (26 feet). Water levels are expected to continue to decrease as the unconfined groundwater system reaches equilibrium with the new level of artificial recharge (Duncan 2007:4.75, 4.81). Currently, the water table elevation is about 11 meters (36 feet) above the estimated water table elevation prior to the start of Hanford operations. Computer simulations show that when equilibrium conditions are established in the aquifer after site closure, the water table may still be 5 to 7 meters (16 to 23 feet) higher than the pre-Hanford water table because of modeling uncertainties, artificial recharge from offsite irrigation, or differences in current Columbia River conditions as compared with pre-Hanford times, such as dam construction (DOE 2010a:2.0-2, 2.0-3).

Across the 200-East Area, the depth to the water table varies from approximately 65 meters (213 feet) to 100 meters (328 feet), and the thickness of the saturated zone above the top of the basalt varies from 0 meters in the north to about 80 meters (262 feet) in the south. The depth to the water table in the 200-West Area varies from about 50 meters (164 feet) to greater than 100 meters (328 feet). Beneath the 200-West Area, the saturated thickness of the unconfined aquifer varies from about 65 meters (213 feet) to greater than 150 meters (492 feet) (Hartman 2000:4.9, 4.16).

Groundwater beneath the 200-West Area generally flows from west to east across most of the area, but is locally influenced by the 200-ZP-1 groundwater pump-and-treat remediation system. The decline in liquid effluent discharges to the soil in the 200-West Area and the resulting decline in the water table have changed the flow direction in the northern part of the area about 35 degrees over the past decade from a north-northeast to a more eastward direction. Flow in the central part of the 200-West Area (the south part of the 200-ZP-1 Operable Unit) is strongly influenced by the operation of the 200-ZP-1 groundwater pump-and-treat remediation system. This system extracts water from the vicinity of the 216-Z cribs and trenches (ditches), treats it to remove carbon tetrachloride and other volatile organic compounds, then reinjects the water into the aquifer west of the area (DOE 2010a:7.0-2, 7.0-3).

Groundwater flow in the central portion of Hanford, which encompasses the 200-East Area, is significantly affected by the presence of a buried flood channel that lies in a northwest-to-southeast orientation. The water table in this area is very flat due to the high permeability of the Hanford formation. Groundwater flow in this region is significantly affected by the presence of the low-permeability sediment of the Ringold Formation (i.e., the Lower Mud Unit) at the water table east and northeast of the 200-East Area, as well as basalt above the water table (see Figure 3–13). These features constitute barriers to groundwater flow. The extent of the basalt units above the water table continues to increase slowly due to the declining water table, resulting in an even greater effect on groundwater flow in this area. Because of the very low hydraulic gradient in the 200-East Area and vicinity, as well as uncertainty in the water-level elevation data, determining precisely the direction of groundwater flow is problematic. What is observable is that water enters the 200-East Area and vicinity from the west and southwest, as well as from beneath the mud units to the east and from the underlying aquifers (i.e., the upper basalt-confined aquifer system), where the confining units have been removed or thinned by erosion. The flow of water divides into two flow paths, one moving to the north through Gable Gap and the other southeast toward the central part of the site (see Figure 3–13). While the precise location of the flow divide has not been established, it has been determined through water-level data that groundwater flows north through Gable Gap and southeast between the 200-East Area and the Central Landfill (DOE 2010a:2.0-3).

3.2.6.3.3 400 Area Description

Groundwater flow within the unconfined aquifer across the 400 Area is generally to the east-southeast. The Hanford formation immediately underlying the area consists mainly of sand-dominated sediments. Depth to the water table, located near the contact between the Hanford and Ringold Formations, is estimated at 49 meters (161 feet). Sediments of the Hanford formation dominate groundwater flow in the 400 Area because of their higher permeability than those of the Ringold Formation. The Ringold Formation consists of gravelly sands, sandy gravel, silty sands, fluvial gravels, and overbank and lacustrine silt and clay. The saturated thickness of this aquifer system is about 140 meters (460 feet) (Hartman 2000:4.25; Hartman, Rediker, and Richie 2009:2.11–2.24).

Nitrate has historically been the only significant contaminant attributable to 400 Area operations. Elevated nitrate has been attributed to a former sanitary sewage lagoon located west and upgradient of the FFTF Ponds (Hartman 2000:4.25; WHC 1992:44). The FFTF Ponds are also a known source of nitrate contamination. In 2009, nitrate concentrations were well below the drinking water standard of 45 milligrams per liter in all 400 Area water supply wells. However, nitrate exceeded the standard in well 699-2-7 associated with the FFTF Ponds (DOE 2010a:5.0-7, 5.0-41).

The 400 Area's three water supply wells are completed in the unconfined (Hanford/Ringold) aquifer system. The primary production well (499-S1-8J) was installed in 1985 in the lower unconfined aquifer system after tritium contamination was detected in the original two wells (499-S0-7 and 499-S0-8) near the top of the aquifer (Hartman 2000:4.25). These elevated tritium levels were associated with the groundwater plume from the vicinity of the PUREX Plant in the 200-East Area. Well 499-S1-8J now serves as the main water supply well for the 400 Area, while 499-S0-7 and 499-S0-8 are backup supply wells. During reporting period 2009, tritium levels were below the drinking water standard (20,000 picocuries per liter); the highest tritium concentration during 2009 was measured in well 499-S0-7 at 6,400 picocuries per liter. Well 699-2-7 associated with the FFTF Ponds had a maximum tritium concentration of 9,800 picocuries per liter (DOE 2010a:5.0-7, 5.0-38, 5.0-41).

3.2.6.3.4 Borrow Area C Description

No groundwater wells have been developed in Borrow Area C to precisely determine groundwater flow and direction and depth to groundwater. Based on regional topography and the direction of flow of Cold Creek, groundwater flow across Borrow Area C is inferred to be generally to the east (see Figure 3–13). Depth to the water table is estimated to average approximately 52 meters (170 feet).

3.2.7 Ecological Resources

Ecological resources include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Terrestrial resources are the plant and animal communities most closely associated with the land; for aquatic resources, a water environment. Wetlands are "those areas that are inundated or saturated by groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR 328.3). Endangered species are those plants and animals in danger of extinction throughout all or a large portion of their range; threatened species, those species likely to become endangered within the foreseeable future. Other organisms may be designated by USFWS and the state as special status species, such as candidate, species of concern, sensitive, and watch.

3.2.7.1 Terrestrial Resources

3.2.7.1.1 General Site Description

Hanford is within the Columbia Basin Ecoregion, an area that historically included over 6 million hectares (14.8 million acres) of steppe and shrub-steppe vegetation. In the early 1800s, the dominant plant in the Hanford area was big sagebrush underlain by perennial Sandberg's bluegrass and bluebunch wheatgrass. With the advent of settlement, livestock grazing and agricultural production contributed to colonization by nonnative plant species. Although agriculture and livestock production were the primary activities within the region and on Hanford at the beginning of the twentieth century, these activities ceased at the site when the Government acquired it in 1943. Remnants of past agricultural practices are still evident. Now the site encompasses undeveloped land interspersed with the industrial development; only about 6 percent of the site has been developed (Duncan 2007:4.84; Neitzel 2005:4.144).

A variety of both native and nonnative plant species are found across the site. A total of 727 species of vascular plants has been recorded on the site, of which 179 are nonnative species. In addition, 29 soil lichens and 6 moss species have been identified. Prior to the 24 Command Fire in July 2000, studies identified as many as 48 vegetation communities and land use areas on Hanford (see Figure 3–15). However, these may be roughly grouped into shrublands, grasslands, areas containing trees, and riparian areas and wetlands (Duncan 2007:4.85–4.87).

Shrublands occupy the most extensive area on Hanford. Of the numerous types present, sagebrush-dominated communities predominate; other shrub communities vary with changes in soils and elevation. Typical vegetation in shrubland habitat includes big sagebrush, threetip sagebrush, bitterbrush, gray rabbitbrush, winterfat, snow buckwheat, and spiny hopsage. In the recent past, big sagebrush plant communities covered about 80 percent of the mapped land on the site; however, much of this area (28,750 hectares [71,040 acres]) was burned by the 24 Command Fire in 2000 and again by the Milepost 17 and Wautoma Fires in 2007 (Duncan 2007:4.89; PNNL 2008a).

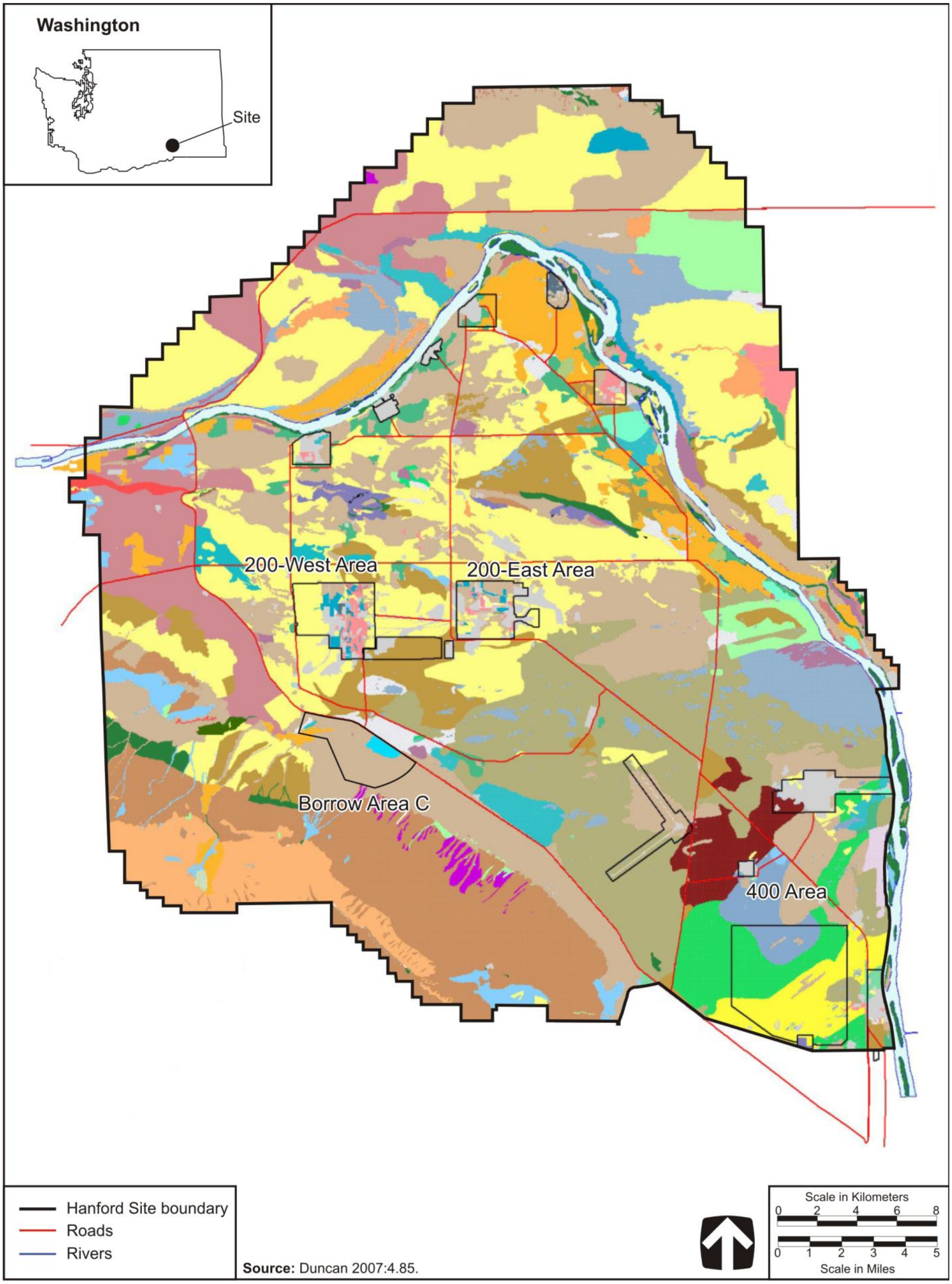


Figure 3–15. Vegetation Communities on the Hanford Site

Source: Duncan 2007:4.86.

Figure 3–15. Vegetation Communities on the Hanford Site *(continued)*

Washington State considers pristine shrub-steppe habitat as a priority habitat because of its relative scarcity in the state and its importance to several state-listed wildlife species (WDFW 2007). Designation and characterization of priority habitat provide a basis for sound, defensible land management planning and assist in the management of regulated species. Sagebrush communities are also considered a Level III resource under the *Hanford Site Biological Resources Management Plan*. Biological resources are ranked from Level I to Level IV, with Level IV being the most significant in terms of the presence of threatened or endangered species, as well as rare, unique, or vanishing habitat. Impacts on Level III resources should be avoided or minimized; however, when avoidance and minimization are not possible, rectification or mitigation is recommended (DOE 2001c:4.7).

While most grasses occur as understory in shrub-dominated plant communities, there are a number of grassland communities on the site. Common species include Sandberg's bluegrass, needle-and-thread grass, Indian ricegrass, and thickspike wheatgrass. Cheatgrass has replaced many native perennial grass species and is well established in many low-elevation (less than 244 meters [800 feet]) and/or disturbed areas (Duncan 2007:4.90).

Before settlement, Hanford's landscape lacked trees, although the Columbia River nearshore supported a few scattered cottonwoods or willows. Homesteaders planted trees in association with agricultural areas. Shade and ornamental trees were planted around former military installations and industrial areas on the site. Currently, 23 species of trees occur on Hanford. The most common species are black locust, Russian olive, cottonwood, mulberry, sycamore, and poplar. These trees provide nesting habitat and cover for many birds and mammals (Duncan 2007:4.90).

Riparian habitat includes riffles, gravel bars, backwater sloughs, shorelines, islands, and palustrine areas associated with the Columbia River floodplain, as well as site springs. Vegetation occurring along the river shoreline includes water smartweed, pondweed, sedges, reed canary grass, and bulbous bluegrass. Trees include willow, mulberry, and Siberian elm. Other riparian vegetation associated with perennial springs and seeps includes bulrush, spike rush, and cattail. North of the Columbia River, several irrigation return ponds support riparian vegetation. The riparian areas associated with Snively and Rattlesnake Springs were greatly impacted by the 24 Command Fire (Duncan 2007:4.92, 4.93).

Within the Columbia Basin, microbiotic crusts commonly occur in the top 1 to 4 millimeters (0.04 to 0.16 inches) of soil and are composed primarily of algae, lichen, and mosses. Living organisms (primarily green algae) and their byproducts bind individual soil particles together to form these crusts. The functions of microbiotic crusts include soil stability and protection from erosion; fixation of atmospheric nitrogen; nutrient contribution to plants, thereby influencing soil-plant water relations; and increased water infiltration, seedling germination, and plant growth. The ecological roles of microbiotic crusts depend on the cover of various crustal components. Carbon inputs are higher when mosses and lichens are present than when the crust is dominated by cyanobacteria. Nitrogen inputs are higher with greater water infiltration. Soil surface stability is related to cyanobacterial biomass, as well as total moss and lichen cover (Duncan 2007:4.87, 4.88).

Several unique habitats and populations of rare plants on Hanford contribute to its biodiversity. Unique habitats include basalt outcrops, river bluffs, dunes, and islands. The tops of Rattlesnake Mountain, Umtanum Ridge, Gable Butte, and Gable Mountain have rock outcrops and thin rocky soils. Plant communities dominated by thymeleaf buckwheat and Sandberg's bluegrass most often occupy these basalt outcrops. The White Bluffs border the Columbia River along the northern shoreline, presenting a steep environment with sparse and patchy vegetation. Vegetation includes black greasewood, spiny hopsage, Indian ricegrass, and a number of sensitive species. Dune areas, such as those occurring on the eastern part of the site near the Energy Northwest complex, support bitterbrush, scrufpea, and thickspike wheatgrass. Island habitat accounts for about 466 hectares (1,152 acres) on Hanford. Vegetation characterizing the islands includes willow, poplar, Russian olive, mulberry, snow buckwheat, lupine, mugwort, and yarrow. The Nature Conservancy of Washington has conducted a number of surveys of the site and has identified a total of 127 populations of 30 rare plants (Duncan 2007:4.89, 4.95, 4.96).

Approximately 300 species of terrestrial vertebrates have been observed on Hanford, including 46 of mammals, 258 of birds, 10 of reptiles, and 5 of amphibians. The shrub and grassland habitats of Hanford support many groups of terrestrial wildlife. Mammals include large game animals such as the Rocky Mountain elk and mule deer; predators such as coyote, bobcat, and badger; and herbivores such as deer, harvest mice, ground squirrels, voles, and black-tailed jackrabbits. Forty-one bird species are common to shrub and grassland habitats, including the western meadowlark, horned lark, long-billed curlew, vesper and sage sparrows, loggerhead shrike, northern harrier, and golden eagle. The side-blotched lizard is the most abundant species of lizard on Hanford, while the Great Basin gopher snake, western yellow-bellied racer, and western rattlesnake are the most common snakes. The painted turtle is also a resident on Hanford. The Great Basin spadefoot toad, Woodhouse's toad, Pacific tree frog, tiger salamander, western toad, and bullfrog are the only amphibians found on the site (Duncan 2007:4.83, 4.84, 4.90-4.92; Landeen and Crow 1997:78).

Many species of insects occur throughout all of the habitats found at Hanford. Butterflies, grasshoppers, and darkling beetles are among the most conspicuous of the approximately 1,500 species of insects identified from specimens collected on the site. The actual number of insect species occurring on Hanford may reach as high as 15,500. Recent site surveys performed by The Nature Conservancy identified 43 new taxa and 142 new findings for the state of Washington. The high diversity of insect species on Hanford is believed to reflect the size, complexity, and quality of the shrub-steppe habitat (Duncan 2007:4.92).

Riparian areas provide nesting and foraging habitat and escape cover for many species of birds and mammals. Mammals occurring primarily in riparian areas include rodents, bats, mink, porcupine, raccoon, and mule deer. Birds common to these areas include the American robin, black-billed magpie, song sparrow, and dark-eyed junco. Great blue herons and black-crowned night herons are associated with trees in riparian habitat, and bald eagles have wintered on Hanford since 1960. Hanford is located in the Pacific Flyway and serves as a resting area for neotropical migrant birds, migratory waterfowl, and shorebirds (Duncan 2007:4.93, 4.94).

A number of species are associated with unique habitats found on Hanford. White Bluffs and Umtanum Ridge provide nesting for birds, including the red-tailed hawk, cliff swallow, and rough-winged swallow. Bluff areas also provide habitat for sensitive species (e.g., the peregrine falcon) that otherwise might be subject to impacts of repeated disturbance. Trees that do not normally occur in arid steppe habitat supply nesting, perching, and roosting sites for many birds such as the ferruginous and Swainson's hawks. Dunes are unique in their association with the surrounding shrub-steppe vegetation and afford habitat for mule deer, coyotes, and burrowing owls. The islands of the Columbia River also afford a unique habitat at Hanford for waterfowl and shorebirds, including the Canada goose, California and ring-billed gulls, and Foster's tern. Some islands accommodate colonial nesting species that may range in population size upward of 2,000 individuals (Duncan 2007:4.95, 4.96).

In response to the 24 Command Fire of 2000, which burned 56,246 hectares (138,986 acres) within Hanford, USFWS prepared the *24 Command Fire, Benton County, Washington, June–July 2000, Burned Area Emergency Rehabilitation Plan* (DOI 2000) that assessed resource issues and impacts and provided recommendations. While vegetation resources were substantially reduced on about 85 percent of the fire area, due to the rather fast passage of the fire over any one area, most soils showed little damage and seed bank sources in the soil were not adversely impacted. Although this will aid natural revegetation, recovery of some plant associations (e.g., sagebrush) may require planting and could take years. Potential long-term impacts of the fire include the establishment of noxious weeds and changes in natural plant communities. The 24 Command Fire had immediate direct impacts on wildlife, including loss of individual animals, especially smaller, less-mobile species and the young of the year, and displacement of more-mobile animals to unaffected areas. However, displacement itself can lead to increased mortality due to road kills; in the case of Rocky Mountain elk, this has occurred. Long-term impacts on wildlife due to loss of food, cover, and breeding habitat are expected as a result of the fire (DOI 2000:94, 95, 99, 100, 119). The Milepost 17 and Wautoma Fires of 2007 burned a large portion of the same area as the 24 Command Fire (see Figure 3–2). The other major fire that occurred in 2007 was the Overlook Fire, which burned 8,527 hectares (21,071 acres) on the north side of the Columbia River. Most of the area burned by the Overlook Fire consisted of native shrub-steppe uplands, but substantial riparian and wetland habitats in the Wahluke Ponds and other low-lying areas were also damaged. Following the fire, a burned-area rehabilitation plan was developed by USFWS, in consultation with tribes and local technical experts, to address short- and long-term rehabilitation needs (USFWS 2009).

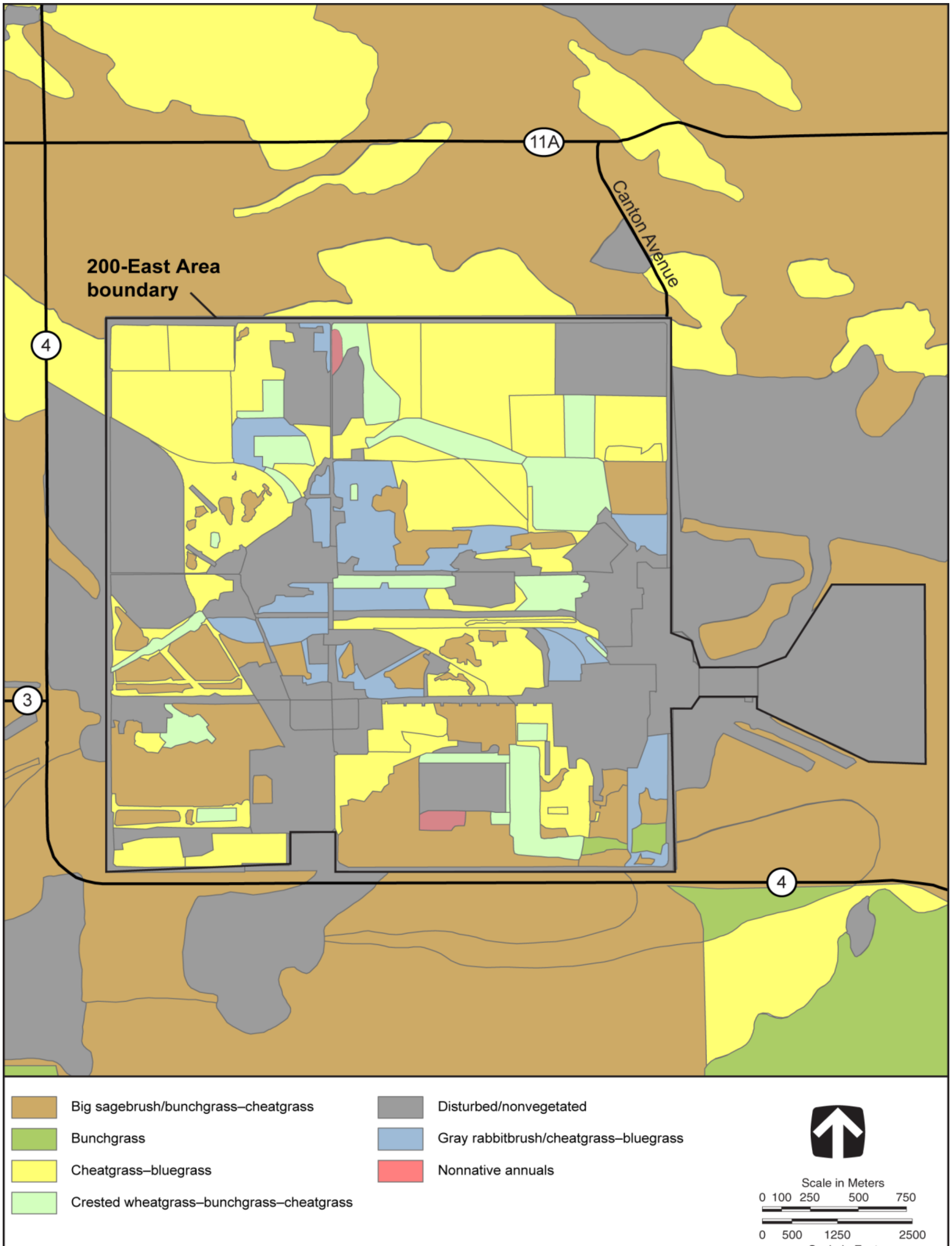
3.2.7.1.2 200 Areas Description

Figures 3–16 and 3–17 illustrate vegetation and land cover in and around the 200-East and 200-West Areas following the 24 Command and Wautoma Fires. Most of the 200 Areas were not directly impacted by either fire (see Figure 3–2). Undisturbed portions of the 200 Areas are characterized by the following communities: big sagebrush/bunchgrass-cheatgrass, cheatgrass-bluegrass, crested wheatgrass-bunchgrass-cheatgrass, and gray rabbitbrush/cheatgrass-bluegrass. The former two communities are prominent in the 200-East Area, while the latter two are more common in the 200-West Area. Most of the waste disposal and storage sites are covered by nonnative vegetation or are kept in a vegetation-free condition by the controlled application of approved herbicides because plants could potentially accumulate waste constituents. Where vegetation is present, it aids in stabilizing surface soil, controlling soil moisture, or displacing more-invasive, deep-rooted species like Russian thistle (Duncan 2007:4.98). Due to the disturbed nature of most of the 200 Areas, wildlife use is limited; however, surveys have recorded the badger, coyote, Great Basin pocket mouse, mule deer, long-billed curlew, killdeer, horned lark, Say's phoebe, American robin, American kestrel, western meadowlark, and common raven (Sackschewsky 2003a:3, 2003b:9, 10; Sackschewsky and Downs 2007).

Surveys of areas potentially affected by the proposed Tank Closure alternatives have been completed (Sackschewsky 2003c, 2003d; Sackschewsky and Downs 2007). While large portions of the 200 Areas have been disturbed, sagebrush habitat, considered a priority habitat by the State of Washington and a Level III resource by the *Hanford Site Biological Resources Management Plan* (DOE 2001c), does occur in a number of locations (see Figures 3–16 and 3–17). It is found within the south-central portion of the 200-East Area and much of the area surrounding the WTP. The former area includes the site of IDF-East, while the latter includes the location within which the DSTs could be built, the location of the Supplemental Treatment Technology Site in the 200-East Area (STTS-East), and the area designated for interim canister storage (see Chapter 4, Figure 4–1). Sagebrush habitat is also found within the southeast corner of the 200-West Area, the location of STTS-West (see Chapter 4, Figure 4–2).

3.2.7.1.3 400 Area Description

The 400 Area, which is classified as "disturbed/nonvegetated" (see Figure 3–15), is located within postfire shrub-steppe habitat dominated by cheatgrass and small shrubs, including gray and green rabbitbrush. Owing to past disturbances and human occupancy of the 400 Area, wildlife is not as abundant as in undisturbed areas. However, a number of species are expected to occur. For example, surveys have identified 50 different bird species in habitats surrounding the building complexes, and 19 species actively nest on or near existing buildings. Species likely present include the American robin, barn swallow, European starling, and pigeon (PNNL 2008b).



Source: Downs 2008a; Sackschewsky and Downs 2007.

Figure 3–16. Vegetation Communities In and Near the 200-East Area

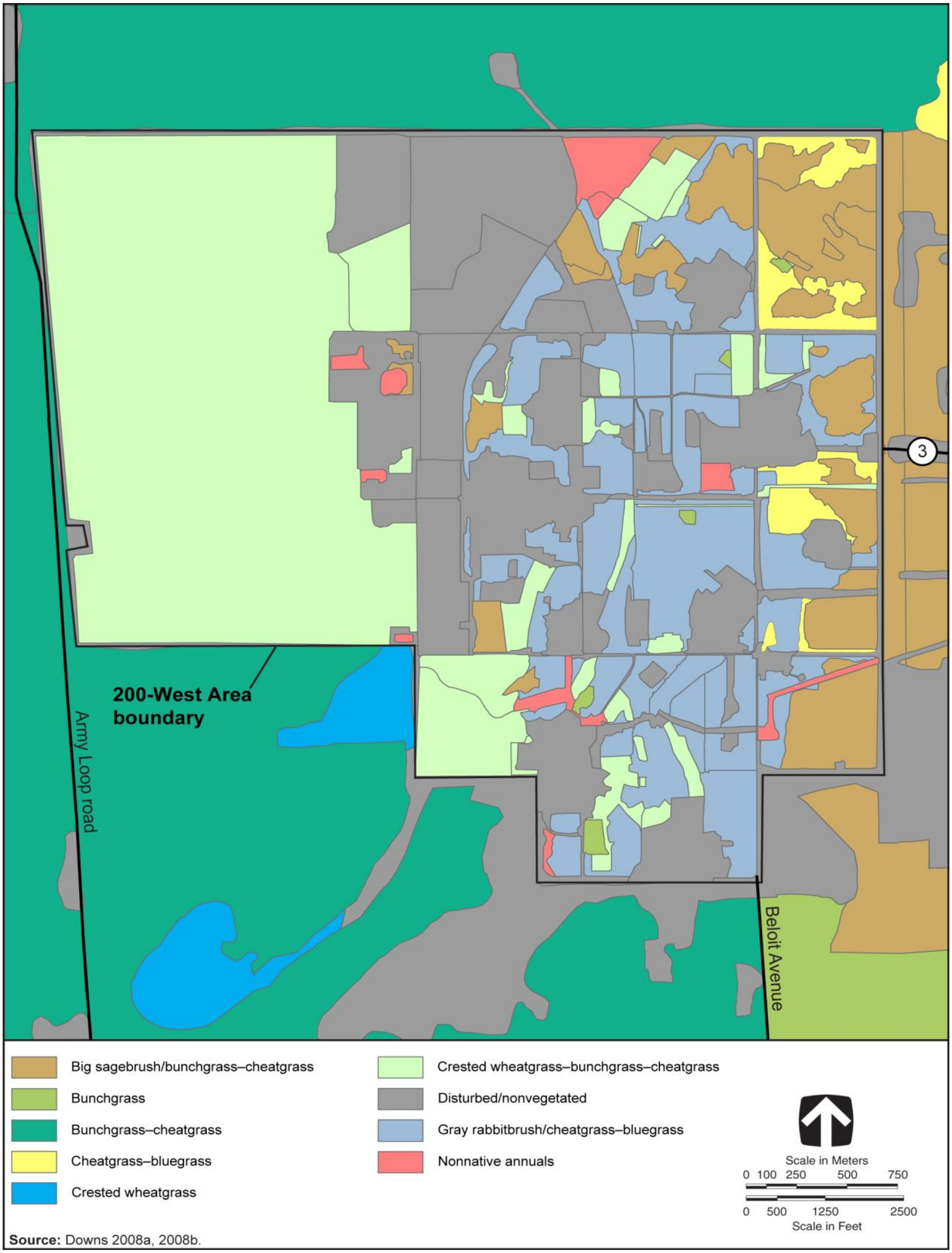


Figure 3–17. Vegetation Communities In and Near the 200-West Area

3.2.7.1.4 Borrow Area C Description

Most of the original vegetation in Borrow Area C was burned in the 24 Command Fire of June 2000. The largest prefire plant community was dominated by Sandberg's bluegrass and cheatgrass, but communities containing other grasses and big sagebrush were also present. Few shrubs remained after the fire, and Sandberg's bluegrass-cheatgrass became the dominant plant community. There is also a rather large, high-quality needle-and-thread grass–Indian ricegrass community, an unusual and relatively pristine community type, in the eastern and western portions of the site (see Figure 3–18). Wildlife inhabiting Borrow Area C include mammals such as the badger, coyote, Rocky Mountain elk, mule deer, and northern pocket gopher; birds such as the horned lark, lark sparrow, rock wren, short-eared owl, and western meadowlark; and reptiles such as the side-blotched lizard (Sackschewsky 2003b:4-7; Sackschewsky and Downs 2007:7-8). A large part of Borrow Area C was burned during the 2007 Wautoma Fire (see Figure 3–2). A biological assessment of the fire has not been made; however, one effect was to maintain the area as grassland.

3.2.7.2 Wetlands

3.2.7.2.1 General Site Description

Riparian habitat occurring in association with the Columbia River includes riffles, gravel bars, backwater sloughs, and cobble shorelines. These habitats occur infrequently along the Hanford Reach and have acquired greater significance because of the loss of wetland habitat elsewhere within the region. Vegetation that occurs along the river shoreline includes willow, mulberry, Siberian elm, water smartweed, reed canary grass, sedges, and rushes (Duncan 2007:4.29, 4.93).

Other large wetland areas at Hanford can be found north of the Columbia River within the Saddle Mountain National Wildlife Refuge and the Wahluke Unit. These two areas encompass all the lands extending from the north bank of the Columbia River northward to the site boundary and east of the Columbia River down to Ringold Springs. Wetland habitat in these areas consists of fairly large ponds resulting from irrigation runoff. These ponds have extensive stands of cattails and other emergent aquatic vegetation surrounding the open-water regions. They are extensively used as nesting sites by waterfowl (Duncan 2007:4.93).

Some wetland habitat exists in the riparian zones of some of the larger spring-fed streams on the Fitzner-Eberhardt Arid Lands Ecology Reserve. These zones are not extensive and usually amount to less than 1 hectare (2.5 acres) in size. On the western side of Hanford, Rattlesnake Springs supports a riparian zone of 2.0 kilometers (1.2 miles) in length, which features cattail, peachleaf willow, and other exotic plants. Snively Springs also contains a diverse biotic community similar to that of Rattlesnake Springs (Duncan 2007:4.23). The 24 Command Fire affected approximately 17.8 hectares (44 acres) of willow riparian habitat, including areas around Rattlesnake Springs, Snively Canyon, Benson Springs, and the Yakima River (DOI 2000:108). The Overlook Fire burned substantial riparian and wetland habitat associated with the irrigation ponds and other low-lying areas north of the Columbia River (USFWS 2009).

3.2.7.2.2 200 Areas Description

The only wetland area in the vicinity of the 200 Areas is West Lake. With the cessation of nuclear materials production activities at Hanford, the amount of water discharged to the ground in the 200 Areas substantially decreased. Thus, over the past 10 years, the lake has decreased in size and currently consists of a group of small isolated pools and mudflats. Predominant plants at West Lake include alkali saltgrass, plantain, and salt rattlepod. Bulrush grows along the shoreline; however, the water is too saline to support aquatic macrophytes (i.e., large aquatic plants) (Duncan 2007:4.98, 4.99).

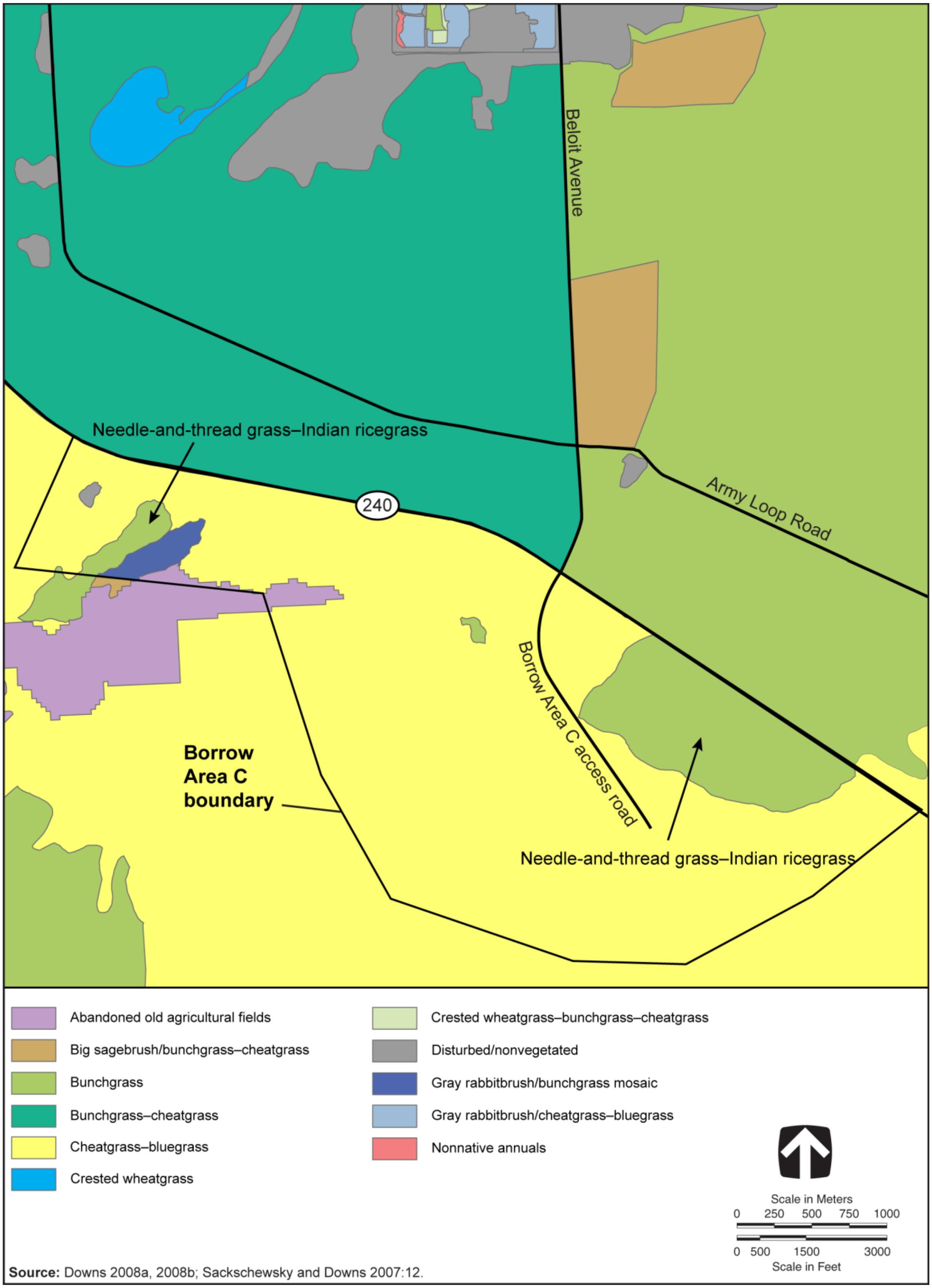


Figure 3–18. Distribution of Vegetation Communities In and Near Borrow Area C

3.2.7.2.3 400 Area Description

There are no natural wetlands in the 400 Area, although the FFTF Ponds (i.e., 4608 B/C Ponds) are present. Wildlife species observed using the cooling and wastewater ponds include a variety of mammals and waterfowl (DOE 1999b:3-36).

3.2.7.2.4 Borrow Area C Description

There are no wetlands located within Borrow Area C.

3.2.7.3 Aquatic Resources

3.2.7.3.1 General Site Description

The Hanford Reach of the Columbia River flows through the northern portion of the site and forms the eastern site boundary. It is the last free-flowing, nontidal segment of the Columbia River in the United States (Duncan 2007:4.99).

Macrophytes are generally sparse in the Columbia River; however, rushes and sedges occur along the shorelines of the slack-water areas. Where they exist, they provide food and shelter for juvenile fish and spawning areas for some species of warm-water game fish. Phytoplankton (free-floating algae) and periphyton (attached algae) are abundant in the Columbia River and provide food for herbivores such as immature insects, which in turn are consumed by predators. Both zooplankton (small, free-floating aquatic animals) and macrophytes are generally sparse in the river because of the strong currents, rocky bottom, and frequently fluctuating water levels. Benthos, or bottom-dwelling organisms, including insect larvae, clams, snails, and crayfish, are found in the river. These organisms are an important food source for juvenile and adult fish (Duncan 2007:4.100).

The Hanford Reach supports 45 anadromous and resident species of fish. Of these species, spring-run Chinook salmon, sockeye salmon, coho salmon, and steelhead use the river as a migration route to and from upstream spawning areas and are of the greatest economic importance. Additionally, fall-run Chinook salmon and steelhead spawn in the Hanford Reach. Inundation of other mainstream Columbia spawning grounds by dams has increased the importance of the Hanford Reach to fall-run Chinook salmon production in the Columbia and Snake Rivers. American shad is another anadromous species that may spawn in the Hanford Reach (Duncan 2007:4.100, 4.101).

Other fish of importance to sport fishermen are mountain whitefish, white sturgeon, smallmouth bass, crappie, channel catfish, walleye, and yellow perch. Large populations of rough fish are also present, including common carp, redside shiner, suckers, and northern pikeminnow (Duncan 2007:4.101).

The Yakima River borders the southern portion of Hanford. Fish found in the river in the site vicinity include smallmouth bass, salmon, steelhead, and channel catfish. Cold Creek and its tributary, Dry Creek, both ephemeral streams within the Yakima River drainage system, do not support any fish populations (DOE 2000a:3-121; YBFWRB 2008).

There are several springs at Hanford. Rattlesnake Springs, Bobcat Springs, and Snively Springs, located on the Fitzner-Eberhardt Arid Lands Ecology Reserve, form short streams that seep into the ground. None of the springs support any fish populations; however, dense blooms of watercress occur, and aquatic insect populations are higher than they are in mountain streams. Site springs are an important source of water for terrestrial animals (DOE 2000a:3-120; Duncan 2007:4.103).

Three clusters of approximately 20 vernal pools are distributed on the eastern end of Umtanum Ridge, in the central part of Gable Butte, and at the eastern end of Gable Mountain (DOE 1999a:4-31). Vernal pools are seasonally flooded depressions that retain water much longer than the surrounding uplands; nonetheless, the pools are shallow enough to dry up each season. Only plants and animals that are adapted to this cycle of wetting and drying can survive in vernal pools over time. These pools can host freshwater crustaceans and other invertebrates and are of value to terrestrial species.

3.2.7.3.2 200 Areas Description

The LERF and TEDF, located in and adjacent to the 200-East Area, contain five ponds. There are three evaporation ponds associated with the LERF, each of which is about 0.8 hectares (2 acres) in size. The two disposal ponds associated with the TEDF are each about 2 hectares (5 acres) in size. None of these ponds support fish populations. Although the LERF ponds are covered by a floating membrane constructed of very low-density polyethylene (Poston, Duncan, and Dirkes 2011:6.24), the TEDF ponds are not covered and, therefore, are accessible to wildlife. West Lake, which has decreased in size in recent years (see Section 3.2.6.1.2), is the only other water body near the 200 Areas; however, the lake is too saline to support aquatic macrophytes (Duncan 2007:4.98, 4.99).

3.2.7.3.3 400 Area Description

Although no natural aquatic habitat occurs in the 400 Area, the FFTF Ponds (i.e., 4608 B/C Ponds) are present (DOE 1999b:3-36). The 400 Area is 6.8 kilometers (4.2 miles) west of the Columbia River.

3.2.7.3.4 Borrow Area C Description

There are no aquatic resources within Borrow Area C.

3.2.7.4 Threatened and Endangered Species

Endangered species are those plants and animals that are in danger of extinction throughout all or a large portion of their range. Threatened species are those species that are likely to become endangered within the foreseeable future. In addition to threatened and endangered species, USFWS, National Marine Fisheries Services, and the state designate other organisms as candidate, species of concern, sensitive, watch, and review (see Table 3–8). This section addresses special status species for Hanford as a whole, as well as for the proposed facility locations. Informal consultation has been conducted with USFWS, National Oceanic and Atmospheric Administration Fisheries, the Washington State Department of Fish and Wildlife, and the Washington Natural Heritage Program concerning listed species that are potentially present on Hanford (see Appendix C).

3.2.7.4.1 General Site Description

Threatened, endangered, and other federally and state-listed special status species that occur on Hanford are presented in Table 3–8. One federally endangered species and 2 federally threatened species are found on the site. Two species of plants, 1 of birds, and 1 of mammals are listed as Federal candidates, and 4 plants, 1 mollusk, 1 fish, 1 amphibian, 1 reptile, 6 birds, and 1 mammal are designated as Federal species of concern. Neither the candidates nor the species of concern receive legal protection; however, they should be considered during project planning. At the state level, 2 species of plants and 2 of birds are listed as endangered, and 10 plants and 3 birds are listed as threatened. Numerous additional plants and animals have other state special status designations.

Table 3–8. Hanford Site Threatened, Endangered, and Other Special Status Species

Common Name	Scientific Name	Status	
		Federal	State
Plants			
Annual paintbrush	*Castilleja exilis*		Watch
Annual sandwort	*Minuartia pusilla* var. *pusilla*		Review Group 1
Awned halfchaff sedge	*Lipocarpha (=Hemicarpha) aristulata*		Threatened
Basalt milkvetch	*Astragalus conjunctus* var. *rickardii*		Watch
Beaked spike-rush	*Eleocharis rostellata*		Sensitive
Bristly combseed	*Pectocarya setosa*		Watch
Canadian St. John's wort	*Hypericum majus*		Sensitive
Chaffweed	*Anagallis minima Centunculus minimus*		Sensitive
Columbia milkvetch	*Astragalus columbianus*	Species of concern	Sensitive
Columbia River mugwort	*Artemisia lindleyana*		Watch
Columbia yellowcress	*Rorippa columbiae*	Species of concern	Endangered
Coyote tobacco	*Nicotiana attenuata*		Sensitive
Crouching milkvetch	*Astragalus succumbens*		Watch
Desert dodder	*Cuscuta denticulate*		Threatened
Desert evening primrose	*Oenothera caespitosa* ssp. *caespitosa*		Sensitive
Dwarf evening primrose	*Camissonia (=Oenothera) pygmaea*		Sensitive
False pimpernel	*Lindernia dubia* var. *anagallidea*		Watch
Fuzzytongue penstemon	*Penstemon eriantherus whitedii*		Sensitive
Geyer's milkvetch	*Astragalus geyeri*		Threatened
Giant helleborine	*Epipactis gigantea*		Watch
Grand redstem	*Ammannia robusta*		Threatened
Gray cryptantha	*Cryptantha leucophaea*	Species of concern	Sensitive
Great Basin gilia	*Aliciella leptomeria*		Threatened
Hoover's desert parsley	*Lomatium tuberosum*	Species of concern	Sensitive
Kittitas larkspur	*Delphinium multiplex*		Watch
Loeflingia	*Loeflingia squarrosa* var. *squarrosa*		Threatened
Lowland toothcup	*Rotala ramosior*		Threatened
Medick milkvetch	*Astragalus speirocarpus*		Watch
Miner's candle	*Cryptantha scoparia*		Sensitive
Mousetail	*Myosurus clavicaulis*		Sensitive
Piper's daisy	*Erigeron piperianus*		Sensitive
Porcupine sedge	*Carex hystericina*		Watch
Robinson's onion	*Allium robinsonii*		Watch
Rosy balsamroot	*Balsamorhiza rosea*		Watch
Rosy pussypaws	*Cistanthe rosea*		Threatened
Scilla onion	*Allium scilloides*		Watch
Small-flowered evening primrose	*Camissonia* (=*Oenothera*) *minor*		Sensitive

Table 3–8. Hanford Site Threatened, Endangered, and Other Special Status Species *(continued)*

Common Name	Scientific Name	Status	
		Federal	State
Plants *(continued)*			
Small-flowered nama	*Nama densum* var. *parviflorum*		Watch
Smooth cliffbrake	*Pellaea glabella var. simplex*		Watch
Snake River cryptantha	*Cryptantha spiculifera (= C. interrupta)*		Sensitive
Stalked-pod milkvetch	*Astragalus sclerocarpus*		Watch
Suksdorf's monkey flower	*Mimulus suksdorfii*		Sensitive
Thompson's sandwort	*Eremogone franklinii* var. *thompsonii*		Review Group 1
Umtanum desert buckwheat	*Eriogonum codium*	Candidate	Endangered
White Bluffs bladderpod	*Physaria douglasii* ssp. *tuplashensis*	Candidate	Threatened
White eatonella	*Eatonella nivea*		Threatened
Winged combseed	*Pectocarya penicillata*		Watch
Insects			
Columbia River tiger beetle[a]	*Cicindela columbica*		Candidate
Mollusks			
California floater	*Anodonta californiensis*	Species of concern	Candidate
Giant Columbia River limpet	*Fisherola (=Lanz) nuttalli*		Candidate
Giant Columbia River spire snail	*Fluminicola (=Lithoglyphus) columbiana*		Candidate
Fish			
Bull trout[b]	*Salvelinus confluentus*	Threatened	Candidate
Leopard dace[b]	*Rhinichthys flacatus*		Candidate
Mountain sucker[b]	*Catastomus platyrhynchus*		Candidate
River lamprey[b]	*Lampetra ayresi*	Species of concern	Candidate
Spring-run Chinook salmon	*Oncorhynchus tshawytscha*	Endangered[c]	Candidate
Steelhead	*Oncorhynchus mykiss*	Threatened[c, d]	Candidate
Amphibians			
Western toad	*Bufo boreas*	Species of concern	Candidate
Reptiles			
Northern sagebrush lizard	*Sceloporous graciosus*	Species of concern	Candidate
Striped whipsnake	*Masticophis taeniatus*		Candidate
Birds			
American white pelican	*Pelecanus erythrorhynchos*		Endangered
Bald eagle[e]	*Haliaeetus leucocephalus*	Species of concern	Sensitive
Burrowing owl	*Athene cunicularia*	Species of concern	Candidate
Common loon	*Gavia immer*		Sensitive
Ferruginous hawk	*Buteo regalis*	Species of concern	Threatened
Flammulated owl[b]	*Otus flammeolus*		Candidate
Golden eagle	*Aquila chrysaetos*		Candidate
Greater sage grouse	*Centrocercus urophasianus phaios*	Candidate	Threatened

Table 3–8. Hanford Site Threatened, Endangered, and Other Special Status Species *(continued)*

Common Name	Scientific Name	Status	
		Federal	State
Birds *(continued)*			
Lewis's woodpecker[b]	*Melanerpes lewis*		Candidate
Loggerhead shrike	*Lanius ludovicianus*	Species of concern	Candidate
Merlin	*Falco columbarius*		Candidate
Northern goshawk[b]	*Accipter gentilis*	Species of concern	Candidate
Peregrine falcon	*Falco peregrinus*	Species of concern	Sensitive
Sage sparrow	*Amphispiza belli*		Candidate
Sage thrasher	*Oreoscoptes montanus*		Candidate
Sandhill crane	*Grus canadensis*		Endangered
Western grebe	*Aechmophorus occidentalis*		Candidate
Western sage grouse	*Centrocercus urophasianus phaios*		Threatened
Mammals			
Black-tailed jackrabbit	*Lepus californicus*		Candidate
Merriam's shrew	*Sorex merriami*		Candidate
Townsend's ground squirrel	*Spermophilus townsendii*	Species of concern	Candidate
Washington ground squirrel[b]	*Spermophilus washingtoni*	Candidate	Candidate
White-tailed jackrabbit	*Lepus townsendii*		Candidate

[a] Probable but not observed on the Hanford Site.
[b] Reported but seldom seen on the Hanford Site.
[c] Protected as an Evolutionarily Significant Unit for the upper Columbia River.
[d] Protected as an Evolutionarily Significant Unit for the middle Columbia River.
[e] Removed from the list of threatened wildlife in the lower 48 states effective August 8, 2007 (72 FR 37346).

Federal:
Candidate: Current information indicates the probable appropriateness of listing as endangered or threatened.
Endangered: In danger of extinction throughout all or a significant portion of its range.
Species of Concern: Conservation standing is of concern, but status information is still needed (not published in the *Federal Register*).
Threatened: Likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

State:
Candidate: Current information indicates the probable appropriateness of listing as endangered or threatened.
Endangered: In danger of becoming extinct or extirpated from Washington State within the foreseeable future if factors contributing to its decline continue.
Review Group 1: Of potential concern; additional fieldwork is needed before a status can be assigned.
Review Group 2: Of potential concern; unresolved taxonomic questions.
Sensitive: Vulnerable or declining and could become endangered or threatened in Washington State without active management or removal of threats.
Threatened: Likely to become endangered in Washington State within the foreseeable future if factors contributing to its decline or habitat degradation or loss continue.
Watch: More abundant and/or less threatened than previously assumed, but still of interest to the state.
Source: Duncan 2007:4.106, 4.107, 4.109–4.113; USFWS 2007:2-35–2-37; WDFW 2010a; WNHP 2009, 2011.

Of the three fish species listed as threatened and endangered, only the upper Columbia River steelhead spawns in the Hanford Reach, although the extent of spawning is not known. The Upper Columbia River spring-run Chinook salmon do not spawn in the Hanford Reach, but adults pass through the Reach while migrating to spawning grounds, and the juveniles use it as a nursery area until they migrate toward the ocean. The bull trout primarily inhabits smaller streams, usually at higher elevations. The bald eagle is a relatively common winter resident along the Hanford Reach. Although it has occasionally attempted to nest on Hanford, it has not been successful (Duncan 2007:4.105, 4.108). Although not listed in Table 3−8 as a special status species, the long-billed curlew is a state monitor species, indicating that it is monitored for status and distribution (WDFW 2010b).

Twelve species of plants that occur on Hanford are listed as threatened or endangered in Washington (see Table 3–8). Four of these, chaffweed, awned halfchaff sedge, grand redstem, lowland toothcup, and Columbia yellowcress, are found in areas along the Columbia River. Desert dodder has been found along a dry drainage in Cold Creek Valley and on White Bluffs. Other species associated with White Bluffs include Geyer's milkvetch and White Bluffs bladderpod. White Bluffs bladderpod has been reported nowhere else in the world. Great Basin gilia has been reported near Gable Mountain and at various locations on the Wahluke Slope. Loeflingia and rosy pussypaws have been found in the sandy areas north of Gable Mountain. Umtanum desert buckwheat has been reported growing in thin rocky soils along the crest of Umtanum Ridge and nowhere else in the world. White eatonella has been found locally on steep, sandy slopes near Vernita Bridge (Sackschewsky and Downs 2001:3.15, 3.34, 3.40, 3.45, 3.49, 3.54, 3.72, 3.92, 3.94, 3.101, 3.103).

Four state-listed threatened or endangered birds have been recorded at Hanford. The American white pelican is fairly common along the Hanford Reach, but does not appear to nest or reproduce there. The ferruginous hawk has nested in several areas, including numerous locations in the eastern portion of the site. The greater sage grouse was sighted on the Fitzner-Eberhardt Arid Lands Ecology Reserve in the late 1900s and, in 2003, a dead individual was found near the 100-F Area. Sandhill cranes have been occasionally observed on the Hanford Reach during their spring migration (DOE 1999a:4-59; Duncan 2007:4.105).

USFWS has revised the designation of critical habitat for the bull trout to include the Mainstem Upper Columbia River and Yakima River units (75 FR 63898). The Mainstem Upper Columbia River unit extends upstream from the John Day Dam to the Chief Joseph Dam and includes the Hanford Reach. It provides connectivity between the Mainstem Upper Columbia River habitat unit and 13 additional units. The Yakima River unit includes the entire Yakima River basin, including the portion bordering Hanford to the south. It supports one of the largest populations of bull trout (South Fork Tieton River population above Tieton Dam) in central Washington and provides spawning, rearing, foraging, migratory, connecting, and overwintering habitat.

Although not critical habitat per se, pristine shrub-steppe habitat is considered by Washington State to be a priority habitat. It is so designated because of its relative scarcity in the state and its requirement as nesting/breeding habitat by several federally and state-listed species (WDFW 2007). Designation and characterization of priority habitat provide a basis for sound and defensible land management planning and assist DOE in integrating stewardship activities into site management to protect regulated species.

Up to 9 plant and 10 animal special status species could have been found in the 56,246-hectare (138,986-acre) area that was burned by the 24 Command Fire at Hanford (DOI 2000:v, 121). Direct effects of the fire on protected vegetation included loss of plants and seed stock. Indirect effects included increased competition from invasive plant species, potential loss of soil productivity due to wind erosion, and loss of seed viability; however, indirect effects could also include such benefits as the release of nutrients back into the soil and reduced competition for soil nutrients, soil moisture, and sun. As for wildlife, the 24 Command Fire was determined to have had no effect on any federally listed threatened or endangered species. Potential impacts on state-listed species included direct loss of adults and young, while indirect effects included loss of habitat used as cover and for feeding and raising young. An assessment of the impacts of the 2007 Milepost 17 and Wautoma Fires on threatened and endangered species has not been made.

3.2.7.4.2 200 Areas Description

No federally or state-listed threatened or endangered species have been observed within, or in the immediate vicinity of, the 200 Areas; however, a number of other special status species have been found within areas potentially affected by Tank Closure alternatives (Sackschewsky 2003c, 2003d; Sackschewsky and Downs 2007). Piper's daisy has been observed in the vicinity of the WTP, along the route of the 200-East Area underground transfer line, between the 200-East and 200-West Areas, and within STTS-West. Stalked-pod milkvetch has been found in the vicinity of the WTP and within both STTS-East and -West. Another milkvetch species, crouching milkvetch, was observed within the vicinity of the WTP, within STTS-East, and between the 200-East and 200-West Areas.

Special status animal species that have been observed within areas potentially impacted by Tank Closure alternatives include the sage sparrow, black-tailed jackrabbit, and loggerhead shrike. The sage sparrow has been found within the vicinity of the WTP, within STTS-West, and between the 200-East and 200-West Areas. The black-tailed jackrabbit has been seen along the route of the 200-East Area underground transfer line and between the 200-East and 200-West Areas. The loggerhead shrike was observed within STTS-West and between the 200-East and 200-West Areas. Finally, the long-billed curlew, a state monitor species, was observed along the route of the 200-East Area underground transfer line. Because of the importance of sagebrush habitat, many of these species could be present anywhere such habitat exists (Sackschewsky 2003c, 2003d; Sackschewsky and Downs 2007). In addition to those animals observed within the 200 Areas, the ferruginous hawk, loggerhead shrike, and burrowing owl have been observed nesting in the vicinity, and the block of habitat to the south provides some of Hanford's best sage sparrow habitat (DOE 1999a:4-57, 4-59).

3.2.7.4.3 400 Area Description

No federally or state-listed threatened or endangered plants or animals have been found in the vicinity of the 400 Area (Duncan 2007:106, 107), although a potential exists for the incidental occurrence of some migratory species such as the peregrine falcon. State-listed sensitive plant species have not been found in the 400 Area; however, Piper's daisy does occur in the vicinity. A fire burned the area in the mid-1980s, leaving it dominated by cheatgrass and some small shrubs (DOE 2000a:3-122).

3.2.7.4.4 Borrow C Area Description

Although no federally or state-listed threatened or endangered species occur within Borrow Area C, the area provides extensive habitat for ground-nesting birds, including the long-billed curlew. Two special status plant species have been observed there. Piper's daisy is known to occur in rather high numbers south of the area, and at least one individual has been found along the new access road. Crouching milkvetch and stalked-pod milkvetch have also been observed in Borrow Area C (Sackschewsky 2003b:7; Sackschewsky and Downs 2007:8).

3.2.8 Cultural and Paleontological Resources

Cultural resources are of two primary categories: prehistoric resources, or physical properties reflecting human activities that predate written records; and historic resources, or physical properties that postdate the advent of written records—in the United States, generally considered to be those documented no earlier than 1492. These resources are of special interest and importance to American Indians and include all areas, sites, and materials deemed important for religious or heritage-related reasons, as well as certain natural resources such as plants, which have many uses within various American Indian groups. Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geologic age that may be sources of information on paleoenvironments and the evolutionary development of plants and animals.

Historic and prehistoric human imprints on the Hanford landscape are well documented, as are local traces of plants and animals from earlier geologic ages, and these cultural and paleontological resources are defined and protected by a series of Federal laws, regulations, and guidelines. The *Hanford Cultural Resources Management Plan* (DOE 2003c) established guidance for identifying, evaluating, recording, curating, and managing such resources. Moreover, cultural resource reviews are typically conducted whenever projects are proposed in previously unsurveyed areas (Neitzel 2005:4.99). Such a review has been conducted in those areas of Hanford that could be developed in connection with the proposed actions analyzed in this *TC & WM EIS* (PNNL 2003, 2007a). Archaeological reconnaissance projects dated from 1926 to 1968 and more-recent National Historic Preservation Act Section 106 and Section 110 surveys conducted between 1987 and 2007 have resulted in formal recording of these resources on archaeological forms and Washington State Historic Property Inventory Forms. DOE archives these records (Duncan 2007:4.6). Additionally, consultation with the Washington State Historic Preservation Office and interested American Indian tribes has been initiated for this EIS (see Appendix C), and a programmatic agreement has been developed among the DOE Richland Operations Office, the Advisory Council on Historic Preservation, and the Washington State Historic Preservation Office regarding the built environment on Hanford (DOE 1996b).

During 1990, the National Park Service formalized the concept of the traditional cultural property (TCP) as a means to identify and protect cultural landscapes, places, and objects that have special cultural significance to American Indians and other ethnic groups. A TCP that is eligible for the National Register of Historic Places (National Register) is associated with the cultural practices or beliefs of a living community that are rooted in that community's history and are important in maintaining the continuing cultural identity of the community.

The Hanford Reach and the greater Hanford Site are central to the practice of the American Indian religion of the region. Native plants and animals are used in ceremonial foods. Prominent landforms such as Rattlesnake Mountain, Gable Mountain, and Gable Butte, as well as various sites along and including the Columbia River, remain sacred.

American Indian TCPs within Hanford include, but are not limited to, a wide variety of landscapes such as archaeological sites, cemeteries, trails and pathways, campsites and villages, fisheries, hunting grounds, plant-gathering areas, holy lands, landmarks, and important places of American Indian history and culture (Duncan 2007:4.120).

3.2.8.1 Prehistoric Resources

3.2.8.1.1 General Site Description

More than 8,000 years of prehistoric human activity in the largely arid environment of the middle Columbia River region have left extensive archaeological deposits along the river shores. Well-watered areas inland from the river also show evidence of concentrated human activity, and recent surveys have indicated transient use of arid lowlands for hunting. These cultural sites were occupied continuously or intermittently over substantial timespans. For this reason, a single location may contain evidence of use during both the prehistoric and historic periods, and thus the number of "occupations" could prove substantially greater than the number of identified sites (Neitzel 2005:4.103).

To date, approximately 32,630 hectares (80,640 acres) of Hanford and adjacent areas have been surveyed for archaeological resources. Approximately 1,550 cultural resource sites and isolated finds and 531 buildings and structures have been documented. Forty-nine cultural resource sites are listed in the National Register. Most of these sites are associated with the American Indian landscape and are part of six archaeological districts situated on the shores and islands of the Columbia River. To protect resources, the National Historic Preservation Act (16 U.S.C. 470 et seq.), Section 304, and the

Archaeological Resources Protection Act (16 U.S.C. 470aa et seq.), Section 9, require agencies to withhold from public disclosure information on the location and character of cultural resources (Duncan 2007:4.115).

Prehistoric period sites common to Hanford include remains of numerous pithouse villages, various types of open campsites, spirit quest monuments (rock cairns), hunting camps, game drive complexes, quarries in mountains and rocky bluffs, hunting and kill sites in lowland stabilized dunes, and small temporary camps near perennial sources of water away from the river (Duncan 2007:4.120).

Although development and amateur artifact collectors have disturbed many prehistoric resources throughout the region, restricted public access imposed at Hanford has resulted in less destruction than in many other areas (Duncan 2007:4.120). Destruction from other causes is also slight. A preliminary assessment of possible effects of the 24 Command Fire, for example, determined that a minimum of 190 previously recorded prehistoric and historic archaeological sites could have been affected (DOI 2000:80). These sites range from lithic to can scatters, American Indian hunting sites to ranch buildings, and spirit quest monuments to gas production wells. The assessment found that wooden structures (e.g., a corral) were destroyed, but that other surface and subsurface artifacts such as glass and lithic debris were not severely altered by the fire. Postfire surface visibility, in fact, has been greatly enhanced, presenting opportunities for archaeologists and historians to refine the boundaries of known sites and to locate new sites, though it also increases the potential for looting and vandalism.

3.2.8.1.2 200 Areas Description

A number of cultural resource surveys have been conducted within the 200 Areas (Chatters and Cadoret 1990; PNNL 2003, 2007b). The most important archaeological resource discovered in the 200 Areas is White Bluffs Road, an extensive linear feature that passes diagonally northeast to southwest through the 200-West Area. In the prehistoric period, the road was used as an American Indian trail. White Bluffs Road, which was mapped prior to 1881, originally ran from Fort Colville to White Bluffs Landing on the Columbia River, then southwest to the Yakima River at a point near Sunnyside, Washington, where it connected with routes to The Dalles, Oregon (Chatters and Cadoret 1990:11). White Bluffs Road in its entirety has been determined to be eligible for listing in the National Register. Two intact segments of the road within the 200-West Area are considered contributing elements. These occur in the southwest and northeast parts of the 200-West Area. A 100-meter (328-foot) easement was created to protect these segments of the road from uncontrolled disturbance. The remaining central portion of the road within the 200-West Area has been determined to be noncontributing. The noncontributing segments of White Bluffs Road are those that do not add to the historic significance of the road, but retain evidence (i.e., contiguous traces) of its bearing (Chatters and Cadoret 1990:11, 21; Duncan 2007:4.130).

Additional finds within and adjacent to the 200 Areas that are associated with the prehistoric period include two cryptocrystalline silica flakes (i.e., fragments chipped from a rock core during toolmaking) and a cryptocrystalline silica base of a projectile point that were collected and curated by archaeologists upon discovery. The former were found within the northwestern portion of the 200-West Area 300 meters (984 feet) northwest of White Bluffs Road and may have been associated with its use (Chatters and Cadoret 1990:15, 16). The latter was discovered immediately to the east of the 200-East Area (PNNL 2003). These artifacts have become part of the curated Hanford collection. An additional isolated and incomplete cryptocrystalline silica projectile point was recorded and left in place in the 200 Areas in 2007. Survey results and geologic data indicate that this area has a low potential for the presence of prehistoric subsurface cultural deposits (PNNL 2007b).

3.2.8.1.3 400 Area Description

In 1978, an archaeological reconnaissance survey of the 400 Area was conducted. At that time, the survey indicated that most of the 400 Area, except for 12.1 hectares (30 acres), had already been disturbed by the construction of FFTF. The survey did not disclose any archaeological resources, and other surveys conducted near the project area disclosed no cultural resources. The 400 Area is considered a low-archaeological-sensitivity area (Duncan 2007:4.133; Prendergast 2002).

3.2.8.1.4 Borrow Area C Description

There are no prehistoric archaeological sites recorded within Borrow Area C. Survey results and geologic data on Borrow Area C indicate no-to-low potential for the presence of prehistoric subsurface cultural deposits (PNNL 2007b).

3.2.8.2 Historic Resources

3.2.8.2.1 General Site Description

Lewis and Clark were some of the first European Americans to visit the Hanford region during their 1804–1806 expedition. They were followed by fur trappers, military units, and miners. It was not until the 1860s that merchants set up stores, a freight depot, and the White Bluffs Ferry on the Hanford Reach, and gold miners began to work the gravel bars. Cattle ranches opened in the 1880s, and farmers soon followed. Several small thriving towns, including Hanford, White Bluffs, and Ringold, grew up along the riverbanks in the early twentieth century. Other ferries were established at Wahluke and Richland. These towns, and nearly all other structures, were razed after the U.S. Government acquired the land for the original Hanford Engineer Works (part of the Manhattan Project) in the early 1940s (Neitzel 2005:1.104). Today, the remnants of homesteads, farm fields, ranches, municipal facilities (e.g., Hanford High School, White Bluff Bank), and abandoned military installations can be found throughout Hanford. There are nearly 5,260 hectares (13,000 acres) of abandoned agricultural lands on the site (DOE and Ecology 1996:4-37).

During the years of the Manhattan Project and the Cold War, numerous nuclear reactors and associated processing facilities were constructed at Hanford. The reactor sites cover over 930 hectares (2,300 acres) of land. All of the reactor buildings and major processing facilities still stand, although many ancillary support structures have been removed. Plutonium produced at Hanford was used in the bomb that destroyed Nagasaki, Japan, to help end World War II. The Hanford 105-B Reactor, the world's first full-scale plutonium production reactor, is listed in the National Register and is designated a National Mechanical Engineering Landmark, a National Historic Civil Engineering Landmark, and a National Nuclear Engineering Landmark (DOE and Ecology 1996:4-37; Neitzel 2005:4.109). On August 19, 2008, the B Reactor was designated as a National Historic Landmark (DOE and DOI 2008).

Approximately 650 historic archaeological sites associated with the early-settler cultural landscape have been recorded since 1987. Archaeological resources from this period are scattered over Hanford and include numerous areas with gold-mining features along the Columbia riverbanks, as well as the remains of homesteads, building foundations, agricultural equipment and fields, ranches, and irrigation features. Historic sites from this period include the Hanford Irrigation Ditch; Old Hanford Townsite; Wahluke Ferry; White Bluffs Townsite; Richmond Ferry; Arrowsmith Townsite; White Bluffs Road; and Chicago, Milwaukee, St. Paul, and Pacific Railroad (Neitzel 2005:4.106).

The Manhattan Project and Cold War era landscape includes cultural resources associated with plutonium production, military operations, R&D, waste management, and environmental monitoring activities. Such activities began with the establishment of Hanford (the Hanford Engineer Works) in 1943 and continued until the end of the Cold War in 1990. DOE identified a National Register–eligible Hanford Site

Manhattan Project and Cold War Era Historic District. Approximately 900 buildings and structures were identified as either contributing properties with no individual documentation requirement (not selected for mitigation) or as noncontributing/exempt properties. There are 528 Manhattan Project and Cold War era buildings/structures and complexes eligible for National Register listing as contributing properties within the Historic District. Of that number, 190 have been recommended for individual documentation (Duncan 2007:4.119, 4.124).

3.2.8.2.2 200 Areas Description

Much of the 200 Areas has been altered by Hanford operations. The Hanford Cultural Resources Program conducted a comprehensive archaeological resources survey of the fenced portions of the 200 Areas during 1987 and 1988 (Chatters and Cadoret 1990). The results indicate minimal evidence of American Indian cultural landscape resources and early settler/farming landscape resources. Archaeological surveys conducted since that time have revealed the same pattern (Duncan 2007:4.6.4.2).

As stated previously (see Section 3.2.8.1.2), the White Bluffs Road traverses the 200-West Area. It was originally used as an American Indian trail connecting an important water source, Rattlesnake Springs, with a favorite river crossing on the Columbia River at White Bluffs. White Bluffs Road was an important transportation route during mining, cattle ranching, and settlement eras in the Washington Territory. It played a role in European-American immigration, development, agriculture, and Hanford operations, and thus is of historic importance (Chatters and Cadoret 1990:17; Neitzel 2005:4.113). As noted previously, White Bluffs Road has been determined to be eligible for listing in the National Register (see Section 3.2.8.1.2). The survey conducted during 2000 on White Bluffs Road recorded an additional 54 historic isolated finds and two precontact isolated finds, as well as six dump features (Duncan 2007:4.130).

The only historic artifacts more than 50 years old that were found in the 200-East Area are a hole-in-top can and a flat-topped crimped can. These artifacts were found in the south-central part of the area (Chatters and Cadoret 1990:11, 13, 15, 16; PNNL 2003). An additional site containing cans is located south of the WTP and slightly north of Route 4 South. This site consists of a small military refuse pile of cans and Coke bottles and is likely associated with the National Register–eligible anti-aircraft artillery site located about 400 meters (1,312 feet) south of Route 4 South. This site is considered a noncontributing feature associated with the anti-aircraft artillery site and thus not eligible for listing in the National Register (PNNL 2003).

A historic property inventory has been completed for 72 buildings and structures in the 200 Areas. Of that number, 58 have been deemed eligible for National Register listing as contributing properties within the Hanford Site Manhattan Project and Cold War Era Historic District and thus recommended for mitigation. Included are the 234-5Z Plutonium Finishing Plant, 236-Z Plutonium Reclamation Facility, 242-Z Water Treatment Facility, 231-Z Plutonium Metallurgical Laboratory, 225-B Encapsulation Building, 221-T Canyon (T Plant) Building, 202-A PUREX Building, 202-S REDOX [Reduction-Oxidation] Plant, 212-N Lag Storage Facility, 282-E Pumphouse and Reservoir Building, 283-E Water Filtration Plant, and 284-W Power House and Steam Plant. The 232-Z Waste Incinerator Facility and the 233-S Plutonium Concentration Building are also eligible for the National Register and, along with the 221-T Plant, have been documented to Historic American Engineering Record Standards. The 233-S building was recently demolished. As required by the programmatic agreement with the Advisory Council on Historic Preservation and the Washington State Historic Preservation Office, DOE assessed the contents of the historic buildings and structures within the 200 Areas, and identified and tagged artifacts with interpretive and/or educational value as exhibits within local, state, or national museums (DOE 1996b:8).

An additional feature of historic importance located to the west of the 200-East Area is a small portion of one of the Hanford Atmospheric Dispersion Test Facility arc roads. This portion of the road was determined to be a contributing property within the Manhattan Project and Cold War Era Historic District and was recommended for individual documentation. A Historic Property Inventory Form was completed, and numerous artifacts were identified as having interpretive or educational value in potential exhibits. A selected, representative number of these artifacts were removed and added to the curated Hanford collection (PNNL 2003).

3.2.8.2.3 400 Area Description

Most of the 400 Area has been so altered by construction activities that archaeologists surveying the site during 1978 were able to find only 122 hectares (300 acres) that were undisturbed (Duncan 2007:4.133). In 2002, the Hanford Cultural Resources Laboratory of Pacific Northwest National Laboratory conducted a cultural resource review for deactivation and decommissioning of FFTF within the 400 Area at Hanford (Prendergast 2002). A historic properties survey conducted as part of the review included a literature and records search for the Area of Potential Effect. Five buildings within FFTF were determined to be eligible for National Register listing under criterion A—i.e., they are contributing properties recommended for mitigation within the Hanford Site Manhattan Project and Cold War Era Historic District. The five buildings include the 405 FFTF Reactor Containment Building, the 436 Training Facility, the 4621-W Auxiliary Equipment Facility, the 4703 FFTF Control Building, and the 4710 Operation Support Building. Selection of these five properties followed from the programmatic agreement between DOE, the Advisory Council on Historic Preservation, and the Washington State Historic Preservation Office (DOE 1996b). Both Historic Property Inventory Forms and Expanded Historic Property Inventory Forms were completed for these facilities (Duncan 2007:4.133).

In addition to these 5 buildings, 16 additional buildings within FFTF are eligible for inclusion in the National Register as contributing properties within the Hanford Site Manhattan Project and Cold War Era Historic District, and for these no individual documentation is required. These 16 buildings include the 403 Fuel Storage Facility; 408-A, 408-B, and 408-C Dump Heat Exchangers; 409-A and 409-B Closed Loop Dump Heat Exchangers; 437 Maintenance and Storage Facility; 451-A Substation; 481 and 481-A Pump Houses; 491-E, 491-S, and 491-W Heat Transport Buildings; 4621-E Auxiliary Equipment Building East; 4701-A Guard House; and 4717 Reactor Service Building (Prendergast 2002).

An additional 16 facilities within FFTF are noncontributing properties and thus not eligible for the National Register. They are the 480-A, 480-B, and 480-D Well Pump Houses; Pump 440 90-Day Pad; 432-A Rigging Shed; 482-A Water Storage Tank T-58, 482-B Water Storage Tank T-87, and 482-C Water Storage Tank T-330; 484 Incontainment Chilled Water Building; 4713-A Carpenter Shop; 4713-B Maintenance Shop; 4713-C Warehouse; 4713-D Manipulator Repair Shop; 4716 Rigging Loft; 4721 Turbine Generator; and 4608-B Process Sewer Building (Prendergast 2002).

In December 2002, the Hanford Cultural Resources Laboratory was contracted by DOE-RL, under a Request for Cultural Resources Review, to prepare a curation management plan for the deactivation and decommissioning of FFTF. The purpose of the plan was to ensure the project is in compliance with the requirements of the National Historic Preservation Act of 1966 (as amended) and the programmatic agreement regarding the maintenance, deactivation, alteration, and demolition of the built environment at Hanford (DOE 1996b; Harvey 2002).

The Hanford Cultural Resources Laboratory conducted walkthroughs and prepared written and photographic documentation of the five buildings (405, 436, 4621-W, 4703, and 4710) inside the 400 Area Property Protected Area that were identified as eligible for inclusion in the National Register under criterion A using either a Historic Property Inventory Form or an Expanded Historic Property Inventory Form. Given the possible occurrence of significant artifacts, the Hanford Cultural Resources

Laboratory also conducted walkthroughs of the 16 contributing properties for which no individual documentation was required. In total, 30 artifacts were identified and tagged in 8 of the 21 historic buildings (405, 4703, 436, 403, 4621-E, 4621-W, 4710, and 4701-A) and 1 of the nonhistoric buildings (4732-C). Included were industrial equipment and machinery, photographs and graphs, publications, control room panels, and models. Dimensions of the artifacts were recorded with a view to assessing storage and curation needs. Issues concerning the eventual storage and curation of these artifacts are not yet resolved (Harvey 2002).

A curation management plan was submitted to the State of Washington's Office of Archaeology and Historic Preservation for review and concurrence. In a response dated February 26, 2003, the Deputy State Historic Preservation Officer reported concurrence with the plan's findings and conclusions and support of its recommendations as to interpretation, storage, and curation of the artifacts at FFTF. The Deputy State Historic Preservation Officer did express concern, however, over the levels of contamination at FFTF and in that connection raised the possibility that none of the historic artifacts would be preserved in light of contamination found at FFTF (Griffith 2003).

3.2.8.2.4 Borrow Area C Description

Survey results and geologic data on Borrow Area C indicate no-to-low potential for the presence of historic subsurface cultural deposits. One historic isolated find recorded in 2007 consists of three hole-in-top cans associated with early settler use (PNNL 2007b).

3.2.8.3 American Indian Interests

3.2.8.3.1 General Site Description

In prehistoric and early historic times, American Indians of various tribal affiliations heavily populated the Hanford Reach, and some of their descendants still live in the region. Present-day tribal members retain traditional secular and religious ties to the region, and many have knowledge of the ceremonies and lifeways of their culture. The Washani, or Seven Drums religion, which has ancient roots, is still practiced by many American Indians. Native plant and animal foods, some of which can be found at Hanford, are used in ceremonies performed by tribal members (DOE 2000a:3-125).

Under separate treaties signed in 1855, a number of regional American Indian tribes ceded lands that included the present area of Hanford to the United States. Under the treaties, the tribes reserved the right to fish at usual and accustomed places in common with the citizens of the territory. They also retained the privilege of hunting, gathering roots and berries, and pasturing horses and cattle upon open and unclaimed land. However, it is the position of DOE that Hanford, like other ceded lands that were settled or used for specific purposes, is not open and unoccupied land. All of these tribes are active participants in decisions regarding Hanford and have expressed concerns about hunting, fishing, pasture rights, and access to plant and animal communities and important sites. Tribal concerns have been considered by DOE in the development of this *TC & WM EIS*. For example, American Indian tribal government perspectives on the cleanup at Hanford are provided in Appendix W.

American Indian TCPs within Hanford include, but are not limited to, various archaeological sites, cemeteries, trails and pathways, campsites and villages, fisheries, hunting grounds, plant-gathering areas, holy lands, landmarks, places important in American Indian history, places of persistence and resistance, and "landscapes of the heart" (Duncan 2007:4.120). Culturally important geographic features include Rattlesnake Mountain, Gable Mountain, Gable Butte, Coyote Rapids, and the White Bluffs portion of the Columbia River.

3.2.8.3.2 200 Areas Description

As noted above (see Section 3.2.8.1.2), White Bluffs Road, which was originally used as an American Indian trail, traverses the 200-West Area. In addition, two cryptocrystalline silica flakes, a cryptocrystalline silica base of a projectile point, and an incomplete cryptocrystalline silica projectile point were found in or near the 200 Areas (PNNL 2003, 2007b). Many sites used for hunting and religious activities lie just to the north of the 200 Areas on Gable Mountain and Gable Butte. These sites are associated with the Gable Mountain/Gable Butte Cultural District (Duncan 2007:4.130). The area is also visible from Gable Mountain and Gable Butte (PNNL 2007b).

3.2.8.3.3 400 Area Description

The 400 Area is not known to contain any American Indian areas of interest (PNNL 2007b). The area is visible from State Route 240 and from three promontories of cultural and religious significance to area tribes: Rattlesnake Mountain to the southwest, Gable Mountain to the north, and Gable Butte to the northwest.

3.2.8.3.4 Borrow Area C Description

Borrow Area C is not known to contain any American Indian areas of interest, and has no-to-low potential for the presence of prehistoric subsurface cultural deposits. The area is visible from Rattlesnake Mountain (PNNL 2007b).

3.2.8.4 Paleontological Resources

3.2.8.4.1 General Site Description

Remains from the Pliocene and Pleistocene ages have been identified at Hanford. The Upper Ringold Formation dates to the late Pliocene age and contains fish, reptile, amphibian, and mammal fossil remains. Late Pleistocene Touchet Beds have yielded mammoth bones. These beds are composed of fluvial sediments deposited along the ridge slopes that surround Hanford (DOE 2000a:3-126).

3.2.8.4.2 200 Areas Description

No paleontological resources have been identified in the 200 Areas (Schinner 2003).

3.2.8.4.3 400 Area Description

No paleontological resources have been reported in the 400 Area. Late Pleistocene Touchet Beds, which have yielded mammoth bones, are found at distances greater than 5 kilometers (3.1 miles) from the 400 Area (DOE 2000a:3-127).

3.2.8.4.4 Borrow Area C Description

No paleontological resources have been reported in Borrow Area C (PNNL 2007b).

3.2.9 Socioeconomics

This section describes socioeconomic variables associated with community growth and development within the Hanford ROI that could potentially be affected, directly or indirectly, by changes at Hanford. Included are economic characteristics, the region's demography, housing and community services, and local transportation.

Hanford and the communities that support it can be described as a dynamic socioeconomic system. The communities provide the people, goods, and services required by Hanford operations. Hanford, in turn, creates the demand for people, goods, and services and pays for them in the form of wages, salaries, benefits, and payments for goods and services. Effective community support of Hanford's demands depends on the communities' ability to respond to changing environmental, social, economic, and demographic conditions.

The areas in which Hanford employees and their families reside, spend their incomes, and use their benefits, thereby affecting the economic conditions of the region, define the Hanford socioeconomic ROI. This ROI encompasses Benton and Franklin Counties, Washington, which coincides with the statistical boundaries of the Tri-Cities (Richland, Pasco, and Kennewick) Metropolitan Statistical Area. According to employee residence records from April 2007, over 90 percent of DOE contract employees of Hanford live in Benton and Franklin Counties. Approximately 73 percent reside in Richland, Pasco, or Kennewick—more than 36 percent in Richland, 11 percent in Pasco, and 25 percent in Kennewick. Residents of other areas of Benton and Franklin Counties, including West Richland, Benton City, and Prosser, account for about 17 percent of total DOE contractor employment (Duncan 2007).

3.2.9.1 Regional Economic Characteristics

In fiscal year 2006, Hanford employed an average of 9,760 persons, approximately 11 percent of the civilian labor force in the ROI (Duncan 2007). For each full-time person employed at Hanford, approximately 0.75 full-time jobs were added to the local economy (Perteet, Thomas/Lane, and SCM 2001), resulting in creation of an estimated 7,300 additional full-time jobs. This total employment of 17,000 persons (Hanford employment plus indirect employment) was equal to approximately 15 percent of the civilian labor force in the ROI (WSESD 2007).

In 2006, the civilian labor force in the ROI reached 112,000. The annual unemployment average in the regional economic area at that time was 6.3 percent, higher than the annual average of 4.9 percent in Washington State (WSESD 2007).

In general, three major sectors of employment have been the principal driving forces of the economy since the early 1970s: DOE and its contractors operating Hanford, Energy Northwest, and the agricultural community. Three other components can also be readily identified as contributors to the economic base of the Tri-Cities area. The first, loosely termed "other major employers," includes the five major non-Hanford employers in the region; the second is the tourism industry; and the third, the local purchasing power of retired former employees (Duncan 2007).

3.2.9.2 Demographic Characteristics

The demographic profile of the estimated population from the year 2010 is presented in Table 3–9. In that year, the population of the ROI was 253,000. This figure represented an increase from the 2000 census of 32 percent (Census 2011a). Self-designated minority individuals constituted 35 percent of the total population. The largest group of this minority population was Hispanic or Latino.

According to income information from the *2006–2010 American Community Survey 5-Year Estimates* (see Table 3–10), the median annual household income in Benton County, in 2010 dollars, was slightly higher than that for the state of Washington, while Franklin County's was approximately $10,000 lower than that for the state. Also, more than 12 percent of the population in Benton County was below the official poverty level, while almost 20 percent of the population of Franklin County was below that level.

Table 3–9. Demographic Profile of Populations in the Hanford Site Socioeconomic Region of Influence, 2010

Population Group	Benton County		Franklin County		Region of Influence	
	Population	Percentage of Total	Population	Percentage of Total	Population	Percentage of Total
Nonminority						
White non-Hispanic	130,000	74.5	33,800	43.2	164,000	64.8
Minority						
Black or African American[a]	2,220	1.3	1,470	1.9	3,690	1.5
American Indian and Alaska Native[a]	1,570	0.9	531	0.7	2,110	0.8
Asian[a]	4,690	2.7	1,430	1.8	6,130	2.4
Native Hawaiian and Other Pacific Islander[a]	253	0.1	107	0.1	360	0.1
Some other race[a]	15,800	9.0	24,900	31.8	40,700	16.1
Two or more races[a]	6,220	3.6	2,470	3.2	8,690	3.4
White Hispanic	14,000	8.0	13,500	17.2	27,400	10.8
Total minority	**44,700**	**25.5**	**44,400**	**56.8**	**89,100**	**35.2**
Total Hispanic or Latino (of any race)[b]	**32,700**	**18.7**	**40,000**	**51.2**	**72,700**	**28.7**
Total	**175,000**		**78,200**		**253,000**	

[a] Includes individuals who identified themselves as Hispanic or Latino.

[b] Includes all individuals who identified themselves as Hispanic or Latino, regardless of race.

Note: Total may not equal the sum of the contributions due to rounding.

Source: Census 2011a.

Table 3–10. Income Information for the Hanford Site Region of Influence, 2010

Income Category	Benton County	Franklin County	Washington State
Median household income[a]	$57,400	$47,700	$57,200
Percentage of persons below the poverty level[b]	12.7	19.9	12.1

[a] Census 2011b.

[b] Census 2011c.

3.2.9.3 Housing and Community Services

Table 3–11 presents information on housing availability, public education, and community health-care services in the ROI in 2010. There were 90,300 housing units in the two-county area, of which 83,500 were occupied. The median value of owner-occupied units was $170,000 in Benton County, which was higher than in Franklin County. The vacancy rate was similar in the two counties, Benton (4.3 percent) and Franklin (4.4 percent). In 2009, there were an estimated 11,900 apartments in the Tri-Cities, with approximately 113 available units for rent (WCRER 2009).

Community services include public education and health care (hospitals, hospital beds, and doctors). In the 2009–2010 school year, 11 school districts provided public education in the ROI, with a total enrollment of 49,100 students. During that time, the average Hanford region public school student-to-teacher ratio was 19.9 to 1, while the state public school student-to-teacher ratio was 19.4 to 1 (USDE 2011).

Table 3–11. Housing and Community Services in the Hanford Site Region of Influence, 2010

	Benton County	Franklin County	Region of Influence
Housing			
Total units[a]	66,900	23,400	90,300
Occupied housing units[a]	62,000	21,400	83,500
Vacant units for sale or rent[b]	2,760	983	3,740
Vacancy rate (percent)	4.3	4.4	4.3
Median value[c, d]	$170,000	$147,000	N/A
Public Education[e]			
Total enrollment	32,400	16,700	49,100
Student-to-teacher ratio	20.4	19.1	19.9
Community Health Care[f]			
Hospitals	4	1	5
Hospital beds per 1,000 persons	2.4	1.2	2.1
Physicians per 1,000 persons[g]	2.6	0.9	2.1

[a] Census 2011d.
[b] Census 2011e.
[c] Census 2011f.
[d] Represents median value of all owner-occupied housing units.
[e] USDE 2011.
[f] Census 2011a; WSHA 2011.
[g] AMA 2011; Census 2011a.
Key: N/A=not applicable.

There are five hospitals within the ROI, including Kadlec Medical Center, Kennewick General Hospital, Lourdes Counseling Center–Richland, Prosser Memorial Hospital in Benton County, and Lourdes Medical Center in Franklin County. The bed-to-person ratio in Benton and Franklin County hospitals (using the 2010 population) averaged 2.1 beds to 1,000 people (Census 2011a; WSHA 2011).

A total of 520 physicians serve the ROI. The average physician-to-population ratio (using the 2010 population) is 2.1 physicians to 1,000 people (AMA 2011; Census 2011a). Benton and Franklin Counties are designated by the Federal Government as health professional shortage areas. This designation can be used to access Federal dollars for improved access to health care in underserved areas of Washington State. Franklin County has already been designated as a medically underserved area (WSDOH 2011).

3.2.9.4 Local Transportation

The transportation network in the vicinity of Hanford includes two interstate highways: Interstates 82 and 182. Interstate 82 is 8 kilometers (5 miles) south-southwest of Hanford. Interstate 182, a 24-kilometer-long (15-mile-long) urban connector route 8 kilometers (5 miles) south-southeast of the site, provides an east-west corridor linking Interstate 82 to the Tri-Cities area. Interstate 82 also serves as a primary link between Hanford and Interstates 90 and 84. Interstate 90, north of the site, is the major link to Seattle and Spokane and extends to the East Coast. Interstate 84, south of Hanford in Oregon, is a major corridor leading to Portland, Oregon. State Route 224 (Van Giesen Street), also south of the site, serves as a 16-kilometer (10-mile) link between Interstate 82 and State Route 240. State Route 24 enters the site from the west, continues eastward across the northernmost portion of the site, and intersects

State Route 17 approximately 24 kilometers (15 miles) east of the site boundary. State Route 17 is a north-south route that links Interstate 90 to the Tri-Cities and joins U.S. Route 395 before continuing south through the Tri-Cities. U.S. Route 395 North also provides direct access to Interstate 90. State Routes 240 and 24 traverse Hanford and are maintained by Washington State (Duncan 2007:4.151).

Access to Hanford is via three main routes: Hanford Route 4 South from Stevens Drive or George Washington Way in the city of Richland, Route 10 from State Route 240 near its intersection with State Route 225, or Route 11A from State Route 240 near its intersection with State Route 24 (see Figure 3–19). The primary commute to Hanford requires most employees to travel through the city of Richland by way of State Route 240 (Bypass Highway) or George Washington Way. These two roadways have an average daily traffic volume of between 30,000 and 40,000 vehicles. To help accommodate the high volume of traffic, the Washington State Department of Transportation (WSDOT) completed the expansion of the Bypass Highway from four to six lanes in 2002. Similarly, the City of Richland made major capacity improvements on Stevens Drive north of State Route 240. By the end of 2009, the WSDOT had completed several improvements to State Route 240, including the interchange at U.S. Route 395 and the construction of two new bridges over the Yakima River, thereby substantially alleviating congestion during the daily commute (WSDOT 2011). Hanford's onsite road network is further described in Section 3.2.2.1.

Private vehicles account for 91 percent of the person-trips to Hanford based on a survey of commuters using either the State Route 240 Bypass Highway or George Washington Way. The remaining person-trips are by forms of high-occupancy vehicles (mostly vanpools). Of the 91 percent of person-trips to Hanford by private vehicles, only 3 percent involve carpools; the remaining 88 percent involve single-occupancy vehicles (BFCOG 2006:2-4; Duncan 2007:4.152).

A Washington State law (Washington State 2006) requires urban growth areas containing a state highway segment exceeding a threshold of 100 person-hours of daily delay per mile during the peak period from 6:00 A.M. to 9:00 A.M. on weekdays to implement commute trip reduction programs. The intent is to reduce the time of commutes by workers from their homes to major worksites during that peak period. The WSDOT was required to establish rules for commute trip reduction plans and implementation procedures in 2007. Benton and Franklin Counties have received an exemption. The Benton County plan and ordinance will include the DOE Hanford Reservation. Construction worksites are excluded by law, provided the construction duration is less than 2 years. The ongoing construction of the WTP would not likely be exempt (BFCOG 2006:2-5, 2-6).

The local intercity transit system, Ben Franklin Transit, provides public transit service throughout the Tri-Cities. The company's rideshare/vanpool program includes a fleet of over 300 vans that operate in 14 cities, six counties, and two states, and services major worksites where riders share the cost of operating the vans. Its services also include ride-matching for individuals seeking private vanpools or carpools (BFCOG 2006:2-5, 2-7, 4-26–4-28). Ben Franklin Transit currently has 24 fixed routes, including one between Richland and the Hanford 300 Area. Its vanpools serve eight locations across Hanford and Energy Northwest. In 2011, over 100 vans were commuting to the WTP, and ridership in general has increased since 2005 more than 40 percent (DeJuan 2011). Transit service availability notwithstanding, ridesharing remains an underutilized resource for reducing congestion, particularly along the routes of the Hanford commute in the Tri-Cities area.

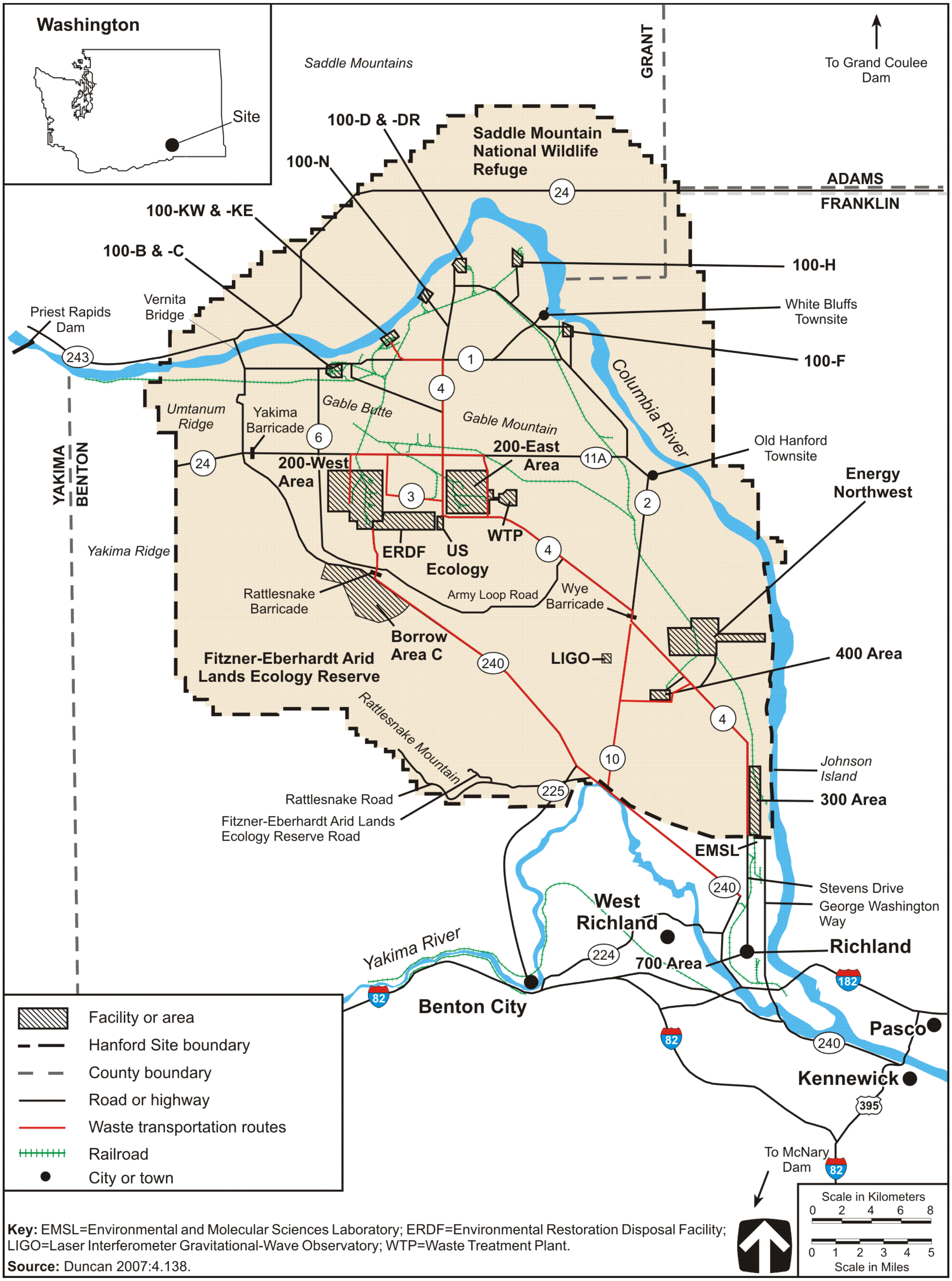


Figure 3–19. Transportation Routes On and Near the Hanford Site

As stated in Section 3.2.2.1.1, the Hanford rail system originally consisted of approximately 209 kilometers (130 miles) of track connecting to the Union Pacific commercial track at the Richland Junction and to a now-abandoned Chicago, Milwaukee, St. Paul, and Pacific Railroad right-of-way near Vernita Bridge. In October 1998, 26 kilometers (16 miles) of track from Columbia Center to Horn Rapids Road were transferred to the Port of Benton and are currently operated by the Tri-City and Olympia Railroad for the Port of Benton (Duncan 2007:4.150). Along with the rail line, the port received from DOE about 304 hectares (750 acres) of land and numerous buildings encompassing the Richland North Area for economic development purposes. The area is now called the Port of Benton Manufacturing Mall. The Tri-City and Olympia Railroad operates from Kennewick through Richland to the manufacturing mall and also services the city of Richland's Horn Rapids Industrial Site via a spur line built in 1999 (BFCOG 2006:4-34).

The Tri-Cities serve as a regional transportation and distribution center with major land, river, and air connections. The Burlington Northern Santa Fe Railroad main line from Vancouver to Spokane via Pasco is traversed by 45 to 55 through-freight movements daily. The total tonnage reflects the large number of export grain trains that operate via this route to water terminals at Portland, Kalama, and Longview. This line operates at or near its maximum practical capacity. Burlington Northern Santa Fe also operates tracks from the Tri-Cities to Auburn via Yakima, Ellensburg, and Stampede Pass. This line has 6 to 10 freight movements daily. The Union Pacific Railroad also operates a line from Portland to Spokane that enters Walla Walla County south of Wallula Junction, then passes along the east side of the Columbia and Snake Rivers, exiting the county at Lyons Ferry (BFCOG 2006:4-33, 4-34).

Passenger rail service is provided by Amtrak from the Pasco Intermodal Depot. Amtrak operates daily on the Burlington Northern Santa Fe tracks from Vancouver through Pasco to Spokane. Similar service is provided between Seattle and Spokane, where the two trains link to continue toward Chicago (BFCOG 2006:4-34).

The Columbia–Snake River system, with its government locks at each of eight dams, affords 748 kilometers (465 miles) of water transportation from Astoria, Oregon, to Lewiston, Idaho. The system allows the three barge lines serving the region to transport commodities to and from locations throughout the world via the ports of Kalama, Longview, Vancouver, and Portland (the Nation's largest wheat export portal). Over 9 million metric tons of cargo are moved on this water highway every year. Docking facilities at the Ports of Benton, Kennewick, and Pasco play important roles in this regional system. Closer to Hanford, the Port of Benton has over 1,830 meters (6,000 feet) of Columbia River frontage zoned for heavy industrial use at the Richland Technology and Business Campus on the west bank of the Columbia River in North Richland. The dock facilities near the north end of the site are used to unload construction materials and heavy equipment, much of it destined for Hanford, as well as other cargoes bound for North Richland (BFCOG 2006:4-35, 4-37).

Daily air passenger and freight services connect the area with most major cities through the Tri-Cities Airport in Pasco. This modern commercial airport links the Tri-Cities to major hubs. Scheduled air service includes Delta Connection, Horizon Air, United Express, and Allegiant Air (Port of Pasco 2011). Either of two runways is available for use as dictated by crosswinds. The main runway is equipped for precision instrumentation landings and takeoffs. Each runway can accommodate landings and takeoffs by medium-range commercial aircraft (Duncan 2007:4.150, 4.151). The immediate area is also served by Richland Airport, which lies northwest of the Richland central business district and adjacent to the Richland Bypass (State Route 40). Owned by the Port of Benton, this general aviation airport has two paved runways and a localizer instrument system (BFCOG 2006:4-31).

3.2.10 Existing Human Health Risk

Environmental health risks of the activities at Hanford include the effects of acute and chronic exposures to ionizing radiation and hazardous chemicals. Ongoing programs to monitor releases and evaluate their potential health impacts are conducted at Hanford. Additionally, studies have been conducted of the pathways and potential risks of radionuclide and toxic chemical releases during past operations at Hanford. These studies focused on the impacts of the releases in terms of risks of cancer incidence and mortality to site workers, the general public, and the maximally exposed individual (MEI). Results of the current assessments and historic studies indicate little risk of enhanced carcinogenesis; doses from site radionuclide releases tend to be far lower than those from natural background radiation, and chemical exposures are well within stipulated guidelines. Yet in keeping with the goal of optimum protection of vulnerable populations, DOE maintains a comprehensive emergency management program that features hazard-specific plans, procedures, and controls (DOE Order 151.1C).

3.2.10.1 Radiological Exposure and Risk

3.2.10.1.1 General Site Description

Major sources and average levels of exposure to background radiation to individuals in the Hanford vicinity are shown in Table 3–12.[1] The average annual dose from background radiation is approximately 620 millirem. About half of the annual dose is from ubiquitous, natural background sources (311 millirem) that can vary depending on geographic location, individual buildings in the geographic area, and age, but is essentially all from space or naturally occurring sources in Earth. About half of the dose is from medical exposure to radiation (300 millirem), including computed tomography, interventional fluoroscopy, x-rays and conventional fluoroscopy, and nuclear medicine (use of unsealed radionuclides for diagnosis and treatment). Another approximately 14 millirem per year are from consumer products and other sources (nuclear power, security, research, and occupational exposure) (NCRP 2009:12). Average background radiation doses from these sources are expected to remain fairly constant over the period of the proposed actions. Background radiation doses, as identified in Table 3–12, are unrelated to Hanford operations.

Table 3–12. Sources of Radiological Exposure of Individual Doses Unrelated to Hanford Site Operations

Source	Effective Dose Equivalent (millirem per year)[a]
Natural background radiation	311
Medical exposure	300
Consumer, industrial, occupational, and other	14
Total (rounded)	**620**

[a] Averages for the United States.
Source: NCRP 2009:12.

Releases of radionuclides to the environment from Hanford operations provide another source of radiological exposure to individuals in the vicinity of Hanford. Types and quantities of radionuclides released from Hanford operations in 2010 are summarized in Section 3.2.4.1. Estimated doses to the public resulting from these releases are presented in Table 3–13. The estimated dose to an MEI in 2010 was 0.18 millirem; over the last 5 years, the annual dose to the MEI has ranged from 0.045 to 0.18 millirem. The 2010 population dose was 1.1 person-rem; over the last 5 years, the annual dose to the

[1] Average doses from background radiation in the Hanford vicinity are assumed to approximate the average dose to an individual in the U.S. population.

population has ranged from 0.44 to 1.1 person-rem (Poston, Duncan, and Dirkes 2011:8.130–8.132).[2] The population dose from natural background radiation sources was approximately 150,000 person-rem. The doses to the public from Hanford activities fall within the limits established in DOE Order 458.1, Change 2, and are much lower than those due to background radiation.

Table 3–13. Radiation Doses to the Public from Hanford Site Operations, 2010 (Total Effective Dose Equivalent)

Members of the Public	Atmospheric Releases[a]	Liquid Releases[b]	Total[c, d]
Maximally exposed individual (millirem)	0.12	0.056	0.18
Population within 80 kilometers (person-rem)[e]	0.30	0.78	1.1
Average individual within 80 kilometers (millirem)[e]	0.00062	0.0016	0.0023

[a] DOE Order 458.1, Change 2, invokes the Clean Air Act regulations (40 CFR 61, Subpart H), which established a compliance limit of 10 millirem per year to a maximally exposed individual.

[b] Includes exposure pathways from direct consumption and use of water for irrigation. Though not directly applicable to concentrations of radionuclides in surface water or groundwater, an effective dose equivalent limit of 4 millirem per year for the drinking water pathway only is frequently used as a measure of performance. It is inspired by the National Primary Drinking Water Regulations maximum contaminant level for beta and photon activity that would result in an equivalent dose of 4 millirem per year (40 CFR 141.66).

[c] DOE Order 458.1, Change 2, establishes an all-pathways dose limit of 100 millirem per year to an individual member of the public.

[d] Total may not equal the sum of the contributions due to rounding.

[e] The collective population dose is based on the 2000 census population of 486,000. The average individual dose is obtained by dividing the population dose by the number of people in the population.

Note: To convert kilometers to miles, multiply by 0.6214.

Source: Poston, Duncan, and Dirkes 2011:8.130, 8.132.

From a risk coefficient of 600 cancer deaths per 1 million person-rem (0.0006 latent cancer fatalities [LCFs] per person-rem) to the public (see Appendix K, Section K.1.1.6), the risk of an LCF to the MEI due to radionuclide releases from Hanford operations in 2010 was estimated to be 1×10^{-7}. That is, the estimated probability of this person dying of cancer at some time in the future as a result of a radiation dose associated with emissions from 1 year of Hanford operations is about 1 in 10 million. Depending on the type of cancer, it takes a few years to several decades from the time of exposure for a radiation-induced cancer to manifest itself. The hypothetical MEI is a person whose place of residence and lifestyle make it unlikely that any other member of the public would receive a higher radiation dose from Hanford releases. This person is assumed to be exposed to radionuclides in the air and on the ground from Hanford emissions, ingest food grown downwind from Hanford and irrigated with water from the Columbia River downstream from Hanford, ingest fish from the Columbia River, and be exposed to radionuclides in the river and on the shoreline during recreation.

Using the same risk coefficient, the calculated population LCF risk is 7×10^{-4}; this low risk implies no excess LCFs are expected in a population of 486,000 living within 80 kilometers (50 miles) of Hanford from normal operations in 2010. To place this number in perspective, it may be compared with the number of cancer fatalities expected in the same population from all causes. The mortality rate from cancer for the entire U.S. population in 2000 was about 200 deaths per 100,000 people, or 0.2 percent per year (Weir et al. 2003:Figure 1). At that rate, expected fatalities from all cancers in the population living within 80 kilometers (50 miles) of Hanford during would be 972. This figure is much higher than the 7×10^{-4} LCFs calculated to result from Hanford operations in 2010.

[2] Potential impacts on the public were calculated using the GENII computer model. Version 2.09 was used in 2009 for the first time; doses calculated with Version 2.09 were about 2.5 times higher than if they had been calculated with the Version 1.485 used in previous years.

Hanford workers receive the same dose as the general public from background radiation, but they receive an additional dose from working in and near facilities with radioactive materials. The average dose to the individual worker and the cumulative dose to all workers at Hanford from operations in recent years are presented in Table 3–14. Using a risk coefficient of 0.0006 LCFs per person-rem among workers, the calculated number of LCFs among Hanford workers from normal operations exposures in 2009 was 0.08.

Table 3–14. Radiation Doses to Workers from Hanford Site Normal Operations (Total Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation					
	Standard[a]	2005	2006	2007	2008	2009
Average radiation worker (millirem)	5,000	89	70	71	45	58
Total of all radiation workers (person-rem)[b]	**None**	**204.1**	**132.9**	**158.0**	**105.9**	**129.3**

[a] No standard is specified for an "average radiation worker"; however, the maximum dose to a worker is limited as follows: The dose limit for an individual worker is 5,000 millirem per year (10 CFR 835). However, the U.S. Department of Energy's (DOE's) goal is to maintain radiological exposure as low as is reasonably achievable. DOE has therefore established the Administrative Control Level of 2,000 millirem per year; the site contractor sets facility administrative control levels below the DOE level, with 500 millirem per year considered a reasonable goal for trained radiation workers and 100 millirem per year for nonradiation workers.

[b] There were 2,294 workers with measurable doses in 2005, 1,911 in 2006, 2,228 in 2007, 2,376 in 2008, and 2,222 in 2009.

Note: Total radiation worker dose presented in the table differs from that calculated from data shown due to rounding.

Source: 10 CFR 835.202; DOE Standard 1098-2008, Change Notice 1; DOE 2008b:3-10; 2009b:3-10; 2010b:3-10; Fluor Hanford 2006b:2.

A number of people work inside the Hanford boundary yet outside access-controlled areas. Considered members of the public, these people are associated with the Columbia Generating Station, operated by Energy Northwest, and with LIGO, operated by the University of California. For these two facilities, a larger dose was determined to be to an individual at LIGO. The calculated radiation dose to a hypothetical receptor at LIGO in 2010 was 0.0054 millirem. This dose, attributed to Hanford stack emissions and assuming full-time occupancy (24 hours per day) of the facility, is well below the 10-millirem-per-year limit for air emissions established by the Clean Air Act (Poston, Duncan, and Dirkes 2011:8.134).

Members of the public may also be exposed to radioactivity through the consumption of wildlife that have access to Hanford. In 2010, the maximum detectable concentration of strontium-90 (12.4 picocuries per gram) was measured in a cottontail rabbit bone sample collected on site at the 100-H Area. Because bone is not normally consumed by humans, it was not considered further (Poston, Duncan, and Dirkes 2011:8.135). In other years, other radionuclides (e.g., cesium-137, uranium isotopes) have been detected in other species such as fish.

There are several non-DOE-related sources of radiological exposure at or near Hanford. These sources include the US Ecology Commercial LLW Disposal Site; the Columbia Generating Station; a nuclear fuel production plant operated by AREVA NP; a commercial LLW treatment facility operated near the site by Perma-Fix Northwest, Inc.; and a commercial decontamination facility operated near the site by PN Services. The radiation dose to a member of the public from these sources in 2010 was conservatively estimated at approximately 0.004 millirem. Therefore, the combined annual dose to a member of the public in 2010 from Hanford area DOE and non-DOE sources was well below any regulatory dose limit (Poston, Duncan, and Dirkes 2011:8.136).

A more detailed presentation of the radioactive environment, including background exposures and radionuclide releases and doses, is presented in the *Hanford Site Environmental Report* (Poston, Duncan, and Dirkes 2011). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (on and off site) are also presented in that report.

3.2.10.1.2 200 Areas Description

External radiation doses on and near Hanford are measured and reported by the site environmental surveillance program. In 2010, the mean annual external dose in the 200 Areas was about 104 millirem—about 33 millirem higher than the historic average of the doses measured at offsite (distant) control locations (Poston, Duncan, and Dirkes 2011:8.122; Poston et al. 2006:10.166). This onsite external dose, which affects workers only, is well below the administrative limit identified in Table 3–14, footnote “a.” Columbia River water is used as a source of drinking water by workers in the 200 Areas. Annual average radionuclide concentrations measured in the drinking water during 2010 were below applicable standards (40 CFR 141; Poston, Duncan, and Dirkes 2011:8.136).

3.2.10.1.3 400 Area Description

In 2010, the mean annual external dose in the 400 Area was about 79 millirem, about 5 millirem higher than the average of doses measured at offsite (distant) control locations (Poston, Duncan, and Dirkes 2011:8.122; Poston et al. 2006:10.166). This onsite external dose, which affects workers only, is well below the administrative limit identified in Table 3–14, footnote “a.”

Drinking water is obtained from groundwater wells in the 400 Area and is consumed by FFTF workers. Tritium and gross beta were detected in these groundwater wells. The measured concentrations in 2010 suggest a potential annual dose to FFTF workers of approximately 0.2 millirem, well below the EPA limit of 4 millirem per year for public drinking water supplies (Poston, Duncan, and Dirkes 2011:8.136).

3.2.10.2 Chemical Environment

The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media, through which people may come in contact with hazardous chemicals (e.g., surface water during swimming, soil through direct contact, food). Hazardous chemicals can cause cancer- and non-cancer-related health effects.

3.2.10.2.1 Carcinogenic Effects

Estimation of carcinogenic health effects focuses on the probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. This probability can be expressed as an incremental or excess individual lifetime cancer risk. The risks from exposure to carcinogenic chemicals are evaluated using chemical-specific unit risk factors published by EPA. The unit risk factor represents the estimated lifetime probability that an individual will develop cancer as a result of exposure to a given concentration of a chemical in air. Assessment of cancer risk from chemical exposures is described in Appendix K, Section K.1.2.6.

3.2.10.2.2 Noncarcinogenic Effects

Noncarcinogenic health effects are expressed in terms of the Hazard Quotient and Hazard Index. The Hazard Quotient is the ratio between the estimated exposure to a toxic chemical and the level of exposure at which adverse health effects can be expected. Hazard Quotients for noncarcinogens are summed to obtain the Hazard Index. If the Hazard Index is less than 1, no adverse health effects are expected.

Adverse public health impacts may result from the inhalation of hazardous chemicals released to the atmosphere during normal Hanford operations. Risks to public health from other possible pathways, such as the ingestion of contaminated drinking water or direct contact with hazardous chemicals, are lower than those from inhalation. Administrative and design controls have been instituted to reduce hazardous chemical releases to the environment and help achieve compliance with permit requirements (e.g., air emission permits, NPDES permits). Moreover, baseline studies have been performed to estimate the highest existing offsite concentrations and the highest concentrations to which members of the public could be exposed, and these studies have been used to develop baseline air emission and other applicable standards for hazardous chemicals (see Section 3.2.4). Hazardous chemical concentrations remain in compliance with applicable guidelines and regulations. Nevertheless, the effectiveness of all controls and mitigation measures is constantly verified through routine monitoring and inspection.

Exposure pathways to Hanford workers during normal operations include the inhalation of contaminants in the workplace atmosphere and direct contact with hazardous materials. The potential for health impacts varies among facilities and workers. DOE policy requires that the workplace be as free as possible from recognized hazards—i.e., conditions likely to cause illness or physical harm. Workers are protected from such hazards through adherence to Occupational Safety and Health Administration and EPA limits on atmospheric and drinking water concentrations of potentially hazardous chemicals. Exposure to hazardous chemicals is also minimized by appropriate training, use of personal protective equipment, monitoring of the workplace environment, limits on the duration of exposure, and engineered and administrative controls. Monitoring and controlling hazardous chemical usage in operational processes help ensure that workplace standards are not exceeded and worker risk is minimized.

3.2.10.3 Health Effects Studies

The question of whether the population around Hanford is subject to elevated cancer incidence or cancer mortality is unresolved. Studies of the health effects of Hanford activities, including studies reported in prior EISs, are summarized below. Included is a summary of the results of the Hanford Environmental Dose Reconstruction (HEDR) Project, even though studies encompassed by that project do not directly address health effects. Existing studies and data suggest that cancer mortality in populations residing near Hanford is not elevated. A survey sponsored by the National Cancer Institute and published in the *Journal of the American Medical Association* (Jablon, Hrubec, and Boice 1991) detected no general increase in the risk of cancer death for people living in 107 counties close to or containing 62 nuclear facilities, including Hanford. Cancer mortality data from Benton, Franklin, and Grant Counties were used in the survey. The survey did not provide an estimate of actual exposures to ionizing radiation or hazardous chemicals, nor did it allow for identification of areas within a given county that might have increased or decreased cancer rates relative to the country as a whole. The authors of the study concluded that, if any excess cancer mortality risk were present in U.S. counties with nuclear facilities, it was too small to be detected using the methods employed.

Sixteen counties are within 80 kilometers (50 miles) of the Hanford boundary—13 counties in Washington and 3 in Oregon. Although the prevailing winds on the 200 Area plateau are from the northwest, in the direction of Franklin County, the prevailing winds at Hanford as a whole are from the south and south-southwest, toward Grant County, Washington. Therefore, Grant County and Franklin County are expected to receive most of the wind-borne contamination from Hanford. Cancer mortality data published by the National Cancer Institute for both white female and white male residents of all U.S. counties from 1970 to 1994 show no elevated cancer rates for white residents of Franklin or Grant County. Cancer mortality rates among white females in the 16 counties ranged from a low of 80.1 per 100,000 person-years[3] in Gilliam County, Oregon, to a high of 149.5 per 100,000 person-years in Lincoln County, Washington. Only Adams, Klickitat, and Lincoln Counties had rates higher than the national rate

[3] In other words, 80.1 deaths per year per 100,000 people.

of 135.9 per 100,000 person-years. Cancer mortality rates among white males in the 16 counties ranged from a low of 161.9 per 100,000 person-years in Gilliam County, Oregon, to a high of 211.8 per 100,000 person-years in Morrow County, Oregon. Morrow County was in fact the only county of the 16 to have a rate higher than the national rate of 209.5 per 100,000 person-years. The data do not include estimates of human exposure to ionizing radiation or hazardous chemicals (DOE 2000a:3-132).

In addition to mortality data, the National Cancer Institute publishes state and county incidence rates for various cancers. Table 3–15 shows the 2003 through 2007 incidence rates for Washington State and the four counties adjacent to Hanford. In the four adjacent counties, the rates for thyroid cancer, leukemia and "all cancers" were lower than the corresponding state incidence rates. In three of the four adjacent counties, the incidence rates for breast cancer were lower than the state average. The Benton County breast cancer incidence rate exceeded the State average, but was lower than rates reported for 11 other counties, all of which are more distant from Hanford. The rates of lung cancer in all four adjacent counties slightly exceeded the state average. However, the highest of these (Franklin County's) was exceeded by the rates for 15 other counties, including 10 on the west side of the Cascade mountain range. The lung cancer rates for the four adjacent counties ranked 16th, 18th, 20th and 21st out of Washington's 39 counties.

Table 3–15. Cancer Incidence Rates[a] for Washington State and Counties Adjacent to the Hanford Site, 2003–2007

Location	All Cancers	Thyroid	Breast	Lung	Leukemia
United States	464.5	10.2	120.6	68.0	12.3
Washington State	479.1	10.3	130.3	66.3	13.9
Benton County	469.7	8.8	137.1	69.3	11.2
Franklin County	441.1	(b)	102.2	70.7	11.5
Grant County	433.2	8.0	103.5	69.4	12.3
Yakima County	436.8	7.6	116.4	68.0	13.2

[a] Cases per 100,000 people per year.

[b] Data has been suppressed by the National Cancer Institute to ensure confidentiality and stability of rate estimates when annual average count is three or fewer cases.

Source: NCI 2010.

Two studies of birth defects in Benton and Franklin Counties were published in 1988 (Sever et al. 1988a, 1988b). The studies focused on congenital malformations among infants born from 1968 to 1980. Results showed a statistically significant association between preconception exposure of the parents to ionizing radiation and neural tube defects in their infants. However, no such association could be observed in regard to other defects in the infants.

The HEDR Project, conducted in the 1980s and 1990s, focused on dose estimation rather than health effects. It featured investigation of the amounts and types of radioactive materials Hanford released from 1944 through 1972, movement of materials through the environment, and exposure of and doses to people. Of primary concern were radioactive releases to the air and to the Columbia River. As for airborne releases, the HEDR Project studies showed that more than 98 percent of the radiation doses that most people outside of Hanford's boundaries received came from iodine-131 released from December 1944 through 1957. Consumption of milk from cows and goats that grazed on pastures downwind of Hanford was the most important iodine-131 exposure pathway. The highest organ doses (to the thyroid) were received by children who lived the closest to Hanford from 1944 through 1951; these doses ranged from 24 to 350 rad. The highest effective dose equivalent to an adult from air emissions was about 1 rem and was accrued over the period from 1944 to 1972. The lifetime risk of a fatal cancer associated with a dose of 1 rem is about 1 in 1,600. Project studies also revealed that the largest releases of radioactive material to the Columbia River occurred from 1950 through 1971 from Hanford production reactors.

The five most prominent contributors to dose were sodium-24, phosphorus-32, zinc-65, arsenic-76, and neptunium-239. Consumption of nonmigratory fish species was the most important exposure pathway. The maximum individual dose during this time period was estimated to be 1.4 rem (TSP 1994).

Many epidemiological studies of Hanford workers have been conducted over the years. The studies have consistently shown a statistically significant elevated risk of death from multiple myeloma associated with radiological exposure among male Hanford workers. The elevated risk was observed only among those workers with a total occupational exposure of 10 rad (approximately 10 rem) or more. Other studies also identified an elevated risk of death from pancreatic cancer, but a recent reanalysis indicated no such risk. Studies of female Hanford workers have shown an elevated risk of death from musculoskeletal system and connective tissue conditions. For a more detailed description of the studies reviewed and their findings, as well as a discussion of the epidemiologic surveillance program implemented by DOE to monitor the health of current workers, refer to Section M.4.2 of the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a: M-224–M-230).

More recently, additional studies have been performed regarding Hanford mortality rates. One study completed in 2005 examined whether there are associations between occupational exposure to external ionizing radiation and mortality among Hanford workers. This study suggests that external radiological exposures of Hanford workers 55 years of age and older increase their risks of dying from lung cancer; owing to data limitations, however, the possible contributions of plutonium and smoking to this risk could not be directly estimated. Another study concluded that workers who have routine potential exposure to plutonium have lower mortality rates than other Hanford workers (NIOSH 2005).

3.2.10.4 Accident History

In the more than 15 years since weapons material production ceased at Hanford, there have been no nuclear-related accidents or accidental releases of hazardous or radioactive materials that caused injury or posed any threat to the offsite public. However, a number of incidents that had actual or potential health impacts on workers have occurred in the course of routine facility operations, decommissioning, and environmental remediation activities in and near the 200 Areas. The most notable of these was a May 1997 explosion caused by spontaneous reaction of nonradioactive chemicals left over from discontinued activities in the Plutonium Recovery Facility. Although no one was directly injured by the explosion and no radioactive materials were released to the environment (DOE 2000a:3-133), eight workers who may have been exposed to unidentified fumes later complained of symptoms that included headaches, dizziness, and an unidentified metallic taste. All were transferred to a nearby medical center where they were examined and released.

Incidents with worker health implications over the period from 2000 through June 2010, as reflected in Occurrence Reporting and Processing System records (DOE 2007a, 2008c, 2010c), include the following:

- Workers were injured from falls resulting in broken bones (January 2009, July 2009, June 2010).
- Workers' skins were contaminated during demolition activities, with subsequent decontamination being successful (May 2009, March 2010).
- Workers received mild electrical shocks (January 2004, May 2005, August 2005, May 2009, August 2009, February 2010, July 2010).
- A worker suffered chemical burns to the face and neck from a solution of sodium hydroxide (December 2009).

- A worker was potentially exposed to asbestos from a truck while unloading asbestos waste at an offsite disposal facility (August 2009).
- A worker cut his fingers with a circular saw while cutting wooden shims (August 2009).
- A worker broke a bone in his hand when drilling a hole in metal ductwork (May 2009).
- Two workers were contaminated when one or more glovebox gloves were breached in the Plutonium Recovery Facility. The workers were decontaminated (April 2009).
- Workers were exposed to high noise levels that exceeded the 8-hour time-weighted average (March 2008, April 2009).
- A worker fractured a bone in his hand while installing rebar at the WTP (May 2008).
- Workers were potentially exposed to chromium while conducting welding operations (March 2003, October 2005, December 2006, January 2007).
- A worker was exposed to lead while torch-cutting a pipe (August 2005).
- Workers were exposed to carbon monoxide levels exceeding occupational limits at the CWC (August 2000) and WTP (February 2005).
- Two workers were exposed to plutonium and americium while performing radiological surveys in a high-contamination area at the 300 Area Remediation Project, resulting in a committed effective dose equivalent of 3 rem to one worker and 0.8 rem to the other (December 2004).
- A painter was overexposed to methylene chloride while cleaning painting equipment (October 2004).
- A worker was exposed to plutonium (an uptake of less than 0.5 millirem) at the Plutonium Finishing Plant while preparing waste for storage in a drum (July 2004).
- A worker received a 15-rem dose to an extremity from curium-244 at the 244-CR vault, pit CR-002, while pulling a thermocouple (July 2004).
- A worker was potentially exposed to mercury from a manometer being removed in the 105-KE Basin (June 2004).
- Workers were exposed to unknown vapors/fumes in tank farms (March 2004).
- A worker injured an eye while manipulating metal stanchions (February 2004).
- Workers in the Plutonium Finishing Plant were exposed to toxic chemicals, including nitrobenzene (September 2002) and nitrogen oxides (March 2003).
- A worker was potentially exposed to asbestos fibers at Building 1717K (December 2002).
- Tank farm workers suffered respiratory irritation as a result of severe wind/dust following the 2000 Hanford 24 Command Fire (March 2001).

Since about 1987, exposure of tank farm workers to chemical vapors has been of concern at Hanford. The tanks are continuously vented to the atmosphere and inhalation is assumed to be the primary route of chemical exposure to workers during routine operations. Evaluations conducted at different times by the tank farms contractor, Hanford DOE officials, the Defense Nuclear Facilities Safety Board, the DOE Office of Independent Oversight and Performance Assurance, and the Office of the Inspector General have resulted in the implementation of physical (engineered) and administrative controls to reduce or eliminate the potential for worker chemical vapor exposures. The history of this issue and the actions taken to resolve it are described in Appendix K, Section K.2.1.2.3.

The most recent incident involving radiological and chemical exposures occurred in July 2007 (DOE 2007b). Approximately 322 liters (85 gallons) of highly radioactive mixed waste from tank 241-S-102 in the 200-West Area was spilled on the ground. Overpressurization of a hose in a dilution line was determined to be the cause. In the hours and days following the spill, a number of Hanford workers identified odors, experienced symptoms or health effects, or expressed concerns about their potential exposure to the waste chemicals from the spill. As of September 1, 2007, 24 workers had reported possible exposure to tank vapors resulting from the spill. The worker health impacts could be attributed to other causes, so it is unclear whether the spill directly contributed to these health effects. Because of the low concentrations and short duration of the event, overexposure or chronic health impacts are unlikely. Consequences of the tank 241-S-102 event could have been more severe if workers had been in the immediate vicinity of the spill at the time of the release, and thus had been exposed to higher radiation or chemical vapor concentrations for a longer period. The board reviewing the accident made a number of recommendations to help prevent future spills and to mitigate worker exposures through, among other things, improvement in safety programs and coordination of emergency and medical response.

In nearly all of these cases, the worker health impacts were minimal or temporary. Information concerning these and other safety-related events at Hanford and other sites is maintained in DOE's Occurrence Reporting and Processing System.

In addition to the incidents reported above, a report by the Government Accountability Project cited evidence of 45 chemical vapor exposure events that required medical attention for at least 67 workers over the period January 2002 to August 2003 (GAP 2003:11).

3.2.10.5 Emergency Preparedness

As required by DOE orders and policies, Hanford has established a comprehensive emergency management program that provides detailed, hazard-specific planning and preparedness measures to minimize the health impacts of accidents involving loss of control over radioactive material or toxic chemicals. This emergency management program embodies the following principles:

- Identification and characterization of the hazardous substances
- Analysis of potential accidents and hazardous releases
- Prediction of consequences of the releases at various locations
- Planned response actions to minimize exposure of workers and the public to the hazard

Emergency response procedures are practiced and exercised regularly to ensure that optimum protective measures can be taken in response to most identified accident conditions and to provide the capability for flexible, effective responses to accidents that were not specifically considered in the emergency planning scenarios.

DOE-RL maintains the Hanford emergency plan and implementing procedures by which DOE and its contractors will respond in the event of an accident. DOE-RL also provides technical assistance to other Federal agencies and to state and local governments. Hanford contractors are responsible for maintaining emergency plans and response procedures for all facilities, operations, and activities under their jurisdiction and for implementing those plans and procedures during emergencies. The DOE-RL, contractor, and state and local government plans are fully coordinated and integrated. Emergency control centers have been established by DOE-RL and its contractors for the principal work areas to provide oversight and support to emergency response actions within those areas.

3.2.11 Environmental Justice

Under Executive Order 12898, DOE is responsible for identifying and addressing disproportionately high and adverse impacts on minority and low-income populations. As discussed in Appendix J, minority persons are those who identify themselves as Hispanic or Latino, Asian, Black or African American, American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander, or multiracial. The Office of Management and Budget defines Hispanic or Latino as "a person of Cuban, Mexican, Puerto Rican, South or Central American or other Spanish culture or origin regardless of race"; therefore, all persons self-identified as Hispanic or Latino, regardless of race, are included in the "Hispanic or Latino" population. Persons whose incomes are below the Federal poverty threshold are designated as low-income. Consistent with Council on Environmental Quality (CEQ) guidance, minority and low-income populations were identified where the percentage of either of those populations in the impacted areas was "meaningfully greater" than those percentages in other reasonable geographic areas of comparison, defined here as the potentially affected counties and states in which the impacted areas are located. While this analysis is based on CEQ guidance, CEQ does not provide numerical (percentage point) guidance; however, the U.S. Nuclear Regulatory Commission, when identifying minority and low-income populations, defines "significantly," similar to "meaningfully greater," as 20 percentage points, and that percentage point guidance definition is used in this *TC & WM EIS* (69 FR 52040). Therefore, meaningfully greater minority and low-income populations are identified where the total minority or low-income population in the impacted area exceeds that population county- or statewide by 20 percentage points, or where either the minority or low-income population is more than 50 percent of the general population in the impacted area.

CEQ guidelines (CEQ 1997) recognize that many minority and low-income populations derive part of their sustenance from subsistence hunting, fishing, and gathering activities (sometimes for species unlike those consumed by the majority population) or depend on water supplies or other resources that are atypical or are used at different rates than they are by other groups. These differential patterns of resource use are to be identified where practical and appropriate. American Indians of various tribal affiliations live in the greater Columbia Basin, and several rely at least partly on natural resources for subsistence. For example, there is some dependence on natural resources for dietary subsistence by some members of the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe, and the Confederated Tribes and Bands of the Yakama Nation. American Indian tribes have historically lived on what is now Hanford and continue to live adjacent to the site. They fish on the Columbia River and gather food resources near Hanford. Some tribes are also recognized to have cultural and religious ties to the site.

During preparation of this *TC & WM EIS*, risks and consequences of both normal operations and accidents were evaluated in terms of potential releases of contaminants from various candidate facilities throughout Hanford. The facilities in the 200 Areas at Hanford include STTS-East, STTS-West, and the HLW Vitrification Facility stack for the WTP facilities. Another potential release point is FFTF in the 400 Area at Hanford. In the analysis of the health impacts of normal operations and accidents, all persons living within 80 kilometers (50 miles) of these facilities were assumed to be potentially affected. For this environmental justice analysis, special emphasis was accorded minority and low-income populations shown to be at risk.

3.2.11.1 Minority Populations

3.2.11.1.1 General Site Description

Minority Populations Surrounding the Hanford Site, 2010

- Minority individuals constituted approximately 39 percent of the total population.
- Approximately 80 percent of the minority population lived in four counties: Benton, Franklin, Grant, and Yakima.
- Hispanic or Latino individuals accounted for approximately 84 percent of the total minority population.

The area within an 80-kilometer (50-mile) radius of the candidate facilities at Hanford encompasses parts of 10 counties in two states: Adams, Benton, Franklin, Grant, Kittitas, Klickitat, Walla Walla, and Yakima Counties in Washington, and Morrow and Umatilla Counties in Oregon. Tables 3–16 and 3–17 provide, for 1990 and 2000, respectively, a breakdown of minority populations in the 10-county area and the two-state region. Over the 10-year period between 1990 and 2000, the total population of the 10-county area increased approximately 23 percent. During that decade, the total minority population in the area increased by approximately 87 percent; the number of people self-identified as Hispanic or Latino, by approximately 93 percent; and the American Indian and Alaska Native population, by approximately 24 percent. The two-state region of Oregon and Washington experienced trends in population growth similar to those observed in the potentially affected 10-county area. The total population increased by approximately 21 percent; the total minority population, by approximately 99 percent; people self-identified as Hispanic or Latino origin, by approximately 119 percent; and the American Indian and Alaska Native population, by approximately 15 percent.

Table 3–16. Populations in the Potentially Affected 10-County Area Surrounding the Hanford Site and the Two-State Region of Washington and Oregon, 1990

	Counties Surrounding the Hanford Site		Washington and Oregon	
Population Group	**Population**	**Percentage of Total**	**Population**	**Percentage of Total**
Nonminority				
White non-Hispanic	448,454	79.3	6,801,354	88.2
Minority				
Black or African American[a]	6,239	1.1	195,979	2.5
American Indian, Eskimo, or Aleut[a]	13,242	2.3	119,979	1.6
Asian or Pacific Islander[a]	7,564	1.3	280,227	3.6
Some other race[a]	69,713	12.3	167,104	2.2
White Hispanic	20,659	3.7	144,370	1.9
Total minority	**117,417**	**20.7**	**907,659**	**11.8**
Total Hispanic or Latino[b]	**91,395**	**16.2**	**327,277**	**4.2**
Total	**565,871**	**100.0**	**7,709,013**	**100.0**

[a] Includes individuals who identified themselves as Hispanic or Latino.

[b] Includes all individuals who identified themselves as Hispanic or Latino, regardless of race.

Source: Census 2007a.

Table 3–17. Populations in the Potentially Affected 10-County Area Surrounding the Hanford Site and the Two-State Region of Washington and Oregon, 2000

Population Group	Counties Surrounding the Hanford Site		Washington and Oregon	
	Population	Percentage of Total	Population	Percentage of Total
Nonminority				
White non-Hispanic	475,146	68.4	7,510,106	80.6
Minority				
Black or African American[a]	7,308	1.1	245,929	2.6
American Indian and Alaska Native[a]	16,432	2.4	138,512	1.5
Asian[a]	8,869	1.3	423,685	4.5
Native Hawaiian and Other Pacific Islander[a]	828	0.1	31,929	0.3
Some other race[a]	112,624	16.2	373,755	4.0
Two or more races[a]	20,717	3.0	318,264	3.4
White Hispanic	52,851	7.6	273,340	2.9
Total minority	**219,629**	**31.6**	**1,805,414**	**19.4**
Total Hispanic or Latino[b]	**176,821**	**25.5**	**716,823**	**7.7**
Total	**694,775**	**100.0**	**9,315,520**	**100.0**

[a] Includes individuals who identified themselves as Hispanic or Latino.

[b] Includes all individuals who identified themselves as Hispanic or Latino, regardless of race.

Source: Census 2007b.

Table 3–18 contains a breakdown of minority populations in the surrounding 10-county area and two-state region (Washington and Oregon) from the *2010 Decennial Census* (Census 2011a). These data show that the total population of the 10-county area has increased by approximately 17 percent since the 2000 census. During that same period, the total minority population increased by approximately 44 percent; the number of people self-identified as Hispanic or Latino, by approximately 50 percent; and the American Indian and Alaska Native population, by approximately 12 percent. The White Hispanic population experienced the largest population increase in the 10-county area at approximately 92 percent, followed by the Asian population at approximately 36 percent. The two-state region experienced trends in population growth similar to those observed in the potentially affected 10-county area, except for the Native Hawaiian and Other Pacific Islander population, which grew by approximately 69 percent in the two-state region, but increased by only approximately 20 percent in the 10-county area. The total population increased by approximately 13 percent; the total minority population, by approximately 48 percent; people self-identified as of Hispanic or Latino origin, by approximately 68 percent; and the American Indian and Alaska Native population, by approximately 13 percent. Similar to that of the 10-county area, the White Hispanic population in the two-state region experienced the largest population increase at approximately 90 percent.

Table 3–18. Populations in the Potentially Affected 10-County Area Surrounding the Hanford Site and the Two-State Region of Washington and Oregon, 2010

Population Group	Counties Surrounding the Hanford Site		Washington and Oregon	
	Population	Percentage of Total	Population	Percentage of Total
Nonminority				
White non-Hispanic	494,342	60.9	7,882,652	74.7
Minority				
Black or African American[a]	9,299	1.1	309,248	2.9
American Indian and Alaska Native[a]	18,396	2.3	157,072	1.5
Asian[a]	12,083	1.5	622,330	5.9
Native Hawaiian and Other Pacific Islander[a]	997	0.1	53,879	0.5
Some other race[a]	146,862	18.1	554,424	5.3
Two or more races[a]	27,808	3.4	457,685	4.3
White Hispanic	101,708	12.5	518,324	4.9
Total minority	**317,153**	**39.1**	**2,672,962**	**25.3**
Total Hispanic or Latino[b]	**265,921**	**32.8**	**1,205,852**	**11.4**
Total	**811,495**	**100.0**	**10,555,614**	**100.0**

[a] Includes individuals who identified themselves as Hispanic or Latino.
[b] Includes all individuals who identified themselves as Hispanic or Latino, regardless of race.
Source: Census 2011a.

3.2.11.1.2 200 Areas Description

According to the *2010 Decennial Census* (Census 2011a), approximately 589,700 people resided in the area within an 80-kilometer (50-mile) radius of the facilities in the 200 Areas—STTS-East, STTS-West, and the WTP. Minorities accounted for approximately 45 percent of the total population. Those who identified themselves as Hispanic or Latino accounted for approximately 86 percent of the minority population and 39 percent of the total population. Table 3–19 provides a breakdown of the populations within 80 kilometers (50 miles) of the 200 Areas.

Table 3–19. Populations Within 80 Kilometers of the 200 Areas at the Hanford Site, 2010

Population Group	Population	Percentage of Total
Nonminority		
White non-Hispanic	325,185	55.1
Minority		
Black or African American[a]	7,172	1.2
American Indian and Alaska Native[a]	11,933	2.0
Asian[a]	9,509	1.6
Native Hawaiian and Other Pacific Islander[a]	643	0.1
Some other race[a]	128,641	21.8
Two or more races[a]	20,858	3.5
White Hispanic	85,712	14.5
Total minority	**264,483**	44.9
Total Hispanic or Latino[b]	**228,660**	38.8
Total	**589,668**	100.0

[a] Includes individuals who identified themselves as Hispanic or Latino.

[b] Includes all individuals who identified themselves as Hispanic or Latino, regardless of race.

Note: To convert kilometers to miles, multiply by 0.6214. Total may not equal the sum of the contributions due to rounding.

Source: Census 2011a.

Figures 3–20 and 3–21 reflect the concentrations of various minority populations as a function of distance from the 200 Areas at Hanford. Block-group data generated from the *2010 Decennial Census* (Census 2011a) reflect a total population of 589,668 within an 80-kilometer (50-mile) radius of the 200 Areas. Outward from the 200 Areas, populations tended to increase sharply near the outskirts of the population centers of Richland, Kennewick/Pasco, and Yakima. It is estimated that 18 percent of the minority population lived within 40 kilometers (25 miles) of the 200 Areas and approximately 57 percent within 56 kilometers (35 miles). Approximately 39 percent of the total population living in the potentially affected 80-kilometer (50-mile) radius of the 200 Areas were self-identified as Hispanic or Latino.

Figure 3–22 shows meaningfully greater minority and nonminority populations living in block groups surrounding the facilities in the 200 Areas. Approximately 92 percent of the minority populations lived in four Washington counties: Benton, Franklin, Grant, and Yakima; approximately 46 percent were concentrated in Yakima County. Of the 406 block groups surrounding the 200 Areas, 145 contained meaningfully greater minority populations.

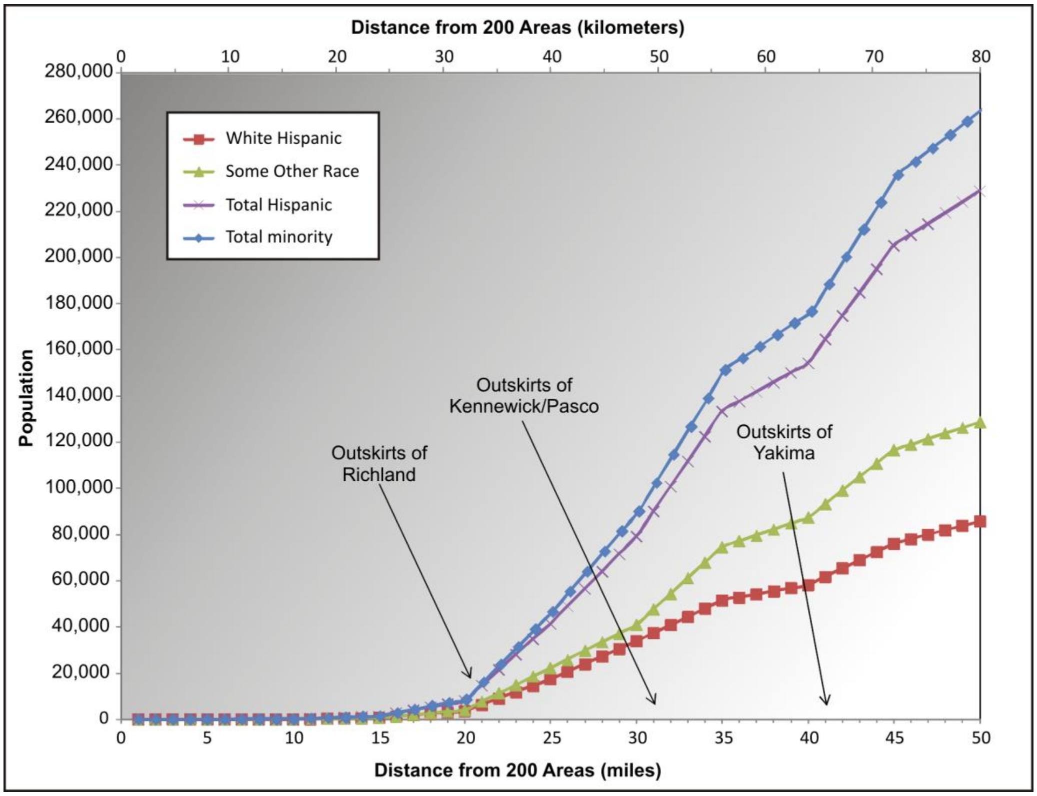


Figure 3–20. Cumulative Larger-Scale Minority Populations Surrounding the 200 Areas at the Hanford Site as a Function of Distance

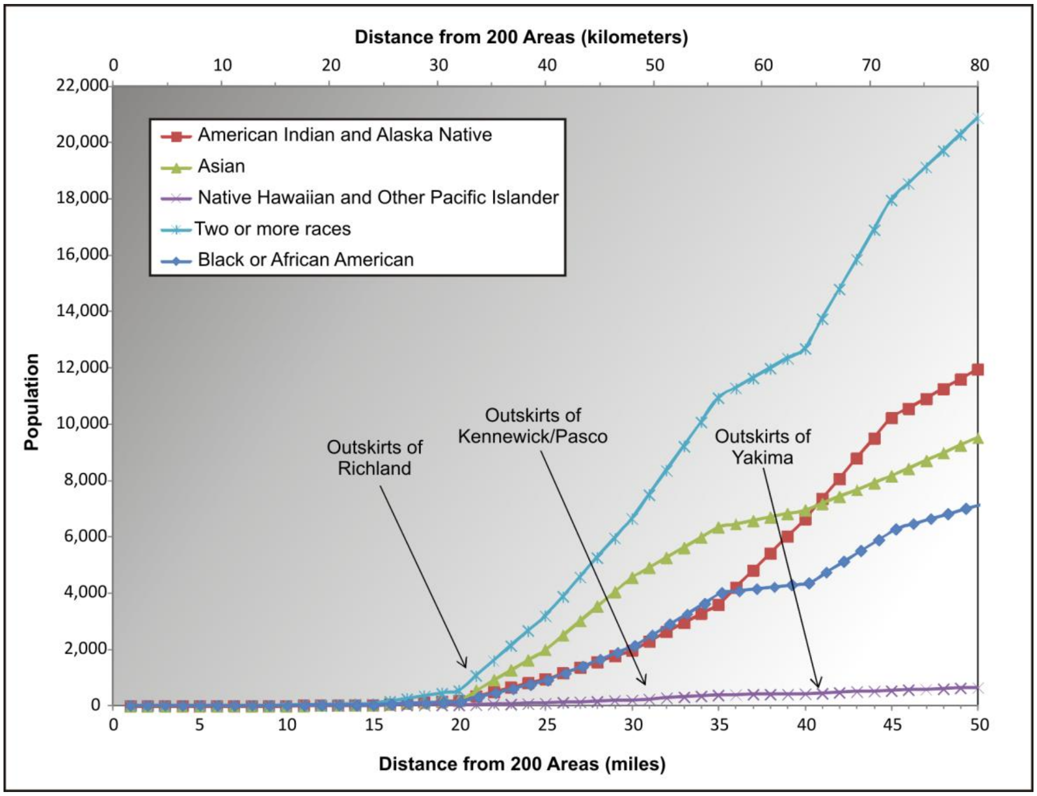


Figure 3–21. Cumulative Smaller-Scale Minority Populations Surrounding the 200 Areas at the Hanford Site as a Function of Distance

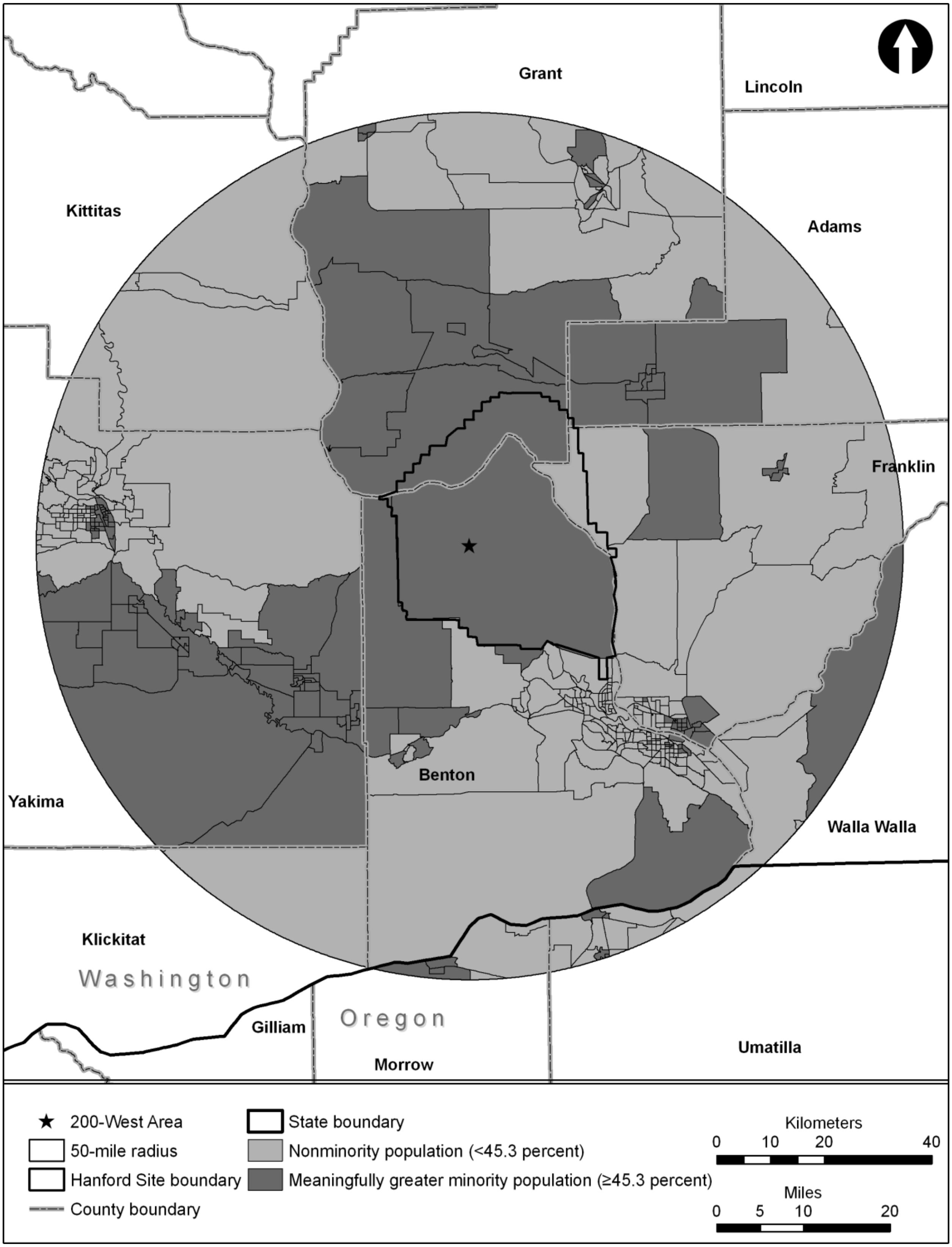


Figure 3–22. Meaningfully Greater Minority and Nonminority Populations Living in Block Groups Surrounding the 200 Areas at the Hanford Site

3.2.11.1.3 400 Area Description

According to the *2010 Decennial Census* (Census 2011a), approximately 445,000 people resided in the area within an 80-kilometer (50-mile) radius of the 400 Area at Hanford. In this area, minorities accounted for approximately 45 percent of the total population. The largest minority group was Hispanic or Latino; they accounted for approximately 88 percent of the minority population and approximately 39 percent of the total population. Table 3–20 provides a breakdown of the population within 80 kilometers (50 miles) of the 400 Area.

Table 3–20. Populations Within 80 Kilometers of the 400 Area at the Hanford Site, 2010

Population Group	Population	Percentage of Total
Nonminority		
White non-Hispanic	246,786	55.5
Minority		
Black or African American[a]	5,272	1.2
American Indian and Alaska Native[a]	6,504	1.5
Asian[a]	7,559	1.7
Native Hawaiian and Other Pacific Islander[a]	528	0.1
Some other race[a]	96,006	21.6
Two or more races[a]	14,941	3.4
White Hispanic	67,387	15.1
Total minority	**198,216**	44.5
Total Hispanic or Latino[b]	**173,540**	39.0
Total	**445,002**	100.0

[a] Includes individuals who identified themselves as Hispanic or Latino.

[b] Includes all individuals who identified themselves as Hispanic or Latino, regardless of race.

Note: To convert kilometers to miles, multiply by 0.6214. Total may not equal the sum of the contributions due to rounding.

Source: Census 2011a.

Figures 3–23 and 3–24 show the minority populations as a function of distance from the 400 Area at Hanford. Block-group data generated from the *2010 Decennial Census* (Census 2011a) reflect a total population of 445,002 surrounding the 400 Area. The significantly lower population here than in other areas in the environs of Hanford, as indicated in this *TC & WM EIS*, can be attributed to Yakima City's location outside the 80-kilometer (50-mile) radius. Sharp increases in population could be seen on the outskirts of Richland and Kennewick/Pasco and at a point approximately 64 kilometers (40 miles) from the 400 Area, most likely attributable to the population center of Hermiston, Oregon. Approximately 36 percent of the minority population in the vicinity of the 400 Area lived within 32 kilometers (20 miles) of it; approximately 50 percent lived within 45 kilometers (28 miles). It is estimated that 39 percent of the population living within 80 kilometers (50 miles) of the 400 Area were Hispanic or Latino.

Figure 3–25 shows meaningfully greater minority and nonminority populations living in block groups surrounding the 400 Area at Hanford. Over 84 percent of the minority populations lived in four Washington counties: Benton, Franklin, Grant, and Yakima; approximately 28 percent were concentrated in Yakima County. Of the 323 block groups surrounding the 400 Area, 111 contained meaningfully greater minority populations.

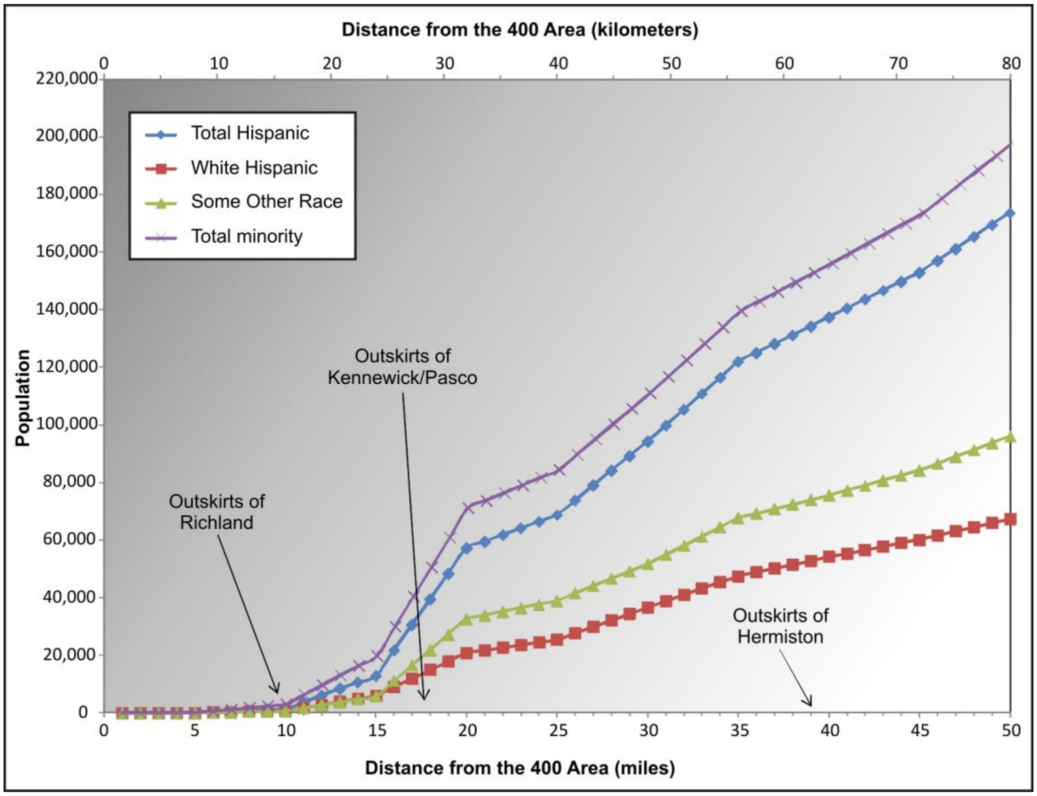


Figure 3–23. Cumulative Larger-Scale Minority Populations Surrounding the 400 Area at the Hanford Site as a Function of Distance

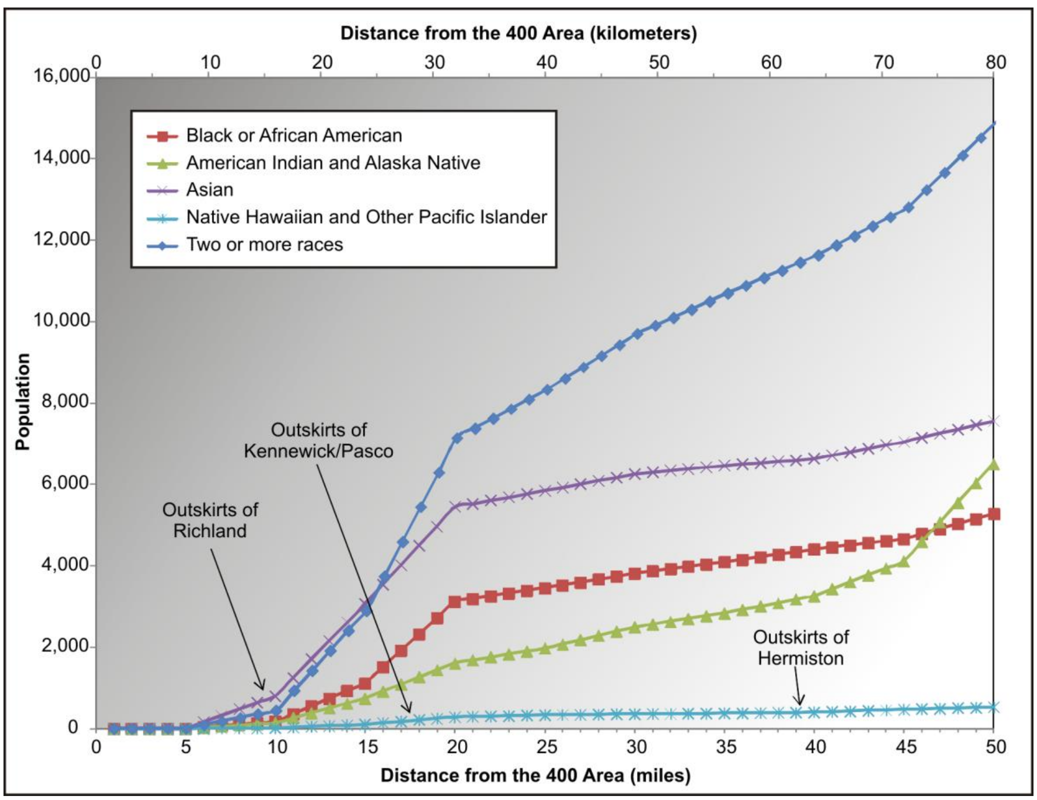


Figure 3–24. Cumulative Smaller-Scale Minority Populations Surrounding the 400 Area at the Hanford Site as a Function of Distance

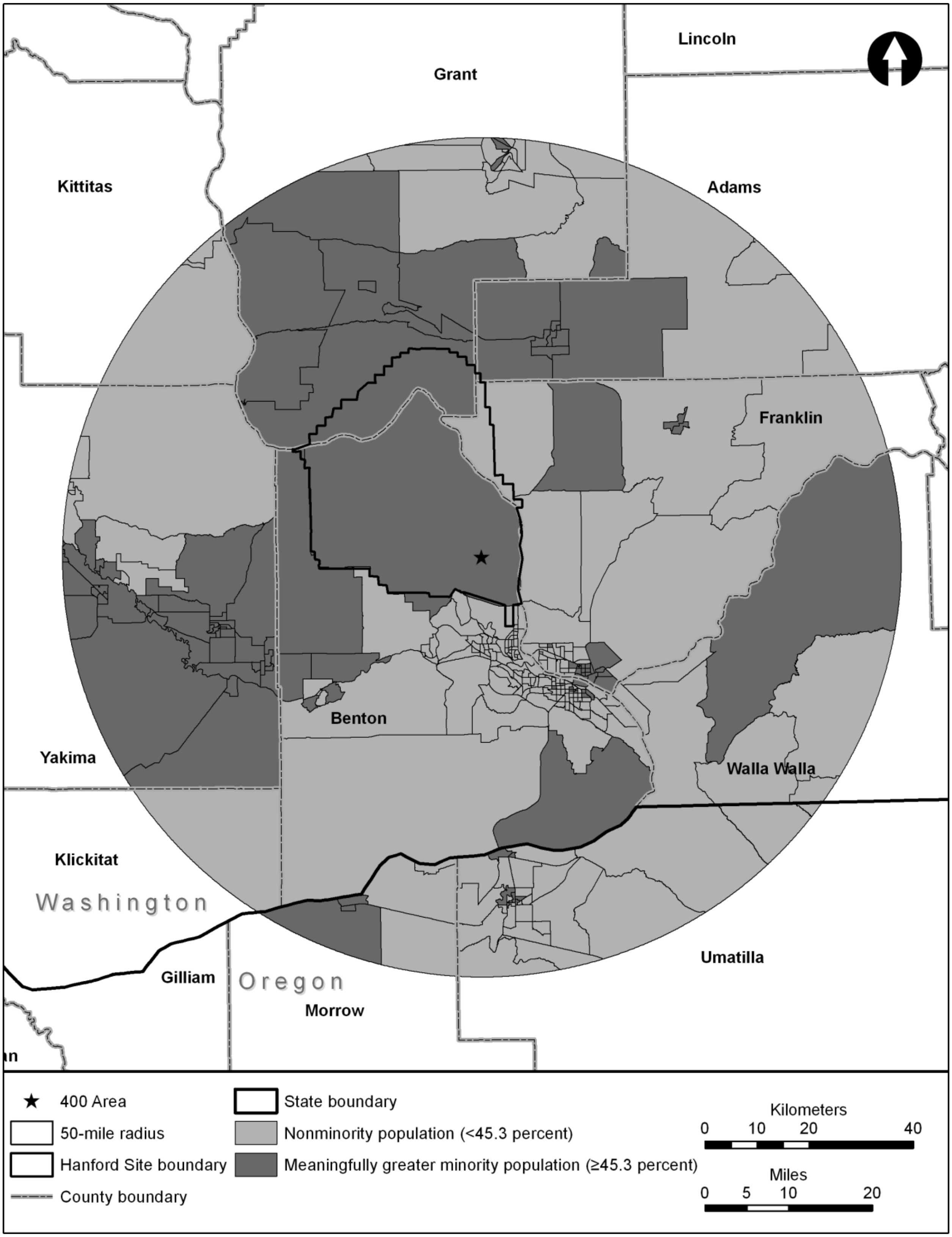


Figure 3–25. Meaningfully Greater Minority and Nonminority Populations Living in Counties Surrounding the 400 Area at the Hanford Site

3.2.11.2 Low-Income Populations

3.2.11.2.1 General Site Description

Low-Income Populations Surrounding the Hanford Site, 2006–2010

- Low-income persons constituted approximately 19 percent of the total population.
- Eighty percent of the low-income population lived in five counties: Benton, Franklin, Grant, Yakima, and Umatilla.
- Approximately 36 percent of the low-income population lived in Yakima County.

Tables 3–21 and 3–22 show the total and low-income populations in the potentially affected 10-county area surrounding the candidate facilities at Hanford and in the two-state region of Washington and Oregon in 1989 and 1999, respectively. From 1989 to 1999, the total population of the 10-county area increased by approximately 23 percent, while the low-income population increased by approximately 13 percent. Over the same period, the two-state region of Washington and Oregon saw an increase in total population of approximately 21 percent, with an increase in low-income population of approximately 16 percent over the 10-year period.

Table 3–21. Total and Low-Income Populations in the Potentially Affected 10-County Area Surrounding the Hanford Site and in the Two-State Region of Washington and Oregon, 1989

Population Group	Counties Surrounding the Hanford Site		Washington and Oregon	
	Population	Percentage of Total	Population	Percentage of Total
Total population	551,346	100.0	7,516,910	100.0
Low-income population	96,773	17.6	862,800	11.5

Note: The total population values used for the low-income comparison are lower than those used for the minority comparisons because the U.S. Census Bureau data relative to income do not take into account those people who live in institutions (e.g., college dormitories, rooming houses, religious group homes, communes, halfway houses).
Source: Census 2007c.

Table 3–22. Total and Low-Income Populations in the Potentially Affected 10-County Area Surrounding the Hanford Site and in the Two-State Region of Washington and Oregon, 1999

Population Group	Counties Surrounding the Hanford Site		Washington and Oregon	
	Population	Percentage of Total	Population	Percentage of Total
Total population	676,966	100.0	9,112,868	100.0
Low-income population	109,693	16.2	1,001,110	11.0

Note: The total population values used for the low-income comparison are lower than those used for the minority comparisons because the U.S. Census Bureau data relative to income do not take into account those people who live in institutions (e.g., college dormitories, rooming houses, religious group homes, communes, halfway houses).
Source: Census 2007d.

Table 3–23 shows the total and low-income populations in the surrounding 10-county area and two-state region (Washington and Oregon) according to the 2006–2010 American Community Survey (ACS) 5-year estimates (Census 2011c). These data show that the total population of the 10-county area has increased by approximately 12 percent, and the low-income population, by approximately 28 percent, since the 2000 census. Over the same period, the two-state region saw an increase in total population of approximately 11 percent, with an increase in the low-income population of approximately 29 percent.

Table 3–23. Total and Low-Income Populations in the Potentially Affected 10-County Area Surrounding the Hanford Site and in the Two-State Region of Washington and Oregon, 2006–2010

	Counties Surrounding the Hanford Site		Washington and Oregon	
Population Group	**Population**	**Percentage of Total**	**Population**	**Percentage of Total**
Total population	760,486	100.0	10,118,976	100.0
Low-income population	140,906	18.5	1,296,280	12.8

Note: The total population values used for the low-income comparison are lower than those used for the minority comparisons because the U.S. Census Bureau data relative to income do not take into account those people who live in institutions (e.g., college dormitories, rooming houses, religious group homes, communes, halfway houses).
Source: Census 2011c.

3.2.11.2.2 200 Areas Description

Table 3–24 shows the total and low-income populations within 80 kilometers (50 miles) of the 200 Areas at Hanford according to the 2006–2010 ACS 5-year estimates (Census 2011c). Low-income persons constituted approximately 19 percent of the total population. Over 92 percent of the low-income population lived in four counties: Benton, Franklin, Grant, and Yakima; approximately 46 percent were concentrated in Yakima County.

Table 3–24. Total and Low-Income Populations Within 80 Kilometers of the 200 Areas at the Hanford Site, 2006–2010

Population Group	Population	Percentage of Total
Total population	554,131	100.0
Low-income population	104,758	18.9

Note: The total population values used for the low-income comparison are lower than those used for the minority comparisons because the U.S. Census Bureau data relative to income do not take into account those people who live in institutions (e.g., college dormitories, rooming houses, religious group homes, communes, halfway houses).
To convert kilometers to miles, multiply by 0.6214.
Source: Census 2011c.

Figure 3–26 shows the total, low-income, and non-low-income populations as a function of distance from the 200 Areas at Hanford. Block-group data generated from the 2006–2010 ACS 5-year estimates (Census 2011c) reflect a total population of 554,131 within an 80-kilometer (50-mile) radius of the 200 Areas. Outward from the 200 Areas, populations tended to increase sharply near the outskirts of the population centers of Richland, Kennewick/Pasco, and Yakima.

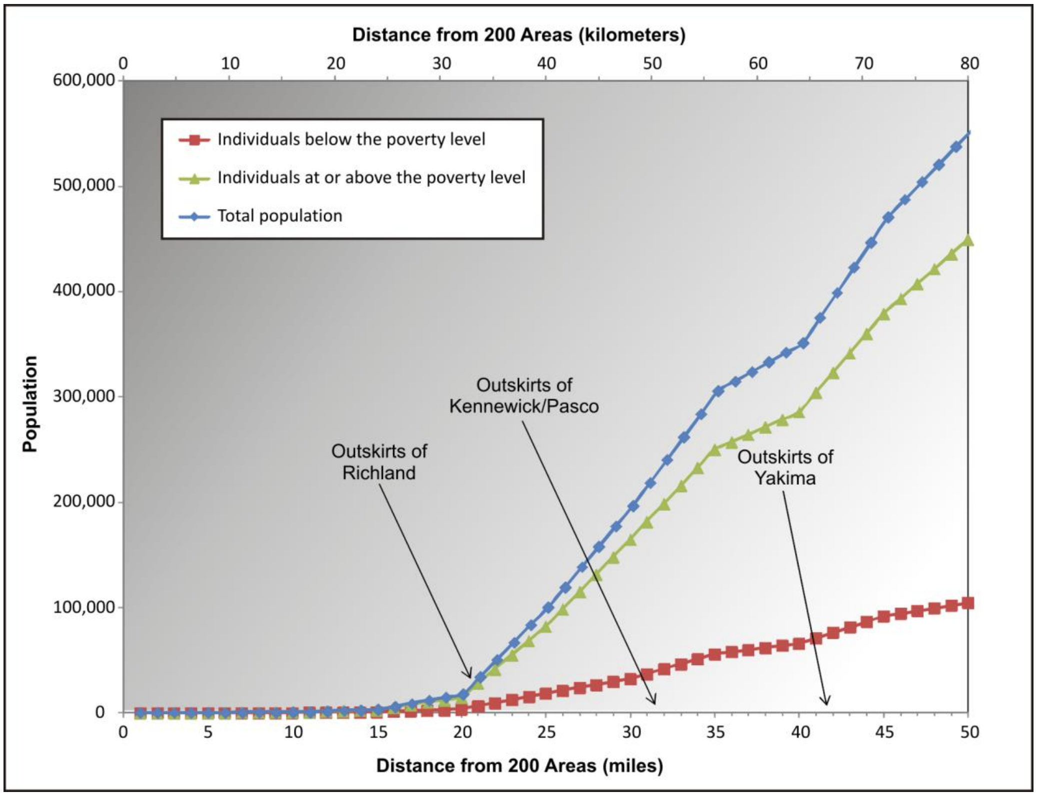


Figure 3–26. Cumulative Low-Income and Non-Low-Income Populations Surrounding the 200 Areas at the Hanford Site as a Function of Distance

Figure 3–27 shows meaningfully greater low-income and non-low-income populations living in the block groups surrounding the 200 Areas at Hanford. Of the 406 block groups surrounding the 200 Areas, 69 contain meaningfully greater low-income populations.

3.2.11.2.3 400 Area Description

Table 3–25 shows the total and low-income populations within 80 kilometers (50 miles) of the 400 Area at Hanford according to the 2006–2010 ACS 5-year estimates (Census 2011b). Low-income individuals constituted approximately 18 percent of the total population. Eighty-four percent lived in four counties: Benton, Franklin, Grant, and Yakima; 25 percent were concentrated in Yakima County.

Table 3–25. Total and Low-Income Populations Within 80 Kilometers of the 400 Area at the Hanford Site, 2006–2010

Population Group	Population	Percentage of Total
Total population	414,101	100.0
Low-income population	74,606	18.0

Note: The total population values used for the low-income comparison are lower than those used for the minority comparisons because the U.S. Census Bureau data relative to income do not take into account those people who live in institutions (e.g., college dormitories, rooming houses, religious group homes, communes, halfway houses).

To convert kilometers to miles, multiply by 0.6214.

Source: Census 2011c.

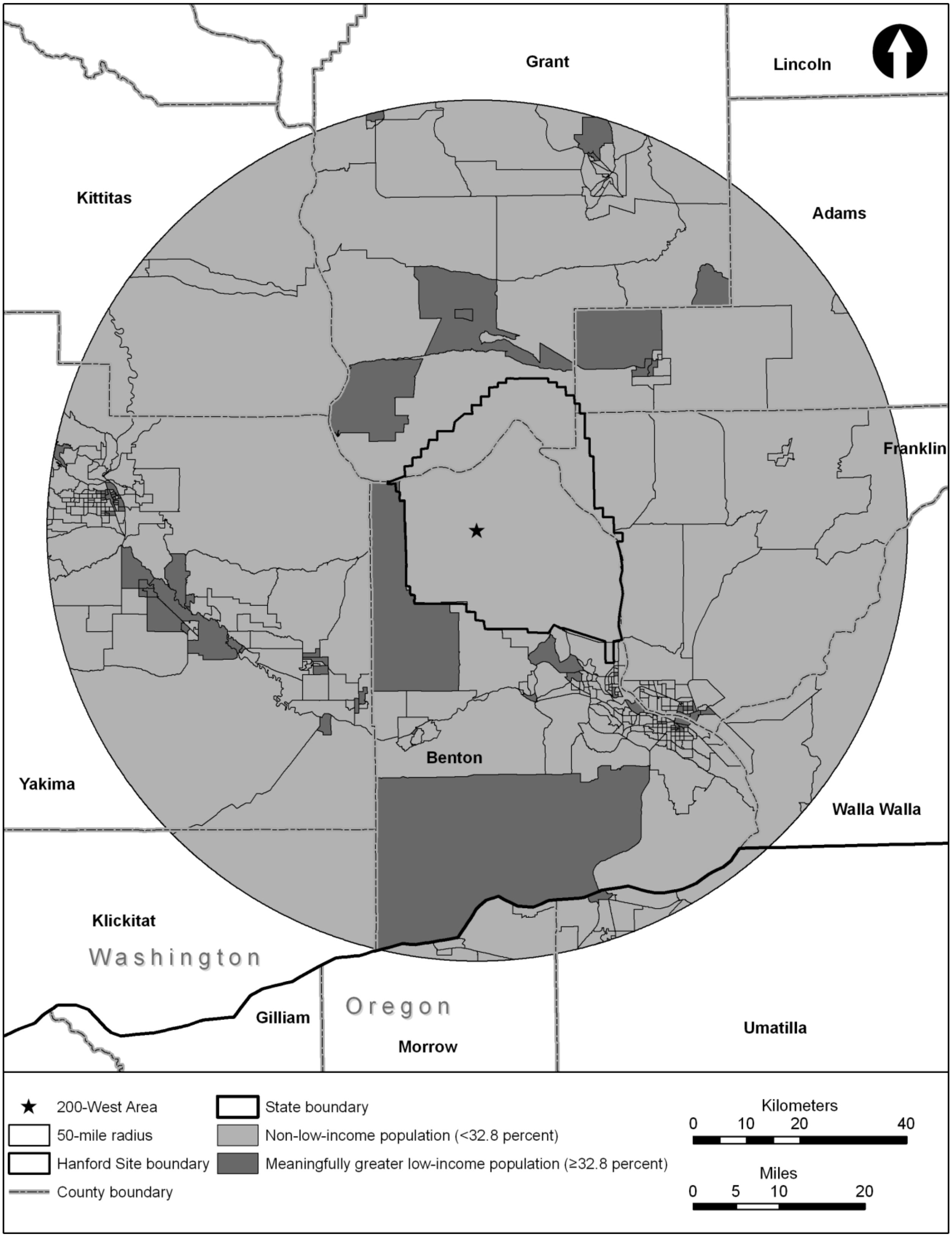


Figure 3–27. Meaningfully Greater Low-Income and Non-Low-Income Populations Living in Block Groups Surrounding the 200 Areas at the Hanford Site

Figure 3–28 illustrates the total, low-income, and non-low-income populations as a function of distance from the 400 Area. Block-group data generated from the 2006–2010 ACS 5-year estimates (Census 2011c) reflect a total population of 414,101 within an 80-kilometer (50-mile) radius of the 400 Area. Low-income individuals constituted approximately 18 percent of the total population in this area. Outward from the 400 Area, populations tended to increase sharply near the outskirts of the population centers of Richland, Kennewick/Pasco, and Hermiston.

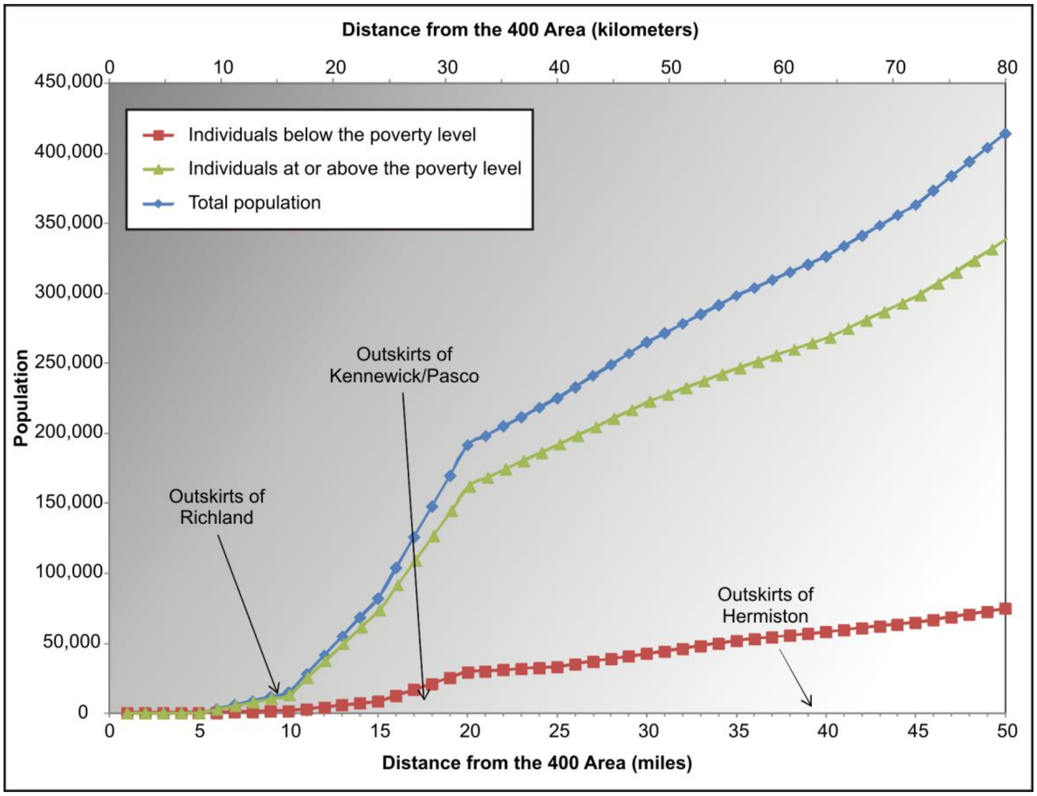


Figure 3–28. Cumulative Low-Income and Non-Low-Income Populations Surrounding the 400 Area at the Hanford Site as a Function of Distance

Figure 3–29 shows meaningfully greater low-income and non-low-income populations living in the block groups surrounding the 400 Area at Hanford. Of the 323 block groups surrounding the 400 Area, 51 contain meaningfully greater low-income populations.

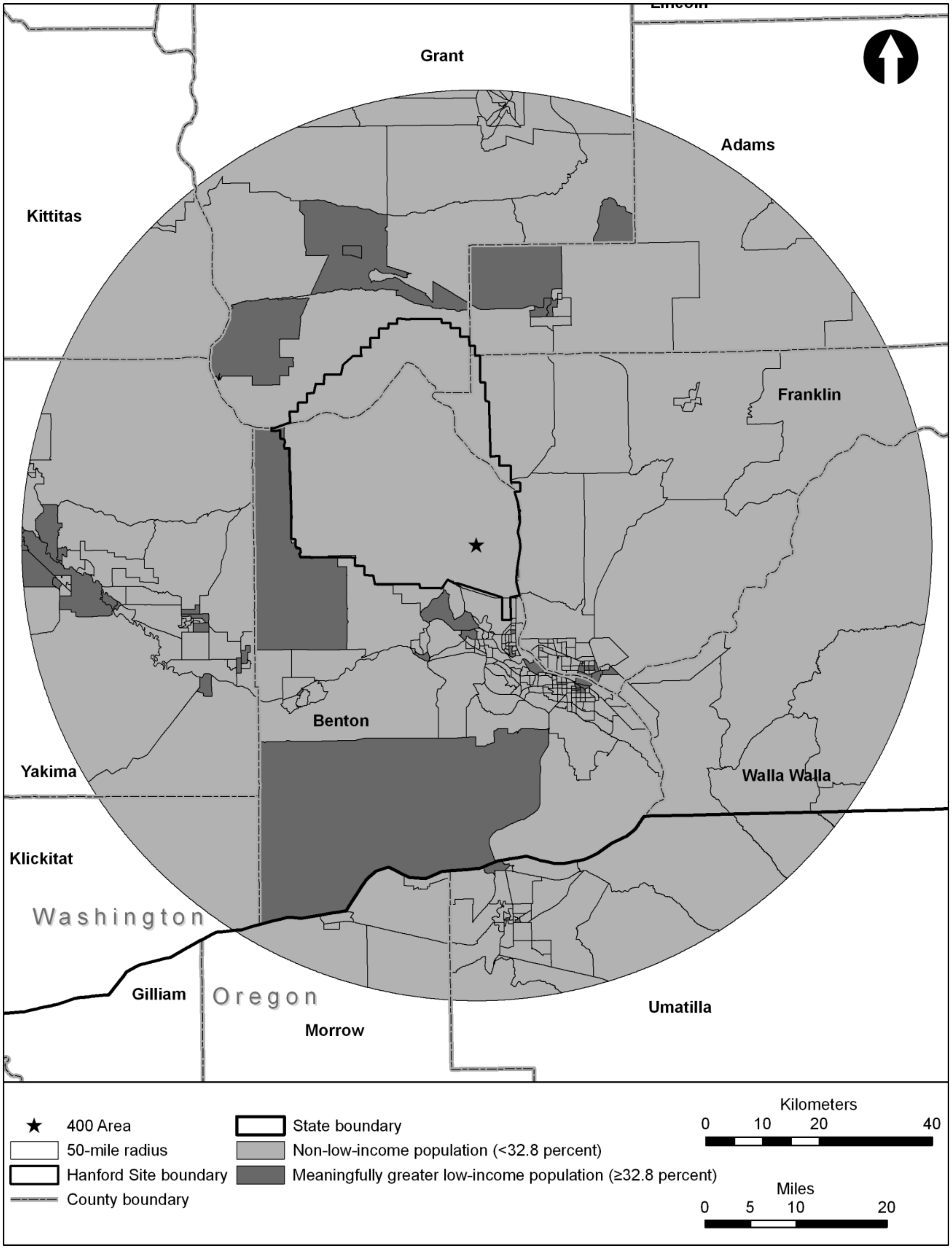


Figure 3–29. Meaningfully Greater Low-Income and Non-Low-Income Populations Living in Block Groups Surrounding the 400 Area at the Hanford Site

3.2.12 Waste Management

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from DOE activities, including management of waste in the 149 SSTs and 28 DSTs. The waste is managed using appropriate TSD technologies in compliance with all applicable Federal and state statutes and DOE orders. In support of the discussion that follows, data on the various technological aspects of waste management are provided in Appendix E.

3.2.12.1 Waste Inventories and Activities

Hanford manages the following types of waste: HLW, transuranic (TRU) waste, mixed TRU waste, LLW, mixed low-level radioactive waste (MLLW), hazardous waste, and nonhazardous waste. Radioactive waste may be contact-handled (CH) or remote-handled (RH). The CH waste has a dose rate lower than 200 millirem per hour when measured at the surface of the container and may be handled without shielding.[4] The RH waste classification applies to containers with a contact dose rate higher than 200 millirem per hour. RH waste requires the use of additional shielding and special facilities to protect workers (P.L. 102-579).

Information on the solid waste generated from activities at Hanford from 2000 through 2006 is provided in Table 3–26. Liquid waste quantities generated and stored within the tank farm system at Hanford from 2000 through 2006 are provided in Table 3–27. The tables show typical waste generation rates in recent years when no substantial waste generation from tank waste treatment and SST closure activities occurred. Projected waste generation shown in Table 3–28, includes the total volumes of waste that would be generated from 2006 through 2035. More-detailed descriptions of TRU waste, LLW, and MLLW management system capabilities at Hanford are included in Appendix E.

Table 3–26. Quantities of Solid Waste[a] Generated on the Hanford Site, 2000–2006

Waste Category	Year						
	2000	2001	2002	2003	2004	2005	2006
	(kilograms)						
Mixed[b]	441,000	328,500	1,025,000	421,000	144,512	349,416	315,188
Radioactive[c]	700,000	1,675,200	1,588,000	758,000	906,591	1,188,212	465,340

[a] Includes containerized liquid waste but not waste in the tank farm system.
[b] Includes transuranic and low-level radioactive waste and has both radioactive and dangerous nonradioactive constituents.
[c] Categorized as transuranic and low-level radioactive waste.
Note: To convert kilograms to pounds, multiply by 2.2046.
Source: Poston et al. 2006:6.18; 2007:6.20.

[4] This legal definition of CH-TRU and RH-TRU waste is from the Waste Isolation Pilot Plant Land Withdrawal Act (P.L 102-579). The 200-millirem-per-hour dose rate at the surface of a container has its basis in transportation requirements and encompasses the assumption that a worker carrying packages with a surface dose rate of 200 millirem per hour for 30 minutes a day will not exceed the recommended local exposure of 100 millirem per day. The legal definition for a waste package emitting exactly 200 millirem per hour is ambiguous. TRU waste packages approaching the definitional limit (200 millirem per hour) are handled directly or remotely, depending on site-specific practices.

Table 3–27. Quantities of Liquid Waste[a] Generated and Stored Within the Tank Farm System on the Hanford Site, 2000–2006

Type of Waste	Year						
	2000[b]	2001	2002	2003	2004	2005	2006
	(liters)						
Liquids added to double-shell tanks	8,920,000	2,980,000	9,280,000	9,710,000	3,316,000	3,668,000	3,547,000
Total waste in double-shell tanks (year end)	79,630,000	79,980,000	87,683,000	92,693,000	95,275,000	98,943,000	101,411,000
Liquid waste evaporated at 242-A Evaporator	2,580,000	2,580,000	1,578,000	4,720,000	734,000	706,700	1,052,000
Liquids pumped from single-shell tanks	2,250,000	590,000	5,288,000	6,185,000	2,778,000	888,000	2,953,000[b]

a Liquid waste sent to underground double-shell storage tanks during these years, rounded to the nearest 1,000 liters. This does not include containerized (e.g., barreled) solid waste.

b Volume includes dilution or flush water; volumes for 2000–2005 do not.

Note: To convert liters to gallons, multiply by 0.26417.

Source: Poston et al. 2006:6.25; 2007:6.27.

Table 3–28. Projected Waste Generation, 2006–2035[a]

Source	Mixed TRU Waste	LLW	MLLW	Hazardous Waste[a]	Nonradioactive/ Nonhazardous Waste[a]
	(cubic meters)				
Onsite non-CERCLA	29,726	17,363	16,074	871	NR
Offsite	N/A	5,564[b]	N/A[b]	N/A	N/A
Total	**29,726**	**22,927**	**16,074**	**871**	**–**

a Hazardous and nonhazardous waste is shipped directly off site, and thus is generally not forecast.

b This does not include the 62,000 cubic meters of LLW and 20,000 cubic meters of MLLW from the U.S. Department of Energy's Settlement Agreement with the State of Washington regarding *State of Washington v. Bodman* (Civil No. 2:03-cv-05018-AAM).

Note: To convert cubic meters to cubic feet, multiply by 35.315.

Key: CERCLA=Comprehensive Environmental Response, Compensation, and Liability Act; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; N/A=not applicable; NR=not reported; TRU=transuranic.

Source: Barcot 2005:1-5, 1-42; 2006:6-54–6-58.

3.2.12.1.1 High-Level Radioactive Waste

HLW was generated from the reprocessing of SNF to recover uranium and plutonium generated in the production reactors. This radioactive waste is considered mixed waste because it also contains toxic and hazardous constituents subject to RCRA. It must be RH because of its high radiation levels. The waste, generated as liquids and sludges, was stored in underground tanks where the salts in the liquid precipitated out of solution as porous solids (called salt cake) and settled with the sludges in the bottom of the tanks. The liquid above the solids was pumped from the older SSTs into newer DSTs. The storage tanks are described in more detail in Chapter 2. The waste contained in the 177 underground storage tanks (149 SSTs and 28 DSTs) is managed by DOE as HLW to provide consistent protection of the environment, workers, and public.

In addition to this liquid and solid material managed as HLW, an inventory of encapsulated cesium and strontium, also managed as HLW, is stored in the Waste Encapsulation and Storage Facility in a water-cooled pool (DOE 2000a:3-138). The Waste Encapsulation and Storage Facility provides safe storage and monitoring of radioactive cesium and strontium capsules. The facility contains seven hot cells and 12 storage/transfer pools. The current inventory consists of 1,312 cesium capsules, 23 overpacked cesium capsules, and 601 strontium capsules (Collins 2001:39). DOE is investigating the possibility of placing the capsules in dry storage.

The 242-A Evaporator is an RCRA-permitted facility in the 200-East Area that concentrates dilute liquid tank waste by evaporation. This reduces the volume of liquid waste sent to the DSTs for storage, and thus the need for more DSTs. Based on historic operating data, production rates achieved in the 242-A Evaporator average about 3.78 million liters (1 million gallons) per campaign and two campaigns per year, each lasting approximately 21 days. During 2006, the 242-A Evaporator completed one cold-run campaign for training purposes and one waste campaign. The volume of waste treated was 2.095 million liters (553,400 gallons) of waste, thereby reducing the waste volume by 901,682 liters (238,200 gallons), or approximately 43 percent of the total volume. The volume of process condensate transferred to the LERF for subsequent treatment in the ETF was 1.249 million liters (330,000 gallons) (Poston et al. 2007). The evaporator has a capacity of 270,000 liters (71,000 gallons) per day. Concentrated waste is returned to the waste storage DSTs, and condensate, as LLW, is discharged to the ETF (DOE 2002c).

3.2.12.1.2 Low-Activity Waste

LAW is waste resulting from the reprocessing of SNF that is determined to be incidental to the reprocessing and, therefore, is not HLW. The waste is managed under DOE regulatory authority in accordance with the requirements for LLW or TRU waste, as appropriate. When determining whether waste from the reprocessing of SNF waste is HLW or another waste type, either the citation or the evaluation process as presented in *Radioactive Waste Management Manual* (DOE Manual 435.1-1, Change 2) is used. As described in Chapter 2, certain alternatives being considered in this *TC & WM EIS* follow from an assumption that some of the tank waste would be determined to be incidental and would be treated as LAW by vitrification in the WTP or by an alternative treatment technology such as bulk vitrification, cast stone, or steam reforming. Because LAW comes from tank waste designated as mixed waste, it would also be managed as MLLW. Vitrification treatment capacity for a portion of the LAW is currently being constructed in the WTP. Additional treatment is analyzed in this *TC & WM EIS*. Hanford does not currently have disposal capability for LAW; however, the analysis allows for disposal of 213,000 cubic meters (7.52 million cubic feet) of WTP-vitrified LAW in an IDF.

3.2.12.1.3 Transuranic and Mixed Transuranic Waste

The waste contained in the 177 underground storage tanks (149 SSTs and 28 DSTs) is managed as HLW; however, the DOE Office of River Protection believes it can demonstrate that some of the tanks should be classified as containing TRU waste, based on the origin of the waste. Appendix E, Section E.1.2.3.11, covers this waste in more detail.

Not all currently generated CH-mixed TRU waste is tank-derived. Nontank waste is being placed in above-grade storage buildings at the 27,871-square-meter (300,000-square-foot) CWC in the 200-West Area (DOE 2002d). The wastes stored at the CWC are segregated to ensure compatibility of the contents of the various storage containers (e.g., acidic and basic materials are stored separately). All waste containers are CH, although some RH-TRU waste is stored at the CWC after it is shielded to CH levels. The CWC can store as much as 20,796 cubic meters (734,418 cubic feet) of MLLW and TRU waste.

Treatment reduces the amount of waste in storage and makes room for newly generated mixed waste. The dangerous waste designation of each container of waste is established at the point of origin from process knowledge or sample analysis. The current volume of waste stored at the CWC totals approximately 6,950 cubic meters (245,430 cubic feet) (Poston et al. 2007). The TRU waste will be maintained in storage until it is shipped to DOE's Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, for disposal (DOE 2002d).

Inspection, verification, opening, headspace gas sampling, sorting, and limited treatment and repackaging of TRU waste containers are performed in the 2706-T Facility of the T Plant complex. The T Plant canyon and tunnel (221-T Building) are used for processing of CH and RH materials. Dry decontamination, inspection, segregation, verification, and repackaging of CH- and RH-TRU waste and large items of contaminated equipment are performed in the canyon. The 2706-T Facility provides verification, treatment, and repackaging of CH-TRU waste. Treatment processes consist of the addition of sorbent material to the waste matrix, neutralization of the waste, and the amalgamation of mercury and other metals (DOE 2002e).

The major function of WRAP is inspection, repackaging, and certification of CH-TRU waste to prepare it for transport and disposal at WIPP. The facility is also used to verify that LLW meets Hanford waste acceptance criteria and to characterize MLLW for quality assurance purposes. WRAP provides the capability for nondestructive examination and assay of incoming waste. Nondestructive examination is an x-ray process used to identify the physical contents of the waste containers. Nondestructive assay is a neutron or gamma energy assay system used to determine radiological content and distribution. WRAP also has limited TRU waste and MLLW treatment capabilities, including deactivation, solidification or absorption of liquids, neutralization of corrosives, amalgamation of mercury and waste, microencapsulation, macroencapsulation, volume reduction by supercompaction, stabilization of reactive waste, and repackaging of waste. WRAP is designed to process 6,800 drums of TRU waste annually (DOE 2000a:3-139). This facility, which began operations in 1997, processed and shipped off site 586 cubic meters (20,694 cubic feet) of waste during 2006 (Poston et al. 2007).

Mobile TRU waste processing facilities or accelerated process lines have been proposed for Hanford to accelerate the rate at which TRU waste can be certified and shipped to WIPP. The functions of these facilities are similar to those of WRAP. They are expected to be developed in stages or modules so that the first module will process standard 208-liter (55-gallon) drums; a second module will process larger boxes. The mobile systems will provide an additional capacity to process about 4,000 CH-TRU drums per year. Units will be located outside near the CWC buildings on ground that has already been disturbed (DOE 2000b).

TRU waste disposal began in 1999 with the opening of WIPP, and Hanford began shipping waste to WIPP in July 2000. Waste to be shipped to WIPP must be certified according to the WIPP Waste Acceptance Criteria. WRAP was designed and built at Hanford to perform, among various other functions, certification of most CH-TRU waste for disposal at WIPP. Currently, CH-TRU waste drums are being removed from the CWC, certified at WRAP, and shipped to WIPP. WIPP is designed to annually receive and handle 14,160 cubic meters (500,000 cubic feet) of CH waste and 283 cubic meters (10,000 cubic feet) of RH waste. WIPP has a designated disposal capacity of 175,600 cubic meters (6.2 million cubic feet) of TRU waste and sufficient capacity to handle the 7,080 cubic meters (250,000 cubic feet) of RH waste that was established in the ROD for WIPP as a total volume (46 FR 9162). As of January 2008, 53,001 cubic meters (1,871,713 cubic feet) of waste has been disposed of at WIPP (DOE 2008d). In 2006, Hanford made 69 shipments (508 cubic meters [17,940 cubic feet]) of waste to WIPP (McKenney 2006).

3.2.12.1.4 Low-Level Radioactive Waste

Radioactive materials handling may result in the contamination of various items and materials with LLW. At Hanford, solid LLW includes protective clothing, plastic sheeting, gloves, paper, wood, analytical waste, contaminated equipment, contaminated soil, nuclear reactor hardware, nuclear fuel hardware, and spent deionizer resin from the purification of water in radioactive material storage basins.

Hanford's solid LLW is sent to the LLBG 218-W-5 (trenches 31 and 34) and the ERDF. The LLBGs are a landfill facility comprising eight separate waste disposal areas in the 200-East and 200-West Areas (DOE 2003a:E-2). The LLBGs cover a noncontiguous combined area of about 220 hectares (544 acres) (DOE 1997a). Two of these LLBGs are used for the disposal of LLW and MLLW (i.e., LLW with a dangerous waste component regulated by WAC 173-303). Seven LLBGs were previously used for disposal of LLW. TRU waste was placed in retrievable storage in four LLBGs; one LLBG (218-W-6) was never used. The LLBGs have been permitted under an RCRA Part A permit since 1985.

Three trenches receive mixed waste regulated by WAC 173-303. Trenches 31 and 34 in LLBG 218-W-5 are lined trenches with leachate collection and removal systems. Trench 94 is an unlined trench in LLBG 218-E-12B that is currently used for disposal of defueled U.S. Navy reactor compartments. LLW and TRU waste have been placed in the other LLBGs. TRU waste has not been placed in the LLBGs without specific DOE approval since August 19, 1987. The TRU waste was placed in a manner that allows for retrieval and/or removal in the future (Poston et al. 2007:6.24).

On June 23, 2004, DOE issued a ROD (69 FR 39449) for the Solid Waste Program at Hanford. Part of the ROD stated that DOE will dispose of LLW in lined disposal facilities. Only two of the LLBG trenches are lined (trenches 31 and 34); therefore, since that date, all LLW, as well as MLLW, is being placed in these two trenches. Disposal of U.S. Navy reactor compartments in the LLBGs is not affected by this ROD (Poston et al. 2007:6.24).

Typically, the trenches (ditches) are about 12 meters (40 feet) wide at the base and are excavated to a depth of approximately 6 meters (20 feet). After they are filled with waste to the desired level, a 2.4-meter (8-foot) layer of soil is placed over the waste so the surface is near the original grade (DOE 1997b). The current combined packaged waste volume in trenches 31 and 34 is 4,301 cubic meters (151,886 cubic feet); however, some of the waste in these trenches has been radiologically stabilized in grout monoliths, which take up additional space. Taking the monoliths into account, the current realized disposal volume in the two trenches is approximately 5,620 cubic meters (198,465 cubic feet) (Poston et al. 2007).

Between 1962 and 1999, Hanford disposed of 283,000 cubic meters (9,994,145 cubic feet) of solid LLW in the LLBGs. The average rate of disposal of offsite waste is about 5,663 cubic meters (200,000 cubic feet) per year (DOE 2002f). In addition, 115 defueled U.S. Navy reactor compartments from nuclear-powered vessels have been disposed of (Poston et al. 2007:6.22).

Within the LLBGs, several techniques can be used to provide extra confinement for higher-activity LLW. These techniques include placement deep within the trench (ditch), burial in high-integrity containers, and in-trench grouting. Generally, high-integrity containers are used for RH-LLW and in-trench grouting for high-activity CH-LLW.

Both on- and offsite generators of LLW are required to meet specific criteria for their waste to be accepted for disposal at Hanford. Those criteria, defined in the *Hanford Site Solid Waste Acceptance Criteria* (Fluor Hanford 2005b), include requirements regarding the waste package, waste package contents, radiological content, physical size, and chemical composition. To verify that generators conform to the waste acceptance criteria, a random sample of incoming CH waste is periodically selected for verification at WRAP, the T Plant complex, or other appropriate locations. Verification of RH waste is typically conducted at the generating facility. Discovery of nonconforming waste can result in rejection of the waste and its return to the generator, or in the required removal or treatment of prohibited items at the generator's expense. Most LLW is stored for only short periods awaiting verification or disposal. LLW that requires some type of treatment before it can be disposed of is stored at the CWC. Three percent of the waste stored at the CWC is LLW (DOE 2002d).

LLW resulting from CERCLA cleanup activities is disposed of at the ERDF, which has been the central Hanford disposal site for contaminated waste generated during such activities since 1996. The ERDF, near the 200-West Area, is an RCRA- and Toxic Substances Control Act–compliant landfill designed to provide disposal capacity for Hanford waste over the next 20 to 30 years. Constructed to RCRA Subtitle C Minimum Technology Requirements, the facility features a double liner and leachate collection system that constitute an effective barrier against contaminant migration to the environment. Environmental restoration waste disposed of in the ERDF includes soil, rubble, or other solid-waste materials classified as hazardous waste, LLW, or mixed (combined hazardous and radioactive) waste (Poston et al. 2007).

There are currently eight waste cells associated with the ERDF site. Cells 1 and 2 were the first constructed, and placement of waste in these cells is nearly complete. An interim cover has been placed over the parts of these two cells that have been brought up to grade. Construction of cells 3 through 8 is complete and they are receiving waste.

During 2006, approximately 475,792 metric tons of remediation waste was disposed of at the facility. The total for the period from operations startup through 2006 was approximately 6.2 million metric tons. Under the 1995 EPA Superfund ROD (EPA 1995), expansion of the ERDF to as much as 414 hectares (1,024 acres) was authorized (Poston et al. 2007).

US Ecology, Inc., operates a licensed, commercial disposal site (the US Ecology Commercial LLW Disposal Site) on land southwest of the 200-East Area that is leased to the State of Washington. This disposal site is not a DOE facility and is not considered part of DOE's Hanford operations (DOE 2000a:3-138).

3.2.12.1.5 Mixed Low-Level Radioactive Waste

Hanford's MLLW was generated from the operation, maintenance, and cleanout of reactors, chemical separation facilities, tank farms, and laboratories. MLLW contains the same types of contaminated materials as LLW; it typically consists of materials such as sludges, ashes, resins, paint waste, lead shielding, contaminated equipment, protective clothing, plastic sheeting, gloves, paper, wood, analytical waste, and contaminated soil. Hazardous components may include lead and other heavy metals; solvents; paints; oils and other hazardous organic materials; or components that exhibit characteristics of ignitability, corrosivity, toxicity, or reactivity as defined by "Dangerous Waste Regulations" (WAC 173-303). Hanford has some LLW that contains polychlorinated biphenyls, which are regulated under the Toxic Substances Control Act. Such waste is managed much like mixed waste, and it is included in MLLW inventories and projections.

The CWC includes 12 small, mixed waste storage buildings, 27 modules for low-flash-point MLLW, and 12 modules for alkali metals (DOE 2002d). During 2006, MLLW was treated and/or directly disposed of in trenches 31 and 34 and the ERDF. Specific operations included the following (Poston et al. 2007):

- MLLW totaling 670 cubic meters (23,660 cubic feet) was treated and disposed of in support of treatment objectives in Hanford Federal Facility Agreement and Consent Order (also known as the Tri-Party Agreement [TPA]) Milestone M-91-42.

- MLLW totaling 154 cubic meters (5,438 cubic feet), or approximately 740 drum equivalents (based on a standard 208-liter [55-gallon] drum), was shipped from Hanford and nonthermally treated to RCRA land-disposal-restriction treatment standards by offsite commercial waste processors. The treated waste was returned to Hanford and disposed of in trenches 31 and 34.

- MLLW totaling 516 cubic meters (18,222 cubic feet), or approximately 2,481 drum equivalents, was shipped from Hanford and nonthermally treated to RCRA land-disposal-restriction treatment standards by offsite commercial waste processors. The treated waste was returned to Hanford and disposed of at the ERDF.

- MLLW totaling 239 cubic meters (8,440 cubic feet), or approximately 1,149 drum equivalents, was treated and disposed of in support of treatment objectives in TPA Milestone M-91-12. This waste was shipped from Hanford and thermally treated to RCRA land-disposal-restriction treatment standards by offsite commercial waste processors. The treated waste was returned to Hanford and disposed of in trenches 31 and 34.

- MLLW totaling 79 cubic meters (103 cubic yards), or approximately 380 drum equivalents, was disposed of in trenches 31 and 34. This waste came from various Hanford generators and was treated either off site by commercial waste processors or on site by the generator, or was not treated because it met land-disposal-restriction treatment standards in the “as-generated” state.

Immobilization or destruction of the hazardous component is generally required before most of the MLLW can be sent to a permitted land disposal facility. The current approach to treatment of MLLW at Hanford involves a combination of on- and offsite commercial treatment facilities. Hanford currently has limited capacity for MLLW treatment at facilities such as trenches 31 and 34 (Brockman 2008), WRAP, and the T Plant complex. WRAP, located near the CWC, also inspects, treats, and repackages MLLW to ensure that it meets the acceptance criteria of the appropriate disposal facility. MLLW received from offsite generators is expected to arrive in a form compliant with regulations that is ready for disposal (DOE 2002g).

Miscellaneous dilute aqueous LLW and liquid MLLW are temporarily stored in the LERF until treated in the ETF. The ETF, in the 200-East Area, treats liquid effluent (wastewater) to remove toxic metals, radionuclides, and ammonia and to destroy organic compounds. The effluent comes from the 242-A Evaporator; the groundwater from the site pump-and-treat projects; and the leachate from onsite solid waste disposal facilities and a variety of other generators, including site cleanup facilities (DOE 2002d).

The LERF, in the 200-East Area, consists of three RCRA-compliant surface basins used to temporarily store process condensate from the 242-A Evaporator and other aqueous waste. The LERF ensures a steady flow and consistent pH of the feed to the ETF. Each basin has a maximum capacity of 29.5 million liters (7.8 million gallons). Generally, spare capacity is maintained to allow for control of any leak that should develop in an operating basin. Each basin is constructed of two flexible, high-density, polyethylene membrane liners. A system is provided to detect, collect, and remove leachate from between the primary and secondary liners. Moreover, a soil and bentonite clay barrier beneath the secondary liner guards against failure of the primary and secondary liners. Each basin has a floating membrane cover constructed of very low-density polyethylene to keep out windblown soil and weeds and to minimize evaporation of small amounts of organic compounds and tritium that may be present in the basin contents. The facility began operating in April 1994 and receives liquid waste from both RCRA- and CERCLA-regulated cleanup activities (Poston et al. 2007).

The volume of wastewater received for interim storage during 2006 was approximately 7.08 million liters (1.87 million gallons). Included were approximately 3.90 million liters (1.03 million gallons) of

RCRA-regulated wastewater (primarily 242-A Evaporator process condensate and mixed-waste trench leachate) and approximately 3.19 million liters (843,000 million gallons) of CERCLA-regulated wastewater (primarily ERDF leachate). Most of the wastewater was received via pipeline direct from the originating facility. Approximately 1.77 million liters (468,000 gallons) of wastewater was received from various facilities via tanker trucks. The treated effluent is stored in tanks, sampled and analyzed, and discharged to the SALDS (also known as the 616-A Crib). The volume of wastewater transferred to the ETF for treatment and disposal during 2006 was 15.6 million liters (4.12 million gallons) (Poston et al. 2007:6.24, 6.25).

The volume of wastewater being stored in the LERF at the end of 2006 was 31.42 million liters (8.30 million gallons). This included 8.10 million liters (2.14 million gallons) of RCRA-regulated wastewater and 23.32 million liters (6.16 million gallons) of CERCLA-regulated wastewater (Poston et al. 2007:6.25).

The treatment of MLLW is primarily accomplished through a series of offsite commercial contracts (e.g., Perma-Fix Northwest). Treated waste is then returned for disposal at Hanford in either the LLBGs or the ERDF. Onsite treatment (primarily macroencapsulation) is conducted on a limited basis. In addition to treatment by generator, treatment has also been performed at the T Plant complex and on a limited basis within Hanford's disposal trenches. For example, MLLW is treated within the boundaries of the ERDF, and greater-than-Category 3 LLW is treated in a similar manner within the LLBGs (Johnson and Parker 2004).

Trenches 31 and 34 are located in LLBG 218-W-5 in the 200-West Area. They are rectangular trenches with approximate floor dimensions of 76.2 by 30.5 meters (250 by 100 feet) and depths of 9.1 to 10.7 meters (30 to 35 feet). These trenches are RCRA-compliant, featuring double liners and leachate collection systems (DOE 2000a:3-139). The bottom and sides of the facilities are covered with a layer of soil 1 meter (3.3 feet) deep to protect the liner system during fill operations. A recessed section at the end of each excavation houses a sump for leachate collection. The leachate generated from operation of the lined MLLW disposal trenches is mostly rainwater or melted snow trapped by the collection systems. The liquid waste is removed from the lined trenches and trucked to the ETF, where it is treated along with other liquid MLLW (Poston et al. 2007:6.23).

The 400 Area waste management unit is located within the FFTF Property Protected Area and consists of two container storage units: the Fuel Storage Facility and the Interim Storage Area. The mixed waste stored in these two container storage units is limited exclusively to debris (e.g., piping, equipment, components) contaminated with elemental sodium and sodium hydroxide generated from FFTF deactivation activities in the FFTF Fuel Storage Facility and the 400 Area Interim Storage Area. Once this waste has been treated, removed, and disposed of, appropriate closure of the 400 Area waste management unit facilities will be done under applicable regulations.

3.2.12.1.6 Hazardous Waste

There are no treatment facilities for hazardous waste at Hanford; therefore, the waste is accumulated in satellite storage areas (for less than 90 days) or at interim RCRA-permitted facilities. The common practice for newly generated hazardous waste is to ship it off site using U.S. Department of Transportation–approved transporters for treatment, recycling, recovery, and disposal at RCRA-permitted commercial facilities (DOE 2000a:3-139).

3.2.12.1.7 Nonhazardous Waste

Sanitary wastewater is discharged to onsite treatment facilities such as septic tanks, subsurface soil adsorption systems, and wastewater treatment plants. These facilities treat an average of 598,000 liters (158,000 gallons) per day of sewage (DOE 2000a:3-139). Sewage at Hanford is treated by various means and in various systems. The sewer system in the 300 Area was recently connected to the City of Richland's system, thereby providing for treatment of that area's sewage at the municipal plant. Moreover, the 400 Area, which until recently used a septic tank and drain field, currently sends its sewage for processing to the Energy Northwest sanitary sewer system. Sanitary waste in the 200 Areas is currently disposed of through septic tanks and drain fields (DOE 1999a:4-112).

The 200 Area TEDF collects the treated wastewater streams from various plants in the 200 Areas and disposes of the clean effluent at two 2-hectare (5-acre) ponds permitted by the State of Washington (DOE 2000a:3-139). The design capacity of the facility is approximately 13,000 liters (3,400 gallons) per minute (DOE 2002d).

Nonhazardous solid waste includes construction debris, office trash, cafeteria waste, furniture and appliances, nonradioactive friable asbestos, powerhouse ash, and nonradioactive/nonhazardous demolition debris (DOE 2000a:3-139). Such waste is disposed of at the Roosevelt Regional Landfill near Goldendale, Washington (Poston et al. 2006:6.17). Nonradioactive friable asbestos and medical waste are shipped off site for disposal at commercial facilities (DOE 2000a:3-139).

3.2.12.2 Waste Minimization

The Hanford Site Pollution Prevention Program is a comprehensive, continual effort to systematically reduce the quantity and toxicity of hazardous, radioactive, mixed, and sanitary wastes; conserve resources and energy; reduce hazardous substance use; and prevent or minimize pollutant releases to all environmental media from all operations and site cleanup activities. In accordance with sound environmental management practices, the pollution prevention program seeks to prevent pollution through establishing goals related to affirmative procurement (the purchase of environmentally preferable products containing recycled material), source reduction, and environmentally safe recycling. DOE Order 436.1, *Departmental Sustainability*, was approved on May 2, 2011. The purpose of this order is to ensure that DOE carries out its missions in a sustainable manner that addresses national energy security and global environmental challenges and advances sustainable, efficient, and reliable energy for the future; to institute wholesale cultural change to factor sustainability and greenhouse gas reductions into all DOE corporate management decisions; and to ensure that DOE achieves the sustainability goals.

DOE-RL is responsible for the Hanford pollution prevention program. The office provides program guidance for Hanford contractors. Integration activities are managed by Fluor Hanford, Inc., under the Project Hanford Management Contract. In 2006, Hanford recycled 1,115 metric tons of sanitary and hazardous wastes. Affirmative procurement at Hanford achieved 100 percent of the 2006 goal. Hanford generated 4,278 cubic meters (151,073 cubic feet) of cleanup and stabilization goal waste (i.e., LLW, MLLW, and hazardous waste) (Poston et al. 2007).

3.2.12.3 *WM PEIS* Records of Decision

Decisions regarding management of the various waste types at Hanford were announced in a series of RODs following publication of the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste (WM PEIS)* (DOE 1997b). The effects of these decisions for the waste types analyzed in this *TC & WM EIS* are shown in Table 3–29. The hazardous waste ROD was issued on July 30, 1998 (63 FR 41810); the HLW ROD, on August 12, 1999 (64 FR 46661); and the LLW and MLLW ROD, on February 18, 2000 (65 FR 10061). The TRU waste ROD was issued on January 20, 1998 (63 FR 3629), and modified on December 19, 2000 (65 FR 82985); July 13, 2001 (66 FR 38646); and August 27, 2002 (67 FR 56989).

Table 3–29. Preferred Treatment of Various Hanford Wastes as Stipulated in the *WM PEIS* Records of Decision

Waste Type	Preferred Actions
HLW	DOE decided that Hanford should store its HLW on site pending the transfer of such waste to an HLW geologic repository.[a]
LLW	DOE decided to treat Hanford's LLW on site. It also selected Hanford as one of the regional disposal sites for LLW.[b]
MLLW	DOE decided to regionalize treatment of MLLW at Hanford. This entails onsite treatment of Hanford's own waste and possibly some MLLW generated at other sites. Hanford was selected as one of the regional disposal sites for MLLW.[b]
TRU waste and mixed TRU waste	DOE decided that Hanford should prepare for storage and store its own TRU waste and small quantities of TRU waste from other sites, pending the disposal of such waste at the Waste Isolation Pilot Plant or another suitable geologic repository.[c]
Hazardous waste	DOE decided to continue using commercial facilities to treat Hanford's nonwastewater hazardous waste and onsite facilities to treat its wastewater hazardous waste.[d]

[a] 64 FR 46661.

[b] 65 FR 10061.

[c] 63 FR 3629; 65 FR 82985; 66 FR 38646; and 67 FR 56989.

[d] 63 FR 41810.

Key: DOE=U.S. Department of Energy; Hanford=Hanford Site; HLW=high-level radioactive waste; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; TRU=transuranic; *WM PEIS*=*Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*.

According to the HLW ROD, immobilized HLW will be stored at the site of generation pending its transfer to an HLW geologic repository. As stipulated in the first TRU waste ROD, DOE will develop and operate mobile and fixed facilities to characterize TRU waste and prepare it for disposal at WIPP. Each DOE site that has generated, or will generate, TRU waste will, as needed, prepare its TRU waste for storage and store it on site. The LLW and MLLW ROD states that, for management of LLW, minimal treatment will be performed at all sites and disposal will continue, to the extent practicable, on site at INL, Los Alamos National Laboratory, the Oak Ridge Reservation (ORR), and the Savannah River Site (SRS). In addition, Hanford and the Nevada National Security Site (NNSS), formerly the Nevada Test Site, will be available to all DOE sites for LLW disposal. MLLW will be treated at Hanford, INL, ORR, and SRS and will be disposed of at Hanford and NNSS. Commercial facilities may also be used for the treatment and disposal of LLW and MLLW. The hazardous waste ROD states that most DOE sites will continue to use offsite facilities for the treatment and disposal of major portions of the nonwastewater hazardous waste, and that ORR and SRS will continue treating some of their own nonwastewater hazardous waste on site in existing facilities where this is economically favorable.

More-detailed information concerning DOE alternatives for the future configuration of waste management facilities at Hanford is presented in the *WM PEIS* (DOE 1997b) and the HLW, TRU waste, hazardous waste, and LLW and MLLW RODs.

3.2.13 Spent Nuclear Fuel

The Nuclear Waste Policy Act of 1982, as amended, assigned the Secretary of Energy responsibility for developing a repository for disposal of HLW and SNF. When such a repository is available, SNF will be transferred from the various nuclear reactor sites to the repository for disposal. Until that repository is available, SNF will be stored in the reactor vessel or another acceptable containment, such as a dry cask storage system.

Several strategies for management—i.e., transportation and treatment or storage—of the SNF from FFTF have been evaluated in depth by DOE. The specific strategies and documentation thereof are as follows:

- As part of previous NEPA reviews, transportation and storage of FFTF fuel at either Hanford or INL (formerly Idaho National Engineering Laboratory) was evaluated in the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE 1995a) and ROD (60 FR 28680); the *Environmental Assessment, Shutdown of the Fast Flux Test Facility, Hanford Site, Richland Washington* (DOE 1995b) and Finding of No Significant Impact (DOE 1995c); and the *Environmental Assessment, Management of Hanford Site Non-defense Production Reactor Spent Nuclear Fuel, Hanford Site, Richland, Washington* (DOE 1997c) and Finding of No Significant Impact (DOE 1997d).

- Transportation and treatment of the FFTF sodium-bonded SNF at the Materials and Fuels Complex (MFC) was evaluated in the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE 1995a) and ROD (60 FR 28680), and the *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE 2000b) and ROD (65 FR 56565).

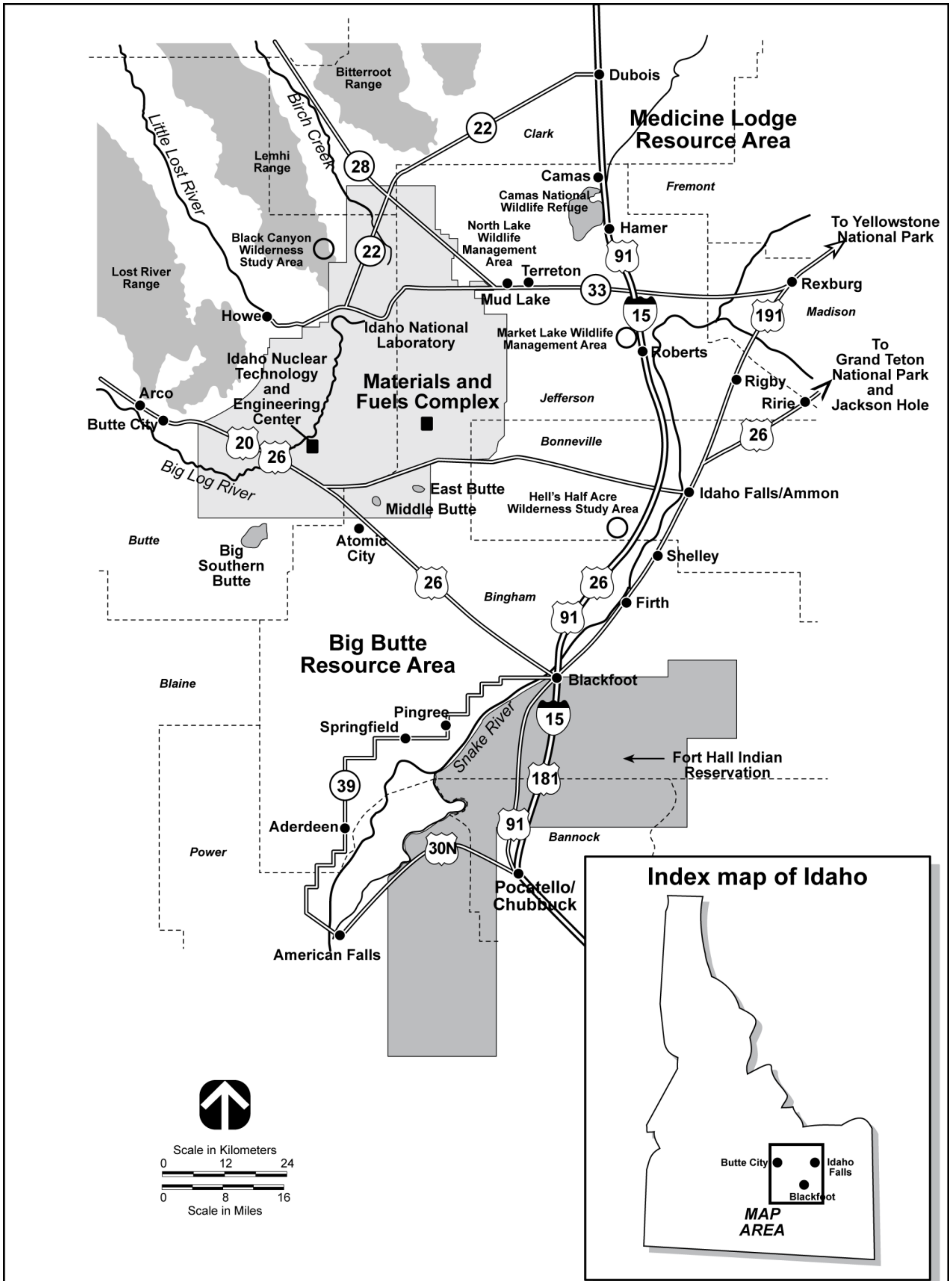
In December 2007, Hanford began to ship sodium-bonded SNF from FFTF to INL, and shipments were completed in April 2008 (Cary 2007). As management and disposition of the FFTF fuel, including the FFTF sodium-bonded fuel, have already been addressed in the above NEPA documents (and decisions), they are not being addressed in this *TC & WM EIS*.

3.3 IDAHO NATIONAL LABORATORY

INL occupies 230,323 hectares (569,135 acres) in southeastern Idaho; the nearest boundary is 39 kilometers (24 miles) west of Idaho Falls, 40 kilometers (25 miles) northwest of Blackfoot, and 16 kilometers (10 miles) east of Arco (see Figure 3–30). Much of the current site was originally withdrawn from public domain in 1943 and commissioned by the U.S. Department of the Navy as the Naval Proving Ground. Presently, INL is administered, managed, and controlled by DOE. Most of the site is within Butte County, but portions are also in Bingham, Jefferson, Bonneville, and Clark Counties. The site is roughly equidistant from Salt Lake City, Utah, and Boise, Idaho (O’Rourke 2006:4, 11).

There are 450 buildings and 2,000 support structures at INL, with more than 279,000 square meters (3 million square feet) of floor space in varying conditions of utility. INL has approximately 25,100 square meters (270,000 square feet) of covered warehouse space and an additional 18,600 square meters (200,000 square feet) of fenced yard space. The total area of the various machine shops is 3,035 square meters (32,665 square feet) (DOE 2000a:3-43).

Fifty-two research and test reactors have been used at INL over the years to test reactor systems, fuel and target design, and overall safety. One such facility, the Experimental Breeder Reactor I, is a designated National Historic Landmark. It was the first reactor to achieve a self-sustaining chain reaction using plutonium as its principal fuel component. Various INL facilities are operated to support reactor operations. These facilities include HLW and LLW processing and storage sites; hot cells; analytical laboratories; machine shops; and laundry, railroad, and administrative facilities. Other activities include management of one of DOE’s largest storage sites for LLW and TRU waste (DOE 2000a).



Source: DOE 2002h:4-120.

Figure 3–30. Idaho National Laboratory Vicinity

The Idaho Nuclear Technology and Engineering Center (INTEC) is located in the south-central portion of INL, approximately 64 kilometers (40 miles) west of Idaho Falls. There are more than 150 buildings within INTEC; the Fuel Process Facility is the largest. Facilities at INTEC include SNF storage and processing areas, a waste solidification facility and related HLW storage facilities, remote analytical laboratories, warehouse facilities, and a coal-fired stream-generating plant that is in standby status (DOE 2002a:4-3; 2011a:3-69).

The MFC, located in the southeastern portion of INL, is about 61 kilometers (38 miles) west of the city of Idaho Falls. It is a testing center for advanced technologies associated with nuclear power systems and comprises 52 major buildings occupying 55,700 square meters (600,000 square feet) of floor space. Included are reactor buildings, laboratories, warehouses, technical and administrative support buildings, and craft shops (DOE 2002h). Five nuclear test reactors have operated at the MFC, although only one is currently active—a small reactor used for radiographic examination of experiments, waste containers, and SNF. Principal facilities at the MFC include the Fuel Manufacturing Facility, Assembly and Testing Facility, Transient Reactor Test Facility, Fuel Conditioning Facility, Hot Fuel Examination Facility, Zero Power Physics Reactor, and Experimental Breeder Reactor II (EBR-II).

3.3.1 Land Resources

The scope of the discussion of land resources in this *TC & WM EIS* is stipulated in Section 3.2.1.

3.3.1.1 Land Use

3.3.1.1.1 General Site Description

The Federal Government, the State of Idaho, and various private parties own lands immediately surrounding INL; BLM administers about 75 percent of the adjacent land. Regional land uses include grazing, wildlife management, mineral and energy production, recreation, and crop production (O'Rourke 2006:13). Small communities and towns near the INL boundaries include Mud Lake and Terreton to the east; Arco, Butte City, and Howe to the west; and Atomic City to the south. Two national natural landmarks border INL: Big Southern Butte (2.4 kilometers [1.5 miles] south) and Hell's Half Acre (2.6 kilometers [1.6 miles] southeast). A portion of Hell's Half Acre National Natural Landmark is designated as a Wilderness Study Area. The Black Canyon Wilderness Study Area is adjacent to INL, and the Craters of the Moon Wilderness Area is about 19 kilometers (12 miles) southwest of the site's western boundary. On November 9, 2000, the President signed a Presidential Proclamation that added 267,500 hectares (661,000 acres) to the 21,850-hectare (54,000-acre) Craters of the Moon National Monument, which encompasses this wilderness area.

Land use designations at INL include Facility Operations, Grazing, General Open Space, and Infrastructure (e.g., roads). Generalized land uses at INL and the surrounding vicinity are shown in Figure 3–31. Facilities are sited within a central core area of about 93,100 hectares (230,000 acres). Public access to most facilities is restricted (DOE 2002h:4-122, 4-123). Approximately 94 percent of INL is undeveloped; 60 percent of the site is used for cattle and sheep grazing (INL 2010; O'Rourke 2006:vi). Facility Operations include industrial and support operations associated with energy research and waste management activities. Land is also used for environmental research associated with the designation of INL as a National Environmental Research Park. During selected years, depredation hunts of game animals managed by the Idaho Department of Fish and Game are permitted in an area that extends 0.8 kilometers (0.5 miles) inside the INL boundary on portions of the northeastern and western borders of the site. Much of INL is open space that has not been designated for specific use. Some of this space serves as a buffer zone between INL facilities and other land uses. In 1999, a total of

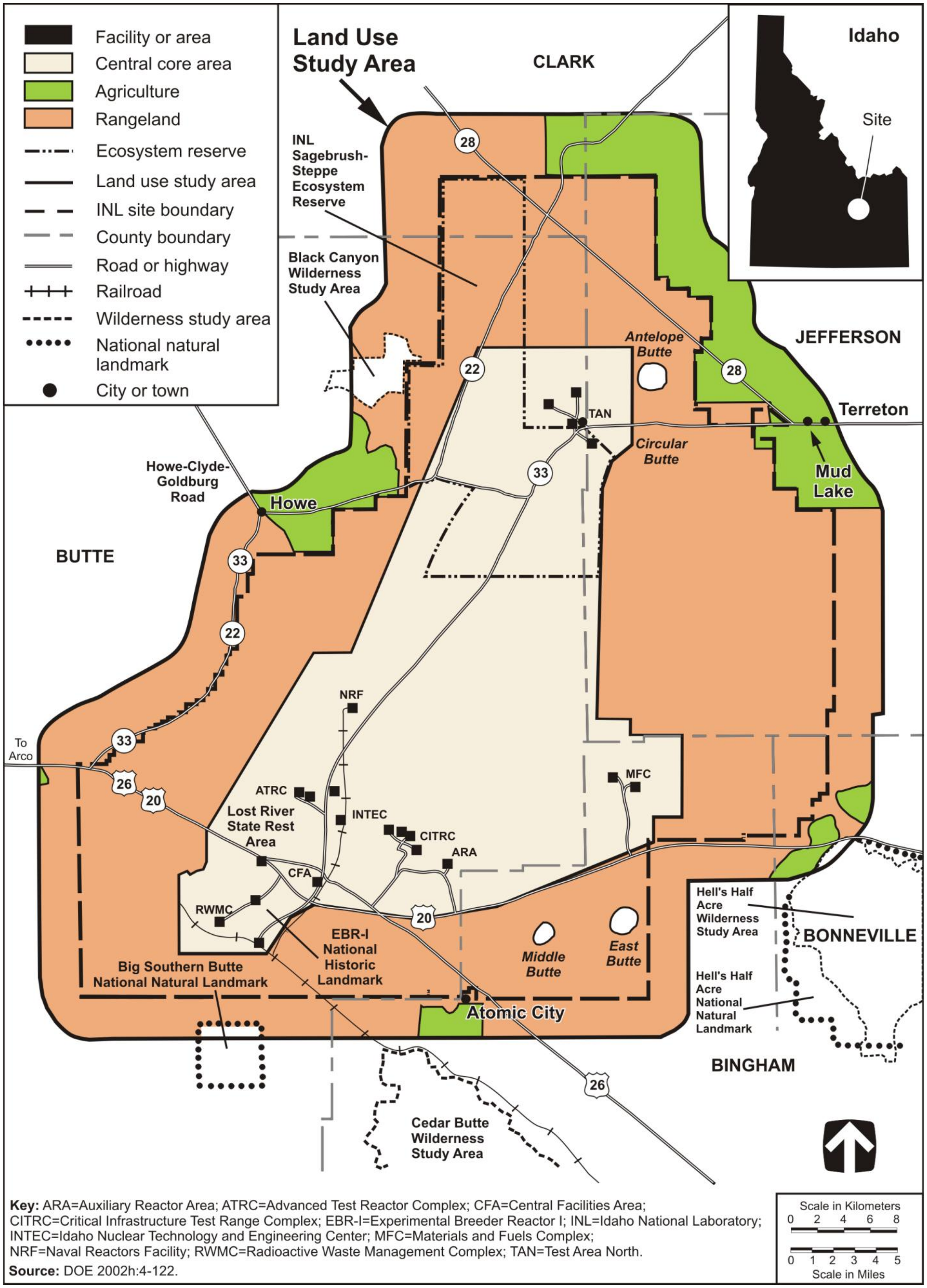


Figure 3–31. Land Use at Idaho National Laboratory and Vicinity

29,244 hectares (72,263 acres) of open space in the northwest corner of the site was designated as the INL Sagebrush-Steppe Ecosystem Reserve. This area represents one of the last sagebrush-steppe ecosystems in the United States and provides a home for a number of rare and sensitive species of plants and animals (O’Rourke 2006:26, 53). DOE land use plans and policies applicable to INL are discussed in the *Idaho National Laboratory Comprehensive Land Use and Environmental Stewardship Report* (O’Rourke 2006).

All county plans and policies encourage development adjacent to previously developed areas to minimize the need for infrastructure improvements and to avoid urban sprawl (Id. Stat. 67-65). Because INL is remote from most developed areas, its lands and adjacent areas are not likely to experience residential and commercial development, and no new development is planned near the site. Recreational and agricultural uses, however, are expected to increase in the surrounding area in response to greater demand for recreational areas and the conversion of rangeland to cropland (DOE 2002h:4-123).

As shown in Figure 3–30, the Fort Hall Reservation is southeast of INL. The Fort Bridger Treaty of July 3, 1868, secured this reservation as the permanent homeland of the Shoshone-Bannock Peoples. According to the treaty, tribal members reserved rights to hunting, fishing, and gathering on surrounding unoccupied lands of the United States. While INL is considered occupied land, it was recognized that certain areas of the INL site have significant cultural and religious significance to the tribes. A 1994 Memorandum of Agreement with the Shoshone-Bannock Tribes provides tribal members with access to the Middle Butte area to perform sacred or religious ceremonies or other educational or cultural activities. Further, in 2002, DOE and the Shoshone-Bannock Tribes signed an Agreement in Principle to continue to improve on the government-to-government relationship established in the Fort Bridger Treaty. This agreement also reaffirmed the Shoshone-Bannock Tribes’ rights under the articles of the treaty and DOE trust responsibility to the tribes (DOE 2005a).

3.3.1.1.2 Idaho Nuclear Technology and Engineering Center

The total fenced area at INTEC is 85 hectares (210 acres), with an additional 22 hectares (54 acres) outside the fence. INTEC is 12 kilometers (7.5 miles) north of the site boundary and 3.2 kilometers (2 miles) north of U.S. Route 20. The site is 0.8 kilometers (0.5 miles) to the southeast of Big Lost River. Land within the fenced portion of the site has been heavily disturbed, with buildings, parking lots, and roadways occupying most areas and no natural habitat present. Ongoing activities at INTEC include storage of SNF, management of high-level waste calcine and sodium-bearing liquid waste, and the operation of the INL CERCLA Disposal Facility, which includes a landfill, evaporation ponds, and a storage and treatment facility. In the future, INTEC will continue to provide management of HLW and SNF (DOE 2011a:3-69; IDEQ 2010).

3.3.1.1.3 Materials and Fuels Complex

The total land area at the MFC, formerly Argonne National Laboratory-West, is 328 hectares (810 acres); however, site facilities are principally situated within about 20 hectares (50 acres), or 6 percent of the site. The MFC is 7 kilometers (4.3 miles) northwest of the nearest site boundary. Land within the fenced portion of the site has been heavily disturbed, with buildings, parking lots, and roadways occupying most areas and no natural habitat present. The Fuel Manufacturing Facility is within the main fenced portion of the site, while the Transient Reactor Test Facility is about 1.2 kilometers (0.75 miles) to the northeast. Land within the site will continue to be used for nuclear and nonnuclear scientific and engineering experiments for DOE, private industry, and academia (DOE 2002h:4-123).

3.3.1.2 Visual Resources

3.3.1.2.1 General Site Description

The Bitterroot, Lemhi, and Lost River Mountain ranges border INL on the north and west (see Figure 3–30). Volcanic buttes near the southern boundary of INL can be seen from most locations on the site. INL generally consists of open desert land covered by big sagebrush and grasslands. Uncultivated grazing range borders much of the site. There are a number of facility areas located throughout INL. Although INL has prepared a comprehensive land use and environmental stewardship plan, no specific visual resource standards have been established (O'Rourke 2006). INL facilities have the appearance of low-density commercial/industrial complexes that are widely dispersed throughout the site. Structure heights generally range from 3 to 30 meters (10 to 100 feet); a few stacks and towers reach 76 meters (250 feet). Although many INL facilities are visible from highways, most are more than 0.8 kilometers (0.5 miles) from public roads (DOE 2000a:3-46). The operational areas are well defined at night by security lights. Such light pollution is a key element of the nighttime visual environment surrounding INL facility complexes. However, given the distances between INL facility complexes across the site and the distances from public areas to INL facilities, this light does not substantially impair offsite visual observation of celestial features.

Public lands adjacent to INL are under BLM jurisdiction and have a VRM Class II rating. Undeveloped lands within INL have a VRM rating consistent with Classes II and III. Management activities within these classes may be seen, but should not dominate the view. The VRM class rating of developed areas of the site is consistent with Class IV, indicating that management activities dominate the view and are the focus of viewer attention (BLM 1986:6, 7). The Black Canyon Wilderness Study Area adjacent to INL is under consideration by BLM for Wilderness Area designation. The Hell's Half Acre Wilderness Study Area is located 2.6 kilometers (1.6 miles) southeast of INL's eastern boundary. This area, famous for its lava flow and hiking trails, also is managed by BLM. The Craters of the Moon Wilderness Area is approximately 19 kilometers (12 miles) southwest of INL's western boundary (DOE 2000a:3-46).

3.3.1.2.2 Idaho Nuclear Technology and Engineering Center

Developed areas within INTEC are consistent with a VRM Class IV rating. While the Fuel Processing Facility is the largest facility at INTEC, the tallest structure is the main stack, which is 76 meters (250 feet) tall. INTEC is visible in the middle ground from U.S. Routes 20 and 26, with Saddle Mountain in the background (DOE 2011a:3-70). Natural features of visual interest within a 40-kilometer (25-mile) radius of INTEC include Big Lost River at 60 meters (200 feet), Middle Butte and Big Southern Butte National Natural Landmark at 17.7 kilometers (11 miles), East Butte at 22.5 kilometers (14 miles), Hell's Half Acre National Natural Landmark and Hell's Half Acre Wilderness Study Area at 37 kilometers (23 miles), and Craters of the Moon National Monument at 40 kilometers (25 miles).

3.3.1.2.3 Materials and Fuels Complex

Developed areas within the MFC are consistent with a VRM Class IV rating. The tallest structure at the MFC is the Fuel Conditioning Facility stack, which is 61 meters (200 feet) in height. The site is visible from U.S. Route 20. Facilities that stand out from the highway include the Transient Reactor Test Facility, Hot Fuel Examination Facility, EBR-II containment shell, and Zero Power Physics Reactor. Natural features of visual interest within a 40-kilometer (25-mile) radius of the MFC include East Butte at 9 kilometers (5.6 miles), Middle Butte at 11 kilometers (6.8 miles), Hell's Half Acre National Natural Landmark and Hell's Half Acre Wilderness Study Area at 15 kilometers (9.3 miles), Big Lost River at 19 kilometers (11.8 miles), and Big Southern Butte National Natural Landmark at 30 kilometers (18.6 miles) (DOE 2002h:4-124).

3.3.2 Infrastructure

The scope of the discussion of infrastructure in this *TC & WM EIS* is stipulated in Section 3.2.2. Characteristics of INL's utility and transportation infrastructure are described below and are summarized in Table 3–30. Section 3.3.9.4 provides further discussion of the local transportation infrastructure, and Section 3.3.12, a description of the site's waste management infrastructure.

Table 3–30. Idaho National Laboratory Sitewide Infrastructure Characteristics

Resource	Usage	Capacity
Transportation		
Roads (kilometers)	140[a]	N/A
Railroads (kilometers)	23	N/A
Electricity		
Energy (megawatt-hours per year)	159,800[b]	481,800
Peak load (megawatts)	36	55
Fuel		
Natural gas (cubic meters per year)	510,000[b]	N/A
Fuel oil (heating) (liters per year)	9,080,000[b]	(c)
Diesel fuel (liters per year)	2,050,000[b]	(c)
Gasoline (liters per year)	1,475,000[b]	(c)
Propane (liters per year)	577,000[b]	(c)
Water (liters per year)	4,200,000,000[b]	43,000,000,000[d]

[a] Includes asphalt-paved roads only.
[b] Average value for fiscal years 2001 through 2004.
[c] Limited only by the ability to ship resources to the site.
[d] Water right allocation.
Note: To convert cubic meters to cubic feet, multiply by 35.315; kilometers to miles, by 0.6214; liters to gallons, by 0.26417.
Key: N/A=not applicable.
Source: DOE 2002a:4-65, 4-79; 2002h:4-124, 4-125; 2005b:90, 91.

3.3.2.1 Ground Transportation

3.3.2.1.1 General Site Description

Two interstate highways serve the INL regional area. Interstate 15, a north-south route that connects several cities along the Snake River, is approximately 40 kilometers (25 miles) east of INL. Interstate 86 intersects Interstate 15 approximately 64 kilometers (40 miles) south of INL and provides a primary linkage from Interstate 15 to points west. Interstate 15 and U.S. Route 91 are the primary access routes to the Shoshone-Bannock Reservation. U.S. Routes 20 and 26 are the main access routes to the southern portion of INL and the MFC (see Figure 3–31). Idaho State Routes 22, 28, and 33 pass through the northern portion of INL, and State Route 33 provides access to the northern INL facilities. The road network at INL provides for onsite ground transportation. From the 444 kilometers (276 miles) of roads on the site, about 140 kilometers (87 miles) of nonpublic paved surface roads have been developed (see Table 3–30). Most of the roads are adequate for the current level of normal transportation activity and could handle increased traffic volume (DOE 2002a:4-64; 2005c:3-9).

The Union Pacific Railroad enters the southern portion of INL and provides rail service to the site. This branch connects with a DOE spur line at Scoville Siding, then links with developed areas within INL.

There are 23 kilometers (14 miles) of railroad track at INL. Rail shipments to and from INL usually are limited to bulk commodities, SNF, and radioactive waste (DOE 2002a:4-65, 4-66).

3.3.2.1.2 Idaho Nuclear Technology and Engineering Center

INTEC is north of U.S. Route 20. It can be accessed from U.S. Route 20 via 7.1 kilometers (4.4 miles) of paved site roads. While there are no physical barriers on the access road, INTEC is a restricted facility. A DOE rail spur runs south to north through INTEC.

3.3.2.1.3 Materials and Fuels Complex

The MFC can be accessed from U.S. Routes 20 and 26. A 4.8-kilometer-long (3-mile-long) paved road from U.S. Route 20 provides direct access to the MFC. No physical barriers are on the access road; however, signs indicate that access is restricted to official business, and the road can be easily blocked by security personnel. The site is also surrounded by two fences for additional security control (ANL 2003:2).

3.3.2.2 Electricity

3.3.2.2.1 General Site Description

DOE presently contracts with the Idaho Power Company to supply electric power to INL. The contract allows for power demand of up to 45 megawatts, which can be increased to 55 megawatts by notifying Idaho Power in advance. Power demand above 55 megawatts is possible, but would have to be negotiated with the company (DOE 2002a:4-79). Power is generated by hydroelectric facilities along the Snake River in southern Idaho, and by large coal-fired, thermal-electric generating plants in southwestern Wyoming and northern Nevada. This power is supplied to INL through the Antelope substation, which is owned and maintained by Rocky Mountain Power. Power can be supplied to the Antelope substation from any of three sources: (1) through the Idaho Power 230-kilovolt Antelope line; (2) from Northwestern Energy (formerly Montana Power Company) through the Rocky Mountain Power 230-kilovolt Antelope-to-Anaconda line; and (3) through the Rocky Mountain Power 161-kilovolt Goshen-to-Antelope line. The Antelope substation transmits power through two 138-kilovolt lines to the Scoville substation 138-kilovolt bus (at the Central Facilities Area substation), which is the origin of the site's distribution system (ANL 2003:7). The INL transmission system is a 138-kilovolt, 105-kilometer (65-mile) dual-loop configuration that encompasses six substations where the power is reduced to distribution voltages for use at the various INL facilities. The loop allows for a redundant power feed to all substations and facilities (ANL 2003:7; DOE 2002a:4-79).

Site electrical energy availability is about 481,800 megawatt-hours per year given the contract load limit of 55 megawatts (DOE 2002a:4-79) for 8,760 hours per year. Total INL electrical energy consumption averages 159,800 megawatt-hours annually (DOE 2005b:90). The recorded peak load for INL was about 36 megawatts; the contract-limited peak load capacity is 55 megawatts (DOE 2002a:4-79) (see Table 3–30).

3.3.2.2.2 Idaho Nuclear Technology and Engineering Center

Annual electrical consumption at INTEC is 46,270 megawatt-hours (INL 2009a).

3.3.2.2.3 Materials and Fuels Complex

Electric power for the MFC is distributed via the EBR-II substation (ANL 2003:7). The MFC uses about 28,700 megawatt-hours of electricity annually (DOE 2002h:4-125).

3.3.2.3 Fuel

3.3.2.3.1 General Site Description

Fuel consumed at INL includes natural gas, fuel oil (heating fuel), diesel fuel, gasoline, and propane. All fuels are transported to the site for use and storage. Fuel storage is provided for each facility, and the inventories are restocked as necessary (DOE 2002h:4-125). INL sitewide fuel oil consumption averages 9.08 million liters (2.4 million gallons) annually (based on data for fiscal years 2001 through 2004), while natural gas consumption averages 510,000 cubic meters (18 million cubic feet) per year. Total diesel fuel consumption averages 2.05 million liters (541,500 gallons); total gasoline consumption, 1.475 million liters (389,700 gallons); and total propane consumption, 577,000 liters (152,400 gallons) annually (see Table 3–30) (DOE 2005b:91).

3.3.2.3.2 Idaho Nuclear Technology and Engineering Center

Fuel consumption at INTEC includes fuel oil, diesel fuel, and propane. The annual consumption of fuel oil at INTEC in fiscal year 2008 was about 3.5 million liters (925,000 gallons); diesel fuel consumption, about 33,000 liters (8,700 gallons); and propane consumption, about 151,000 liters (40,000 gallons) (INL 2009a).

3.3.2.3.3 Materials and Fuels Complex

Fuel oil is used in four boilers at the MFC for heat and hot water. The annual consumption of fuel oil at the MFC in fiscal year 2008 was about 2.20 million liters (582,000 gallons). Fuel oil usage varies with the severity of the winters. Natural gas is not available at the MFC (INL 2009a).

3.3.2.4 Water

3.3.2.4.1 General Site Description

The Snake River Plain Aquifer is the source of all water used at INL. The water is provided by a system of about 30 wells, together with pumps and storage tanks. That system is administered by DOE, which holds the Federal Reserved Water Right of 43 billion liters (11.4 billion gallons) per year for the site (DOE 2002h:4-125). INL sitewide groundwater production and usage is approximately 4,200 million liters (1,100 million gallons) annually (see Table 3–30) (DOE 2005b:90).

3.3.2.4.2 Idaho Nuclear Technology and Engineering Center

Total water use at INTEC was reported as 1.8 billion liters (500 million gallons) in fiscal year 2007 (Fossum and Ischay 2009).

3.3.2.4.3 Materials and Fuels Complex

The MFC water supply and distribution system is a combined fire-protection, potable, and service water system supplied via two onsite deep production wells. These deep wells (EBR-II No. 1 and EBR-II No. 2) have a pumping capacity of 3,400 liters (900 gallons) per minute or 1,790 million liters (473 million gallons) annually. Well water is pumped to a 757,000-liter (200,000-gallon) primary storage tank and then through the distribution system for its varied uses. A second 1,514,000-liter (400,000-gallon) water storage tank is reserved for fire protection and maintained at full capacity. The deep wells can be valved to either storage tank or directly to the distribution system. The MFC's water demand and usage from its two production wells is approximately 182 million liters (48 million gallons) annually (ANL 2003:7, 8).

3.3.3 Noise and Vibration

3.3.3.1 General Site Description

Major noise sources within INL include various industrial machines and equipment (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials-handling equipment, vehicles). Most INL industrial facilities are far enough from the site boundary that noise levels from these sources are not measurable or are barely distinguishable from background noise levels at that boundary.

Existing INL-related noises of public significance result from the transportation of people and materials to and from the site and in-town facilities via buses, trucks, private vehicles, and freight trains. Noise measurements along U.S. Route 20, about 15 meters (50 feet) from the roadway, indicate that traffic sound levels range from 64 to 86 dBA, and that the primary source is buses (71 to 80 dBA). While few people reside within 15 meters (50 feet) of the roadway, INL traffic noise might be objectionable to members of the public residing near principal highways or busy bus routes. Noise levels along these routes may have decreased somewhat with reductions in employment and bus service at INL over the last few years. The acoustic environment along the INL site boundary is typical of a rural location removed from traffic noise; the average day-night sound level is in the range of 35 to 50 dBA. Playas and remote lava flows at INL are exposed to low ambient sound levels in the range of 35 to 40 dBA (Leonard 1993:3-18–3-21). Except for the prohibition of nuisance noise, neither the State of Idaho nor local governments have established regulations that specify acceptable community noise levels applicable to INL. The EPA guidelines for environmental noise protection recommend an average day-night sound level limit of 55 dBA to protect the public from the effects of broadband environmental noise in typically quiet outdoor and residential areas (EPA 1974:21, 29). Land use compatibility guidelines adopted by the Federal Aviation Administration and the Federal Interagency Committee on Urban Noise indicate that annual day-night average sound levels less than 65 dBA are compatible with residential land uses (14 CFR 150). These guidelines further indicate that levels up to 75 dBA are compatible with residential uses if suitable noise reduction features are incorporated into structures. It is expected that, for most residences near INL, day-night average sound levels are compatible with residential land use, although noise levels may be higher than 65 dBA for some residences along major roadways.

3.3.3.2 Idaho Nuclear Technology and Engineering Center

No distinguishing noise characteristics at INTEC have been identified. INTEC is 12 kilometers (7.5 miles) from the nearest site boundary, so the contribution from the area to noise levels at the site boundary is unmeasurable (DOE 2000a:3-47).

3.3.3.3 Materials and Fuels Complex

No distinguishing noise characteristics at the MFC have been identified. The MFC is 7 kilometers (4.3 miles) from the nearest site boundary, so the contribution from the area to noise levels at the site boundary is unmeasurable (DOE 2002h).

3.3.4 Air Quality

The scope of the discussion of air quality in this *TC & WM EIS* is stipulated in Section 3.2.4.

3.3.4.1 Nonradioactive Releases

3.3.4.1.1 General Site Description

The climate at INL and the surrounding region is characterized as that of a semiarid steppe. The average annual temperature at INL (at the Central Facilities Area) is 5.6 °C (42 °F); average monthly temperatures range from a minimum of –8.8 °C (16.1 °F) in January to a maximum of 20 °C (68 °F) in July. The average annual precipitation is 22 centimeters (8.7 inches) (Clawson, Start, and Ricks 1989:55, 77). Prevailing winds at INL are southwest or northeast (DOE 1999c:4.7-1). The annual average windspeed is 3.4 meters per second (7.5 miles per hour) (DOE 1996a:3-112). Figures 3–32 and 3–33 show wind roses for the meteorological station at the MFC at 10-meter (33-foot) and 75-meter (250-foot) elevations, respectively, for the period 1997 through 2006. Applicable NAAQS and Idaho State ambient air quality standards are presented in Table 3–31.

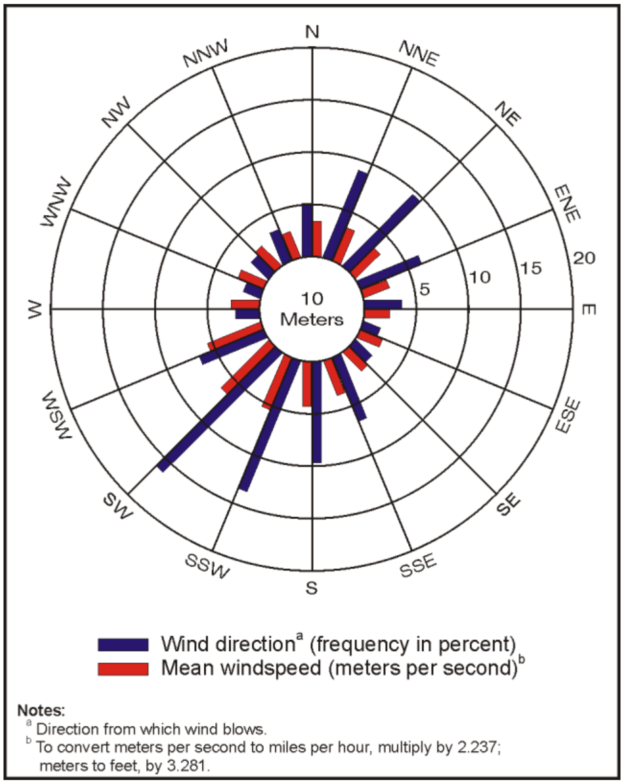


Figure 3–32. Wind Rose for the Materials and Fuels Complex Meteorological Station at Idaho National Laboratory, 1997–2006 (10-Meter Elevation)

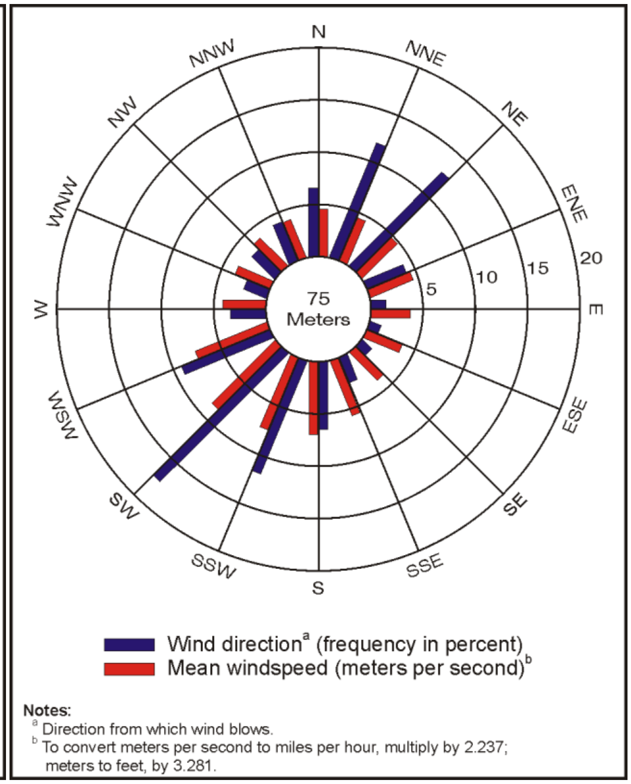


Figure 3–33. Wind Rose for the Materials and Fuels Complex Meteorological Station at Idaho National Laboratory, 1997–2006 (75-Meter Elevation)

The primary source of air pollutants at INL is the combustion of fuel oil for heating. Other emission sources include waste burning, industrial processes, stationary diesel engines, vehicles, and fugitive dust from waste burial and construction activities. Emissions for 2006 are presented in Table 3–32.

Routine offsite monitoring of nonradioactive air pollutants is performed only for total suspended particulates (DOE 2009a:4.24).

Table 3–31. Modeled Nonradioactive Ambient Air Pollutant Concentrations from Idaho National Laboratory Sources and Ambient Air Quality Standards

Pollutant	Averaging Period	More-Stringent Standard[a]	INL Concentration[b]
		(micrograms per cubic meter)	
Carbon monoxide	8 hours	10,000[c]	71
	1 hour	40,000[c]	350
Lead	Quarterly	1.5[c]	0.0081
Nitrogen dioxide	Annual	100[c]	2.3
	1 hour	188[c]	NR
Ozone	8 hours	147[c]	(d)
PM_{10}	24 hours	150[c]	20
$PM_{2.5}$	Annual	15[c]	1.3
	24 hours	35[c]	20[e]
Sulfur dioxide	Annual	80[c]	4.5
	24 hours	365[c]	32
	3 hours	1,300[c]	140
	1 hour	197[c]	NR

[a] The more stringent of the Federal and state standards is presented if both exist for the averaging period. National Ambient Air Quality Standards (40 CFR 50), other than those for ozone, particulate matter, lead, and pollutants averaged annually, are not to be exceeded more than once per year. The annual arithmetic mean $PM_{2.5}$ standard is attained when the weighted annual arithmetic mean concentration (3-year average) does not exceed the standard. The 24-hour $PM_{2.5}$ standard is met when the 98th percentile over 3 years of 24-hour average concentrations is less than or equal to the standard value. The 24-hour PM_{10} standard is met when the standard value is not exceeded more than once per year. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration (3-year average) is less than or equal to the standard value. The 1-hour nitrogen dioxide standard is met when the 3-year average of the 98th percentile of the daily maximum 1-hour average does not exceed the standard value.

[b] Includes contributions from existing INL facilities with actual 1997 emissions, plus reasonably foreseeable sources such as the Advanced Mixed Waste Treatment Project and CPP-606 steam production boilers. The Federal 1-hour sulfur dioxide standard is met when the 3-year average 99th percentile of the daily maximum 1-hour average does not exceed the standard value.

[c] Federal and state standard.

[d] Not directly emitted or monitored by the site.

[e] Assumed to be the same as the concentration of PM_{10} because there are no specific data for $PM_{2.5}$.

Note: The State of Idaho also has ambient standards for fluorides.

Key: INL=Idaho National Laboratory; NR=not reported; PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

Source: 40 CFR 50; 71 FR 61144; DOE 2002a:C.2-43; IDAPA 58.01.01.576; IDAPA 58.01.01.577.

Table 3–32. Air Pollutant Emissions at Idaho National Laboratory, 2006

Pollutant	Sources Other Than MFC and INTEC	MFC	INTEC
	(metric tons per year)		
Nitrogen dioxide	57	5.3	10
PM_{10}	1.9	0.27	0.63
Sulfur dioxide	3.7	1.9	3.3
Volatile organic compounds	1.7	0.05	0.1

Key: INTEC=Idaho Nuclear Technology and Engineering Center; MFC=Materials and Fuels Complex; PM_{10}=particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.

Source: Depperschmidt 2007.

Monitoring for nitrogen dioxide has not been performed at onsite locations since 2003 (DOE 2006:3.5). In 2003 quarterly mean concentrations at the Van Buren Boulevard location ranged from 2.9 to 3.9 parts per billion (ppb), with an annual mean of 3.5 ppb. Quarterly means at the Experimental Field Station, determined from two quarters of data, ranged from 7.4 to 10.7 ppb, with a mean concentration of 9.1 ppb. The mean concentrations were well below the ambient standard of 54 ppb (DOE 2004b:4.22).

Some monitoring data have also been collected by the National Park Service at the Craters of the Moon Wilderness Area. The monitoring program has shown no exceedances of the 1-hour ozone standard, although there was some degradation in concentrations between 1993 and 2002 (NPS 2003:5). Concentrations in 2006 were about 50 percent of the ambient standard for 1-hour values and less than 60 percent of the 8-hour standard (EPA 2007). During the period of $PM_{2.5}$ monitoring, concentrations ranged from 0.409 to 25.1 micrograms per cubic meter (DOE 2006:4.25).

3.3.4.1.2 Idaho Nuclear Technology and Engineering Center

The existing ambient air pollutant concentrations attributable to sources at INL, including INTEC, are presented in Table 3–31. These concentrations are based on dispersion modeling at the INL site boundary and public roads. The modeled pollutant concentrations presented in the *Idaho High-Level Waste and Facilities Disposition Final Environmental Impact Statement* for assessing cumulative impacts were adapted as a baseline. Sources considered included existing INL facilities with actual 1997 emissions, plus reasonably foreseeable sources such as the Advanced Mixed Waste Treatment Project (AMWTP) and the CPP-606 steam production boilers. To account for the contribution of the CPP-606 boilers, the cumulative concentrations for the Continued Operation Alternative evaluated in the aforementioned EIS were used as the baseline (DOE 2002a:C.2-43). Concentrations shown in Table 3–31 represent a small percentage of these ambient air quality standards. Given these limited contributions from INL sources and low background concentrations of criteria pollutants, it may be concluded that INL emissions should not result in air pollutant concentrations that violate the ambient air quality standards.

EPA has established PSD increments for certain pollutants such as sulfur dioxide, nitrogen dioxide, and PM. The increments specify a maximum allowable increase above a certain baseline concentration for a given averaging period and apply only to sources constructed or modified after a specified baseline date. These sources are known as increment-consuming sources, and the baseline date is the date of submittal of the first application for a PSD permit in a given area. Increment consumption for the CPP-606 boilers, for example, was analyzed in connection with its PSD permit application for INL (DOE 2002a).

EPA has also established PSD area classifications distinguished in terms of allowable increases in pollution. A PSD Class I area, for example, is one in which very little increase in pollution is allowed due to the pristine nature of the area; a Class II area, one in which moderate increases in pollution are allowed. The PSD Class I area nearest to INL is the Craters of the Moon Wilderness Area in Idaho, 53 kilometers (33 miles) west-southwest of the center of the site. There are no other Class I areas within 100 kilometers (62 miles) of INL. INL and its vicinity are classified as a Class II area. Current PSD increment consumptions in these Class I and Class II areas are stipulated in Tables 3–33 and 3–34, respectively.

Table 3–33. PSD Increment Consumption at Craters of the Moon Wilderness Area (Class I) by Existing (1996) and Projected Sources Subject to PSD Regulation

Pollutant	Averaging Period	Allowable PSD Increment[a]	Amount of PSD Increment Consumed
		(micrograms per cubic meter)	
Nitrogen dioxide	Annual	2.5	0.27
Respirable particulates[b]	Annual 24 hours	4 8	0.032 0.61
Sulfur dioxide	Annual 24 hours 3 hours	2 5 25	0.23 3.4 11

[a] All increments specified are State of Idaho standards (IDAPA 58.01.01.581).

[b] Data on particulate size are not available for most sources. For purposes of increment comparisons, however, it is conservatively assumed that all particulates emitted are of respirable size (i.e., 10 micrometers or less in diameter).

Note: Estimated increment consumption includes existing Idaho National Laboratory sources that are subject to PSD regulations, as well as the Idaho Nuclear Technology and Engineering Center CPP-606 boilers. Increment consumption was modeled using the CALPUFF model in screening mode.

Key: PSD=Prevention of Significant Deterioration.

Source: DOE 2002a:4-37.

Table 3–34. PSD Increment Consumption at Idaho National Laboratory Area (Class II) by Existing (1996) and Projected Sources Subject to PSD Regulation

Pollutant	Averaging Period	Allowable PSD Increment[a]	Amount of PSD Increment Consumed
		(micrograms per cubic meter)	
Nitrogen dioxide	Annual	25	8.8
Respirable particulates[b]	Annual 24 hours	17 30	0.53 10
Sulfur dioxide	Annual 24 hours 3 hours	20 91 512	3.6 27 120

[a] All increments specified are State of Idaho standards (IDAPA 58.01.01.581).

[b] Data on particulate size are not available for most sources. For purposes of increment comparisons, however, it is conservatively assumed that all particulates emitted are of respirable size (i.e., 10 micrometers or less in diameter).

Note: Estimated increment consumption includes existing Idaho National Laboratory sources that are subject to PSD regulations, as well as the Idaho Nuclear Technology and Engineering Center CPP-606 boilers. Class II increment consumption was modeled using the ISCST3 dispersion model.

Key: PSD=Prevention of Significant Deterioration.

Source: DOE 2002a:4-38.

3.3.4.1.3 Materials and Fuels Complex

The existing ambient air concentrations attributable to sources at INL, including MFC, are presented in Table 3–31.

3.3.4.2 Radioactive Releases

Primary releases of radioactive air pollutants at INL and localized releases at INTEC and the MFC are presented in Table 3–35. During 2008, an estimated 5,330 curies of radioactivity were released to the atmosphere from all INL sources. About 0.8 percent of this amount was from the MFC and about 39 percent was from the Advanced Test Reactor Complex (ATRC). Approximately 50 percent was released from INTEC (DOE 2009a:4.7–4.12).

Table 3–35. Airborne Radionuclide Releases to the Environment at Idaho National Laboratory, 2008

Radionuclide[a]	INTEC	Materials and Fuels Complex	Other Facilities[b]	Total
	(curies)			
Hydrogen-3 (tritium)	3.75×10^{2}	3.15	1.22×10^{3}	1.60×10^{3}
Carbon-14	3.38×10^{-4}	–	1.95×10^{-1}	1.95×10^{-1}
Sodium-24	–	–	2.08×10^{-4}	2.08×10^{-4}
Argon-41	–	1.52	1.22×10^{3}	1.22×10^{3}
Cobalt-60	6.02×10^{-4}	–	6.76×10^{-3}	7.36×10^{-3}
Krypton-85	2.3×10^{3}	3.70×10^{1}	3.00	2.34×10^{3}
Strontium-90	2.82×10^{-1}	1.45×10^{-5}	1.22×10^{-1}	4.04×10^{-1}
Technetium-99	7.32×10^{-5}	–	9.48×10^{-5}	1.68×10^{-4}
Iodine-129	4.06×10^{-2}	–	9.34×10^{-2}	1.34×10^{-1}
Cesium-137	1.23	–	2.40×10^{-1}	1.47
Uranium-233	6.86×10^{-8}	–	3.60×10^{-4}	3.60×10^{-4}
Uranium-234	1.11×10^{-7}	–	3.88×10^{-7}	4.99×10^{-7}
Uranium-235	2.91×10^{-5}	–	9.49×10^{-5}	1.24×10^{-4}
Uranium-238	1.18×10^{-4}	–	–	1.18×10^{-4}
Neptunium-237	3.42×10^{-6}	–	2.29×10^{-4}	2.32×10^{-4}
Plutonium-238	1.03×10^{-4}	–	1.80×10^{-5}	1.21×10^{-4}
Plutonium-239	1.03×10^{-4}	1.49×10^{-6}	7.33×10^{-3}	7.43×10^{-3}
Plutonium-240	2.49×10^{-4}	–	1.30×10^{-3}	1.55×10^{-3}
Plutonium-241	9.55×10^{-3}	–	9.85×10^{-3}	1.94×10^{-2}
Americium-241	1.12×10^{-4}	–	3.07×10^{-3}	3.18×10^{-3}
Other radionuclides	1.94	–	1.64×10^{2}	1.66×10^{2}
Total releases	2.68×10^{3}	4.17×10^{1}	2.61×10^{3}	5.33×10^{3}

a Values are not corrected for decay after release.

b Includes the Advanced Test Reactor, Central Facilities Area, Critical Infrastructure Test Range Complex, Radioactive Waste Management Complex, and Test Area North.

Note: A dashed line indicates no reported release.

Key: INTEC=Idaho Nuclear Technology and Engineering Center.

Source: DOE 2009a:4.7–4.12.

Routine monitoring for radioactive air pollutants is performed at locations within, around, and distant from INL. The monitors are operated by the management and operations contractor and the environmental surveillance, education, and research contractor. The monitoring network maintained by the managing and operating contractor includes 17 onsite locations and 4 distant locations. The network maintained by the environmental surveillance, education, and research contractor includes 3 onsite locations, 8 boundary locations, and 6 distant locations. The distant monitors are as far away as Jackson, Wyoming (161 kilometers [100 miles] east), and Craters of the Moon National Monument (50 kilometers [31 miles] west-southwest). These monitoring programs and recent results are described in Chapter 4 of the *Idaho National Laboratory Site Environmental Report, Calendar Year 2008* (DOE 2009a:4.20).

3.3.5 Geology and Soils

The scope of the discussion of geology and soils in this *TC & WM EIS* is stipulated in Section 3.2.5.

3.3.5.1 General Site Description

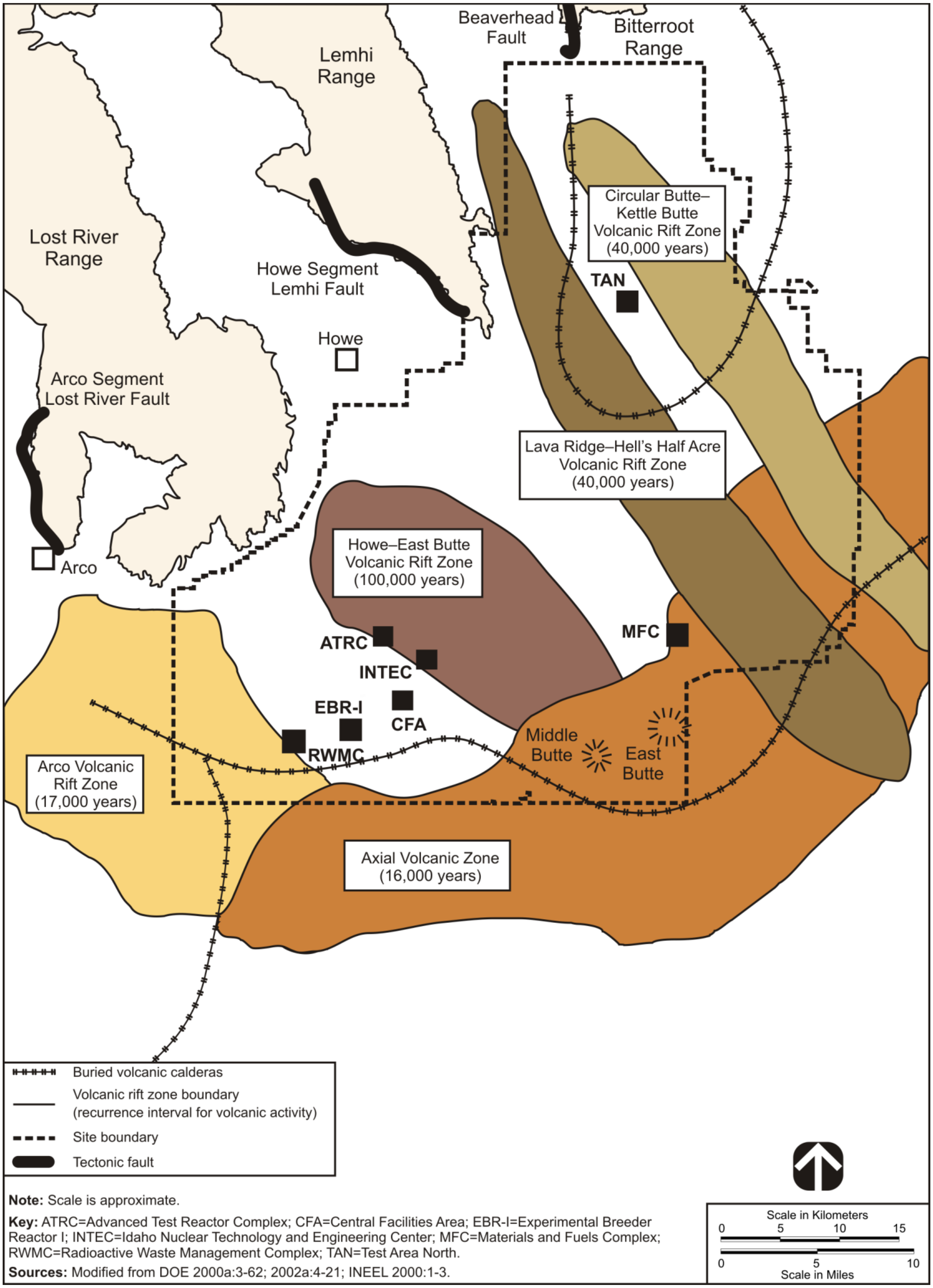
3.3.5.1.1 Physiography and Structural Geology

INL occupies a rather flat area on the northwestern edge of the Eastern Snake River Plain, which is part of the Eastern Snake River Plain Physiographic Province. The area consists of a broad plain built up from the eruptions of multiple flows of basaltic lava over the past 4 million years. Four northwest-trending volcanic rift zones that cut across the Eastern Snake River Plain have been identified as the source areas for the most recent basaltic eruptions that occurred between 2,100 and 4 million years ago. The Eastern Snake River Plain is bounded on the north and south by the north-to-northwest-trending mountains of the northern Basin and Range Physiographic Province, with peaks up to 3,660 meters (12,000 feet) in height that are separated by intervening basins filled with terrestrial sediments and volcanic rocks. The peaks are sharply separated from the intervening basins by late Tertiary to Quaternary normal faults. The basins are 5 to 20 kilometers (3 to 12 miles) wide and grade onto the Eastern Snake River Plain. Several northwest-trending front-range faults have been mapped in the immediate vicinity of INL. To the northeast, the Eastern Snake River Plain is bounded by the Yellowstone Plateau (ANL 2003:15, 16, 18; DOE 2002a:4-20, 4-21, 4-23). Figure 3–34 shows the major geologic features of INL and the vicinity.

The Yellowstone Plateau is a high volcanic plateau underlain by Pleistocene rhyolitic volcanic rock. Its elevation of about 2,100 to 2,600 meters (6,900 to 8,500 feet) is significantly higher than that of the Eastern Snake River Plain, but not as high as the mountain summits of the northern Basin and Range Province. The plateau is characterized by extremely high heat flow, very high temperatures at shallow depths, abundant hot-spring and geyser activity, and landforms controlled by thick rhyolitic lava flows. These characteristics reflect the recent volcanic activity in the area, spanning from several tens of thousands to 2 million years ago (ANL 2003:16).

The mountains northwest of the Eastern Snake River Plain and near INL are composed of thick sequences of late Precambrian through Pennsylvanian sedimentary strata, mostly limestones. They occurred within westward-dipping thrust sheets that formed during Mesozoic Era east-directed compression. The Eastern Snake River Plain formed as a result of interaction of the North American tectonic plate with a rising plume and hot mantle rocks, the so-called Yellowstone Hotspot. As the North American plate moved southwestward, its interaction with the hotspot produced the low-elevation, low-relief volcanic province that is the Eastern Snake River Plain. The crust of the INL area was directly above the hotspot about 4.3 to 6.5 million years ago (ANL 2003:16, 17).

The Arco Segment of the Lost River Fault is mapped as ending about 7 kilometers (4.3 miles) from the INL boundary. The Howe Segment of the Lemhi Fault ends near the northwest boundary of the site (see Figure 3–34). Both segments are considered capable or potentially active (DOE 2002h:4-130). A capable fault is one that has had movement at or near the surface at least once within the past 35,000 years or recurrent movement within the past 500,000 years (10 CFR 100).



Note: Scale is approximate.

Key: ATRC=Advanced Test Reactor Complex; CFA=Central Facilities Area; EBR-I=Experimental Breeder Reactor I; INTEC=Idaho Nuclear Technology and Engineering Center; MFC=Materials and Fuels Complex; RWMC=Radioactive Waste Management Complex; TAN=Test Area North.

Sources: Modified from DOE 2000a:3-62; 2002a:4-21; INEEL 2000:1-3.

Figure 3–34. Major Geologic Features of Idaho National Laboratory

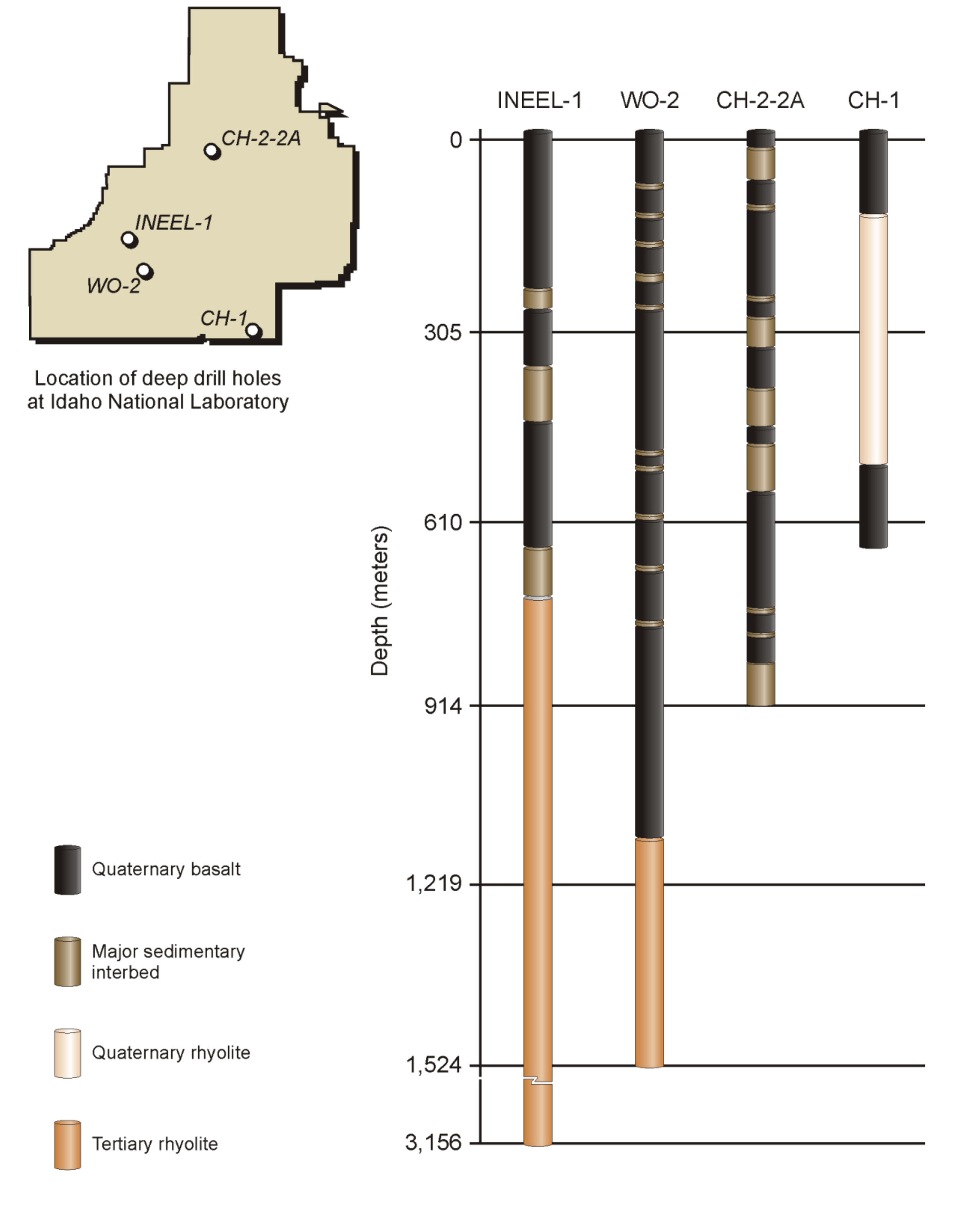
3.3.5.1.2 Stratigraphy

The upper 1 to 2 kilometers (0.6 to 1.2 miles) of the crust beneath INL is composed of a sequence of Quaternary (recent to 2 million years old) basalt lava flows and poorly consolidated sedimentary interbeds that are collectively called the Snake River Group. The lava flows at the surface range from 2,100 to 2 million years old (DOE 2002a:4-20; 2002h:4-130). The sediments are composed of fine-grained silts that were deposited by wind; silts, sands, and gravels deposited by streams; and clays, silts, and sands deposited in lakes such as Mud Lake and its much larger Ice Age predecessor, Lake Terreton. The accumulation of these materials in the Eastern Snake River Plain resulted in the observed sequence of interlayered basalt lava flows and sedimentary interbeds. Basaltic volcanism on the Eastern Snake River Plain has been a sporadic process. During the long periods of inactivity between volcanic events, sediments accumulated to thicknesses of less than 1 meter (3.3 feet) to greater than 60 meters (197 feet). During short periods of volcanic activity, several lava flows commonly accumulated to thicknesses reaching several tens of meters. Basalt lava flows were erupted from vents concentrated in the four volcanic rift zones and along the central axis of the Eastern Snake River Plain (the Axial Volcanic Rift Zone) (see Figure 3–34). The basalts, along with interbedded sediments, are underlain by a great thickness of rhyolitic volcanic rocks that erupted when the area was over the Yellowstone Hotspot more than 4 million years ago (ANL 2003:18). Figure 3–35 depicts the general stratigraphy beneath INL.

Several Quaternary rhyolite domes are located along the Axial Volcanic Rift Zone near the south and southeast borders of INL. Their names and ages are Big Southern Butte (300,000 years), a rhyolite dome near Cedar Butte (400,000 years), East Butte (600,000 years), Middle Butte (age unknown), and an unnamed butte near East Butte (1.2 million years). Paleozoic carbonate rocks (limestone), late-Tertiary rhyolitic volcanic rocks, and large alluvial fans occur in limited areas along the northwest margin of INL. A wide band of Quaternary mainstream alluvium (unconsolidated gravels and sands) extends along the course of Big Lost River from the southwestern corner of INL to Big Lost River sinks area in north-central INL. Lacustrine (lake) deposits of clays and sands in the Ice Age Lake Terreton occur in the northern part of INL. Beach sands deposited at the high stand of Lake Terreton were reworked by winds in late Pleistocene and Holocene ages to form large dune fields (eolian deposits) in the northeastern part of INL. Elsewhere on INL, the basaltic lava flows are variably covered with a thin veneer of eolian silt (loess), which can be up to several meters thick, but mostly ranges in thickness from 0 to 2 meters (6.6 feet) (ANL 2003:20).

3.3.5.1.3 Rock and Mineral Resources

Mineral resources within INL include sand, gravel, pumice, silt, clay, and aggregate (e.g., sand, gravel, crushed stone). These resources are extracted at several quarries or pits at INL and are used for road and new facility construction and maintenance, waste burial activities, and ornamental landscaping. The geologic history of the Eastern Snake River Plain makes the potential for petroleum production at INL very low. The potential for geothermal energy exists at INL and in parts of the Eastern Snake River Plain; however, a study conducted in 1979 identified no economically productive geothermal resources (DOE 2002a:4-23).



Note: To convert meters to feet, multiply by 3.281.
Source: Modified from DOE 2002a:4-22.

Figure 3–35. Lithologic Logs of Deep Drill Holes at Idaho National Laboratory

3.3.5.1.4 Seismicity and Geologic Hazards

The seismic characteristics of the Eastern Snake River Plain and the adjacent Basin and Range Province are different. The Eastern Snake River Plain has historically experienced infrequent small-magnitude earthquakes (DOE 2002a:4-20). In contrast, the major episode of Basin and Range faulting that began approximately 16 million years ago continues today (Rodgers et al. 2002). Since the installation of INL's seismic network in 1971, only 35 microearthquakes (magnitude of less than 2.0) have been detected within the Eastern Snake River Plain. However, INL's seismic stations record about 2,000 annually elsewhere in southeast Idaho (INL 2009b). Thus, the Eastern Snake River Plain and INL have lower seismicity than adjacent regions.

The largest historic earthquake near INL took place on October 28, 1983, about 90 kilometers (56 miles) northwest of the western site boundary, near Borah Peak in the Lost River Range (part of the Basin and Range Province). It occurred in the middle portion of the Lost River Fault. The earthquake had a surface-wave magnitude of 7.3 (moment magnitude of 7.0). An MMI of up to IX was assigned for effects at the event's epicenter (ANL 2003:22; DOE 2002h:4-132). The ATRC within the INL Reactor Technology Complex (RTC) experienced an MMI of VI during this event, with no damage to the ATRC found upon inspection (DOE 2002h:4-132). Since 1973, 27 earthquakes have been recorded within 100 kilometers (62 miles) of south-central INL, ranging in magnitude from 2.6 to 3.9. These represent minor earthquakes, with none centered closer than 76 kilometers (47 miles) from the south-central portion of the site. Most of the earthquakes had epicenters to the north and west of INL in the Basin and Range Province (USGS 2010b).

Earthquake-produced ground motion is expressed in units of percent *g* (force of acceleration relative to that of the Earth's gravity). Two differing measures of this motion are peak horizontal (ground) acceleration and response spectral acceleration. Seismic hazard metrics and maps developed by USGS and adapted for use in the *International Building Code* reflect maximum calculated ground motions of 0.2- and 1.0-second spectral accelerations for earthquakes with a 2 percent probability of exceedance in 50 years—i.e., an annual probability of occurrence of about 1 in 2,500. Appendix F, Section F.5.2, of this *TC & WM EIS* provides a more detailed explanation of the map parameters and their use. For south-central INL facilities, the calculated maximum considered earthquake ground motion is approximately 0.41 *g* for a 0.2-second spectral acceleration and 0.09 *g* for a 1.0-second spectral acceleration. The calculated peak ground acceleration for the given probability of exceedance at the site is approximately 0.12 *g* (USGS 2008). An update to the INL seismic hazard evaluation was performed to recalculate design-basis earthquake spectra for key facilities in accordance with DOE standards. For this site-specific analysis, the calculated peak ground accelerations at the RTC for earthquakes with annual probabilities of occurrence of about 1 in 1,000 and 1 in 10,000 are 0.09 *g* and 0.19 *g*, respectively (INEEL 2000:ES-1). The USGS earthquake ground motion values are cited to provide the reader with a general understanding of the seismic hazard as quantified by a well-accepted authority. However, for design of moderate- or high-hazard nuclear facilities, DOE prescribes seismic criteria that are more rigorous and provide a greater margin of safety than the values cited here (see Appendix F, Section F.5.2).

INL lies in a region in which ground motions are controlled by fault-specific sources with estimated maximum earthquake magnitudes that have rather long recurrence intervals. The Borah Peak earthquake produced peak ground accelerations ranging from 0.022 *g* to 0.078 *g* across INL. Specifically, the ATRC at the RTC experienced peak ground accelerations of 0.022 *g* to 0.030 *g* (INEEL 2005:2A-34; Jackson and Boatwright 1985:57). This caused the ATRC protective systems to automatically scram (shut down) the reactor, as the seismic switches were designed to trip at a ground acceleration of 0.01 *g* (Gorman and Guenzler 1983:14). At the MFC, recorded peak ground accelerations ranged from 0.032 *g* to 0.048 *g* (Jackson and Boatwright 1985:57). Neither the ATRC nor MFC facilities experienced structural or component damage from the Borah Peak earthquake (ANL 2003:22).

Earthquakes with moment magnitudes higher than 5.5 and associated strong ground shaking and surface fault rupture are not likely within the Eastern Snake River Plain, given the region's seismic history and geology. Moderate-to-strong ground shaking from earthquakes in the Basin and Range Province, however, could affect INL (DOE 2002a:4-23). Consequently, INL authorities have supported efforts to estimate, for all regional earthquake sources, the levels of ground shaking that are expected at INL facilities—specifically, estimates of the levels of ground shaking that would not be exceeded in specified time periods. A probabilistic ground-motion study for all facility areas was finalized in 2000. This study, which updated the 1996 INL sitewide seismic hazard evaluation, involved assessment of seismic hazard at five INL site areas using recently developed ground-motion attenuation relationships appropriate for INL (INEEL 2000). The INL ground-motion evaluation incorporated the results of all geologic, seismologic, and geophysical investigations conducted since the 1960s. The fault segments closest to INL facilities, the Lost River, Beaverhead, and Lemhi Faults, were studied in detail with a view to estimating their maximum earthquake magnitudes, their distances from INL facilities, and the timing and frequency of recent earthquakes. Results of these investigations indicated that these faults are capable of generating earthquakes of magnitude 6.6 to 7.2, and that the most recent earthquakes on the southernmost fault segments occurred more than 15,000 years ago. The data collected also continue to support historic observations that the alternating sequence of basalt and sedimentary interbeds composing the Eastern Snake River Plain tend to dampen seismic energy, resulting in reduced earthquake ground motions as compared with locations with uniform basaltic rock (INL 2009b).

Basaltic volcanic activity occurred over a period from about 2,100 to 4 million years ago in the INL site area. Although no eruptions have occurred on the Eastern Snake River Plain during recorded history, lava flows from the Hell's Half Acre lava field erupted near the southern INL boundary as recently as 5,400 years ago. The most recent eruptions within the area occurred about 2,100 years ago in an area 31 kilometers (19 miles) southwest of the site at the Craters of the Moon Wilderness Area. The estimated recurrence interval for volcanism associated with the five identified volcanic zones ranges from 16,000 to 100,000 years (DOE 2002a:4-25; 2002h:4-132). These zones are depicted in Figure 3–34.

Because the Yellowstone Hotspot is no longer present beneath the INL area, there is no threat of catastrophic volcanism such as at Yellowstone. The main volcanic threat at INL is from basaltic lava flows. INL seismic stations are located near or within identified volcanic rift zones to provide early warning of any signs of renewed volcanic activity (INL 2009b).

Seismicity concerns continue to influence facility design and construction at INL. Lessons learned from studies of INL seismic design-basis events are incorporated into facility architectural and engineering standards. New facilities and facility upgrades are designed in accordance with the requirements of applicable DOE standards and orders (DOE 2002a:4-24)—for example, DOE Order 420.1B, Change 1, which requires that nuclear or nonnuclear facilities be designed, constructed, and operated so as to protect the public, workers, and the environment from the adverse impacts of natural phenomena hazards, including earthquakes. Furthermore, expected levels of earthquake ground motion as determined in the INL probabilistic seismic hazards assessment are now part of the seismic design criteria for new and existing facilities (INL 2009b).

3.3.5.1.5 Soils

Four basic soilscapes exist at INL: river-transported sediments deposited on alluvial plains, fine-grained sediments deposited into lake or playa basins, colluvial sediments originating from bordering mountains, and windblown sediments (silt and sand) over lava flows. The alluvial deposits follow the courses of the modern Big Lost River and Birch Creek. The playa soils are found in the north-central part of the site; the colluvial sediments, along the western edge of INL; and the windblown sediments, throughout the rest of the site. Surficial sediments range in thickness from less than 0.3 meters (1 foot) at basalt outcrops east of INTEC to 95 meters (312 feet) near the Big Lost River sinks. No soils designated as prime or unique farmland exist within the INL boundaries (DOE 2002h:4-132).

3.3.5.2 Idaho Nuclear Technology and Engineering Center

The Arco Segment of the Lost River Fault terminates approximately 32 kilometers (20 miles) to the west of INTEC. INTEC is also situated near the western edge of the Howe–East Butte Volcanic Rift Zone, which has an estimated recurrence interval for volcanic activity of 100,000 years (DOE 2005c:3-11). However, no volcanic vents in the vicinity of INTEC are younger than 400,000 years, and the probability of volcanic activity from this source is considered low based on the estimated recurrence interval (DOE 2002a:4-23–4-25). INTEC is situated adjacent to Big Lost River in relatively flat terrain. The average elevation of INTEC is approximately 1,499 meters (4,917 feet) above mean sea level. Surface sediments are alluvial deposits from Big Lost River that are composed of gravel-sand-silt mixtures that are 7.6 to 19.8 meters (25 to 65 feet) thick and that contain locally interbedded silt and clay deposits that are generally less than 2.7 meters (9 feet) thick. All soil near INTEC was originally fine loam over a sand or sand-cobble mix deposited in the floodplain of Big Lost River. However, all natural soils within INTEC fences have been disturbed. The soils beneath the INTEC area are not subject to liquefaction because of the high content of gravel mixed with the alluvial sands and silts. In addition, the sediments are not saturated (DOE 2000a:3-63).

As a result of past practices, radioactive and hazardous materials have been released to surface soils at INTEC. Contaminants found in the soil include metals, organic compounds, and radionuclides. Results from CERCLA (42 U.S.C. 9601 et seq.) risk assessments indicated that radionuclides are the most significant soil contaminants (DOE 2002a:4-23).

3.3.5.3 Materials and Fuels Complex

The MFC is within a topographically closed basin of the Axial Volcanic Rift Zone. That zone has an estimated recurrence interval for volcanism of 16,000 years. The nearest capable fault is the Howe Segment of the Lemhi Fault, 31 kilometers (19 miles) northwest of the site (see Figure 3–34).

Low ridges of basalt found east of the area rise as high as 30 meters (100 feet) above the level of the plain. Sediments cover most of the underlying basalt on the plain, except where pressure ridges form basalt outcrops. Soils in the MFC area generally consist of light, well-drained, brown-gray, silty loams to brown, extremely stony loams. Soils are highly disturbed within developed areas of the site (DOE 2002h:4-132).

3.3.6 Water Resources

The scope of the discussion of water resources in this *TC & WM EIS* is stipulated in Section 3.2.6.

3.3.6.1 Surface Water

3.3.6.1.1 General Site Description

INL is in the Mud Lake–Lost River Basin (also known as the Pioneer Basin). This closed drainage basin includes three main streams—Big and Little Lost Rivers and Birch Creek (see Figure 3–36). These three streams are essentially intermittent and drain the mountain areas to the north and west of INL, although most flow is diverted for irrigation in the summer months before it reaches the site boundaries. Flow that reaches INL infiltrates the ground surface along the length of the streambeds in the spreading areas at the southern end of INL and, if the streamflow is sufficient in the ponding areas (playas or sinks), in the northern portion of INL as well. During dry years, there is little or no surface-water flow on the INL site.

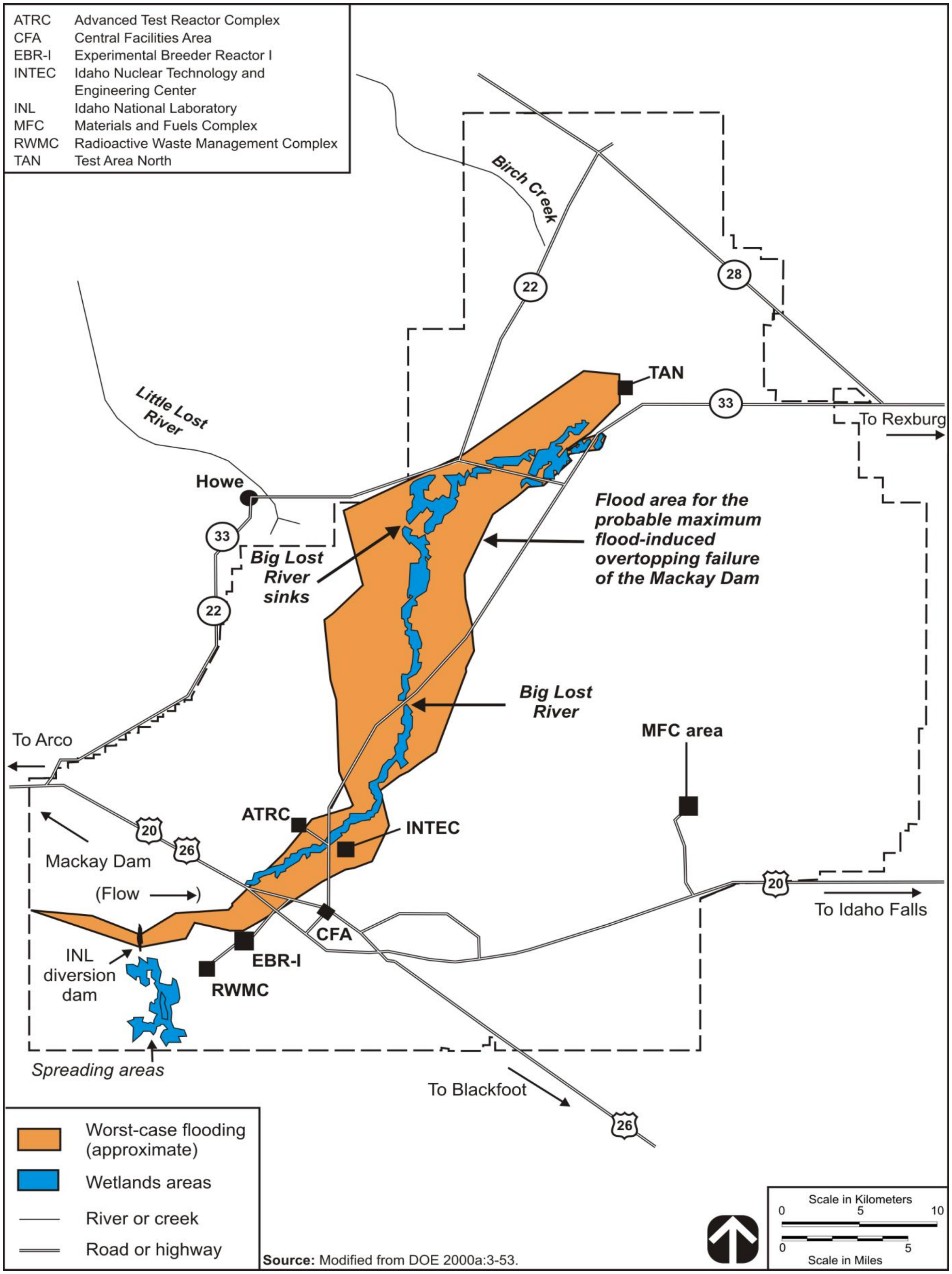


Figure 3–36. Surface-Water Features at Idaho National Laboratory

Because the Mud Lake–Lost River Basin is a closed drainage basin, water does not flow off INL, but instead infiltrates the ground surface to recharge the aquifer or is consumed by evapotranspiration. Big Lost River flows southeast from Mackay Dam, past Arco, and onto the Snake River Plain. On the INL site near the southwestern boundary, a diversion dam prevents flooding of downstream areas during periods of heavy runoff by diverting water to a series of natural depressions or spreading areas (see Figure 3–36). During periods of high flow or low irrigation demand, Big Lost River continues northeastward past the diversion dam, passes within about 61 meters (200 feet) of INTEC, and ends in a series of playas 24 to 32 kilometers (15 to 20 miles) northwest of the MFC, where the water infiltrates the ground surface (DOE 2002a:4-40; 2002h:4-133).

Flow from Birch Creek and Little Lost River infrequently reaches INL. The waters in these streams are diverted in summer months for irrigation prior to reaching the site. Yet during periods of unusually high precipitation or rapid snowmelt, those waters can enter INL from the northwest and infiltrate the ground, recharging the underlying aquifer (DOE 2002a:4-40).

The only other surface-water bodies on the site are natural wetland-like ponds and manmade percolation and evaporation ponds (DOE 2002h:4-133). The latter are used for wastewater management at INL. Discharges to the ground surface are through infiltration ponds, trenches (ditches), and a sprinkler irrigation system. Infiltration ponds include the INTEC New Percolation Ponds, Test Area North/Technical Support Facility Sewage Treatment Plant Disposal Pond, RTC Cold Waste Pond, MFC Industrial Waste Pond and Ditch, and MFC Sanitary Lagoons. Wastewater at INTEC also is discharged to the INTEC Sewage Treatment Plant and associated infiltration trenches and to a sprinkler irrigation system at the Central Facilities Area that is used during the summer months to land-apply industrial and treated sanitary wastewater (DOE 2009a:5.4, 5.8).

Discharge of wastewater to the land surface is regulated under Idaho “Rules for the Reclamation and Reuse of Municipal and Industrial Wastewater” (IDAPA 58.01.17). An approved Wastewater-Land Application Permit (WLAP) normally requires the monitoring of nonradiological parameters in the influent waste, effluent waste, and groundwater, as applicable. WLAPs generally require compliance of specified groundwater monitoring wells with Idaho groundwater quality primary and secondary constituent standards (IDAPA 58.01.11). WLAPs specify annual discharge volume, application rates, and effluent quality limits. As required, an annual report is prepared and submitted to the Idaho Department of Environmental Quality (DOE 2006:5.3). The facilities covered by WLAPs include the RTC Cold Waste Pond, Central Facilities Area Sewage Treatment Facility, and the INTEC New Percolation Ponds. Also, INL has submitted an application to the State of Idaho to obtain a WLAP for the MFC Industrial Waste Pond (DOE 2009a:5.4, 5.5).

Water bodies in Idaho are designated by the Department of Environmental Quality for specific and varied uses to ensure protection of the water quality for such uses. Big Lost River, Little Lost River, and Birch Creek in the vicinity of INL have been designated as cold water aquatic communities available for use in salmonid spawning and primary contact recreation, and the Big Lost River sinks and channel and lowermost Birch Creek, as domestic water supplies and special resource waters (IDAPA 58.01.02). In general, the waters of Big Lost River, Little Lost River, and Birch Creek are similar in quality because they reflect the similar carbonate mineral compositions of the mountain ranges drained by them, as well as chemically similar irrigation water return flows. Neither surface water nor the effluents discharged directly to it are used for drinking water on the site, so there are no surface-water rights issues at INL. Moreover, none of the rivers or streams on or near INL have been classified as wild and scenic (DOE 2002h:4-133, 4-135). Based on a regulatory determination made in 2005, INL site industrial activities are no longer subject to NPDES permitting requirements due to the determination that no stormwater discharge from INL industrial activities is likely to reach streams. Similarly, the regulatory determination also reduced the area (stormwater corridor) under the purview of the NPDES Storm Water for Construction Activities Program (DOE 2006:2.13). Nonetheless, INL’s General Permit for Storm

Water Discharges from Construction Sites was issued in June 1993 and has been renewed twice since then. INL site contractors obtain coverage under the general permit for individual construction projects. Stormwater pollution plans are completed for individual construction projects. Inspections of construction sites are performed in accordance with permit requirements. Only construction projects that are determined to have a reasonable potential to discharge pollutants to a regulated surface water are required to have a stormwater pollution prevention plan and permit (DOE 2009a:2.13).

Flooding of Big Lost River was evaluated for its potential impact on INL facilities. Included was an evaluation of the impact of probable maximum flood due to the failure of Mackay Dam, 72 kilometers (45 miles) upstream of INL (see Figure 3–36). The maximum flood was assumed to result in the overtopping and rapid failure of Mackay Dam. This flood would result in a peak surface-water elevation at INTEC of 1,499 meters (4,917 feet)—the average elevation at that facility—as well as a peak flow of 1,892 cubic meters (66,830 cubic feet) per second in Big Lost River measured near INTEC. Thus, INTEC would be flooded, especially at the north end. Moreover, because the ground surface at INL and INTEC is rather flat, the floodwaters would spread over a large area and pond in the lower-lying areas. Although predicted flood velocities would be fairly slow and water depths shallow, some facilities could be impacted. There is no record of historical flooding at INTEC from Big Lost River, although evidence of flooding in geologic time exists (DOE 2002a:4-42, 4-43). The INL diversion dam, constructed in 1958 and enlarged in 1984, was designed to secure INL from the 300-year flood (estimated peak flow of slightly above 142 cubic meters [5,000 cubic feet] per second) of Big Lost River by directing flow through a diversion channel into four spreading areas. Effects of a systematic (noninstantaneous) failure of the diversion dam were included in the probable maximum flood analysis (DOE 2002a:4-42, 2005c:3-19; Koslow and Van Haaften 1986:24, 26, 30). Studies have also been performed that indicate the potential for varying degrees of flooding based on assumptions relative to the 100-year and 500-year floods.

A preliminary map of the 100-year floodplain for Big Lost River prepared by USGS and published in 1998 (from 1996 studies) indicated that INTEC may be subject to flooding from a 100-year flood. USGS estimated the 100-year flow at approximately 206 cubic meters (7,260 cubic feet) per second at the Arco gauging station, 19 kilometers (12 miles) upstream of the INL diversion dam. This estimate and the resulting preliminary 100-year floodplain map assumed that the INL diversion dam did not exist and that some 29 cubic meters (1,040 cubic feet) of water per second would be captured by the diversion channel and flow to the spreading areas southwest of the diversion dam. The analysis also assumed the remaining 176 cubic meters (6,220 cubic feet) per second of flow would run down the Big Lost River channel on the INL site. Both a U.S. Army Corps of Engineers analysis and an INL geotechnical analysis concluded that the INL diversion dam could withstand flows up to 170 cubic meters (6,000 cubic feet) per second. Culverts running through the diversion dam could convey a maximum of an additional 34 cubic meters (1,200 cubic feet) per second, but their condition and capacity as a function of water elevation are unknown. A subsequent DOE-commissioned flood hazard study published in 1999 by the Bureau of Reclamation was used to produce floodplain maps from flow estimates of 93 cubic meters (3,270 cubic feet) per second for the 100-year flow and 116 cubic meters (4,086 cubic feet) per second for the 500-year Big Lost River flow. The flows and frequencies were based on stream gauge data and two-dimensional modeling constrained by geomorphic evidence. The data and models showed that small areas of the northern portion of INTEC could flood at the estimated 100- and 500-year flows (DOE 2002a:4-42–4-46).

Additional studies aimed at reducing the uncertainty in flood hazard estimates at INL were recently undertaken by both USGS and the Bureau of Reclamation because of the large difference in the earlier estimates. USGS, in cooperation with DOE, published a study in 2003 providing its new estimate of the 100-year peak flow for Big Lost River at INL. The estimate was based on analysis of recorded and estimated peak-flow data, long-term gauging station data, and documented conditions in the basin during historical high-flow periods. The analysis resulted in a 100-year peak-flow estimate of 118 cubic meters

(4,170 cubic feet) per second near Arco and a flow of about 106 cubic meters (3,750 cubic feet) per second for Big Lost River immediately upstream from the INL diversion dam (Hortness and Rousseau 2003:2, 21, 22). The Bureau of Reclamation published the INL Big Lost River flood hazard study of record in 2005 (Adams 2006). This study used historic stream gauge measurements and reprocessed topographic data, in combination with geologic and geomorphic maps and trenching data, to constrain high-resolution two-dimensional hydraulic models of Big Lost River on INL. These data and analyses were independently peer reviewed with respect to meeting DOE flood hazard study and other requirements. The study yielded a series of inundation maps and stage discharge estimates for DOE Big Lost River flood hazard characterization purposes, including a 100-year peak-flow estimate of 87 cubic meters (3,072 cubic feet) per second at the INL diversion dam (Ostenaa and O'Connell 2005:iii, iv). These latest results indicate the potential for substantially less flooding at INL facilities than predicted by previous studies.

3.3.6.1.2 Idaho Nuclear Technology and Engineering Center

INTEC is situated on an alluvial plain, with its northwestern corner located approximately 61 meters (200 feet) from the Big Lost River channel near the channel's intersection with Lincoln Boulevard. INTEC is surrounded by a stormwater drainage ditch system. Stormwater runoff from most INTEC areas flows through the ditches to an abandoned gravel pit on the northeastern side of INTEC, where it infiltrates into the subsurface. Stormwater runoff volumes are usually small and spread over a wide area (DOE 2002a:4-40). The only other surface-water features at the site are the INTEC New Percolation Ponds. The two ponds constitute a rapid infiltration system and are excavated into the surficial alluvium and surrounded by bermed alluvial material. Each pond measures 93 by 93 meters (305 by 305 feet) and is 3 meters (10 feet) deep. The ponds receive wastewater from the INTEC Sewage Treatment Plant located east of INTEC and outside the INTEC security fence. The plant treats sanitary and other related waste at INTEC and uses four sewage lagoons for physical and biological treatment of sanitary waste before discharge to the percolation ponds. In 2008, the INTEC New Percolation Ponds received an average flow of 5.4 million liters (1.4 million gallons) per day, and flow and effluent concentrations were within specified Idaho Wastewater Reuse Permit limits (DOE 2009a:5.4–5.10).

INTEC and other facilities have been evaluated for susceptibility to the probable maximum flood, as discussed above. Other than natural topography, the primary choke points for probable maximum flood flows are the diversion dam on the INL site and the culverts near INTEC that allow Big Lost River to flow beneath Lincoln Boulevard between INTEC and the ATRC. The probable maximum flood would quickly overtop the diversion dam. The Lincoln Boulevard culverts are capable of passing about 42 cubic meters (1,500 cubic feet) of floodwater per second (DOE 2002a:4-42).

3.3.6.1.3 Materials and Fuels Complex

There are no named streams within the MFC area and no permanent natural surface-water features near the area. Neither the 100-year flood study nor flooding scenarios involving the failure of Mackay Dam on Big Lost River indicate that floodwaters would reach the MFC (see Figure 3–36).

Nevertheless, an unnamed dry streambed lies within several hundred feet of the Transient Reactor Test Facility Control Building adjacent to the main MFC site. As much as 1.5 million cubic meters (53 million cubic feet) of water could flow within a few hundred feet of that building during a 100-year storm if the worst-possible frozen ground conditions existed. In addition, a flood-control diversion dam is located about 0.8 kilometers (0.5 miles) south of the Hot Fuel Examination Facility. This dam was built to control surface-water flows from the south attributable to severe spring precipitation onto frozen ground. Water flowing from the south is diverted to the west and through a ditch that extends along the western boundary of the MFC site, discharging to the Industrial Waste Pond (ANL 2003:25).

Two small sewage lagoons and the Industrial Waste Pond are located outside the MFC boundary fence to the northwest. The 1-hectare (2.4-acre) Industrial Waste Pond is used for the disposal of industrial cooling water and stormwater emanating from the MFC facilities (ANL 2003:25).

3.3.6.2 Vadose Zone

3.3.6.2.1 General Site Description

The vadose zone at INL comprises the entire sequence of Quaternary-age basaltic lava flows and sedimentary interbeds that lie between the surface and the regional water table (top of the Snake River Plain Aquifer). Thus, the thickness of the vadose zone beneath INL ranges from about 61 meters (200 feet) in the northern part of the site to more than 274 meters (900 feet) in the southern portion of INL (ANL 2003:13).

This zone is important because chemical sorption to geologic materials in the vadose zone retards or prevents the downward movement of some contaminants. During dry conditions, the transport of contaminants downward toward the aquifer is very slow. Measurements taken at the Radioactive Waste Management Complex (RWMC) during unsaturated flow conditions indicated a downward infiltration rate ranging from 0.36 to 1.1 centimeters (0.14 to 0.43 inches) per year. In another study performed during near-saturated flow conditions in the same area, standing water infiltrated downward 2.1 meters (6.9 feet) in less than 24 hours (DOE 2002a:4-49).

3.3.6.2.2 Idaho Nuclear Technology and Engineering Center

The stratigraphic characteristics of the vadose zone at INTEC are similar to those of INL as a whole, but with a thickness ranging from about 140 to 146 meters (460 to 480 feet) (DOE 2002a:4-49). The geologic and groundwater environments of INTEC are further described in Sections 3.3.5.2 and 3.3.6.3.2, respectively.

3.3.6.2.3 Materials and Fuels Complex

The vadose zone beneath the MFC is approximately 213 meters (700 feet) thick and comprises the basalt flows and interbedded sediments characteristic of the Snake River Group. The geologic and groundwater environments of the MFC are further described in Sections 3.3.5.3 and 3.3.6.3.3, respectively.

3.3.6.3 Groundwater

3.3.6.3.1 General Site Description

The Snake River Plain Aquifer lies below INL. It covers an area of approximately 2.5 million hectares (6.1 million acres) in southeastern Idaho. Aquifer boundaries are formed by contact with less-permeable rocks at the margins of the Eastern Snake River Plain. These boundaries correspond to the mountains on the west and north and the Snake River on the east (ANL 2003:13). This aquifer is the major source of drinking water for southeastern Idaho and has been designated a Sole Source Aquifer by EPA (DOE 2002a:4-47; 2002h:4-135). Water storage in the aquifer is estimated at some 2,500 billion cubic meters (660,400 billion cubic gallons), and irrigation wells can yield 26,500 liters (7,000 gallons) per minute (DOE 2002a:4-47). The aquifer is composed of numerous thin basalt flows, with interbedded sediments extending to depths in excess of 1,067 meters (3,500 feet) below the land surface. Figure 3–35 shows the relationship of these strata from boreholes drilled at INL. The interbeds accumulated over time as some basalt flows were exposed at the surface long enough to collect sediment. These sedimentary interbeds lie at various depths, with their distribution and continuity controlled by basalt flow topography, sediment input, and subsidence rate. In some instances, the process of sediment accumulation resulted in discontinuous distributions of fairly impermeable sedimentary interbeds, which led to a localized perching of groundwater. USGS has estimated that the thickness of the active portion of the Snake River Plain Aquifer at INL ranges between 76 and 250 meters (250 and 820 feet). Depth to the water table ranges from about 61 meters (200 feet) below land surface in the northern part of the site to more than 274 meters (900 feet) in the southern part (ANL 2003:13, 14).

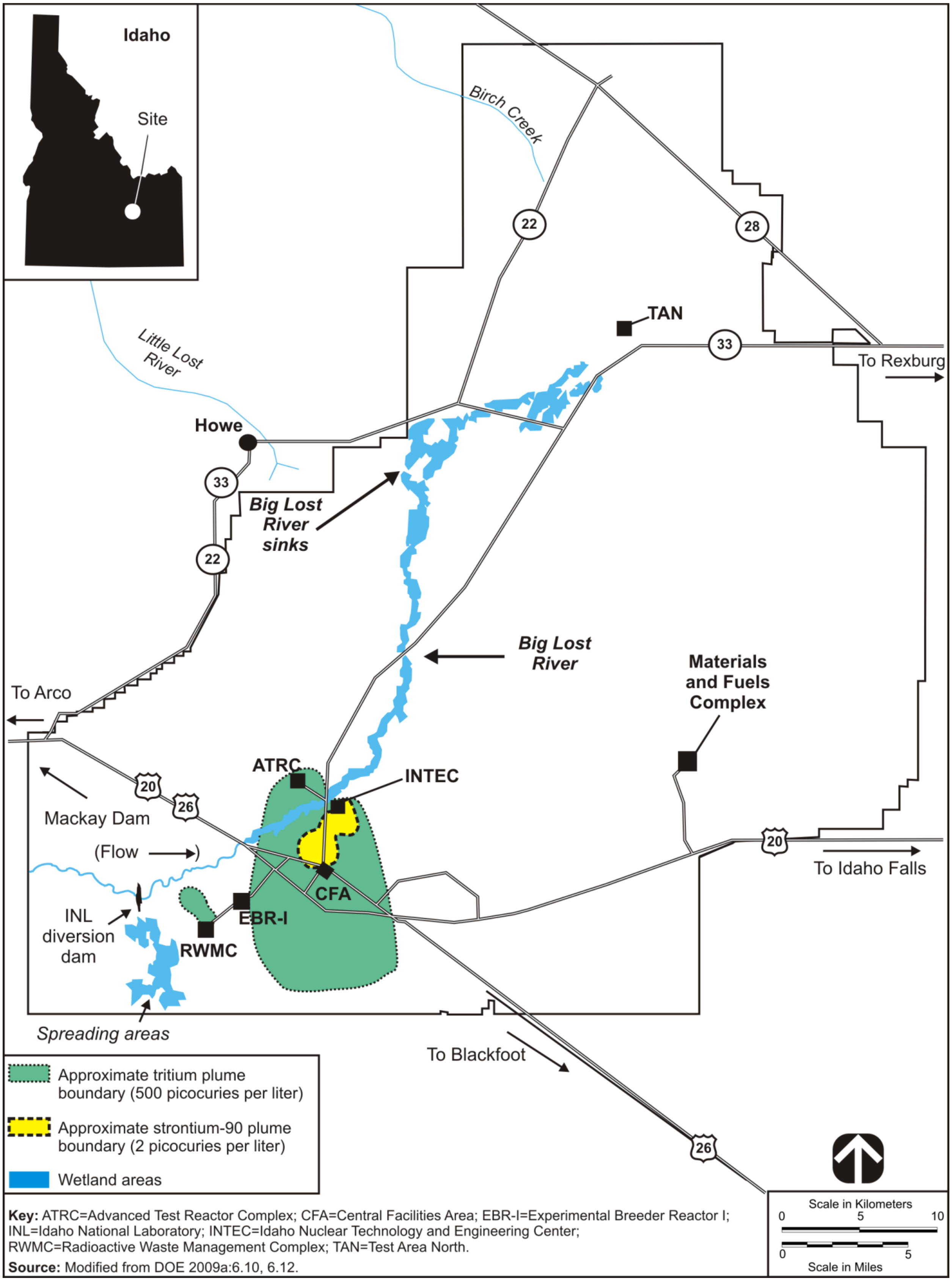
Water movement regionally in the aquifer is mainly horizontal through basalt interflow zones, i.e., highly permeable rubble zones between basalt flows. Groundwater flow is primarily toward the southwest. Locally, the flow direction can be affected by recharge from rivers, surface-water spreading areas, and heterogeneities in the aquifer. Transmissivity in the aquifer ranges from roughly 100 to 10,000 square meters (1,000 to 100,000 square feet) per day and in places exceeds 100,000 square meters (1 million square feet) per day (ANL 2003:14). Flow rates in the aquifer have been reported to range from about 1.5 to 6.1 meters (5 to 20 feet) per day (DOE 2002h:4-135).

Big Lost River, Little Lost River, and Birch Creek terminate at sinks on or near INL and recharge the aquifer. Recharge occurs through the surface of the Eastern Snake River Plain from flow in the channel of Big Lost River and its diversion area. Additionally, recharge may occur from melting of local snowpacks during years in which snowfall accumulates on the Eastern Snake River Plain and from local agricultural irrigation activities (ANL 2003:15). Valley underflow from the mountains to the north and northeast of the Eastern Snake River Plain has also been cited as a source of recharge (DOE 2002a:4-47). Aquifer discharge is via large spring flows to the Snake River and pumping for irrigation. The aquifer discharges approximately 8,800 billion cubic meters (2,320 million cubic gallons) of water annually to springs and rivers (ANL 2003:15). Major springs and seepages from the aquifer occur in the vicinity of the American Falls Reservoir (southwest of Pocatello) and the Thousand Springs area (near Twin Falls) between Milner Dam and King Hill (DOE 2002a:4-47).

Perched water occurs in the vadose zone at INL when sediments or dense basalt with low permeability impedes the downward flow of water to the aquifer (DOE 2002a:4-47). These perched water tables tend to slow the migration of pollutants to the Snake River Plain Aquifer. Other perched water tables detected beneath INTEC and the RTC are attributable mainly to disposal ponds (DOE 2002h:4-135).

INL has an extensive groundwater-quality monitoring network maintained by USGS. USGS performs groundwater monitoring, analyses, and studies of the Snake River Plain Aquifer under and adjacent to INL.

Historical waste disposal practices have produced localized plumes of radiochemical and chemical constituents beneath the site. These areas are regularly monitored by USGS, and reports are published showing the extent of contamination plumes. Of principal concern over the years have been the movements of the tritium and strontium-90 plumes. The general extent of these plumes beneath INL is shown in Figure 3–37. Results for some monitoring wells within the plumes have shown decreasing concentrations of tritium and strontium-90 over the past 15 years. In 2008, USGS personnel collected and analyzed over 1,300 samples for radionuclides and inorganic constituents, including trace elements, and approximately 40 samples for purgeable organic compounds. Several purgeable organic compounds continue to be found by USGS in monitoring wells, including drinking water wells, at INL. The concentration of carbon tetrachloride was above the EPA MCL during 2008. Concentrations of other organic compounds were below MCLs and State of Idaho groundwater primary and secondary standards.



Key: ATRC=Advanced Test Reactor Complex; CFA=Central Facilities Area; EBR-I=Experimental Breeder Reactor I; INL=Idaho National Laboratory; INTEC=Idaho Nuclear Technology and Engineering Center; RWMC=Radioactive Waste Management Complex; TAN=Test Area North.

Source: Modified from DOE 2009a:6.10, 6.12.

Figure 3–37. Extent of Hydrogen-3 (Tritium) and Strontium-90 Plumes Within the Snake River Plain Aquifer at Idaho National Laboratory

No contaminant exceeded an EPA MCL in a well along the southern boundary of INL or downgradient of the site during 2008. Analysis of the areal extent of the groundwater plumes detected tritium in two wells (USGS-104 and -106), which are guard wells located just south of the Central Facilities Area in the southern portion of INL. Both of these wells have a history of tritium detections. Over the past 20 years, both wells have exhibited a downward trend in tritium concentration. The tritium concentrations in these wells currently are less than 1,100 picocuries per liter and considerably less than the EPA MCL of 20,000 picocuries per liter (DOE 2009a:6.1, 6.3, 6.8–6.11, 6.31, 6.36).

The INTEC facility used direct injection as a disposal method until 1984. This wastewater contained high concentrations of both tritium and strontium-90. Injection at INTEC was discontinued in 1984, and the injection well was sealed in 1990. Once direct injection ceased, wastewater from INTEC was directed to a pair of shallow percolation ponds, from which the water infiltrated into the subsurface. Disposal of low- and intermediate-level radioactive waste solutions to the percolation ponds ceased in 1993 with the installation of the Liquid Effluent Treatment and Disposal Facility. New INTEC percolation ponds went into operation in August 2002. The RTC also discharged contaminated wastewater, but mainly to a shallow percolation pond. This pond was replaced in 1993 by a flexible plastic (Hypalon®)-lined evaporation pond, which stopped the addition of tritium to groundwater (DOE 2009a:6.8, 6.9, 6.35, 6.36).

Concentrations of tritium in the area of aquifer contamination have continued to decrease. Two monitoring wells downgradient of the RTC (well 65) and INTEC (well 77) have continually shown the highest tritium concentrations in the aquifer over time and are considered representative of maximum concentration trends in the rest of the aquifer. The average tritium concentration in well 65 decreased from 6,100 ± 300 picocuries per liter in 2007 to 5,710 ± 190 picocuries per liter in 2008, and the tritium concentration in well 77 decreased from 6,690 ± 160 picocuries per liter in 2007 to 5,620 ± 150 picocuries per liter in 2008. The EPA MCL for tritium in drinking water is 20,000 picocuries per liter, which is the same as the Idaho groundwater primary constituent standard. Still, values in both wells 65 and 77 have remained below the 20,000-picocuries-per-liter standard in recent years as a result of radioactive decay, a decrease in tritium disposal rates, and dilution within the Snake River Plain Aquifer (DOE 2009a:6.9, 6.10).

Strontium-90 contamination at INTEC is a remnant of the earlier injection of wastewater. At the RTC, by contrast, disposition of strontium-90 was via infiltration ponds. Strontium-90 at the RTC is retained in surficial sedimentary deposits, interbeds, and perched groundwater zones; however, no strontium-90 contamination has been detected in the RTC vicinity. The area of the strontium-90 contamination from INTEC is approximately the same as it was in 1991. Concentrations in wells have shown a general decrease since 1990. This decrease in concentration is probably the result of radioactive decay, discontinued strontium-90 disposal, advective dispersion, and dilution within the aquifer. Increases observed prior to the last few years were probably due in part to a lack of the recharge from Big Lost River that typically acts to dilute the strontium-90. An increase in the disposal of other chemicals into INTEC percolation ponds also may have changed the affinity of strontium-90 for soil and rock surfaces, causing it to become more mobile (DOE 2009a:6.11).

From 1982 to 1985, INL used about 7.9 billion liters (2.1 billion gallons) per year from the Snake River Plain Aquifer, the only source of water at INL. This represents less than 0.3 percent of the groundwater withdrawn from that aquifer. Since 1950, DOE has held a Federal Reserved Water Right for the INL site that permits a pumping capacity of approximately 2.3 cubic meters (80 cubic feet) per second, with a maximum water consumption of 43 billion liters (11.4 billion gallons) per year. Total groundwater withdrawal at INL historically averages between 15 and 20 percent of that permitted amount. INL's production well system currently withdraws a total of about 4.2 billion liters (1.1 billion gallons) of water annually (see Section 3.3.2.4). Most of the groundwater withdrawn for use by INL facilities is returned to the subsurface via percolation ponds (DOE 2002h:4-136).

3.3.6.3.2 Idaho Nuclear Technology and Engineering Center

Groundwater directly beneath INTEC generally flows to the southwest and southeast, with some flow to the south. The local groundwater flow is complex and variable and is influenced by recharge from Big Lost River (when flow is present), percolation ponds, areas of lower-aquifer transmission, and possibly pumping from the production wells. Groundwater beyond the influence of INTEC recharge sources flows to the south-southwest. The groundwater velocity beneath INTEC has been estimated at 3 to 8 meters (10 to 25 feet) per day. Depth to the water table in the Snake River Plain Aquifer ranges from approximately 140 to 146 meters (460 to 480 feet) below the ground surface. Also, several zones of perched water lie beneath INTEC. These zones are primarily located beneath, and extend outward from, the percolation ponds and the sewage treatment plant lagoons when Big Lost River is dry. Additional perched water bodies and interactions occur in the northern part of INTEC during periods of flow in Big Lost River and subsequent infiltration (DOE 2002a:4-47).

Water is supplied to INTEC by two deep wells (CPP–01 and CPP–02) in the northwestern corner of the area. The wells are about 180 meters (590 feet) deep. These wells can each supply up to approximately 11,400 liters per minute (3,000 gallons per minute) of water for use in the INTEC fire water, potable water, treated water, and demineralized water systems. The production wells at INTEC have historically contained measurable quantities of strontium-90 (DOE 2000a:3-58). During 2008, routine drinking water compliance sampling found that all INTEC monitored parameters were below their respective drinking water limits (DOE 2009a:5.19).

3.3.6.3.3 Materials and Fuels Complex

The depth of the Snake River Plain Aquifer water table beneath the MFC ranges between 183 and 213 meters (600 to 700 feet), and groundwater flow is generally to the southwest across the site (ANL 2003:13, 14). All water used at the MFC is groundwater from the underlying aquifer and is withdrawn via two production wells (see Section 3.3.2.4.3).

The MFC samples five wells (four monitoring and one production) twice a year for radionuclides, metals, total organic carbon, total organic halogens, and water quality parameters as part of the CERCLA ROD for Waste Area Group 9. Levels of gross beta and certain uranium isotopes detected in groundwater during fiscal year 2008 were low, and were found to be consistent with levels attributable to natural sources. In addition, except for one groundwater sample that contained lead concentrations in excess of primary and/or secondary MCLs, all concentrations of metals, total organic carbon, and total organic halogens, as well as general water quality parameters, were below respective MCLs. Overall, the data show no evidence of impacts of activities at the MFC (DOE 2009a:6.30, 6.32, 6.33).

3.3.7 Ecological Resources

The scope of the discussion of ecological resources in this *TC & WM EIS* is stipulated in Section 3.2.7.

3.3.7.1 Terrestrial Resources

3.3.7.1.1 General Site Description

INL lies in a cool desert ecosystem dominated by some of the best-condition shrub-steppe communities in the United States. Approximately 94 percent of the site is undeveloped and provides important habitat for species native to the region (DOE 2002h:4-136; 2011b). Approximately 60 percent of the area on the periphery of the site is grazed by sheep and cattle. Although sagebrush communities occupy about 80 percent of INL, a total of 11 plant communities have been identified. Additionally, areas of lava and developed areas are present on the site (see Figure 3–38). These communities may be grouped into six types: shrub steppe; juniper woodlands; grasslands; playas, bare ground, and disturbed areas; lava; and wetlands. In total, 398 plant taxa have been documented at INL (DOE 2002h:4-136; 2002i).

Among the sensitive habitats on the INL site are the interspersions of low and big sagebrush communities in the northern portion of INL and the juniper communities in the northwestern and southeastern portions of the site. The former provide critical winter and spring range for pronghorn, while the latter are important to nesting raptors and songbirds. Riparian vegetation, primarily cottonwood and willow, along Big Lost River and Birch Creek is also important nesting habitat for hawks, owls, and songbirds (DOE 2002h:4-136). Recently, approximately 29,244 hectares (72,263 acres) of open space in the north-central portion of the site was designated as the INL Sagebrush-Steppe Ecosystem Reserve. The area was set aside because it represents some of the last sagebrush-steppe habitat in the United States and provides habitat for numerous rare and sensitive plants and animals (O'Rourke 2006:26).

INL supports numerous animal species, including 1,240 insect, 1 amphibian, 11 reptile, 210 bird, and 47 mammal species (DOE 2011b; Hampton 2005; O'Rourke 2006:24). Common animals on the site include the short-horned lizard, Great Basin gopher snake, sage sparrow, Townsend's ground squirrel, and black-tailed jackrabbit. Important game animals include the mule deer, Rocky Mountain elk, and pronghorn. Yearly estimates show that an average of 500 pronghorn live on INL during the summer and anywhere from 600 to 6,500 winter on the site (Stoller 2004). Although pronghorn may be found across INL at any time of the year, their important wintering areas are in the northeastern portion of the site, the area of the Big Lost River sinks, the west-central portion of the site along the Big Lost River, and the south-central portion of the site. Hunting Rocky Mountain elk and pronghorn is permitted only within 0.8 kilometers (0.5 miles) of the site boundary on INL lands adjacent to agricultural lands. Numerous raptors such as the golden eagle and prairie falcon, as well as carnivores such as the coyote and mountain lion, are also found on INL. A variety of migratory birds have been found on INL (DOE 2002h:3-64, 3-65).

3.3.7.1.2 Idaho Nuclear Technology and Engineering Center

INTEC is surrounded by sagebrush-steppe communities (see Figure 3–38); however, nearly the entire site has been developed. Thus, there is little or no natural habitat present, and INTEC does not support the diversity of wildlife found in surrounding areas. Breeding bird surveys designed to monitor the avifauna population in proximity to anthropogenic activities and disturbances at INL have found that the most common breeding birds in the INTEC area are Brewer's sparrow, horned lark, sage thrasher, and western meadowlark (Shurtliff and Whiting 2010:1, 28).

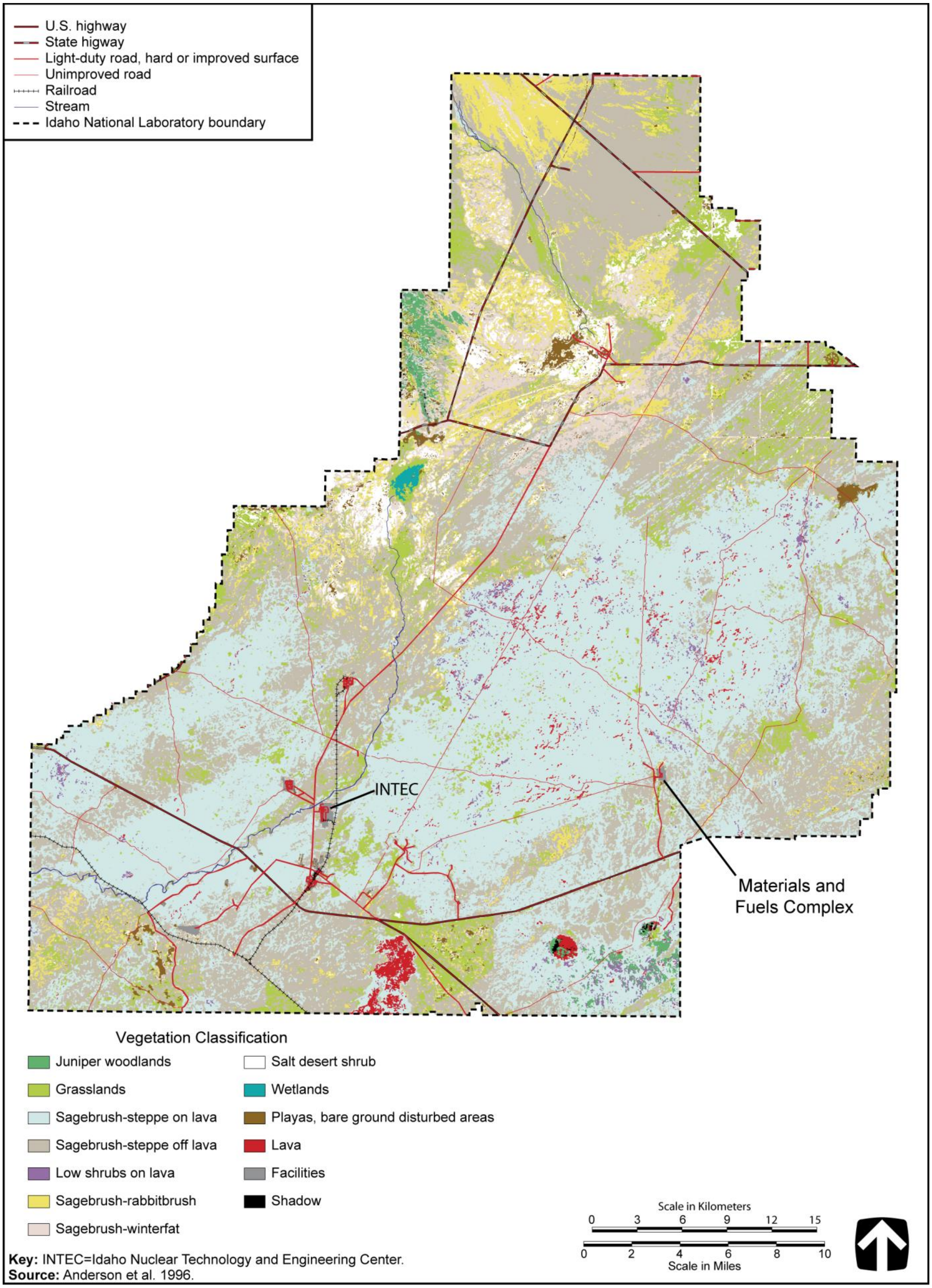


Figure 3–38. Vegetation Communities at Idaho National Laboratory

3.3.7.1.3 Materials and Fuels Complex

The MFC is within one of several sagebrush communities found on INL (see Figure 3–38). While sagebrush is present on undeveloped portions of the site, developed areas are nearly devoid of vegetation and thus generally not as important to animals as the surrounding areas. Rocky Mountain elk and mule deer are the most important large mammals in the general site area, but many other species common to the region are also expected. The MFC wastewater pond acts as an important source of water for wildlife found in the site vicinity (DOE 2002h:4-138).

3.3.7.2 Wetlands

3.3.7.2.1 General Site Description

National wetland inventory maps have been completed by USFWS for most of INL. These maps indicate that there are 55 hectares (135 acres) of wetland areas within INL. The primary wetland areas are associated with Big Lost River and the river's spreading areas and sinks, although smaller (less than about 0.4 hectares [1 acre]), isolated wetlands also occur intermittently. Wetlands associated with Big Lost River are classified as "riverine/intermittent," indicating a defined stream channel with flowing water during only part of the year. The only areas of jurisdictional wetlands are the Big Lost River sinks (see Figure 3–36) (DOE 2002h:4-138; O'Rourke 2006:21).

3.3.7.2.2 Idaho Nuclear Technology and Engineering Center

Riparian vegetation exists along Big Lost River, which is just to the west of INTEC; however, this vegetation is in poor condition because of only intermittent flows in recent years. The Big Lost River spreading areas and sinks are seasonal wetlands that are 14.5 kilometers (9 miles) southwest and 22.5 kilometers (14 miles) north of INTEC, respectively. These areas provide more than 809 hectares (2,000 acres) of wetland habitat during wet years (DOE 2002h:4-138). There are no wetlands within INTEC.

3.3.7.2.3 Materials and Fuels Complex

Riparian vegetation exists along Big Lost River, which is 18 kilometers (11 miles) west of the MFC; however, as noted previously, this vegetation is in poor condition. The Big Lost River spreading areas and sinks are seasonal wetlands that provide 809 hectares (2,000 acres) of wetland habitat during wet years. They are located 34 kilometers (21 miles) west-southwest and 23 kilometers (14 miles) northwest of the MFC, respectively. Within the MFC itself, small areas of intermittent marsh occur along cooling-tower blowdown ditches (DOE 2002h:4-138).

3.3.7.3 Aquatic Resources

3.3.7.3.1 General Site Description

Aquatic habitat at INL is limited to Big Lost River, Little Lost River, Birch Creek, and a number of liquid waste disposal ponds. All three streams are intermittent and drain into four sinks in the north-central part of the site. Six species of fish have been observed within water bodies on site. Species observed in Big Lost River include brook trout, rainbow trout, mountain whitefish, speckled dace, shorthead sculpin, and kokanee salmon. The Little Lost River and Birch Creek, southwest and northwest of the MFC, respectively, enter the site only during periods of high flow. The liquid waste disposal ponds on INL, while considered aquatic habitat, do not support fish (DOE 2002h:4-138).

3.3.7.3.2 Idaho Nuclear Technology and Engineering Center

Big Lost River is located 61 meters (200 feet) west of INTEC. As noted above, water flows only intermittently in the river and thus does not support permanent fish populations. INTEC contains manmade infiltration ponds (see Section 3.3.6.1.1); however, as is the case for Big Lost River, they do not support fish.

3.3.7.3.3 Materials and Fuels Complex

There is no natural aquatic habitat in the vicinity of the MFC. The nearest such habitat is Big Lost River, which is 19 kilometers (12 miles) west of the site. The MFC waste disposal ponds do not contain any fish populations, but they do provide habitat for a variety of aquatic invertebrates (DOE 2002h:4-139).

3.3.7.4 Threatened and Endangered Species

3.3.7.4.1 General Site Description

With the delisting of the gray wolf as an experimental, nonessential population in the northern Rocky Mountains, no listed or proposed threatened or endangered species and no proposed or designated critical habitat are currently known to occur in the area of INL (DOE 2009c:3; Foss 2009). The greater sage grouse is listed by USFWS as a candidate species (USFWS 2010); it is a common species on INL (GSS 2011). However, state-listed threatened and other special status species occur, or possibly occur, on INL (see Table 3–36). Idaho special status species include one threatened, two priority, three sensitive, two monitor, one imperiled, and one vulnerable. The bald eagle is listed by the state as threatened, but has been delisted in the lower 48 states by USFWS (72 FR 37346).

3.3.7.4.2 Idaho Nuclear Technology and Engineering Center

As noted above, there are no federally listed threatened or endangered species or critical habitat on INL; thus, none occur within INTEC. Also, due to the developed nature of INTEC, no state special status species are expected.

3.3.7.4.3 Materials and Fuels Complex

Although no federally listed threatened or endangered animals occur on INL, several studies have documented the presence of other state special status species in the immediate area of the MFC. The Townsend's big-eared bat has been observed using nearby caves and foraging over water sources at INL. Given the proximity of the MFC to Rattlesnake Cave and the distance to another water source, it is highly likely that Townsend's big-eared bats frequently forage at the facility (Burandt 2008). Additionally, pygmy rabbits have been observed in the area of the MFC (Vilord et al. 2005). Surveys of state-listed plants have not been conducted in the site vicinity.

A rattlesnake hibernaculum (a place to overwinter) is located a little over 1.6 kilometers (1 mile) south of the MFC. Concern for rattlesnakes within the state has grown in recent years, and, in fact, all reptiles receive protection in Idaho. The Great Basin rattlesnake could migrate as far north as the MFC once it leaves the hibernaculum in the spring (Jenkins and Peterson 2005:3, 4, 27).

Table 3–36. Idaho National Laboratory Threatened, Endangered, and Other Special Status Species

Common Name	Scientific Name	Status	
		Federal[a]	State[b]
Plants			
Cushion milkvetch	*Astragalus gilviflorus*		Priority 1
Lemhi milkvetch	*Astragalus aquilonius*		Sensitive
Puzzling halimolobos	*Halimolobos perplexa*		Monitor
Narrowleaf oxytheca	*Oxytheca dendroidea*		Sensitive
Nipple coryphantha	*Escobaria missouriensis*		Monitor
Spreading gilia	*Ipomopsis polycladon*		Priority 2
Winged-seed evening primrose	*Camissonia pterosperma*		Sensitive
Birds			
Bald eagle[c]	*Haliaeetus leucocephalus*		Threatened
Greater sage grouse	*Centrocercus urophasianus*	Candidate	
Mammals			
Pygmy rabbit	*Brachylagus idahoensis*		S2
Townsend's big eared bat	*Corynorhinus townsendii*		S3

[a] Status definition:
Candidate: Current information indicates the probable appropriateness of listing as endangered or threatened.

[b] Status definitions:
Priority 1: A taxon in danger of becoming extinct in Idaho in the foreseeable future if identifiable factors contributing to its decline continue to operate; these are taxa whose populations are present only at a critically low level or whose habitats have been degraded or depleted to a significant degree.
Priority 2: A state taxon likely to be classified as Priority 1 within the foreseeable future in Idaho if factors contributing to its population decline or habitat degradation or loss continue.
Sensitive: A state taxon with small populations or localized distributions within Idaho that presently do not meet the criteria for classification as Priority 1 or 2, but whose populations and habitats may be jeopardized without active management or removal of threats.
Monitor: Taxa that are common within a limited range or taxa that are uncommon but have no identifiable threats.
Threatened: Any native species likely to be classified as endangered within the foreseeable future throughout all or a significant portion of its Idaho range.
S2: Imperiled; at risk because of restricted range, few populations, rapidly declining numbers, or other factors.
S3: Vulnerable; at moderate risk because of restricted range, relatively few populations, recent widespread decline, or other factors.

[c] Removed, effective August 8, 2007, from the list of threatened wildlife in the lower 48 states (72 FR 37346).

Note: The U.S. Fish and Wildlife Service does not currently distribute a list of species of concern for Idaho (Cheney 2008).

Source: Foss 2009; IDFG 2011; IDGOSC 2008; INL 2009c.

3.3.8 Cultural and Paleontological Resources

INL has a well-documented record of cultural and paleontological resources due in part to a longstanding cultural resource management program outlined in the *Idaho National Laboratory Cultural Resource Management Plan* (DOE 2005a) and adopted by a programmatic agreement between the DOE Idaho Operations Office (DOE-ID), the Idaho State Historic Preservation Office, and the Advisory Council on Historic Preservation. Past surveys have encompassed 8 to 10 percent of the INL site. These surveys have identified more than 2,200 prehistoric and historic archaeological resources and yielded an inventory of more than 200 DOE-administered buildings potentially eligible for inclusion in the National Register (O'Rourke 2006:28). In addition, consultations with local Shoshone-Bannock tribal members have served to identify TCPs.

Most cultural resource surveys have been in conjunction with major modification, demolition, or abandonment of site facilities. Approximately 40 to 50 specific projects are reviewed annually at INL for potential impacts on prehistoric and historic archaeological resources and TCPs. A similar number of project reviews are also performed to identify impacts on historic architectural properties.

Cultural sites were often occupied continuously or intermittently over substantial timespans. For this reason, a single location may have been used during both prehistoric and historic periods. In the discussions that follow, the numbers of prehistoric and historic resources are presented. The sum of these resources, however, may be greater than the total number of sites identified due to the dual-use history of various sites.

3.3.8.1 Prehistoric Resources

3.3.8.1.1 General Site Description

Prehistoric resources identified at INL are by definition physical properties reflecting human activities that predate written records; these generally reflect American Indian hunting and gathering activities. Approximately 1,980 prehistoric archaeological resources have been identified on INL. About half of these are isolates and half are sites (DOE 2005b). Most of the prehistoric sites are lithic scatters or locations (DOE 2002h:4-140). Resources appear to be concentrated along Big Lost River and Birch Creek, atop buttes, and within craters or caves. These include residential bases; campsites; caves; hunting blinds; rock alignments; and limited-activity locations such as lithic and ceramic scatters, hearths, and concentrations of fire-affected rock. Most sites at INL have not been formally evaluated for nomination to the National Register, but they are considered to be potentially eligible. Given the rather high density of prehistoric sites at INL, additional sites are likely to be identified as surveys continue.

3.3.8.1.2 Idaho Nuclear Technology and Engineering Center

The total fenced area at INTEC is 85 hectares (210 acres), with an additional 22 hectares (54 acres) outside the fence (DOE 2011a:3-69). Areas within the fence are highly disturbed and unlikely to yield significant prehistoric material. Archaeological surveys indicate that the area near INTEC contains only limited evidence of prehistoric use, though Big Lost River gravels could contain buried prehistoric artifacts (DOE 2002a:4-11).

3.3.8.1.3 Materials and Fuels Complex

The most recent cultural resource survey conducted near the MFC took place in 1996 and covered an area to the south of the site that had been burned over by a wildfire and was proposed for revegetation. A total of 12 isolated finds and 2 archaeological sites were located. Isolated finds included items such as pieces of Shoshone brownware pottery and projectile points. The archaeological sites yielded collections of projectile points, scrapers, and volcanic glass flakes. Areas within the fenced portion of the MFC site are highly disturbed and are not likely to yield significant archaeological material (DOE 2002h:4-140, 4-141).

3.3.8.2 Historic Resources

3.3.8.2.1 General Site Description

Approximately 200 historic archaeological sites are known on INL, and at least 200 historic architectural properties have been identified during surveys of nearly 500 buildings administered by DOE-ID (DOE 2005b). These resources represent European-American activities such as fur trapping and trading, immigration, transportation, mining, agriculture, and homesteading, as well as more-recent military, scientific, and engineering R&D activities. Examples of historic resources include Goodale's Cutoff (a spur of the Oregon Trail), remnants of homesteads and ranches, irrigation canals, and a variety of structures from the World War II era.

The Experimental Breeder Reactor I, the first reactor to achieve a self-sustaining chain reaction using plutonium instead of uranium as the principal fuel component, is listed in the National Register and is designated as a National Historic Landmark. Many other INL structures built between 1949 and 1974 are considered eligible for the National Register because of their exceptional scientific and engineering significance and their major role in the development of nuclear science and engineering since World War II. Additional historic sites are likely to exist in unsurveyed portions of INL (DOE 2002h:4-141).

3.3.8.2.2 Idaho Nuclear Technology and Engineering Center

Historic trails, sites, and structures at and near INTEC have been identified as potentially eligible for listing on the National Register of Historic Places. Six INTEC structures proposed for demolition or modification have undergone State Historic Preservation Office reviews and have been determined to be eligible for listing in the National Register. These structures include the Waste Calciner Facility (CPP-633), the two monitoring stations (CPP-709 and CPP-734), the Radium-Lanthanum Process Off-Gas Blower Room (CPP-631), the Underwater Fuel Receiving and Storage Building (CPP-603), and the CPP-603 Basin Sludge Tank Control House (CPP-648). Memorandums of Agreement with the State Historic Preservation Office are in place to ensure that any adverse impacts of alteration of these facilities are mitigated (DOE 2002a:4-15).

3.3.8.2.3 Materials and Fuels Complex

A number of recent items, including farm implements, a belt buckle, broken glass, and a large scattering of cans, have been found in the MFC vicinity. Historic architectural properties are also present, including EBR-II, which has been designated as an American Nuclear Society Nuclear Historic Landmark (DOE 2002h:4-141). Future building surveys at the MFC are expected to result in the identification of additional historic architectural properties potentially eligible for nomination to the National Register.

3.3.8.3 American Indian Interests

3.3.8.3.1 General Site Description

TCPs at INL are associated with the two groups of nomadic hunters and gatherers that used the region at the time of European-American contact: the Shoshone and Bannock Tribes. Both of these used the area that now encompasses INL as they harvested plant and animal resources and obsidian from Big Southern Butte and Howe Point. Because the INL site is considered part of the Shoshone-Bannock Tribes' ancestral homeland, it contains many localities that are important for traditional, cultural, educational, and religious reasons. These include not only prehistoric archaeological sites that are important in the context of a religious or cultural heritage, but also features of the natural landscape and air, plant, water, and animal resources that have special significance (DOE 2002h:4-141).

DOE entered into an Agreement in Principle with the Shoshone-Bannock Tribes in 2002. In addition to defining a broad range of interests and working relationships and reaffirming the Tribes' rights under the Fort Bridger Treaty of 1868, the agreement devotes particular attention to the management of INL cultural resources. Its overall intent is to foster confidence on the part of the Shoshone-Bannock Tribes that INL cultural resources are managed in a spirit of protection and stewardship. To achieve this, the agreement provides for routine tribal participation in new and ongoing INL projects, with an open invitation to comment on, visit, observe, and assist in cultural resource management work (DOE 2005a; Ringe Pace et al. 2005).

3.3.8.3.2 Idaho Nuclear Technology and Engineering Center

Although INTEC and the surrounding area may contain American Indian resources, it is unlikely that undisturbed American Indian resources exist within the fenced perimeter of the site (DOE 2000a:3-71).

3.3.8.3.3 Materials and Fuels Complex

Over the past two decades, efforts have been under way to assemble complete inventories of cultural resources in the vicinity of major operating facilities at INL, including the MFC. Although prehistoric American Indian artifacts have been found in the MFC vicinity, areas within the fenced portion of the MFC site are highly disturbed and not likely to contain American Indian areas of interest (DOE 2000a:3-71).

3.3.8.4 Paleontological Resources

3.3.8.4.1 General Site Description

The region encompassing INL also has abundant and varied paleontological resources, including plant, vertebrate, and invertebrate remains in soils and lake and river sediments and organic materials found in caves and archaeological sites. Vertebrate fossils recovered from the Big Lost River floodplain consist of isolated bones and teeth from large mammals of the Pleistocene epoch, or Ice Age. These fossils were discovered during excavations and well-drilling operations. Fossils have been recorded in the vicinity of the Naval Reactors Facility. Occasional skeletal elements of fossil mammoth, horse, and camel have been retrieved from the Big Lost River diversion dam and the RWMC on the southwestern side of INL and from river and alluvial fan gravels and Lake Terreton sediments near Test Area North. A mammoth tooth dating from the Pleistocene epoch was recovered from the ATRC. In total, 24 paleontological localities have been identified on INL (DOE 2002h:4-141, 4-142).

3.3.8.4.2 Idaho Nuclear Technology and Engineering Center

To date, paleontological resources identified have included vertebrate and invertebrate animals, pollen, and plant fossils found in alluvial gravels along Big Lost River and in caves, lava tubes, and lake sediments; however, the INTEC vicinity was not identified as one of the locations where paleontological resources were found (DOE 2002h:4-141,4-142).

3.3.8.4.3 Materials and Fuels Complex

Paleontological resources have not been found in the immediate MFC vicinity (DOE 2002h:4-142).

3.3.9 Socioeconomics

Statistics for population, the regional economy, housing, community services, and local transportation have been developed for the ROI, a four-county area in Idaho (i.e., Bonneville, Bingham, Bannock, and Jefferson Counties) in which 92.3 percent of all INL employees reside (see Table 3–37).

Table 3–37. Distribution of Employees by Place of Residence in the Idaho National Laboratory Region of Influence, 2008

County	Number of Employees[a]	Total Site Employment (percent)
Bonneville	5,016	59.1
Bingham	1,276	15.0
Bannock	822	9.7
Jefferson	718	8.5
Total	**7,832**	**92.3**

[a] Number of employees includes contractors and subcontractors in the state of Idaho.
Source: Wiser 2008.

3.3.9.1 Regional Economic Characteristics

In December 2009, the civilian labor force in the ROI reached 123,000. The annual unemployment average in the four-county area at that time was 7.2 percent, slightly less than the annual unemployment average for Idaho (9.1 percent) (IDC&L 2011).

In 2009, trade, utilities, and transportation represented the largest sector of employment (22 percent). This was followed by government (19.0 percent) and education and health services (14.4 percent). The totals for these employment sectors in Idaho were 19.8, 18.6, and 12.6 percent, respectively (IDC&L 2011). In 2008, INL employed 8,483 persons (Dahl 2008; Wiser 2008).

3.3.9.2 Demographic Characteristics

The 2010 population in the four-county ROI was 259,000. As depicted in the demographic profile presented as Table 3–38, the predominant population was white; of the minority populations, Hispanic or Latino and American Indian and Alaska Native were the largest groups.

Income information for the ROI in 2010 is provided in Table 3–39. As indicated, Jefferson County had the highest median household income of the four counties ($51,600) and the lowest percentage of persons (10.2) living below the poverty level. Bingham County had the lowest median household income ($44,100) and the largest number of individuals (14.7) living below the poverty level. The average median household income in the four counties was comparable to the median household income of the state of Idaho ($46,400) during the same time period.

Table 3–38. Demographic Profile of Populations in the Idaho National Laboratory Socioeconomic Region of Influence, 2009

Population Group	Population (percentage of total)				
	Bannock County	Bingham County	Bonneville County	Jefferson County	Region of Influence
Nonminority					
White non-Hispanic	71,600 (86.4)	34,200 (74.9)	88,900 (85.3)	22,900 (87.7)	218,000 (84.1)
Minority					
Black or African American[a]	625 (0.8)	105 (0.2)	585 (0.6)	52 (0.2)	1,370 (0.5)
American Indian and Alaska Native[a]	2,620 (3.2)	2,970 (6.5)	790 (0.8)	203 (0.8)	6,580 (2.5)
Asian[a]	1,080 (1.3)	285 (0.6)	856 (0.8)	103 (0.4)	2,320 (0.9)
Native Hawaiian and Other Pacific Islander[a]	188 (0.2)	36 (0.1)	86 (0.1)	23 (0.1)	333 (0.1)
Some other race[a]	1,720 (2.1)	4,480 (9.8)	5,330 (5.1)	1,510 (5.8)	13,000 (5.0)
Two or more races[a]	2,210 (2.7)	979 (2.1)	2,170 (2.1)	401 (1.5)	5,760 (2.2)
White Hispanic	2,840 (3.4)	2,580 (5.6)	5,540 (5.3)	919 (3.5)	11,900 (4.6)
Total Minority	**11,300 (13.6)**	**11,400 (25.1)**	**15,400 (14.7)**	**3,220 (12.3)**	**41,300 (15.9)**
Total Hispanic or Latino (of any race)[b]	**5,590 (6.7)**	**7,860 (17.2)**	**11,900 (11.4)**	**2,640 (10.1)**	**28,000 (10.8)**
Total	**82,800**	**45,600**	**104,000**	**26,100**	**259,000**

[a] Includes individuals who identified themselves as Hispanic or Latino.
[b] Includes all individuals who identified themselves as Hispanic or Latino, regardless of race.
Note: Total may not equal the sum of the contributions due to rounding.
Source: Census 2011a.

Table 3–39. Income Information for the Idaho National Laboratory Region of Influence, 2010

Income Category	Bannock County	Bingham County	Bonneville County	Jefferson County	Idaho State
Median household income[a]	$44,800	$44,100	$50,400	$51,600	$46,400
Percentage of persons below the poverty level[b]	14	14.7	11	10.2	13.6

[a] Census 2011b.
[b] Census 2011c.

3.3.9.3 Housing and Community Services

Table 3–40 presents information on housing availability in the ROI, as well as data on public education and community health-care services in the region. As indicated, there were 95,500 housing units. Home values were highest in Jefferson County, with a median value of $154,000, and lowest in Bingham County, where the median value was $125,000.

Table 3–40. Housing and Community Services in the Idaho National Laboratory Region of Influence, 2010

	Bannock County	Bingham County	Bonneville County	Jefferson County	Region of Influence
Housing					
Total units[a]	32,700	15,900	38,600	8,340	95,500
Occupied housing units[a]	29,900	14,300	35,400	7,780	87,300
Vacant units for sale or rent[b]	1,190	373	1,570	306	3,440
Vacancy rate (percent)	3.8	2.5	4.3	3.8	3.8
Median value[c, d]	$136,000	$125,000	$153,000	$154,000	$142,000
Public Education[e]					
Total enrollment	14,000	10,100	21,100	5,990	51,100
Student-to-teacher ratio	19.9	18.3	20.1	18.5	19.4
Community Health Care[f]					
Hospitals	2	3	3	0	8
Hospital beds per 1,000 persons	2.6	3.4	3.2	0	2.7
Physicians per 1,000 persons[g]	2.3	1.1	2.2	0.5	1.9

[a] Census 2011d.
[b] Census 2011e.
[c] Census 2011f.
[d] Represents median value of all owner-occupied housing units.
[e] USDE 2011.
[f] Census 2011a; IDHW 2011.
[g] Census 2011a; Leonard 2011.

As also shown in the table, student enrollment in grades K–12 in the ROI in 2010 was 51,100. Bonneville County had the highest enrollment, and Jefferson County, the lowest. The average student-to-teacher ratio was 19.4 to 1, slightly higher than the state of Idaho ratio of 18.2 to 1 (USDE 2011).

A total of eight hospitals served the ROI in 2010, with a ratio of 2.7 hospital beds per 1,000 people. In that year, there was a ratio of 1.9 physicians per 1,000 residents. Bannock County had the highest ratio (2.3), and Jefferson County, the lowest (0.5) (IDHW 2011).

3.3.9.4 Local Transportation

Two interstate highways serve the INL region. Interstate 15, a north-south route that connects several cities along the Snake River, is approximately 40 kilometers (25 miles) east of INL. Interstate 86 intersects Interstate 15 approximately 64 kilometers (40 miles) south of INL and provides a primary linkage from Interstate 15 to points west. Interstate 15 and U.S. Route 91 are the primary access routes to the Shoshone-Bannock Tribes' Fort Hall Reservation (DOE 2002a:4–64).

U.S. Routes 20 and 26 are the main access routes to the southern portion of INL, with U.S. Route 20 providing the most direct access to the MFC and to INL facilities to the west of the MFC (see Figure 3–30). Idaho State Routes 22, 28, and 33 pass through the northern portion of INL, with State Route 33 providing access to the northern INL facilities (DOE 2002a:4-64). U.S. Routes 20 and 26 (two-lane, with a speed limit of 105 kilometers [65 miles] per hour) have the heaviest use because they provide direct links between INL and Idaho Falls and Blackfoot, Idaho. INL personnel living in

Pocatello, Idaho, use Interstate 15 (four-lane, with a speed limit of 120 kilometers [75 miles] per hour) and U.S. Route 26 en route to and from the site. Those living in Mud Lake, Rexburg, and Terreton (north of the site) use State Route 33. These routes connect to INL's onsite road network, which consists of about 140 kilometers (87 miles) of paved roads (see Section 3.3.2.1.1). The paved public highways running through INL total an additional 145 kilometers (90 miles) of roadway (ANL 2003:9).

Major regional roadway segments serving INL have historically operated at Level of Service A, which is defined as free-flow traffic conditions (DOE 2002a:4-64). According to data from rural traffic flow mapping performed annually by the State of Idaho, annual average daily traffic (AADT) and associated levels of service on major roadway segments serving INL did not change substantially between 1996 and 2009. The AADT on U.S. Route 20 from Idaho Falls to INL was 2,000 in 2009 as opposed to 2,100 in 1996. Corresponding AADT changes observed on other roadway segments include the following: from INL west to Arco on U.S. Route 20, 2,000 in 2009 versus 1,900 in 1996; from Blackfoot, Idaho, to INL on U.S. Route 26, 1,600 in 2009 versus 1,400 in 1996; and from Mud Lake to INL on State Route 33, 620 in 2009 versus 600 in 1996 (ITD 2010). Peak hourly traffic can be assumed to be 15 percent of the AADT. Two-lane roads servicing INL are designed for approximately 1,000 vehicles per hour in optimum weather conditions. The four-lane interstate can accommodate more than 2,000 vehicles per hour (ANL 2003:9). DOE buses provide transportation between INL facilities and surrounding communities for DOE and contractor personnel. Extensive use of this system keeps automobile traffic light.

The Mackay Branch Line of the Union Pacific Railroad, the major railroad in the area, services the southern portion of INL through the Scoville Spur. Freight services are received from the Union Pacific's main lines from Butte, Montana, on the north and Pocatello, Idaho, and Salt Lake City, Utah, on the south. Interconnections are made from these locations to areas throughout the United States. INL freight comes through Blackfoot, Idaho, on the north-south track of the Union Pacific's Mackay Branch Line, 23 kilometers (14 miles) of which traverse the southern part of INL (ANL 2003:9, 10, 11). Rail shipments to and from INL usually are limited to bulk commodities, SNF, and radioactive waste (DOE 2002a:4-66). There are no navigable waterways within the area capable of accommodating waterborne transportation of material shipments to INL.

The cities of Idaho Falls and Pocatello both have airports with passenger and cargo service (ANL 2003:10). Idaho Falls Regional Airport services eastern Idaho, southern Montana, and western Wyoming. The airport is served by Skywest/Delta Airlines and United Express (CIF 2011). There is a helicopter pad on site at the MFC and at each of the other major INL facilities. A Federal Aviation Administration low-altitude airway crosses the southwest portion of INL in a northwestwardly direction (ANL 2003:10).

3.3.10 Existing Human Health Risk

The scope of the discussion of human health risk in this *TC & WM EIS* is stipulated in Section 3.2.10.

3.3.10.1 Radiological Exposure and Risk

Major sources and average levels of exposure to background radiation of individuals in the INL vicinity are shown in Table 3–41.[5] The average annual dose from background radiation near INL is approximately 670 millirem. A little more than half of the annual dose is from ubiquitous, natural background sources (354 millirem) that can vary depending on geographic location, individual buildings in a geographic area, and age, but is essentially all from space or naturally occurring sources in Earth (DOE 2009a). A little less than half of the dose is from medical exposure to radiation (300 millirem),

5 Average doses from background radiation in the INL vicinity from radon; medical exposures; and consumer, industrial, and occupational exposures are assumed to approximate the average dose to an individual in the U.S. population.

including computed tomography, interventional fluoroscopy, x-rays and conventional fluoroscopy, and nuclear medicine (use of unsealed radionuclides for diagnosis and treatment). Another approximately 14 millirem per year are from consumer products and other sources (nuclear power, security, and research and occupational exposure) (NCRP 2009:12). Average background radiation doses from these sources are expected to remain fairly constant over the period of the proposed actions. Background radiation doses, as indicated in Table 3–41, are unrelated to INL operations.

Table 3–41. Sources of Radiological Exposure of Individual Doses Unrelated to Idaho National Laboratory Operations

Source	Effective Dose Equivalent (millirem per year)[b]
Cosmic radiation[a]	48
Terrestrial radiation[a]	66
Internal (terrestrial and global cosmogenic)[b]	40
Radon in homes (inhaled)[b]	200
Medical exposure[b]	300
Consumer, industrial, and occupational[b]	14
Total (rounded)	**670**

[a] Data for natural background radiation are from DOE 2009a:7.18. Cosmic and terrestrial doses represent site-specific Idaho National Laboratory region values that are higher than the U.S. average. This results in a higher background dose than that presented in Table 3–12.

[b] Averages for the United States (NCRP 2009).

Releases of radionuclides to the environment from operations provide another source of radiological exposure for individuals in the vicinity of INL. Types and quantities of radionuclides released from INL operations in 2008 are summarized in Section 3.3.4.2. Estimated doses to the public resulting from these releases are presented in Table 3–42. The estimated dose to an MEI in 2008 was 0.13 millirem; over the last 5 years, the annual dose to the MEI has ranged from 0.039 to 0.13 millirem. The 2008 population dose was 0.78 person-rem; over the last 5 years, the annual dose to the population has ranged from 0.32 to 0.78 person-rem. The population dose varies with the size of the population, which has grown from 281,495 to 300,656 from 2004 to 2008 (DOE 2005d:8.1; 2006:8.1; 2007c:8.3, 8.7; 2008d:8.5, 8.8; 2009a:8.1). The population dose from natural background radiation sources was approximately 106,432 person-rem. The doses to the public from INL activities fall within the radiation limits given in DOE Order 458.1, Change 2, *Radiation Protection of the Public and the Environment*, and are much lower than those from background radiation.

Table 3–42. Radiation Doses to the Public from Idaho National Laboratory Operations, 2008 (Total Effective Dose Equivalent)

Members of the Public	Atmospheric Releases[a]	Liquid Releases[b]	Total[c]
Maximally exposed individual (millirem)	0.13	–	0.13
Population within 80 kilometers (person-rem)[d]	0.78	–	0.78
Average individual within 80 kilometers (millirem)[d]	0.0026	–	0.0026

a DOE Order 458.1, Change 2, invokes the Clean Air Act regulations (40 CFR 61, Subpart H), which established a compliance limit of 10 millirem per year to a maximally exposed individual.

b No dose is calculated because no surface water flows off Idaho National Laboratory and no Idaho National Laboratory radionuclides have been detected in offsite drinking water wells.

c DOE Order 458.1, Change 2, establishes an all-pathways dose limit of 100 millirem per year to an individual member of the public.

d The collective population dose is based on an estimated 2008 population of 300,656. The average individual dose is obtained by dividing the population dose by the number of people in the population.

Note: To convert kilometers to miles, multiply by 0.6214.

Source: DOE 2009a:8.8.

Given a risk estimator of 600 cancer deaths per 1 million person-rem to the public (see Appendix K, Section K.1.1.6), the fatal cancer risk to the MEI due to radionuclide releases from INL operations in 2008 is estimated to be 8.0×10^{-8}. That is, the estimated probability of this person dying of cancer at some point in the future from radiological exposure associated with 1 year of INL operations is 1 in 13 million (it takes many years from the time of radiological exposure for a cancer to manifest itself). The hypothetical MEI is a person whose residence and lifestyle make it unlikely that any other member of the public would receive a higher radiation dose from INL releases. This person is assumed to be exposed to radionuclides in the air and on the ground from INL emissions and to ingest locally grown food.

According to the same risk estimator, 5×10^{-4} excess fatal cancers are projected in the population living within 80 kilometers (50 miles) of INL from normal operations in 2008. To place this number in perspective, it may be compared with the number of fatal cancers expected in the same population from all causes. The mortality rate associated with cancer for the entire U.S. population is 0.2 percent per year. On this basis, the number of fatal cancers expected from all causes in the population living within 80 kilometers (50 miles) of INL in 2008 would be 601. This number is much higher than the number of fatal cancers estimated from INL operations in 2008.

Members of the public may also be exposed to radioactivity through the consumption of wildlife that has access to INL. A member of the public would receive a maximum potential radiation dose of about 0.052 millirem per year from eating 225 grams (8 ounces) of waterfowl that have used the radioactive wastewater ponds on the site. One of the game animals (a mule deer) collected during 2008 had a high concentration of cesium-137 in the muscle, a concentration that could deliver a dose of approximately 0.23 millirem to someone who ate 27,000 grams (952 ounces) of muscle and 500 grams (18 ounces) of liver from the animal (DOE 2009a:8.9, 8.10).

INL workers receive the same dose as the general public from background radiation, but they also receive an additional dose from working in facilities with nuclear materials. The average dose to the individual worker and the cumulative dose to all workers at INL from operations in recent years are presented in Table 3–43. Given a risk estimator of 0.0006 LCFs per person-rem among workers (see Appendix K, Section K.1.1.6), the calculated number of LCFs among INL workers from normal operations exposures in 2009 was 0.07.

Table 3–43. Radiation Doses to Workers from Idaho National Laboratory Normal Operations (Total Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation					
	Standard[a]	**2005**	**2006**	**2007**	**2008**	**2009**
Average radiation worker (millirem)	5,000	88	80	71	61	61
Total of all radiation workers (person-rem)[b]	**None**	**181.6**	**161.7**	**133.7**	**120.1**	**111.2**

[a] No standard is specified for an "average radiation worker"; however, the maximum dose to a worker is limited as follows: The radiation limit for an individual worker is 5,000 millirem per year (10 CFR 835). However, DOE's goal is to maintain radiological exposure as low as is reasonably achievable. DOE has therefore established the Administrative Control Level of 2,000 millirem per year; the site contractor sets facility administrative control levels below the DOE level, with 500 millirem per year considered a reasonable goal for trained radiation workers.

[b] There were 2,054 workers with measurable doses in 2005, 2,023 in 2006, 1,871 in 2007, 1,957 in 2008, and 1,808 in 2009.

Note: Total radiation worker dose presented in the table differs from that calculated from data shown due to rounding.

Key: DOE=U.S. Department of Energy.

Source: 10 CFR 835.202; DOE Standard 1098-2008, Change Notice 1; DOE 2008b:3-10; 2009b:3-10; 2010b:3-10.

3.3.10.2 Chemical Environment

The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (e.g., soil through direct contact or via the food pathway).

Adverse health impacts on the public are minimized through administrative and design controls to decrease hazardous chemical releases to the environment and to achieve compliance with permit requirements. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts on the public may occur during normal operations at INL via inhalation of air containing hazardous chemicals released to the atmosphere by INL operations. Risks to public health from ingestion of contaminated drinking water or direct exposure are potential pathways; the water pathway is considered an unlikely source of exposure at INL because no surface water flows off the site and radioactive contaminants have not been found in drinking water wells offsite (DOE 2009a:8.2).

Baseline air emission concentrations for air pollutants and their applicable standards are presented in Section 3.3.4. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are compared with applicable guidelines and regulations.

Chemical exposure pathways to INL workers during normal operations may include inhalation, the drinking of INL potable water, and physical contact with hazardous materials associated with work assignments. Workers are protected from hazards specific to the workplace through appropriate training, personal protective equipment, monitoring, and management controls. INL workers are also protected by adherence to Occupational Safety and Health Administration and EPA occupational standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals. Monitoring that reflects the frequency and amounts of chemicals used in the operational processes ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at INL are substantially better than required by standards.

3.3.10.3 Health Effect Studies

Epidemiological studies were conducted on communities surrounding INL to determine whether there were excess cancers in the general population. The studies discussed are representative of the health effects studies that have been performed for the impacts on the public and workers at INL. In 1991, INL completed a 3-year effort to evaluate historical releases of radioactive materials and potential doses to a hypothetical individual who may have resided at an offsite location with the highest concentration of airborne radionuclides. The evaluation found that "radiation doses from airborne releases over the operating history of INL were small compared with doses from background radiation" (CDC 2005a). No excess cancer mortality was reported, and although excess cancer incidence was observed, no association with INL was established. A study by the State of Idaho completed in June 1996 found excess brain cancer incidence in the six counties surrounding INL, but a followup survey concluded that there was nothing that clearly linked all these cases to one another or to any one thing (DOE 2002h:4-149).

Two recent health effects studies of INL-related impacts were conducted by agencies of the U.S. Department of Health and Human Services. The *Public Health Assessment: Idaho National Engineering and Environmental Laboratory*, performed by the Agency for Toxic Substances and Disease Registry, focused on INL (formerly the Idaho National Engineering and Environmental Laboratory) operations from 1987 to 2000. It was published in March 2004 and concluded that "under normal operating conditions, INL poses no past, current, or future apparent public health hazard for the surrounding community" (ATSDR 2004). A dose reconstruction was completed by the Centers for Disease Control and Prevention in 2004 as a follow-on to DOE's 1991 evaluation of potential doses from the Aircraft Nuclear Propulsion Program Initial Engine Test series and the Idaho Chemical Processing Plant. The study by the Centers for Disease Control and Prevention also found that the calculated doses "were small and not sufficient to cause human health effects" (CDC 2005a).

Under a DOE–Centers for Disease Control and Prevention cooperative agreement, an epidemiological study evaluated a group of workers at DOE's Hanford, INL, and Oak Ridge sites for evidence of a connection between paternal exposure to ionizing radiation and childhood leukemia. This study yielded no evidence of such a link (Sever et al. 1997).

The National Institute for Occupational Safety and Health reported on an epidemiologic study of mortality and radiation-related risk of cancer among INL workers in 2005. The study concerned over 63,000 civilian workers employed at INL between 1949 and 1991. It concluded that mortality risk for most causes of death was lower among INL workers than the regional population; however, the cancer mortality rate was slightly elevated among workers, but for most cancer types was not likely related to ionizing radiation. The study showed some evidence of a link between workplace radiological exposures and the risk of brain cancer, leukemia, and lymphatic cancers. The study also found elevated rates of mortality for asbestos-related diseases, particularly among asbestos workers (CDC 2005b).

In 1997, DOE began providing free medical screening for former and current workers at certain DOE sites, including INL. The goal of this program, which is ongoing, is to detect work-related illnesses at an early stage when medical intervention may be helpful. It also helps workers determine if a current health condition is the result of work-related exposure (WHPP 2008).

3.3.10.4 Accident History

Since the early 1950s, there have been eight criticality accidents at INL (DOE 2002h:4-150). Those accidents occurred during processing, control-rod maintenance, critical experiment setups, and intentional destructive power excursions. Accidents connected with experiments typically involved power excursions that were significantly larger than expected. The accidents at the site resulted in various levels of radiological exposure to the involved workers and in impacts on equipment ranging from little or no damage to total loss. Exposure of the public from these accidents was minimal.

As described in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a), DOE conducted a historical dose evaluation study to estimate the offsite radiation doses for the entire operating history of INL (Wenzel, Peterson, and Dickson 1993). Radionuclide releases resulted from a variety of tests and experiments, as well as a few accidents. The study concluded that the offsite radiation doses from operations and accidents were small compared with doses from background radiation. Releases have declined in frequency and size since the time of the study; in fact, for more than a decade of INL operation, there have been no serious unplanned releases of radioactivity or other hazardous substances.

Incidents with worker health implications over the period from 2000 through June 2010, as identified through Occurrence Reporting and Processing System records (DOE 2007a, 2010c), include the following:

- Fifteen workers were exposed during waste handling operations at the AMWTP. The highest estimated committed effective dose received was 84 millirem, but the majority of workers received estimated committed effective doses of less than 30 millirem (June 2010).
- Workers tripped or slipped and fell, suffering broken bone(s) (June 2004, July 2004, February 2006, March 2006, June 2006, August 2006, January 2007, February 2007, March 2008, November 2008, March 2009, August 2009, November 2009, January 2010, February 2010, March 2010).
- Workers received electrical shocks (March 2001, September 2001, November 2004, December 2004, March 2005, April 2006, June 2007, August 2009, November 2009, December 2009, February 2010).
- A worker was exposed to respirable quartz in excess of occupational safety limits (July 2002, May 2009).
- A worker was exposed to radiation, with an estimated dose to the left hand of 57 millirem and a dose to the right hand of 30 millirem (January 2009).
- Workers' skins were contaminated, with subsequent decontamination being successful (September 2000, October 2000, January 2001, March 2001, July 2001, September 2001, June 2003, June 2006, July 2006, January 2009).
- A worker severed a portion of a finger while using a paper cutter or saw (January 2006, September 2008).
- A worker was exposed to hexavalent chromium above the Occupational Safety and Health Administration permissible exposure limit while stick-welding stainless steel (August 2007).
- A worker suffered minor chemical burns (April 2003, December 2005).
- Workers were potentially exposed to asbestos during building maintenance activities (July 2004, June 2006).
- Two workers were exposed to noise levels above occupational safety limits during demolition activities (September 2005).
- A worker was exposed to methyl chloride, requiring medical attention (December 2003).

- A worker was exposed to crystalline silica in excess of occupational safety limits during work with bentonite (June 2005).
- A worker was exposed to iron oxide and manganese in excess of occupational safety limits (2001).
- Workers were exposed to unknown vapors/fumes in laboratory operations (April 2000).
- A worker was exposed to plutonium in the CPP-602 Laboratory, resulting in a committed effective dose equivalent of 5 millirem (March 2000).

3.3.10.5 Emergency Preparedness

Each DOE site has established an emergency management program that would be activated in the event of an accident. This program was developed and is maintained to ensure adequate response to most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program includes emergency planning, training, preparedness, and response.

Government agencies whose plans are interrelated with the INL emergency management program include the State of Idaho; Bingham, Bonneville, Butte, Clark, and Jefferson Counties; the U.S. Bureau of Indian Affairs; and the Fort Hall Indian Reservation. INL contractors are responsible for responding to emergencies at their facilities. Specifically, the Emergency Action Director is responsible for recognition, classification, notification, and protective action recommendations. At INL, emergency preparedness resources include fire protection from onsite and offsite locations and radioactive and hazardous chemical material response. Emergency response facilities include an emergency control center at each facility, at the INL Warning Communication Center, and at the INL Site Emergency Operations Center. Seven INL medical facilities are available to provide routine and emergency service. In addition, DOE has specified actions to be taken at all DOE sites to implement lessons learned from the emergency response to an accidental explosion at Hanford in May 1997.

3.3.11 Environmental Justice

The scope of the discussion of environmental justice in this *TC & WM EIS* is stipulated in Section 3.2.11. During preparation of this *TC & WM EIS*, risks and consequences of both normal operations and accidents were evaluated in terms of potential releases of contaminants from various candidate facilities at INL. Potential release points at INL include INTEC and the MFC.

3.3.11.1 Minority Populations

The 80-kilometer (50-mile) radius surrounding the candidate facilities at INL encompasses parts of 15 counties: Bannock, Bingham, Blaine, Bonneville, Butte, Caribou, Clark, Custer, Fremont, Jefferson, Lemhi, Lincoln, Madison, Minidoka, and Power Counties in the state of Idaho. Tables 3–44 and 3–45 provide a breakdown of minority populations in the potentially affected counties and the state of Idaho in 1990 and 2000. The total population of the 15-county area experienced an increase of approximately 14 percent from 1990 to 2000. During that decade, the total minority population in that area increased by approximately 63 percent; individuals who self-identified as Hispanic or Latino, by approximately 65 percent; and the American Indian and Alaska Native population, by approximately 15 percent. From 1990 to 2000, the total population of Idaho increased approximately 29 percent. The total minority population in the state increased by approximately 98 percent; the American Indian and Alaska Native population, by approximately 28 percent; and people self-identified as Hispanic or Latino, by over 92 percent.

Table 3–44. Populations in Potentially Affected Counties Surrounding the Idaho National Laboratory and in the State of Idaho, 1990

Population Group	Counties Around Idaho National Laboratory		Idaho	
	Population	Percentage of Total	Population	Percentage of Total
Nonminority				
White non-Hispanic	265,901	91.1	928,661	92.2
Minority				
Black or African American[a]	900	0.3	3,370	0.3
American Indian, Eskimo, or Aleut[a]	5,592	1.9	13,780	1.4
Asian or Pacific Islander[a]	2,361	0.8	9,365	0.9
Some other race[a]	10,704	3.7	29,783	3.0
White Hispanic	6,494	2.2	21,790	2.2
Total Minority	**26,051**	**8.9**	**78,088**	**7.8**
Total Hispanic or Latino[b]	**17,900**	**6.1**	**52,927**	**5.3**
Total	**291,952**	**100.0**	**1,006,749**	**100.0**

[a] Includes individuals who identified themselves as Hispanic or Latino.

[b] Includes all individuals who identified themselves as Hispanic or Latino, regardless of race.

Source: Census 2007a.

Table 3–45. Populations in Potentially Affected Counties Surrounding the Idaho National Laboratory and in the State of Idaho, 2000

Population Group	Counties Around Idaho National Laboratory		Idaho	
	Population	Percentage of Total	Population	Percentage of Total
Nonminority				
White non-Hispanic	289,942	87.2	1,139,291	88.0
Minority				
Black or African American[a]	1,181	0.4	5,456	0.4
American Indian and Alaska Native[a]	6,423	1.9	17,645	1.4
Asian[a]	2,197	0.7	11,889	0.9
Native Hawaiian and Other Pacific Islander[a]	299	0.1	1,308	0.1
Some other race[a]	17,188	5.2	54,742	4.2
Two or more races[a]	5,607	1.7	25,609	2.0
White Hispanic	9,546	2.9	38,013	2.9
Total Minority	**42,441**	**12.8**	**154,662**	**12.0**
Total Hispanic or Latino[b]	**29,492**	**8.9**	**101,690**	**7.9**
Total	**332,383**	**100.0**	**1,293,953**	**100.0**

[a] Includes individuals who identified themselves as Hispanic or Latino.

[b] Includes all individuals who identified themselves as Hispanic or Latino, regardless of race.

Source: Census 2007b.

Table 3–46 contains a breakdown of minority populations in the surrounding 15-county area and the State of Idaho according to the *2010 Decennial Census* (Census 2011a). These data show that the total population of the 15-county area had increased by approximately 16 percent since the 2000 census. During that same period, the total minority population increased by approximately 51 percent; the number of people self-identified as Hispanic or Latino, by approximately 62 percent; and the American Indian and Alaska Native Population, by approximately 17 percent. The White Hispanic population experienced the largest population increase in the 15-county area at approximately 107 percent, followed by the total Hispanic population at 62 percent, and the Black or African American population and the Native Hawaiian and Other Pacific Islander population at approximately 52 percent each. The State of Idaho experienced trends in population growth similar to those observed in the potentially affected 15-county area. The total population of Idaho increased by approximately 21 percent; the total minority population, by approximately 63 percent; people self-identified as of Hispanic or Latino origin, by approximately 73 percent; and the American Indian and Alaska Native population, by approximately 22 percent. Similar to that of the 15-county area, the White Hispanic population of the state experienced the largest population increase at approximately 111 percent, followed by the Black or African American population at approximately 80 percent and the total Native Hawaiian and Other Pacific Islander population at approximately 77 percent.

Table 3–46. Populations in Potentially Affected Counties Surrounding the Idaho National Laboratory and in the State of Idaho, 2010

Population Group	Counties Around Idaho National Laboratory		Idaho	
	Population	Percentage of Total	Population	Percentage of Total
Nonminority				
White non-Hispanic	322,969	83.4	1,316,243	84.0
Minority				
Black or African American[a]	1,798	0.5	9,810	0.6
American Indian and Alaska Native[a]	7,494	1.9	21,441	1.4
Asian[a]	3,092	0.8	19,069	1.2
Native Hawaiian and Other Pacific Islander[a]	455	0.1	2,317	0.1
Some other race[a]	23,654	6.1	79,523	5.1
Two or more races[a]	7,959	2.1	38,935	2.5
White Hispanic	19,787	5.1	80,244	5.1
Total Minority	**64,239**	**16.6**	**251,339**	**16.0**
Total Hispanic or Latino[b]	**47,695**	**12.3**	**175,901**	**11.2**
Total	**387,208**	**100.0**	**1,567,582**	**100.0**

[a] Includes individuals who identified themselves as Hispanic or Latino.

[b] Includes all individuals who identified themselves as Hispanic or Latino, regardless of race.

Source: Census 2011a.

3.3.11.1.1 Idaho Nuclear Technology and Engineering Center

According to the *2010 Decennial Census* (Census 2011a), approximately 152,500 people resided within an 80-kilometer (50-mile) radius of INTEC. In this area, minority populations accounted for approximately 19 percent of the total population. Those who identified themselves as Hispanic or Latino were the largest minority group, constituting about 74 percent of the minority population and approximately 14 percent of the total population. Table 3–47 shows a breakdown of the population within 80 kilometers (50 miles) of INTEC.

Table 3–47. Populations Within 80 Kilometers of INTEC at Idaho National Laboratory, 2010

Population Group	Population	Percentage of Total
Nonminority		
White non-Hispanic	124,085	81.4
Minority		
Black or African American[a]	677	0.4
American Indian and Alaska Native[a]	4,068	2.7
Asian[a]	1,126	0.7
Native Hawaiian and Other Pacific Islander[a]	123	0.1
Some other race[a]	10,655	7.0
Two or more races[a]	3,233	2.1
White Hispanic	8,470	5.6
Total Minority	**28,408**	**18.6**
Total Hispanic or Latino[b]	**21,006**	**13.8**
Total	**152,493**	**100.0**

[a] Includes individuals who identified themselves as Hispanic or Latino.

[b] Includes all individuals who identified themselves as Hispanic or Latino, regardless of race.

Note: To convert kilometers to miles, multiply by 0.6214. Total may not equal the sum of the contributions due to rounding.

Key: INTEC=Idaho Nuclear Technology and Engineering Center.

Source: Census 2011a.

Figures 3–39 and 3–40 illustrate minority populations as a function of distance from INTEC. Block-group data generated from the *2010 Decennial Census* (Census 2011a) reflect an estimated total population of 152,493. Sharp spikes in populations can be seen around the outskirts of large population centers. However, large spikes did not occur until a point about 64 kilometers (40 miles) away, in the vicinity of Idaho Falls. The next significant jump occurred at approximately 76 kilometers (47 miles), near Pocatello. Approximately 15 percent of the minority population live within 58 kilometers (36 miles) of INTEC, and approximately 50 percent within 71 kilometers (44 miles). It is estimated that 14 percent of the population living within the potentially affected 80-kilometer (50-mile) radius of INTEC were self-identified as Hispanic or Latino.

Figure 3–41 shows meaningfully greater minority and nonminority populations living in block groups surrounding INTEC. Over 87 percent of the minority populations lived in two Idaho counties: Bingham and Bonneville; approximately 49 percent were concentrated in Bonneville County. Of the 127 block groups surrounding INTEC, 11 contained meaningfully greater minority populations.

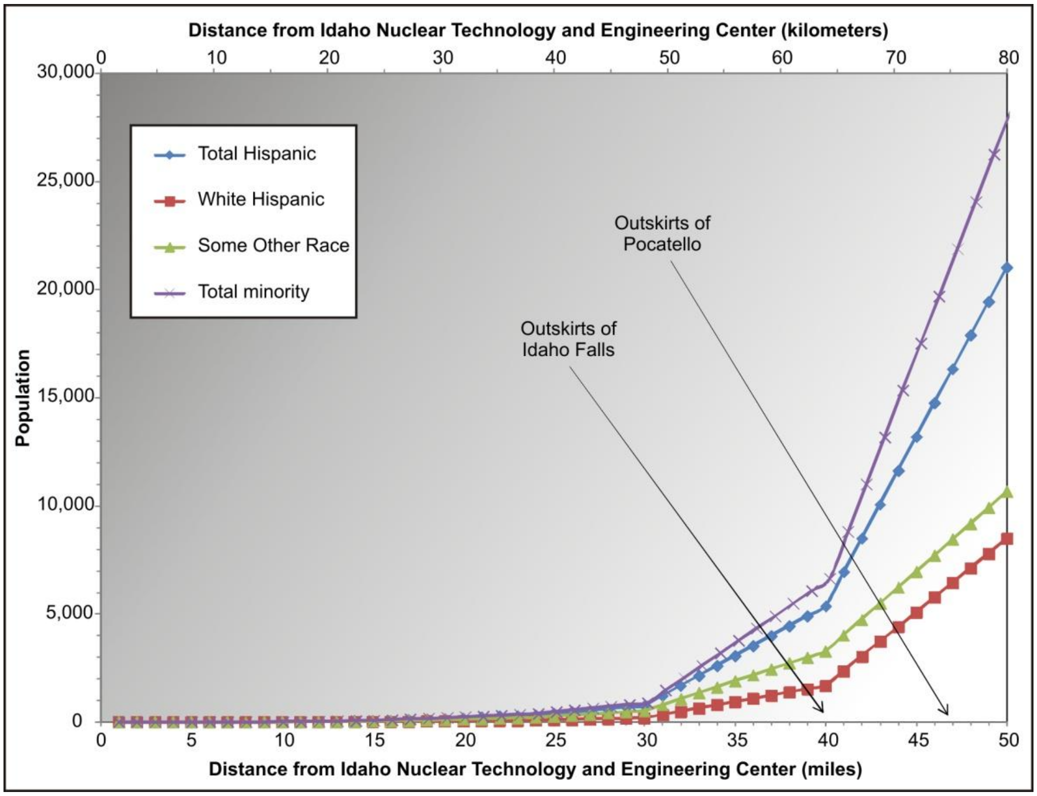


Figure 3–39. Cumulative Larger-Scale Minority Populations Surrounding INTEC at Idaho National Laboratory as a Function of Distance

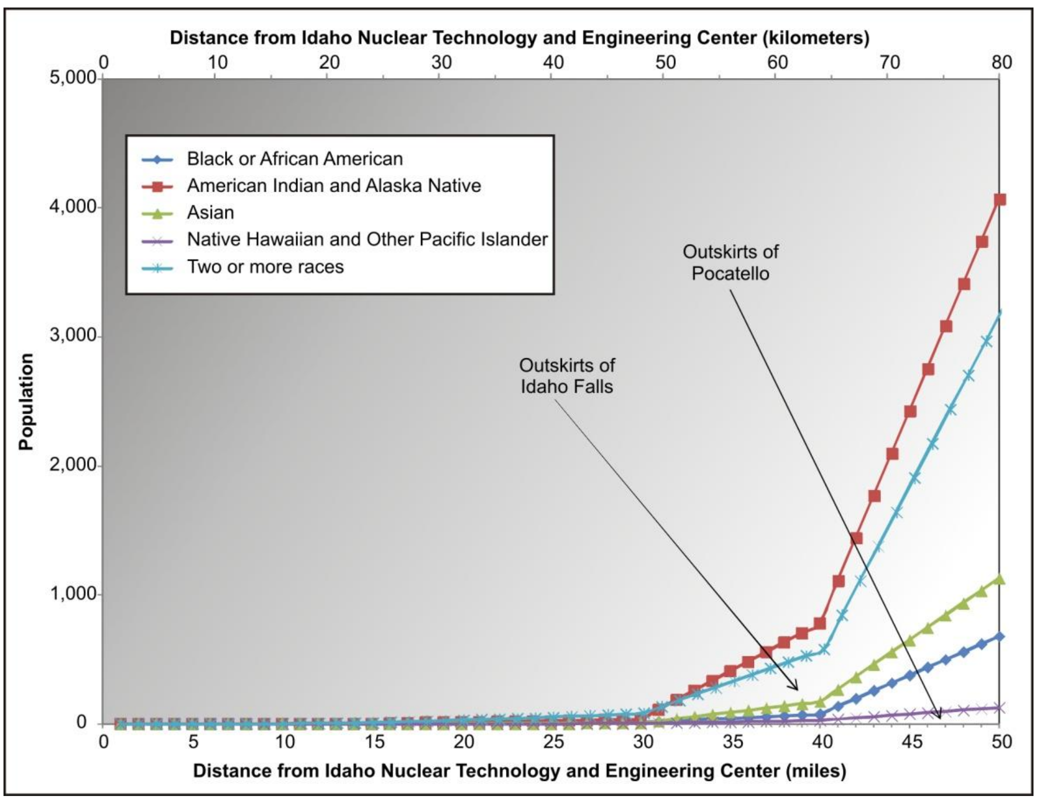


Figure 3–40. Cumulative Smaller-Scale Minority Populations Surrounding INTEC at Idaho National Laboratory as a Function of Distance

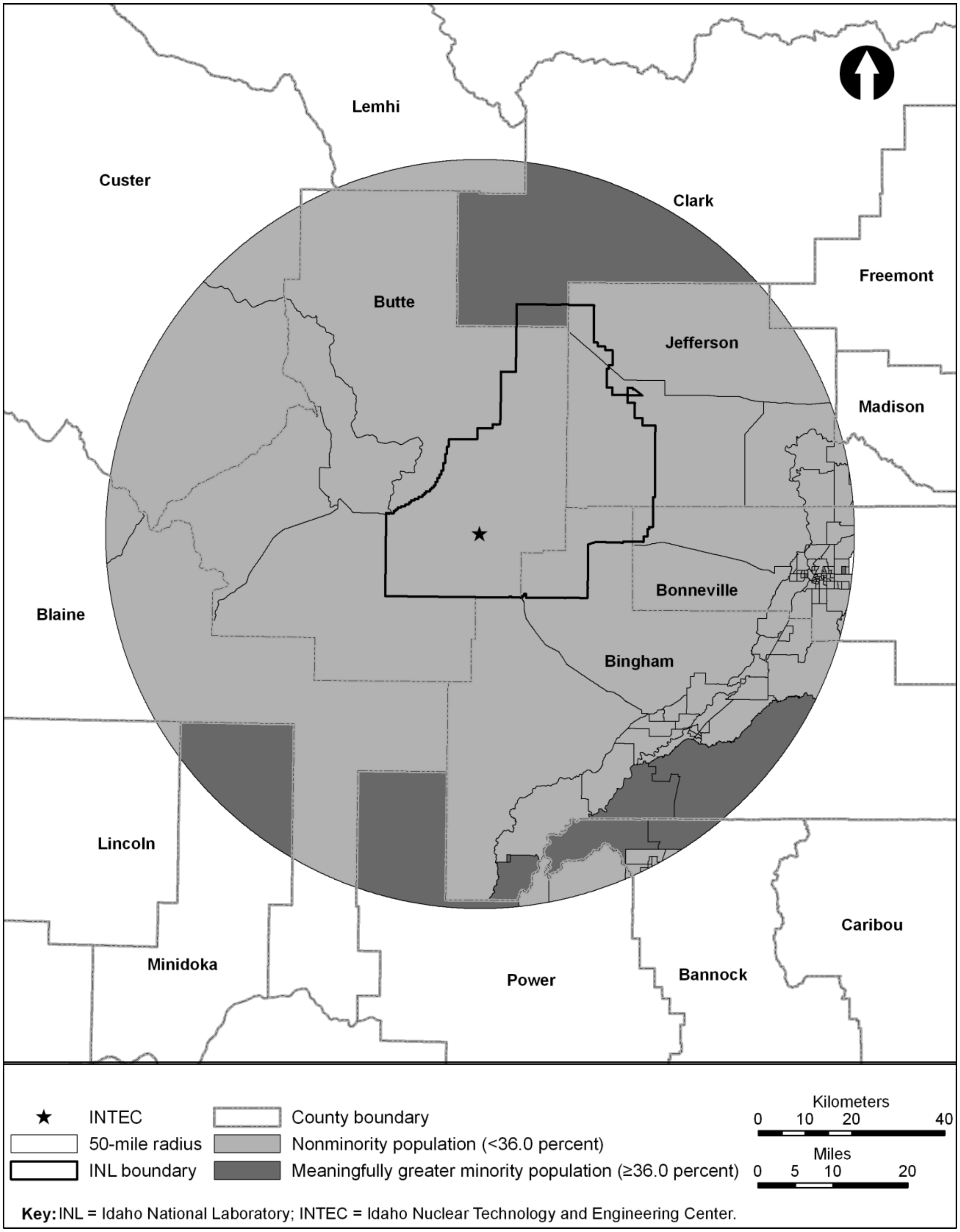


Figure 3–41. Meaningfully Greater Minority and Nonminority Populations Living in Block Groups Surrounding INTEC at Idaho National Laboratory

3.3.11.1.2 Materials and Fuels Complex

According to the *2010 Decennial Census* (Census 2011a), approximately 250,800 people resided within an 80-kilometer (50-mile) radius of the MFC. In this area, minority populations accounted for approximately 16 percent of the total population. Those who identified themselves as Hispanic or Latino were the largest minority group, constituting about 70 percent of the minority population and approximately 11 percent of the total population. Table 3–48 shows a breakdown of the population within 80 kilometers (50 miles) of the MFC.

Table 3–48. Populations Within 80 Kilometers of the Materials and Fuels Complex at Idaho National Laboratory, 2010

Population Group	Population	Percentage of Total
Nonminority		
White non-Hispanic	211,541	84.3
Minority		
Black or African American[a]	1,079	0.4
American Indian and Alaska Native[a]	5,763	2.3
Asian[a]	2,057	0.8
Native Hawaiian and Other Pacific Islander[a]	276	0.1
Some other race[a]	13,345	5.3
Two or more races[a]	5,124	2.0
White Hispanic	11,525	4.6
Total Minority	**39,297**	**15.7**
Total Hispanic or Latino[b]	**27,634**	**11.0**
Total	**250,838**	**100.0**

[a] Includes individuals who identified themselves as Hispanic or Latino.

[b] Includes all individuals who identified themselves as Hispanic or Latino, regardless of race.

Note: To convert kilometers to miles, multiply by 0.6214. Total may not equal the sum of the contributions due to rounding.

Source: Census 2011a.

Figures 3–42 and 3–43 illustrate minority populations as a function of distance from the MFC. Block-group data generated from the *2010 Decennial Census* (Census 2011a) reflect an estimated total population of 250,838. Sharp spikes in populations can be seen around the outskirts of large population centers. However, large spikes did not occur until a point about 48 kilometers (30 miles) away, in the vicinity of Idaho Falls. The next significant jump occurred at approximately 72 kilometers (45 miles), near Pocatello. Approximately 10 percent of the minority population live within 47 kilometers (29 miles) of the MFC, and approximately 50 percent, within 56 kilometers (35 miles). It is estimated that approximately 11 percent of the population living within the potentially affected 80-kilometer (50-mile) radius of the MFC were self-identified as Hispanic or Latino.

Figure 3–44 shows meaningfully greater minority and nonminority populations living in block groups surrounding the MFC. Approximately 82 percent of the minority populations lived in three Idaho counties: Bannock, Bingham, and Bonneville; approximately 39 percent were concentrated in Bonneville County. Of the 184 block groups surrounding the MFC, 11 contained meaningfully greater minority populations.

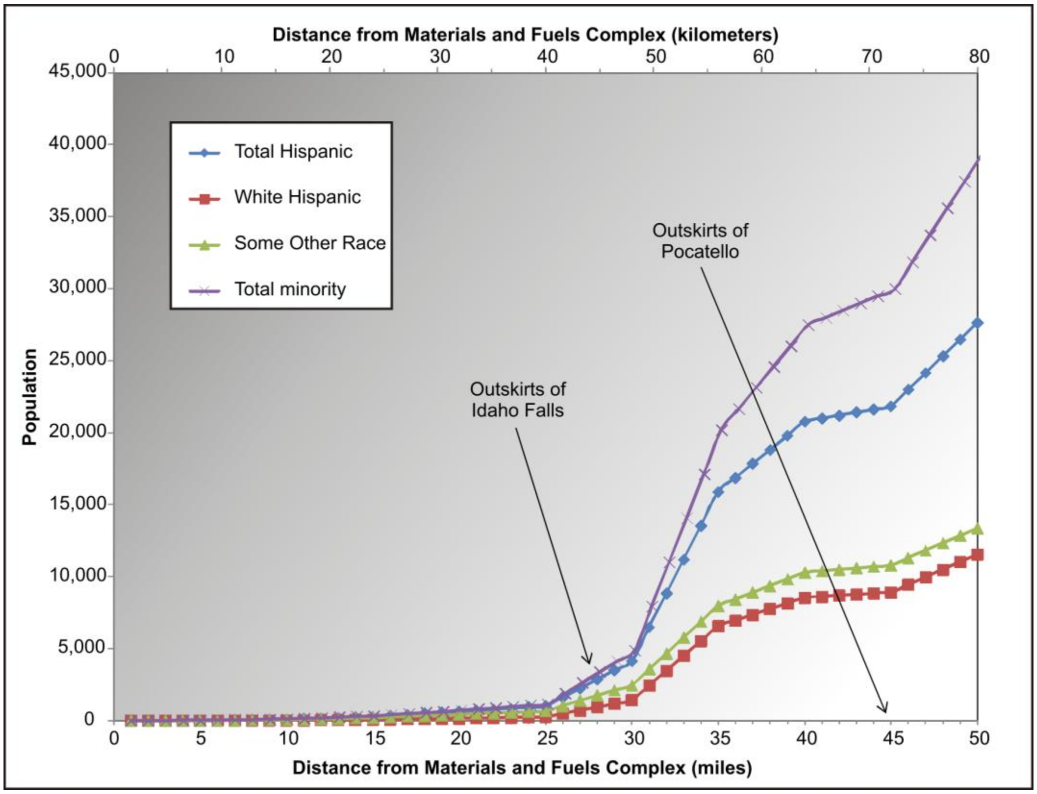


Figure 3–42. Cumulative Larger-Scale Minority Populations Surrounding the Materials and Fuels Complex at Idaho National Laboratory as a Function of Distance

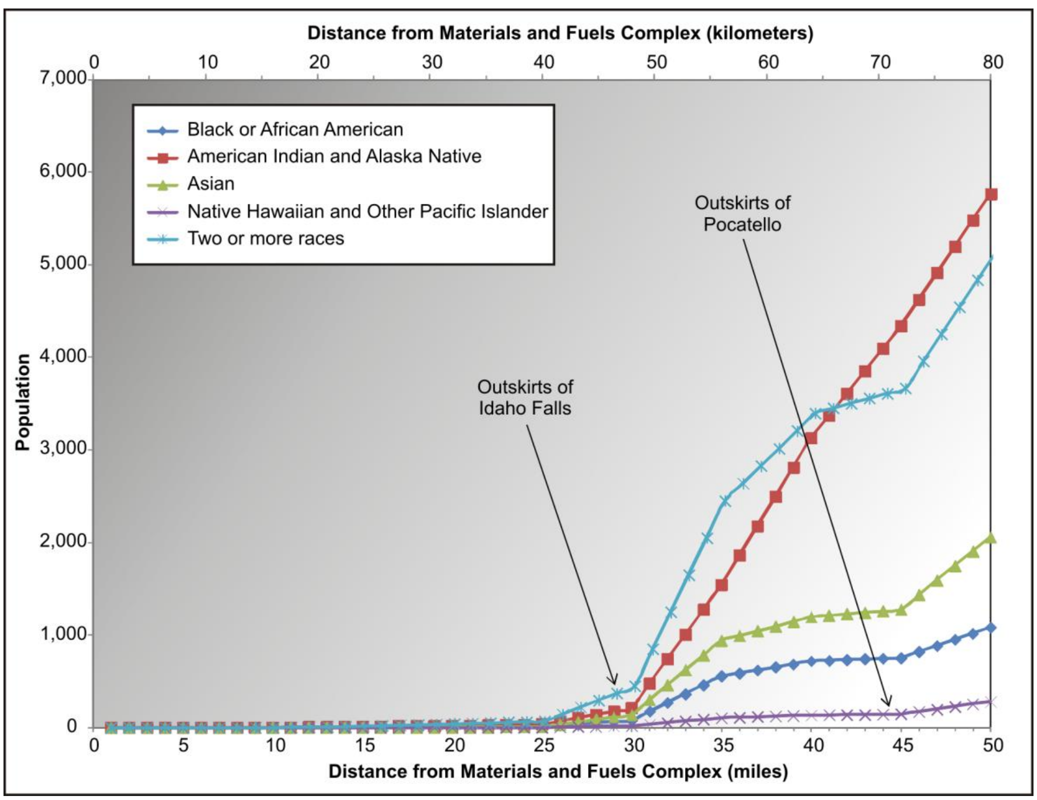


Figure 3–43. Cumulative Smaller-Scale Minority Populations Surrounding the Materials and Fuels Complex at Idaho National Laboratory as a Function of Distance

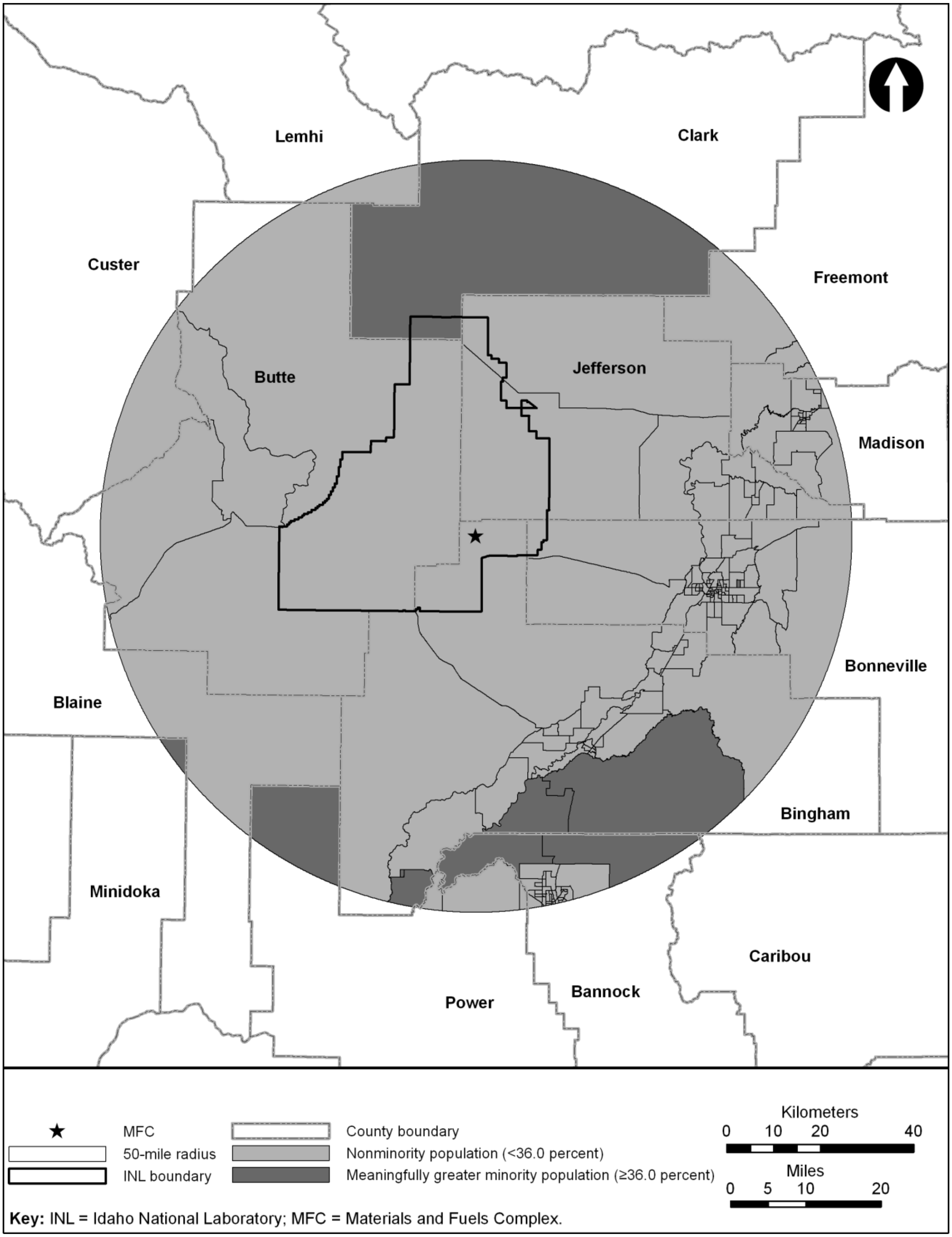


Figure 3–44. Meaningfully Greater Minority and Nonminority Populations Living in Block Groups Surrounding the Materials and Fuels Complex at Idaho National Laboratory

3.3.11.2 Low-Income Populations

Tables 3–49 and 3–50 show the total and low-income populations in the 15-county area surrounding INL and in the state of Idaho in 1989 and 1999, respectively. From 1989 to 1999, the total population of the 15-county area surrounding INL increased by approximately 14 percent, while the low-income population increased by approximately 11 percent. Over the same period, the total population of Idaho increased by approximately 28 percent, and the low-income population, by approximately 14 percent.

Table 3–49. Total and Low-Income Populations in the Potentially Affected 15-County Area Surrounding Idaho National Laboratory and in the State of Idaho, 1989

Population Group	Counties Surrounding Idaho National Laboratory		Idaho	
	Population	Percentage of Total	Population	Percentage of Total
Total population	287,513	100.0	985,553	100.0
Low-income population	40,056	13.9	130,588	13.3

Note: The total population values used for the low-income comparison are lower than those used for the minority comparisons because the U.S. Census Bureau data relative to income do not take into account those people who live in institutions (e.g., college dormitories, rooming houses, religious group homes, communes, halfway houses).
Source: Census 2007c.

Table 3–50. Total and Low-Income Populations in the Potentially Affected 15-County Area Surrounding Idaho National Laboratory and in the State of Idaho, 1999

Population Group	Counties Surrounding Idaho National Laboratory		Idaho	
	Population	Percentage of Total	Population	Percentage of Total
Total population	326,438	100.0	1,263,205	100.0
Low-income population	44,516	13.6	148,732	11.8

Note: The total population values used for the low-income comparison are lower than those used for the minority comparisons because the U.S. Census Bureau data relative to income do not take into account those people who live in institutions (e.g., college dormitories, rooming houses, religious group homes, communes, halfway houses).
Source: Census 2007d.

Table 3–51 shows the total and low-income populations in the surrounding 15-county area and the state of Idaho according to the 2006–2010 ACS 5-year estimates (Census 2011c). These data show that the total population of the 15-county area had increased by approximately 13 percent, and the low-income population by approximately 18 percent, since the 2000 census. Over the same period, the state of Idaho saw an increase in total population of approximately 18 percent, with an increase in the low-income population of approximately 37 percent.

Table 3–51. Total and Low-Income Populations in the Potentially Affected 15-County Area Surrounding Idaho National Laboratory and in the State of Idaho, 2006–2010

Population Group	Counties Surrounding Idaho National Laboratory		Idaho	
	Population	Percentage of Total	Population	Percentage of Total
Total population	369,719	100.0	1,496,581	100.0
Low-income population	52,437	14.2	203,177	13.6

Note: The total population values used for the low-income comparison are lower than those used for the minority comparisons because the U.S. Census Bureau data relative to income do not take into account those people who live in institutions (e.g., college dormitories, rooming houses, religious group homes, communes, halfway houses).
Source: Census 2011c.

3.3.11.2.1 Idaho Nuclear Technology and Engineering Center

Table 3–52 shows the total and low-income populations within 80 kilometers (50 miles) of INTEC. According to the 2006–2010 ACS 5-year estimates (Census 2011c), low-income individuals constituted approximately 12 percent of the total population. Approximately 90 percent of the low-income population resided in Bonneville and Bingham Counties. Approximately 55 percent were concentrated in Bonneville County.

Table 3–52. Total and Low-Income Populations Within 80 Kilometers of INTEC at Idaho National Laboratory, 2006–2010

Population Group	Population	Percentage of Total
Total population	146,824	100.0
Low-income population	17,845	12.2

Note: The total population values used for the low-income comparison are lower than those used for the minority comparisons because the U.S. Census Bureau data relative to income do not take into account those people who live in institutions (e.g., college dormitories, rooming houses, religious group homes, communes, halfway houses).

To convert kilometers to miles, multiply by 0.6214.

Key: INTEC=Idaho Nuclear Technology and Engineering Center.

Source: Census 2011c.

Figure 3–45 shows the total, low-income, and non-low-income populations as a function of distance from INTEC. Block-group data generated from the 2006–2010 ACS 5-year estimates (Census 2011c) reflect a total population of 146,824 within an 80-kilometer (50-mile) radius of INTEC.

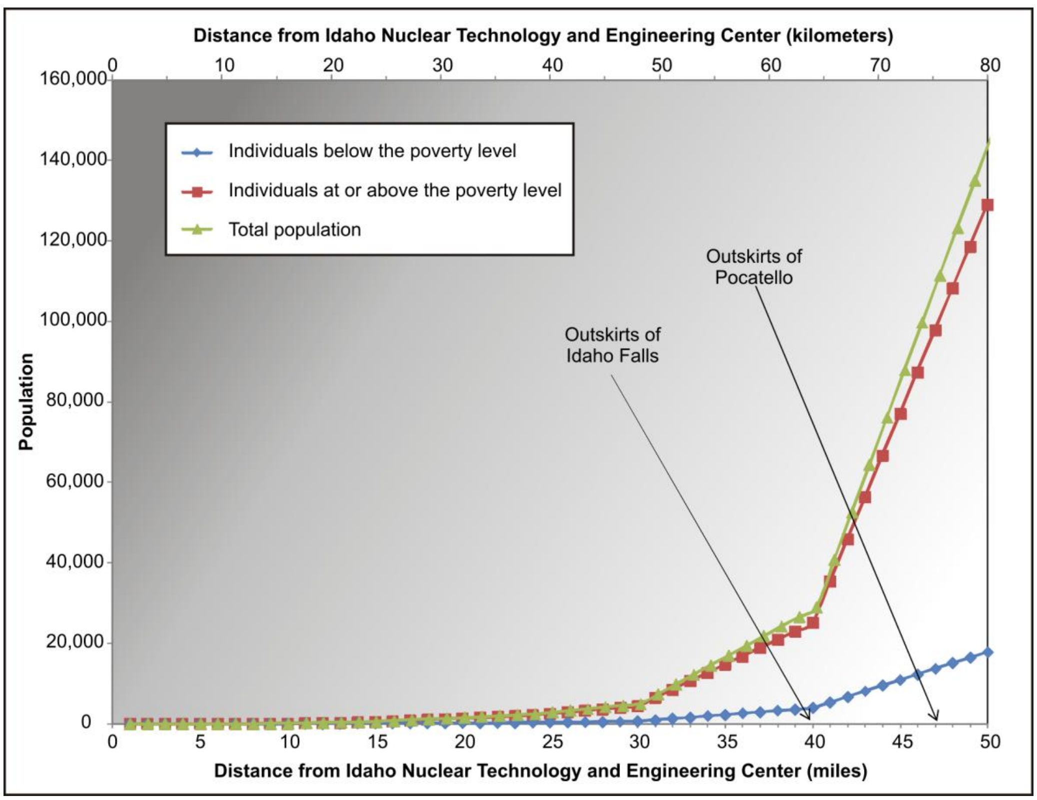


Figure 3–45. Low-Income and Non-Low-Income Populations Surrounding INTEC at Idaho National Laboratory as a Function of Distance

Figure 3–46 shows meaningfully greater low-income and non-low-income populations living in the block groups surrounding INTEC at INL. Of the 127 block groups surrounding INTEC, 4 contained meaningfully greater low-income populations.

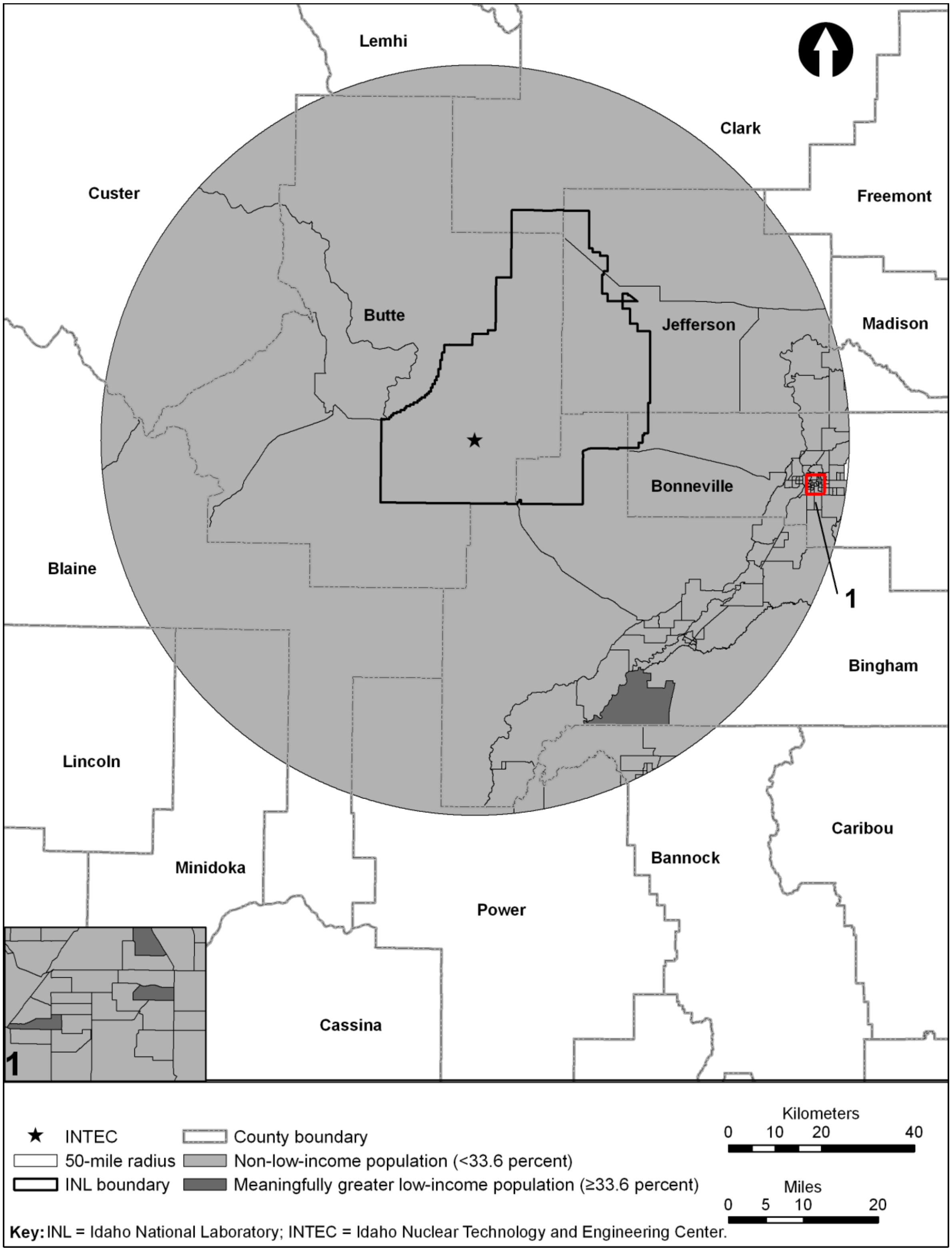


Figure 3–46. Meaningfully Greater Low-Income and Non-Low-Income Populations Living in Block Groups Surrounding INTEC at Idaho National Laboratory

3.3.11.2.2 Materials and Fuels Complex

Table 3–53 shows the total and low-income populations within 80 kilometers (50 miles) of the MFC. According to the 2006–2010 ACS 5-year estimates (Census 2011c), low-income individuals constituted approximately 14 percent of the total population. Approximately 91 percent of the low-income population resided in four counties; Bannock, Bingham, Bonneville and Madison; approximately 30 percent were concentrated in Madison County.

Table 3–53. Total and Low-Income Populations Within 80 Kilometers of the Materials and Fuels Complex at Idaho National Laboratory, 2006–2010

Population Group	Population	Percentage of Total
Total population	239,013	100.0
Low-income population	34,344	14.4

Note: The total population values used for the low-income comparison are lower than those used for the minority comparisons because the U.S. Census Bureau data relative to income do not take into account those people who live in institutions (e.g., college dormitories, rooming houses, religious group homes, communes, halfway houses).
To convert kilometers to miles, multiply by 0.6214.
Source: Census 2011c.

Figure 3–47 shows the total, low-income, and non-low-income populations as a function of distance from the MFC. Block-group data generated from the 2006–2010 ACS 5-year estimates (Census 2011c) reflect a total population of 239,013 within an 80-kilometer (50-mile) radius of the MFC.

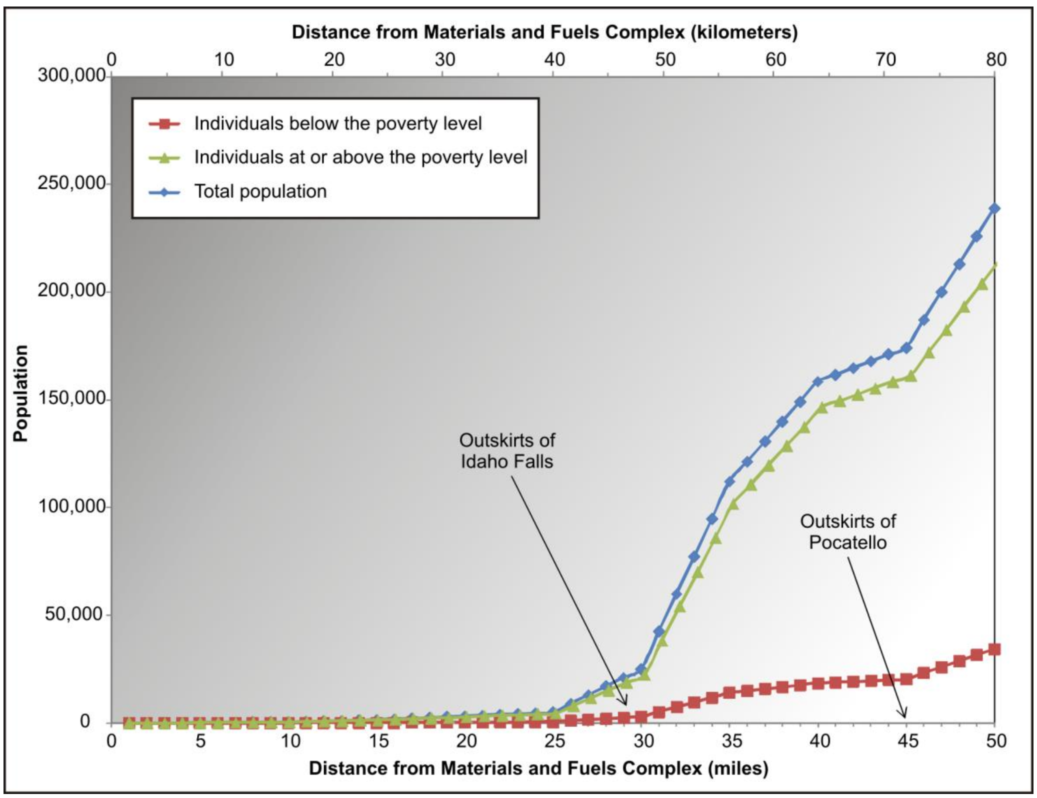


Figure 3–47. Low-Income and Non-Low-Income Populations Surrounding the Materials and Fuels Complex at Idaho National Laboratory as a Function of Distance

Figure 3–48 shows meaningfully greater low-income and non-low-income populations living in the block groups surrounding the MFC at INL. Of the 184 block groups surrounding the MFC, 13 contained meaningfully greater low-income populations.

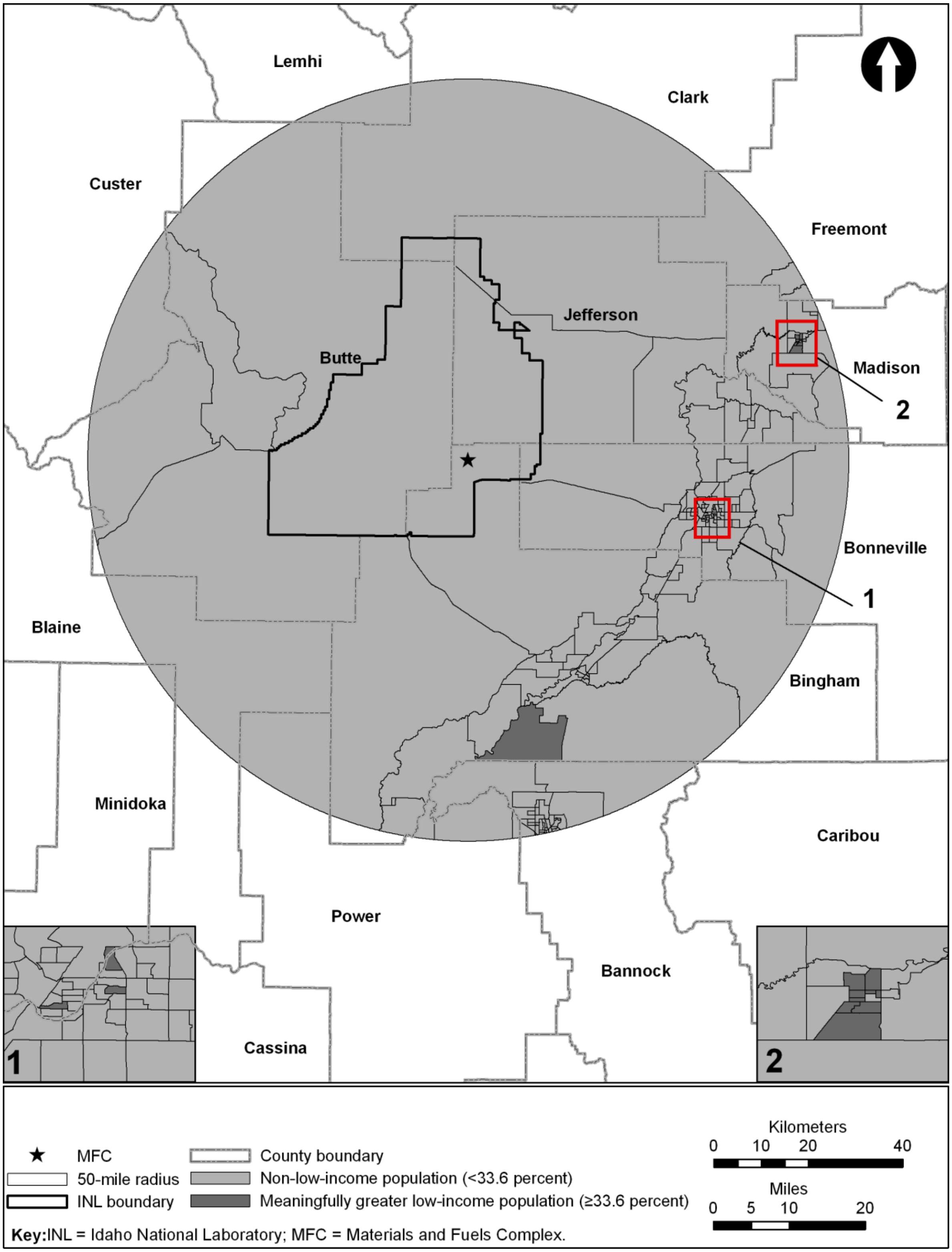


Figure 3–48. Meaningfully Greater Low-Income and Non-Low-Income Populations Living in Block Groups Surrounding the Materials and Fuels Complex at Idaho National Laboratory

3.3.12 Waste Management

The scope of the discussion of waste management in this *TC & WM EIS* is stipulated in Section 3.2.12.

3.3.12.1 Waste Inventories and Activities

INL manages the following types of waste: HLW, TRU waste, LLW, MLLW, hazardous waste, and nonhazardous waste. Because there is no HLW, TRU waste, or mixed TRU waste associated with the activities being assessed at INL under the action alternatives, these waste types are not discussed in this *TC & WM EIS*. Waste generation rates and the inventory of stored waste from activities at INL are provided in Table 3–54. INL waste management facilities are summarized in Table 3–55.

Table 3–54. Waste Generation Rates and Inventories at Idaho National Laboratory, 2006 (cubic meters)

Waste Type	Generation Rate	Inventory[a]
Transuranic[b]	185.77	51,530
Low-level radioactive	11,002	3,268
Mixed low-level radioactive	26,675	3,191
Hazardous[c]	320	88
Nonhazardous liquid[c]	78	25.81
Nonhazardous solid[c]	456	55.21

[a] Real volumes have been reported, but it must be noted that some waste streams are significantly larger due to the abatement of decontamination and decommissioning activities.

[b] Volumes include transuranic and mixed transuranic waste combined.

[c] Generally, such waste is not held in long-term storage.

Note: To convert cubic meters to cubic yards, multiply by 1.308.

Source: Willcox 2007.

3.3.12.1.1 Low-Level Radioactive Waste

Approximately 6,350 cubic meters (224,335 cubic feet) of legacy and newly generated LLW were disposed of at the Subsurface Disposal Area in 2008. The Subsurface Disposal Area is a 39-hectare (97-acre) disposal area at INL containing buried hazardous and radioactive waste (DOE 2009a:3.12, 3.16). In 2006, 11,002 cubic meters (388,525 cubic feet) of solid LLW was generated at INL (see Table 3–54).

Disposal of CH-LLW and open pit disposal of RH-LLW at the RWMC ceased September 30, 2008. The RH-LLW disposal vaults will remain open for the disposal of Naval Reactors RH-LLW through approximately the end of 2015 based on remaining disposal capacity. CH-LLW and RH-LLW previously disposed of in the open pit at RWMC will be disposed of at NNSS. INL is currently evaluating and pursuing options for uninterrupted RH-LLW disposal capability beyond 2015 (IDEQ 2000; INL 2008a).

Table 3–55. Waste Management Facilities at Idaho National Laboratory

Facility Name/Description	Facility Number	Process Design Capacity[a]	Status	Applicable Waste Types			
				TRU	LLW	MLLW	HAZ
Treatment Facility[a]							
NWCF Debris Treatment Process	CPP-659	60,020	Permitted			X	X
NWCF HEPA Filter Leach System	CPP-659	1,060	Permitted			X	X
Contaminated-Equipment Storage Building	MFC-794	56,780/Storage 1,666/Treatment	Permitted	X		X	X
Hot Fuel Examination Facility	MFC-785	40,598/Storage 1,666/Treatment	Permitted	X		X	X
Sodium Components Maintenance Shop	MFC-793	119,919/Storage 6,163/Treatment	Permitted			X	X
Transient Reactor Test Facility	MFC-720	26,649/Storage 1,666/Treatment	Permitted	X		X	X
Advanced Mixed Waste Treatment Project Waste Storage Facility	WMF-676	486,078	Permitted	X		X	
NWCF Storage	CPP-659	2,050,051 (containers) 791 cubic meters (waste pile)	Permitted			X	X
Radioactive Mixed Waste Staging Facility	CPP-1617	8,494,871	Permitted			X	X
SWEPP Storage Area	WMF-610	107,428/Storage 99,933/Treatment	Permitted	X	X	X	
Radioactive Scrap and Waste Facility	MFC-771	200,622	Permitted	X	X	X	X
Sodium Storage Building	MFC-703	181,696	Permitted			X	X
TSA Retrieval Enclosure Retrieval Modification Facility (includes the capacities for the TSA-1/TSA-R and TSA-2 storage units)	RWMC	16,810,415	Interim status	X		X	
Advanced Mixed Waste Treatment Project Waste Storage Facility	RWMC	76,791,396/Storage 99,933/Treatment	Permitted	X		X	
Fluorinel Dissolution Process Cell Container Storage	CPP-666	141,193	Permitted			X	X
Integrated Waste Treatment Unit	CPP-1696	640,766/Storage 19,078/Treatment	Permitted			X	
Sodium Process Facility Building	MFC-799	85,246/Storage 5,754/Treatment	Permitted			X	X
Experimental Breeder Reactor Complex	MFC	406,090/Storage 5.7 liters/day/tank	Permitted			X	

[a] Capacities expressed in liters unless otherwise noted.

Note: To convert cubic meters to cubic yards, multiply by 1.308; liters to gallons, multiply by 0.26417.

Key: CPP=Chemical Processing Plant; HAZ=hazardous; HEPA=high-efficiency particulate air; LLW=low-level radioactive waste; MFC=Materials and Fuels Complex; MLLW=mixed low-level radioactive waste; NWCF=New Waste Calcining Facility; RWMC=Radioactive Waste Management Complex; SWEPP=Stored Waste Examination Pilot Plant; TRU=transuranic; TSA=Transuranic Storage Area; TSA-1=TSA Pad 1; TSA-2=TSA Pad 2; TSA-R=TSA Pad R; WMF=Waste Management Facility.

Source: INL 2008b.

3.3.12.1.2 Mixed Low-Level Radioactive Waste

MLLW and polychlorinated biphenyl–contaminated LLW are stored at several onsite areas. Such waste is stored at the Radioactive Mixed Waste Staging Facility at INTEC and the RWMC. Smaller quantities are stored in various other facilities at INL, including the Radioactive Sodium Storage Facility and Radioactive Scrap and Waste Facility at the MFC.

As part of the *Idaho National Laboratory Site Treatment Plan* (DOE 2007d), a required plan for developing treatment capacities and technologies for each facility at which DOE generates or stores mixed waste, pursuant to RCRA, Section 3021(b), as amended by Section 105(b) of the Federal Facility Compliance Act, preferred options for treatment to eliminate the hazardous waste component of many types of MLLW have been identified. MLLW is or will be processed to RCRA land-disposal-restriction treatment standards through several treatment facilities. The specific facilities and their operational status are as follows: AMWTP, operational; debris treatment, operational; high-efficiency particulate air filter leaching, operational as needed; remote-handled waste disposition project, planned/DOE approved; Sodium Processing Facility, in standby; and Sodium Component Maintenance Shop, operational. Commercial treatment facilities are also being considered, as appropriate. Currently, INL ships MLLW for treatment to the following Perma-Fix Environmental Services, Inc., treatment facilities: Perma-Fix Florida, Gainesville, Florida; Material & Energy Corporation and Diversified Scientific Services, Inc., Kingston, Tennessee; and Perma-Fix Northwest, Richland, Washington. Waste treated at these facilities is currently sent to NNSS for disposal. A limited amount of MLLW is treated and disposed of at EnergySolutions of Utah.

The AMWTP characterizes and then sorts, sizes, repackages, and compacts mixed TRU waste. If during characterization, a retrieved container is assayed as not meeting the definition of TRU waste, it is determined to be mixed low-level waste. The overall goal of the AMWTP is to prepare TRU waste now buried or stored at INL for shipment to WIPP, a permanent geologic repository near Carlsbad, New Mexico. The facility will treat waste to meet the most current requirements; reduce waste volumes and life-cycle costs to DOE; and perform all tasks in a safe, environmentally compliant manner.

A contract for treatment services was awarded to British Nuclear Fuels Limited, Inc., in December 1996. British Nuclear Fuels Limited, Inc., completed construction of the AMWTP in December 2002, fulfilling a TPA milestone. AMWTP retrieval operations commenced in March 2003, and treatment facility operations commenced in August 2004. The British Nuclear Fuels Limited, Inc., contract was terminated effective April 30, 2005, and Bechtel BWXT Idaho, LLC, assumed operation of the AMWTP on May 1, 2005. Certification of the treatment facility was obtained in May 2005, allowing for certification of treated TRU waste and shipment thereof to WIPP. Treated TRU waste was first shipped from the AMWTP to WIPP on May 31, 2005.

In 2006 approximately 26,675 cubic meters (942,028 cubic feet) of MLLW was inventoried at INL. In addition to this waste, approximately 3,191 cubic meters (112,690 cubic feet) of MLLW was generated in 2006 (see Table 3–54) (Willcox 2007). DOE assumes that new facilities would be constructed if additional MLLW treatment and disposal capacity were needed (DOE 2002a).

3.3.12.1.3 Hazardous Waste

Approximately 1 percent of the total waste generated at INL (not including liquid nonhazardous waste) is hazardous waste. The average hazardous waste generation rate for the 5-year period 2000 through 2004 was approximately 420 cubic meters (14,830 cubic feet) per year (DOE 2005b). The waste generator normally holds hazardous waste in a temporary accumulation area (not identified as a "treatment facility" in Table 3–55) until it is shipped directly to the offsite commercial treatment facility. Most of the hazardous waste generated annually at INL is transported off site for treatment and disposal. Offsite shipments are surveyed to determine that the waste has no radiological content—i.e., it is not mixed waste. Highly reactive or unstable materials such as waste explosives are addressed case by case and managed on or off site consistent with regulatory requirements.

The operation of the AMWTP and the steam reforming technology for processing mixed TRU/sodium-bearing waste at INTEC would increase this generation rate minimally—i.e., less than 1 percent (DOE 1999c, 2002a).

3.3.12.1.4 Nonhazardous Waste

Approximately 90 percent of the solid waste generated at INL is classified as industrial waste and is disposed of on site in a landfill complex in the Central Facilities Area or off site at the Bonneville County landfill. The onsite landfill complex contains separate areas for petroleum-contaminated media, industrial waste, and asbestos waste. The landfill covers 4.9 hectares (12 acres) and is being expanded by 91 hectares (225 acres) to provide capacity for at least 30 years. The average annual volume of waste disposed of from 2000 through 2004 was approximately 40,000 cubic meters (1.41 million cubic feet) (DOE 2005b).

Sewage is disposed of in surface impoundments. Wastewater in the impoundments is allowed to evaporate, and the resulting sludge is placed in the landfill. Solids are separated and reclaimed where possible.

3.3.12.2 Waste Minimization

DOE-ID has an active waste minimization and pollution prevention program to reduce the total amount of waste generated and disposed of at INL. Waste is eliminated through source reduction or material substitution; the recycling of potential waste materials that cannot be minimized or eliminated; and the treatment of all waste generated to reduce its volume, toxicity, or mobility prior to storage or disposal. DOE-ID published its first *Waste Minimization Plan* in 1990, defining specific goals, methodologies, responsibilities, and achievements of programs and organizations. The mission of the waste minimization and pollution prevention program is to reduce, reuse, and recycle wastes generated and pollutants by implementing cost-effective pollution prevention techniques, practices, and policies. Pollution prevention is required by various Federal statutes, including, but not limited to, the Pollution Prevention Act, RCRA, and Executive Order 13423. Pollution prevention is one of the key underpinnings of the INL Site Environmental Management System. It functions as an important preventive mechanism because generating less waste reduces waste management costs, compliance vulnerabilities, and the potential for releases to the environment. INL is promoting the inclusion of pollution prevention into all planning activities, as well as the concept that pollution prevention is integral to mission accomplishment (DOE 2007c).

3.3.12.3 *WM PEIS* Records of Decision

The *WM PEIS* RODs affecting INL are shown in Table 3–56. Decisions on the various waste types were announced in a series of RODs following publication of the *WM PEIS* (DOE 1997b). The hazardous waste ROD (63 FR 41810) was published on August 5, 1998, and the LLW and MLLW ROD (65 FR 10061) was published on February 25, 2000. The LLW and MLLW ROD states that, for the management of LLW, minimal treatment will be performed at all sites and onsite disposal will continue to the extent practicable at INL, Los Alamos National Laboratory, ORR, and SRS. In addition, Hanford and NNSS will be available to all DOE sites for LLW disposal. MLLW will be treated at Hanford, INL, ORR, and SRS and disposed of at Hanford and NNSS. The hazardous waste ROD states that most DOE sites will continue to use offsite facilities for treatment and disposal of major portions of their nonwastewater hazardous waste, and ORR and SRS will continue treating some of their own nonwastewater hazardous waste on site in existing facilities, where this is economically feasible. More-detailed information concerning DOE's decisions for the future configuration of waste management facilities at INL is presented in the hazardous waste and LLW and MLLW RODs.

Table 3–56. *WM PEIS* Records of Decision Affecting Idaho National Laboratory

Waste Type	Preferred Action
LLW	DOE has decided to treat and dispose of INL's LLW on and off site.[a]
MLLW	DOE has decided to regionalize treatment of MLLW at INL. This includes the onsite treatment of INL's waste and could include treatment of some MLLW generated at other sites.[a]
Hazardous	DOE has decided to continue to use commercial facilities for treatment of INL nonwastewater hazardous waste. DOE will also continue to use onsite facilities for wastewater hazardous waste.[b]

[a] 65 FR 10061.

[b] 63 FR 41810.

Key: DOE=U.S. Department of Energy; INL=Idaho National Laboratory; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; *WM PEIS=Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*.

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CHAPTER 4
SHORT-TERM ENVIRONMENTAL CONSEQUENCES

Chapter 4 presents the potential short-term impacts on the existing natural and human environment and on human health of implementing reasonable alternatives for each of the following: (1) tank waste retrieval, treatment, and disposal and single-shell tank system closure at the Hanford Site (Hanford); (2) decommissioning of the Fast Flux Test Facility and auxiliary facilities and disposition of Hanford's inventory of radioactively contaminated bulk sodium; and (3) management of waste resulting from other Hanford activities and limited volumes from other U.S. Department of Energy sites. Impact analyses of the alternatives and options considered for each of the three sets of proposed actions are presented separately in Sections 4.1, 4.2, and 4.3, respectively. Impacts analyses are grouped first by resource area or discipline (e.g., land resources) and then by alternative so that impacts can be meaningfully compared across alternatives. All disciplines were analyzed in a manner commensurate with their importance and the expected level of impact on them under a specific alternative—the sliding-scale assessment approach. The combined impacts of implementing selected alternatives from each of the three sets of proposed actions are presented in Section 4.4. Cumulative impacts associated with the alternative combinations are presented in Chapter 6. Mitigation measures to reduce the potential for environmental impacts are summarized in Chapter 7, Section 7.1. Analyses of comparative impacts across the alternatives are presented in Chapter 7, Sections 7.2 through 7.4. A detailed discussion of each alternative is provided in Chapter 2, Section 2.5, and a comparison of the environmental effects between alternatives is presented in Chapter 2, Section 2.7.

4.1 TANK CLOSURE ALTERNATIVES

This section describes the potential short-term environmental and human health impacts associated with implementation of each of the 11 Tank Closure alternatives considered in this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)* for retrieving and treating the tank waste inventory generated during the defense production years at the Hanford Site (Hanford). The impact analyses also consider different closure scenarios associated with the single-shell tank (SST) system.

Dates for Alternatives

The dates referenced in this environmental impact statement (EIS) for the alternatives were selected to support relationships between, and durations for, activities, thus allowing comparisons of the alternatives. They do not necessarily represent the current dates. For example, this EIS used a Waste Treatment Plant (WTP) startup date of 2018; the current WTP startup date is 2022. Note that the durations, rather than the startup dates, of the activities evaluated in this EIS are of the most significance. As this EIS evaluates modeling from 1944 through 11,944, the dates provide a reference for past, current, and future activities.

Tank Closure Alternative 1: No Action reflects the environmental baseline against which the impacts of the other action alternatives can be compared. Under Alternative 1, the U.S. Department of Energy (DOE) assumes for analysis purposes that construction of the River Protection Project Waste Treatment Plant (WTP) would be terminated in 2008. Therefore, it is expected that short-term incremental impacts would peak in the 2006–2008 timeframe during WTP construction. It is also expected that subsequent incremental impacts would be very small for most of the disciplines analyzed over the ensuing 100-year administrative control period assumed in the analysis. During this period, proposed activities would be conducted at existing facilities in developed areas; no new land disturbance would take place; proposed activities would be consistent with current operations; and routine gaseous and effluent emissions would generally continue in accordance with governing regulatory requirements, resulting in little incremental impact.

In contrast, Alternatives 2 through 6 would involve the construction, subsequent operation, and eventual deactivation of new facilities over varying timeframes (ranging from 34 years to 161 years) in the 200-East and 200-West Areas of Hanford to support tank waste retrieval, treatment, and disposal. Except for Alternative 2A, each of these alternatives also analyzes closure of the Hanford SST system by means of either landfill closure (i.e., construction of a surface barrier) or selective or full clean closure (i.e., removal) of the SST system and associated waste and contaminated soils. Each of the 11 Tank Closure alternatives (Alternatives 1 through 6C) is described in detail in Chapter 2, Section 2.5.

4.1.1 Land Resources

In contrast to Alternative 1, Alternatives 2 through 6C would involve the construction, subsequent operation, and eventual deactivation of new facilities over varying timeframes in the 200-East and 200-West Areas of Hanford to support tank waste retrieval, treatment, and disposal. The major new project facilities and infrastructure components that would be constructed or upgraded to support the implementation of each Tank Closure alternative are summarized in Table 4–1. Facility locations and affected Hanford areas are depicted in Figures 4–1 and 4–2.

Table 4–1. Summary of Major New Facilities Required to Support Tank Closure Alternatives

	Alternative										
Facility	**1**	**2A**	**2B**	**3A**	**3B**	**3C**	**4**	**5**	**6A**	**6B**	**6C**
Bulk Vitrification Facility (200-East Area)				X							
Bulk Vitrification Facility (200-West Area)				X			X	X			
Canister Storage Building completion	(a)	X	X	X	X	X	X	X	X	X	X
Cast Stone Facility (200-East Area)					X		X	X			
Cast Stone Facility (200-West Area)					X						
Cesium and Strontium Capsule Processing Facility		X	X	X	X	X	X	X	X	X	X
Chemical wash system							X		X	X	
CH-Mixed TRU Waste Facilities				X	X	X	X	X			
Containment structures			X	X	X	X	X		X	X	X
Double-shell tanks (new)								X			
Double-shell tank replacement(s)		X[b]							X[c]		
Effluent Treatment Facility replacement(s)		X[b]	X	X	X	X	X	X	X[c]	X[d]	X
Hanford landfill barrier								X			
HLW Debris Storage Facilities									X	X	
HLW Melter Interim Storage Facilities		X	X	X	X	X	X	X	X	X	X
IHLW Interim Storage Modules		X	X	X	X	X	X	X	X	X	X
IHLW Interim Storage Module replacement(s)									X[c]		
IHLW Shipping/Transfer Facility		X	X	X	X	X	X	X	X	X	X
IHLW Shipping/Transfer Facility replacement(s)									X[c]		
ILAW Interim Storage Facilities										X	X
LAW Vitrification Facility expansion			X							X	X
Mobile retrieval systems		X	X	X	X	X	X	X	X	X	X
Modified RCRA Subtitle C barrier[e]			X	X	X	X	X		X		X
Modified sluicing retrieval systems		X	X	X	X	X		X			X
Preprocessing Facility							X		X	X	
RH-Mixed TRU Waste Facility				X	X	X	X	X			
Solid-Liquid Separations Facility (200-West Area)				X	X	X	X	X			
Steam Reforming Facility (200-West Area)						X					
Steam Reforming Facility (200-East Area)						X					
Sulfate Removal Facility								X			
TRU Waste Interim Storage Facility				X	X	X	X	X			
Underground transfer lines		X	X	X	X	X	X	X	X	X	X
Underground transfer line replacement		X[b]							X[c]		

Table 4–1. Summary of Major New Facilities Required to Support Tank Closure Alternatives (*continued*)

Facility	Alternative										
	1	**2A**	**2B**	**3A**	**3B**	**3C**	**4**	**5**	**6A**	**6B**	**6C**
Vacuum-based retrieval systems		X	X	X	X	X	X	X	X	X	X
Waste receiver facilities			X	X	X	X	X	X		X	X
Waste Treatment Plant completion[f]	(a)	X	X	X	X	X	X	X	X	X	X
Waste Treatment Plant replacement(s)		X[b]							X[c]		
242-A Evaporator replacement(s)		X[b]	X	X	X	X	X	X	X[c]	X	X

[a] Construction of the Waste Treatment Plant and Canister Storage Building would be terminated, and no tank waste would be retrieved and treated under this alternative.

[b] The operating timeframe under this alternative requires a one-time total replacement of these facilities and associated infrastructure, except for two replacements of the Effluent Treatment Facility.

[c] The operating timeframe under this alternative (Base and Option Cases) requires two replacements of the Waste Treatment Plant, three replacements of the IHLW Shipping/Transfer Facility and IHLW Interim Storage Modules, three replacements of 28 double-shell tanks, five replacements of the Effluent Treatment Facility, one replacement of the underground transfer lines and associated infrastructure, and six replacements of the 242-A Evaporator.

[d] The operating timeframe under this alternative (Base and Option Cases) requires three replacements of the Effluent Treatment Facility.

[e] The engineered landfill closure barrier would be a surface structure constructed in five "lobes"—three in the 200-West Area covering tank farms (1) T, TY, and TX (T Barrier); (2) U (U Barrier); and (3) SY, S, and SX (S Barrier), and two much larger lobes in the 200-East Area covering tank farms (4) B, BY, and BX (B Barrier); and (5) AN, AZ, AX, AY, A, AW, AP, and C (A Barrier). The barriers would also cover six sets of cribs and trenches (ditches) including the B Cribs, BX Trenches, BY Cribs, T Cribs, T Trenches, TX Trenches, and TY Cribs, with the T and TX Trenches considered one set. Under Alternative 6A, the modified RCRA Subtitle C barrier would be constructed under only the Base Option.

[f] The completed Waste Treatment Plant would consist of two HLW and two LAW melters under Alternatives 2A, 3A, 3B, and 4; two HLW and three LAW melters under Alternative 5; two HLW and six LAW melters under Alternatives 2B, 6B, and 6C; and five HLW melters under Alternative 6A.

Note: See Figures 4–1 and 4–2 for locations.

Key: CH=contact-handled; Hanford=Hanford Site; HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; RCRA=Resource Conservation and Recovery Act; RH=remote-handled; TRU=transuranic.

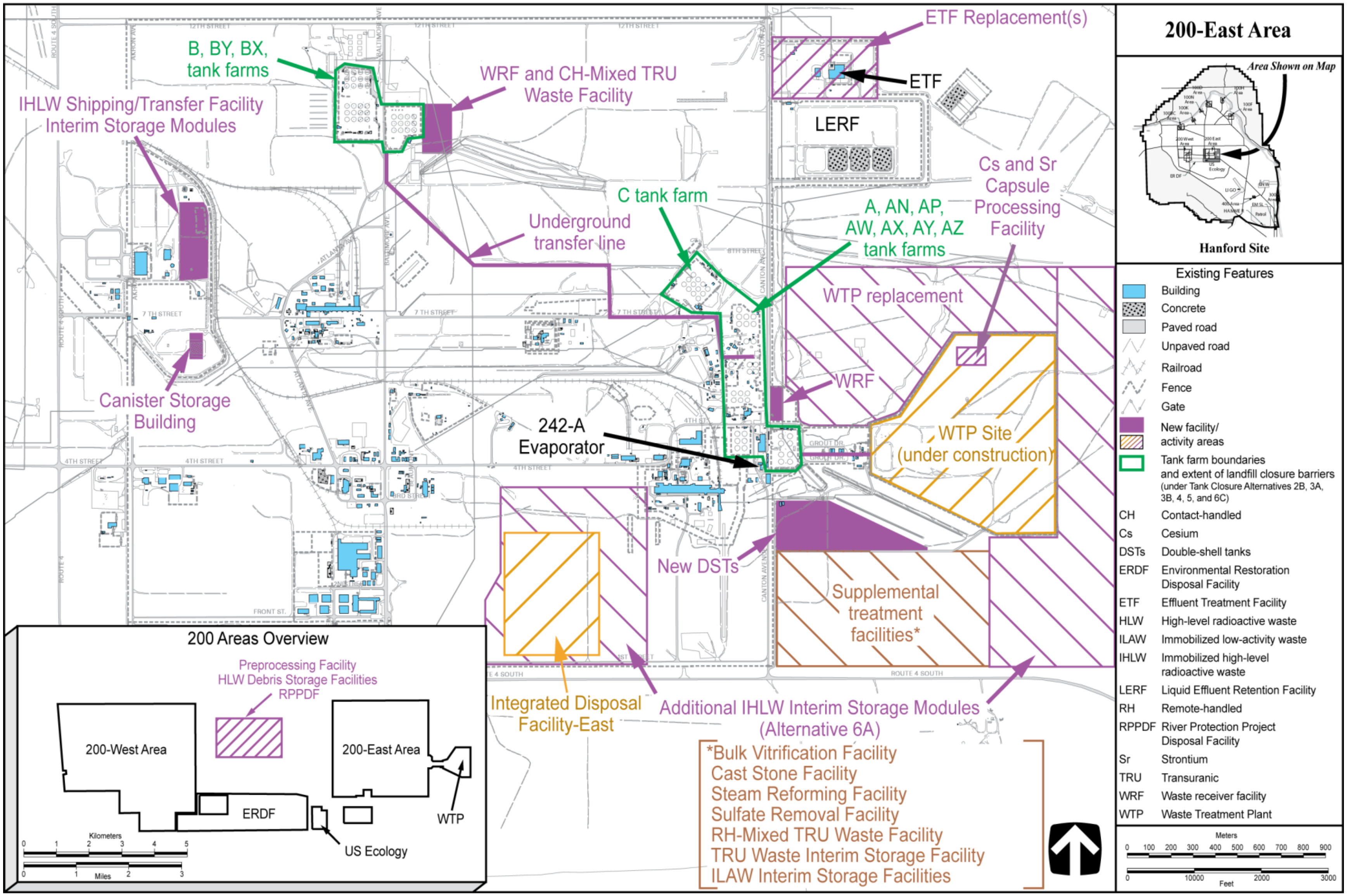


Figure 4–1. 200-East Area New Facility Locations and Affected Areas

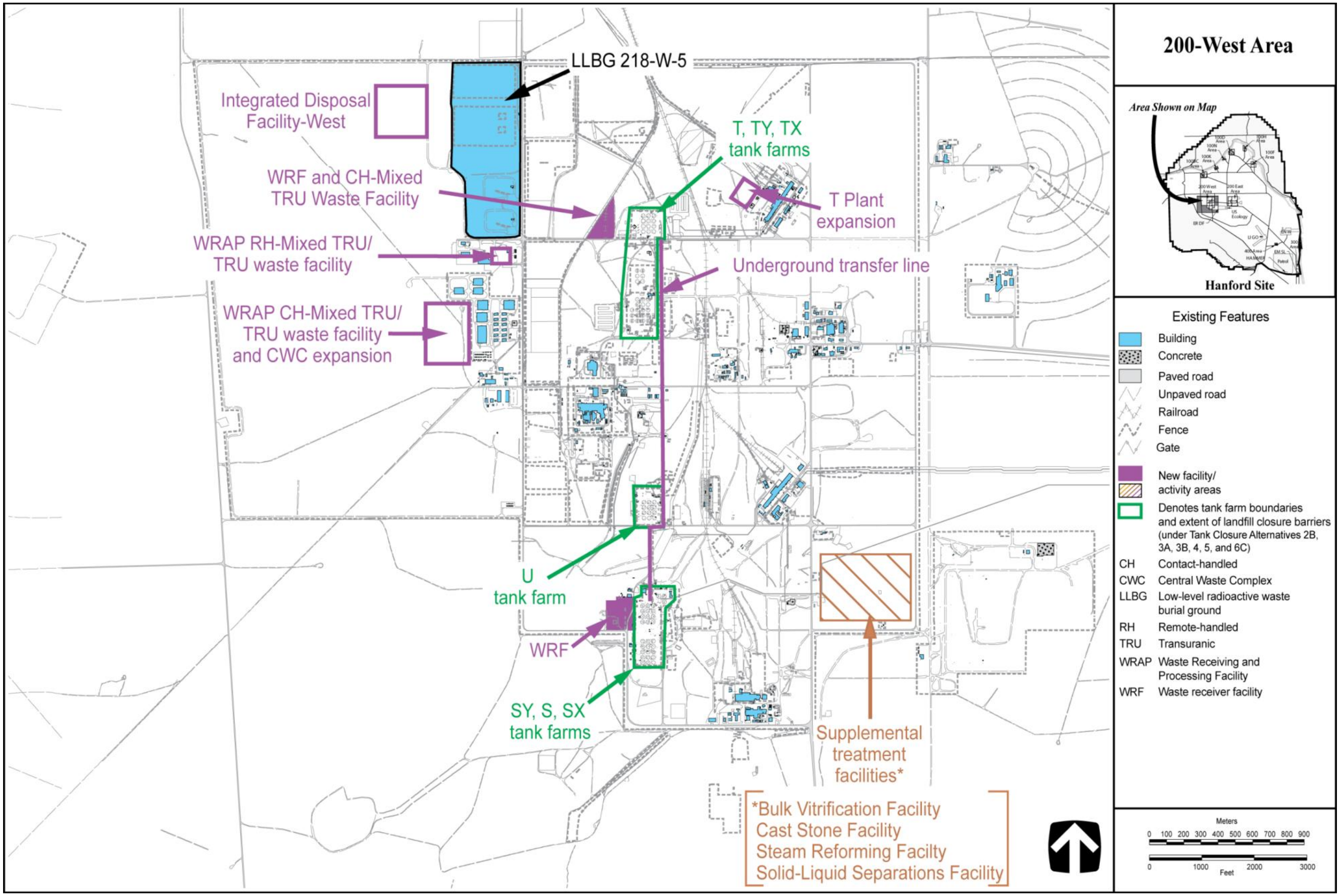


Figure 4–2. 200-West Area New Facility Locations and Affected Areas

4.1.1.1 Alternative 1: No Action

4.1.1.1.1 Land Use

Under the No Action Alternative, no new facility construction would be initiated within either the 200-East or 200-West Area. Construction of the WTP and Canister Storage Building would be terminated (see Chapter 2, Section 2.5.2.1). Ongoing tank system upgrades within existing facilities and related construction projects would also end. Thus, the present industrial status of the 200 Areas would remain unchanged, as would its land use designation as Industrial-Exclusive.

Implementation of this alternative would entail a long-term commitment of land within the 200 Areas. The 17 hectares (42 acres) of land encompassing the existing 18 tank farms and six sets of cribs and trenches (ditches) (i.e., B Cribs, BX Trenches, BY Cribs, T Cribs and Trenches, TX Trenches, and TY Cribs) would be indefinitely committed to waste management use following the DOE 100-year administrative control period, as no tank waste would be retrieved, treated, or disposed of under this alternative.

The No Action Alternative would require that geologic material be excavated from the 926.3-hectare (2,289-acre) Borrow Area C for use in activities such as tank stabilization and WTP closure. The amount of material required would necessitate the development of 2 hectares (5 acres) of Borrow Area C. Borrow Area C has been designated Conservation (Mining), and its use for this purpose would be consistent with the Hanford land use plan established in accordance with the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement (Hanford Comprehensive Land-Use Plan EIS)*, including the 2008 supplement analysis (DOE 1999, 2008) and Records of Decision (RODs) (64 FR 61615; 73 FR 55824).

4.1.1.1.2 Visual Resources

Implementation of the No Action Alternative would not result in new construction within the 200 Areas. Accordingly, the industrial appearance of the 200-East and 200-West Areas from State Route 240 and nearby higher elevations (i.e., Gable Mountain, Gable Butte, and Rattlesnake Mountain) would remain unchanged, as would the U.S. Bureau of Land Management (BLM) Visual Resource Management Class IV rating.

As noted above, 2 hectares (5 acres) of Borrow Area C would be excavated under the No Action Alternative. Although development would not dominate the view from State Route 240 or nearby higher elevations, it would attract the attention of the viewer. Thus, the BLM visual resource management rating of Borrow Area C and the vicinity would change from Class II to Class III.

4.1.1.2 Alternative 2A: Existing WTP Vitrification; No Closure

4.1.1.2.1 Land Use

In addition to completion of the WTP, a number of new facilities would be constructed under this alternative, as listed in Table 4–1. All of these facilities would be located either within or immediately adjacent to the 200-East or 200-West Area. In all cases, they would be located within the 5,064-hectare (12,513-acre) area of the 200 Area Plateau designated Industrial-Exclusive. In total, new facilities would occupy 33.9 hectares (83.8 acres), all but 3.2 hectares (8 acres) of which would be located within or adjacent to the 200-East Area (see Figures 4–1 and 4–2). Thus, about 0.7 percent of the land within the Industrial-Exclusive land area would be affected. During operations, impacts on land use would be minimal, as all activities would take place within the Industrial-Exclusive area.

Implementation of this alternative would entail a commitment of land within the area designated as Industrial-Exclusive over the long term. In addition to the 33.9 hectares (83.8 acres) of land that would be required for new facilities and infrastructure, 17 hectares (42 acres) of the land encompassing the existing 18 tank farms (including the six sets of cribs and trenches [ditches]) would be indefinitely committed to waste management use following the DOE 100-year administrative control period, as no SST system closure would take place under this alternative. Taken together, this would entail a total land commitment of 50.9 hectares (126 acres), or 1 percent of the area designated as Industrial-Exclusive.

Alternative 2A would require excavation of geologic material from Borrow Area C for use in activities associated with new construction, tank waste disposal activities, and tank stabilization. The amount of material required would necessitate the development of 29.1 hectares (72 acres), or 3.1 percent of the area. Borrow Area C has been designated Conservation (Mining), and its use for this purpose would be consistent with the Hanford land use plan established in accordance with the *Hanford Comprehensive Land-Use Plan EIS* and the 2008 supplement analysis (DOE 1999, 2008) and RODs (64 FR 61615; 73 FR 55824).

4.1.1.2.2 Visual Resources

As all construction and operational activities associated with this alternative would occur either within or immediately adjacent to the 200-East and 200-West Areas, which are already developed as industrial sites, there would be little change in their overall visual character. There would be a negligible impact on the view from State Route 240, as the changes in the 200-East Area would not be visible from the roadway, and the only change in the 200-West Area would be construction of an underground transfer line. The views from nearby higher elevations (i.e., Gable Mountain, Gable Butte, and Rattlesnake Mountain), which are important to American Indians with cultural ties to Hanford, would also remain largely unchanged. Further, the overall BLM Visual Resource Management Class IV rating of the 200 Areas would not change under this alternative.

As noted above, 29.1 hectares (72 acres) of Borrow Area C would be excavated under this alternative. Development of Borrow Area C would be readily visible from State Route 240 and Rattlesnake Mountain and would result in the BLM visual resource management rating changing from Class II to Class IV. Upon completion of work under this alternative, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact.

4.1.1.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

4.1.1.3.1 Land Use

In addition to completion of the WTP with expanded low-activity waste (LAW) vitrification capacity, a number of new facilities would be constructed under this alternative, as listed in Table 4–1. The 18 tank farms and six sets of cribs and trenches (ditches) would also be covered by modified Resource Conservation and Recovery Act (RCRA) Subtitle C landfill barriers (see Chapter 2, Section 2.5.2.2.2). All of these facilities would be located either within or immediately adjacent to the 200-East or 200-West Area and would be within the area designated as Industrial-Exclusive. In total, new facilities would occupy 16.7 hectares (41.3 acres)—13 hectares (32.2 acres) in or adjacent to the 200-East Area and 3.7 hectares (9.1 acres) in the 200-West Area (see Figures 4–1 and 4–2). Thus, about 0.3 percent of the land within the Industrial-Exclusive area would be affected. During the operational and closure phases of the project, impacts on land use would be minimal, as all activities would take place within the Industrial-Exclusive area.

Implementation of this alternative would entail a commitment of land designated as Industrial-Exclusive over the long term. In addition to the 16.7 hectares (41.3 acres) of land that would be committed to new facilities and infrastructure, an additional 84.2 hectares (208 acres) of land encompassed by the boundaries of the five modified RCRA Subtitle C barriers would be indefinitely committed to waste management use following the DOE 100-year postclosure care period. Taken together, this would entail a total land commitment of 101 hectares (249 acres), or 2 percent of the area designated as Industrial-Exclusive.

Alternative 2B would require excavation of geologic material from Borrow Area C for use in activities associated with construction of new facilities, disposal of tank waste, and placement of the modified RCRA Subtitle C barriers. The amount of material required would necessitate the development of 95.1 hectares (235 acres), or about 10 percent of the area. Although development of Borrow Area C would represent a change in the current land use, this area has been designated Conservation (Mining), and its use for this purpose would be consistent with the Hanford land use plan established in accordance with the *Hanford Comprehensive Land-Use Plan EIS* and the 2008 supplement analysis (DOE 1999, 2008) and RODs (64 FR 61615; 73 FR 55824).

4.1.1.3.2 Visual Resources

In general, impacts on visual resources would be similar to those described in Section 4.1.1.2.2 under Alternative 2A; however, as part of landfill closure, containment structures would be built over the BX and SX tank farms in the 200-East and 200-West Areas to support removal of the upper 4.6 meters (15 feet) of contaminated soil. Upon completion of activities in these tank farms, both structures would be removed. Closure would also result in the tank farms being covered with modified RCRA Subtitle C barriers. The 200-East Area containment structure and closure barriers would be visible only from nearby higher elevations, while the 200-West Area containment structure and closure barriers would be visible from State Route 240 and nearby higher elevations. However, as the 200 Areas are currently industrial sites, the BLM Visual Resource Management Class IV rating would not change under this alternative.

Under this alternative, 95.1 hectares (235 acres) of Borrow Area C would be excavated. Development of Borrow Area C would be readily visible from State Route 240 and Rattlesnake Mountain and would result in the BLM visual resource management rating changing from Class II to Class IV. Upon completion of work under this alternative, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact.

4.1.1.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

4.1.1.4.1 Land Use

In addition to completion of the WTP, a number of new facilities would be constructed under this alternative, as listed in Table 4–1. A modified RCRA Subtitle C landfill barrier also would be constructed over all 18 tank farms and six sets of cribs and trenches (ditches) (see Chapter 2, Section 2.5.2.3.1). Similar to the previously described alternatives, all facilities would be located within or adjacent to the 200-East and 200-West Areas and would be within the area designated as Industrial-Exclusive. In total, new facilities would occupy 16.3 hectares (40.4 acres)—12.2 hectares (30.1 acres) in or adjacent to the 200-East Area and 4.2 hectares (10.3 acres) in the 200-West Area (see Figures 4–1 and 4–2). Thus, about 0.3 percent of the land within the Industrial-Exclusive area would be affected. As all activities would take place within the Industrial-Exclusive area and only a small part of the area would be affected, the impacts of this alternative on land use would be minimal.

Implementation of this alternative would entail a commitment of land designated as Industrial-Exclusive over the long term. In addition to the 16.3 hectares (40.4 acres) of land that would be committed to new facilities and infrastructure, an additional 84.2 hectares (208 acres) of land encompassed by the boundaries of the five modified RCRA Subtitle C barriers would be indefinitely committed to waste management use following the DOE 100-year postclosure care period. Taken together, this would entail a total land commitment of 100 hectares (248 acres), or 2 percent of the area designated as Industrial-Exclusive.

Under this alternative, it would be necessary to supply geologic material from Borrow Area C for the construction of facilities, the disposal of tank waste, and the placement of the modified RCRA Subtitle C barriers. In total, 100 hectares (247 acres), or about 11 percent of the land within Borrow Area C, would be excavated. Borrow Area C has been designated Conservation (Mining), and its use for this purpose would be consistent with the Hanford land use plan established in accordance with the *Hanford Comprehensive Land-Use Plan EIS* and the 2008 supplement analysis (DOE 1999, 2008) and RODs (64 FR 61615; 73 FR 55824).

4.1.1.4.2 Visual Resources

Impacts on visual resources would be similar to those described in Section 4.1.1.3.2 under Alternative 2B. Construction, operations, and closure activities associated with this alternative would not greatly change the industrial nature of the view from State Route 240 or nearby higher elevations. Thus, the BLM Visual Resource Management Class IV rating for the 200 Areas would not change. Although an additional 4.9 hectares (12 acres) of land within Borrow Area C would be disturbed under this alternative, the visual impacts of developing the site would be similar to those described under Alternative 2B.

4.1.1.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

4.1.1.5.1 Land Use

Under this alternative, new facilities would be similar to those under Alternative 3A, except the Cast Stone Facilities would be built instead of Bulk Vitrification Facilities (see Table 4–1 and Chapter 2, Section 2.5.2.3.2). Similar to the previously described alternatives, all facilities would be located within or adjacent to the 200-East and 200-West Areas and would be within the area designated as Industrial-Exclusive. In total, new facilities under this alternative would occupy 17.2 hectares (42.6 acres)—12.6 hectares (31.2 acres) in or adjacent to the 200-East Area and 4.6 hectares (11.4 acres) in the 200-West Area (see Figures 4–1 and 4–2). Thus, about 0.3 percent of the land within the Industrial-Exclusive area would be affected.

Implementation of this alternative would entail a commitment of land designated as Industrial-Exclusive over the long term. In addition to the 17.2 hectares (42.6 acres) of land that would be committed to new facilities and infrastructure, an additional 84.2 hectares (208 acres) encompassed by the boundaries of the five modified RCRA Subtitle C barriers would be indefinitely committed to waste management use following the DOE 100-year postclosure care period. Taken together, this would entail a total land commitment of 102 hectares (251 acres), or 2 percent of the area designated Industrial-Exclusive.

Under Alternative 3B, 92.3 hectares (228 acres), or about 10 percent of Borrow Area C, would be excavated to supply the geologic material needed for new facilities' construction, tank waste disposal activities, and placement of the modified RCRA Subtitle C barriers. Although development of Borrow Area C would represent a change in the current land use, this area has been designated as Conservation (Mining), and its use as a borrow pit would be consistent with the Hanford land use plan established in accordance with the *Hanford Comprehensive Land-Use Plan EIS* and the 2008 supplement analysis (DOE 1999, 2008) and RODs (64 FR 61615; 73 FR 55824).

4.1.1.5.2 Visual Resources

Impacts on visual resources would be similar to those described in Section 4.1.1.4.2 under Alternative 3A. Construction, operations, deactivation, and closure activities associated with this alternative would not greatly change the industrial nature of the view from State Route 240 or nearby higher elevations. Thus, the BLM Visual Resource Management Class IV rating for the 200 Areas would not change. Although the land requirement in Borrow Area C would be somewhat less (i.e., 7.7 hectares [19 acres]) under Alternative 3B, visual impacts generally would be similar to those described under Alternative 3A.

4.1.1.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

4.1.1.6.1 Land Use

Under this alternative, new facilities would be similar to those under Alternative 3A, except the Steam Reforming Facilities would be built instead of Bulk Vitrification Facilities (see Table 4–1 and Chapter 2, Section 2.5.2.3.3). All facilities would be located within or adjacent to the 200-East and 200-West Areas and would be within the area designated as Industrial-Exclusive. In total, new facilities under this alternative would occupy 17.2 hectares (42.4 acres)—12.8 hectares (31.7 acres) in or adjacent to the 200-East Area and 4.3 hectares (10.7 acres) in the 200-West Area (see Figures 4–1 and 4–2). Thus, about 0.3 percent of the land within the Industrial-Exclusive area would be affected.

Implementation of this alternative would entail a commitment of land designated as Industrial-Exclusive over the long term. In addition to the 17.2 hectares (42.4 acres) of land that would be committed to new facilities and infrastructure, an additional 84.2 hectares (208 acres) encompassed by the boundaries of the five modified RCRA Subtitle C barriers would be indefinitely committed to waste management use following the DOE 100-year postclosure care period. Taken together, this would entail a total land commitment of 101 hectares (250 acres), or 2 percent of the area designated as Industrial-Exclusive.

Alternative 3C would require excavation of geologic material from Borrow Area C for use in activities associated with construction of new facilities, disposal of tank waste, and placement of the modified RCRA Subtitle C barriers. The amount of material required would necessitate the development of 92.7 hectares (229 acres), or about 10 percent of the area. Borrow Area C has been designated Conservation (Mining), and its use for this purpose would be consistent with the Hanford land use plan established in accordance with the *Hanford Comprehensive Land-Use Plan EIS* and the 2008 supplement analysis (DOE 1999, 2008) and RODs (64 FR 61615; 73 FR 55824).

4.1.1.6.2 Visual Resources

Impacts on visual resources would be similar to those described in Section 4.1.1.4.2 under Alternative 3A. Construction, operations, deactivation, and closure activities associated with this alternative would not greatly change the industrial nature of the view from State Route 240 or nearby higher elevations. Thus, the BLM Visual Resource Management Class IV rating for the 200 Areas would not change. Because nearly the same amount of geologic material would be required under Alternative 3C (92.7 hectares [229 acres]) as under Alternative 3B (92.3 hectares [228 acres]), visual impacts would be similar to those described under Alternative 3B.

4.1.1.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

4.1.1.7.1 Land Use

In addition to completing the WTP, a number of new facilities would be constructed under this alternative, as listed in Table 4–1. Additionally, modified RCRA Subtitle C landfill barriers would be placed over the 10 tank farms that would not be clean-closed and the six sets of cribs and trenches (ditches) (see Chapter 2, Section 2.5.2.4). While most facilities would be located within or adjacent to the 200-East and 200-West Areas and would be within the area designated as Industrial-Exclusive, the high-level radioactive waste (HLW) Preprocessing Facility (PPF) would be located between the 200-East and 200-West Areas. In total, new facilities under this alternative would occupy 19.8 hectares (48.9 acres)—13.7 hectares (33.8 acres) in or adjacent to the 200-East Area, 4.2 hectares (10.3 acres) in the 200-West Area, and 1.9 hectares (4.8 acres) between the 200-East and 200-West Areas (see Figures 4–1 and 4–2). Thus, about 0.4 percent of the land within the Industrial-Exclusive land use designation would be affected. This loss would be slightly offset by the clean closure of the BX and SX tank farms, which would be potentially available for future use consistent with the *Hanford Comprehensive Land-Use Plan EIS* and the 2008 supplement analysis (DOE 1999, 2008) and RODs (64 FR 61615; 73 FR 55824). As all activities would take place within the dedicated Industrial-Exclusive area and only a small part of the area would be affected, impacts of this alternative on land use would be minimal.

Implementation of this alternative would entail a commitment of land designated as Industrial-Exclusive over the long term. In addition to the 19.8 hectares (48.9 acres) of land that would be committed to new facilities and infrastructure, an additional 60.7 hectares (150 acres) of land encompassed by the boundaries of the modified RCRA Subtitle C barriers would be indefinitely committed to waste management use following the DOE 100-year postclosure care period. Taken together, this would entail a total land commitment of 80.5 hectares (199 acres), or about 1.6 percent of the area designated as Industrial-Exclusive.

Alternative 4 would require excavation of geologic material from Borrow Area C for use in activities associated with construction of new facilities, disposal of tank waste, clean closure of the BX and SX tank farms, and placement of the modified RCRA Subtitle C barriers. The amount of material required would necessitate the development of 102 hectares (252 acres), or 11 percent of the area. Although development of Borrow Area C would represent a change in the current land use, this area has been designated Conservation (Mining), and its use for this purpose would be consistent with the Hanford land use plan established in accordance with the *Hanford Comprehensive Land-Use Plan EIS* and the 2008 supplement analysis (DOE 1999, 2008) and RODs (64 FR 61615; 73 FR 55824).

4.1.1.7.2 Visual Resources

Impacts on visual resources would be similar to those described in Section 4.1.1.3.2 under Alternative 2B. Construction, operations, deactivation, and closure activities associated with this alternative would not greatly change the industrial nature of the view from State Route 240 or nearby higher elevations. Thus, the BLM Visual Resource Management Class IV rating for the 200 Areas would not change. Although an additional 2 hectares (5 acres) of land would be disturbed within Borrow Area C under this alternative, visual impacts also would be similar to those described under Alternative 3A.

4.1.1.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

4.1.1.8.1 Land Use

In addition to completion of the WTP, a number of new facilities would be constructed under this alternative, as listed in Table 4–1. Additionally, Hanford landfill barriers would be placed over all 18 tank farms and six sets of cribs and trenches (ditches) (see Chapter 2, Section 2.5.2.5). Similar to the previously described alternatives, all facilities would be located within or adjacent to the 200-East and 200-West Areas and would be within the area designated as Industrial-Exclusive. In total, new facilities would occupy 20.2 hectares (49.9 acres)—16 hectares (39.6 acres) in or adjacent to the 200-East Area and 4.2 hectares (10.3 acres) in the 200-West Area (see Figures 4–1 and 4–2). Thus, about 0.4 percent of the land within the Industrial-Exclusive area would be affected. During the operational and closure phases of the project, impacts on land use would be minimal, as all activities would take place within the Industrial-Exclusive area.

Implementation of this alternative would entail a commitment of land designated as Industrial-Exclusive over the long term. In addition to the 20.2 hectares (49.9 acres) of land that would be committed to new facilities and infrastructure, an additional 84.2 hectares (208 acres) of land encompassed by the boundaries of the five Hanford barriers would be indefinitely committed to waste management use following the DOE 100-year postclosure care period. Taken together, this would entail a total land commitment of 104 hectares (258 acres), or 2.1 percent of the area designated as Industrial-Exclusive.

This alternative would require excavation of geologic material from Borrow Area C for use in activities associated with construction of new facilities, disposal of tank waste, and placement of the Hanford barriers. The amount of material required would necessitate the development of 117 hectares (290 acres), or about 13 percent of the area. Borrow Area C has been designated Conservation (Mining) and its use for this purpose would be consistent with the Hanford land use plan established in accordance with the *Hanford Comprehensive Land-Use Plan EIS* and the 2008 supplement analysis (DOE 1999, 2008) and RODs (64 FR 61615; 73 FR 55824).

4.1.1.8.2 Visual Resources

Impacts on visual resources would be similar to those described in Section 4.1.1.3.2 under Alternative 2B. Construction, operations, deactivation, and closure activities associated with this alternative would not greatly change the industrial nature of the view from State Route 240 or nearby higher elevations. Thus, the BLM Visual Resource Management Class IV rating for the 200 Areas would not change.

Under this alternative, 117 hectares (290 acres) of Borrow Area C would be excavated. Development of Borrow Area C would be readily visible from State Route 240 and Rattlesnake Mountain and would result in the BLM visual resource management rating changing from Class II to Class IV. Upon completion of work under this alternative, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact.

4.1.1.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

4.1.1.9.1 Land Use

4.1.1.9.1.1 Base Case

In addition to completion of the WTP with expanded HLW vitrification capacity, a number of new facilities would be constructed under this alternative, as listed in Table 4–1. Most of these facilities would be located within or adjacent to the 200-East Area and within the existing boundaries of the 200-West Area, although the PPF and HLW Debris Storage Facility would be located between the 200-East and 200-West Areas. While most facilities would be located within the area designated as Industrial-Exclusive, a portion of the area needed for immobilized high-level radioactive waste (IHLW) Interim Storage Modules (i.e., 86.2 hectares [213 acres]) would be located outside of this area to the east. These facilities have been located in this area to facilitate movement of IHLW on site. In total, new facilities would occupy approximately 210 hectares (519 acres), consisting of 153 hectares (377 acres) within or adjacent to the 200-East Area, 3.2 hectares (8 acres) in the 200-West Area, and 54.2 hectares (134 acres) between the 200-East and 200-West Areas (see Figures 4–1 and 4–2). Excluding the land located outside of the Industrial-Exclusive area needed for the IHLW Interim Storage Modules, about 2.4 percent of the Industrial-Exclusive area would be affected under this alternative.

Although clean closure would permit unrestricted use of the tank farm sites, a 25.4-hectare (62.7-acre) modified RCRA Subtitle C landfill barrier would be placed over the six sets of cribs and trenches (ditches). Taken together with the land required for facility construction, this would entail a total land commitment of 236 hectares (582 acres). Excluding the land needed for the IHLW Interim Storage Modules located outside of the Industrial-Exclusive area, about 2.9 percent of the area designated as Industrial-Exclusive would be affected under this alternative. Actions taken under this alternative would not change the Industrial-Exclusive designation of the 200 Areas. It is possible that the remediated tank farm areas could be used for construction of the HLW Debris Storage Facilities required under this alternative, with the balance of these facilities constructed in the area just to the west of the 200-East Area; however, the land values provided above assume these facilities would all be built between the 200-East and 200-West Areas.

To supply geologic material for use in activities associated with construction of new facilities, clean closure of the tank farms, disposal of tank waste, and placement of the modified RCRA Subtitle C landfill barrier, 381 hectares (942 acres) of Borrow Area C would have to be excavated. This level of development would represent about 41 percent of Borrow Area C. Borrow Area C has been designated Conservation (Mining), and its use for this purpose would be consistent with the Hanford land use plan established in accordance with the *Hanford Comprehensive Land-Use Plan EIS* and the 2008 supplement analysis (DOE 1999, 2008) and RODs (64 FR 61615; 73 FR 55824).

4.1.1.9.1.2 Option Case

Impacts on land use would generally be similar to, although slightly greater (i.e., 2 hectares [5 acres]) than, those described under Alternative 6A, Base Case. However, under the Option Case, a 25.4-hectare (62.7-acre) modified RCRA Subtitle C landfill barrier would not be used to cover the six sets of cribs and trenches (ditches), because they would be removed and their deep plumes would be remediated, making this area available for alternative uses in the future. Thus, a total land commitment of 212 hectares (524 acres) would be required. However, about 2.5 percent of the area designated as Industrial-Exclusive would be affected under the Option Case. This excludes the land needed for the IHLW Interim Storage Modules (86.2 hectares [213 acres]) located outside of the Industrial-Exclusive area. In addition, remediation of the deep plumes would necessitate the use of more fill material. Thus, it would be necessary to excavate more geologic material from Borrow Area C (specifically, 458 hectares [1,131 acres]), or about 49 percent of the area would have to be developed.

4.1.1.9.2 Visual Resources

4.1.1.9.2.1 Base Case

As noted in Section 4.1.1.9.1.1, 210 hectares (519 acres) of land would be converted to industrial use under Alternative 6A, Base Case, with all but 3.2 hectares (8 acres) in or adjacent to the 200-East Area or between the 200-East and 200-West Areas. Thus, although the overall appearance of the 200-West Area would not noticeably change, that of the 200-East Area and the area between the 200-East and 200-West Areas would. In terms of size, the most noticeable aboveground structures would be the HLW Debris Storage Facilities (52.2 hectares [129 acres]) and IHLW Interim Storage Modules (89.4 hectares [221 acres]), which would be located to the west and just to the east of the 200-East Area, respectively. These facilities would noticeably add to the overall industrial nature of the 200 Areas and would be visible from nearby higher elevations. The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford. Closure activities would involve constructing containment structures over the tank farms. Structures within the 200-West Area would be visible from State Route 240 and nearby higher elevations, while those between the 200-East and 200-West Areas and within and adjacent to the 200-East Area would be visible only from higher elevations. Containment structures would be removed upon completion of clean closure activities. Although there would be an overall increase in the industrial appearance of the 200 Areas, the BLM Visual Resource Management Class IV rating would not change.

As noted above, 381 hectares (942 acres) of Borrow Area C would be excavated under this alternative. Development of Borrow Area C would be readily visible from State Route 240 and Rattlesnake Mountain and would change the BLM visual resource management rating from Class II to Class IV. Upon completion of work under this alternative, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact.

4.1.1.9.2.2 Option Case

Impacts on visual resources under the Option Case would be similar to those discussed above for the Base Case because the area disturbed would be nearly the same. Although land occupied by the cribs and trenches (ditches) would be available for alternative uses in the future, following their removal and remediation, the overall appearance of the 200 Areas from State Route 240 or nearby higher elevations would not change significantly; thus, the BLM Visual Resource Management Class IV rating would not change.

Compared with Alternative 6A, Base Case, remediation of the deep plumes associated with the cribs and trenches (ditches) would require excavation of an additional 76.5 hectares (189 acres) of Borrow Area C. This excavation would further impact the view of the area from State Route 240 and nearby higher elevations, changing the BLM visual resource management rating from Class II to Class IV (as would be the situation for the Base Case). Similar to the Base Case, excavations in Borrow Area C would be recontoured and revegetated upon completion of work associated with this alternative.

4.1.1.10 Alternative 6B: All Vitrification with Separations; Clean Closure

4.1.1.10.1 Land Use

4.1.1.10.1.1 Base Case

In addition to completion of the WTP with expanded LAW vitrification capacity, a number of new facilities would be constructed under this alternative (see Table 4–1). As would be the case under Alternative 6A (see Section 4.1.1.9.1), most facilities would be located within or adjacent to the 200-East and 200-West Areas; however, the PPF and the HLW Debris Storage Facility would be located between the 200-East and 200-West Areas. All facilities would be within the area designated as Industrial-Exclusive. In total, new facilities would occupy 119 hectares (294 acres)—61 hectares (151 acres) in or adjacent to the 200-East Area, 3.7 hectares (9.1 acres) in the 200-West Area, and 54.2 hectares (134 acres) between the 200-East and 200-West Areas (see Figures 4–1 and 4–2). Thus, about 2.3 percent of the land within the Industrial-Exclusive land use zone would be affected. During operations, impacts on land use would be minimal, as all activities would take place within the dedicated Industrial-Exclusive area.

Although clean closure would permit unrestricted use of the tank farm sites, the six sets of cribs and trenches [ditches] would still have a 25.4-hectare (62.7-acre) modified RCRA Subtitle C landfill barrier placed over them. Taken together with the land required for facility construction, this would entail a total land commitment of 144 hectares (357 acres), or 2.9 percent of the land designated as Industrial-Exclusive. Actions taken under this alternative would not result in a change in the designation of the 200 Areas from Industrial-Exclusive. It is possible that the remediated tank farm areas could be used for construction of the HLW Debris Storage Facilities required under this alternative, with the balance of these facilities constructed in the area just to the west of the 200-East Area; however, the land values provided above assume these facilities would all be built between the 200-East and 200-West Areas.

This alternative would require excavation of geologic material from Borrow Area C for use in activities associated with new facility construction, clean closure of the tank farms, and placement of the modified RCRA Subtitle C landfill barrier. The amount of material required would necessitate the development of 240 hectares (592 acres), or about 26 percent of the area. Although development of Borrow Area C would represent a change in the current land use, this area has been designated Conservation (Mining), and its use for this purpose would be consistent with the Hanford land use plan established in accordance with the *Hanford Comprehensive Land-Use Plan EIS* and the 2008 supplement analysis (DOE 1999, 2008) and RODs (64 FR 61615; 73 FR 55824).

4.1.1.10.1.2 Option Case

Impacts on land use under Alternative 6B, Option Case, would generally be similar to, although slightly greater (i.e., 2 hectares [5 acres]) than, those described above for Alternative 6B, Base Case (see Section 4.1.1.10.1.1). However, under the Option Case, a 25.4-hectare (62.7-acre) modified RCRA Subtitle C landfill barrier would not be used to cover the six sets of cribs and trenches (ditches), because they would be removed and their deep plumes would be remediated, making this area available for alternative uses in the future. Thus, a total land commitment of 121 hectares (299 acres), or about 2.4 percent of the area designated as Industrial-Exclusive, would be required. However, remediation of the deep plumes would necessitate the use of more geologic material. Thus, the size of the excavated area within Borrow Area C would increase to 316 hectares (781 acres), or about 34 percent of the area, compared with 240 hectares (592 acres) under Alternative 6B, Base Case.

4.1.1.10.2 Visual Resources

4.1.1.10.2.1 Base Case

Impacts on visual resources under Alternative 6B, Base Case, would be similar to, but less than, those under Alternative 6A, Base Case (see Section 4.1.1.9.2.1). This is because about one-half as much land within the 200 Areas would be converted to industrial use under this alternative. Although the industrial appearance of the 200 Areas would increase overall as a result of actions taken under this case, the BLM Visual Resource Management Class IV rating would not change.

As noted above, 240 hectares (592 acres) of Borrow Area C would be excavated under this alternative. Development of Borrow Area C would be readily visible from State Route 240 and Rattlesnake Mountain, changing the BLM visual resource management rating from Class II to Class IV. Upon completion of work under this alternative, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact.

4.1.1.10.2.2 Option Case

Impacts on visual resources under Alternative 6B, Option Case, would be similar to those discussed above for the Base Case. Although land occupied by the cribs and trenches (ditches) would be available for alternative uses in the future following their removal and remediation, the overall appearance of the 200 Areas from State Route 240 or nearby higher elevations would not change significantly; thus, the BLM Visual Resource Management Class IV rating would not change.

Remediation of the deep plumes associated with the cribs and trenches (ditches) under this case would require excavation of an additional 76.5 hectares (189 acres) from Borrow Area C compared with Alternative 6B, Base Case. This excavation would further impact the view of the area from State Route 240 and nearby higher elevations, changing the BLM visual resource management rating from Class II to Class IV (as would be the situation under the Base Case). Upon completion of work associated with the Option Case, excavations in Borrow Area C would be recontoured and revegetated.

4.1.1.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

4.1.1.11.1 Land Use

In addition to completion of the WTP with expanded HLW vitrification capacity, a number of new facilities would be constructed under this alternative, as listed in Table 4–1. All of these facilities would be located within or adjacent to the 200-East Area and within the existing boundaries of the 200-West Area. In all cases, the facilities would be located within areas designated as Industrial-Exclusive. In total, new facilities would occupy 61.5 hectares (152 acres)—57.9 hectares (143 acres) within or adjacent to the 200-East Area and 3.7 hectares (9.1 acres) in the 200-West Area (see Figures 4–1 and 4–2). Thus, 1.2 percent of the land within the Industrial-Exclusive land use designation would be affected. Implementation of this alternative would entail a commitment of land within the Industrial-Exclusive area over the long term. In addition to the 61.5 hectares (152 acres) of land that would be committed to new facilities and infrastructure, an additional 84.2 hectares (208 acres) of land encompassed by the boundaries of the five modified RCRA Subtitle C barriers would be indefinitely committed to waste management use. Taken together, this would entail a total land commitment of 146 hectares (360 acres), or about 2.9 percent of the Industrial-Exclusive area. Actions taken under this alternative would not result in a change in the 200 Areas' Industrial-Exclusive designation. It is possible that the remediated tank farms could be used for construction of the HLW Debris Storage Facilities required under this alternative, with the balance of these facilities constructed in the area just to the west of the 200-East Area; however, the land values provided above assume these facilities would all be built between the 200-East and 200-West Areas.

Alternative 6C would require excavation of geologic material from Borrow Area C for use in activities associated with new facility construction, closure of the BX and SX tank farms, and placement of a modified RCRA Subtitle C landfill barrier over the 18 tank farms and six sets of cribs and trenches (ditches). The amount of material required would necessitate the development of 104 hectares (258 acres), or about 11 percent of the area. Borrow Area C has been designated Conservation (Mining), and its use for this purpose would be consistent with the Hanford land use plan established in accordance with the *Hanford Comprehensive Land-Use Plan EIS* and the 2008 supplement analysis (DOE 1999, 2008) and RODs (64 FR 61615; 73 FR 55824).

4.1.1.11.2 Visual Resources

As noted above, 61.5 hectares (152 acres) of land would be converted to industrial use under this alternative, with all but 3.7 hectares (9.1 acres) in or adjacent to the 200-East Area. Thus, the overall appearance of the 200-East Area and vicinity would change, but that of the 200-West Area would not. In terms of size, the most noticeable aboveground structures would be the IHLW Interim Storage Modules (44.9 hectares [111 acres]). These facilities would add to the overall industrial nature of the 200-East Area and would be visible from nearby higher elevations (the viewscape from these higher elevations is important to American Indians with cultural ties to Hanford). Closure activities would involve constructing containment structures over the tank farms. Structures within the 200-West Area would be visible from State Route 240 and nearby higher elevations, while those within and adjacent to the 200-East Area would be visible only from higher elevations. Containment structures would be removed upon completion of clean closure activities. Although there would be an overall increase in the industrial appearance of the 200 Areas, the BLM Visual Resource Management Class IV rating would not change.

As noted above, 104 hectares (258 acres) of Borrow Area C would be excavated under this alternative. Development of Borrow Area C would be readily visible from State Route 240 and Rattlesnake Mountain and would result in the BLM visual resource management rating changing from Class II to Class IV. Upon completion of work under this alternative, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact.

4.1.2 Infrastructure

This subsection presents the potential impacts of the Tank Closure alternatives on key utility infrastructure resources, including projected activity demands for electricity, fuel, and water, over the timeframe considered for each alternative. For analysis purposes, project timeframes for each alternative include the active project phase (during which construction, operations, deactivation, and closure activities were assumed to be ongoing) and extend through the 100-year administrative control, institutional control, or postclosure care period, as applicable. Total and peak annual utility infrastructure requirements were projected for each Tank Closure alternative, as well as for component project phases (i.e., construction, operations, deactivation, and closure, as applicable).

Assumptions for electricity demand include power to operate portable demolition equipment, work area lighting, and other items as part of facility construction, as well as power to meet the much larger demands of operational facilities. During construction, deactivation, and closure, electric power may be provided either via direct service connections and temporary connections, or via portable diesel- or gasoline-fired generators, especially in outlying portions of the 200 Areas. The projections include fuel consumption to power fuel-fired generators and heavy and mobile equipment to support all project phases under each alternative. It was assumed for analysis purposes that liquid fuels are not capacity-limiting resources, as supplies would be replenished from offsite sources to support each alternative and provided at the point of use on an as-needed basis. Facility operations would consume liquid fuels primarily to produce steam and hot water for facility processes, to provide space heating, and, to a lesser degree, to operate backup generators. In particular, the WTP steam plant would utilize diesel fuel for the production of high-pressure steam as part of the waste vitrification processes.

Water would be required during construction for soil compaction, dust control, and possibly work surface and equipment washdown. Standard construction practices dictate that, at least initially, construction water would be trucked to construction locations on an as-needed basis for these uses until water supply and wastewater treatment utilities are in place. Concrete and grout would be produced in onsite batch plants, which would require large volumes of water. By comparison, relatively little water would be required to meet the potable and sanitary needs of the construction workforce. During operations, water would be required to support process makeup requirements and facility cooling, as well as the potable and sanitary needs of the operations workforce and other uses. To stabilize and partially decontaminate waste treatment, retrieval, and disposal facilities, water would also be used during facility deactivation activities; however, this requirement would be relatively small compared with those for operational and construction demands and for many closure activities, including construction of surface barriers.

Hanford's site utility infrastructure is described in Chapter 3, Section 3.2.2. Table 4–2 summarizes the projected utility infrastructure resource requirements under the Tank Closure alternatives. Projected demands for key utility infrastructure resources and impacts on the respective utility systems from implementation of each of the Tank Closure alternatives are further discussed in the following sections.

Table 4–2. Tank Closure Alternatives – Summary of Utility Infrastructure Requirements

Alternative	Activity Phase	Electricity (M megawatt-hours)	Diesel Fuel[a] (M liters)	Gasoline (M liters)	Water (M liters)
1	Construction	0.11	29.5	2.96	3,270
	Operations	0.000000015	5.93	0.0	0.0
	Deactivation[b]	0.0104	0.47	1.65	29.5
	Closure	N/A	N/A	N/A	N/A
	Total[c]	**0.12**	**35.9**	**4.61**	**3,300**
	Peak (Year)	**0.035 (2008)**	**11.8 (2008)**	**1.0 (2008)**	**1,090 (2008)**

Table 4–2. Tank Closure Alternatives – Summary of Utility Infrastructure Requirements (*continued*)

Alternative	Activity Phase	Electricity (M megawatt-hours)	Diesel Fuel[a] (M liters)	Gasoline (M liters)	Water (M liters)
2A	Construction	0.91	345	48.7	32,800
	Operations	34.2	4,380	160	170,000
	Deactivation	0.48	227	12.6	5,150
	Closure	0.0	1.89	0.005	29.3
	Total[c]	**35.6**	**4,960**	**221**	**208,000**
	Peak (Year)	**0.56 (2078–2079)**	**112 (2078–2079)**	**5.36 (2023–2024)**	**3,720 (2065–2067)**
2B	Construction	0.55	178	30.4	13,200
	Operations	15.9	3,480	107	70,600
	Deactivation	1.42	194	4.78	1,870
	Closure	0.022	185	14.5	677
	Total[c]	**17.9**	**4,040**	**156**	**86,300**
	Peak (Year)	**1.18 (2040)**	**271 (2040)**	**8.23 (2040)**	**3,590 (2040)**
3A	Construction	0.48	172	29.0	13,200
	Operations	12.1	1,390	66.0	60,500
	Deactivation	1.48	114	6.40	2,590
	Closure	0.022	185	14.5	677
	Total[c]	**14.1**	**1,860**	**116**	**77,000**
	Peak (Year)	**0.79 (2040)**	**80.8 (2035–2036)**	**5.03 (2035–2036)**	**2,200 (2039)**
3B	Construction	0.48	172	28.8	13,200
	Operations	10.8	1,400	66.0	60,600
	Deactivation	0.84	114	6.40	2,590
	Closure	0.022	185	14.5	677
	Total[c]	**12.1**	**1,870**	**116**	**77,000**
	Peak (Year)	**0.48 (2039)**	**81.2 (2035–2036)**	**5.03 (2035–2036)**	**2,200 (2039)**
3C	Construction	0.49	173	29.5	13,200
	Operations	18.7	1,500	66.0	60,900
	Deactivation	0.89	114	6.40	2,610
	Closure	0.022	185	14.5	677
	Total[c]	**20.1**	**1,980**	**116**	**77,300**
	Peak (Year)	**0.84 (2039)**	**86.1 (2035–2036)**	**5.03 (2035–2036)**	**2,210 (2039)**
4	Construction	0.49	183	28.4	13,200
	Operations	12.6	1,560	71.0	65,800
	Deactivation	0.84	114	5.81	2,590
	Closure	0.88	190	27.9	655
	Total[c]	**14.8**	**2,050**	**133**	**82,200**
	Peak (Year)	**0.55 (2038–2039)**	**76.2 (2038–2039)**	**10.9 (2043)**	**2,180 (2020–2021)**

Table 4–2. Tank Closure Alternatives – Summary of Utility Infrastructure Requirements (*continued*)

Alternative	Activity Phase	Electricity (M megawatt-hours)	Diesel Fuel[a] (M liters)	Gasoline (M liters)	Water (M liters)
5	Construction	0.50	176	29.2	13,200
	Operations	10.5	3,550	68.9	76,000
	Deactivation	1.14	114	6.26	2,610
	Closure	0.025	268	19.2	760
	Total[c]	**12.2**	**4,110**	**124**	**92,500**
	Peak (Year)	**0.63 (2033)**	**229 (2029–2032)**	**5.89 (2029–2032)**	**3,830 (2033)**
6A, Base Case	Construction	1.80	491	69.1	28,300
	Operations	175	21,300	598	597,000
	Deactivation	6.0	718	22.2	17,300
	Closure	2.09	400	24.8	1,110
	Total[c]	**185**	**23,000**	**714**	**643,000**
	Peak (Year)	**1.93 (2138)**	**232 (2138)**	**8.92 (2149–2150)**	**6,570 (2138)**
6A, Option Case	Construction	1.80	491	69.1	28,300
	Operations	175	21,300	598	597,000
	Deactivation	6.0	718	22.2	17,300
	Closure	5.38	501	22.0	1,350
	Total[c]	**188**	**23,100**	**711**	**643,000**
	Peak (Year)	**1.97 (2078)**	**235 (2078)**	**7.49 (2163)**	**6,580 (2138)**
6B, Base Case	Construction	0.58	207	38.6	13,300
	Operations	16.3	3,560	146	76,200
	Deactivation	1.43	196	5.05	1,910
	Closure	2.85	400	25.6	1,150
	Total[c]	**21.1**	**4,360**	**216**	**92,600**
	Peak (Year)	**1.25 (2040)**	**255 (2040)**	**6.61 (2040)**	**3,530 (2040)**
6B, Option Case	Construction	0.58	207	38.6	13,300
	Operations	16.3	3,560	146	76,200
	Deactivation	1.43	196	5.05	1,910
	Closure	5.48	481	22.0	1,350
	Total[c]	**23.8**	**4,440**	**212**	**92,800**
	Peak (Year)	**1.30 (2040)**	**259 (2040)**	**6.63 (2040)**	**3,530 (2040)**
6C	Construction	0.55	180	30.4	13,200
	Operations	15.9	3,480	107	70,600
	Deactivation	1.42	194	4.78	1,870
	Closure	0.022	185	14.5	677
	Total[c]	**17.9**	**4,040**	**156**	**86,300**
	Peak (Year)	**1.18 (2040)**	**271 (2040)**	**8.23 (2040)**	**3,590 (2040)**

Table 4–2. Tank Closure Alternatives – Summary of Utility Infrastructure Requirements (*continued*)

[a] Assumed to be inclusive of all Number 2 diesel fuel, including road diesel and heating fuel oil.
[b] Reflects activities during the 100-year administrative control period for the No Action Alternative only.
[c] Totals may not equal the sum of the contributions due to rounding.
Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate. To convert liters to gallons, multiply by 0.26417.
Key: M=million; N/A=not applicable.
Source: SAIC 2010a.

4.1.2.1 Alternative 1: No Action

Under Alternative 1, peak utility infrastructure demand would occur over the first 3 years of the project period (assumed to be 2006–2008), and construction of the WTP and related activities would be ongoing. Following termination of these activities at the end of 2008, the predicted demand from tank farm routine operations and related monitoring activities during the administrative control period provides the baseline against which the other alternatives can be most meaningfully compared. Table 4–2 above summarizes the projected infrastructure resource requirements under Alternative 1.

4.1.2.1.1 Electricity

Under Alternative 1, peak annual electrical energy demand in 2008 would remain well within the 1.74-million-megawatt-hour annual capacity (based on a peak load capacity of 199 megawatts) of the Hanford electric power transmission system. Annual electrical energy demand over the subsequent 100-year administrative control period of 0.0001 million megawatt-hours would be a very small fraction (about 0.06 percent) of the 0.17 million megawatt-hours of electricity currently used annually at Hanford.

4.1.2.1.2 Fuel

Annualized liquid fuel consumption (diesel fuel and gasoline) of about 0.02 million liters (0.005 million gallons) during the 100-year administrative control period would be a small fraction (about 0.5 percent) of the 4.3 million liters (1.1 million gallons) of liquid fuels currently used annually at Hanford.

4.1.2.1.3 Water

Peak annual water requirements in 2008 would be well within the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System. Annualized water demands over the ensuing 100-year administrative control period of about 0.29 million liters (0.08 million gallons) would also be a very small fraction (about 0.04 percent) of the approximately 816.6 million liters (215.7 million gallons) of water used annually at Hanford.

4.1.2.2 Alternative 2A: Existing WTP Vitrification; No Closure

Alternative 2A would involve construction, operation, and subsequent deactivation, as appropriate, of a number of new facilities, including replacement facilities, over an extended timeframe. The active project phase under Alternative 2A would run about 90 years, from 2006 through completion of WTP deactivation activities in 2095, excluding the subsequent 100-year administrative control period. Table 4–2 in Section 4.1.2 summarizes the projected infrastructure resource requirements under Alternative 2A. The annual average is the sum of the resource requirement divided by the duration of the alternative (in years).

4.1.2.2.1 Electricity

Electrical energy requirements under Alternative 2A would be dominated by operation of the WTP replacement, along with deactivation of the first WTP, in the 2078–2079 timeframe. The peak electrical energy demand of 0.56 million megawatt-hours (approximating an electric load of 64 megawatts) would be about 32 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system.

4.1.2.2.2 Fuel

Peak diesel fuel consumption under Alternative 2A would total 112 million liters (29.6 million gallons) in 2078–2079, with demand driven by deactivation of the first WTP. Gasoline demand would peak earlier, in 2023–2024, due to operation of the WTP and other facilities along with Effluent Treatment Facility (ETF) replacement construction.

4.1.2.2.3 Water

Water requirements under Alternative 2A would peak in the 2065–2067 timeframe, primarily to support ongoing WTP operations, WTP replacement construction, and Borrow Area C operations. The projected peak water demand of 3,720 million liters (983 million gallons) would be about 20 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 16 percent of the 200 Areas' historical average annual water use of more than 22,700 million liters (6,000 million gallons).

4.1.2.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

The construction, operation, and deactivation of an expanded WTP, in concert with landfill closure activities under this alternative, would place the most demand on utility infrastructure. The active project phase under Alternative 2B would run about 40 years, from 2006 through completion of WTP deactivation, landfill closure, and most other activities in 2045, excluding the subsequent 100-year postclosure (landfill) care period. Table 4–2 in Section 4.1.2 summarizes the projected infrastructure resource requirements under Alternative 2B.

4.1.2.3.1 Electricity

Operation of the WTP and Cesium and Strontium Capsule Processing Facility, coinciding with grout facility operations and construction of surface barrier lobes for landfill closure, would dominate the electrical energy requirements. The peak electrical energy demand of 1.18 million megawatt-hours (approximating an electric load of 135 megawatts) in 2040 would be about 68 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system.

4.1.2.3.2 Fuel

Peak liquid fuel consumption under Alternative 2B would total about 279 million liters (73.7 million gallons) in 2040; demands would be driven by the activities described above.

4.1.2.3.3 Water

Peak water requirements would also occur in 2040, dominated by peak operations coinciding with landfill closure activities. The projected peak water demand of 3,590 million liters (947 million gallons) would be about 19 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford

Export Water System and about 16 percent of the 200 Areas' historical average annual water use of more than 22,700 million liters (6,000 million gallons).

4.1.2.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

Alternative 3A would involve construction, operation, and subsequent deactivation, as appropriate, of a number of new facilities over a 30-year timeframe. Construction, operation, and deactivation of the WTP, including the various waste retrieval and supplemental treatment facilities, in concert with landfill closure activities, would place the highest demand on utility infrastructure. The timeframe of the active project phase under Alternative 3A would run about 37 years, from 2006 through completion of WTP deactivation, landfill closure, and most other activities in 2042, excluding the subsequent 100-year postclosure (landfill) care period. Table 4–2 in Section 4.1.2 summarizes the projected infrastructure resource requirements under Alternative 3A.

4.1.2.4.1 Electricity

Operation of the Cesium and Strontium Capsule Processing Facility, combined with deactivation of the bulk vitrification and separations facilities and construction of surface barrier lobes for landfill closure, would dominate the peak electrical energy requirements. The peak electrical energy demand of 0.79 million megawatt-hours (approximating an electric load of 90 megawatts) in 2040 would be about 45 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system.

4.1.2.4.2 Fuel

Peak liquid fuel consumption under Alternative 3A would total about 85.8 million liters (22.7 million gallons) within the 2035–2036 timeframe. Peak demands would be driven by the WTP, supplemental treatment facility, and Borrow Area C operations, along with surface barrier construction activities.

4.1.2.4.3 Water

Peak water requirements would occur in 2039 under Alternative 3A, with demands dominated by facility operations and Borrow Area C operations and surface barrier construction. The projected peak water demand of 2,200 million liters (581 million gallons) would be about 12 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 10 percent of the 200 Areas' historical average annual water use of more than 22,700 million liters (6,000 million gallons).

4.1.2.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

Construction, operation, and deactivation of the WTP, including the various waste retrieval and supplemental treatment facilities, in concert with landfill closure activities, would place the highest demand on utility infrastructure. The active project phase under Alternative 3B would run about 37 years, from 2006 through completion of WTP deactivation, landfill closure, and most other activities in 2042, excluding the subsequent 100-year postclosure (landfill) care period. Overall, utility demands under this alternative would be very similar to those under Alternative 3A. Table 4–2 in Section 4.1.2 summarizes the projected infrastructure resource requirements under Alternative 3B.

4.1.2.5.1 Electricity

Total electrical energy requirements for implementation of Alternative 3B were projected to be somewhat less than those under Alternative 3A. Although total electrical energy requirements would be dominated by facility operations, led by the WTP and its subsequent deactivation, the nonthermal supplemental treatment facilities under this alternative would have a lower operational demand than the thermal supplemental treatment facilities considered under Alternative 3A. Peak projected electrical energy demand would occur over the 2039 period, driven by ongoing operation of the WTP, Cast Stone Facilities, and Solid-Liquid Separations Facility, coinciding with grout facility operations and construction of landfill closure surface barrier lobes. The peak electrical energy demand of 0.48 million megawatt-hours (approximating an electric load of 55 megawatts) would be about 28 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system.

4.1.2.5.2 Fuel

Peak liquid fuel consumption under Alternative 3B would total about 86.2 million liters (22.8 million gallons) in the 2035–2036 timeframe. Peak demands would be driven by WTP and other facility operations along with Borrow Area C operations and surface barrier construction activities.

4.1.2.5.3 Water

Peak water requirements would occur in 2039 under Alternative 3B. Peak demands under this alternative would correspond to facility operation activities coinciding with Borrow Area C operations and surface barrier construction activities. The projected peak water demand of 2,200 million liters (581 million gallons) would be about 12 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 10 percent of the 200 Areas' historical average annual water use of more than 22,700 million liters (6,000 million gallons).

4.1.2.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

Similar to Alternatives 3A and 3B, construction, operation, and deactivation of the WTP, including the various waste retrieval and supplemental treatment facilities, in concert with landfill closure activities, would place the highest demand on utility infrastructure. The active project phase under Alternative 3C would run about 37 years, from 2006 through completion of WTP deactivation, landfill closure, and most other activities in 2042, excluding the subsequent 100-year postclosure (landfill) care period. Table 4–2 in Section 4.1.2 summarizes the projected infrastructure resource requirements under Alternative 3C.

4.1.2.6.1 Electricity

Total and peak electrical energy demands under this alternative would largely be dominated by operation of the WTP, Steam Reforming Facilities, Solid-Liquid Separations Facility, and grout facility; construction of landfill closure surface barrier lobes would be secondary contributors in the peak timeframe. Power demand would be greater under this alternative than under Alternative 3A or 3B because of the relatively greater energy demands of steam reforming supplemental treatment versus either bulk vitrification or cast stone supplemental treatments. The peak electrical energy demand of 0.84 million megawatt-hours (approximating an electric load of 96 megawatts) over the 2039 timeframe would be about 48 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system.

4.1.2.6.2 Fuel

Peak liquid fuel consumption under Alternative 3C would total about 91.1 million liters (24.1 million gallons) in 2035–2036. As under Alternatives 3A and 3B, liquid fuel requirements would be driven by the facility and Borrow Area C operation requirements coinciding with surface barrier construction activities.

4.1.2.6.3 Water

Peak water requirements would also occur in the 2039 timeframe, driven by facility operations, with construction of landfill closure surface barrier lobes as an additional large contributor. The projected peak water demand of 2,210 million liters (581 million gallons) would be about 12 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 10 percent of the 200 Areas' historical average annual water use of more than 22,700 million liters (6,000 million gallons).

4.1.2.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

Construction, operation, and deactivation of the WTP, including the various waste retrieval and supplemental treatment facilities, would place the highest demand on utility infrastructure. This alternative also represents a hybrid supplemental treatment approach relative to Alternatives 3A through 3C, involving both thermal and nonthermal treatment technologies. However, unlike the previously discussed alternatives, requirements for clean closure of just the BX and SX tank farms would increase usage of some utility resources and slightly extend the demand for utility infrastructure resources further into the future. The active project phase under Alternative 4 would run about 40 years, from 2006 through completion of WTP deactivation, landfill closure, and most other activities in 2045, excluding the subsequent 100-year postclosure (landfill) care period. Table 4–2 in Section 4.1.2 summarizes the projected total and annual average infrastructure resource requirements under Alternative 4.

4.1.2.7.1 Electricity

Electrical energy demand for various tank farm closure activities, including operation of the PPF to support clean closure of the BX and SX tank farms and facility operations, led by the WTP, would result in peak requirements in 2038–2039. The peak electrical energy demand of 0.55 million megawatt-hours (approximating an electric load of 63 megawatts) would be about 32 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system.

4.1.2.7.2 Fuel

Peak diesel fuel consumption under Alternative 4 would total 76.2 million liters (20.1 million gallons) in 2038–2039. Peak demands would be driven by operation of the WTP and PPF, along with clean closure activities. Gasoline consumption would peak later, in 2043, due to operation of the Cesium and Strontium Capsule Processing Facility at the same time as PPF deactivation, as well as concurrent construction of surface barriers for landfill closure of the tank farms that would not be clean-closed.

4.1.2.7.3 Water

Peak water requirements would occur in 2020–2021 under this alternative due to facility operations coinciding with PPF construction. The projected peak water demand of 2,180 million liters (576 million gallons) would be about 12 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 10 percent of the 200 Areas' historical average annual water use of more than 22,700 million liters (6,000 million gallons).

4.1.2.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

Construction and operation of an expanded WTP on an accelerated schedule and supplemental treatment facilities, in concert with landfill closure activities, would place the highest demand on utility infrastructure. The active project phase under Alternative 5 would run about 34 years, from 2006 through completion of WTP deactivation, landfill closure, and most other activities in 2039, excluding the subsequent 100-year postclosure (landfill) care period. Table 4–2 summarizes the projected total and annual average infrastructure resource requirements under Alternative 5.

4.1.2.8.1 Electricity

Facility operations, led by the WTP and Sulfate Removal Facility, would dominate the electrical energy requirements under Alternative 5; the peak electrical energy demand occurring in 2033 would coincide with the projected startup of SST grouting operations and with WTP and supplemental treatment facility operations. The peak electrical energy demand of 0.63 million megawatt-hours (approximating an electric load of 71 megawatts) would be about 36 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system.

4.1.2.8.2 Fuel

Peak liquid fuel consumption under Alternative 5 would total about 235 million liters (62.1 million gallons) in the 2029–2032 timeframe, with demands driven by the activities described above, as well as Hanford surface barrier construction activities.

4.1.2.8.3 Water

Peak water requirements would occur over the 2033 timeframe, driven by facility operations, led by the WTP, along with Hanford surface barrier construction activities. The projected peak water demand of 3,830 million liters (1,010 million gallons) would be about 21 percent of the 18,500-million-liter (4,890-million-gallon) current annual capacity of the Hanford Export Water System and about 17 percent of the 200 Areas' historical average annual water use of more than 22,700 million liters (6,000 million gallons).

4.1.2.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

Under this alternative, three WTP facilities would be constructed, operated, and deactivated sequentially. A replacement facility would be under construction while the previous facility is still operating. Likewise, deactivation of the previous facility would occur when the replacement facility begins operation. These overlapping activities, along with clean closure activities, would compound utility infrastructure resource demands, and peak activities would occur over a much longer timeframe than under the previously discussed alternatives. The active project phase under Alternative 6A would run about 161 years, from 2006 through completion of deactivation of the third WTP, completion of closure activities, and most other activities in 2166 under both the Base and Option Cases, excluding the subsequent 100-year institutional control period. The two cases (Base and Option Cases) considered under Alternative 6A differ as to closure of six sets of cribs and trenches (ditches) in the B and T Areas; landfill closure under the Base Case versus removal and clean closure under the Option Case. Table 4–2 in Section 4.1.2 summarizes the projected total and annual average infrastructure resource requirements under Alternative 6A.

4.1.2.9.1 Electricity

4.1.2.9.1.1 Base Case

As with the alternatives discussed previously, WTP activities would dominate the overall electrical energy requirements. The peak electrical energy demand under Alternative 6A, Base Case, would occur in 2138. This peak would be primarily due to ongoing WTP operations and construction of the second WTP replacement coinciding with deactivation of the first WTP replacement. The peak electrical energy demand of 1.93 million megawatt-hours (approximating an electric load of 220 megawatts) in 2138 would be about 111 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system. Total electricity consumption would also be much higher under Alternative 6A due to the much longer operating period of key facilities.

4.1.2.9.1.2 Option Case

Electrical energy requirements under Alternative 6A, Option Case, would be somewhat higher than those under the Base Case, with peak demands occurring in 2078. The difference would be due to the higher electricity demand to support concurrent WTP operations, WTP replacement construction, and WTP deactivation, plus the added demand of removing the B Area cribs and trenches (ditches) in the same timeframe under this option. The peak electrical energy demand of 1.97 million megawatt-hours (approximating an electric load of 225 megawatts) would be about 113 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system.

4.1.2.9.2 Fuel

4.1.2.9.2.1 Base Case

Peak diesel fuel consumption under Alternative 6A, Base Case, would total up to 232 million liters (61.3 million gallons) in 2138, corresponding with ongoing WTP operations and WTP replacement construction and coinciding with deactivation of the first WTP replacement. Gasoline consumption would peak later, in 2149–2150, due to WTP operations combined with surface barrier construction for landfill closure of the B and T Area cribs and trenches (ditches).

4.1.2.9.2.2 Option Case

Peak and total liquid fuel consumption under Alternative 6A, Option Case, would be somewhat higher than consumption under the Base Case, with peak diesel fuel demands also occurring in 2078 at 235 million liters (62.1 million gallons). Gasoline consumption would peak later, in 2163, driven by Cesium and Strontium Capsule Processing Facility operations and deactivation of the PPF.

4.1.2.9.3 Water

4.1.2.9.3.1 Base Case

Peak water requirements under Alternative 6A, Base Case, would also occur in 2138, as described for the other utility resources. The projected peak water demand of up to 6,570 million liters (1,740 million gallons) in 2138 would be about 36 percent of the 18,500-million-liter (4,890-million-gallon) current annual capacity of the Hanford Export Water System and about 29 percent of the 200 Areas' historical average annual water use of more than 22,700 million liters (6,000 million gallons).

4.1.2.9.3.2 Option Case

Peak and total water demand under Alternative 6A, Option Case, is projected to be nearly identical to that under the Base Case in magnitude and timing, except the water requirements for closure activities would be slightly higher.

4.1.2.10 Alternative 6B: All Vitrification with Separations; Clean Closure

The primary difference between Alternative 6A and Alternative 6B is that Alternative 6B would accomplish waste processing in a shorter timeframe using an expanded WTP and without requiring WTP replacements. The construction, operation, and deactivation of an expanded WTP, in concert with clean closure activities under this alternative, would place the most demand on utility infrastructure. The active project phase under Alternative 6B would run about 95 years, from 2006 through completion of deactivation of the PPF, completion of clean closure activities, and most other activities in 2100 under both the Base and Option Cases, excluding the subsequent 100-year institutional control period. The two cases (Base and Option Cases) considered under Alternative 6B differ as to closure of six sets of cribs and trenches (ditches) in the B and T Areas: landfill closure under the Base Case versus removal and clean closure under the Option Case. Table 4–2 in Section 4.1.2 summarizes the projected infrastructure resource requirements under Alternative 6B.

4.1.2.10.1 Electricity

4.1.2.10.1.1 Base Case

Facility operations, led by the WTP and the Cesium and Strontium Capsule Processing Facility, coinciding with clean closure activities, would result in peak electrical energy demands in 2040 under Alternative 6B, Base Case. The peak electrical energy demand of 1.25 million megawatt-hours (approximating an electric load of 143 megawatts) in 2040 would be about 72 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system.

4.1.2.10.1.2 Option Case

Electrical energy requirements under Alternative 6B, Option Case, would be somewhat higher than those under the Base Case, but peak demands would also occur in 2040. The difference would occur because of the higher electricity demand required to support the addition of clean closure of the six sets of cribs and trenches (ditches) under this option. The peak electrical energy demand of 1.30 million megawatt-hours (approximating an electric load of 148 megawatts) would be about 75 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system.

4.1.2.10.2 Fuel

4.1.2.10.2.1 Base Case

Peak liquid fuel consumption under Alternative 6B, Base Case, would total about 262 million liters (69.2 million gallons) in 2040, with demands driven by the activities described above for electricity.

4.1.2.10.2.2 Option Case

Peak and total liquid fuel consumption under Alternative 6B, Option Case, would be somewhat higher than consumption under the Base Case, with peak fuel demands also occurring in 2040 at 266 million liters (70.3 million gallons).

4.1.2.10.3 Water

4.1.2.10.3.1 Base Case

Peak water requirements under Alternative 6B, Base Case, would occur in 2040, with the timing of the peak based on the activities discussed above. The projected peak water demand of up to 3,530 million liters (933 million gallons) in 2040 would be about 19 percent of the 18,500-million-liter (4,890-million-gallon) current annual capacity of the Hanford Export Water System and about 15 percent of the 200 Areas' historical average annual water use of more than 22,700 million liters (6,000 million gallons).

4.1.2.10.3.2 Option Case

Peak and total water demand under Alternative 6B, Option Case, is projected to be nearly identical to that under the Base Case in magnitude and timing, except the water requirements for closure activities would be slightly higher.

4.1.2.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

The construction, operations, and deactivation of an expanded WTP, in concert with landfill closure activities, would place greater demands on utility infrastructure. Infrastructure requirements under this alternative would mirror those under Alternative 2B, except additional immobilized low-activity waste (ILAW) storage facilities would be needed. The active project phase under Alternative 6C would run about 40 years, from 2006 through completion of WTP deactivation, landfill closure, and most other activities in 2045, excluding the subsequent 100-year postclosure (landfill) care period. Table 4–2 in Section 4.1.2 summarizes the projected total and annual average infrastructure resource requirements under Alternative 6C.

4.1.2.11.1 Electricity

WTP and Cesium and Strontium Capsule Processing Facility operations, coinciding with grout facility operations and construction of surface barrier lobes for landfill closure, would dominate the electrical energy requirements under Alternative 6C. The peak electrical energy demand of 1.18 million megawatt-hours (approximating an electric load of 135 megawatts) in 2040 would be about 68 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system.

4.1.2.11.2 Fuel

Peak liquid fuel consumption under Alternative 6C would total about 279 million liters (73.7 million gallons) in 2040, with demands driven by the activities described above.

4.1.2.11.3 Water

Peak water requirements would occur in 2040, dominated by peak operations coinciding with landfill closure activities. The projected peak water demand of 3,590 million liters (940 million gallons) would be about 19 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 16 percent of the 200 Areas' historical average annual water use of more than 22,700 million liters (6,000 million gallons).

4.1.3 Noise and Vibration

Perceived Change in Sound Level

Change in Level	Perceived Change to the Human Ear
± 1 dB	Not perceptible
± 3 dB	Threshold of perception
± 5 dB	Clearly noticeable
± 10 dB	Twice (or half) as loud
± 20 dB	Fourfold change

Key: dB=decibel. **Source:** MPCA 1999:9.

Facility construction, operations, deactivation, and closure activities, as applicable to each alternative, would result in minor noise impacts of operation of employee vehicles, trucks, construction equipment, generators, and other equipment. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary. Heavy diesel equipment used for construction under most of the alternatives is expected to cause the highest noise levels. For example, if 150 items of construction equipment were operating at the WTP construction site with a sound pressure level of 88 decibels A-weighted (dBA) at 15 meters (50 feet), the contribution to the sound level at the nearest site boundary would be 18 dBA (SAIC 2010a). During a normal daytime shift, the estimated maximum sound level at the site boundary would be well below the Washington State standard daytime maximum noise level limit of 60 dBA for industrial sources impacting residential receptors (WAC 173-60).

Some disturbance of wildlife near the 200 Areas could occur as a result of heavy machinery noise during construction, deactivation, and closure activities, as applicable to each alternative. Noise from operational activities is expected to be similar to existing activities in these areas, resulting in little change in noise levels and impacts on wildlife. Mitigation of impacts on threatened and endangered species is discussed in Section 4.1.7.

The number of employee vehicles and trucks delivering materials for various phases of tank closure activities would vary over the duration of the project and by alternative. The increase in the number of employee vehicle and truck trips is expected to result in a minor increase in traffic noise levels along routes to the site.

Activities at Hanford associated with Tank Closure alternatives that would involve excavation, earthmoving, transportation of fill material, and other vehicle traffic through Hanford could result in ground vibration that could affect operations of the Laser Interferometer Gravitational-Wave Observatory (LIGO). Most of the activities identified to have impacts on this facility would be those that require the use of heavy vehicles or large construction equipment. It is expected that blasting would also have an impact on this facility if it is required for mining. Although DOE would coordinate vibration-producing activities with LIGO, the impacts of such activities under the Tank Closure alternatives are expected to interfere to some degree with the operations of this facility.

4.1.3.1 Alternative 1: No Action

Under Tank Closure Alternative 1, some routine operations and monitoring activities would continue. Activities under this Tank Closure alternative would result in some noise impacts of operation of employee vehicles, trucks, and construction equipment. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be minor due to the distance to the Hanford boundary. Noise levels from tank closure activities would be reduced from the current levels. No additional noise-related disturbance of wildlife is expected near the 200 Areas under this Tank Closure alternative.

4.1.3.2 Alternative 2A: Existing WTP Vitrification; No Closure

Construction, operation, and deactivation of facilities under this Tank Closure alternative would result in minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment, as discussed above. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of tank closure activities would vary over the duration of the project. The highest number of employee trips is expected to occur from 2078 through 2079 during WTP operations and deactivation (SAIC 2010a). The increase in the number of employee vehicles and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This increase in employee and truck traffic (discussed in Section 4.1.9) was compared with the existing average traffic volume (see Chapter 3, Section 3.2.9.4). For the purpose of comparing the alternatives, the increase in traffic noise level can be estimated from the ratio of the projected traffic volume to the existing traffic volume (see Appendix F, Section F.3).

4.1.3.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

Facility construction, operation, and deactivation and tank farm closure activities under this Tank Closure alternative would result in minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment, as discussed above. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be minor due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of tank closure activities would vary over the duration of the project. The highest number of employee trips is expected to occur in 2040 during WTP operations and vacuum-based retrieval (VBR) system construction (SAIC 2010a). The increased number of employee vehicle and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This assessment and conclusion is similar to that previously described under Alternative 2A (see Section 4.1.3.2).

4.1.3.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

Facility construction, operation, and deactivation and tank farm closure activities under this Tank Closure alternative would result in minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment, as discussed above. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of tank closure activities would vary over the duration of the project. The highest number of employee trips is expected to occur in 2035 during WTP operations and VBR system construction (SAIC 2010a). The increase in the number of employee vehicle and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This assessment and conclusion is similar to that previously described under Alternative 2A (see Section 4.1.3.2).

4.1.3.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

Facility construction, operation, and deactivation and tank farm closure activities under this Tank Closure alternative would cause minor noise impacts of employee vehicles, trucks, construction equipment, generators, and process equipment, as discussed above. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of tank closure activities would vary over the duration of the project. The highest number of employee trips is expected to occur in 2035 during WTP operations and VBR system construction (SAIC 2010a). The increase in the number of employee vehicle and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This assessment and conclusion is similar to that previously described under Alternative 2A (see Section 4.1.3.2).

4.1.3.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

Facility construction, operation, and deactivation and tank farm closure activities under this Tank Closure alternative would cause minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment, as discussed above. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of tank closure activities would vary over the duration of the project. The highest number of employee trips is expected to occur in 2035 during WTP operations and VBR system construction (SAIC 2010a). The increase in the number of employee vehicle and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This assessment and conclusion is similar to that previously described under Alternative 2A (see Section 4.1.3.2).

4.1.3.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

Facility construction, operation, and deactivation and tank farm closure activities under this Tank Closure alternative would cause minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment, as discussed above. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of tank closure activities would vary over the duration of the project. The highest number of employee trips is expected to occur in 2019 during WTP operations and construction of the PPF and mobile retrieval system (MRS) (SAIC 2010a). The increase in the number of employee vehicle and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This assessment and conclusion is similar to that previously described under Alternative 2A (see Section 4.1.3.2).

4.1.3.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

Facility construction, operation, and deactivation and tank farm closure activities under this Tank Closure alternative would result in minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment, as discussed above. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of tank closure activities would vary over the duration of the project. The highest number of employee trips is expected to occur from 2029 through 2032 during WTP operation and VBR system construction and operations (SAIC 2010a). The increase in the number of employee vehicle and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This assessment and conclusion is similar to that previously described under Alternative 2A (see Section 4.1.3.2).

4.1.3.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

4.1.3.9.1 Base Case

Facility construction, operation, and deactivation and tank farm closure activities under this Tank Closure alternative would cause minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment, as discussed above. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of tank closure activities would vary over the duration of the project. The highest number of employee trips is expected to occur in 2141 during WTP operations and PPF construction (SAIC 2010a). The increase in the number of employee vehicle and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This assessment and conclusion is similar to that previously described under Alternative 2A (see Section 4.1.3.2).

4.1.3.9.2 Option Case

Facility construction, operation, and deactivation and tank farm closure activities under this Tank Closure alternative would cause minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment, as discussed above. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of tank closure activities would vary over the duration of the project. The highest number of employee trips is expected to occur in 2041 during WTP operations, HLW Interim Storage Facility operations, and PPF construction (SAIC 2010a). The increase in the number of employee vehicle and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This assessment and conclusion is similar to that previously described under Alternative 2A (see Section 4.1.3.2).

4.1.3.10 Alternative 6B: All Vitrification with Separations; Clean Closure

4.1.3.10.1 Base Case

Facility construction, operation, and deactivation and tank farm closure activities under this Tank Closure alternative would cause minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment, as discussed above. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee and truck traffic to deliver materials for various phases of tank closure activities would vary over the duration of the project. The highest number of employee trips is expected to occur from 2021 through 2022 during PPF construction and MRS and WTP operations (SAIC 2010a). The increase in the number of employee vehicle and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This assessment and conclusion is similar to that previously described under Alternative 2A (see Section 4.1.3.2).

4.1.3.10.2 Option Case

Facility construction, operation, and deactivation and tank farm closure activities under this Tank Closure alternative would cause minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment, as discussed above. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee traffic and truck traffic to deliver materials for various phases of tank closure activities would vary over the duration of the project. The highest number of employee trips is expected to occur from 2021 through 2022 during PPF construction and MRS and WTP operations (SAIC 2010a). The increase in the number of employee vehicle and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This assessment and conclusion is similar to that previously described under Alternative 2A (see Section 4.1.3.2).

4.1.3.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

Facility construction, operation, and deactivation and tank farm closure under this Tank Closure alternative would cause minor noise impacts of employee vehicles, trucks, construction equipment and activity, generators, and process equipment, as discussed above. The offsite noise levels from activities at the WTP and 200-East and 200-West Areas would be negligible due to the distance to the Hanford boundary.

Employee traffic and truck traffic to deliver materials for various phases of tank closure activities would vary over the duration of the project. The highest number of employee trips is expected to occur in 2040 during WTP operations, routine operations, VBR system construction and operations, and modified RCRA Subtitle C barrier construction (SAIC 2010a). The increase in the number of employee vehicle and truck trips is expected to cause a minor increase in traffic noise levels along routes to the site. This assessment and conclusion is similar to that previously described under Alternative 2A (see Section 4.1.3.2).

4.1.4 Air Quality

Activities under the various Tank Closure alternatives would result in some air quality impacts due to air pollutant emissions from employee vehicles, trucks, and construction equipment and, as applicable under most Tank Closure alternatives, heating equipment, generators, and process equipment. Criteria pollutant concentrations for the activities associated with each Tank Closure alternative were modeled, and the year with peak concentrations for each alternative, pollutant, and averaging time was identified (see Appendix G). Comparisons of these concentrations with the ambient standards are reflected in Table 4–3. The maximum concentrations resulting from these activities under each Tank Closure alternative would be below the ambient standards for the 8-hour carbon monoxide concentrations, annual concentrations of nitrogen dioxide and PM_{10} [particulate matter with an aerodynamic diameter less than or equal to 10 micrometers], and all sulfur dioxide averaging-period concentrations. Standards would be exceeded for the 24-hour concentrations of particulate matter (PM) under all Tank Closure alternatives, the annual concentrations of $PM_{2.5}$ [PM with an aerodynamic diameter less than or equal to 2.5 micrometers] under the action alternatives, the 1-hour concentrations of nitrogen dioxide under all alternatives, and the 1-hour concentrations of carbon monoxide under several Tank Closure alternatives. The peak period identified under each alternative and the primary contributing activities are discussed for each Tank Closure alternative below. Maximum air quality impacts are expected to occur along State Route 240, along or near the Hanford boundary to the east and southeast, or along the Hanford Reach boundary to the west and southwest. The concentration estimates of PM would be high as a result of the correspondingly high estimated emissions. PM concentrations would be reduced by applying appropriate dust control measures (see Chapter 7, Section 7.1).

Table 4–3. Tank Closure Alternatives – Maximum Incremental Criteria Pollutant Concentrations

Pollutant and Averaging Period	Standard[a] (micrograms per cubic meter)	Maximum Modeled Increment (micrograms per cubic meter)												
		Alternatives												
		1	2A	2B	3A	3B	3C	4	5	6A, Base Case	6A, Option Case	6B, Base Case	6B, Option Case	6C
Carbon Monoxide														
8-hour	10,000[b]	3,410	6,500	6,330	9,360	9,640	9,600	6,030	8,100	5,650	4,180	5,770	5,770	6,120
1-hour	40,000[b]	23,300	**44,900**	**40,500**	**60,900**	**62,000**	**61,900**	40,000	**51,600**	35,100	26,100	38,500	38,500	37,900
Nitrogen Dioxide														
Annual	100[b]	8.19	18.3	20.5	17.9	18.1	18.1	13.6	21.2	18.7	15.8	14.2	15.6	20.5
1-hour	188	**15,200**	**36,500**	**35,200**	**37,800**	**38,000**	**38,000**	**28,400**	**38,600**	**36,400**	**27,000**	**33,200**	**26,200**	**35,300**
PM_{10}[c]														
Annual	50[d]	5.08	16.2	35.0	34.9	34.9	34.9	23.9	35.7	39.0	39.1	37.0	16.2	35.5
24-hour	150[b]	**546**	**1,990**	**4,910**	**4,910**	**4,910**	**4,910**	**3,360**	**5,320**	**5,150**	**3,880**	**5,510**	**2,080**	**4,960**
$PM_{2.5}$[c]														
Annual	15[d]	5.08	**16.2**	**35.0**	**34.9**	**34.9**	**34.9**	**23.9**	**35.7**	**39.0**	**39.1**	**37.0**	**16.2**	**35.5**
24-hour	35[b]	**546**	**1,990**	**4,910**	**4,910**	**4,910**	**4,910**	**3,360**	**5,320**	**5,150**	**3,880**	**5,510**	**2,080**	**4,960**
Sulfur Dioxide														
Annual	50[d]	0.0128	0.0823	0.308	0.151	0.0945	0.0939	0.0946	0.153	0.0781	0.0767	0.292	0.298	0.308
24-hour	260[d]	1.37	4.6	9.26	10.9	6.17	6.11	7.1	10.1	4.41	3.35	6.91	7.31	9.26
3-hour	1,300[b]	8.00	26.9	52.4	50	33.3	33.1	31.5	46.1	23.4	19.3	40.9	42.6	52.4
1-hour	197[e]	24.0	70.7	105	132	88.2	87.6	77.9	112	58.9	47.4	71.5	76.4	105

[a] The more stringent of the Federal and Washington State standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The annual $PM_{2.5}$ standard is met when the 3-year average of the annual means is less than or equal to the standard. The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the 98th percentile 24-hour averages is less than or equal to the standard. The 1-hour nitrogen dioxide standard is met when the 3-year average 98th percentile of the daily maximum 1-hour average does not exceed the standard value.

[b] Federal and Washington State standard.

[c] The Federal standards for $PM_{2.5}$ are 15 micrograms per cubic meter annual average and 35 micrograms per cubic meter 24-hour average. No specific data for $PM_{2.5}$ were available, but for the purpose of analysis concentrations were assumed to be the same as PM_{10}.

[d] Washington State standard.

[e] Federal standard.

Note: The National Ambient Air Quality Standards also include standards for lead and ozone. No sources of lead emissions have been identified for the alternatives evaluated. Washington State also has ambient standards for fluorides. Concentrations in **bold** text indicate potential exceedance of the standard.

Key: PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

Source: Appendix G, Section G.3.

Construction activities considered in estimating PM emissions include general construction equipment activity, windblown particulates from disturbed areas, resuspension of road dust, fuel combustion in construction equipment, and concrete batch plant operations. The emission factor used for these estimates is intended to provide a gross estimate of total suspended particulate emissions when detailed engineering data that would allow for a more refined estimate are not available. For the purpose of this analysis, emissions of PM_{10} and $PM_{2.5}$ from general construction activities were assumed to be the same as the total suspended particulate emissions. This results in a substantial overestimate of PM_{10} and $PM_{2.5}$ emissions. Further, the analysis did not consider emission controls that could be applied in the construction areas, as discussed in Chapter 7, Section 7.1. A refined analysis of emissions based on more-detailed engineering of the construction activities and application of appropriate control technologies is expected to result in substantially lower estimates of emissions and ambient concentrations from the major construction activities under any of the Tank Closure alternatives.

The sulfur dioxide emission factor used for fuel-burning sources was based on equipment burning a distillate fuel with a sulfur content of about 0.0015 percent (15 parts per million [ppm]), which is being phased in beginning in 2007. No adjustment was made for more-restrictive emission standards for nitrogen dioxide and PM, which are also scheduled to be phased in beginning in 2007. In future years, pollutant emissions and impacts are expected to be smaller than estimated in this analysis as better fuels, combustion technologies, emission controls, and alternative energy sources are developed.

Effects of Criteria Air Pollutants

Criteria air pollutants can harm health and the environment and cause property damage. The following are the chief pollutants of concern:

Carbon Monoxide – A colorless, odorless, and tasteless gas that is produced naturally by the human body, where it serves various physiological purposes. At abnormally high levels, however, carbon monoxide is highly toxic to humans and animals because prolonged exposure by inhalation can reduce oxygen in the bloodstream, causing a variety of diseases, including neurodegenerations, hypertension, heart failure, and inflammation.

Nitrogen Dioxide – One of the main precursors to the formation of ground-level ozone, nitrogen dioxide also contributes to the formation of acid rain and toxic chemicals, deterioration of water quality, impairment of visibility, and global warming.

Ozone – The triatomic form of oxygen. In the stratosphere, ozone protects Earth from the Sun's ultraviolet rays, but in lower levels of the atmosphere, ozone is considered an air pollutant. Human or animal exposure to abnormally high levels of ozone can cause breathing difficulties such as aggravated asthma symptoms, as well as more-long-term respiratory illnesses such as lung irritation, reduced lung capacity, and permanent lung damage. High ozone levels also can make sensitive plants more susceptible to damage, affect the appearance of other plants, and reduce crop yields and forest growth.

Particulate Matter – Any finely divided solid or liquid material other than uncombined (i.e., pure) water. Inhalation of particulate matter can result in increased respiratory symptoms, decreased lung function, aggravated asthma, development of chronic bronchitis, irregular heartbeat, nonfatal heart attacks, and premature death in people with heart or lung disease. Fine particulate ($PM_{2.5}$) is a major cause of reduced visibility. Particulate matter also can contribute to acidification of streams and lakes, changes in the nutrient balance of coastal waters and larger river basins, depletion of nutrients in soil, damage to forests and crops, and damage to stone and other building materials.

Sulfur Dioxide – A common air pollutant that contributes to the formation of acid rain, which damages trees, crops, and buildings and makes soils, lakes, and streams acidic. Sulfur dioxide also contributes to reduced visibility.

Lead – The primary sources of lead emissions are ore and metals processing and leaded aviation gasoline use. Exposure to lead can damage organs, including the kidneys, liver, brain, and nerves, especially in infants and young children; it is also harmful to animals and fish.

Source: EPA 2007.

The contributions to the total ambient concentrations from sources in the region and existing and reasonably anticipated sources at Hanford that are unrelated to tank closure are expected to change over the period of the activities evaluated in this environmental impact statement (EIS) and are addressed in the cumulative impacts section. The existing contributions of Hanford sources and regional monitored concentrations are discussed in Chapter 3, Section 3.2.4.

The Clean Air Act, as amended, requires that Federal actions conform to the host state's "state implementation plan" (see Appendix G, Section G.4). The final rule, "Determining Conformity of General Federal Actions to State or Federal Implementation Plans," requires a conformity determination for certain-size projects in nonattainment areas. Hanford is within an area currently designated as in attainment for criteria air pollutants. Therefore, a conformity determination for these Tank Closure alternatives is not necessary to meet the requirements of the final rule (40 CFR 93, Subpart B).

Both carcinogenic and noncarcinogenic toxic pollutant concentrations were evaluated. Potential exposure of members of the public to airborne pollutants would come from process emissions during operations and emissions from equipment used during construction, operations, deactivation, and closure. Selected air toxics were modeled because they represent toxic constituents associated with emissions from operation of gasoline- and diesel-fueled equipment. Ammonia was also selected for modeling because of its relatively high concentration compared with other toxic constituents in the tank vapor spaces. Ammonia's concentration, combined with its toxicity, makes it a good indicator constituent for analysis; that is, if ammonia is found to be within the acceptable source impact level, other toxics should be as well. Maximum concentrations under each alternative and the Washington State acceptable source impact levels are presented in Table 4–4. These concentrations were below the acceptable source impact levels for all Tank Closure alternatives, except for mercury under Alternatives 2B, 6B (Base and Option Cases), and 6C. The acceptable source impact levels used by the state in the permitting process represent concentrations that are sufficiently low to protect human health and safety from potential carcinogenic and other toxic effects (WAC 173-460).

For noninvolved workers at nearby facilities, the highest annual concentration of each toxic chemical was used to estimate the Hazard Quotient for each chemical, as described in Appendix G. The Hazard Quotients were summed to give the Hazard Index from noncarcinogenic chemicals associated with each Tank Closure alternative. A Hazard Index of less than 1 indicates that adverse health effects of non-cancer-causing agents are not expected. Hazard Indices for each alternative are summarized in Table 4–5. For carcinogens, the highest annual concentration was used to estimate the increased cancer risk from a chemical. Cancer risks from nonradioactive toxic pollutant emissions under each Tank Closure alternative are summarized in Table 4–6.

Table 4–4. Tank Closure Alternatives – Maximum Incremental Toxic Chemical Concentrations

Pollutant	Averaging Period	Acceptable Source Impact Level[a] (micrograms per cubic meter)	Maximum Modeled Increment (micrograms per cubic meter) – Alternatives: 1	2A	2B	3A	3B	3C	4	5	6A, Base Case	6A, Option Case	6B, Base Case	6B, Option Case	6C
Ammonia	24-hour	70.8	26.1	19.9	12.0	12.2	12.2	12.3	12.1	12.3	10.5	10.2	12.2	12.2	11.7
Benzene	Annual	0.0345	0.00252	0.00588	0.00459	0.00597	0.00622	0.00598	0.00354	0.00601	0.0048	0.00311	0.00460	0.0037	0.0046
1,3-Butadiene	Annual	0.00588	0.000070	0.000159	0.000127	0.000146	0.000151	0.000146	0.000107	0.000151	0.000141	0.0000842	0.000133	0.000101	0.000127
Formaldehyde	Annual	0.167	0.00227	0.0052	0.0041	0.00488	0.00504	0.00488	0.00334	0.00498	0.0045	0.00272	0.00428	0.00327	0.0041
Mercury	24-hour	0.09	0.0	0.00590	**0.117**	0.0169	0.00786	0.0129	0.0130	0.0182	0.00237	0.00236	**0.117**	**0.117**	**0.117**
Toluene	24-hour	5,000	1.69	4.3	3.62	6	6.26	6	3	5.42	3.72	2.56	3.96	2.8	3.63
Xylene	24-hour	(b)	0.506	1.29	1.1	1.78	1.86	1.78	0.896	1.62	1.14	0.747	1.2	0.84	1.11

[a] WAC 173-460. Acceptable source impact levels were updated in this environmental impact statement.

[b] Not listed in WAC 173-460.

Note: To convert cubic meters to cubic feet, multiply by 35.315. Concentrations in **bold** are above the acceptable source impact level.

Source: Appendix G, Section G.3.

Table 4–5. Tank Closure Alternatives – Nonradioactive Airborne Toxic Chemical Hazard Index for the Nearest Noninvolved Worker

Chemical	Hazard Quotient												
	Alternatives												
	1	2A	2B	3A	3B	3C	4	5	6A, Base Case	6A, Option Case	6B, Base Case	6B, Option Case	6C
Ammonia	7.9×10^{-2}	9.14×10^{-2}	5.42×10^{-2}	5.47×10^{-2}	5.50×10^{-2}	5.53×10^{-2}	5.37×10^{-2}	5.79×10^{-2}	6.90×10^{-2}	6.66×10^{-2}	6.67×10^{-2}	6.42×10^{-2}	5.33×10^{-2}
Mercury	0.00	3.02×10^{-3}	4.07×10^{-2}	3.72×10^{-2}	5.07×10^{-3}	1.91×10^{-2}	1.44×10^{-2}	1.64×10^{-2}	1.43×10^{-3}	1.41×10^{-3}	4.07×10^{-2}	4.07×10^{-2}	4.07×10^{-2}
Toluene	3.28×10^{-5}	7.03×10^{-4}	4.93×10^{-4}	5.27×10^{-4}	5.55×10^{-4}	5.70×10^{-4}	5.21×10^{-4}	6.45×10^{-4}	1.53×10^{-3}	1.44×10^{-3}	9.39×10^{-4}	8.49×10^{-4}	4.28×10^{-4}
Xylene(s)	4.92×10^{-4}	1.01×10^{-2}	7.22×10^{-3}	7.71×10^{-3}	8.10×10^{-3}	8.32×10^{-3}	7.66×10^{-3}	9.39×10^{-3}	2.23×10^{-2}	2.10×10^{-2}	1.38×10^{-2}	1.25×10^{-2}	6.62×10^{-3}
Hazard Index	7.95×10^{-2}	1.05×10^{-1}	1.03×10^{-1}	1.00×10^{-1}	6.87×10^{-2}	8.34×10^{-2}	7.63×10^{-2}	8.43×10^{-2}	9.43×10^{-2}	9.05×10^{-2}	1.22×10^{-1}	1.18×10^{-1}	1.01×10^{-1}

Source: Appendix G, Section G.3.

Table 4–6. Tank Closure Alternatives – Nonradioactive Airborne Toxic Chemical Cancer Risk for the Nearest Noninvolved Worker

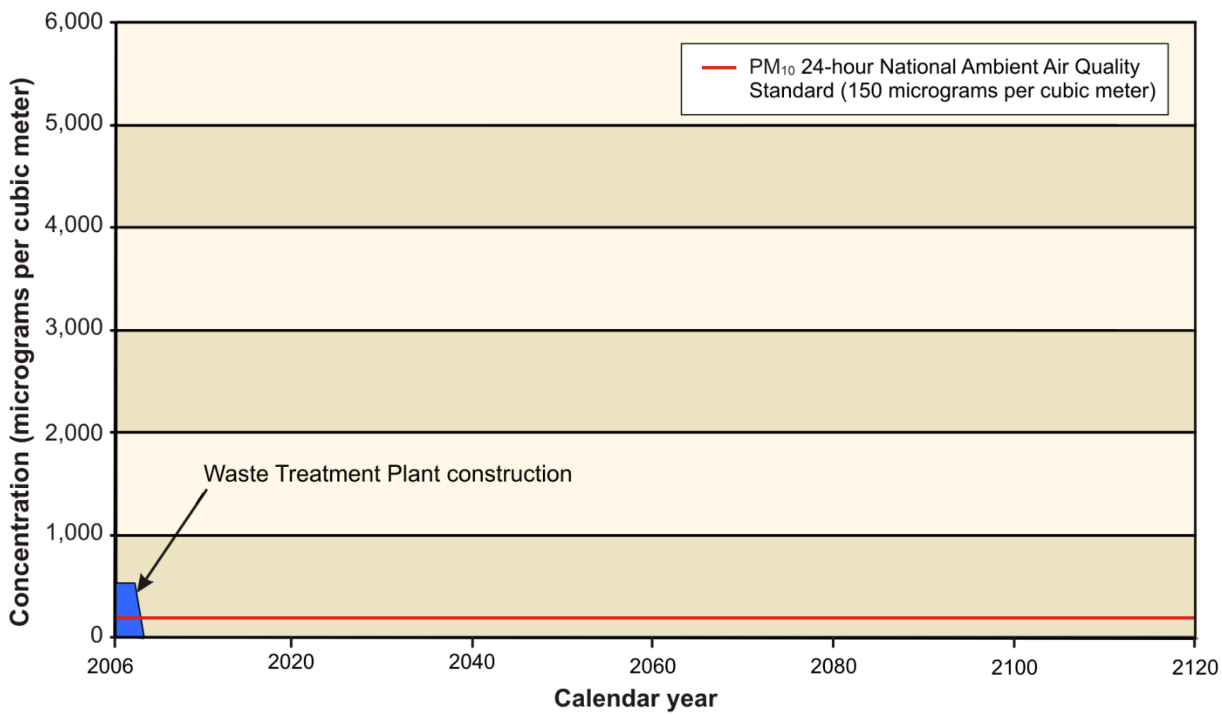
Chemical	Alternatives												
	1	2A	2B	3A	3B	3C	4	5	6A, Base Case	6A, Option Case	6B, Base Case	6B, Option Case	6C
Benzene	2.04×10^{-7}	2.54×10^{-6}	2.32×10^{-6}	2.42×10^{-6}	2.56×10^{-6}	2.56×10^{-6}	2.36×10^{-6}	2.85×10^{-6}	6.69×10^{-6}	6.23×10^{-6}	4.85×10^{-6}	4.39×10^{-6}	2.19×10^{-6}
1,3-Butadiene	2.18×10^{-8}	1.63×10^{-7}	2.02×10^{-7}	2.07×10^{-7}	2.14×10^{-7}	2.15×10^{-7}	2.37×10^{-7}	2.34×10^{-7}	5.46×10^{-7}	5.03×10^{-7}	4.58×10^{-7}	4.15×10^{-7}	1.97×10^{-7}
Formaldehyde	3.08×10^{-7}	2.62×10^{-6}	2.99×10^{-6}	3.06×10^{-6}	3.18×10^{-6}	3.20×10^{-6}	3.46×10^{-6}	3.51×10^{-6}	8.20×10^{-6}	7.58×10^{-6}	6.64×10^{-6}	6.01×10^{-6}	2.89×10^{-6}

Source: Appendix G, Section G.3.

4.1.4.1 Alternative 1: No Action

Criteria pollutant concentrations from activities under Tank Closure Alternative 1 are presented in Table 4–3. Peak concentrations of carbon monoxide and nitrogen dioxide would occur in 2008. Peak concentrations of PM and sulfur dioxide would occur from 2006 through 2008. These peak period concentrations would result primarily from WTP construction activities and tank upgrade construction. The maximum air quality impacts of PM_{10} emissions would occur south of State Route 240 and 1,000 meters (0.6 miles) southeast of the site boundary. Figure 4–3 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.

Maximum concentrations for carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–4. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated under this alternative. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–5 and 4–6. A Hazard Index of less than 1 indicates that adverse health effects of non-cancer-causing agents are not expected.



Key: PM_{10} =particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.

Figure 4–3. Tank Closure Alternative 1 PM_{10} Maximum 24-Hour Concentration

4.1.4.2 Alternative 2A: Existing WTP Vitrification; No Closure

Criteria pollutant concentrations from activities under Tank Closure Alternative 2A are presented in Table 4–3. Peak concentrations of all criteria pollutants would occur from 2065 through 2066. These peak period concentrations would result primarily from WTP replacement construction and Borrow Area C operations, with two exceptions: sulfur dioxide would result from WTP operations and replacement construction, and carbon monoxide would result from WTP and 242-A Evaporator replacement construction. The maximum air quality impacts of PM_{10} emissions would occur south of State Route 240 (24-hour average) and southeast near the site boundary. Figure 4–4 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–4. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated under this alternative. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–5 and 4–6.

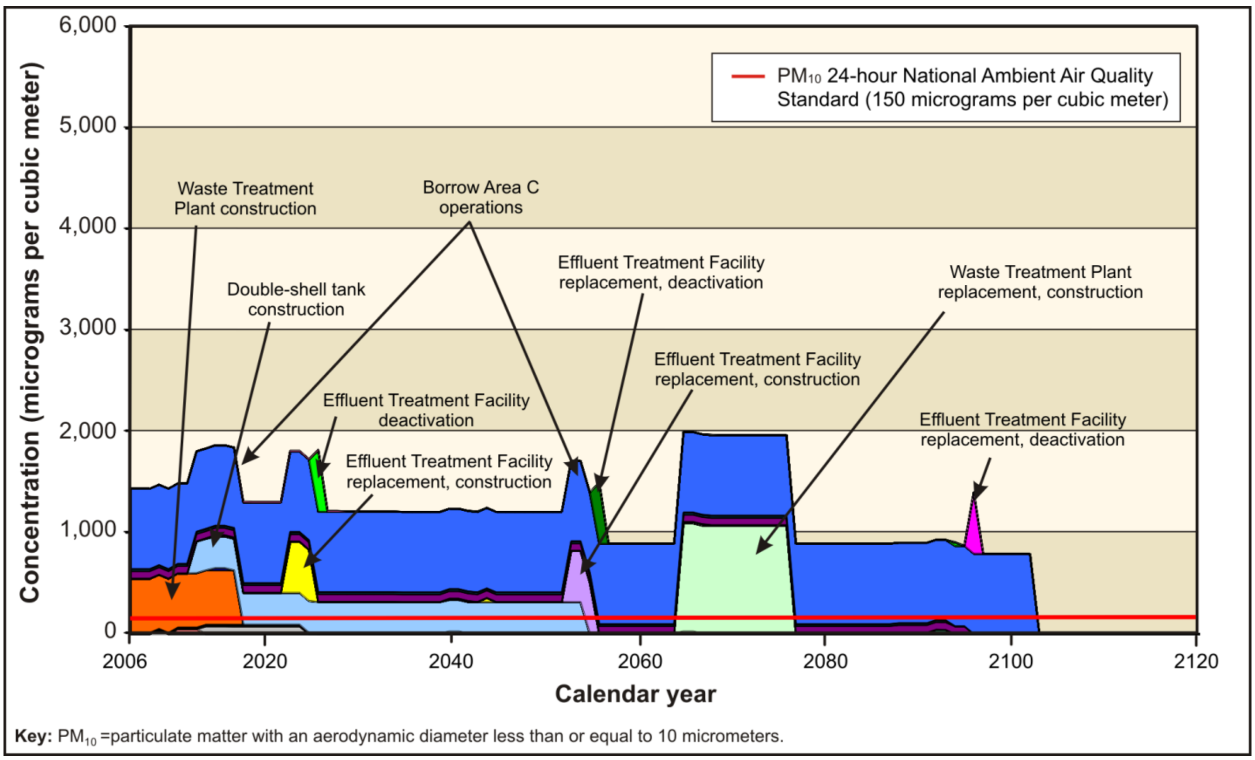
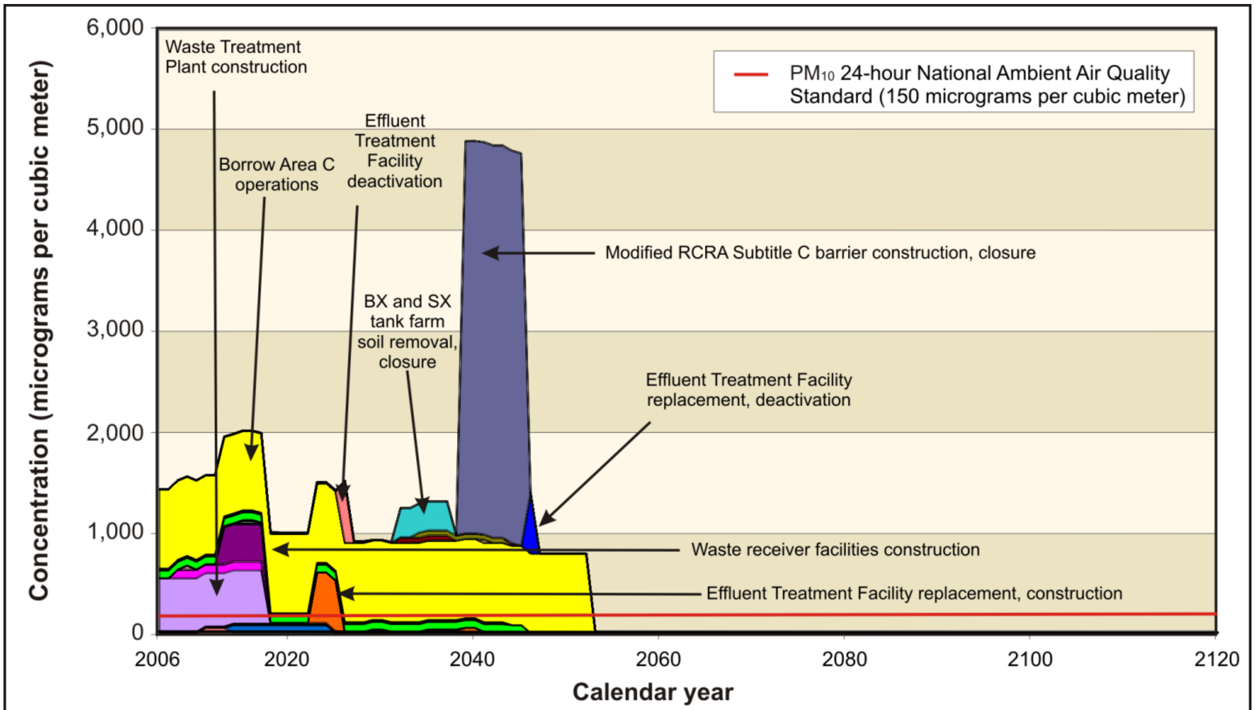


Figure 4–4. Tank Closure Alternative 2A PM_{10} Maximum 24-Hour Concentration

4.1.4.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

Criteria pollutant concentrations from activities under Tank Closure Alternative 2B are presented in Table 4–3. Peak concentrations of all criteria pollutants would occur in 2040, except for the carbon monoxide 1-hour average, for which the peak concentration would occur from 2015 through 2016. The peak period PM_{10} concentration would result primarily from modified RCRA Subtitle C barrier placement and Borrow Area C operations. The maximum air quality impacts of PM_{10} emissions would occur to the south along State Route 240 and to the southeast along the Hanford boundary. Figure 4–5 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–4. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated under this alternative, except for mercury. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–5 and 4–6.



Key: PM_{10} =particulate matter with an aerodynamic diameter less than or equal to 10 micrometers; RCRA=Resource Conservation and Recovery Act.

Figure 4–5. Tank Closure Alternative 2B PM_{10} Maximum 24-Hour Concentration

4.1.4.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

Criteria pollutant concentrations from activities under Tank Closure Alternative 3A are presented in Table 4–3. Peak concentrations of carbon monoxide, sulfur dioxide, and nitrogen dioxide would occur from 2035 through 2036. Peak concentrations of PM would occur in 2039. These peak period concentrations would result primarily from modified RCRA Subtitle C barrier construction (for nitrogen dioxide and PM); Cesium and Strontium Capsule Processing Facility construction and modified RCRA Subtitle C barrier construction (for carbon monoxide); and Cesium and Strontium Capsule Processing Facility construction, WTP operations, and Bulk Vitrification Facility operations (for sulfur dioxide). PM_{10} concentrations would exceed ambient concentration standards periodically through the year 2052. Figure 4–6 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.

Maximum concentrations for carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–4. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated under this alternative. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–5 and 4–6.

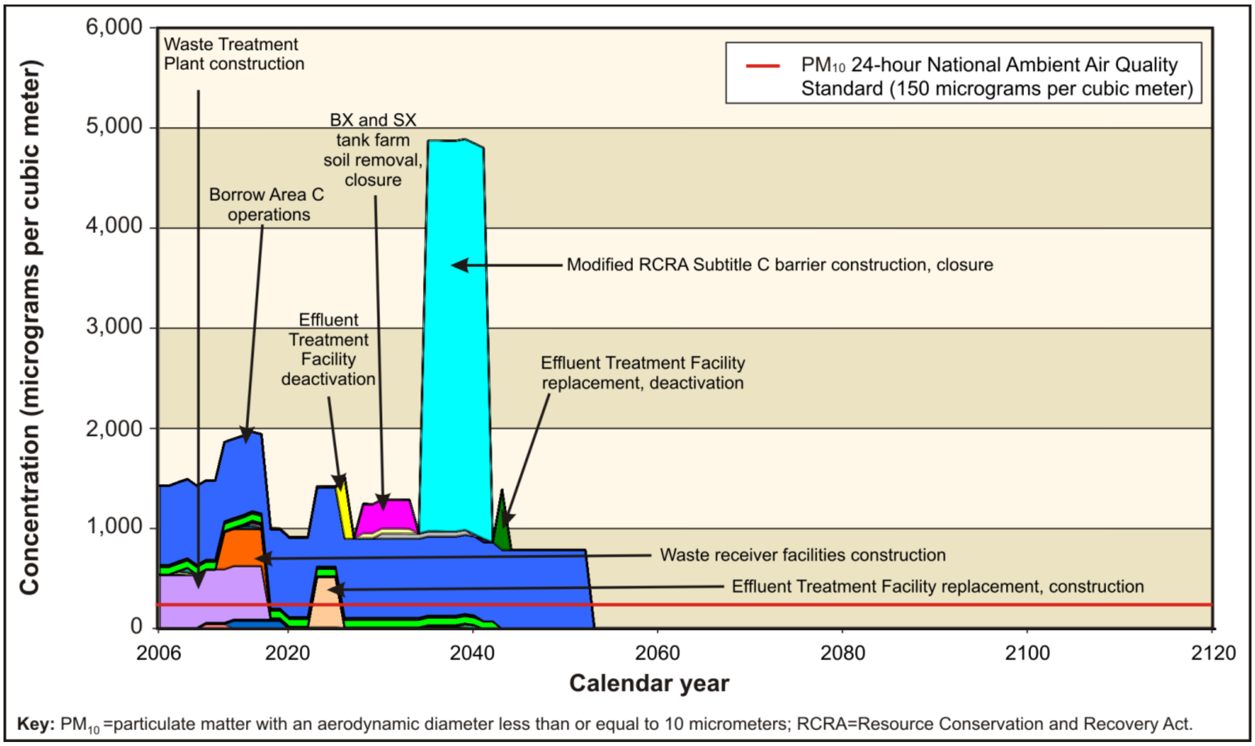
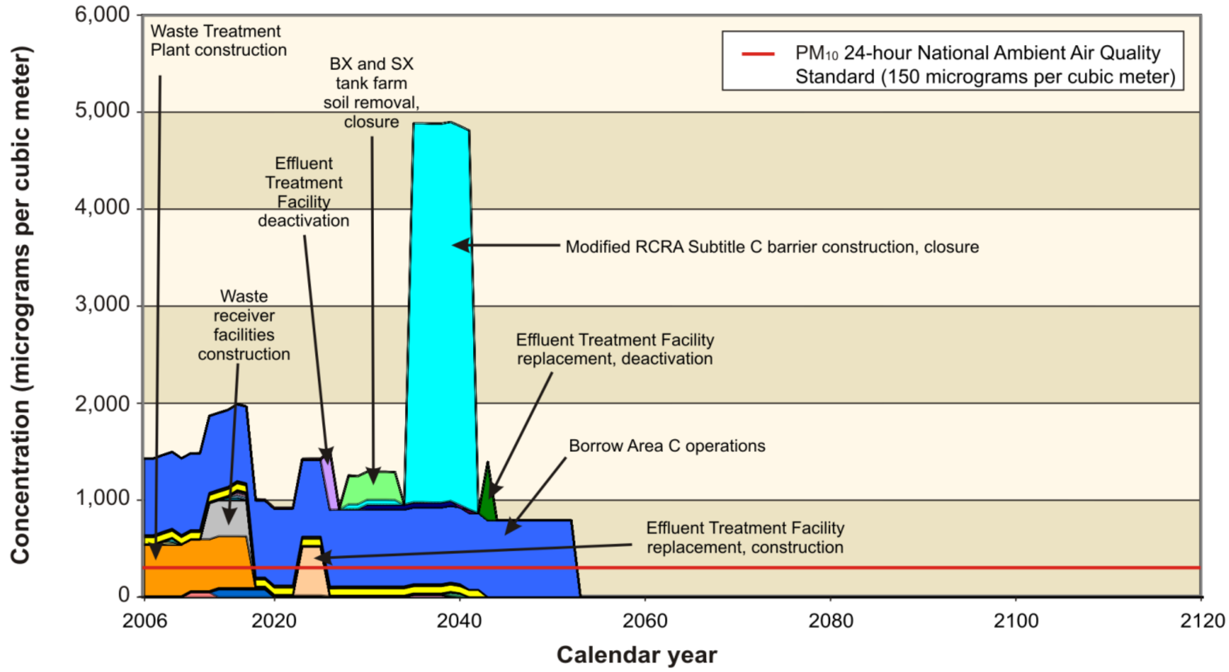


Figure 4–6. Tank Closure Alternative 3A PM_{10} Maximum 24-Hour Concentration

4.1.4.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

Criteria pollutant concentrations from activities under Tank Closure Alternative 3B are presented in Table 4–3. Peak concentrations of carbon monoxide, nitrogen dioxide, and sulfur dioxide would occur from 2035 through 2036. Peak concentrations of PM would occur in 2039. These peak period concentrations would result primarily from modified RCRA Subtitle C barrier construction and Borrow Area C operations (for PM); Cesium and Strontium Capsule Processing Facility deactivation, WTP operations, and modified RCRA Subtitle C barrier construction (for sulfur dioxide); Cesium and Strontium Capsule Processing Facility construction and modified RCRA Subtitle C barrier construction (for carbon monoxide); and modified RCRA Subtitle C barrier construction (for nitrogen dioxide). PM_{10} concentrations would exceed ambient concentration standards periodically from 2006 through 2052. Figure 4–7 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.

Maximum concentrations for carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–4. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated under this alternative. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–5 and 4–6.



Key: PM_{10} =particulate matter with an aerodynamic diameter less than or equal to 10 micrometers; RCRA=Resource Conservation and Recovery Act.

Figure 4–7. Tank Closure Alternative 3B PM_{10} Maximum 24-Hour Concentration

4.1.4.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

Criteria pollutant concentrations from activities under Tank Closure Alternative 3C are presented in Table 4–3. Peak concentrations of carbon monoxide, nitrogen dioxide, and sulfur dioxide would occur from 2035 through 2036. Peak concentrations of PM would occur in 2039. These peak period concentrations would result primarily from modified RCRA Subtitle C barrier construction and Borrow Area C operations (for PM); Cesium and Strontium Capsule Processing Facility construction, WTP operations, and modified RCRA Subtitle C barrier construction (for sulfur dioxide); modified RCRA Subtitle C barrier construction (for nitrogen dioxide); and Cesium and Strontium Capsule Processing Facility construction and modified RCRA Subtitle C barrier construction (for carbon monoxide). The peak period concentration of sulfur dioxide would result primarily from WTP operations. PM_{10} concentrations would exceed ambient concentration standards periodically from 2006 through 2052. Figure 4–8 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.

Maximum concentrations for carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–4. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated under this alternative. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–5 and 4–6.

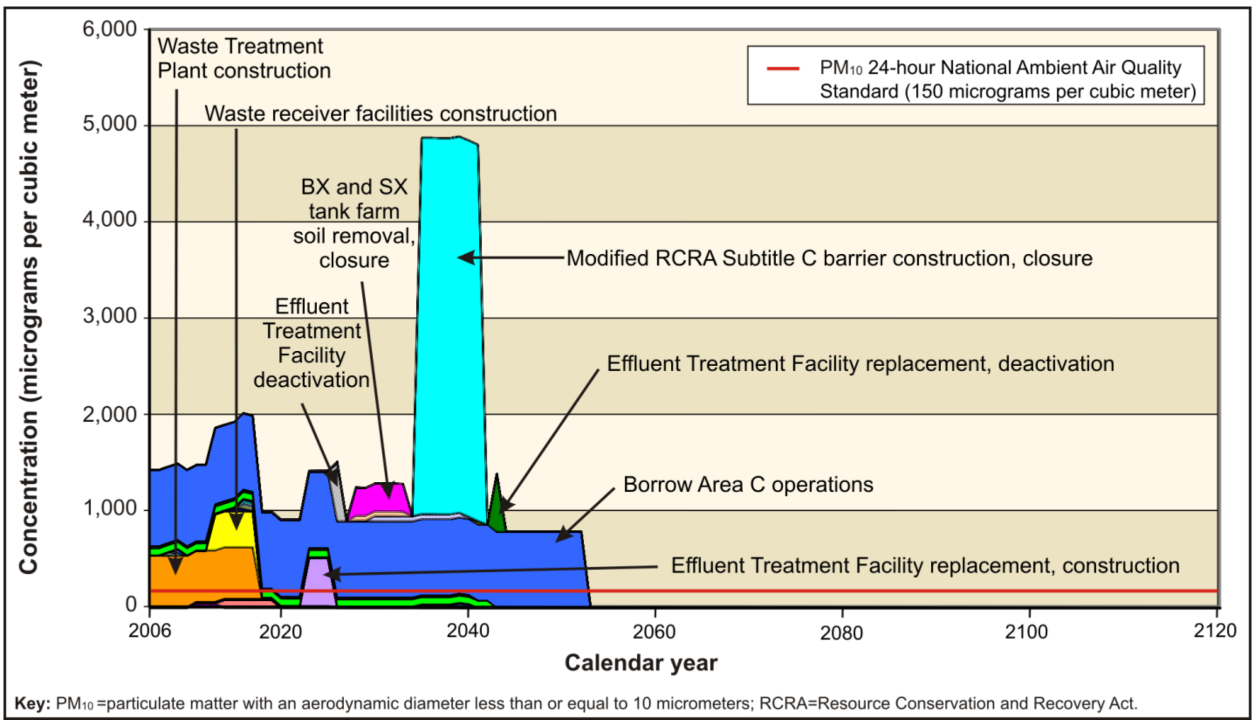


Figure 4–8. Tank Closure Alternative 3C PM_{10} Maximum 24-Hour Concentration

4.1.4.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

Criteria pollutant concentrations from activities under Tank Closure Alternative 4 are presented in Table 4–3. Peak concentrations of carbon monoxide would occur in 2016. Peak concentrations of nitrogen dioxide and sulfur dioxide would occur from 2038 through 2039. The peak concentration of PM would occur in 2042. These peak period concentrations would result primarily from WTP construction (for carbon monoxide), modified RCRA Subtitle C barrier construction (for nitrogen dioxide and PM), and WTP and Bulk Vitrification Facility operations and modified RCRA Subtitle C barrier construction (for sulfur dioxide). PM_{10} concentrations would exceed ambient concentration standards periodically from 2006 through 2052. Figure 4–9 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.

Maximum concentrations for carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–4. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated under this alternative. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–5 and 4–6.

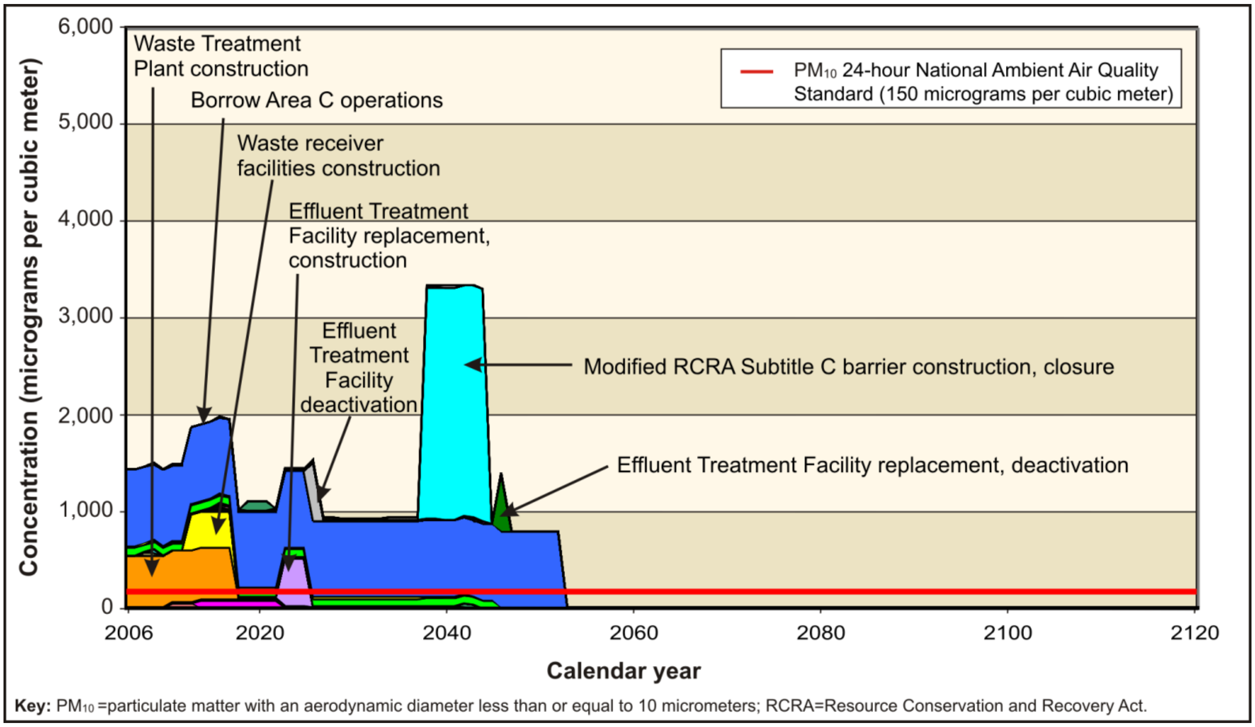


Figure 4–9. Tank Closure Alternative 4 PM_{10} Maximum 24-Hour Concentration

4.1.4.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

Criteria pollutant concentrations from activities under Tank Closure Alternative 5 are presented in Table 4–3. Peak concentrations of carbon monoxide (8-hour average), nitrogen dioxide, and sulfur dioxide would occur from 2029 through 2032. The peak concentration of carbon monoxide (1-hour average) would occur in 2016. The peak concentration of PM would occur in 2037. These peak period concentrations would result primarily from Hanford barrier construction (for carbon monoxide [8-hour average], nitrogen dioxide, and PM); WTP, tank upgrade, and Sulfate Removal Facility construction (for carbon monoxide [1-hour average]); and WTP and Bulk Vitrification Facility operations and Hanford barrier construction (for sulfur dioxide). PM_{10} concentrations would exceed ambient concentration standards periodically through 2052. Figure 4–10 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.

Maximum concentrations for carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–4. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated under this alternative. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–5 and 4–6.

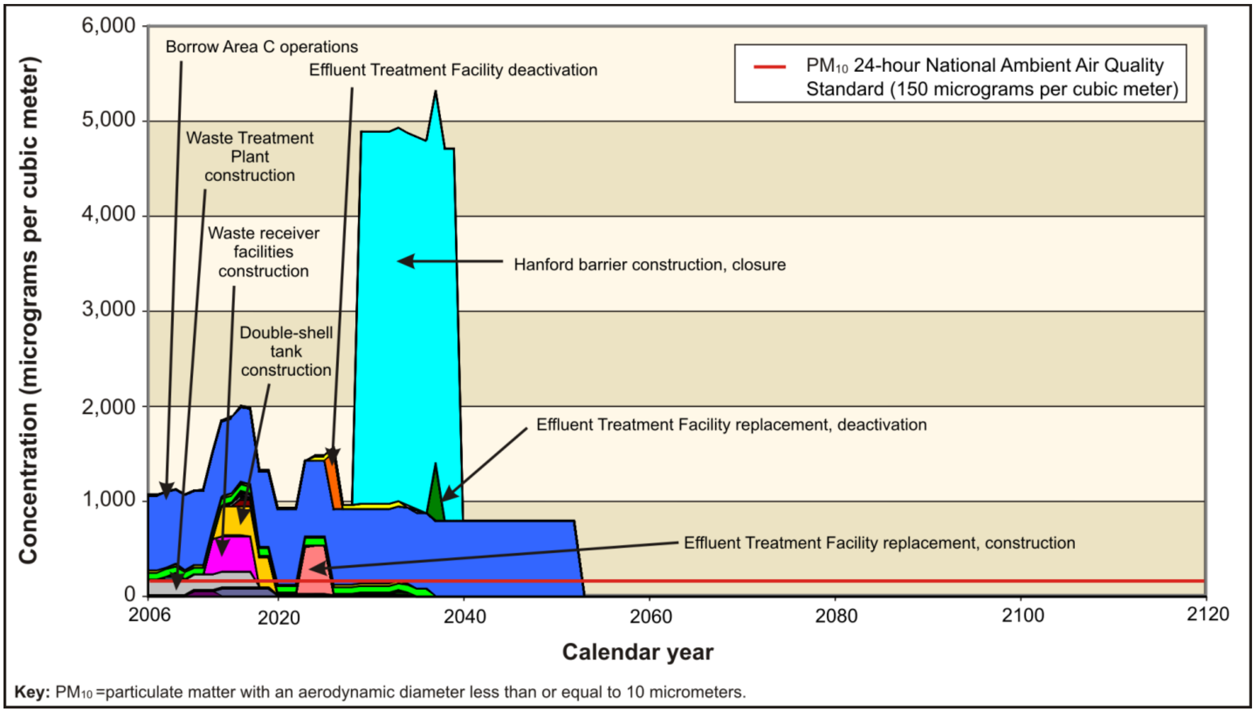


Figure 4–10. Tank Closure Alternative 5 PM_{10} Maximum 24-Hour Concentration

4.1.4.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

4.1.4.9.1 Base Case

Criteria pollutant concentrations from activities under Tank Closure Alternative 6A, Base Case, are presented in Table 4–3. Peak concentrations of carbon monoxide, nitrogen dioxide, PM, and sulfur dioxide would occur from 2149 through 2150. These peak period concentrations would result primarily from modified RCRA Subtitle C barrier construction. PM_{10} concentrations would exceed ambient concentration standards periodically through 2197. The peak period concentration for PM (annual) would result primarily from double-shell tank (DST) replacement construction and ETF replacement construction. Figure 4–11 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.

Maximum concentrations for carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–4. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated under this alternative. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–5 and 4–6.

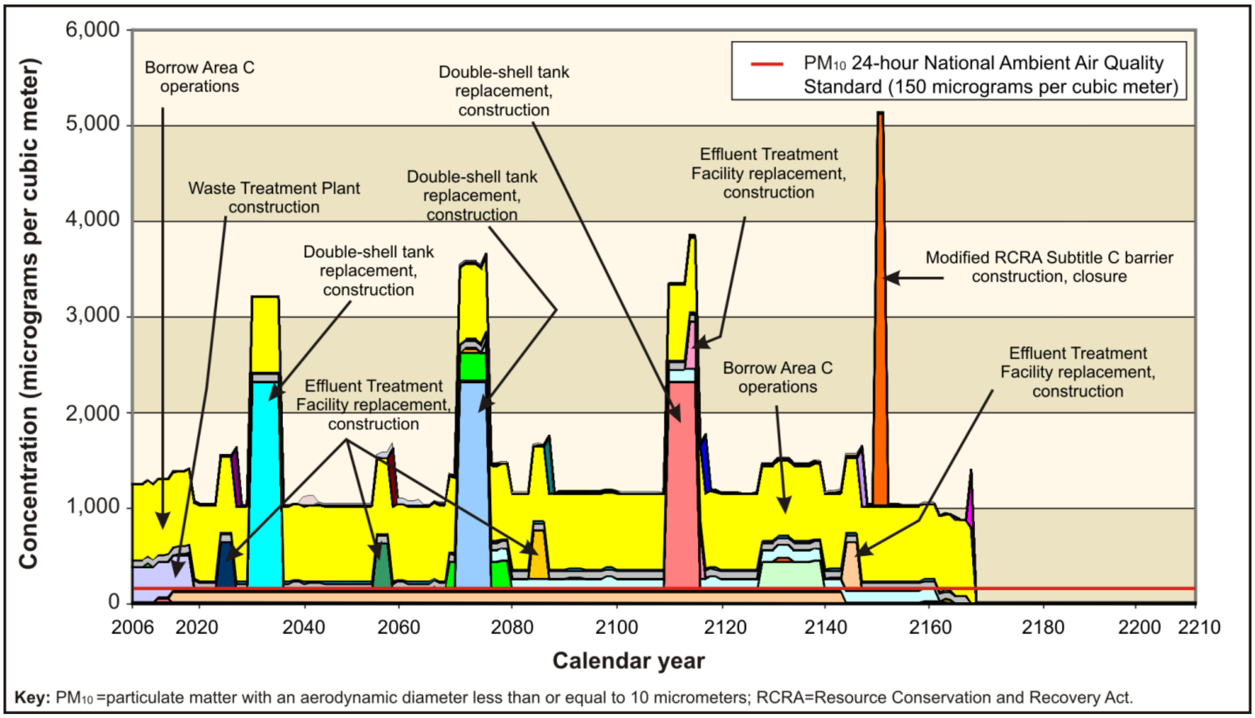


Figure 4–11. Tank Closure Alternative 6A, Base Case, PM_{10} Maximum 24-Hour Concentration

4.1.4.9.2 Option Case

Criteria pollutant concentrations from activities under Tank Closure Alternative 6A, Option Case, are presented in Table 4–3. Peak concentrations of carbon monoxide and PM would occur from 2113 through 2114. Peak concentrations of sulfur dioxide (1-hour, 3-hour, and annual averages) would occur from 2158 through 2161. Peak concentrations of sulfur dioxide (24-hour average) would occur in 2115. Peak concentrations of nitrogen dioxide would occur from 2069 through 2074. These peak period concentrations would result primarily from ETF and DST replacement construction (for carbon monoxide and PM); ETF replacement construction and WTP operations (for sulfur dioxide [24-hour average]); WTP operations (for sulfur dioxide [1-hour, 3-hour, and annual averages]); and DST and WTP replacement construction and WTP operations (for nitrogen dioxide). PM_{10} concentrations would exceed ambient concentration standards periodically through 2197. Figure 4–12 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.

Maximum concentrations for carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–4. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated under this alternative. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–5 and 4–6.

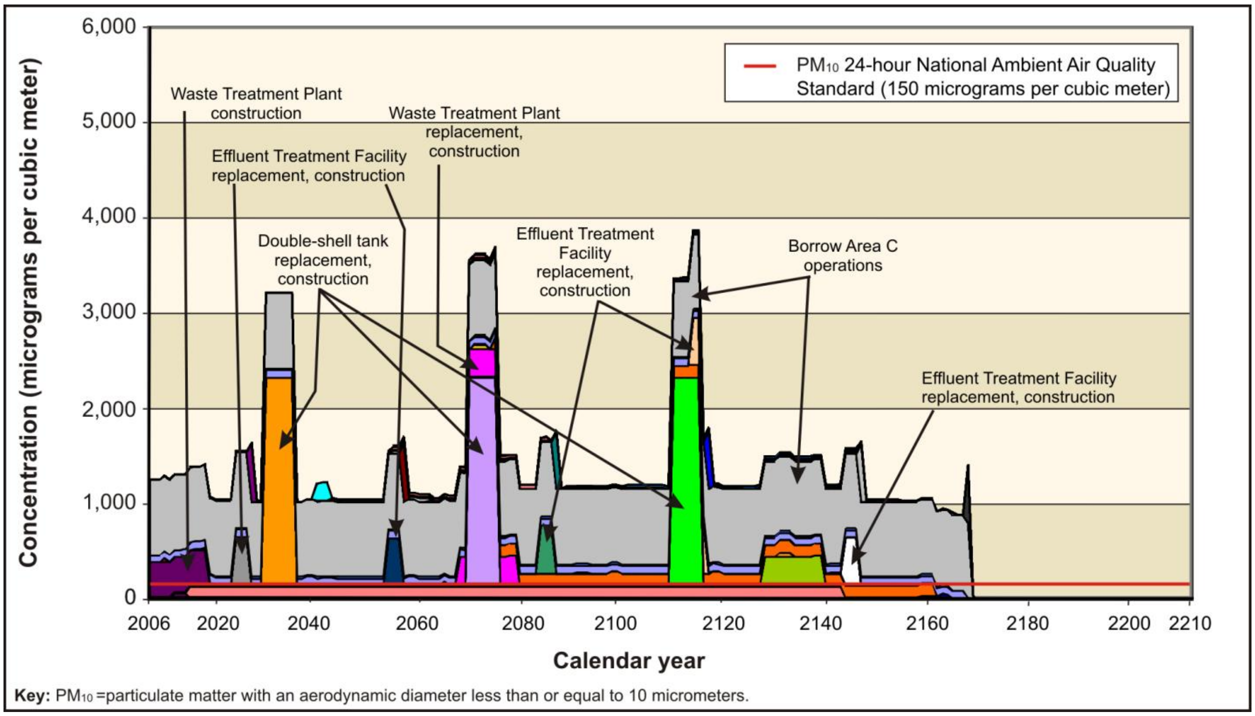


Figure 4–12. Tank Closure Alternative 6A, Option Case, PM_{10} Maximum 24-Hour Concentration

4.1.4.10 Alternative 6B: All Vitrification with Separations; Clean Closure

4.1.4.10.1 Base Case

Criteria pollutant concentrations from activities under Tank Closure Alternative 6B, Base Case, are presented in Table 4–3. Peak concentrations of carbon monoxide would occur in 2016. Peak concentrations of nitrogen dioxide and PM would occur in 2101. Peak concentrations of sulfur dioxide would occur in 2040. These peak period concentrations would result primarily from WTP, tank upgrade, and 242-A Evaporator construction (for carbon dioxide); modified RCRA Subtitle C barrier construction (for nitrogen dioxide and PM); and WTP and Cesium and Strontium Capsule Processing Facility operations (for sulfur dioxide). PM_{10} concentrations would exceed ambient concentration standards periodically through 2102. Figure 4–13 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.

Maximum concentrations for carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–4. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated under this alternative, except for mercury. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–5 and 4–6.

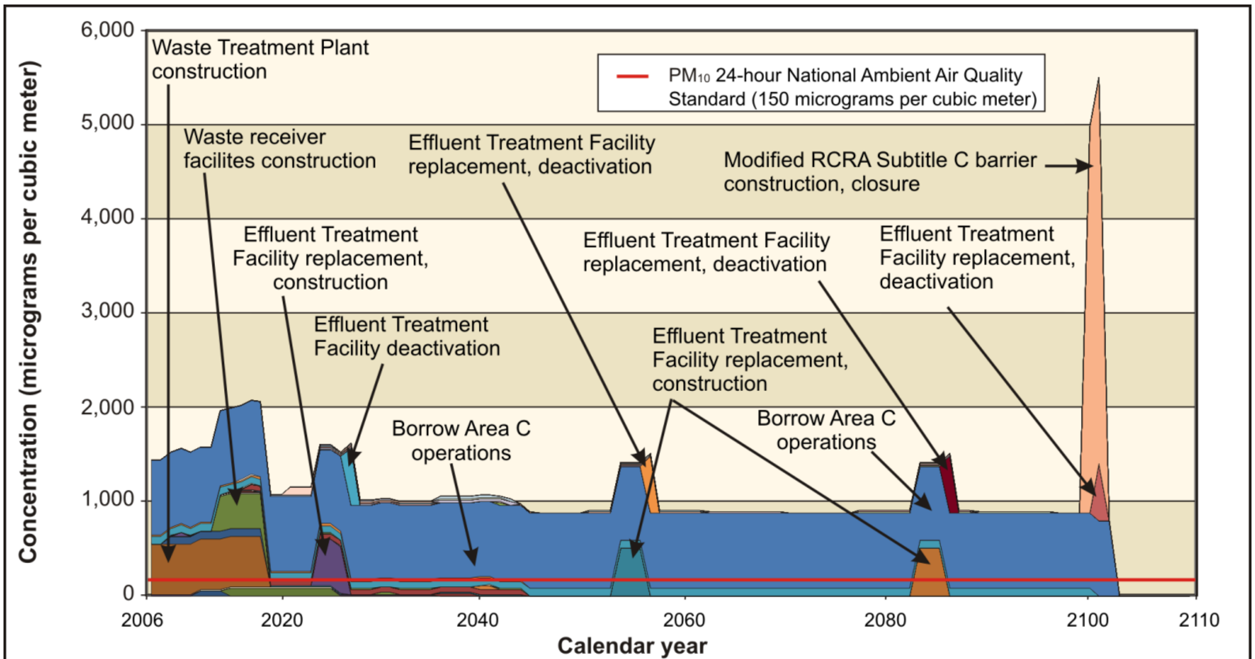


Figure 4–13. Tank Closure Alternative 6B, Base Case, PM_{10} Maximum 24-Hour Concentration

4.1.4.10.2 Option Case

Criteria pollutant concentrations from activities under Tank Closure Alternative 6B, Option Case, are presented in Table 4–3. Peak concentrations of carbon monoxide and PM would occur in 2016. Peak concentrations of nitrogen dioxide and sulfur dioxide would occur in 2040. These peak period concentrations would result primarily from WTP construction (for carbon monoxide), WTP and waste receiver facility (WRF) construction and Borrow Area C operations (for PM), and WTP and Cesium and Strontium Capsule Processing Facility operations (for nitrogen dioxide and sulfur dioxide). PM_{10} concentrations would exceed ambient concentration standards periodically through 2102. Figure 4–14 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.

Maximum concentrations for carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–4. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated under this alternative, except for mercury. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–5 and 4–6.

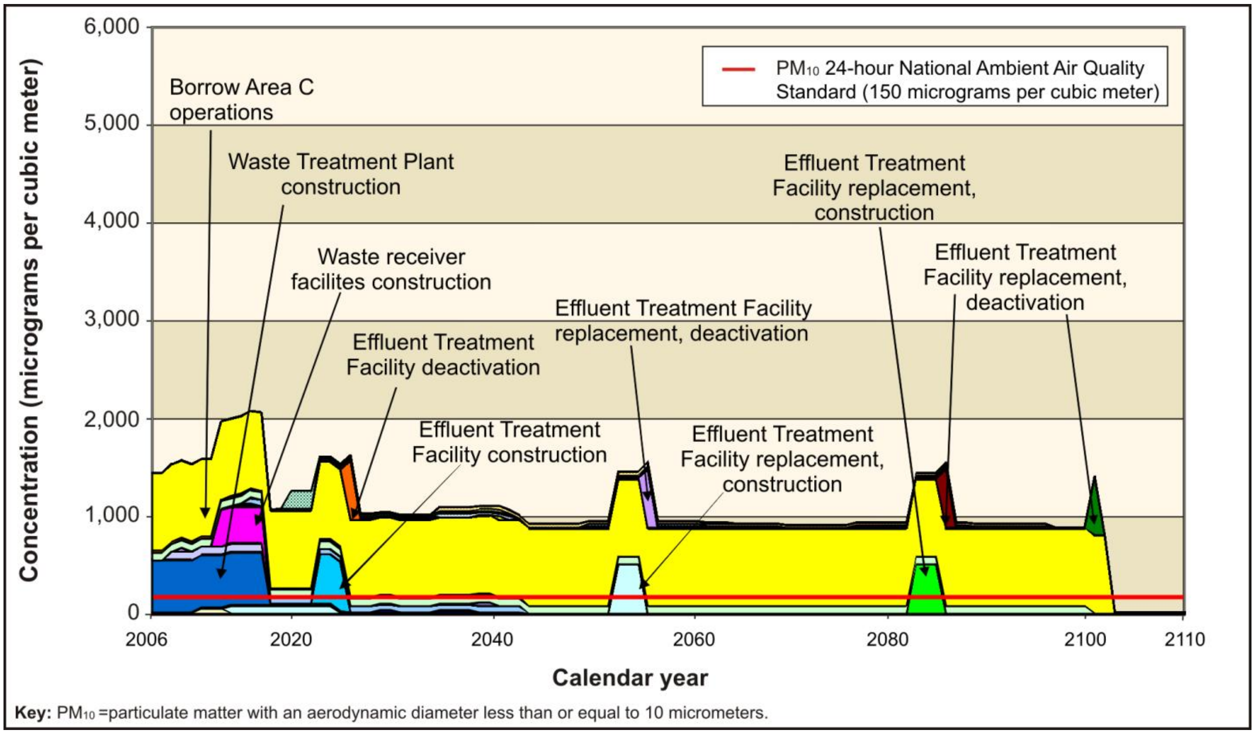


Figure 4–14. Tank Closure Alternative 6B, Option Case, PM_{10} Maximum 24-Hour Concentration

4.1.4.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

Criteria pollutant concentrations from activities under Tank Closure Alternative 6C are presented in Table 4–3. Peak concentrations of carbon monoxide, nitrogen dioxide, PM, and sulfur dioxide would occur in 2040. The peak period concentrations of carbon monoxide, nitrogen dioxide, and PM would result primarily from modified RCRA Subtitle C barrier construction. The peak period concentrations of sulfur dioxide would result primarily from WTP and Cesium and Strontium Capsule Processing Facility operations and modified RCRA Subtitle C barrier construction. PM_{10} concentrations would exceed ambient concentration standards periodically through 2052. Figure 4–15 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities to these concentrations.

Maximum concentrations for carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–4. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated under this alternative, except for mercury. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–5 and 4–6.

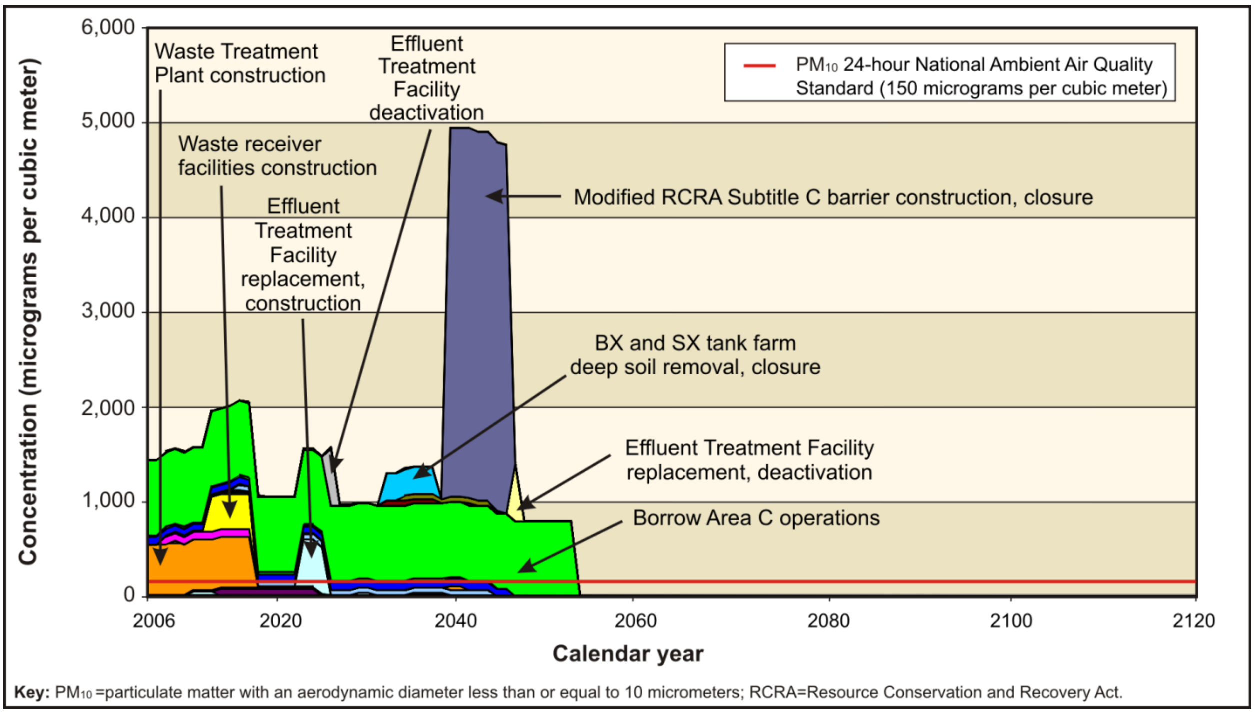


Figure 4–15. Tank Closure Alternative 6C PM_{10} Maximum 24-Hour Concentration

4.1.5 Geology and Soils

Impacts on geology and soils under the Tank Closure alternatives generally are expected to be directly proportional to the total area of land disturbed by site grading, soil compaction, and depth of excavation associated with construction of new facilities to support tank farm closure activities. These impacts would be associated with site excavation work and grading in preparation for constructing building foundations, roadways, parking areas, and laydown areas. Impacts would also include disturbance from trenching and excavation work to install piping, utilities, and other conveyances between buildings and other facilities, as well as disturbance due to exhumation of contaminated soils and other media associated with tank closure.

Under the Tank Closure alternatives, excavation depths for facility construction are not expected to exceed about 12 meters (40 feet) and would be limited by the depth of excavation needed to pour concrete for the walls and basements of the Vitrification Facility melter bays within the WTP. Excavation for most facilities is expected to be less than 3 meters (10 feet). The gravel, sand, and silt deposits of the Hanford formation, which compose the uppermost strata across the 200 Areas, are up to 65 meters (213 feet) thick across the 200 Areas, so the lateral and vertical extent of this unit would not be greatly impacted by facility construction. Uncontaminated soils and sediments excavated during facility construction would typically be stockpiled on site for future construction uses, such as foundation backfill.

Site construction for the WTP is ongoing, and the denuded surface soils and unconsolidated sediments resulting from excavations to support tank waste retrieval, treatment, and disposal, as well as the excavations and cut slopes required for other facilities' construction, would be subject to wind and water erosion if left exposed over an extended period of time. Adherence to standard best management practices for soil erosion and sediment control during construction would minimize soil erosion and loss. To reduce the risk from exposing contaminated soils, areas in which new facilities would be constructed under this alternative would be surveyed prior to any ground disturbance. Any contamination would be remediated as necessary. After construction, disturbed areas would either lie within the footprint of the new buildings or be covered by other impervious or semipervious surfaces; excavations would be backfilled and revegetated and would not be subject to long-term soil erosion.

Consumption of geologic resources (rock, minerals, and soils) to support facility construction, operations, and deactivation, as applicable, would constitute the major indirect impact on geologic and soil resources from implementation of Tank Closure alternatives, as summarized in Table 4–7. Varying quantities of geologic resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm closure. Geologic resources, including relatively large volumes of gravel, sand, and silt, are available from the suprabasalt sediments and associated soils at Hanford. Rock, in the form of basalt, is also plentiful. As discussed in the *Environmental Assessment, Use of Existing Borrow Areas, Hanford Site, Richland, Washington* (DOE 2001a), a number of active gravel and sand pits and two rock quarries at Hanford have been identified for use in providing a continual supply of borrow materials for new facility construction, maintenance of existing facilities, and fill and capping material for remediation and other sites. Of the two active quarries on the site, quarry No. 2 (referred to as "Borrow Area C" in this EIS), located due south of the 200-West Area just south of State Route 240, has large volumes of basalt and sand (DOE 2001a:1-1, 3-1–3-4). This approximately 926.3-hectare (2,289-acre) borrow area has been designated as a source of materials such as rock riprap (basalt), aggregate (gravel and sand), and soil (silt and loam) that would be needed to support tank farm closure and supporting activities, as described in this EIS (DOE 2003a:5-3, 6-15, 6-21, 6-46, 6-73).

In addition, gravel pit No. 30, located between the 200-East and 200-West Areas, would continue to provide aggregate (gravel and sand) for operation of onsite concrete batch plants to support new facility construction, including those at the WTP adjacent to the 200-East Area. Cement (a product of limestone and other minerals) to feed the batch plants would continue to be procured via offsite sources. Additional borrow materials would also be required for site grading, backfilling excavations, and other uses and could be obtained from either Borrow Area C or gravel pit No. 30.

Geologic resources would also be required for the production of grout. Grout, which is principally composed of cement, fly ash, sand, and sodium bentonite clay mixed with water, would be used to varying degrees under all Tank Closure alternatives to fill and stabilize tanks and associated ancillary equipment within each tank farm and to fill ancillary equipment outside the landfill closure barrier lobes that would be constructed under all alternatives except Alternative 2A. The boxes into which removed ancillary equipment would be placed for disposal would also be filled with grout. Cement, fly ash, and sodium bentonite would be obtained off site from local, commercial sources. Sand for the grout mixture would be obtained from Borrow Area C (DOE 2003a:6-1–6-55).

Table 4–7. Summary of Major Geologic and Soil Resource Impact Indicators and Requirements

Parameter/ Resource	Tank Closure Alternative										
	1	**2A**	**2B**	**3A**	**3B**	**3C**	**4**	**5**	**6A, Base Case,** ***Option Case***	**6B, Base Case,** ***Option Case***	**6C**
New, permanent land disturbance[a]	2	63.1	112	116	110	110	122	138	591 *668*	359 *437*	166
Construction Materials											
Concrete	33,400	675,000	424,000	347,000	345,000	354,000	495,000	368,000	6,140,000 *6,260,000*	1,410,000 *1,530,000*	800,000
Cement[b]	8,270	162,000	102,000	83,500	83,200	85,100	120,000	87,800	1,500,000 *1,530,000*	346,000 *374,000*	195,000
Sand[b]	16,200	327,000	206,000	168,000	167,000	172,000	240,000	178,000	3,010,000 *3,070,000*	685,000 *742,000*	388,000
Gravel[b]	21,100	427,000	268,000	219,000	218,000	224,000	312,000	233,000	3,920,000 *4,000,000*	889,000 *965,000*	507,000
Other Borrow Materials[c]											
Rock/basalt	0	14,300	14,300	9,630	9,630	9,630	12,800	9,630	350,000 *350,000*	14,300 *14,300*	14,300
Sand	187	1,250	3,750	3,750	3,750	3,750	3,750	3,750	1,250 *1,250*	1,250 *1,250*	3,750
Gravel	246	5,630	8,470	8,470	8,470	8,470	11,400	8,470	11,000 *11,000*	8,910 *8,910*	8,470
Soil (specification backfill)	55,100	550,000	782,000	748,000	748,000	748,000	2,020,000	221,000	9,320,000 *13,100,000*	8,550,000 *12,300,000*	782,000
Operations Materials											
Cement	0	0	0	0	27,700[d]	0	17,700[d]	17,700[d]	0	0	0
Sand	0	0	0	148,000[e]	0	0	50,200[e]	50,200[e]	0	0	0
Soil	0	0	0	187,000[e]	0	0	63,100[e]	63,100[e]	0	0	0
Kaolin clay/iron oxide	0	0	0	0	0	207,000[f]	0	0	0	0	0

Table 4–7. Summary of Major Geologic and Soil Resource Impact Indicators and Requirements (*continued*)

Parameter/ Resource	Tank Closure Alternative										
	1	2A	2B	3A	3B	3C	4	5	6A, Base Case, *Option Case*	6B, Base Case, *Option Case*	6C
Closure-Specific Materials											
Grout[g]	0	100	796,000	796,000	796,000	796,000	721,000	791,000	237,000 *788,000*	237,000 *788,000*	796,000
Cement	0	10.0	13,200	13,000	13,200	13,200	20,500	12,600	28,000 *93,000*	28,000 *93,000*	13,200
Sand[h]	0	50.1	774,000	774,000	774,000	774,000	661,000	772,000	116,000 *384,000*	116,000 *384,000*	774,000
Barrier materials	0	0	2,300,000[i]	2,300,000[i]	2,300,000[i]	2,300,000[i]	1,280,000[i]	3,830,000[j]	689,000[k] *0*	689,000[k] *0*	2,300,000[i]
Total[l]	**92,800**	**1,320,000**	**4,360,000**	**4,570,000**	**4,240,000**	**4,230,000**	**4,650,000**	**5,380,000**	**17,400,000** ***20,900,000***	**10,900,000** ***14,400,000***	**4,780,000**

a Reflects land area assumed to be permanently disturbed for new facilities. The value also includes land area excavated from Borrow Area C or elsewhere to supply geologic materials listed in the table.
b Component of concrete.
c Resources for miscellaneous uses not exclusively tied to facility construction, operations, or closure, such as site grading and backfill for excavations.
d Resources to support Cast Stone Facility operations in addition to fly ash and blast furnace slag additives that would not be procured from onsite deposits.
e Resources to support Bulk Vitrification Facility operations.
f Resources to support Steam Reforming Facility operations in addition to other materials; reported in total metric tons.
g Grout comprises cement, sand, fly ash, and other materials.
h Principal component of grout that would be obtained from onsite deposits.
i Volume includes soil, sand, gravel, rock, and asphalt for construction of modified Resource Conservation and Recovery Act Subtitle C barriers for landfill closure of all tank farms and six sets of cribs and trenches (ditches), except under Alternative 4, in which the BX and SX tank farms would be clean-closed rather than landfill-closed.
j Volume includes soil, sand, gravel, rock, and asphalt for construction of Hanford barriers for landfill closure of all tank farms and six sets of cribs and trenches (ditches).
k Volume includes soil, sand, gravel, rock, and asphalt for construction of modified Resource Conservation and Recovery Act Subtitle C barriers for landfill closure of the six sets of cribs and trenches (ditches) in the B and T Areas.
l Excludes concrete, cement, grout, and kaolin clay/iron oxide. Totals may not equal the sum of the contributions due to rounding.

Note: All values are expressed in cubic meters except land disturbance, which is in hectares. Values presented in the table have been rounded to no more than three significant digits, where appropriate. To convert cubic meters to cubic yards, multiply by 1.308; hectares to acres, by 2.471.

Source: SAIC 2010a.

Materials would also be required for construction of barriers for landfill closure of the Hanford tank farms. These engineered barriers would be composed of layers of topsoil in the upper part, underlain by layers of sand, gravel, asphalt, and/or riprap in the lower part. The structures would be constructed in lobes ranging from the approximately 2.7-meter-thick (9-foot-thick) modified RCRA Subtitle C barriers that would be constructed under Alternatives 2B, 3A–3C, 4, and 6C to the more robust, 4.6-meter-thick (15-foot-thick) Hanford barrier that would be constructed under Alternative 5. Under Alternatives 6A and 6B, Base Cases, a modified RCRA Subtitle C barrier of very limited extent would be constructed for landfill closure of just the six sets of cribs and trenches (ditches) in the B and T Areas. These structures are further described in Chapter 2, Section 2.3.4.1. For postclosure care of the landfills, sodium bentonite clay or grout would be required for completion of groundwater monitoring wells (DOE 2003a:6-86, 6-87).

Development of Borrow Area C using modern open-pit excavation techniques (with excavations averaging 4.6 meters [15 feet] deep) and allocation of 20 percent of the total site for cut-slope maintenance, haul roads, and stockpile and buffer areas could yield, conservatively, 34.3 million cubic meters (44.9 million cubic yards) of borrow material to address the geologic resource requirements discussed above. In addition, gravel pit No. 30, located between the 200-East and 200-West Areas, is an approximately 54-hectare (134-acre) borrow site containing a large quantity of aggregate suitable for multiple uses (DOE 2001a:3-4, A-3). Aggregate reserves at gravel pit No. 30 are estimated at 15.3 million cubic meters (20 million cubic yards) of material (DOE 1999:D-4), part of the estimated total of 49.6 million cubic meters (64.9 million cubic yards) of borrow materials available on site. To access Borrow Area C, a 2.0-kilometer-long (1.25-mile-long) paved haul road was completed in 2006 from State Route 240 and the intersection of Beloit Avenue south to Borrow Area C to enable transport of excavated borrow materials to points of use across Hanford. It was assumed for analysis purposes that gravel pit No. 30 and Borrow Area C would be available and would be operated for as long as necessary to support the active project phase associated with each Tank Closure alternative.

Facilities constructed to support tank waste retrieval, treatment, and disposal would be deactivated when they are no longer needed. This activity is not expected to directly impact geology and soils, as facilities would not be demolished or destroyed, and no additional land disturbance should be required. Waste materials and contaminated media would be removed from deactivated facilities and properly disposed of; they would not be disposed of in an unabated manner where they could contaminate geologic materials or underlying groundwater.

The following sections present projected impacts on geologic and soil resources specific to implementation of each of the Tank Closure alternatives, as well as the effects of geologic conditions on proposed project activities.

4.1.5.1 Alternative 1: No Action

WTP construction and ongoing tank farm facility upgrades and associated construction activities would continue through 2008 under Alternative 1, at which time WTP construction would be terminated. As the WTP site is already disturbed, construction activities through 2008 would have a negligible incremental impact on geologic strata and soils. However, an area of 17 hectares (42 acres), consisting of the 18 tank farms, would be indefinitely committed to waste management use (see Section 4.1.1.1.1). Ongoing tank system upgrades would be confined to developed areas. In addition to cement, sand, and gravel used principally for concrete production, construction activities through 2008 would require additional geologic resources, including borrow materials for site grading, backfilling, and other uses, as shown in Table 4–7.

Total geologic resource requirements under Alternative 1 were projected to be 92,800 cubic meters (121,000 cubic yards), with little or no geologic resources expected to be required during the

100-year administrative control period. Excavation of about 2 hectares (5 acres) of Borrow Area C would be required to supply this volume of geologic material. However, it is expected that this volume would continue to be supplied by gravel pit No. 30, which has sufficient reserves to supply this relatively small demand volume without use of Borrow Area C, as further described in Section 4.1.5.

Hazards from large-scale geologic conditions at Hanford are summarized in Chapter 3, Section 3.2.5.1.4, and were previously analyzed in the *Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility* (DOE 2000). Review of the previous analyses, as well as data presented in this EIS, indicates that the ground shaking of Modified Mercalli Intensity (MMI) V to VII that is associated with the postulated earthquakes (see Appendix F, Table F–7) could potentially affect the integrity of inadequately designed or nonreinforced structures and cause moderate damage in some other structures. Analysis of a beyond-design-basis accident triggered by an earthquake-induced tank dome collapse has been considered; the result is incorporated by reference in Section 4.1.11.1.

4.1.5.2 Alternative 2A: Existing WTP Vitrification; No Closure

Construction of new facilities to support tank waste retrieval, treatment, and disposal under Alternative 2A would permanently disturb about 33.9 hectares (83.8 acres) of land. Most of this activity would be located within or adjacent to the 200-East or 200-West Area and would include completion of WTP construction activities (see Section 4.1.1.2.1 and Table 4–1). An additional 29.1 hectares (72 acres) would also be excavated from Borrow Area C, making a total of 63.1 hectares (156 acres) of new, permanent land disturbance. An additional 17 hectares (42 acres) of land, consisting of the 18 tank farms and adjacent areas, would remain in waste management use. Other direct impacts on geology and soils under Alternative 2A, including factors that could lead to increased wind and water erosion, would generally be similar to those described in Section 4.1.5; excavation depths are not expected to exceed about 12 meters (40 feet) and would generally be less than 3 meters (10 feet).

Construction activities and subsequent operations would not preclude the use of rare or otherwise valuable geologic or soil resources. The surficial soils, unconsolidated strata, and underlying basaltic bedrock of the 200 Areas are present elsewhere in the region and at Hanford. However, relatively large quantities of geologic resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; and waste retrieval activities over the active phase of this alternative. In addition to the cement, sand, and gravel used principally for concrete production, additional geologic resources in the form of borrow materials would be required for site grading, backfilling, and other uses, as shown in Table 4–7 and further described in Section 4.1.5. Total geologic resource requirements under Alternative 2A were projected to be 1.32 million cubic meters (1.73 million cubic yards). This volume is not expected to deplete locally available deposits or material stockpiles because reserves of aggregate and other borrow materials available on site from gravel pit No. 30 and Borrow Area C are estimated to total 49.6 million cubic meters (64.9 million cubic yards), as further described in Section 4.1.5.

Hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions with the potential to affect new facilities in the 200 Areas are summarized in Chapter 3, Section 3.2.5.1.4. Maximum considered earthquake ground motions for Hanford encompass those that may cause substantial structural damage to buildings (equivalent to an MMI of VII and up), thus presenting safety concerns for occupants. Ground shaking of MMI VII associated with postulated earthquakes is possible, as supported by the historical record for the region. However, this level of ground motion is expected to primarily affect the integrity of inadequately designed or nonreinforced structures (see Appendix F, Table F–7). All facilities would be designed, constructed, and operated in compliance with applicable DOE orders, requirements, and governing standards established to protect public and worker health and the environment. DOE Order 420.1B requires that nuclear and nonnuclear facilities be designed, constructed, and operated so that the public, workers, and environment are protected from adverse impacts of natural phenomena hazards, including earthquakes. As further described in Appendix F, Section F.5.2, the order stipulates natural phenomena hazards mitigation for DOE facilities and specifically provides for reevaluation and upgrade of existing DOE facilities when there is a significant degradation in the safety basis for the facility. An analysis of potential effects of a beyond-design-basis earthquake on human health and the environment is provided in Section 4.1.11.2.

4.1.5.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

Construction of new facilities to support tank waste retrieval, treatment, and disposal and landfill closure under Alternative 2B would permanently disturb about 16.7 hectares (41.3 acres) of land. Most of this activity would take place within or adjacent to the 200-East or 200-West Area and would include completion of WTP construction activities with expanded LAW vitrification capacity (see Section 4.1.1.3.1 and Table 4–1). An additional 95.1 hectares (235 acres) would also be excavated from Borrow Area C, making a total of 112 hectares (276 acres) of new, permanent land disturbance.

The type and intensity of anticipated direct impacts on geology and soils under this alternative, including factors that could lead to increased wind and water erosion, would generally be similar to those under Alternative 2A (see Sections 4.1.5 and 4.1.5.2); excavation depths are not expected to exceed about 12 meters (40 feet) and would be less than 3 meters (10 feet) for most activities. However, the total scale of direct impacts associated with new facility construction would generally be greater than under Alternative 2A due to the addition of the expanded LAW Vitrification Facility melter bays and activities associated with landfill closure of the SST system. Specifically, to support landfill closure of the tank farms under this alternative, a portable grout production facility would be required in both the 200-East and 200-West Areas to fill and stabilize tanks and ancillary equipment in each area (DOE 2003a:6-9). Domed containment structures would also be erected over both the BX and SX tank farms in the 200-East and 200-West Areas, respectively, to support removal of the upper 4.6 meters (15 feet) of contaminated soils.

The upper 4.6 meters (15 feet) of soils and encountered ancillary equipment within the BX and SX tank farms would then be excavated and removed for disposal as mixed low-level radioactive waste (MLLW) in the River Protection Project Disposal Facility (RPPDF). Waste generation and management activities under this alternative are further discussed in Section 4.1.14.3. The excavations would be backfilled with clean soil from Borrow Area C (DOE 2003a:6-90–6-95).

Construction of the modified RCRA Subtitle C barrier would then commence. To complete landfill closure of the SST system, the engineered barrier would be emplaced in five separate lobes to cover all 18 tank farms and the six sets of cribs and trenches (ditches) associated with the B and T tank farms. Surface clearing, grading, and grubbing work associated with emplacement of the engineered surface barrier lobes would likely encompass all other site construction activities from a soil erosion perspective, as relatively large areas of denuded soils would be exposed at one time. However, the depth of excavation would not exceed that necessary to achieve the uniform topography upon which to emplace barrier layers. In addition, landfill construction and barrier layer placement would occur in the later stages of the waste retrieval and treatment phases of this alternative after most other construction activities have been completed. Regardless, standard best management practices for soil erosion and sediment control would be employed, including watering to control fugitive dust over the estimated 7-year construction period (DOE 2003a:6-73, 6-74).

Construction activities and subsequent operations would not preclude the use of rare or otherwise valuable geologic or soil resources. The surficial soils, unconsolidated strata, and underlying basaltic bedrock of the 200 Areas are present elsewhere in the region and at Hanford. However, relatively large quantities of geologic resources would be required under this alternative to support ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm landfill closure, as shown in Table 4–7 and further described in Section 4.1.5.

Total geologic resource requirements under Alternative 2B were projected to be 4.36 million cubic meters (5.7 million cubic yards). This volume is not expected to deplete locally available deposits or material stockpiles because reserves of aggregate and other borrow materials available on site from gravel pit No. 30 and Borrow Area C are estimated to total 49.6 million cubic meters (64.9 million cubic yards), as further described in Section 4.1.5.

Under this alternative, design consideration of hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions with the potential to affect new and existing facilities would be substantially the same as those described in Section 4.1.5.2 under Alternative 2A.

4.1.5.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

Construction of new facilities to support tank waste retrieval, treatment, and disposal and landfill closure under Alternative 3A would permanently disturb about 16.3 hectares (40.4 acres) of land. Most of this activity would occur within or adjacent to the 200-East or 200-West Area and would include completion of WTP construction activities. Also, a Bulk Vitrification Facility and facilities for mixed transuranic (TRU) waste supplemental treatment would be constructed under this alternative in or adjacent to the 200-East and 200-West Areas (see Section 4.1.1.4.1 and Table 4–1). An additional 100 hectares (247 acres) would be excavated from Borrow Area C, making a total of 116 hectares (287 acres) of new, permanent land disturbance. Nevertheless, the type and intensity of anticipated direct impacts on geology and soils under this alternative, including factors that could lead to increased wind and water erosion, would generally be similar to those described in Sections 4.1.5 and 4.1.5.3 under Alternative 2B; excavation depths are not expected to exceed about 12 meters (40 feet) and would be less than 3 meters (10 feet) for most activities. Further, activity-specific impacts under this alternative related to landfill closure of the SST system would be the same as those described in Section 4.1.5.3 under Alternative 2B. However, the total scale of direct impacts under this alternative would be greater than under Alternative 2B due to the construction of supplemental treatment facilities combined with landfill closure of the SST system.

Construction activities and subsequent operations would not preclude the use of rare or otherwise valuable geologic or soil resources for the reasons previously described in Section 4.1.5.3. In addition to the relatively large quantities of a number of geologic resources required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm closure (see Table 4–7), soil and/or sand would be used in the bulk vitrification process to form glass and to stabilize bulk vitrification waste form roll-off boxes prior to disposal (DOE 2003b:6-70, 6-74). Due to the larger demands for construction-related uses and materials for bulk vitrification operations, total geologic resource requirements under Alternative 3A are projected to be 4.57 million cubic meters (5.98 million cubic yards). This volume is not expected to deplete locally available deposits or material stockpiles because reserves of aggregate and other borrow materials available on site from gravel pit No. 30 and Borrow Area C are estimated to total 49.6 million cubic meters (64.9 million cubic yards), as further described in Section 4.1.5.

Design consideration of hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions with the potential to affect new and existing facilities under this alternative would be substantially the same as those described in Section 4.1.5.2 under Alternative 2A.

4.1.5.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

Construction of new facilities to support tank waste retrieval, treatment, and disposal and landfill closure under Alternative 3B would permanently disturb 17.2 hectares (42.6 acres) of land. Most of this activity would be located within or adjacent to the 200-East or 200-West Area and would include completion of WTP construction activities. In addition, a Cast Stone Facility and facilities for mixed TRU waste supplemental treatment would be constructed in or adjacent to the 200-East and 200-West Areas (see Section 4.1.1.5.1 and Table 4–1). An additional 92.3 hectares (228 acres) would be excavated from Borrow Area C, making a total of 110 hectares (271 acres) of new, permanent land disturbance.

The type and intensity of anticipated direct impacts on geology and soils under this alternative, including factors that could lead to increased wind and water erosion, would generally be similar to those described in Sections 4.1.5 and 4.1.5.4 under Alternative 3A; excavation depths are not expected to exceed about 12 meters (40 feet) and would be less than 3 meters (10 feet) for most activities. Further, activity-specific impacts under this alternative related to landfill closure of the SST system would be similar to those generally described in Sections 4.1.5 and 4.1.5.3 under Alternative 2B. Overall, the total scale of direct impacts under this alternative would be very similar to those under Alternative 3A.

Construction activities and subsequent operations would not preclude the use of rare or otherwise valuable geologic or soil resources for the reasons previously described in Section 4.1.5.3. As under Alternative 3A, relatively large quantities of a number of geologic resources or products made from rock and mineral resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm closure (see Table 4–7). Under this alternative, use of the cast stone supplemental treatment technology would reduce the demand for clean soil and sand, compared with Alternative 3A, because the cast stone process would immobilize tank waste utilizing fly ash and blast furnace slag (both industrial waste products) derived from local offsite and regional sources and Portland cement (produced from limestone and other minerals) (DOE 2003b:6-94, 6-95, 6-111–6-113). Due to the smaller demands for supplemental treatment operations associated with cast stone as compared with bulk vitrification, total geologic resource requirements under Alternative 3B are projected to be 4.23 million cubic meters (5.53 million cubic yards). This volume is not expected to deplete locally available deposits or material stockpiles because reserves of aggregate and other borrow materials available on site from gravel pit No. 30 and Borrow Area C are estimated to total 49.6 million cubic meters (64.9 million cubic yards), as further described in Section 4.1.5.

Design consideration of hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions that could potentially affect new and existing facilities under this alternative would be substantially the same as those described in Section 4.1.5.2 under Alternative 2A.

4.1.5.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

Construction of new facilities to support tank waste retrieval, treatment, and disposal and landfill closure under Alternative 3C would permanently disturb about 17.2 hectares (42.4 acres) of land. Most of this activity would be located within or adjacent to the 200-East or 200-West Area and would include completion of WTP construction activities. In addition, a Steam Reforming Facility and facilities for mixed TRU waste supplemental treatment would be constructed in or adjacent to both the 200-East and 200-West Areas (see Section 4.1.1.6.1 and Table 4–1). An additional 92.7 hectares (229 acres) would be excavated from Borrow Area C, making a total of 110 hectares (271 acres) of new, permanent land disturbance. The type and intensity of anticipated direct impacts on geology and soils, including factors that could lead to increased wind and water erosion, would generally be similar to those described in

Sections 4.1.5 and 4.1.5.4 under Alternative 3A; excavation depths are not expected to exceed about 12 meters (40 feet) and would be less than 3 meters (10 feet) for most activities. Further, activity-specific impacts under this alternative related to landfill closure of the SST system would be the same as those described in Section 4.1.5.3 under Alternative 2B. Overall, the total scale of direct impacts under this alternative would be very similar to those under Alternative 3A.

Construction activities and subsequent operations would not preclude the use of rare or otherwise valuable geologic or soil resources for the reasons previously described in Section 4.1.5.2. As under Alternatives 3A and 3B, relatively large quantities of a number of geologic resources or products made from rock and mineral resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm closure (see Table 4–7). Under this alternative, geologic resources utilized in the steam reforming supplemental treatment process would be limited to iron oxide and kaolin clay, which would be obtained from offsite regional sources (DOE 2003b:6-37, 6-38, 6-45, 6-61).

Similar to Alternative 3B, total geologic resource requirements under Alternative 3C are projected to be 4.24 million cubic meters (5.55 million cubic yards). This volume is not expected to deplete locally available deposits or material stockpiles because reserves of aggregate and other borrow materials available on site from gravel pit No. 30 and Borrow Area C are estimated to total 49.6 million cubic meters (64.9 million cubic yards), as further described in Section 4.1.5.

Design consideration of hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions that could potentially affect new and existing facilities under this alternative would be substantially the same as those described in Section 4.1.5.2 under Alternative 2A.

4.1.5.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

Construction of new facilities to support tank waste retrieval, treatment, and disposal and tank farm closure under Alternative 4 would permanently disturb about 19.8 hectares (48.9 acres) of land. Most of this activity would be located within or adjacent to the 200-East or 200-West Area and would include completion of WTP construction activities. In addition, a Cast Stone Facility would be constructed adjacent to the 200-East Area, while a Bulk Vitrification Facility would be constructed in the 200-West Area. Facilities for mixed TRU waste supplemental treatment would also be constructed, as well as a PPF for treatment of highly contaminated rubble, soil, and equipment from selective clean closure of the BX and SX tank farms (see Section 4.1.1.7.1 and Table 4–1). An additional 102 hectares (252 acres) would be excavated from Borrow Area C, making a total of 122 hectares (301 acres) of new, permanent land disturbance.

The type and intensity of anticipated direct impacts on geology and soils under this alternative, including factors that could lead to increased wind and water erosion, would generally be similar to those described in Section 4.1.5 and Sections 4.1.5.4 through 4.1.5.6 under Alternatives 3A through 3C. However, while activity-specific impacts related to landfill closure of the SST system would be similar to those described in Section 4.1.5.3 under Alternative 2B, selective clean closure of the BX and SX tank farms would involve deep excavation work that would entail additional direct and indirect impacts under this alternative.

As under Alternatives 2B, 3A, 3B, and 3C, a portable grout production facility would be required in both the 200-East and 200-West Areas to fill and stabilize tanks and ancillary equipment in each area (DOE 2003a:6-9). Domed containment structures would also be temporarily erected over both the BX and SX tank farms in the 200-East and 200-West Areas, respectively, to support clean closure, encompassing excavation and removal of contaminated soils, tanks, and associated ancillary equipment within these areas.

In support of clean closure of the BX and SX tank farms, excavation to a depth of about 20 meters (65 feet) below the land surface or 3 meters (10 feet) below the base elevations of the waste tanks would be required at a minimum. This excavation depth is expected to be sufficient to remove soils and sediments contaminated by retrieval-related leaks, as well as contamination from historic waste releases that have accumulated horizontally on compacted strata beneath the waste tanks. For some tank sites, excavation to depths of up to 78 meters (255 feet) below land surface may be required to remediate contaminant plumes from past-practice discharges that have migrated through the vadose zone soils and sediments and possibly to the water table.

To accomplish excavation of the magnitude required for clean closure, work would proceed by first filling each tank with a 0.3-meter (1-foot) layer of grout to stabilize the residual waste and reduce worker exposure. Jet-grouted pile (retaining) walls that extend down the length of each tank elevation to a depth of about 38 meters (125 feet) would then be installed. This would be followed by erection of the containment structure. Closure operations would then proceed by excavation and removal of soils and ancillary equipment, including demolition and removal of the tank structures, tank slabs, and footings. Excavated soils would be characterized and transported either directly to the RPPDF or to the PPF for treatment prior to final disposal as MLLW. Ancillary equipment and tank debris would also be sent to the PPF for treatment prior to onsite disposal. Final closure of the BX and SX tank farms would involve filling the open excavations with clean soil derived from Borrow Area C (DOE 2003c:3–8, 13, 17). Waste generation and management activities under this alternative are further discussed in Section 4.1.14.7.

Construction activities and subsequent operations would not preclude the use of rare or otherwise valuable geologic or soil resources for the main reasons previously described in Section 4.1.5.2. As under Alternatives 3A through 3C, relatively large quantities of a number of geologic resources or products made from rock and mineral resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; supplemental treatment operations; and, most substantially, tank farm closure (see Table 4–7). Under this alternative, the additional demand for borrow material for backfill of excavations in the BX and SX tank farms would be partly compensated for by the fact that construction of the landfill closure barrier would require less resources, as compared with Alternatives 2B through 3C. Total geologic resource requirements under Alternative 4 are projected to be 4.65 million cubic meters (6.1 million cubic yards). This volume is not expected to deplete locally available deposits or material stockpiles because reserves of aggregate and other borrow materials available on site from gravel pit No. 30 and Borrow Area C are estimated to total 49.6 million cubic meters (64.9 million cubic yards), as further described in Section 4.1.5.

Design consideration of hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions that could potentially affect new and existing facilities under this alternative would be substantially the same as those described in Section 4.1.5.2 under Alternative 2A.

4.1.5.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

Construction of new facilities to support tank waste retrieval, treatment, and disposal and landfill closure under Alternative 5 would permanently disturb about 20.2 hectares (49.9 acres) of land. Most of this activity would be located within or adjacent to the 200-East or 200-West Area and would include completion of WTP construction activities. In addition, a Cast Stone Facility would be constructed adjacent to the 200-East Area, while a Bulk Vitrification Facility would be constructed in the 200-West Area. Facilities for mixed TRU waste supplemental treatment would also be constructed. To support accelerated treatment under this alternative, new DSTs and a Sulfate Removal Facility would be built (see Section 4.1.1.8.1 and Table 4–1). An additional 117 hectares (290 acres) would also be excavated from Borrow Area C, making a total of 138 hectares (340 acres) of new, permanent land disturbance.

The type and intensity of anticipated direct impacts on geology and soils, including factors that could lead to increased wind and water erosion, would generally be similar to those described in Sections 4.1.5 and 4.1.5.4 under Alternative 3A; excavation depths are not expected to exceed about 12 meters (40 feet) and would be less than 3 meters (10 feet) for most activities. Further, activity-specific impacts under this alternative related to landfill closure of the SST system would be somewhat greater than those described in Section 4.1.5.3 under Alternative 2B. Specifically, instead of construction of a modified RCRA Subtitle C barrier as under Alternatives 2B through 3C, a more robust Hanford barrier with a 4.6-meter (15-foot) thickness would be constructed under Alternative 5 for landfill closure of the tank farms. As under the other landfill closure alternatives, a portable grout production facility would be required in both the 200-East and 200-West Areas to fill and stabilize tanks and ancillary equipment in each area (DOE 2003a:6-9). In contrast, there would be no contaminated soil removal at any tank farm under this alternative, and ancillary equipment outside the barrier lobes would be neither removed nor grouted.

Construction activities and subsequent operations would not preclude the use of rare or otherwise valuable geologic or soil resources for the main reasons previously described in Section 4.1.5.2. As under Alternatives 3A through 3C, relatively large quantities of a number of geologic resources or products made from rock and mineral resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; supplemental treatment operations; and, most substantially, tank farm closure (see Table 4–7). Under this alternative, while there would be no additional demand for borrow material for backfill of tank farm excavations, construction of the thicker Hanford barrier across all tank farms would drive an overall greater demand for geologic resources, as compared with the previous alternatives. Total geologic resource requirements under Alternative 5 are projected to be 5.38 million cubic meters (7.04 million cubic yards). This volume is not expected to deplete locally available deposits or material stockpiles because reserves of aggregate and other borrow materials available on site from gravel pit No. 30 and Borrow Area C are estimated to total 49.6 million cubic meters (64.9 million cubic yards), as further described in Section 4.1.5.

4.1.5.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

4.1.5.9.1 Base Case

Construction of new facilities to support tank waste retrieval, treatment, and disposal; clean closure of the SST system; and landfill closure of six sets of cribs and trenches (ditches) under Alternative 6A, Base Case, would permanently disturb about 210 hectares (519 acres) of land. Most of this activity would be located within or adjacent to the 200-East or 200-West Area and would include completion of WTP construction activities with expanded HLW vitrification and associated IHLW canister storage capacity. In addition, due to the longer timeframe required to process all tank waste under this alternative, a number of facilities would have to be replaced over time, including the WTP.

For clean closure activities, domed containment structures would also be temporarily erected over each tank farm in the 200-East and 200-West Areas to facilitate excavation and removal of contaminated soils, tanks, and associated ancillary equipment within these areas. Finally, a PPF for treatment of highly contaminated deep soils generated during clean closure activities would also be constructed to the west of the 200-East Area (see Section 4.1.1.9.1.1 and Table 4–1). An additional 381 hectares (942 acres) would also be excavated from Borrow Area C, making a total of 591 hectares (1,460 acres) of new, permanent land disturbance.

The type and intensity of anticipated direct impacts on geology and soils under this alternative, including factors that could lead to increased wind and water erosion, would be similar to those generally described in Section 4.1.5. Still, the potential for soil erosion would increase from site activities under all Tank Closure alternatives, but the potential would be somewhat greater under this alternative due to the much greater land area disturbed. Also, while excavation depths for new facility construction would generally not be expected to exceed about 12 meters (40 feet) for the WTP HLW melter bays, clean closure of the SST system farm would involve deep excavation work at all tank farm locations. To be specific, deep soil removal, including excavation to a depth of about 20 meters (65 feet) below the land surface or 3 meters (10 feet) below the base elevations of the waste tanks, would be required at a minimum. This excavation depth is expected to be sufficient to remove soils and sediments contaminated by retrieval-related leaks, as well as contamination from historic waste releases that have accumulated horizontally on compacted strata beneath the waste tanks. For some tank sites, excavation to depths of up to 78 meters (255 feet) below the land surface may be required to remediate contaminant plumes from past-practice discharges that have migrated through the vadose zone soils and sediments and possibly to the water table.

To accomplish excavation of the magnitude required for clean closure, work would proceed by first filling each tank with a 0.3-meter (1-foot) layer of grout to stabilize the residual waste and reduce worker exposure. Jet-grouted pile (retaining) walls that extend down the length of each tank elevation to a depth of about 38 meters (125 feet) would then be installed. This installation would be followed by erection of the containment structure. Closure operations would then proceed by excavation and removal of soils and ancillary equipment, including demolition and removal of the tank structures, tank slabs, and footings. Excavated soils, except for tank bottom soils managed as HLW, would be characterized and transported either directly to the RPPDF or to the PPF for treatment prior to final disposal as MLLW. Highly and moderately contaminated ancillary equipment and tank debris and intermixed soil would be packaged in shielded boxes and transported to onsite HLW Debris Storage Facilities. Final closure of the tank farms would involve filling the open excavations with clean soil derived from Borrow Area C (DOE 2003c:3-8, 13, 17). Waste generation and management activities under this alternative are further discussed in Section 4.1.14.9.1.

As an additional closure action under this alternative, a modified RCRA Subtitle C barrier of very limited extent would be constructed for landfill closure of the six sets of cribs and trenches (ditches) in the B and T Areas that are located outside the areas that would be clean-closed (see Section 4.1.5).

Construction activities and subsequent operations would not preclude the use of rare or otherwise valuable geologic or soil resources for the main reasons previously described in Section 4.1.5. However, large quantities of a number of geologic resources or products made from rock and mineral resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm clean closure (see Table 4–7). In addition to geologic resources to support facility construction, large volumes of borrow materials would be required for site grading, backfilling (particularly for tank excavations), and other uses. Total geologic resource requirements under Alternative 6A, Base Case, are projected to be 17.4 million cubic meters (22.8 million cubic yards). While this volume could deplete immediately available stockpiles, it is not expected to deplete onsite reserves because aggregate and other borrow materials available on site from gravel pit No. 30 and Borrow Area C are estimated to total 49.6 million cubic meters (64.9 million cubic yards), as further described in Section 4.1.5. Similar materials are also widely available in the region, and offsite commercial quarries could supplement onsite sources if needed.

Design consideration of hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions that could potentially affect new and existing facilities under this alternative would be substantially the same as those described in Section 4.1.5.2 under Alternative 2A.

4.1.5.9.2 Option Case

Construction of new facilities to support tank waste retrieval, treatment, and disposal and clean closure of the SST system and the six sets of cribs and trenches (ditches) under Alternative 6A, Option Case, would permanently disturb about 212 hectares (524 acres) of land. Construction requirements and associated impacts on geology and soils would be very similar to those described in Section 4.1.5.9.1 under Alternative 6A, Base Case, although a larger PPF would be constructed under this case. Further, a larger volume of material and associated land area totaling 458 hectares (1,131 acres) would be excavated from Borrow Area C to support remediation activities, making a total of 668 hectares (1,650 acres) of new, permanent land disturbance. The type and intensity of anticipated direct impacts on geology and soils under this alternative, including factors that could lead to increased wind and water erosion, would generally be similar to those described in Section 4.1.5. Tank farm closure activities would essentially be the same as described in Section 4.1.5.9.1 under Alternative 6A, Base Case, with one major exception. Under Alternative 6A, Option Case, the six sets of cribs and trenches (ditches) in the B and T Areas would be clean-closed along with all SSTs, instead of being landfill-closed, as under the Base Case. This would require additional excavation work and soil removal in areas adjacent to the B and T tank farms.

Total geologic resource requirements under Alternative 6A, Option Case, are projected to be 20 million cubic meters (26 million cubic yards). While this demand volume could deplete immediately available stockpiles during the course of project implementation, it is not expected to deplete onsite reserves because aggregate and other borrow materials available on site from gravel pit No. 30 and Borrow Area C are estimated to total 49.6 million cubic meters (64.9 million cubic yards), as further described in Section 4.1.5. Similar materials are also widely available in the region, and offsite commercial quarries could supplement onsite sources if needed.

Design consideration of hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions that could potentially affect new and existing facilities under this alternative would be substantially the same as those described in Section 4.1.5.2 under Alternative 2A.

4.1.5.10 Alternative 6B: All Vitrification with Separations; Clean Closure

4.1.5.10.1 Base Case

Construction of new facilities to support tank waste retrieval, treatment, and disposal; clean closure of the SST system; and landfill closure of the six sets of cribs and trenches (ditches) under Alternative 6B, Base Case, would permanently disturb about 119 hectares (294 acres) of land. Most of this activity would be located within or adjacent to the 200-East or 200-West Area and would include completion of WTP construction activities with expanded LAW vitrification capacity.

To support clean closure activities, domed containment structures would be temporarily erected over each tank farm in the 200-East and 200-West Areas to facilitate excavation and removal of contaminated soils, tanks, and associated ancillary equipment within these areas. Finally, a PPF for treatment of highly contaminated deep soils generated during clean closure activities would be constructed to the west of the 200-East Area (see Section 4.1.1.10.1.1 and Table 4–1). An additional 240 hectares (592 acres) would be excavated from Borrow Area C, making a total of 359 hectares (886 acres) of new, permanent land disturbance.

Construction requirements and associated impacts on geology and soils would be somewhat greater than those described in Section 4.1.5.3 under Alternative 2B because additional ILAW Interim Storage Facilities would be required under this alternative. The type and intensity of anticipated direct impacts on geology and soils under this alternative, including factors that could lead to increased wind and water erosion, would generally be similar to those described in Section 4.1.5; excavation depths are not expected to exceed about 12 meters (40 feet) and would be less than 3 meters (10 feet) for most activities.

Additionally, activity-specific impacts under this alternative related to clean closure of the SST system and landfill closure of the six sets of cribs and trenches (ditches) in the B and T Areas would essentially be the same as those described in Section 4.1.5.9.1 under Alternative 6A, Base Case. Overall, even with clean closure as a component of this alternative, the total scale of direct impacts under this alternative would be much less than under Alternative 6A due to the smaller scale of new facility construction required, which is comparable to, but still greater than, that under Alternative 2B.

Construction activities and subsequent operations would not preclude the use of rare or otherwise valuable geologic or soil resources for the main reasons previously described in Section 4.1.5. However, large quantities of a number of geologic resources or products made from rock and mineral resources would be required for ongoing facility construction; upgrades to existing facilities, including the 200 Area tank farms; waste retrieval activities; and, most substantially, tank farm clean closure (see Table 4–7). As under Alternative 6A, large volumes of borrow materials would be required for site grading, backfilling (particularly for tank excavations), and other uses in addition to geologic resources to support facility construction. Total geologic resource requirements under Alternative 6B, Base Case, are projected to be 10.9 million cubic meters (14.3 million cubic yards). While this demand volume could deplete immediately available stockpiles during the course of project implementation, it is not expected to deplete onsite reserves because aggregate and other borrow materials available on site from gravel pit No. 30 and Borrow Area C are estimated to total 49.6 million cubic meters (64.9 million cubic yards), as further described in Section 4.1.5. Similar materials are also widely available in the region, and offsite commercial quarries could supplement onsite sources if needed.

Design consideration of hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions that could potentially affect new and existing facilities under this alternative would be substantially the same as those described in Section 4.1.5.2 under Alternative 2A.

4.1.5.10.2 Option Case

Construction of new facilities to support tank waste retrieval, treatment, and disposal and clean closure of the SST system and the six sets of cribs and trenches (ditches) under Alternative 6B, Option Case, would permanently disturb about 121 hectares (299 acres) of land. Construction requirements and associated impacts on geology and soils would be very similar to those described in Section 4.1.5.10.1 under Alternative 6B, Base Case; however, a larger PPF than is considered under the Base Case would be constructed. An additional 316 hectares (781 acres) would be excavated from Borrow Area C, making a total of 437 hectares (1,080 acres) of new, permanent land disturbance. The type and intensity of anticipated direct impacts on geology and soils under this alternative, including factors that could lead to increased wind and water erosion, would generally be similar to those described in Section 4.1.5. Tank farm closure activities would essentially be the same as described in Section 4.1.5.9.1 under Alternative 6A, Base Case, with one major exception. Under Alternative 6B, Option Case, the six sets of cribs and trenches (ditches) in the B and T Areas would be clean-closed along with all SSTs, instead of being landfill-closed, as under the Base Case. This would require additional excavation work and soil removal and replacement in areas adjacent to the B and T tank farms.

Total geologic resource requirements under Alternative 6B, Option Case, are projected to be 14.4 million cubic meters (18.8 million cubic yards). While this demand volume could deplete immediately available stockpiles during the course of project implementation, it is not expected to deplete onsite reserves because aggregate and other borrow materials available on site from gravel pit No. 30 and Borrow Area C are estimated to total 49.6 million cubic meters (64.9 million cubic yards), as further described in Section 4.1.5. Similar materials are also widely available in the region, and offsite commercial quarries could supplement onsite sources if needed.

Design consideration of hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions that could potentially affect new and existing facilities under this alternative would be substantially the same as those described in Section 4.1.5.2 under Alternative 2A.

4.1.5.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

Construction of new facilities to support tank waste retrieval, treatment, and disposal and landfill closure of the SST system and the six sets of cribs and trenches (ditches) under Alternative 6C would permanently disturb about 61.5 hectares (152 acres) of land. Most of this activity would be located within or adjacent to the 200-East or 200-West Area and would include completion of WTP construction activities with expanded HLW vitrification capacity (see Section 4.1.1.11.1 and Table 4–1).

Construction requirements and associated impacts on geology and soils would be somewhat greater than those described in Section 4.1.5.3 under Alternative 2B, as additional ILAW Interim Storage Facilities would be required under this alternative. Additionally, impacts and activities associated with removal of the upper 4.6 meters (15 feet) of contaminated soil in the BX and SX tank farms and subsequent emplacement of a modified RCRA Subtitle C barrier for landfill closure of all 18 tank farms and the six sets of cribs and trenches (ditches) associated with the B and T tank farms would be the same as described in Section 4.1.5.3. Further, an additional 104 hectares (258 acres) would be excavated from Borrow Area C, making a total of 166 hectares (410 acres) of new, permanent land disturbance. Otherwise, the type and intensity of anticipated direct impacts on geology and soils under this alternative, including factors that could lead to increased wind and water erosion, would generally be similar to those described in Section 4.1.5.

Total geologic resource requirements under Alternative 6C are projected to be 4.78 million cubic meters (6.25 million cubic yards). While this demand volume could deplete immediately available stockpiles during the course of project implementation, it is not expected to deplete onsite reserves because aggregate and other borrow materials available on site from gravel pit No. 30 and Borrow Area C are estimated to total 49.6 million cubic meters (64.9 million cubic yards), as further described in Section 4.1.5. Similar materials are also widely available in the region, and offsite commercial quarries could supplement onsite sources if needed.

Design consideration of hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions that could potentially affect new and existing facilities under this alternative would be substantially the same as those described in Section 4.1.5.2 under Alternative 2A.

4.1.6 Water Resources

This subsection presents the potential direct, short-term impacts of implementing the Tank Closure alternatives on water resources encompassing surface water, the vadose zone, and groundwater. Potential short-term impacts of facility construction, operations, deactivation, and closure activities were analyzed over the active project phase for each alternative, extending through the 100-year administrative control, institutional control, or postclosure care period, as applicable, for each alternative. Long-term impacts on water resources, including contamination releases to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.1.1.

Under the Tank Closure alternatives, direct impacts on surface water, the vadose zone, and groundwater would be similar in nature; any variability would be related to the intensity and duration of the activities conducted under each alternative. Generally, facility construction activities are not expected to have any direct impact on surface-water features, including the Columbia River, as there are no natural, perennial surface-water drainages on the Central Plateau of Hanford. While several manmade ponds and impoundments are located in the 200 Areas, including the two Treated Effluent Disposal Facility (TEDF) disposal ponds and the three Liquid Effluent Retention Facility (LERF) impoundments adjacent to the

200-East Area, these ponds and impoundments would not be directly impacted by construction activities. In addition, no portion of the 200 Areas lies within a floodplain. Although the southwest corner of the 200-West Area is within the probable maximum flood zone of Cold Creek, no facilities would be constructed there under any Tank Closure alternative.

While portions of the probable maximum flood zone associated with Cold Creek lie within the confines of Borrow Area C, production operations associated with material extraction to support tank closure and waste management activities would be conducted to avoid impacting the watercourse and associated floodplain. Any changes in the extent and nature of predicted mining that could impact the floodplain would be evaluated, and a floodplain assessment would be prepared as required by Executive Order 11988, *Floodplain Management*, and Federal regulations (10 CFR 1022).

All construction- and closure-related land disturbances, especially for new facility construction, would expose soils and sediments to possible erosion by infrequent, heavy rainfall or by wind. While unlikely to reach surface-water features as discussed above, stormwater runoff from exposed areas could convey soil, sediments, and other pollutants (e.g., construction waste materials and spilled materials, such as petroleum, oils, and lubricants from construction equipment) from construction footprint and laydown areas. Nevertheless, appropriate soil erosion and sediment control measures, as well as spill prevention and waste management practices, would be employed to minimize suspended sediment, the transport of other deleterious materials, and any potential water-quality impacts. Further, all construction and other ground-disturbing activities would be conducted in accordance with current National Pollutant Discharge Elimination System (NPDES) and state waste discharge general permits for stormwater discharges associated with construction activities, issued by the Washington State Department of Ecology (Ecology). The NPDES permit specifically requires the development and implementation of a stormwater pollution prevention plan.

Once completed, new facilities, including the WTP and other tank waste retrieval, treatment, and storage/disposal facilities, would incorporate appropriate stormwater management controls to collect, convey, and detain stormwater from buildings and other impervious surfaces so as to minimize the impacts of onsite hydrology and soil erosion. Hanford's NPDES Storm Water Multi-Sector General Permit would cover stormwater discharges associated with industrial activity and, as necessary, stormwater discharges would be covered under state waste discharge permits for discharges to the ground.

Under normal operations associated with waste retrieval, treatment, and disposal and tank closure, facility design combined with adherence to spill prevention and emergency response plans and procedures would help to ensure that involved hazardous substances, including spills, should they occur, do not reach soils or surfaces where they could be conveyed to surface water or groundwater. For construction, operations, deactivation, and closure activities, adherence to best management practices and other preventive measures under applicable permits and compliance plans would be coordinated by DOE with those measures in similar sitewide pollution prevention plans.

Direct, short-term impacts of tank closure activities, including tank waste retrieval, treatment, and disposal and SST system closure, on the vadose zone and underlying groundwater would mainly be limited to SST leaks that could be induced by waste retrieval activities under all alternatives, except Alternative 1: No Action.

Projected impacts on water resources specific to implementation of each of the Tank Closure alternatives are presented in the following sections.

4.1.6.1 Alternative 1: No Action

4.1.6.1.1 Surface Water

No additional direct impacts on surface water or groundwater availability or quality resources are expected in the short term under Alternative 1, as ongoing tank farm facility upgrades and associated construction activities would not result in any additional land disturbance in the 200 Areas. Sanitary and industrial wastewater generation in the 200 Areas is expected to decrease with the termination of WTP construction. It was assumed that existing facilities, or their equivalents, would continue to be available to manage liquid waste generated under this alternative, with any necessary operational-life extensions or replacements completed as needed. Specifically, sanitary wastewater would continue to be managed via existing 200 Area collection and treatment facilities. Nonhazardous process wastewater would continue to be discharged to the TEDF in the 200-East Area, while any dilute, radioactive liquid effluents would continue to be managed in the 200 Area LERF prior to treatment in the ETF (DOE 2003d:6-10). The State-Approved Land Disposal Site (SALDS), located north of the 200-West Area, is the ultimate discharge point for liquid waste after it passes through the LERF/ETF system. Waste management is further discussed in Section 4.1.14. Additional water use associated with the proposed facility upgrades and WTP construction would peak in 2008 and then fall to pre-WTP activity levels, as quantified in Section 4.1.2.1. In total, water use to support activities under this alternative has been conservatively estimated at 3,300 million liters (872 million gallons).

4.1.6.1.2 Vadose Zone and Groundwater

This alternative would result in impacts on groundwater quality over the long term only; no short-term impacts would occur because no tank waste retrieval would be performed. The SSTs, DSTs, and miscellaneous underground storage tanks (MUSTs) would fail over time, resulting in the release of their contents to the vadose zone and unconfined aquifer system. These releases would add to the range of 2.84–3.97 million liters (0.75–1.05 million gallons) of waste estimated to have leaked to the vadose zone to date. Ultimately, these contaminants would be discharged to the Columbia River. Long-term impacts on water resources, including contamination releases to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.1.1.1.

4.1.6.2 Alternative 2A: Existing WTP Vitrification; No Closure

4.1.6.2.1 Surface Water

Facility construction activities and normal facility operation are not expected to have any direct impact on surface-water features or surface-water quality under Alternative 2A for the same reasons as previously described in Section 4.1.6.

There would be no direct discharge of effluents to either surface water or groundwater during construction, operations, and deactivation under Alternative 2A. Nonhazardous sanitary wastewater (sewage) would be managed via appropriate sanitary wastewater collection and treatment systems. During the early phases of new facility construction, it was assumed that portable toilet facilities would be provided for construction personnel, with collected waste disposed of at offsite contractor facilities, as is standard construction practice. During facility operations and deactivation, sanitary wastewater would be disposed of via the dedicated sanitary sewer or septic/drain field system serving a particular facility. A dedicated sanitary sewage collection, treatment, and drain field disposal system will serve the WTP complex. Industrial wastewater effluent may be generated as a result of some construction activities, including facility commissioning, but would mainly consist of process effluents from the WTP. Nonhazardous process wastewater would be discharged to the TEDF in the 200-East Area, while radioactive liquid effluents would be discharged to the 200 Area LERF prior to treatment in the ETF (DOE 2003b:6-10). It was assumed that these facilities, or their equivalents, would continue to be available to manage process liquids generated under this alternative, with any necessary operational-life extensions or replacements completed as needed. Due to the relatively long treatment timeframe associated with this alternative, it would be necessary to replace the ETF twice and the 242-A Evaporator once. Waste generation and management activities under this alternative are further discussed in Section 4.1.14.

Water would be required during construction for soil compaction, dust control, concrete production, and possibly for work surface and equipment washdown. During operations, water would be required to support process makeup requirements and facility cooling, as well as the potable and sanitary needs of the operations workforce and other uses. Water would also be used during facility deactivation activities to stabilize and partially decontaminate waste treatment, retrieval, and disposal facilities, but this requirement would be relatively small compared with operational and construction demands. In total, water use to support activities under this alternative has been conservatively estimated at 208,000 million liters (55,000 million gallons), with a peak demand of 3,720 million liters (983 million gallons). While some water use would occur through 2193 associated with the DOE administrative control period, this water demand would primarily occur during the 88-year facility construction, waste retrieval, and waste treatment phases. This peak demand is substantially less than the production capacity of the Hanford Export Water System, which withdraws water from the Columbia River, and it is not expected to greatly impact the availability of surface water for downstream users. The impact of this water demand on Hanford's utility infrastructure is further detailed in Section 4.1.2.2.

4.1.6.2.2 Vadose Zone and Groundwater

Facility construction is unlikely to have any direct impact on groundwater hydrology or existing contaminant plumes under this alternative. As described in Section 4.1.5.2, the depth of excavation for facility construction would not exceed about 12 meters (40 feet), and the depth of the water table in the unconfined aquifer beneath the 200 Areas averages more than 50 meters (164 feet). As such, construction dewatering should not be required for any proposed activities under this alternative. In addition, construction activities would be conducted so as to avoid contaminated geologic media in the vadose zone.

In addition, there would be no direct discharge of effluents to either surface water or groundwater during construction, operations, and deactivation. Sanitary wastewater, nonhazardous process wastewater, and radioactive liquid effluents would be discharged to permitted onsite treatment facilities, as discussed in Section 4.1.6.2.1 above. The only potential effect of these discharges on groundwater would be to maintain or possibly expand the groundwater mounds (i.e., locally elevated water table areas) that exist beneath the TEDF ponds adjacent to the 200-East Area and the WTP site and beneath the SALDS located north of the 200-West Area. The latter is the ultimate discharge point for treated effluent passing through the LERF and the ETF.

During normal operations, the main direct impact on the vadose zone and groundwater in the 200 Areas would be due to leaks from the tank systems during retrieval operations. Leaks are projected to occur due to liquid volume additions (mainly water) under pressure during retrieval. Under this alternative, DOE would utilize a combination of retrieval technologies, including modified sluicing, VBR, and the MRS. The scope of waste retrieval operations is further described in Chapter 2, Section 2.2.2.1. The MRS would be used in tanks that are assumed or have been confirmed to have leaked in the past, as it introduces sluice liquid in a controlled fashion while pumping out the resulting waste slurry at approximately the same rate as liquid is introduced. Thus, this system minimizes increases in liquid volume within the tank during retrieval. Nevertheless, for analysis purposes, it was assumed that each of the 149 SSTs would leak an average of 15,000 liters (4,000 gallons) during retrieval to the surrounding soils and sediments within the vadose zone (DOE 2003e:4-8–4-11). These releases would add to the range of 2.84–3.97 million liters (0.75–1.05 million gallons) of waste estimated to have leaked to the vadose zone to date and could contribute to groundwater contaminant migration over the long term.

Although tank waste retrieval would result in removal of 99 percent of the tank waste by volume as proposed under this alternative, residual tank waste inventories would have the potential to result in impacts on groundwater quality over the long term. Even after implementation of corrective action measures to fill deteriorating tanks with grout or gravel, Hanford SSTs, DSTs, and MUSTs would fail over time, resulting in release of their contents to the vadose zone and unconfined aquifer system. Ultimately, these contaminants would be discharged to the Columbia River. Long-term impacts on water resources, including contamination releases to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.1.1.2.

4.1.6.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

4.1.6.3.1 Surface Water

Facility construction activities and normal facility operations are not expected to have any direct impact on surface-water features or surface-water quality under Alternative 2B for the same reasons as previously described in Sections 4.1.6 and 4.1.6.2.1. Effluents generated by facility operations would be managed in a manner similar to that described in Section 4.1.6.2.1. However, to ensure the availability of treatment facilities to process liquid waste generated under this alternative, the ETF and the 242-A Evaporator would each be replaced once. Waste generation and management activities are further discussed in Section 4.1.14.3.

Water would be required to support new facility construction, facility operations, and facility deactivation, as summarized in Section 4.1.6.2.1. Under this alternative, excavation work associated with emplacement of the modified RCRA Subtitle C barrier for landfill closure of the SST system and the six sets of cribs and trenches (ditches) would add to the water required for dust control and soil compaction. In total, water use to support activities under this alternative has been conservatively estimated at 86,300 million liters (22,800 million gallons), with a peak demand of 3,590 million liters (948 million gallons). While some water use may occur through 2145 associated with the DOE postclosure care period, water demand would be concentrated during the 40-year facility construction, waste retrieval, waste treatment, and SST system closure phases. This peak demand is substantially less than the production capacity of the Hanford Export Water System, which withdraws water from the Columbia River, and it is not expected to greatly impact the availability of surface water for downstream users. The impact of this water demand on Hanford's utility infrastructure is further detailed in Section 4.1.2.3.

4.1.6.3.2 Vadose Zone and Groundwater

Facility construction is unlikely to have any direct impact on groundwater hydrology or existing contaminant plumes under this alternative for the same reasons as previously described in Section 4.1.6.2.2. The exception under this alternative would involve closure activities, including removal and disposal of the upper 4.6 meters (15 feet) of contaminated soils and encountered ancillary equipment within the BX and SX tank farms.

Furthermore, potential impacts of the discharge of facility effluents to permitted onsite treatment facilities would be similar to those described in Section 4.1.6.2.2. Waste generation and management activities are further discussed in Section 4.1.14.3.

Although tank waste retrieval would result in removal of 99 percent of the tank waste by volume, residual tank waste inventories would have the potential to result in impacts on groundwater quality over the long term. In the short term, leaks could occur due to liquid volume additions (mainly water) under pressure during tank waste retrieval activities, as further described in Section 4.1.6.2.2 under Alternative 2A. As a short-term measure following retrieval, individual SSTs and DSTs in each tank farm would be stabilized by filling them with cement grout, then emplacing a landfill barrier over the tank farms. The modified RCRA Subtitle C barrier lobes would impede the movement of residual contaminants from the tanks to the vadose zone, principally by retarding surface-water infiltration. Similarly, the barrier system would impede further movement of previously released tank-related contaminants in the vadose zone. The modified RCRA Subtitle C barrier is designed for a 500-year performance period. Nevertheless, this barrier would degrade over time, allowing infiltration and contaminant migration, and the SSTs, DSTs, and MUSTs would fail, resulting in release of their contents to the vadose zone and unconfined aquifer system. Ultimately, these contaminants could be discharged to the Columbia River. Long-term impacts on water resources, including contamination releases to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.1.1.3.

4.1.6.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

4.1.6.4.1 Surface Water

Facility construction activities and normal facility operations are not expected to have any direct impact on surface-water features or surface-water quality under Alternative 3A for the same reasons as previously described in Sections 4.1.6 and 4.1.6.2.1. Any potential for direct or indirect impacts on stormwater or surface-water quality would be very similar to that under Alternative 2B, as the total land area that would be disturbed is similar, despite the addition of Bulk Vitrification Facilities under this alternative.

Effluents generated by facility operations would be managed in a manner similar to that described in Section 4.1.6.2.1. However, to ensure the availability of treatment facilities to process liquid waste generated under this alternative, the ETF and the 242-A Evaporator would be replaced once. Waste generation and management activities are further discussed in Section 4.1.14.4.

Water would be required to support new facility construction, facility operations, and facility deactivation, as summarized in Section 4.1.6.2.1. As under Alternative 2B (see Section 4.1.6.3.1), excavation work associated with emplacement of the modified RCRA Subtitle C barrier for landfill closure of the SST system and the six sets of cribs and trenches (ditches) in the B and T Areas under this alternative would add to the water required for dust control and soil compaction. In total, water use to support activities under this alternative has been conservatively estimated at 77,000 million liters (20,300 million gallons), with a peak demand of 2,200 million liters (576 million gallons), which is less than the estimated requirements under Alternatives 2A and 2B. While some water use may occur through 2141 associated with the DOE postclosure care period, this water demand would primarily occur during the 36-year facility construction, waste retrieval, waste treatment, and SST system closure phases. This demand is substantially less than the production capacity of the Hanford Export Water System, which withdraws water from the Columbia River, and it is not expected to greatly impact the availability of surface water for downstream users. The impact of this water demand on Hanford's utility infrastructure is further detailed in Section 4.1.2.4.

4.1.6.4.2 Vadose Zone and Groundwater

Facility construction is unlikely to have any direct impact on groundwater hydrology or existing contaminant plumes under this alternative for the same reasons as previously described in Section 4.1.6.2.2. As under Alternative 2B, the exception under this alternative would involve closure activities, including removal and disposal of the upper 4.6 meters (15 feet) of contaminated soils and encountered ancillary equipment within the BX and SX tank farms.

Furthermore, potential impacts of the discharge of facility effluents to permitted onsite treatment facilities would be similar to those described in Section 4.1.6.2.2. Waste generation and management activities are further discussed in Section 4.1.14.4.

As under the previous alternatives, tank waste retrieval activities would result in removal of 99 percent of the tank waste by volume under this alternative. The residual tank waste inventories would still have the potential to result in impacts on groundwater quality over the long term. In the short term, leaks could occur due to liquid volume additions (mainly water) under pressure during tank waste retrieval activities, as further described in Section 4.1.6.2.2 under Alternative 2A. As a short-term measure following retrieval, individual SSTs and DSTs in each tank farm would be stabilized by filling them with cement grout, then emplacing a landfill barrier over the tank farms. The modified RCRA Subtitle C barrier system would impede the movement of residual contaminants from the tanks to the vadose zone, principally by retarding surface-water infiltration. Similarly, the barrier system would impede further movement of previously released tank-related contaminants in the vadose zone. The modified RCRA Subtitle C barrier is designed for a 500-year performance period. Nevertheless, this barrier would degrade over time, allowing infiltration and contaminant migration, and the SSTs, DSTs, and MUSTs would fail, resulting in release of their contents to the vadose zone and unconfined aquifer system. Ultimately, these contaminants could be discharged to the Columbia River. Long-term impacts on water resources, including contamination releases to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.1.1.4.

4.1.6.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

4.1.6.5.1 Surface Water

Facility construction activities and normal facility operations are not expected to have any direct impact on surface-water features or surface-water quality under Alternative 3B for the same reasons as previously described in Sections 4.1.6 and 4.1.6.2.1. Any potential for direct or indirect impacts on stormwater or surface-water quality would be very similar to those under Alternatives 2B and 3A, as the total land area that would be disturbed would be similar, despite the addition of Cast Stone Facilities under this alternative.

Effluents generated by facility operations would be managed in a manner similar to that described in Section 4.1.6.2.1. However, to ensure the availability of treatment facilities to process liquid waste generated under this alternative, the ETF and the 242-A Evaporator would each be replaced once. Waste generation and management activities are further discussed in Section 4.1.14.5.

Water would be required to support new facility construction, facility operations, and facility deactivation, as summarized in Section 4.1.6.2.1. As under Alternative 2B (see Section 4.1.6.3.1), excavation work associated with emplacement of the modified RCRA Subtitle C barrier for landfill closure of the SST system and the six sets of cribs and trenches (ditches) in the B and T Areas under this alternative would add to the water required for dust control and soil compaction. In total, water use to support activities under this alternative has been conservatively estimated at 77,000 million liters (20,300 million gallons), with a peak demand of 2,200 million liters (576 million gallons), which is less than the estimated requirements under Alternatives 2A and 2B and the same as those under Alternative 3A. While some water use may occur through 2141 associated with the DOE postclosure care period, this water demand would primarily occur during the 36-year facility construction, waste retrieval, waste treatment, and SST system closure phases. This demand is substantially less than the production capacity of the Hanford Export Water System, which withdraws water from the Columbia River, and it is not expected to greatly impact the availability of surface water for downstream users. The impact of this water demand on Hanford's utility infrastructure is further detailed in Section 4.1.2.5.

4.1.6.5.2 Vadose Zone and Groundwater

Facility construction is unlikely to have any direct impact on groundwater hydrology or existing contaminant plumes under this alternative for the same reasons as previously described in Section 4.1.6.2.2. As under Alternative 2B, the exception under this alternative would involve closure activities, including removal and disposal of the upper 4.6 meters (15 feet) of contaminated soils and encountered ancillary equipment within the BX and SX tank farms.

Furthermore, potential impacts of the discharge of facility effluents to permitted onsite treatment facilities would be similar to those described in Section 4.1.6.2.2. Waste generation and management activities are further discussed in Section 4.1.14.5.

As under the previous alternatives, tank waste retrieval activities would result in removal of 99 percent of the tank waste by volume under this alternative. The residual tank waste inventories would still have the potential to result in impacts on groundwater quality over the long term. In the short term, leaks could occur due to liquid volume additions (mainly water) under pressure during tank waste retrieval activities, as further described in Section 4.1.6.2.2 under Alternative 2A. As a short-term measure following retrieval, individual SSTs and DSTs in each tank farm would be stabilized by filling them with cement grout, then emplacing a landfill barrier over the tank farms. The modified RCRA Subtitle C barrier system would impede the movement of residual contaminants from the tanks to the vadose zone, principally by retarding surface-water infiltration. Similarly, the barrier system would impede further movement of previously released tank-related contaminants in the vadose zone. The modified RCRA Subtitle C barrier is designed for a 500-year performance period. Nevertheless, this barrier would degrade over time, allowing infiltration and contaminant migration, and the SSTs, DSTs, and MUSTs would fail, resulting in release of their contents to the vadose zone and unconfined aquifer system. Ultimately, these contaminants could be discharged to the Columbia River. Long-term impacts on water resources, including contamination releases to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.1.1.5.

4.1.6.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

4.1.6.6.1 Surface Water

Facility construction activities and normal facility operations are not expected to have any direct impact on surface-water features or surface-water quality under Alternative 3B for the same reasons as previously described in Sections 4.1.6 and 4.1.6.2.1. Any potential for direct or indirect impacts on stormwater or surface-water quality would be very similar to that under Alternatives 2B, 3A, and 3B, as the total land area that would be disturbed would be similar, despite the addition of Steam Reforming Facilities under this alternative.

Effluents generated by facility operations would be managed in a manner similar to that described in Section 4.1.6.2.1. However, to ensure the availability of treatment facilities to process liquid waste generated under this alternative, the ETF and the 242-A Evaporator would each be replaced once. Waste generation and management activities are further discussed in Section 4.1.14.6.

Water would be required to support new facility construction, facility operations, and facility deactivation, as summarized in Section 4.1.6.2.1. As under Alternative 2B (see Section 4.1.6.3.1), excavation work associated with emplacement of the modified RCRA Subtitle C barrier for landfill closure of the SST system and the six sets of cribs and trenches (ditches) in the B and T Areas under this alternative would add to the water required for dust control and soil compaction. In total, water use to support activities under this alternative has been conservatively estimated at 77,300 million liters (20,400 million gallons), with a peak demand of 2,200 million liters (579 million gallons), which is less than the estimated requirements under Alternatives 2A and 2B and just slightly more than under Alternatives 3A and 3B. While some water use may occur through 2141 associated with the DOE postclosure care period, this water demand would primarily occur during the 36-year facility construction, waste retrieval, waste treatment, and SST system closure phases. This demand is substantially less than the production capacity of the Hanford Export Water System, which withdraws water from the Columbia River, and it is not expected to greatly impact the availability of surface water for downstream users. The impact of this water demand on Hanford's utility infrastructure is further detailed in Section 4.1.2.6.

4.1.6.6.2 Vadose Zone and Groundwater

Facility construction is unlikely to have any direct impact on groundwater hydrology or existing contaminant plumes under this alternative for the same reasons as previously described in Section 4.1.6.2.2. As under Alternative 2B, the exception under this alternative would involve closure activities, including removal and disposal of the upper 4.6 meters (15 feet) of contaminated soils and encountered ancillary equipment within the BX and SX tank farms.

Furthermore, potential impacts of the discharge of facility effluents to permitted onsite treatment facilities would be similar to those described in Section 4.1.6.2.2. Waste generation and management activities are further discussed in Section 4.1.14.6.

As under the previous alternatives, tank waste retrieval activities would result in removal of 99 percent of the tank waste by volume under this alternative. The residual tank waste inventories would still have the potential to result in impacts on groundwater quality over the long term. In the short term, leaks could occur due to liquid volume additions (mainly water) under pressure during tank waste retrieval activities, as further described in Section 4.1.6.2.2 under Alternative 2A. As a short-term measure following retrieval, individual SSTs and DSTs in each tank farm would be stabilized by filling them with cement grout, then emplacing a landfill barrier over the tank farms. The modified RCRA Subtitle C barrier system would impede the movement of residual contaminants from the tanks to the vadose zone, principally by retarding surface-water infiltration. Similarly, the barrier system would impede further movement of previously released tank-related contaminants in the vadose zone. The modified RCRA Subtitle C barrier is designed for a 500-year performance period. Nevertheless, this barrier would degrade over time, allowing infiltration and contaminant migration, and the SSTs, DSTs, and MUSTs would fail, resulting in release of their contents to the vadose zone and unconfined aquifer system. Ultimately, these contaminants could be discharged to the Columbia River. Long-term impacts on water resources, including contamination releases to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.1.1.6.

4.1.6.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

4.1.6.7.1 Surface Water

Facility construction activities and normal facility operations are not expected to have any direct impact on surface-water features or surface-water quality under Alternative 4 for the same reasons as previously described in Sections 4.1.6 and 4.1.6.2.1. Any potential for direct or indirect impacts on stormwater or surface-water quality would be very similar to that for Alternatives 2B, 3A, 3B, and 3C, as the total land area that would be disturbed would be similar and would include construction of Bulk Vitrification and Cast Stone Facilities in addition to construction of a new PPF to process waste generated from selective clean closure activities under this alternative.

Nevertheless, effluents generated by facility operations would be managed in a manner similar to that described in Section 4.1.6.2.1. However, to ensure the availability of treatment facilities to process liquid waste generated under this alternative, the ETF and the 242-A Evaporator would each be replaced once.

Operation of the PPF for treatment of waste generated as a result of clean closure actions would also generate effluents. Concentrated hazardous constituents and radionuclides from this process would be returned to the WTP influent for eventual vitrification (DOE 2003c:9, 10). Waste generation and management activities under this alternative are further discussed in Section 4.1.14.7.

Water would be required to support new facility construction, facility operations, and facility deactivation, as summarized in Section 4.1.6.2.1. As under Alternative 2B (see Section 4.1.6.3.1), excavation work associated with emplacement of the modified RCRA Subtitle C barrier for landfill closure of the SST system and the six sets of cribs and trenches (ditches) in the B and T Areas, plus clean closure of the BX and SX tank farms under this alternative, would add to the water required for dust control and soil compaction. In total, water use to support activities under this alternative has been conservatively estimated at 82,200 million liters (21,700 million gallons), with a peak demand of 2,180 million liters (576 million gallons), which is greater overall than Alternatives 3A, 3B, and 3C, largely due to a higher treatment operations demand under this alternative. While some water use may occur through 2144 associated with the DOE postclosure care period, this water demand would primarily occur during the 39-year facility construction, waste retrieval, waste treatment, and SST system and tank farm closure phases. This demand is substantially less than the production capacity of the Hanford Export Water System, which withdraws water from the Columbia River, and it is not expected to greatly impact the availability of surface water for downstream users. The impact of this water demand on Hanford's utility infrastructure is further detailed in Section 4.1.2.7.

4.1.6.7.2 Vadose Zone and Groundwater

Facility construction is unlikely to have any direct impact on groundwater hydrology or existing contaminant plumes under this alternative for the same reasons as previously described in Section 4.1.6.2.2. However, to implement selective clean closure at the BX and SX tank farm sites, excavation to depths of up to 78 meters (255 feet) below land surface may be required, particularly in the BX tank farm, to remediate contaminant plumes from past-practice discharges that have migrated through the vadose zone soils and sediments and possibly to the water table. This would have a beneficial impact by stemming further contaminant migration from these sources (see Section 4.1.5.7). Construction dewatering would likely be necessary in some tank farm excavations to allow clean closure to proceed, and, depending on the amount of pumping required, dewatering activities may have a local effect on groundwater flow and existing contaminant plumes beneath the tank farms. In addition, the water would require special handling and treatment. Therefore, this groundwater would be conveyed to onsite ETFs for processing.

Furthermore, potential impacts of the discharge of facility effluents to permitted onsite treatment facilities would be similar to those described in Section 4.1.6.2.2. Sanitary wastewater, nonhazardous process wastewater, and radioactive liquid effluents would be discharged to permitted onsite treatment facilities, as discussed above in Section 4.1.6.7.1. Waste generation and management activities are further discussed in Section 4.1.14.7.

Although tank waste retrieval would result in removal of 99.9 percent of the tank waste by volume in contrast to 99 percent under the previously discussed action alternatives, residual tank waste inventories would have the potential to result in impacts on groundwater quality over the long term. In the short term, leaks could occur due to liquid volume additions (mainly water) under pressure during tank waste retrieval activities, as further described in Section 4.1.6.2.2 under Alternative 2A. As a short-term measure following retrieval, individual SSTs and DSTs in each tank farm would be stabilized by filling them with cement grout, then emplacing a landfill barrier over the tank farms. Under this alternative, the modified RCRA Subtitle C barrier lobes placed over each tank farm that would not be clean-closed would impede the movement of residual contaminants from the tanks to the vadose zone, principally by retarding surface-water infiltration. Similarly, the barrier system would impede further movement of previously released tank-related contaminants in the vadose zone. The modified RCRA Subtitle C barrier is designed for a 500-year performance period. Nevertheless, this barrier would degrade over time, allowing infiltration and contaminant migration, and the Hanford SSTs, DSTs, and MUSTs would fail, resulting in release of their contents to the vadose zone and unconfined aquifer system. Ultimately, these contaminants could be discharged to the Columbia River. Long-term impacts on water resources, including contamination releases to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.1.1.7.

4.1.6.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

4.1.6.8.1 Surface Water

Facility construction activities and normal facility operations are not expected to have any direct impact on surface-water features or surface-water quality under Alternative 5 for the same reasons as previously described in Sections 4.1.6 and 4.1.6.2.1. Any potential for direct or indirect impacts on stormwater or surface-water quality would be somewhat greater than that for Alternatives 2B, 3A, 3B, 3C, and 4 due to the slightly larger land area that would be disturbed under this alternative, which includes construction of Bulk Vitrification and Cast Stone Facilities in addition to a Sulfate Removal Facility to support accelerated waste treatment.

Effluents generated by facility operations would be managed in a manner similar to that described in Section 4.1.6.2.1. However, to ensure the availability of treatment facilities to process liquid waste generated under this alternative, the ETF and the 242-A Evaporator would be replaced once. Waste generation and management activities are further discussed in Section 4.1.14.8.

Water would be required to support new facility construction, facility operations, and facility deactivation, as summarized in Section 4.1.6.2.1. In contrast to Alternatives 2B through 4, wherein a modified RCRA Subtitle C barrier would be constructed (see Section 4.1.6.3.1), excavation work associated with emplacement of the more robust Hanford barrier under this alternative would add to the amount of water required for dust control and soil compaction. In total, water use to support activities under this alternative has been conservatively estimated at 92,500 million liters (24,400 million gallons), with a peak demand of 3,830 million liters (1,000 million gallons). While some water use may occur through 2139 associated with the DOE postclosure care period, this water demand would primarily occur during the 34-year facility construction, waste retrieval, and waste treatment phases and extend through landfill closure. This demand is substantially less than the production capacity of the Hanford Export Water System, which withdraws water from the Columbia River, and it is not expected to greatly impact availability of surface water for downstream users. The impact of this water demand on Hanford's utility infrastructure is further detailed in Section 4.1.2.8.

4.1.6.8.2 Vadose Zone and Groundwater

Facility construction is unlikely to have any direct impact on groundwater hydrology or existing contaminant plumes under this alternative for the same reasons as previously described in Section 4.1.6.2.2, as there would be no contaminated soil removal in the BX and SX tank farms prior to emplacement of the landfill closure barrier.

Furthermore, potential impacts of the discharge of facility effluents to permitted onsite treatment facilities would be similar to those described in Section 4.1.6.2.2. Waste generation and management activities are further discussed in Section 4.1.14.8.

To expedite waste treatment and tank farm closure, tank waste retrieval activities would result in removal of 90 percent of the tank waste by volume under this alternative. The residual tank waste inventories would still have the potential to result in impacts on groundwater quality over the long term. In the short term, leaks could occur due to liquid volume additions (mainly water) under pressure during tank waste retrieval activities, as further described in Section 4.1.6.2.2 under Alternative 2A. As a short-term measure following retrieval, individual SSTs and DSTs in each tank farm would be stabilized by filling them with cement grout, then emplacing a landfill barrier over the tank farms. As opposed to the modified RCRA Subtitle C barrier proposed under Alternatives 2B through 4 and 6C, the more robust Hanford barrier, which is designed for a 1,000-year performance period, would be used for landfill closure (DOE 2003a:6-64). This would help compensate for the lower volume of tank waste retrieved under this alternative. The Hanford barrier would impede the movement of residual contaminants from the tanks to the vadose zone, principally by retarding surface-water infiltration. Similarly, the barrier system would impede further movement of previously released tank-related contaminants in the vadose zone. Nevertheless, the Hanford barrier would still degrade over time, allowing infiltration and contaminant migration, and the SSTs, DSTs, and MUSTs would fail, resulting in release of their contents to the vadose zone and unconfined aquifer system. Ultimately, these contaminants could be discharged to the Columbia River. Long-term impacts on water resources, including contamination releases to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.1.1.8.

4.1.6.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

4.1.6.9.1 Surface Water

4.1.6.9.1.1 Base Case

Facility construction activities and normal facility operations are not expected to have any direct impact on surface-water features or surface-water quality under Alternative 6A, Base Case, for the same reasons as previously described in Sections 4.1.6 and 4.1.6.2.1. Nevertheless, the potential for direct or indirect impacts on stormwater or surface-water quality would be highest under this alternative, compared with the previously discussed alternatives, due to the substantially larger land area that would be disturbed by new facility construction and then converted to impervious surface. This increased potential would be reduced by the much longer timeframe over which construction and operations activities would take place compared with the previously discussed alternatives.

Effluents generated by facility operations would be managed in a manner similar to that described in Section 4.1.6.2.1. However, due to the relatively long operational timeframe to complete waste treatment, the ETF would be replaced five times and the 242-A Evaporator would be replaced six times to ensure the availability of treatment facilities to process liquid waste generated under this alternative. PPF operation for treatment of waste generated as a result of clean closure actions would also generate effluents. A portion of the ensuing waste streams would be solidified for onsite disposal, while concentrated hazardous constituents and radionuclides from this process would be vitrified, with the resulting PPF glass waste form also disposed of on site. Waste generation and management activities are further discussed in Section 4.1.14.9.

Water would be required to support new facility construction, facility operations, and facility deactivation, as summarized in Section 4.1.6.2.1. In contrast to the previously described alternatives, complete clean closure of the SST system under this alternative and emplacement of the modified RCRA Subtitle C barrier for landfill closure of the six sets of cribs and trenches (ditches) in the B and T Areas would add to the water required for dust control and soil compaction. In total, water use to support activities under this alternative has been conservatively estimated at 643,000 million liters (170,000 million gallons), with a peak demand of 6,570 million liters (1,740 million gallons), which is nearly an order of magnitude greater than that of the previously described alternatives due to HLW waste treatment operations occurring over a relatively long period of time. While some water use associated with the DOE postclosure care period for the B and T Areas may persist through 2250, this water demand would primarily occur during the 159-year facility construction, waste retrieval, waste treatment, and facility deactivation and closure phases. Despite its relatively long timeframe, this demand is substantially less than the production capacity of the Hanford Export Water System, which withdraws water from the Columbia River, and it is not expected to greatly impact the availability of surface water for downstream users. The impact of this water demand on Hanford's utility infrastructure is further detailed in Section 4.1.2.9.3.

4.1.6.9.1.2 Option Case

Potential direct and indirect impacts of tank closure–related facility construction, waste retrieval, waste treatment, and facility deactivation and closure activities on surface-water resources would be similar to those discussed in Section 4.1.6.9.1.1 under Alternative 6A, Base Case. One exception is that under Alternative 6A, Option Case, the six sets of cribs and trenches (ditches) in the B and T Areas would be removed instead of being landfill-closed, as under Alternative 6A, Base Case. Removal would require construction and operation of a larger PPF to process the added waste from clean closure of the cribs and trenches (ditches). It was estimated that removal would increase water use by approximately 200 million liters (53 million gallons), driven by the closure phase of this option, compared with Alternative 6A, Base Case, and would generate additional effluents from the PPF. Nevertheless, removal is not expected to have any additional impact on surface water and water quality, and effluents generated by facility operations under this option would be managed in a manner similar to that described in Section 4.1.6.2.1.

4.1.6.9.2 Vadose Zone and Groundwater

4.1.6.9.2.1 Base Case

Facility construction is unlikely to have any direct impact on groundwater hydrology or existing contaminant plumes under this alternative. However, to implement selective clean closure under this alternative, excavation to depths of up to 78 meters (255 feet) below the land surface may be required, particularly in the B tank farm, to remediate contaminant plumes from past-practice discharges that have migrated through the vadose zone soils and sediments and possibly to the water table (see Section 4.1.5.9.1). Excavation and remediation would have a beneficial impact by stemming further contaminant migration from the tank farms. Construction dewatering would likely be necessary in some tank farm excavations to allow clean closure to proceed, and, depending on the amount of pumping required, dewatering activities might have a local effect on groundwater flow and existing contaminant plumes beneath the tank farms. In addition, the water would require special handling and treatment. Therefore, this groundwater would be conveyed to onsite ETFs for processing.

There would be no direct discharge of effluents to either surface water or groundwater during construction, operations, deactivation, or closure. Sanitary wastewater, nonhazardous process wastewater, and radioactive liquid effluents would be discharged to permitted onsite treatment facilities, as discussed above in Sections 4.1.6.9.1.1 and 4.1.6.2.1. The only potential effect of these discharges on groundwater would be to maintain or possibly expand the groundwater mounds (i.e., locally elevated water table areas) that exist beneath the TEDF ponds adjacent to the 200-East Area and the WTP site and beneath the SALDS located north of the 200-West Area. The latter is the ultimate discharge point for treated effluent passing through the LERF and the ETF.

During normal operations, the main direct impact on the vadose zone and groundwater in the 200 Areas would be due to leaks from the tank systems during retrieval operations. Leaks are projected to occur due to liquid volume additions (mainly water) under pressure during retrieval, as further described in Section 4.1.6.2.2 under Alternative 2. Nonetheless, clean closure of all 12 SST farms under this alternative, coupled with deep soil removal, would measurably reduce the long-term risk to groundwater quality. Clean closure would not eliminate all contamination stemming from historic tank waste operations, such as historic releases to cribs and trenches (ditches), which have already moved downgradient in the vadose zone and in the unconfined aquifer system beneath Hanford. In addition, landfill closure of the six sets of cribs and trenches (ditches) in the B and T Areas would delay, but not prevent, future migration of contaminants from these sources. Ultimately, these contaminants could be discharged to the Columbia River. Long-term impacts on water resources, including contamination releases to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.1.1.9.

4.1.6.9.2.2 Option Case

Direct, short-term impacts of tank closure activities, including facility construction, tank waste retrieval, waste treatment operations, and SST system clean closure, on the vadose zone and groundwater under this option would be very similar to, but ultimately less than, those described in Section 4.1.6.9.2.1 under Alternative 6A, Base Case. While direct disturbance of the vadose zone and unconfined aquifer would be temporarily greater under this option in association with the removal of the six sets of cribs and trenches (ditches) in the B and T Areas, this action would essentially remove this source of contamination from further impacting the underlying groundwater over the long term. Long-term impacts on water resources, including contamination releases to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.1.1.9.

4.1.6.10 Alternative 6B: All Vitrification with Separations; Clean Closure

4.1.6.10.1 Surface Water

4.1.6.10.1.1 Base Case

Facility construction activities and normal facility operations are not expected to have any direct impact on surface-water features or surface-water quality under Alternative 6B, Base Case, for the same reasons as previously described in Sections 4.1.6 and 4.1.6.2.1. Nevertheless, the potential for direct or indirect impacts on stormwater or surface-water quality would be relatively high under this alternative compared with those under the previously discussed alternatives, except for Alternative 6A, Base Case, due to the substantially larger land area that would be disturbed from new facility construction and then converted to impervious surface.

Effluents generated by facility operations would be managed in a manner similar to that described in Section 4.1.6.2.1. However, to ensure the availability of treatment facilities to process liquid waste generated under this alternative, the ETF would be replaced twice and the 242-A Evaporator would be replaced once. As under Alternative 6A (see Section 4.1.6.9.1.1), PPF operation for treatment of waste generated as a result of clean closure actions would also generate effluents. A portion of the ensuing waste streams would be solidified for disposal on site, while concentrated hazardous constituents and radionuclides from this process would be vitrified, with the resulting PPF glass waste form also disposed of on site. Waste generation and management activities are further discussed in Section 4.1.14.10.

Water would be required to support new facility construction, facility operations, and facility deactivation, as summarized in Section 4.1.6.2.1. While SST system closure activities would be the same as those under Alternative 6A, Base Case (see Section 4.1.6.9.1.1), overall water requirements for new facility construction and waste treatment operations would be an order of magnitude lower under this alternative than under Alternative 6A, Base Case. In total, water use to support activities under this alternative has been conservatively estimated at 92,600 million liters (24,500 million gallons), with a peak demand of 3,500 million liters (925 million gallons). While some water use associated with the DOE postclosure care period for the B and T Areas may persist through 2201, this water demand would primarily occur during the 95-year facility construction, waste retrieval, waste treatment, and facility deactivation and closure phases. This demand is substantially less than the production capacity of the Hanford Export Water System, which withdraws water from the Columbia River, and it is not expected to greatly impact the availability of surface water for downstream users. The impact of this water demand on Hanford's utility infrastructure is further detailed in Section 4.1.2.10.3.

4.1.6.10.1.2 Option Case

Potential direct and indirect impacts of tank closure–related facility construction, waste retrieval, facility treatment, facility deactivation, and closure activities on surface-water resources would be similar to those discussed in Section 4.1.6.10.1.1 under Alternative 6B, Base Case. One exception is that under Alternative 6B, Option Case, the six sets of cribs and trenches (ditches) in the B and T Areas would be removed instead of being landfill-closed, as under Alternative 6A, Base Case. This removal would require construction and operation of a larger PPF to process the added waste from clean closure of the cribs and trenches (ditches). It was estimated that clean closure would increase water use by approximately 200 million liters (53 million gallons), driven by the closure phase of this option, compared with Alternative 6B, Base Case, and generate additional effluents from the PPF. Nevertheless, removal is not expected to have any additional impact on surface water and water quality, and effluents generated by facility operations under this option would be managed in a manner similar to that described in Section 4.1.6.2.1.

4.1.6.10.2 Vadose Zone and Groundwater

4.1.6.10.2.1 Base Case

Direct, short-term impacts of tank closure activities under this alternative case would be very similar, if not identical, to those described in Section 4.1.6.9.2.1 under Alternative 6A, Base Case, because waste retrieval and tank closure actions, including clean closure of the SST system and landfill closure of the six sets of cribs and trenches (ditches) in the B and T Areas, would be identical under this alternative case. Long-term impacts on water resources, including contamination releases to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.1.1.10.

4.1.6.10.2.2 Option Case

Under this alternative case, direct, short-term impacts of tank closure activities on the vadose zone and groundwater would be very similar to, but ultimately less than, those described in Section 4.1.6.9.2.1 under Alternative 6A, Base Case, and essentially identical to those under Alternative 6A, Option Case (see Section 4.1.6.9.2.2). While direct disturbance of the vadose zone and unconfined aquifer would be temporarily greater under this option in association with the removal of the six sets of cribs and trenches (ditches) in the B and T Areas, this action would essentially remove this source of contamination from further impacting the underlying groundwater over the long term. Long-term impacts on water resources, including contamination releases to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.1.1.10.

4.1.6.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

4.1.6.11.1 Surface Water

Facility construction activities and normal facility operations are not expected to have any direct impact on surface-water features or surface-water quality under Alternative 6C for the same reasons as previously described in Sections 4.1.6 and 4.1.6.2.1. In general, effects on surface-water resources would be very similar to those described under Alternative 2B (see Section 4.1.6.3.1). While additional ILAW Interim Storage Facilities would be constructed and operated under this alternative, they are not expected to have any incremental impact on surface water. Effluents generated by facility operations would be managed in a manner similar to that described in Section 4.1.6.2.1. To ensure the availability of treatment facilities to process liquid waste generated under this alternative, the ETF and the 242-A Evaporator would be replaced once, as also required under Alternative 2B. Waste generation and management activities are further discussed in Section 4.1.14.11.

Water would be required to support new facility construction, facility operations, and facility deactivation, as previously summarized in Section 4.1.6.2.1. Under this alternative, excavation work associated with emplacement of the modified RCRA Subtitle C barrier for landfill closure of the SST system and six sets of cribs and trenches (ditches) would add to the water required for dust control and soil compaction. In total, water use to support activities under this alternative has been conservatively estimated at 86,300 million liters (22,800 million gallons), with a peak demand of 3,590 million liters (975 million gallons). While some water use associated with the DOE postclosure care period may persist through 2145, this water demand would primarily occur during the 40-year facility construction, waste retrieval, waste treatment, and SST system closure phases. This demand would be substantially less than the production capacity of the Hanford Export Water System, which withdraws water from the Columbia River, and it is not expected to greatly impact availability of surface water for downstream users. The impact of this water demand on Hanford's utility infrastructure is further detailed in Section 4.1.2.11.

4.1.6.11.2 Vadose Zone and Groundwater

Facility construction is unlikely to have any direct impact on groundwater hydrology or existing contaminant plumes under this alternative for the same reasons as previously described in Section 4.1.6.2.2. The exception under this alternative would involve closure activities, including removal and disposal of the upper 4.6 meters (15 feet) of contaminated soils and encountered ancillary equipment within the BX and SX tank farms.

Furthermore, potential impacts of the discharge of facility effluents to permitted onsite treatment facilities would be similar to those described in Section 4.1.6.2.2. Waste generation and management activities are further discussed in Section 4.1.14.11.

Although tank waste retrieval would result in removal of 99 percent of the tank waste by volume, residual tank waste inventories would have the potential to result in impacts on groundwater quality over the long term. In the short term, leaks could occur due to liquid volume additions (mainly water) under pressure during tank waste retrieval activities, as further described in Section 4.1.6.2.2 under Alternative 2A. As a short-term measure following retrieval, individual SSTs and DSTs in each tank farm would be stabilized by filling them with cement grout, then emplacing a landfill barrier over the tank farms. The modified RCRA Subtitle C barrier lobes would impede movement of residual contaminants from the tanks to the vadose zone, principally by retarding surface-water infiltration. Similarly, the barrier system would impede further movement of previously released tank-related contaminants in the vadose zone. The modified RCRA Subtitle C barrier is designed for a 500-year performance period. Nevertheless, this barrier would degrade over time (following the end of DOE administrative control), allowing infiltration and contaminant migration, and the SSTs, DSTs, and MUSTs would fail, resulting in release of their contents to the vadose zone and unconfined aquifer system. Ultimately, these contaminants could be discharged to the Columbia River. Long-term impacts on water resources, including contamination releases to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.1.1.11.

4.1.7 Ecological Resources

4.1.7.1 Alternative 1: No Action

Under the No Action Alternative, there would be no new construction within the 200 Areas, although some work would take place within previously disturbed areas. Thus, there would be no additional impact on terrestrial resources, wetlands, aquatic resources, or threatened and endangered species under this alternative.

This alternative would require excavation of 2 hectares (5 acres) from Borrow Area C to supply geologic material for use in activities such as the stabilization of tanks and closure of the WTP. Due to the limited area to be disturbed, impacts on terrestrial resources would be minimal. As there are no wetlands or aquatic resources within Borrow Area C, these resources would not be affected. Surveys have identified Piper's daisy (state sensitive), stalked-pod milkvetch (state watch), crouching milkvetch (state watch), and the long-billed curlew (state monitor) within Borrow Area C. Because of the limited area to be disturbed, impacts on these species are expected to be minimal. A mitigation action plan would be prepared prior to excavation of Borrow Area C if conflicts with any of these species were likely. Due to the greater amount of land to be disturbed under the action alternatives, ecological impacts resulting from excavation of Borrow Area C are addressed in more detail below (see Sections 4.1.7.2 through 4.1.7.11).

4.1.7.2 Alternative 2A: Existing WTP Vitrification; No Closure

4.1.7.2.1 Terrestrial Resources

As noted in Section 4.1.1.2.1, 33.9 hectares (83.8 acres) would be disturbed by construction of new facilities within the 200 Areas under this alternative. Of this total, 30.7 hectares (75.8 acres) would be developed within the 200-East Area and 3.2 hectares (8 acres) within the 200-West Area. The only new construction to take place within the 200-West Area is an underground transfer line that would be built along existing roads and, thus, would have a negligible impact on terrestrial resources. Within and adjacent to the 200-East Area, most new facilities would be built within previously disturbed areas and thus would have a negligible impact on terrestrial resources. However, the underground transfer line, new DSTs, and replacement WTP would disturb 14.2 hectares (35 acres) of big sagebrush habitat. Late successional sagebrush habitat is considered a Level III resource under the *Hanford Site Biological Resources Management Plan* (DOE 2001b:4.11). The loss of 1.2 hectares (3 acres) of sagebrush habitat resulting from construction of the 200-East Area portion of the underground transfer line would not be mitigable; however, Hanford guidance may require the replacement of other sagebrush habitat at a ratio ranging from 1:1 to 3:1 (DOE 2003f:20, 21, 31). Specific measures to mitigate the loss of sagebrush habitat would be set forth in a mitigation action plan prior to construction.

Microbiotic crusts, which are expected to occur only on undisturbed sites within the 200 Areas, would be destroyed by new construction. Thus, including both sagebrush and nonsagebrush habitat, up to 16.2 hectares (40 acres) of crusts could be destroyed. There would be no impacts on terrestrial plant communities from operations.

Wildlife potentially affected by the construction of new facilities under this alternative could include the mule deer, coyote, northern pocket gopher, sage sparrow, and western meadowlark. As the sage sparrow is listed as a candidate species, it is discussed in Section 4.1.7.2.4. Ground disturbance would result in the loss of less-mobile species such as small mammals and reptiles, including their nests and young. Larger, more-mobile species, such as many mammals and birds, would be displaced to similar surrounding habitat. Their ultimate survival would depend on whether the areas into which they moved were at their carrying capacity (i.e., contained the maximum number of the individual animals that the habitat is capable of supporting). If construction took place during the breeding season for ground-nesting birds, generally between March and July, the eggs and nests of these birds could be destroyed and the adults displaced. Actions taken to mitigate the disturbance of sagebrush habitat would help maintain wildlife populations dependent on this important community. Although Hanford is on the Pacific Flyway, construction would not impact any bodies of water or wetlands; thus, waterfowl would not be affected under this alternative.

Wildlife could also be affected by noise and human disturbance during construction. The most obvious reaction would be a startle or fright response resulting from transient, unexpected noise. Such noise could cause animals to flee the area. If construction were to take place near a highway, this could lead to increased mortality from collisions with motor vehicles. Lower, more-constant noise levels may cause wildlife to temporarily avoid the construction zone. It is also likely that some animals would adapt to the lower noise levels during construction. Human disturbance, such as movement of construction workers or equipment outside of the work zone, could result in indirect effects on wildlife. As with noise disturbance, this could cause some animals to move from the area, while others would be able to adapt. Proper maintenance of equipment and clear marking of construction work zones to prevent intrusion into areas not slated for development would help prevent these impacts. Implementation of a spill prevention and control plan also would help reduce potential impacts on terrestrial resources.

Operations would have a negligible impact on terrestrial animals provided proper mitigation measures are taken, such as limiting unnecessary noise by properly maintaining equipment and keeping workers from intruding into undeveloped areas. As is the case during construction, proper handling of petroleum products and chemicals to prevent or rapidly clean up spills would minimize impacts on wildlife. As the 200 Areas are already illuminated at night, additional lighting associated with the operation of new facilities should have a negligible impact on nocturnal animals or those active during dusk or dawn (e.g., effects on navigation or predator–prey relationships).

Under Alternative 2A, 29.1 hectares (72 acres) of Borrow Area C would be excavated to supply needed geologic material. As noted in Chapter 3, Section 3.2.7.1.4, the two major plant communities present within the area are cheatgrass-bluegrass (782 hectares [1,933 acres]) and needle-and-thread grass/Indian ricegrass (107 hectares [265 acres]) (see Chapter 3, Figure 3–18). The latter represents an unusual and relatively pristine community type at Hanford; thus, it is considered a more highly valued community than the former. It is not possible to determine specific impacts on ecological resources from developing Borrow Area C because the particular portion of the site from which geologic material would be excavated is unknown. However, most of Borrow Area C can be developed without substantial adverse impacts on species or habitats (Sackschewsky and Downs 2007:8). To the extent that it is possible, the needle-and-thread grass/Indian ricegrass community should be avoided during excavation. A mitigation action plan would be developed prior to excavation.

4.1.7.2.2 Wetlands

As noted in Chapter 3, Section 3.2.7.2, there are no wetlands within the 200-East Area, 200-West Area, or Borrow Area C, although West Lake is located about 4.8 kilometers (3 miles) to the north. Implementation of this alternative would not impact any site wetlands.

4.1.7.2.3 Aquatic Resources

The five ponds associated with the LERF and the TEDF, which are located within and adjacent to the 200-East Area, would not be directly affected by construction of any of the new facilities planned for the area. During operations, they would receive effluent discharges. As noted in Chapter 3, Section 3.2.7.3.2, these ponds, though accessible to wildlife, do not support fish populations. There are no aquatic resources within Borrow Area C. Potential indirect impacts on Columbia River aquatic resources of air emissions and groundwater are addressed in Chapter 5, Section 5.1.3.2.

4.1.7.2.4 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within or in the immediate vicinity of the 200 Areas or Borrow Area C; therefore, impacts on this group of plants and animals are not expected under this alternative. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with this alternative, including development of Borrow Area C, designated critical habitat would not be adversely affected.

A number of state-listed, special status species have been observed within areas that would be disturbed by construction under Alternative 2A. Two state-listed species were observed near or along the 200-East Area underground transfer line. The black-tailed jackrabbit (state candidate) has been observed near the underground transfer line route, and Piper's daisy (state sensitive) was identified on the edge of sagebrush habitat along the route. Thus, construction of the underground transfer line has the potential to disturb both of these listed species. Two listed plants, stalked-pod milkvetch and crouching milkvetch (both state watch), were observed within the area where the replacement WTP and new DSTs would be placed. Due to the presence of sagebrush habitat within these areas, other special status species could potentially be present.

Although mitigation would not be required for the state watch species, they should be considered during project planning. Impacts on state candidate and sensitive species, which are considered Level III resources under the *Hanford Site Biological Resources Management Plan*, require mitigation where impacts would occur. When avoidance and minimization are not possible or are insufficient, mitigation via rectification or compensation is recommended (DOE 2001b:4.9, 8.11). A comprehensive mitigation action plan, which would deal with the loss of listed species (as well as sagebrush habitat), would be developed prior to construction. Operations of new facilities within the 200 Areas are not expected to impact any federally or state-listed species.

As noted in Chapter 3, Section 3.2.7.4.4, surveys have identified Piper's daisy, stalked-pod milkvetch, crouching milkvetch, and the long-billed curlew (state monitor) within the boundaries of Borrow Area C. Mitigation requirements for Piper's daisy and the two species of milkvetch are addressed above. Although avoidance and minimization of impacts on state monitor species is recommended, mitigation is not required (DOE 2001b:4.11). A mitigation action plan would be developed prior to excavation.

4.1.7.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

4.1.7.3.1 Terrestrial Resources

As noted in Section 4.1.1.3.1, 16.7 hectares (41.3 acres) would be disturbed by construction of new facilities within the 200 Areas under this alternative. Of this total, 13 hectares (32.2 acres) would be developed within the 200-East Area and 3.7 hectares (9.1 acres) within the 200-West Area. The only new construction to take place within the 200-West Area is an underground transfer line that would be built along existing roads and, thus, would have a negligible impact on terrestrial resources. Within the 200-East Area, an underground transfer line would disturb 3.2 hectares (8 acres) of undisturbed land, 1.2 hectares (3 acres) of which is sagebrush habitat. The loss of this sagebrush habitat would not be mitigable. As all other new facilities constructed within the 200-East Area would be built within previously disturbed areas, they would have a negligible impact on terrestrial resources.

Under this alternative, closure would involve removal of soil from around the BX tank farm in the 200-East Area and the SX tank farm in the 200-West Area and covering all 18 tank farms and six sets of cribs and trenches (ditches) with landfill barriers. As barriers would ultimately cover the BX and SX tank farms, the impact of soil removal is not addressed separately. Because land at the tank farms has been disturbed from past and present operations, no sagebrush habitat is present. Thus, placement of landfill closure barriers over these areas would have negligible impacts on terrestrial resources. Upon completion, the barriers would be planted with a mixture of grasses.

This alternative would have a negligible impact on site wildlife, although any loss of sagebrush habitat has the potential to impact certain species, such as the sage sparrow. While some members of smaller, less-mobile species could be lost during construction of new facilities, most animals are expected to disperse to surrounding areas. Although the revegetated landfill closure barriers would provide some habitat for terrestrial species, their overall value would be minimal because to limit root penetration they would be maintained as grasslands. Operational impacts on terrestrial resources would be similar to those addressed in Section 4.1.7.2.1.

Under Alternative 2B, 95.1 hectares (235 acres) of Borrow Area C would be excavated to supply needed geologic material. Overall, impacts on terrestrial resources from the excavation of geologic material from the area would be similar to those described above under Alternative 2A.

4.1.7.3.2 Wetlands

As noted in Chapter 3, Section 3.2.7.2, there are no wetlands within the 200 Areas or Borrow Area C, although West Lake is located about 4.8 kilometers (3 miles) to the north of the 200 Areas. Implementation of this alternative would not impact any site wetlands.

4.1.7.3.3 Aquatic Resources

The five ponds associated with the LERF and the TEDF, which are located within and adjacent to the 200-East Area, would not be directly affected by construction of any of the new facilities planned for the area. During operations they would receive effluent discharges. As noted in Chapter 3, Section 3.2.7.3.2, these ponds, though accessible to wildlife, do not support fish populations. There are no aquatic resources within Borrow Area C. Potential indirect impacts on Columbia River aquatic resources of air emissions and groundwater are addressed in Chapter 5, Section 5.1.3.3.

4.1.7.3.4 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within or in the immediate vicinity of the 200 Areas or Borrow Area C; therefore, impacts on this group of plants and animals are not expected under this alternative. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with this alternative, including development of Borrow Area C, designated critical habitat would not be adversely affected.

Two state-listed species were observed near or along the 200-East Area underground transfer line. The black-tailed jackrabbit (state candidate) and Piper's daisy (state sensitive) have been identified along the route of the 200-East Area underground transfer line and could be disturbed by construction. As other proposed facilities associated with this alternative would be constructed on previously disturbed land, there is little potential to disturb special status species. Mitigation requirements, including preparation of a mitigation action plan, would be similar to those discussed in Section 4.1.7.2.4.

The operation of new facilities is not expected to impact any listed species. Placement of landfill barriers during closure also is not expected to disturb any listed species, as none have been identified in the affected areas.

Impacts on special status species resulting from excavation of geologic material from 95.1 hectares (235 acres) in Borrow Area C generally would be similar to those described under Alternative 2A (see Section 4.1.7.2.4). As is the case under Alternative 2A, specific impacts cannot be identified because the exact areas to be excavated are unknown. A mitigation action plan would be developed prior to excavation.

4.1.7.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

4.1.7.4.1 Terrestrial Resources

As noted in Section 4.1.1.4.1, 16.3 hectares (40.4 acres) would be needed for construction of new facilities within the 200 Areas under this alternative. Of this total, 12.2 hectares (30.1 acres) would be needed within the 200-East Area and 4.2 hectares (10.3 acres) within the 200-West Area. Most new facilities would be built on previously disturbed land and therefore would have a negligible impact on terrestrial resources. However, within and adjacent to the 200-East Area, construction of new facilities would impact 3.6 hectares (8.8 acres) of sagebrush habitat. Within the 200-West Area, new facilities would be constructed on 0.4 hectares (1.1 acres) of such habitat within the 200-West Area Supplemental Treatment Technology Site (STTS-West). Sagebrush habitat disturbed by the 200-East Area underground transfer line and in the 200-West Area would not be mitigable. In addition, mitigation would not be required within the 200-East Area Supplemental Treatment Technology Site (STTS-East) because the loss of sagebrush habitat would not meet the minimum mitigation threshold (5 hectares [12.5 acres]) (DOE 2003f:20, 21).

Impacts on terrestrial resources during operations would be similar to those described in Section 4.1.7.2.1; impacts on terrestrial resources during closure would be similar to those described in Section 4.1.7.3.1.

Under Alternative 3A, 100 hectares (247 acres) of Borrow Area C would be excavated to supply needed geologic material. Overall, impacts on terrestrial resources from the excavation of geologic material from the area would be similar to those described under Alternative 2A.

4.1.7.4.2 Wetlands

As noted in Chapter 3, Section 3.2.7.2, there are no wetlands within the 200 Areas or Borrow Area C, although West Lake is located about 4.8 kilometers (3 miles) to the north of the 200 Areas. Implementation of this alternative would not impact any site wetlands.

4.1.7.4.3 Aquatic Resources

The five ponds associated with the LERF and the TEDF, which are located within and adjacent to the 200-East Area, would not be directly affected by construction of any of the new facilities planned for the area. During operations, they would receive effluent discharges. As noted in Chapter 3, Section 3.2.7.3.2, these ponds, though accessible to wildlife, do not support fish populations. There are no aquatic resources within Borrow Area C. Potential indirect impacts on Columbia River aquatic resources of air emissions and groundwater are addressed in Chapter 5, Section 5.1.3.4.

4.1.7.4.4 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within or in the immediate vicinity of the 200 Areas or Borrow Area C; therefore, impacts on this group of plants and animals are not expected under this alternative. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with this alternative, including development of Borrow Area C, designated critical habitat would not be adversely affected.

Under this alternative, a number of state-listed, special status species have been observed in areas where new facilities would be built; therefore, these species could be impacted by construction activities. The stalked-pod milkvetch and crouching milkvetch (both state watch) have been observed in STTS-East, while the loggerhead shrike (Federal species of concern and state candidate) and sage sparrow (state candidate) have been observed within STTS-West. Due to the presence of sagebrush habitat within this area, other special status species could potentially be present. The black-tailed jackrabbit (state candidate) and Piper's daisy (state sensitive) were observed along the route of the 200-East Area underground transfer line. Mitigation requirements, including preparation of a mitigation action plan, would be similar to those discussed in Section 4.1.7.2.4.

The operation of new facilities is not expected to impact any listed species. Placement of landfill barriers during closure also is not expected to disturb any listed species, as none have been identified in the affected areas.

Impacts on special status species resulting from excavation of geologic material from 100 hectares (247 acres) in Borrow Area C generally would be similar to those described under Alternative 2A (see Section 4.1.7.2.4). As is the case under Alternative 2A, specific impacts cannot be identified because the exact areas to be excavated are unknown. A mitigation action plan would be developed prior to excavation.

4.1.7.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

4.1.7.5.1 Terrestrial Resources

As noted in Section 4.1.1.5.1, 17.2 hectares (42.6 acres) would be needed for construction of new facilities within the 200 Areas under this alternative. Of this total, 12.6 hectares (31.2 acres) would be developed within the 200-East Area and 4.6 hectares (11.4 acres) within and adjacent to the 200-West Area. As is the case under Alternative 3A, most new facilities would be built within previously disturbed areas and, therefore, would have a negligible impact on terrestrial resources. However, within and adjacent to the 200-East Area, construction of new facilities would impact a total of 4 hectares (9.9 acres) of sagebrush habitat. Within the 200-West Area, construction would take place on 0.9 hectares (2.2 acres) of sagebrush habitat within STTS-West. The loss of sagebrush habitat associated with construction of the 200-East Area underground transfer line and facilities in STTS-West would not be mitigable. In addition, mitigation would not be required within STTS-East because the loss of sagebrush habitat would not meet the minimum mitigation threshold (5 hectares [12.5 acres]) (DOE 2003f:20, 21).

Impacts on terrestrial resources during operations would be similar to those described in Section 4.1.7.2.1; impacts on terrestrial resources during closure, similar to those described in Section 4.1.7.3.1.

Under Alternative 3B, 92.3 hectares (228 acres) of Borrow Area C would be excavated to supply needed geologic material. Overall impacts on terrestrial resources from the excavation of geologic material from the area would be similar to those described under Alternative 2A.

4.1.7.5.2 Wetlands

As noted in Chapter 3, Section 3.2.7.2, there are no wetlands within the 200 Areas or Borrow Area C, although West Lake is located about 4.8 kilometers (3 miles) to the north of the 200 Areas. Implementation of this alternative would not impact any site wetlands.

4.1.7.5.3 Aquatic Resources

The five ponds associated with the LERF and the TEDF, which are located within and adjacent to the 200-East Area, would not be directly affected by construction of any of the new facilities planned for the area. During operations they would receive effluent discharges. As noted in Chapter 3, Section 3.2.7.3.2, these ponds, though accessible to wildlife, do not support fish populations. There are no aquatic resources within Borrow Area C. Potential indirect impacts on Columbia River aquatic resources of air emissions and groundwater are addressed in Chapter 5, Section 5.1.3.5.

4.1.7.5.4 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within or in the immediate vicinity of the 200 Areas or Borrow Area C; therefore, impacts on this group of plants and animals are not expected under this alternative. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with this alternative, including development of Borrow Area C, designated critical habitat would not be adversely affected.

Although slightly more land would be required under Alternative 3B than under Alternative 3A, construction would take place within the same general areas. Thus, potential impacts on state-listed, special status species would be similar to those discussed in Section 4.1.7.4.4. Mitigation requirements, including preparation of a mitigation action plan, would be similar to those discussed in Section 4.1.7.2.4.

The operation of new facilities is not expected to impact any listed species. Placement of landfill barriers during closure also is not expected to disturb any listed species, as none have been identified in the affected areas.

Impacts on special status species resulting from excavation of geologic material from 92.3 hectares (228 acres) in Borrow Area C would be similar to, but greater than, those described under Alternative 2A because more area would be disturbed (see Section 4.1.7.2.4). As is the case under Alternative 2A, specific impacts cannot be identified because the exact areas to be excavated are unknown. A mitigation action plan would be developed prior to excavation.

4.1.7.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

4.1.7.6.1 Terrestrial Resources

As noted in Section 4.1.1.6.1, 17.2 hectares (42.4 acres) would be needed for construction of new facilities within the 200 Areas under this alternative. Of this total, 12.8 hectares (31.7 acres) would be disturbed within and adjacent to the 200-East Area and 4.3 hectares (10.7 acres) within the 200-West Area. As is the case under Alternative 3A, most new facilities would be built within previously disturbed areas and therefore would have a negligible impact on terrestrial resources. However, in the 200-West Area, new facilities would be constructed on 0.6 hectares (1.5 acres) of sagebrush habitat within STTS-West. Construction of these new facilities within and adjacent to the 200-East Area would impact 4.2 hectares (10.4 acres) of sagebrush habitat. The loss of sagebrush habitat associated with construction of the 200-East Area underground transfer line and facilities in STTS-West would not be mitigable. In addition, mitigation would not be required within STTS-East because the loss of sagebrush habitat would not meet the minimum mitigation threshold (5 hectares [12.5 acres]) (DOE 2003f:20, 21).

Impacts on terrestrial resources during operations would be similar to those described in Section 4.1.7.2.1, and those during closure would be similar to those described in Section 4.1.7.3.1.

Under Alternative 3C, 92.7 hectares (229 acres) of Borrow Area C would be excavated to supply needed geologic material. Overall impacts on terrestrial resources from the excavation of geologic material from the area would be similar to those described under Alternative 3A.

4.1.7.6.2 Wetlands

As noted in Chapter 3, Section 3.2.7.2, there are no wetlands within the 200 Areas and Borrow Area C, although West Lake is located about 4.8 kilometers (3 miles) to the north of the 200 Areas. Implementation of this alternative would not impact any site wetlands.

4.1.7.6.3 Aquatic Resources

The five ponds associated with the LERF and the TEDF, which are located within and adjacent to the 200-East Area, would not be directly affected by construction of any of the new facilities planned for the area. During operations they would receive effluent discharges. As noted in Chapter 3, Section 3.2.7.3.2, these ponds, though accessible to wildlife, do not support fish populations. There are no aquatic resources within Borrow Area C. Potential indirect impacts on Columbia River aquatic resources of air emissions and groundwater are addressed in Chapter 5, Section 5.1.3.6.

4.1.7.6.4 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within or in the immediate vicinity of the 200 Areas or Borrow Area C; therefore, impacts on this group of plants and animals are not expected under this alternative. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with this alternative, including development of Borrow Area C, designated critical habitat would not be adversely affected.

Although slightly more land would be required under this alternative than under Alternative 3A, construction would take place within the same general areas. Thus, potential impacts on state-listed, special status species would be similar to those discussed in Section 4.1.7.4.4. Mitigation requirements, including preparation of a mitigation action plan, would be similar to those discussed in Section 4.1.7.2.4.

The operation of new facilities is not expected to impact any listed species. Placement of landfill barriers during closure also is not expected to disturb any listed species, as none have been identified in the affected areas.

Impacts on special status species resulting from excavation of geologic material from 92.7 hectares (229 acres) in Borrow Area C generally would be similar to those described under Alternative 2A (see Section 4.1.7.2.4). As is the case under Alternative 2A, specific impacts cannot be identified because the exact areas to be excavated are unknown. A mitigation action plan would be developed prior to excavation.

4.1.7.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

4.1.7.7.1 Terrestrial Resources

As noted in Section 4.1.1.7.1, 19.8 hectares (48.9 acres) would be needed for construction of new facilities within the 200 Areas under this alternative. Of this total, 13.7 hectares (33.8 acres) would be needed within or adjacent to the 200-East Area, 4.2 hectares (10.3 acres) within the 200-West Area, and 1.9 hectares (4.8 acres) between the 200-East and 200-West Areas. Most new facilities would be built within previously disturbed areas and therefore would have a negligible impact on terrestrial resources. However, within and adjacent to the 200-East Area, construction of new facilities would impact a total of 4 hectares (9.9 acres) of sagebrush habitat and would disturb 0.4 hectares (1.1 acres) of sagebrush habitat within the 200-West Area. Facilities located between the 200-East and 200-West Areas would disturb 1.9 hectares (4.8 acres) of sagebrush habitat. The loss of sagebrush habitat associated with construction of the 200-East Area underground transfer line and facilities in STTS-West would not be mitigable. In addition, mitigation would not be required within STTS-East because the loss of sagebrush habitat would not meet the minimum mitigation threshold (5 hectares [12.5 acres]). However, the loss of 1.9 hectares (4.8 acres) of sagebrush habitat between the 200-East and 200-West Areas would be mitigable at a ratio of 3:1 (DOE 2003f:20, 21). Specific measures to mitigate this loss would be set forth in a mitigation action plan prior to construction.

Impacts on terrestrial resources during operations would be similar to those described in Section 4.1.7.2.1; impacts on terrestrial resources during closure, similar to those described in Section 4.1.7.3.1. Clean closure of the BX and SX tank farms and six sets of cribs and trenches (ditches) has the potential to increase wildlife habitat provided that native plant communities have been reestablished; however, because the remediated areas are part of the highly developed 200 Areas, they could also be used for other industrial purposes.

Under Alternative 4, 102 hectares (252 acres) of Borrow Area C would be excavated to supply needed geologic material. Overall impacts on terrestrial resources from the excavation of geologic material from the area would be similar to those described under Alternative 3A.

4.1.7.7.2 Wetlands

As noted in Chapter 3, Section 3.2.7.2, there are no wetlands within the 200 Areas and Borrow Area C, although West Lake is located about 4.8 kilometers (3 miles) to the north of the 200 Areas. Implementation of this alternative would not impact any site wetlands.

4.1.7.7.3 Aquatic Resources

The five ponds associated with the LERF and the TEDF, which are located within and adjacent to the 200-East Area, would not be directly affected by construction of any of the new facilities planned for the area. During operations they would receive effluent discharges. As noted in Chapter 3, Section 3.2.7.3.2, these ponds, though accessible to wildlife, do not support fish populations. There are no aquatic resources within Borrow Area C. Potential indirect impacts on Columbia River aquatic resources of air emissions and groundwater are addressed in Chapter 5, Section 5.1.3.7.

4.1.7.7.4 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within or in the immediate vicinity of the 200 Areas and Borrow Area C; therefore, impacts on this group of plants and animals are not expected under this alternative. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with this alternative, including development of Borrow Area C, designated critical habitat would not be adversely affected.

Facilities built under Alternative 4 would disturb about the same amount of land within the same areas (i.e., the 200-East underground transfer line, STTS-East, and STTS-West) as is the case under Alternative 3A. Thus, potential impacts on state-listed, special status species would be similar to those discussed in Section 4.1.7.4.4. Mitigation requirements, including preparation of a mitigation action plan, would be similar to those discussed in Section 4.1.7.2.4.

The operation of new facilities is not expected to impact any listed species. Placement of landfill barriers during closure also is not expected to disturb any listed species, as none have been identified in the affected areas.

Impacts on special status species resulting from excavation of geologic material from 102 hectares (252 acres) in Borrow Area C generally would be similar to those described under Alternative 2A (see Section 4.1.7.2.4). As is the case under Alternative 2A, specific impacts cannot be identified because the exact areas to be excavated are unknown. A mitigation action plan would be developed prior to excavation.

4.1.7.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

4.1.7.8.1 Terrestrial Resources

As noted in Section 4.1.1.8.1, 20.2 hectares (49.9 acres) would be needed for construction of new facilities within the 200 Areas under this alternative. Of this total, 16 hectares (39.6 acres) within or adjacent to the 200-East Area and 4.2 hectares (10.3 acres) within the 200-West Area would be disturbed. Most new facilities would be built within previously disturbed areas and therefore would have a negligible impact on terrestrial resources. However, within and adjacent to the 200-East Area, construction of new facilities would impact a total of 4 hectares (9.9 acres) of sagebrush habitat, and within the 200-West Area, new facilities would be constructed on 0.4 hectares (1.1 acres) of sagebrush habitat. The loss of sagebrush habitat associated with construction of the 200-East Area underground transfer line and facilities in STTS-West would not be mitigable. In addition, mitigation would not be required within STTS-East since the loss of sagebrush habitat would not meet the minimum mitigation threshold (5 hectares [12.5 acres]) (DOE 2003f:20, 21).

Under Alternative 5, 117 hectares (290 acres) of Borrow Area C would be excavated to supply needed geologic material. Overall impacts on terrestrial resources from the excavation of geologic material from the area would be similar to those described above under Alternative 2A (see Section 4.1.7.2.1).

4.1.7.8.2 Wetlands

As noted in Chapter 3, Section 3.2.7.2, there are no wetlands within the 200 Areas and Borrow Area C, although West Lake is located about 4.8 kilometers (3 miles) to the north of the 200 Areas. Implementation of this alternative would not impact any site wetlands.

4.1.7.8.3 Aquatic Resources

The five ponds associated with the LERF and the TEDF, which are located within and adjacent to the 200-East Area, would not be directly affected by construction of any of the new facilities planned for the area. During operations they would receive effluent discharges. As noted in Chapter 3, Section 3.2.7.3.2, these ponds, though accessible to wildlife, do not support fish populations. There are no aquatic resources within Borrow Area C. Potential indirect impacts on Columbia River aquatic resources of air emissions and groundwater are addressed in Chapter 5, Section 5.1.3.8.

4.1.7.8.4 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within or in the immediate vicinity of the 200 Areas and Borrow Area C; therefore, impacts on this group of plants and animals are not expected under this alternative. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with this alternative, including development of Borrow Area C, designated critical habitat would not be adversely affected.

Although slightly more land would be required under Alternative 5 compared with Alternative 3A, construction would take place within the same general areas. Thus, potential impacts on state-listed, special status species would be similar to those discussed in Section 4.1.7.4.4. Mitigation requirements, including preparation of a mitigation action plan, would be similar to those discussed in Section 4.1.7.2.4.

The operation of new facilities is not expected to impact any listed species. Placement of landfill barriers during closure also is not expected to disturb any listed species, as none have been identified in the affected areas.

Impacts on state-listed, special status species resulting from excavation of geologic material from 117 hectares (290 acres) in Borrow Area C generally would be similar to those described under Alternative 2A (see Section 4.1.7.2.4). As is the case under Alternative 2A, specific impacts cannot be identified because the exact areas to be excavated are unknown. A mitigation action plan would be developed prior to excavation.

4.1.7.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

4.1.7.9.1 Terrestrial Resources

4.1.7.9.1.1 Base Case

As noted in Section 4.1.1.9.1, under this alternative, 210 hectares (519 acres) would be needed for construction of new facilities within the 200 Areas. Of this total, 153 hectares (377 acres) would be required within or adjacent to the 200-East Area, 3.2 hectares (8 acres) within the 200-West Area, and 54.2 hectares (134 acres) between the 200-East and 200-West Areas. Most of the land (i.e., 182 hectares [450 acres]) within or adjacent to the 200-East Area and between the 200-East and 200-West Areas that would be used for new construction contains sagebrush habitat, while sagebrush habitat would not be affected in the 200-West Area. The loss of sagebrush habitat associated with construction of the 200-East Area underground transfer line and facilities in STTS-West would not be mitigable; however, Hanford guidance may require the replacement of other sagebrush habitat at a ratio ranging from 1:1 to 3:1 (DOE 2003f:20, 21, 31). Specific measures to mitigate this loss would be set forth in a mitigation action plan prior to construction.

Implementation of this alternative would result in impacts on wildlife similar in nature to those described in Section 4.1.7.2.1; however, due to the greater extent of habitat destruction, the extent of the impacts would be greater. As the tank farms would undergo clean closure, the area occupied by the farms would be available for unrestricted use. If that use involved revegetation with native species, there would be an opportunity to increase terrestrial habitat in the area, including sagebrush habitat. Operational impacts on terrestrial resources would be somewhat greater than those addressed in Section 4.1.7.2.1.

Under Alternative 6A, Base Case, 381 hectares (942 acres) of Borrow Area C would be excavated to supply needed geologic material. As noted in Chapter 3, Section 3.2.7.1, the two major communities present within the area are Sandberg's bluegrass/cheatgrass (782 hectares [1,933 acres]) and needle-and-thread grass/Indian ricegrass (107 hectares [265 acres]) (see Chapter 3, Figure 3–18). The latter represents an unusual and relatively pristine community type at Hanford and thus is considered a more highly valued community than the former. It is not possible to determine specific impacts on ecological resources of developing Borrow Area C because the area(s) from which different types of geologic material would be excavated is not known. However, because approximately 41 percent of Borrow Area C would be developed, it is likely that at least some of the more highly valued needle-and-thread grass/Indian ricegrass community would be impacted. To the extent that it is possible, the needle-and-thread grass/Indian ricegrass community should be avoided.

4.1.7.9.1.2 Option Case

Impacts on terrestrial resources under this option would generally be similar to those described for the Base Case (see Section 4.1.7.9.1.1), including the loss of 184 hectares (455 acres) of sagebrush habitat. However, under the Option Case, a modified RCRA Subtitle C landfill barrier would not be used to cover the six sets of cribs and trenches (ditches) because they would be removed and their deep plumes remediated. Thus, compared with the Base Case, an additional 25.4 hectares (62.7 acres) of land would become available for alternative uses in the future, including possible restoration of shrub-steppe habitat.

The Option Case would require that 458 hectares (1,131 acres) of land be excavated from Borrow Area C to supply needed geologic material. Although somewhat more habitat would be disturbed, impacts on ecological resources, including the highly valued needle-and-thread grass/Indian ricegrass community, would be similar to those described above for the Base Case.

4.1.7.9.2 Wetlands

4.1.7.9.2.1 Base and Option Cases

As noted in Chapter 3, Section 3.2.7.2, there are no wetlands within the 200 Areas or Borrow Area C, although West Lake is located about 4.8 kilometers (3 miles) to the north of the 200 Areas. Implementation of either the Base or Option Case would not impact any site wetlands.

4.1.7.9.3 Aquatic Resources

4.1.7.9.3.1 Base and Option Cases

The five ponds associated with the LERF and the TEDF, which are located within and adjacent to the 200-East Area, would not be directly affected by construction of any of the new facilities planned for the area. During operations they would receive effluent discharges. As noted in Chapter 3, Section 3.2.7.3.2, these ponds, though accessible to wildlife, do not support fish populations. There are no aquatic resources within Borrow Area C. Potential indirect impacts on Columbia River aquatic resources of air emissions and groundwater are addressed in Chapter 5, Section 5.1.3.9.

4.1.7.9.4 Threatened and Endangered Species

4.1.7.9.4.1 Base Case

Federally or state-listed threatened or endangered species have not been observed within or in the immediate vicinity of the 200 Areas and Borrow Area C; therefore, impacts on this group of plants and animals are not expected under this alternative. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with this alternative, including development of Borrow Area C, designated critical habitat would not be adversely affected.

Under this alternative, a number of state-listed, special status species have been observed within areas that would be disturbed by construction. The black-tailed jackrabbit (state candidate) and Piper's daisy (state sensitive) have been identified along the route of the 200-East Area underground transfer line. Two listed plants, stalked-pod milkvetch and crouching milkvetch (both state watch), were observed in the area where the IHLW Interim Storage Modules (and replacements), replacement WTP, and new DSTs would be built. Due to the presence of sagebrush habitat within these areas, other special status species could potentially be present. In addition, under this alternative, the PPF and HLW Debris Storage Facility would be constructed between the 200-East Area and 200-West Areas. The loggerhead shrike, black-tailed jackrabbit, sage sparrow, and crouching milkvetch have all been observed within this area. Mitigation measures, including the preparation of a mitigation action plan, would be similar to those described in Section 4.1.7.2.4.

The operation of new facilities is not expected to impact any listed species. Placement of landfill barriers over the six sets of cribs and trenches (ditches) during closure also is not expected to disturb any listed species, as none have been identified in the affected areas.

As noted in Section 4.1.7.2.4, surveys have identified Piper's daisy (state sensitive), stalked-pod milkvetch, crouching milkvetch, and the long-billed curlew (state monitor) within the boundaries of Borrow Area C. Due to the extent of development under this alternative, it is highly likely that one or all of these species could be impacted by the excavation of geologic material. Mitigation measures related to special status species are addressed in Section 4.1.7.2.4 and would include the preparation of a mitigation action plan prior to site development.

4.1.7.9.4.2 Option Case

Impacts on special status species generally would be similar to those described above for the Base Case; however, because an additional 76.5 hectares (189 acres) would be excavated from Borrow Area C, potential impacts on state-listed species would be greater.

4.1.7.10 Alternative 6B: All Vitrification with Separations; Clean Closure

4.1.7.10.1 Terrestrial Resources

4.1.7.10.1.1 Base Case

As noted in Section 4.1.1.10.1, under this alternative, 119 hectares (294 acres) would be needed for construction of new facilities within the 200 Areas. Of this total, 61 hectares (151 acres) would be required within or adjacent to the 200-East Area, 3.7 hectares (9.1 acres) within the 200-West Area, and 54.2 hectares (134 acres) between the 200-East and 200-West Areas. Most of the land (i.e., 102 hectares [253 acres]) within or adjacent to the 200-East Area and between the 200-East and 200-West Areas has not been disturbed; all but 2 hectares (5 acres) is sagebrush habitat. Only previously disturbed areas would be utilized in the 200-West Area. The loss of sagebrush habitat associated with construction of the 200-East Area underground transfer line and facilities in STTS-West would not be mitigable; however, Hanford guidance may require the replacement of other sagebrush habitat at a ratio ranging from 1:1 to 3:1 (DOE 2003f:20, 21, 31). Specific measures to mitigate the loss of sagebrush habitat would be set forth in a mitigation action plan prior to construction.

Under this option, the tank farms would undergo clean closure; thus, the area occupied by these farms would be available for unrestricted use. If that use involved revegetation with native species, there would be an opportunity to increase terrestrial habitat in the area, including sagebrush habitat. Operational impacts would be similar to those addressed in Section 4.1.7.2.1.

Under Alternative 6B, Base Case, 240 hectares (592 acres) of Borrow Area C would be excavated to supply needed geologic material. Impacts on terrestrial resources from the excavation of geologic material from the area would be similar to, but somewhat less than, those described for the Base Case under Alternative 6A (see Section 4.1.7.9.1.1).

4.1.7.10.1.2 Option Case

Impacts on terrestrial resources under this case would generally be similar to those described for the Base Case (see Section 4.1.7.9), including the loss of 102 hectares (253 acres) of sagebrush habitat. However, under the Option Case, a modified RCRA Subtitle C landfill barrier would not be used to cover the six sets of cribs and trenches (ditches) because they would be removed and their deep plumes would be remediated. Thus, compared with the Base Case, an additional 25.4 hectares (62.7 acres) of land would become available for alternative uses in the future, including possible restoration of shrub-steppe habitat.

Under the Option Case, 316 hectares (781 acres) would need to be excavated from Borrow Area C to supply geologic material. As this land represents about 34 percent of Borrow Area C, compared with 26 percent for the Base Case, potential impacts on the highly valued needle-and-thread grass/Indian ricegrass community would be greater. To the extent that it is possible, the needle-and-thread grass/Indian ricegrass community should be avoided.

4.1.7.10.2 Wetlands

4.1.7.10.2.1 Base and Option Cases

As noted in Chapter 3, Section 3.2.7.2, there are no wetlands within the 200 Areas and Borrow Area C, although West Lake is located about 4.8 kilometers (3 miles) to the north of the 200 Areas. Implementation of this alternative would not impact any site wetlands.

4.1.7.10.3 Aquatic Resources

4.1.7.10.3.1 Base and Option Cases

The five ponds associated with the LERF and the TEDF, which are located within and adjacent to the 200-East Area, would not be directly affected by construction of any of the new facilities planned for the area. During operations they would receive effluent discharges. As noted in Chapter 3, Section 3.2.7.3.2, these ponds, though accessible to wildlife, do not support fish populations. There are no aquatic resources within Borrow Area C. Potential indirect impacts on Columbia River aquatic resources of air emissions and groundwater are addressed in Chapter 5, Section 5.1.3.10.

4.1.7.10.4 Threatened and Endangered Species

4.1.7.10.4.1 Base Case

Federally or state-listed threatened or endangered species have not been observed within or in the immediate vicinity of the 200 Areas and Borrow Area C; therefore, impacts on this group of plants and animals are not expected under this alternative. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with this alternative, including development of Borrow Area C, designated critical habitat would not be adversely affected.

Under this alternative, a number of state-listed, special status species have been observed within areas that would be disturbed by construction. The black-tailed jackrabbit (state candidate) and Piper's daisy (state sensitive) have been identified along the route of the 200-East Area underground transfer line. Two listed plants, stalked-pod milkvetch and crouching milkvetch (both state watch), were observed within the area where the ILAW Storage Facility would be built. Due to the presence of sagebrush habitat within this area, other special status species could potentially be present. In addition, under this alternative, the HLW Debris Storage Facility would be constructed between the 200-East and 200-West Areas. The loggerhead shrike, black-tailed jackrabbit, sage sparrow, and crouching milkvetch have all been observed within this area. Mitigation measures, including the preparation of a mitigation action plan, would be similar to those described in Section 4.1.7.2.4.

The operation of new facilities is not expected to impact any listed species. Placement of landfill barriers over the six sets of cribs and trenches (ditches) during closure also is not expected to disturb any listed species, as none have been identified in the affected areas.

Impacts on state-listed special status species resulting from excavation of geologic material from 240 hectares (592 acres) in Borrow Area C generally would be similar to those described under Alternative 6A (see Section 4.1.7.9.4). As is the case under Alternative 6A, specific impacts cannot be identified because the exact areas to be excavated are unknown. A mitigation action plan would be developed prior to excavation.

4.1.7.10.4.2 Option Case

Impacts on special status species would be similar to those noted above for the Base Case, although a greater potential exists to affect these species within Borrow Area C due to the greater area of habitat disturbed (i.e., 316 hectares [781 acres] versus 240 hectares [592 acres]).

4.1.7.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

4.1.7.11.1 Terrestrial Resources

As noted in Section 4.1.1.11.1, under this alternative, 61.5 hectares (152 acres) would be disturbed by construction of new facilities within the 200 Areas. Of this total, 57.9 hectares (143 acres) within or adjacent to the 200-East Area and 3.7 hectares (9.1 acres) within the 200-West Area would be utilized. Most of the land (i.e., 46.1 hectares [114 acres]) within or adjacent to the 200-East Area that would be used for new construction contains sagebrush habitat, while only previously disturbed areas would be affected in the 200-West Area. The loss of sagebrush habitat associated with construction of the 200-East Area underground transfer line would not be mitigable; however, Hanford guidance may require the replacement of other sagebrush habitat at a ratio of 3:1 (DOE 2003f:20, 21, 31). Specific measures to be taken to mitigate the loss of sagebrush habitat would be set forth in a mitigation action plan prior to construction.

Construction and operational impacts of this alternative on wildlife would be similar to those described in Section 4.1.7.2.1; impacts on terrestrial resources during closure, similar to those described in Section 4.1.7.3.1.

Under Alternative 6C, a total of 104 hectares (258 acres) of Borrow Area C would be excavated to supply needed geologic material. Impacts on terrestrial resources from the excavation of geologic material from the area would be similar to those described above under Alternative 2A (see Section 4.1.7.2.1).

4.1.7.11.2 Wetlands

As noted in Chapter 3, Section 3.2.7.2, there are no wetlands within the 200 Areas and Borrow Area C, although West Lake is located about 4.8 kilometers (3 miles) to the north of the 200 Areas. Implementation of this alternative would not impact any site wetlands.

4.1.7.11.3 Aquatic Resources

The five ponds associated with the LERF and the TEDF, which are located within and adjacent to the 200-East Area, would not be directly affected by construction of any of the new facilities planned for the area. During operations they would receive effluent discharges. As noted in Chapter 3, Section 3.2.7.3.2, these ponds, though accessible to wildlife, do not support fish populations. There are no aquatic resources within Borrow Area C. Potential indirect impacts on Columbia River aquatic resources of air emissions and groundwater are addressed in Chapter 5, Section 5.1.3.11.

4.1.7.11.4 Threatened and Endangered Species

Federally or state-listed threatened or endangered species have not been observed within or in the immediate vicinity of the 200 Areas and Borrow Area C; therefore, impacts on this group of plants and animals are not expected under this alternative. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with this alternative, including development of Borrow Area C, designated critical habitat would not be adversely affected.

Under this alternative, a number of state-listed, special status species have been observed within areas that would be disturbed by construction. The black-tailed jackrabbit (state candidate) and Piper's daisy (state sensitive) have been identified along the route of the 200-East Area underground transfer line. Two listed plants, stalked-pod milkvetch and crouching milkvetch (both state watch), were observed within the area where the ILAW Storage Facility would be built. Due to the presence of sagebrush habitat within this area, other special status species could potentially be present. Mitigation measures, including the preparation of a mitigation action plan, would be similar to those described in Section 4.1.7.2.4.

The operation of new facilities is not expected to impact any listed species. Placement of landfill barriers over the 18 tank farms and six sets of cribs and trenches (ditches) during closure also is not expected to disturb any listed species, as none have been identified in the affected areas.

Impacts on state-listed, special status species resulting from excavation of geologic material from 104 hectares (258 acres) in Borrow Area C generally would be similar to those described under Alternative 2A (see Section 4.1.7.2.4). As is the case under Alternative 2A, specific impacts cannot be identified because the exact areas to be excavated are unknown. A mitigation action plan would be developed prior to excavation.

4.1.8 Cultural and Paleontological Resources

4.1.8.1 Alternative 1: No Action

Under Alternative 1: No Action, no new facilities would be constructed within either the 200-East or 200-West Area, and construction of the WTP and Canister Storage Building would be terminated. The survey and geology of the 200-East and 200-West Areas indicate that the potential for subsurface archaeological resources is low (Chatters and Cadoret 1990).

The No Action Alternative would require a commitment of land within the 200 Areas over the long term. Additionally, 2 hectares (5 acres) of geological material would be excavated from Borrow Area C for use in stabilization of tanks and closure of the WTP. The survey and geology of Borrow Area C indicate that subsurface cultural deposits have no potential or a low potential of being present (PNNL 2007).

4.1.8.1.1 Prehistoric Resources

As noted in Chapter 3, Section 3.2.8.1.2, the prehistoric White Bluffs Road (eligible for listing in the National Register of Historic Places [National Register]), which was in use prior to exploration and settlement of the area, traverses the northwest portion of the 200-West Area in a southwest to northeast direction. The only other prehistoric resources found in the 200 Areas were isolated flakes and projectile point fragments, most of which were collected and curated by archaeologists upon discovery. As there would be no new construction under this alternative, prehistoric resources would not be disturbed.

If prehistoric resources were discovered during the excavation of geologic material from Borrow Area C, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented.

4.1.8.1.2 Historic Resources

Historic artifacts found within or adjacent to the 200-East Area include a number of historic cans and bottles. These artifacts would not be affected under this alternative. There would be no impact on White Bluffs Road or other early historic artifacts within the 200-West Area. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected under this alternative.

As is the case for prehistoric resources, if historic resources were discovered during the excavation of geologic material from Borrow Area C, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented.

4.1.8.1.3 American Indian Interests

Under this alternative, no resources would be directly affected by project-related facilities. Prehistoric resources that may be of American Indian interest are discussed in Section 4.1.8.1.1. Rattlesnake Mountain, Gable Mountain, and Gable Butte, all of which are important to American Indians for religious and other cultural purposes, would not be directly affected under this alternative. As noted in Section 4.1.1.1.2, the industrial appearance of the 200-East and 200-West Areas from Gable Mountain and Gable Butte would remain unchanged because no new construction within the 200 Areas would occur. The 2 hectares (5 acres) of Borrow Area C that would be excavated would be noticeable from Rattlesnake Mountain, although this development would not dominate the view. If there were visual impacts on American Indian interests, appropriate mitigation measures would be developed in consultation with area tribes.

4.1.8.1.4 Paleontological Resources

There would be no impacts on paleontological resources under this alternative, as no such resources have been discovered within the 200 Areas or Borrow Area C. As is the case for cultural resources, if any paleontological resources were discovered during the excavation of geologic material from Borrow Area C, procedures in place to properly manage the discovery site would be implemented.

4.1.8.2 Alternative 2A: Existing WTP Vitrification; No Closure

4.1.8.2.1 Prehistoric Resources

Under Alternative 2A, there would be no impacts on known prehistoric resources. White Bluffs Road would not be affected by construction of the underground transfer line, and most of the prehistoric isolated artifacts found in the 200 Areas were collected and curated by archaeologists upon discovery. The survey and geology of the 200-East and 200-West Areas and Borrow Area C indicate that subsurface cultural deposits have little or no potential of being present. If prehistoric resources were discovered during construction or excavation, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented.

4.1.8.2.2 Historic Resources

Under Alternative 2A, there would be no impacts on White Bluffs Road or other known early historic artifacts within the 200-West Area, as all such resources are located in the northwest part of the area and would not be affected by construction of the underground transfer line. As is the case for prehistoric resources, if historic resources were discovered during construction or excavation, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

4.1.8.2.3 American Indian Interests

Under this alternative, no resources would be directly affected by project-related facilities. Prehistoric resources that may be of American Indian interest are discussed in Section 4.1.8.2.1. Rattlesnake Mountain, Gable Mountain, and Gable Butte, all of which are important to American Indians for religious and other cultural purposes, would not be directly affected under this alternative, and, as noted in Section 4.1.1.2.2, the view from these places would remain largely unchanged. The construction of the underground transfer line and changes in the 200-East Area would not be visible from Gable Mountain and Gable Butte. However, the 29.1 hectares (72 acres) excavated from Borrow Area C would be readily visible from Rattlesnake Mountain. Upon completion of work, Borrow Area C would be revegetated, lessening the visual impact. If there were visual impacts on American Indian interests, appropriate mitigation measures would be developed in consultation with area tribes.

4.1.8.2.4 Paleontological Resources

There would be no impacts on known paleontological resources under this alternative, as no such resources have been discovered within the 200 Areas or Borrow Area C. As is the case for cultural resources, if any paleontological resources were found during construction or excavation, procedures in place to properly manage the discovery site would be implemented.

4.1.8.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

4.1.8.3.1 Prehistoric Resources

Under Alternative 2B, there would be no impacts on known prehistoric resources. The survey and geology of the 200-East and 200-West Areas and Borrow Area C indicate that subsurface cultural deposits have little or no potential of being present. If prehistoric resources were discovered during construction or excavation, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented.

4.1.8.3.2 Historic Resources

Under Alternative 2B, there would be no impacts on White Bluffs Road or other known early historic artifacts within the 200-West Area, as all such resources are located in the northwest part of the area and would not be affected by construction of the underground transfer line. As is the case for prehistoric resources, if historic resources were discovered during construction or excavation, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

4.1.8.3.3 American Indian Interests

Prehistoric resources that may be of American Indian interest are discussed in Section 4.1.8.3.1. Under this alternative, visual impacts would be similar to those described in Section 4.1.8.2.3 under Alternative 2A; however, as part of landfill closure, the 200-East and 200-West Area containment structures and closure barriers would be visible from nearby higher elevations like Gable Mountain and

Gable Butte, both of which are important to American Indians for religious and other cultural purposes. The view of the 200 Areas from these places would remain largely unchanged from its current industrial nature. Under this alternative, 95.1 hectares (235 acres) of Borrow Area C would be excavated. The development of Borrow Area C would be readily visible from Rattlesnake Mountain. Upon completion of work under this alternative, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impacts. If there were visual impacts on American Indian interests, appropriate mitigation measures would be developed in consultation with area tribes.

4.1.8.3.4 Paleontological Resources

There would be no impacts on paleontological resources under this alternative, as no such resources have been discovered within the 200 Areas or Borrow Area C. As is the case for cultural resources, if any paleontological resources were found during construction or excavation, procedures in place to properly manage the discovery site would be implemented.

4.1.8.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

4.1.8.4.1 Prehistoric Resources

Under Alternative 3A, existing prehistoric resources would not be affected. The survey and geology of the 200-East and 200-West Areas and Borrow Area C indicate that subsurface cultural deposits have little or no potential of being present. If prehistoric resources were discovered during construction or excavation, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented.

4.1.8.4.2 Historic Resources

Under this alternative, there would be no impacts on White Bluffs Road or other early historic artifacts within the 200-East and 200-West Areas because none are located within areas to be disturbed by new facilities. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected under this alternative. As is the case for prehistoric resources, if historic resources were discovered during excavation or construction, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

4.1.8.4.3 American Indian Interests

Under this alternative, visual impacts would be similar to those under Alternative 2B, as described in Section 4.1.8.3.3. Prehistoric resources that may be of American Indian interest are discussed in Section 4.1.8.4.1. Construction and closure activities would not greatly change the industrial nature of the view from nearby higher elevations like Gable Mountain and Gable Butte, both of which are important to American Indians for religious and other cultural purposes. The view of the 200 Areas from these places would remain largely unchanged from its current industrial nature. An additional 4.9 hectares (12 acres) of land would be disturbed within Borrow Area C, and the visual impacts would be similar to those described under Alternative 2B. If there were visual impacts on American Indian interests, appropriate mitigation measures would be developed in consultation with area tribes.

4.1.8.4.4 Paleontological Resources

There would be no impacts on paleontological resources under this alternative, as no such resources have been discovered within the 200 Areas or Borrow Area C. As is the case for cultural resources, if any paleontological resources were found during construction, procedures in place to properly manage the discovery site would be implemented.

4.1.8.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

4.1.8.5.1 Prehistoric Resources

Under Alternative 3B, known prehistoric resources would not be affected. The survey and geology of the 200-East and 200-West Areas and Borrow Area C indicate that subsurface cultural deposits have little or no potential of being present. If prehistoric resources were discovered during excavation or construction, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented.

4.1.8.5.2 Historic Resources

Under this alternative, there would be no impacts on White Bluffs Road or known early historic artifacts within the 200-East and 200-West Areas because none are located within the construction or excavation areas. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected under this alternative. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

4.1.8.5.3 American Indian Interests

Impacts on American Indian interests for this alternative would be similar to those described under Alternative 2B. Prehistoric resources that may be of American Indian interest are discussed in Section 4.1.8.5.1. Closure activities would not greatly change the industrial view of nearby higher elevations. The land requirement in Borrow Area C would be slightly less under Alternative 3B (e.g., 2.8 hectares [7 acres]), but visual impacts would be similar (see Section 4.1.1.5.2). If there were visual impacts on American Indian interests, appropriate mitigation measures would be developed in consultation with area tribes.

4.1.8.5.4 Paleontological Resources

There would be no impacts on known paleontological resources under this alternative because no such resources have been discovered within the 200 Areas or Borrow Area C. As is the case for cultural resources, if any paleontological resources were found during construction, procedures in place to properly manage the discovery site would be implemented.

4.1.8.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

4.1.8.6.1 Prehistoric Resources

Under Alternative 3C, known prehistoric resources would not be affected. The survey and geology of the 200-East and 200-West Areas and Borrow Area C indicate that subsurface cultural deposits have little or no potential of being present. If prehistoric resources were discovered during construction, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented.

4.1.8.6.2 Historic Resources

Under this alternative, there would be no impacts on White Bluffs Road or known early historic artifacts within the 200-East or 200-West Area because all such resources are located in the northwest part of the area and would not be affected by construction or excavation. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected under this alternative. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

4.1.8.6.3 American Indian Interests

Under this alternative, visual impacts would be similar to those in Section 4.1.8.3.3 under Alternative 2B. Prehistoric resources that may be of American Indian interest are discussed in Section 4.1.8.6.1. Construction, operations, deactivation, and closure activities in the 200 Areas would not greatly change the industrial nature of the view from Gable Mountain or Gable Butte, and approximately the same amount of geologic material would be required in Borrow Area C. If there were visual impacts on American Indian interests, appropriate mitigation measures would be developed in consultation with area tribes.

4.1.8.6.4 Paleontological Resources

There would be no impacts on known paleontological resources under this alternative because no such resources have been discovered within the 200 Areas or Borrow Area C. As is the case for cultural resources, if any paleontological resources were found during construction, procedures in place to properly manage the discovery site would be implemented.

4.1.8.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

4.1.8.7.1 Prehistoric Resources

Under Alternative 4, known prehistoric resources would not be affected. The survey and geology of the 200-East and 200-West Areas and Borrow Area C indicate that subsurface cultural deposits have little or no potential of being present. If prehistoric resources were discovered during construction or excavation, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented.

4.1.8.7.2 Historic Resources

Under this alternative, there would be no impacts on White Bluffs Road or other known early historic artifacts within the 200-East or 200-West Area because all such resources are located in the northwest part of the area and would not be affected by construction or excavation. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected under this alternative. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

4.1.8.7.3 American Indian Interests

Under this alternative, visual impacts would be similar to those described in Section 4.1.8.3.3 under Alternative 2B. Prehistoric resources that may be of American Indian interest are discussed in Section 4.1.8.7.1. Construction and closure activities would not greatly change the industrial nature of the view from nearby higher elevations like Gable Mountain and Gable Butte. Although an additional 6.9 hectares (17 acres) of land within Borrow Area C would be disturbed, the view would remain largely unchanged. If there were visual impacts on American Indian interests, appropriate mitigation measures would be developed in consultation with area tribes.

4.1.8.7.4 Paleontological Resources

There would be no impacts on known paleontological resources under this alternative because no such resources have been discovered within the 200 Areas or Borrow Area C. As is the case for cultural resources, if any paleontological resources were found during construction, procedures in place to properly manage the discovery site would be implemented.

4.1.8.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

4.1.8.8.1 Prehistoric Resources

Under Alternative 5, known prehistoric resources would not be affected. The survey and geology of the 200-East and 200-West Areas and Borrow Area C indicate that subsurface cultural deposits have little or no potential of being present. If prehistoric resources were discovered during construction or excavation, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented.

4.1.8.8.2 Historic Resources

Under this alternative, there would be no impacts on White Bluffs Road or other known early historic artifacts within the 200-East or 200-West Area because all such resources are located in the northwest part of the area and would not be affected by construction or excavation. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected under this alternative. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

4.1.8.8.3 American Indian Interests

The impacts on American Indian interests under this alternative would be similar to those under Alternative 2B for construction, operations, deactivation, and closure activities. Prehistoric resources that may be of American Indian interest are discussed in Section 4.1.8.8.1. The industrial nature of the view from nearby higher elevations like Gable Mountain and Gable Butte would not greatly change.

Under this alternative, 117 hectares (290 acres) of Borrow Area C would be excavated. Development of Borrow Area C would be visible from Rattlesnake Mountain. Upon completion of work under this alternative, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact. If there were visual impacts on American Indian interests, appropriate mitigation measures would be developed in consultation with area tribes.

4.1.8.8.4 Paleontological Resources

There would be no impacts on known paleontological resources under this alternative because no such resources have been discovered within the 200 Areas or Borrow Area C. As is the case for cultural resources, if any paleontological resources were found during construction, procedures in place to properly manage the discovery site would be implemented.

4.1.8.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

4.1.8.9.1 Prehistoric Resources

4.1.8.9.1.1 Base Case

Under Alternative 6A, Base Case, prehistoric resources would not be affected. The survey and geology of the 200-East and 200-West Areas and Borrow Area C indicate that subsurface cultural deposits have little or no potential of being present. If prehistoric resources were discovered during construction, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented.

4.1.8.9.1.2 Option Case

As with the Base Case, under Alternative 6A, Option Case, known prehistoric resources would not be affected. If prehistoric resources were discovered during excavation of this alternative, appropriate measures would be implemented.

4.1.8.9.2 Historic Resources

4.1.8.9.2.1 Base Case

There would be no impacts on White Bluffs Road or other known early historic artifacts within the 200-East and 200-West Areas because all such resources are located in the northwest part of the area and would not be affected by construction or excavation. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected under this alternative. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

4.1.8.9.2.2 Option Case

Similar to Alternative 6A, Base Case, historic resources would not be affected under the Option Case.

4.1.8.9.3 American Indian Interests

4.1.8.9.3.1 Base Case

Prehistoric resources that may be of American Indian interest are discussed in Section 4.1.8.9.1.1. Under this alternative case, 210 hectares (519 acres) would be converted to industrial use. The majority of this land would be within or adjacent to the 200-East Area and between the 200-East and 200-West Areas. Facilities constructed would noticeably add to the industrial nature of the 200 Areas and would be visible from nearby higher elevations like Gable Mountain and Gable Butte (see Section 4.1.1.9.2.1). The viewscape from these higher elevations is important to American Indians with cultural ties to Hanford.

In addition, 381 hectares (942 acres) of Borrow Area C would be excavated under this alternative. This would be visible from Rattlesnake Mountain, an area of cultural significance to the American Indians. Upon completion of work under this alternative, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact. If there were visual impacts on American Indian interests, appropriate mitigation measures would be developed in consultation with area tribes.

4.1.8.9.3.2 Option Case

Activities and impacts under the Option Case would be similar to those discussed above under the Base Case. Remediation of the deep plumes would require more fill material. It would be necessary to excavate an additional 76.5 hectares (189 acres) of Borrow Area C compared with the Base Case. This excavation would cause a greater impact on the view from higher elevations such as Rattlesnake Mountain. As noted under the Base Case, excavations in Borrow Area C would be recontoured and revegetated upon completion of work, thereby lessening the visual impact. If there were visual impacts on American Indian interests, appropriate mitigation measures would be developed in consultation with area tribes.

4.1.8.9.4 Paleontological Resources

4.1.8.9.4.1 Base Case

There would be no impacts on known paleontological resources under this alternative because no such resources have been discovered within the 200 Areas or Borrow Area C. As is the case for cultural resources, if any paleontological resources were found during construction, procedures in place to properly manage the discovery site would be implemented.

4.1.8.9.4.2 Option Case

There would be no impacts on known paleontological resources under this alternative because no such resources have been discovered within the 200 Areas or Borrow Area C. As is the case for cultural resources, if any paleontological resources were found during construction, procedures in place to properly manage the discovery site would be implemented.

4.1.8.10 Alternative 6B: All Vitrification with Separations; Clean Closure

4.1.8.10.1 Prehistoric Resources

4.1.8.10.1.1 Base Case

Under Alternative 6B, Base Case, known prehistoric resources would not be affected. The survey and geology of the 200-East and 200-West Areas and Borrow Area C indicate that subsurface cultural deposits have little or no potential of being present. If prehistoric resources were discovered during construction or excavation, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented.

4.1.8.10.1.2 Option Case

Similar to Alternative 6B, Base Case, prehistoric resources would not be affected under the Option Case.

4.1.8.10.2 Historic Resources

4.1.8.10.2.1 Base Case

There would be no impacts on White Bluffs Road or other known early historic artifacts within the 200-East or 200-West Area because all such resources are located in the northwest part of the area and would not be affected by construction or excavation. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected under this alternative. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

4.1.8.10.2.2 Option Case

Similar to the Base Case, historic structures would not be affected under the Option Case.

4.1.8.10.3 American Indian Interests

4.1.8.10.3.1 Base Case

Prehistoric resources that may be of American Indian interest are discussed in Section 4.1.8.10.1.1. Under Alternative 6B, Base Case, there would be an overall increase in the industrial appearance of the 200 Areas, although less than half as much land within the 200 Areas would be converted to industrial use compared with Alternative 6A. Facilities constructed would noticeably add to the industrial nature of the 200 Areas and would be visible from nearby higher elevations like Gable Mountain and Gable Butte. Additionally, approximately 240 hectares (592 acres) of Borrow Area C would be excavated. This would be visible from Rattlesnake Mountain, and thus would have an impact on the viewscape. Upon completion of the work, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact. If there were visual impacts on American Indian interests, appropriate mitigation measures would be developed in consultation with area tribes.

4.1.8.10.3.2 Option Case

Activities and visual impacts would be similar to those noted under the Base Case. Remediation of the deep plumes would result in disturbance of an additional 76.5 hectares (189 acres) within Borrow Area C compared with the Base Case. This would further impact the view from Rattlesnake Mountain.

4.1.8.10.4 Paleontological Resources

4.1.8.10.4.1 Base Case

There would be no impacts on known paleontological resources under this alternative case because no such resources have been discovered within the 200 Areas or Borrow Area C. As is the case for cultural resources, if any paleontological resources were found during construction, procedures in place to properly manage the discovery site would be implemented.

4.1.8.10.4.2 Option Case

There would be no impacts on known paleontological resources under this alternative case because no such resources have been discovered within the 200 Areas or Borrow Area C. As is the case for cultural resources, if any paleontological resources were found during construction, procedures in place to properly manage the discovery site would be implemented.

4.1.8.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

4.1.8.11.1 Prehistoric Resources

Under Alternative 6C, known prehistoric resources would not be affected. The survey and geology of the 200-East and 200-West Areas and Borrow Area C indicate that subsurface cultural deposits have little or no potential of being present. If prehistoric resources were discovered during construction, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented.

4.1.8.11.2 Historic Resources

Under this alternative, there would be no impacts on White Bluffs Road or other known early historic artifacts within the 200-East and 200-West Areas because all such resources are located in the northwest part of the area and would not be affected by construction or excavation. Buildings associated with the Manhattan Project and Cold War era are found within both the 200-East and 200-West Areas; however, none of these structures would be affected under this alternative. As is the case for prehistoric resources, if historic resources were discovered, procedures in place to properly identify, evaluate, record, curate, and manage the discovery site would be implemented.

4.1.8.11.3 American Indian Interests

Prehistoric resources that may be of American Indian interest are discussed in Section 4.1.8.11.1. Under Alternative 6C, newly constructed aboveground facilities would add to the overall industrial view from the higher elevations, such as Gable Mountain and Gable Butte, which are important to American Indians with cultural ties to Hanford. In addition, 104 hectares (258 acres) of Borrow Area C would be excavated. This would also be visible from Rattlesnake Mountain. Upon completion of work under this alternative, excavations in Borrow Area C would be recontoured and revegetated, thereby lessening the visual impact. If there were visual impacts on American Indian interests, appropriate mitigation measures would be developed in consultation with area tribes.

4.1.8.11.4 Paleontological Resources

There would be no impacts on known paleontological resources under this alternative because no such resources have been discovered within the 200 Areas or Borrow Area C. As is the case for cultural resources, if any paleontological resources were found during construction, procedures in place to properly manage the discovery site would be implemented.

4.1.9 Socioeconomics

The potential primary (direct) and secondary (indirect) impacts of all tank closure activities on employment, regional demographics, housing and community services, and local transportation were analyzed for this section of the EIS. The potential primary impacts were identified by analyzing projected changes in employment (in terms of full-time equivalents [FTEs]) and truck activity related to the activities in each alternative (see Appendix I). The projected changes in employment and truck activity could impact the need for housing units, public services, and local transportation in the region.

Projected changes in employment would likely result in additional, secondary changes in employment, salaries, expenditures in the area, and demands for social services. Analyses of these potential secondary economic and social impacts across the alternatives were conducted using a blended multiplier developed by the U.S. Department of Commerce, Bureau of Economic Analysis, Regional Input-Output Modeling System specifically for the Tri-Cities area, that is, Richland, Pasco, and Kennewick, Washington. The multiplier used was a blend of the new industrial and commercial construction multiplier and the engineering and architectural services multiplier. The value of the blended multiplier was approximately 1.75, meaning that, for each full-time worker employed in support of tank closure activities, approximately three-quarters of an additional full-time job could be created elsewhere in the regional economy (Perteet, Thomas/Lane, and SCM 2001).

When calculating workforce estimates, partial FTE employee quantities were rounded up to the nearest whole FTE. The resulting conservative workforce estimates represent the upper limit of workforce requirements. For each type of activity (e.g., construction, operations, closure), a peak workforce estimate was calculated and the year(s) in which the peak occurred was noted. As each activity type may peak during different years, the totals do not add up because they represent different time periods. In addition, figures throughout this section may not tally due to rounding.

The projected workforce estimates could also impact the local commuter traffic. A 2005 commuter survey found that only 12 percent of employees commuting to Hanford used carpools or vanpools (two or more persons per vehicle); the remaining 88 percent used their own cars (one person per vehicle) (BFCOG 2006). It was assumed that employees would commute to work in vehicles averaging 1.25 persons each (Malley 2007). The conversion factor used when calculating the number of trips per day from trips per year was 260 days worked in a year. In addition, the number of calculated truck trips associated with the various activities was rounded up to the nearest whole trip. Impacts of onsite truck trips, i.e., trips conducted solely on site, are included in the onsite analysis. Impacts of the onsite portion of truck trips to or from the site are included in the offsite analysis.

Common Socioeconomic Impacts

The potential socioeconomic impacts of the alternatives below have many commonalities based on the activities associated with them. Construction, operations, and deactivation of the WTP and its replacements most often dominate the employment requirements for many of the Tank Closure alternatives.

As can be seen in Figure 4–16, each alternative includes at least one peak employment period, generally followed by an employment decline. Most alternatives include several growth periods with a leveling off in between. Most alternatives also include reduced workforce estimates for the final years when administrative controls of remaining facilities and postclosure care would be provided. During the high employment periods, increases in the projected workforce would result in some in-migration of workers from outside the region and associated secondary impacts on the local economy. The number of in-migrating workers and the sizes of their accompanying families would affect the predicted impacts on most public services.

After some peak employment periods, sharp drops in onsite employment might occur. These reductions could also reduce the number of indirect jobs in the region supporting Hanford activities. If these workers are unable to find employment in other industries, they could move out of the region, thereby reducing the overall regional population and decreasing the demand for housing and community services (Perteet, Thomas/Lane, and SCM 2001:3-4).

In the area of transportation, annual workforce estimates impact commuter traffic whether or not workers are new to the community, because they all use local roads to access the project site. Increased traffic from both higher employment and additional truck shipments would result in additional impacts on the local transportation system. The current roadway system has no additional capacity during the commute hours, so all workforce increases would impact the major commute routes. These impacts could include increased degradation of the roadways, increased congestion, and the need for increased maintenance to the roadways.

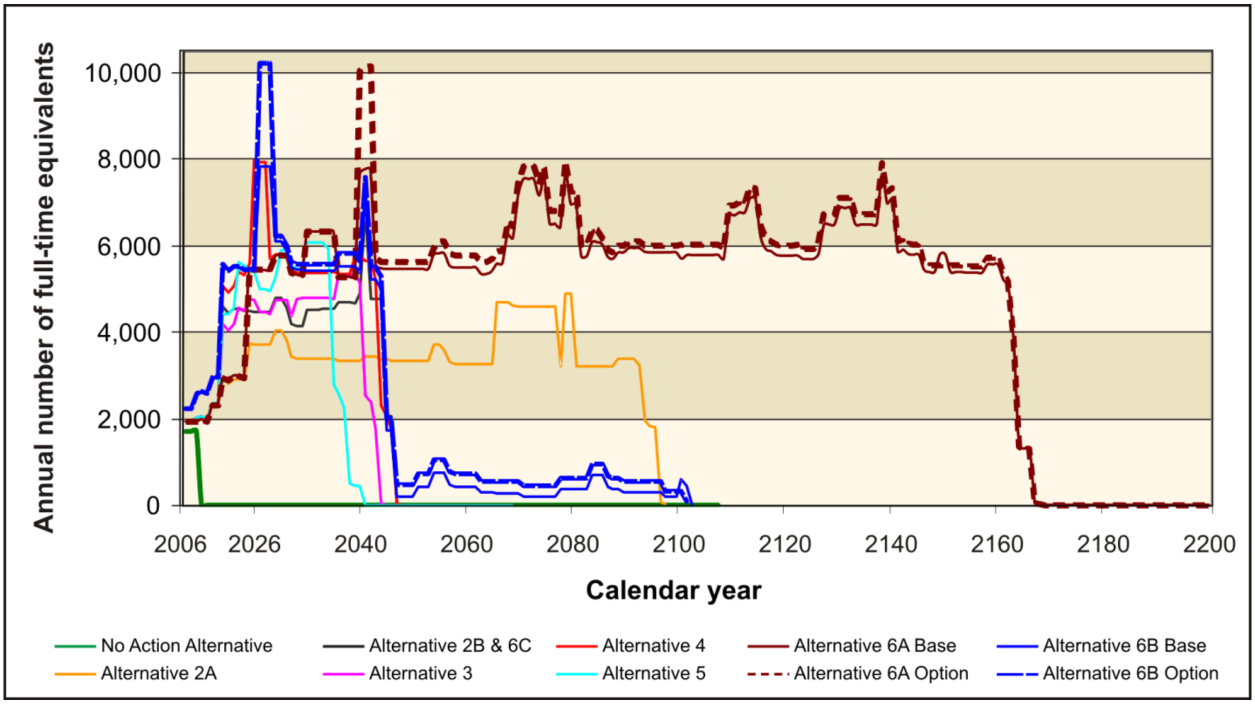


Figure 4–16. Tank Closure Alternatives – Annual Workforce Estimates (2006–2200)

4.1.9.1 Alternative 1: No Action

Under Alternative 1: No Action, total onsite employment, as shown in Figure 4–16, would remain steady (about 1,730 FTEs) until 2008, then drop immediately to 15 FTEs, the number needed to provide administrative controls for 100 years through 2107. Over 50 percent of the workforce (906 FTEs) during the peak years would be performing construction activities (see Table 4–8) associated with the WTP. In addition to the direct employment associated with the No Action Alternative, approximately 1,300 indirect positions likely to be created would have a secondary impact on the region in the peak years.

Table 4–8. Tank Closure Alternative 1 Peak Annual Estimated Workforce Requirements

Work Activity	Peak Year(s)	Workforce Peak or Peak Range (FTEs)
Construction	2006–2008	1,070
Operations	2006–2008	651
Deactivation	2008–2107	15

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate.
Key: FTE=full-time equivalent.
Source: Appendix I; SAIC 2010a.

4.1.9.1.1 Regional Economic Characteristics

The No Action Alternative would have an immediate short-term effect on the regional economy. The 1,730 jobs would be approximately 1.4 percent of the projected labor force in the region of influence (ROI) (120,000 jobs) in 2008. For comparison, the approximately 10,000 people employed at Hanford in 2006 represented about 10 percent of overall employment within the Hanford ROI. The reduction in onsite employment and expenditures in 2009 would correspondingly reduce the number of indirect jobs in the region supporting Hanford activities. If these workers were unable to find employment in other industries, they could move out of the region, thereby reducing the overall regional population and decreasing the demand for housing and community services.

4.1.9.1.2 Demographic Characteristics

The in-migration of workers to support construction of the WTP would increase rapidly during the early years of the project. The differential between the WTP impact and the baseline regional labor force projection would then get smaller, approaching zero with time. Therefore, any changes in the demographic characteristics of the Tri-Cities area and the Hanford ROI would be largely reversed by implementation of Alternative 1.

4.1.9.1.3 Housing and Community Services

As construction on the WTP ceases in 2008, any demand for new housing and community services would also cease. Reduced demand for housing by construction and operations workers would likely reduce the cost and increase availability of houses and rental units.

4.1.9.1.4 Local Transportation

The traffic associated with the WTP, including both commuter and local truck traffic, would impact the local transportation system. Currently, there is no excess capacity on the major Hanford commute routes during the peak commute hours. Under Washington State law, Benton and Franklin Counties and the cities of Kennewick, Pasco, Richland, and West Richland must adopt commute trip reduction (CTR) program plans for major employers. The intent of the CTR program plans is to reduce commutes by workers from their homes to major work sites during the peak period of 6:00 A.M. to 9:00 A.M. on weekdays. Construction work sites are generally excluded under the law, provided the construction duration is less than 2 years. The ongoing construction of the Hanford WTP would likely not be exempt. As construction on the WTP ceases, traffic levels on roads in the region are also expected to be substantially reduced.

4.1.9.1.4.1 Commuter Traffic

Before termination of construction activities in 2008, about 1,700 employees would be commuting to the 200 Areas for activities associated with tank farm operations and WTP construction. Assuming an average of 1.25 persons per passenger vehicle, this could represent about 1,400 passenger vehicles per day commuting to the site. From 2009 through 2107, administrative controls would require about 15 FTEs. Therefore, commuter traffic to the 200-East and 200-West Areas at that time would decrease substantially compared with recent levels.

4.1.9.1.4.2 Truck Traffic

The heaviest period of offsite truck activity would occur from 2006 through 2008 during construction of the WTP, prior to termination of activities in 2008. Around 1,000 trips per year (4 trips per day) would be required to deliver materials to the site. Onsite truck trips would also occur during construction of the WTP (over 20 trips per day). During the 100-year administrative control period, it is projected that there would be about 1 trip per year by offsite trucks delivering diesel fuel and gasoline to the site.

4.1.9.2 Alternative 2A: Existing WTP Vitrification; No Closure

Under Alternative 2A, near-term employment would increase to, and then remain steady at or above, 3,000 FTEs through 2064. The total onsite workforce would increase by nearly 50 percent starting in 2065 to a peak of 4,920 FTEs in 2078 and 2079 (see Figure 4–16). From 2080 through 2092, the total onsite workforce would again be steady at or above 3,000 FTEs. The workforce employment for the remaining years would steadily decrease until 2097, when only 15 FTEs would be required to cover administrative controls. The existence of these direct jobs is expected to result in the creation of another 3,700 indirect positions in the ROI during the peak years.

Under this alternative, the employment period would be dominated by construction and operations activities at the WTP. Workers constructing the WTP (2006 through 2017) and its replacement facility (2065 through 2076) would dominate the construction workforce of up to 1,880 FTEs. From 2053 through 2076, over half of the roughly 2,940 FTE operations workers would be employed at the WTP (see Figure 4–17). Workers deactivating the WTP and its replacement facility would dominate the deactivation workforce, which is projected to reach approximately 1,700 FTEs from 2078 through 2079 and again from 2094 through 2095 (see Table 4–9).

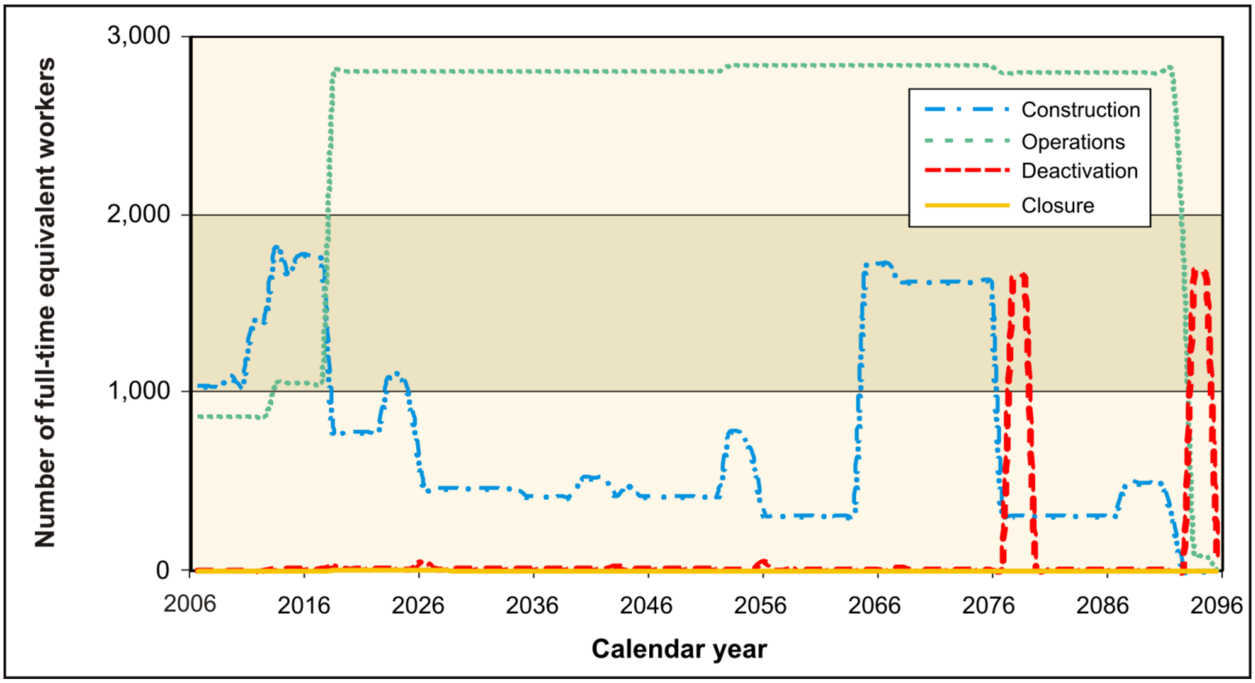


Figure 4–17. Tank Closure Alternative 2A Annual Estimated Onsite Full-Time-Equivalent Workforce Requirements (2006–2096)

Table 4–9. Tank Closure Alternative 2A Peak Annual Estimated Workforce Requirements

Work Activity	Peak Year(s)	Workforce Peak or Peak Range (FTEs)
Construction	2013–2017 2065–2076	1,720–1,880 1,670–1,780
Operations	2018–2092	2,890–2,940
Deactivation	2078–2079 2094–2095	1,710 1,720–1,740
Closure	2018–2028	9

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate.
Key: FTE=full-time equivalent.
Source: Appendix I; SAIC 2010a.

4.1.9.2.1 Regional Economic Characteristics

The peak workforce estimate of 4,920 jobs under Alternative 2A would occur in 2078 and 2079. This estimate is approximately 1.8 percent of the projected labor force in the ROI (267,000) in 2078, as compared with 10 percent in 2006. Nevertheless, implementing Alternative 2A could alter the economic characteristics of the region by increasing demands for goods and services in the Tri-Cities area over an extended period of time (i.e., approximately 90 years) due to increases in expenditures, income, and employment (direct and indirect) at Hanford.

4.1.9.2.2 Demographic Characteristics

While this alternative would draw some workers from the local labor force, the continuing demand for operations workers would compel drawing from outside the region. The in-migration of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region.

4.1.9.2.3 Housing and Community Services

Implementation of this alternative would increase the demand for housing and would impact schools and other community services within the Hanford ROI. The demand for housing by construction and operations workers would impact the cost and availability of houses and rental units. School enrollments are expected to increase, and utilities and police and fire services may need to be expanded.

4.1.9.2.4 Local Transportation

Implementation of this alternative is expected to have an impact on the local transportation system, especially during the commute periods. It is expected that all new commute period trips would impact the regionally established level of service (LOS), reducing it to a level below the minimum acceptable ("D") LOS (Perteet, Thomas/Lane, and SCM 2001).

4.1.9.2.4.1 Commuter Traffic

Under Alternative 2A, the near-term peak years of construction and operations activities would begin in 2013. The projected increase in commuter traffic to the site would be primarily due to construction and operations at the WTP and other facilities. These activities could ultimately increase the number of site personnel to almost 4,920 FTEs annually in 2078 and 2079. Assuming an average of 1.25 persons per passenger vehicle, this could represent up to 4,000 passenger vehicles per day commuting to the site during peak years.

4.1.9.2.4.2 Truck Traffic

The number of annual offsite truck trips is projected to average over 2,500 trips per year (10 trips per day) from 2011 through 2095. The peak years for offsite truck traffic under Alternative 2A would be from 2065 through 2079, averaging around 3,400 trips per year. During that time, construction of the replacement WTP would account for the major portion of offsite truck traffic—3,920 peak truck trips (15 trips per day) in 2078 and 2079.

Onsite truck traffic supporting similar activities would peak from 2011 through 2017, requiring an average of about 15,300 truck trips per year (59 trips per day) to move concrete aggregate materials and other borrow materials on site. Onsite truck traffic would peak again from 2065 through 2076, with an average of about 12,600 truck trips per year (48 trips per day) for construction of the replacement WTP.

4.1.9.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

Under Alternative 2B, the total workforce requirements would increase until 2013, when it would remain steady at or above 4,000 FTEs (see Figure 4–16). Peak employment would occur in 2040, when onsite employment would reach 6,860 FTEs. As a result of this increase in direct employment, an additional 5,130 indirect jobs are projected in this peak year. Direct employment is then projected to significantly decrease until 2045, when deactivation workers would make up the bulk (74 percent) of the workforce requirements. The workforce requirements would then decline until 2047, when 3 FTEs would be needed for postclosure care of the site.

As shown in Figure 4–18, the total workforce projection would be dominated (over 70 percent) first by construction workers from 2013 through 2017, followed by operations workers through 2043. As under Alternative 2A, construction and operations workers for the WTP would be the major workforce during this time period. Of the 5,540 FTE peak operations workforce (see Table 4–10), 70 percent would be employed at the WTP and in its supplemental operations. In addition, deactivation of the WTP in 2044 and 2045 would dominate the workforce requirements, with a projection of over 1,500 FTEs. From 2039 through 2045, construction of the modified RCRA Subtitle C barrier over the SSTs would dominate the closure workforce.

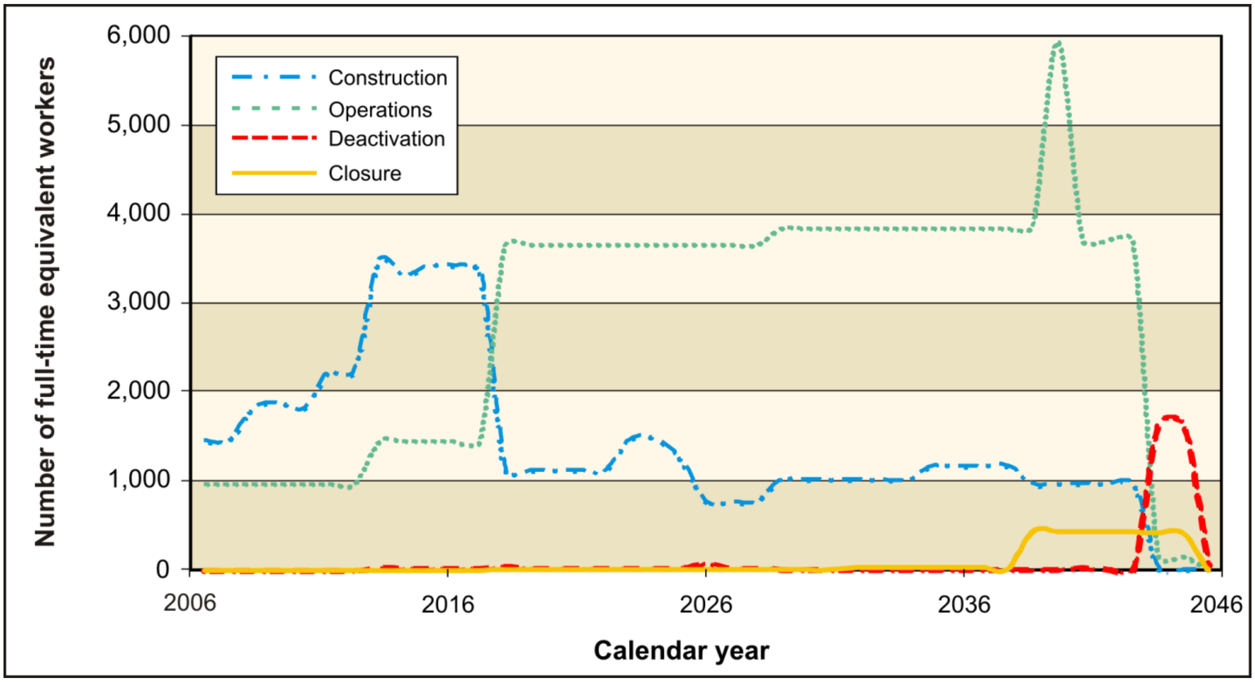


Figure 4–18. Tank Closure Alternative 2B Annual Estimated Onsite Full-Time-Equivalent Workforce Requirements (2006–2046)

Table 4–10. Tank Closure Alternative 2B Peak Annual Estimated Workforce Requirements

Work Activity	Peak Year(s)	Workforce Peak or Peak Range (FTEs)
Construction	2013–2017	3,080–3,240
Operations	2018–2043	3,400–5,540
Deactivation	2044–2045	1,530–1,540
Closure	2039–2045	394–412

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate.
Key: FTE=full-time equivalent.
Source: Appendix I; SAIC 2010a.

4.1.9.3.1 Regional Economic Characteristics

Under Alternative 2B, the near-term impact on economic conditions within the ROI would exceed those impacts under Alternative 2A. The peak workforce estimate of 6,860 FTEs in 2040 would occur much earlier than the peak under Alternative 2A of 4,920 FTEs in 2078–2079. This estimate would be approximately 3.6 percent of the projected labor force in the ROI (189,000) in 2040, compared with approximately 10 percent in 2006. Implementing Alternative 2B could temporarily (for 30 years) increase demands for goods and services in the Tri-Cities area due to increases in expenditures, income, and employment (direct and indirect) at Hanford. The increase in demand would be followed by an abrupt decrease in expenditures, income, and employment.

4.1.9.3.2 Demographic Characteristics

While this alternative would draw some workers from the local labor force, the continuing demand for operations workers would compel drawing from outside the region. The in-migration of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region. More workers would be required over a longer period of time under this alternative compared with Alternative 2A.

4.1.9.3.3 Housing and Community Services

Implementation of this alternative would increase the demand for housing and would impact schools and other community services within the ROI, exceeding the demands of Alternative 2A. The demand for housing by construction and operations workers would impact the cost and availability of houses and rental units. School enrollment is expected to increase, and utilities and police and fire services may need to be expanded.

4.1.9.3.4 Local Transportation

As under Alternative 2A, implementation of this alternative is expected to have an impact on the local transportation system, especially during the commute periods. It is expected that all new commute period trips would impact the regionally established LOS, reducing it to a level below the minimum acceptable ("D") LOS (Perteet, Thomas/Lane, and SCM 2001).

4.1.9.3.4.1 Commuter Traffic

Under Alternative 2B, the peak years of construction and operations activities at the site would begin in 2013. The projected increase in commuter traffic to and from the site would be primarily due to activities from the expanded WTP. These and other activities would increase the number of site personnel to about 6,900 FTEs in 2040. Assuming an average of 1.25 persons per passenger vehicle, this could represent up to 5,500 commuter vehicles per day commuting to and from the site during the peak years.

4.1.9.3.4.2 Truck Traffic

From 2006 through 2017, the number of annual offsite truck trips is projected to be small, ranging from 1,100 to 2,900 (4 to 11 trips per day). The heaviest period of offsite truck activity would occur from 2018 through 2043, mainly to support WTP operations. It is projected that an average of 6,820 truck trips per year (26 trips per day) would be needed for daily operations at the WTP and the tank-filling grout facility. At its peak in 2040, there would be an estimated 12,400 truck trips per year (48 trips per day).

Onsite trucking would increase during the construction period from 2011 through 2017. During that time, construction of the IHLW Shipping/Transfer Facility and IHLW Interim Storage Modules, the WTP, and WRFs would account for the major portion of onsite truck traffic—18,000 peak truck trips in 2013. Onsite truck traffic would average around 15,000 truck trips per year (58 trips per day) during this construction period. Onsite truck traffic would be the heaviest from 2039 through 2045, averaging around 53,800 truck trips per year (207 trips per day). This period of onsite truck activity would support closure activities under Alternative 2B. At its peak from 2039 through 2043, closure activities, led by construction of the modified RCRA Subtitle C landfill barrier, would require an estimated 56,500 truck trips per year (217 trips per day).

4.1.9.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

Under Alternative 3A, total onsite employment would increase until 2013, when it would remain steady at or above 4,000 FTEs, peaking at 5,330 FTEs in 2035 (see Figure 4–16). This increase in direct employment would result in the creation of another approximately 4,000 indirect jobs in the ROI in the peak year. Employment is then projected to decrease substantially until 2042, when deactivation workers would make up the bulk (95 percent) of the employment requirements. The employment requirements would then decline until 2044, when three FTEs would be needed for postclosure care of the site.

Under this alternative, construction employment would almost triple by the time it peaks in 2016 at 3,040 FTEs (see Table 4–11). The operations workforce would increase until 2018, remaining above 3,000 FTEs from 2018 through 2039, as shown in Figure 4–19. Almost half of these workers (1,700 FTEs) would be employed at the WTP during this period. The workforce required for deactivation of the WTP would peak in 2041 at 1,860 FTEs. Closure workforce requirements would remain steady until 2035, when requirements would increase to approximately 400 FTEs for 7 years.

Table 4–11. Tank Closure Alternative 3A Peak Annual Estimated Workforce Requirements

Work Activity	Peak Year(s)	Workforce Peak or Peak Range (FTEs)
Construction	2013 2016–2017	2,750 2,980–3,040
Operations	2018–2039	3,480–3,700
Deactivation	2041–2042	1,700–1,860
Closure	2035–2041	394–412

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate.
Key: FTE=full-time equivalent.
Source: Appendix I; SAIC 2010a.

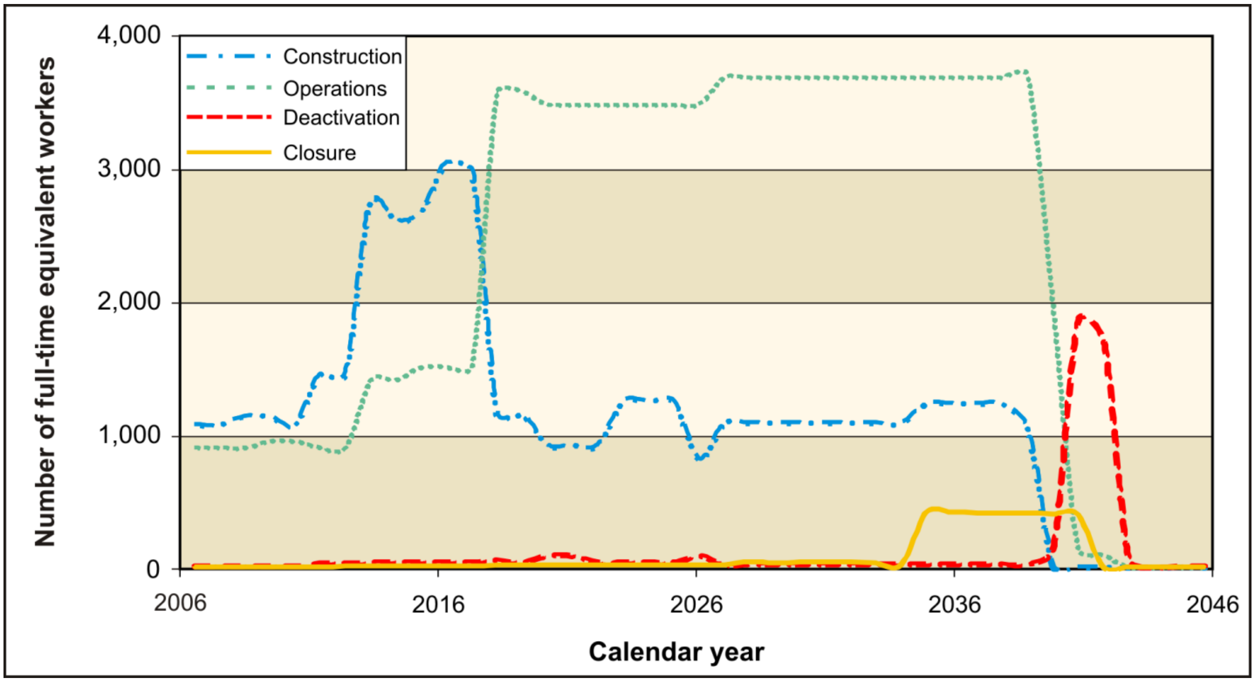


Figure 4–19. Tank Closure Alternatives 3A, 3B, and 3C Annual Estimated Onsite Full-Time-Equivalent Workforce Requirements (2006–2046)

4.1.9.4.1 Regional Economic Characteristics

The peak workforce estimate of 5,330 FTEs under Alternative 3A would occur in 2035. This estimate represents approximately 3.0 percent of the projected labor force in the ROI (179,000 FTEs) in 2035. The near-term impacts on economic conditions could alter the economic characteristics of the region by temporarily (for 30 years) increasing demands for goods and services in the Tri-Cities area due to increases in expenditures, income, and employment (direct and indirect) at Hanford. The increase in demand would be followed by an abrupt decrease in expenditures, income, and employment beginning in 2043.

4.1.9.4.2 Demographic Characteristics

While this alternative would draw some workers from the local labor force, the continuing demand for operations workers would compel drawing from outside the region. The in-migration of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region.

4.1.9.4.3 Housing and Community Services

Implementation of this alternative would increase the demand for housing and would impact schools and other community services within the Hanford ROI. The demand for housing by construction and operations workers would impact the cost and availability of houses and rental units. School enrollment is expected to increase, and utilities and police and fire services may need to be expanded.

4.1.9.4.4 Local Transportation

Implementation of Alternative 3A is expected to have an impact on the local transportation system, especially during the commute periods. The local transportation system has additional capacity during noncommute periods, but has no additional capacity during the morning and afternoon peaks. It is expected that all new commute period trips would impact the regionally established LOS, reducing it to a level below the minimum acceptable (“D”) LOS (Perteet, Thomas/Lane, and SCM 2001).

4.1.9.4.4.1 Commuter Traffic

Under Alternative 3A, the construction and operations activities at the site would remain steady from 2013 through 2039. The projected increase in commuter traffic to and from the site during this period would be primarily due to construction of the WTP, the WRF, and retrieval systems. These activities would increase the number of site personnel to over 5,300 FTEs in 2035. Assuming an average of 1.25 persons per passenger vehicle, the increased traffic could represent a peak of about 4,300 commuter vehicles per day traveling to and from the site.

4.1.9.4.4.2 Truck Traffic

From 2006 through 2017, the number of annual offsite truck trips is projected to be small, ranging from 1,100 to 3,000 trips per year (4 to 12 trips per day). The heaviest period of offsite truck activity would occur from 2018 through 2039 during operations of the WTP, Bulk Vitrification Facilities, and grout facilities. It is projected that an average of 5,200 truck trips per year (20 trips per day) would be required to ship in materials during that period. At its peak in 2035 and 2036, there would be an estimated 6,300 truck trips per year (24 trips per day).

Onsite trucking would be at its highest from 2035 through 2041 due to the movement of concrete aggregate materials and other borrow materials that support closure activities, the process of filling the SSTs with grout, construction of a modified RCRA Subtitle C barrier, and the transport of resources needed for daily operations at the Bulk Vitrification Facilities. Onsite truck traffic would average around 55,400 truck trips per year (213 per day) during this period.

4.1.9.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

The socioeconomic impacts of implementing Alternative 3B would be virtually identical to those impacts of implementing Alternative 3A. This alternative uses the cast stone process in place of the bulk vitrification process as a supplemental treatment. All activities related to the cast stone process would be carried out in the same years as the bulk vitrification process and would be differentiated only by the workforce requirements. In addition to the direct employment associated with this alternative, approximately 3,900 indirect positions would likely be created in the peak year.

Figure 4–19 presents the workforce increases and decreases associated with Alternative 3B. Construction, operations, and deactivation of the Cast Stone Facilities in the 200-East and 200-West Areas would have smaller employment requirements than the Bulk Vitrification Facilities under Alternative 3A, resulting in slightly lower peak FTE employment projections (see Table 4–12).

The total workforce estimate peaks in 2035 (5,260 FTEs) under Alternative 3B. As this total workforce estimate is about 70 FTEs less than under Alternative 3A, the impacts on the economic and demographic characteristics and housing and community services under Alternative 3B would be similar to those impacts described under Alternative 3A.

Table 4–12. Tank Closure Alternative 3B Peak Annual Estimated Workforce Requirements

Work Activity	Peak Year(s)	Workforce Peak or Peak Range (FTEs)
Construction	2013 2016–2017	2,750 2,870–2,940
Operations	2018–2039	3,400–3,630
Deactivation	2041–2042	1,700–1,820
Closure	2035–2041	394–412

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate.
Key: FTE=full-time equivalent.
Source: Appendix I; SAIC 2010a.

4.1.9.5.1 Local Transportation

Implementation of Alternative 3B is expected to have an impact on the local transportation system similar to the impact of Alternative 3A, especially during the commute periods.

4.1.9.5.1.1 Commuter Traffic

Under Alternative 3B, the construction and operations activities at the site would remain steady from 2013 through 2039, similar to Alternative 3A. Assuming an average of 1.25 persons per passenger vehicle, the increased traffic could represent a peak of about 4,200 commuter vehicles per day traveling to and from the site.

4.1.9.5.1.2 Truck Traffic

From 2006 through 2017, the number of annual offsite truck trips is projected to be small, ranging from 1,100 to 2,900 (4 to 11 trips per day). Similar to Alternative 3A, the heaviest period of offsite truck activity would occur from 2018 through 2039 during operations of the WTP and Cast Stone Facilities. It is projected that an average of 8,400 truck trips per year (32 trips per day) would be required to ship in materials during this period. At its peak in 2035 and 2036, there would be an estimated 9,500 truck trips per year (36 trips per day).

Similar to Alternative 3A, onsite trucking would be at its highest from 2035 through 2041, averaging around 54,000 truck trips per year (208 trips per day) during this period. This period of onsite truck activity would support closure activities under Alternative 3B.

4.1.9.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

The socioeconomic impacts of implementing Alternative 3C would be virtually identical to those impacts of implementing Alternative 3A. This alternative uses the steam reforming process in place of the bulk vitrification process as a supplemental treatment. All activities related to the steam reforming process would be carried out in the same years as the bulk vitrification process and would be differentiated only by the workforce requirements.

Figure 4–19 presents the workforce increases and decreases associated with Alternative 3C. Construction, operation, and deactivation of the Steam Reforming Facilities in the 200-East and 200-West Areas would have larger employment requirements than the Bulk Vitrification Facilities under Alternative 3A, resulting in higher peak FTE employment projections (see Table 4–13).

Table 4–13. Tank Closure Alternative 3C Peak Annual Estimated Workforce Requirements

Work Activity	Peak Year(s)	Workforce Peak or Peak Range (FTEs)
Construction	2013 2016–2017	2,750 3,360–3,420
Operations	2018–2039	3,600–3,830
Deactivation	2041–2042	1,700–1,930
Closure	2035–2041	394–412

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate.
Key: FTE=full-time equivalent.
Source: Appendix I; SAIC 2010a.

The total workforce estimate peaks in 2035 (5,460 FTEs) under Alternative 3C. As this total workforce estimate is only 130 FTEs more than under Alternative 3A, the impacts on the economic and demographic characteristics and housing and community services under Alternative 3C would be similar to those impacts described under Alternative 3A. In addition to the direct employment associated with this alternative, approximately 4,100 indirect jobs would likely be created in the peak year.

4.1.9.6.1 Local Transportation

Implementation of Alternative 3C is expected to have an impact on the local transportation system similar to the impact under Alternative 3A, especially during the commute periods.

4.1.9.6.1.1 Commuter Traffic

Under Alternative 3C, construction and operations activities at the site would remain steady from 2013 through 2039, similar to Alternative 3A. Assuming an average of 1.25 persons per passenger vehicle, the increased traffic could represent a peak of over 4,300 commuter vehicles per day traveling to and from the site.

4.1.9.6.1.2 Truck Traffic

From 2006 through 2017, the number of annual offsite truck trips is projected to be small, ranging from 1,100 to 3,200 (4 to 12 trips per day). Similar to Alternative 3A, truck traffic would then increase until the heaviest period of offsite truck activity (2018 through 2039), which would occur during operations of the WTP and Steam Reforming Facilities. It is projected that an average of 36,000 truck trips per year (138 trips per day) would be required to ship in materials during that time. At its peak from 2035 through 2036, there would be an estimated 37,000 truck trips per year (142 trips per day).

Similar to Alternative 3A, onsite trucking would be at its highest from 2035 through 2041, averaging around 54,000 truck trips per year (208 trips per day) during this period. This period of onsite truck activity would support closure activities under Alternative 3C.

4.1.9.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

Under Alternative 4, total onsite employment would steadily increase, more than doubling by 2013 and reaching a peak of 8,000 FTEs in 2019 (see Figure 4–16). Total employment projections would then remain steady at or above 5,000 FTEs through 2042. This would be followed by a sharp decrease in the workforce until 2047, when only 3 FTEs would be needed for postclosure care of the site. The existence of these direct jobs is expected to result in the creation of almost 6,000 indirect jobs in the ROI in the peak year.

Under this alternative, construction employment would more than triple by the time it reaches its peak of 3,380 FTEs in 2016 (see Table 4–14 and Figure 4–20), shortly thereafter dropping and remaining steady at over 1,000 FTEs until 2042. The operations workforce would increase until 2018, remaining around 4,000 FTEs until 2042. The workforce required for deactivation of the WTP (1,700 FTEs) would not occur until 2044 and 2045. The workforce required to construct the PPF, which supports tank farm clean closure, would make up the bulk (2,390 FTEs) of the peak closure workforce requirements in 2019.

Table 4–14. Tank Closure Alternative 4 Peak Annual Estimated Workforce Requirements

Work Activity	Peak Year(s)	Workforce Peak or Peak Range (FTEs)
Construction	2013 2016–2017	3,150 3,310–3,380
Operations	2018–2042	3,700–4,020
Deactivation	2044–2045	1,700–1,710
Closure	2019–2021	2,410

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate.
Key: FTE=full-time equivalent.
Source: Appendix I; SAIC 2010a.

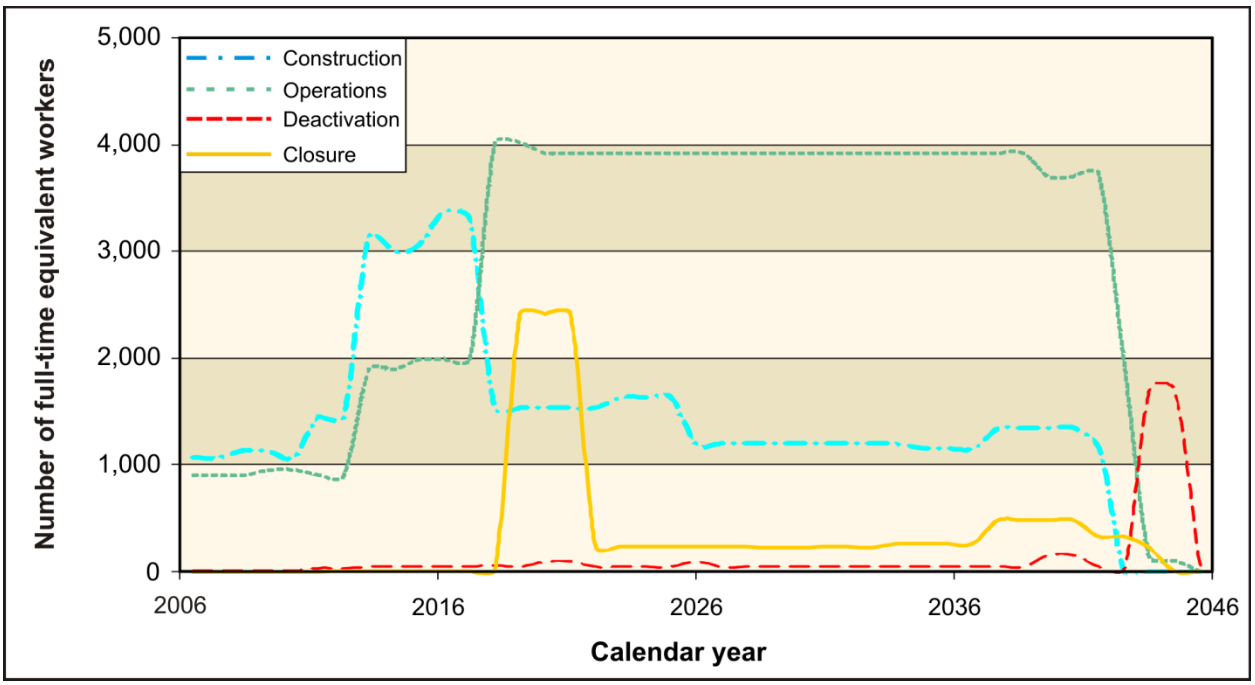


Figure 4–20. Tank Closure Alternative 4 Annual Estimated Onsite Full-Time-Equivalent Workforce Requirements (2006–2046)

4.1.9.7.1 Regional Economic Characteristics

The near-term impacts on economic conditions within the ROI under Alternative 4 would exceed those of many of the other alternatives. The peak workforce estimate of 8,000 FTEs would be mostly operations workers (4,020 FTEs). This peak workforce would be approximately 5.5 percent of the projected labor force in the ROI (146,000 FTEs) in 2019 compared with approximately 10 percent in 2006. Implementing Alternative 4 would alter the economic characteristics of the region by temporarily (for 30 years) increasing demands for goods and services in the Tri-Cities area due to increases in expenditures, income, and employment (direct and indirect) at Hanford. The increase in demand would be followed by an abrupt decrease in expenditures, income, and employment beginning in 2046.

4.1.9.7.2 Demographic Characteristics

While this alternative would draw some workers from the local labor force, the continuing demand for operations workers would draw from outside the region. The in-migration of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region.

4.1.9.7.3 Housing and Community Services

Implementation of this alternative would increase the demand for housing and would impact schools and other community services within the ROI. The demand for housing by construction and operations workers would impact the cost and availability of houses and rental units. School enrollment is expected to increase, and utilities and police and fire services may need to be expanded.

4.1.9.7.4 Local Transportation

Implementation of this alternative is expected to have an impact on the local transportation system, especially during the commute periods. The local transportation system has additional capacity during noncommute periods, but has no additional capacity during the morning and afternoon peaks. It is expected that all new commute period trips would impact the regionally established LOS, reducing it to a level below the minimum acceptable ("D") LOS (Perteet, Thomas/Lane, and SCM 2001).

4.1.9.7.4.1 Commuter Traffic

Under Alternative 4, the peak years of construction and operations activities at the site would occur from 2013 through 2042. The projected increase in commuter traffic to and from the site would be primarily due to construction and subsequent operations of the WTP, WRF, and retrieval systems. These and other activities would increase the number of site personnel to almost 8,000 FTEs in 2019. Assuming an average of 1.25 persons per passenger vehicle, this could represent up to 6,400 commuter vehicles per day traveling to and from the site during the peak years.

4.1.9.7.4.2 Truck Traffic

From 2006 through 2017, an average of approximately 2,200 offsite truck trips per year (9 trips per day) is projected to ship in construction materials primarily for construction of the WTP and the IHLW Shipping/Transfer Facility. The heaviest period of offsite truck activity would occur from 2018 through 2043 during construction of the WRFs; operations of the WTP, Bulk Vitrification Facility, and Cast Stone Facility; and various closure activities. It is projected that an average of 8,800 truck trips per year (34 trips per day) would be required to ship in construction materials and equipment for the removal of tanks, ancillary equipment, and soils in support of clean closure of the BX and SX tank farms. At its peak in 2043, there would be an estimated 16,600 truck trips per year (64 trips per day).

Onsite trucking would be at its highest from 2038 through 2044, averaging 40,000 truck trips per year (154 trips per day) during this period. This period of onsite truck activity would support closure activities under Alternative 4, including clean closure of the BX and SX tank farms and construction of the first four lobes of the modified RCRA Subtitle C barrier for landfill closure of the remaining tank farms in the SST system.

4.1.9.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

The total onsite employment under Alternative 5 would steadily increase until 2013, when onsite employment would more than double (see Figure 4–16). Total employment requirements would then remain above 4,000 FTEs through 2033, ranging from 4,330 to 6,100 FTEs. The total workforce requirements during that time period would include several substantial increases. In 2016, the total employment requirements would increase by 23 percent over the previous year; in 2024, requirements would increase by 12 percent; and in 2029, requirements would increase by 11 percent. In 2034, a sharp decrease in total employment would begin, falling steadily until 2040, when only a handful of workers (3 FTEs) would be needed for postclosure care of the site. In addition to the direct employment associated with this alternative, approximately 4,600 indirect positions would likely be created as a secondary impact on the ROI in the peak years.

Under this alternative, the construction workforce would almost quadruple by the time it reaches its peak of 4,000 FTEs in 2016 (see Table 4–15). From 2023 through 2033, construction workforce requirements would remain above 1,000 FTEs, dropping to 0 in 2035. The operations workforce requirements would increase from 2018 through 2033 to 4,150 FTEs. Operations activities at the WTP related to retrieval systems and other activities would require a shorter time period than under the other alternatives. The deactivation workforce requirements would peak in 2035 (2,040 FTEs); the majority of the deactivation workforce (1,700 FTEs) would be required for deactivating the WTP. Closure workforce requirements would remain small, ranging from 0 to 21 FTEs until 2029, when requirements would increase to over 400 FTEs for a period of 11 years (see Figure 4–21).

Table 4–15. Tank Closure Alternative 5 Peak Annual Estimated Workforce Requirements

Work Activity	Peak Year(s)	Workforce Peak or Peak Range (FTEs)
Construction	2016–2017	3,940–4,000
Operations	2018–2033	3,850–4,150
Deactivation	2035	2,040
Closure	2029–2039	418–438

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate.
Key: FTE=full-time equivalent.
Source: Appendix I; SAIC 2010a.

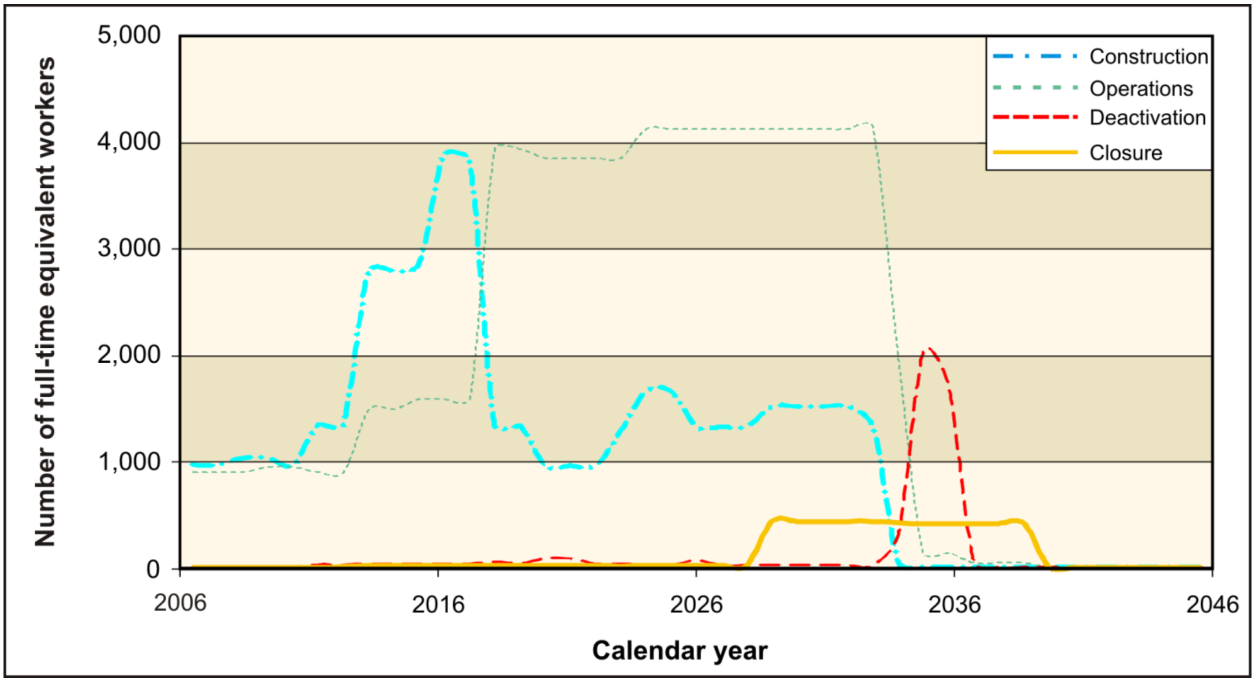


Figure 4–21. Tank Closure Alternative 5 Annual Estimated Onsite Full-Time-Equivalent Workforce Requirements (2006–2046)

4.1.9.8.1 Regional Economic Characteristics

The peak workforce estimate of 6,100 FTEs (from 2029 through 2032) represents approximately 3.7 percent of the projected labor force in the ROI (166,000) in 2029. Nevertheless, implementing Alternative 5 would alter the economic characteristics of the region by temporarily (for 20 years) increasing demands for goods and services in the Tri-Cities area due to increases in expenditures, income, and employment (direct and indirect) at Hanford. The increase in demand would be followed by an abrupt decrease in expenditures, income, and employment.

4.1.9.8.2 Demographic Characteristics

While this alternative would draw some workers from the local labor force, the demand for operations workers would compel drawing from outside the region. The in-migration of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region.

4.1.9.8.3 Housing and Community Services

Implementation of this alternative would increase the demand for housing and would impact schools and other community services within the Hanford ROI. The demand for housing by construction and operations workers would impact the cost and availability of houses and rental units. School enrollment is expected to increase, and utilities and police and fire services may need to be expanded.

4.1.9.8.4 Local Transportation

Implementation of this alternative is expected to have an impact on the local transportation system, especially during the commute periods. The local transportation system has additional capacity during noncommute periods, but has no additional capacity during the morning and afternoon peaks. It is expected that all new commute period trips would impact the regionally established LOS, reducing it to a level below the minimum acceptable (“D”) LOS (Perteet, Thomas/Lane, and SCM 2001).

4.1.9.8.4.1 Commuter Traffic

Under Alternative 5, the peak years of construction and operations activity at the site would occur from 2016 through 2033. The projected increase in commuter traffic to and from the site would be primarily due to construction of the WTP, WRF, and retrieval systems. These activities would increase the number of site personnel to over 6,000 FTEs from 2029 through 2032. Assuming an average of 1.25 persons per passenger vehicle, this personnel increase could represent about 4,900 commuter vehicles per day traveling to and from the site.

4.1.9.8.4.2 Truck Traffic

From 2006 through 2017, an average of 2,300 offsite truck trips per year (9 trips per day) is projected to ship construction materials primarily for construction of the WTP, the IHLW Shipping/Transfer Facility, and the TRU Waste Interim Storage Facility. The heaviest period of offsite truck activity would occur from 2018 through 2033. It is projected that an average of 13,900 truck trips per year (53 trips per day) would be required during construction of the WTP and the new DSTs; operations of the WTP, Sulfate Removal Facility, Bulk Vitrification Facility, and Cast Stone Facility; and various closure activities. At its peak from 2029 through 2032, there would be an estimated 14,700 truck trips per year (57 trips per day).

Onsite trucking would be at its highest from 2029 through 2039 and would average around 54,500 truck trips per year (210 trips per day). This period of onsite truck activity under Alternative 5 would support closure activities led by construction of the Hanford landfill barrier and would peak from 2029 through 2032 at an estimated 60,800 truck trips per year (234 trips per day).

4.1.9.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

Alternative 6A, Base and Option Cases, would differ only in the intensity of some closure activities. Under both alternatives, near-term employment would steadily increase for both cases until 2018, when total employment requirements would more than double to 5,470 FTEs (see Figure 4–16). The total onsite workforce would remain at or above 5,000 FTEs until 2163. During this time period, in both cases there would be a large number of substantial increases and subsequent decreases in total onsite workforce requirements. These large spikes in total workforce requirements would potentially occur in 2029–2034, 2039–2041, 2069–2074, 2078, 2109–2114, and 2138. Under Alternative 6A, Base Case, the peak of 7,790 FTEs would occur in 2041. Alternative 6A, Option Case, would have a peak in 2041 with a high of 10,200 FTEs. Beginning in 2163, there would be a sharp decrease (over 60 percent) in total employment, through 2168, when only a handful of workers would be needed for postclosure care of the site. The existence of these direct jobs is expected to result in the creation of up to 7,600 additional indirect jobs under the Option Case in the peak years.

Under this alternative, more than 4,600 FTE operations workers would make up the bulk of the total onsite employment requirements from 2018 through 2162 (see Figure 4–22). Almost half of these operations workers (2,170 FTEs) would be employed at the WTP. In both cases, the construction workforce would experience 10 spikes (short-term annual increases and subsequent decreases in employment) involving more than a 15 percent change in workforce requirements. The largest of these spikes would peak in 2015–2016, 2029–2034, 2070–2072, 2113–2114, and 2130–2132 (see Figure 4–22). The bulk of the deactivation workforce requirements would occur during the deactivation of the WTP (1,210 FTEs) and its replacement facilities over the periods 2078–2080, 2138–2140, and 2164–2166. The closure workforce would remain under 200 FTEs under Alternative 6A, Base Case, except for the periods 2039–2041 and 2149–2150 (see Table 4–16). Under Alternative 6A, Option Case, the closure workforce requirements after the 2039–2041 peak would more than double those under Alternative 6A, Base Case, ranging from 193 to 503 FTEs.

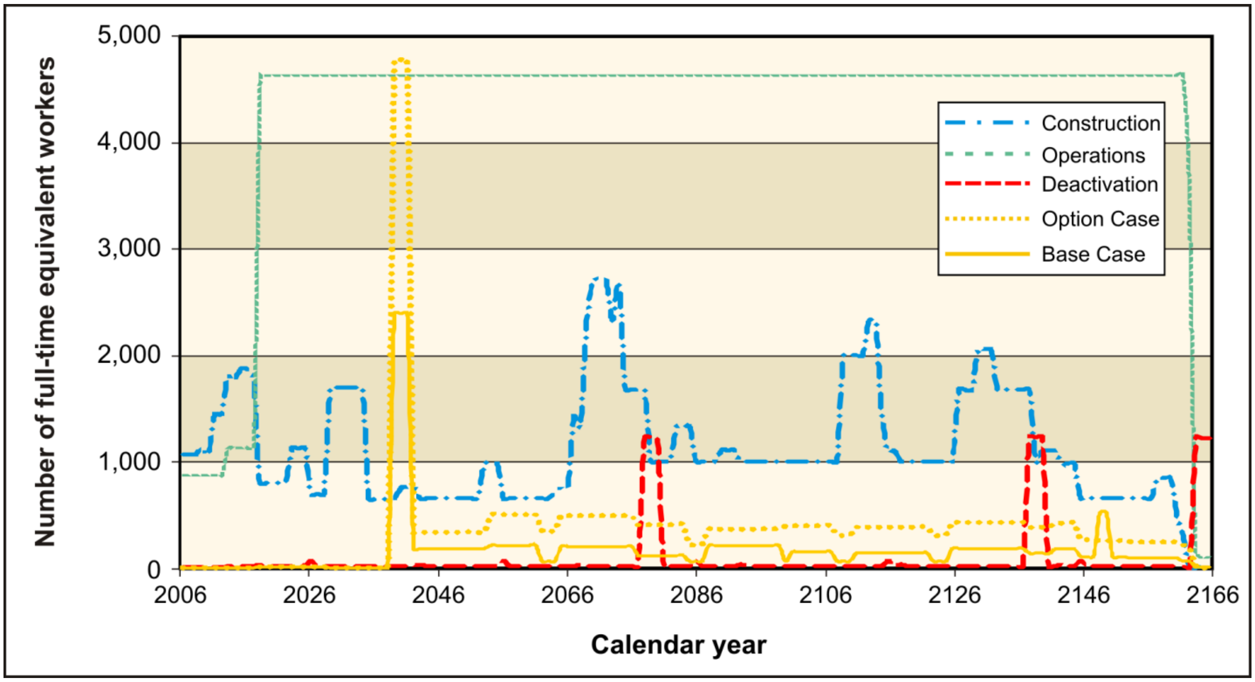


Figure 4–22. Tank Closure Alternative 6A, Base/Option Case, Annual Estimated Onsite Full-Time-Equivalent Workforce Requirements (2006–2166)

Table 4–16. Tank Closure Alternative 6A, Base/Option Case, Peak Annual Estimated Workforce Requirements

Work Activity	Peak Year(s)	Base Case Workforce Peak or Peak Range (FTEs)	Option Case Workforce Peak or Peak Range (FTEs)
Construction	2013–2017 2029–2034 2069–2074 2113–2114 2130–2132	1,770–1,870 1,700 2,330–2,710 2,330 2,060	Same
Operations	2018–2162	4,640–4,660	Same
Deactivation	2078–2080 2138–2140 2164–2166	1,230 1,230 1,220–1,230	Same
Closure	2039–2041 2149–2150	2,390 515	4,780 N/A

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate.
Key: FTE=full-time equivalent; N/A=not applicable.
Source: Appendix I; SAIC 2010a.

4.1.9.9.1 Regional Economic Characteristics

4.1.9.9.1.1 Base Case

Implementing Alternative 6A, Base Case, would alter the economic characteristics of the region by increasing demands for goods and services in the Tri-Cities area over an extended period of time (i.e., approximately 150 years) due to increases in expenditures, income, and employment (direct and indirect) at Hanford. According to estimates, the peak workforce of up to 7,790 FTEs would occur in 2041. This peak represents approximately 4.0 percent of the projected labor force in the ROI (191,000) in 2041. The peaks would be followed by abrupt decreases in expenditures, income, and employment.

4.1.9.9.1.2 Option Case

The socioeconomic impacts of implementing the Option Case would be higher than those of implementing the Base Case. The number of closure workers under the Option Case is double that under the Base Case. The peak workforce estimate in 2041 (10,200 FTEs) represents 5.3 percent of the projected labor force in the ROI (191,000) in 2041.

4.1.9.9.2 Demographic Characteristics

While this alternative would draw some workers from the local labor force, the continuing demand for operations workers would compel drawing from outside the region. The in-migration of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region. The impacts on the demographic characteristics of the ROI would be virtually the same for the Base and Option Cases, except during the peak year (2041). The increased number of closure workers under the Option Case represents a 3 percent increase in the total number of workers over that of the Base Case.

4.1.9.9.3 Housing and Community Services

Implementation of this alternative for both the Base and Option Cases would increase the demand for housing and would impact schools and other community services within the ROI. The demand for housing by construction and operations workers would impact the cost and availability of houses and rental units. School enrollment is expected to increase, and utilities and police and fire services may need to be expanded.

4.1.9.9.4 Local Transportation

Implementation of Alternative 6A for both the Base and Option Cases is expected to have an impact on the local transportation system, especially during the commute periods. The local transportation system has additional capacity during noncommute periods, but has no additional capacity during the morning and afternoon peaks. It is expected that all new commute period trips would impact the regionally established LOS, reducing it to a level below the minimum acceptable ("D") LOS (Perteet, Thomas/Lane, and SCM 2001).

4.1.9.9.4.1 Commuter Traffic

Under Alternative 6A for both the Base and Option Cases, the near-term peak years of activity at the site would occur from 2039 through 2041. The projected increase in commuter traffic to and from the site would be primarily due to the operation of the WTP and Interim Storage Facility, as well as construction of the PPF. These activities would increase the number of site personnel to over 10,200 FTEs in 2041 under Alternative 6A, Option Case. Assuming an average of 1.25 persons per passenger vehicle, this personnel increase could represent over 8,100 commuter vehicles per day traveling to and from the site. Under Alternative 6A, Base Case, over 6,200 commuter vehicles could travel to and from the site each day.

4.1.9.9.4.2 Truck Traffic

Under both the Base and Option Cases, an average of 1,600 offsite truck trips per year (6 trips per day) is projected from 2006 through 2017 to ship in construction materials, primarily for construction projects. The heaviest period of offsite truck activity would occur during periods of IHLW Interim Storage Module construction, WTP operations and deactivation, and closure activities. From 2018 through 2163, it is projected that an average of 8,000 (under Alternative 6A, Base Case) and 9,800 (under Alternative 6A, Option Case) truck trips per year (31 and 38 trips per day, respectively) would be required to ship in materials to support facility operations and tank farm clean closure activities. Under Alternative 6A, Base Case, the peak would occur in 2138, with a projected 12,700 truck trips per year (49 trips per day). Under Alternative 6A, Option Case, the peak would occur in 2054 and 2055, with an estimated 17,500 truck trips per year (67 trips per day).

Onsite trucking under Alternative 6A, Base Case, would be at its highest from 2149 through 2150 due to construction of the modified RCRA Subtitle C barrier for landfill closure of the remaining tank farms in the SST system. At its peak, there would be an estimated 60,800 truck trips per year (234 trips per day). Under Alternative 6A, Option Case, the peak would occur in 2074, with up to 59,500 onsite truck trips per year (229 trips per day). These periods of onsite truck activity would support IHLW Interim Storage Modules and closure activities under Alternative 6A.

4.1.9.10 Alternative 6B: All Vitrification with Separations; Clean Closure

As with Alternative 6A, the impacts under Alternative 6B, Base and Option Cases, differ only in the intensity of some closure workforce employment projections (see Table 4–16). Under both alternatives, total employment would steadily increase, more than doubling by 2013. Under Alternative 6B, Base Case, the peak of 7,860 FTEs would be in 2021 and 2022. Projections for Alternative 6B, Option Case, show the highest total onsite workforce of all Tank Closure alternatives, reaching a peak of over 10,200 FTEs in 2021 and 2022. As a result of these increases in employment, up to 7,600 additional indirect jobs are projected for the peak years. Employment for both the Base and Option Cases would then decrease to remain steady at or above 5,000 FTEs until a short spike in 2040. The total onsite workforce would then sharply decrease until 2046. From 2046 until 2096, the total onsite workforce would range from 200 to 762 FTEs under Alternative 6B, Base Case, and from 454 to 1,052 FTEs under Alternative 6B, Option Case. Beginning in 2102 under Alternative 6B, Base Case, only 3 FTEs would be needed for postclosure care of the site.

Under Alternative 6B, construction workers would dominate the workforce, as they more than double by 2013 and remain above 3,500 FTEs until 2017 (see Figure 4–23). The largest contributor (1,190 FTEs) to the workforce at this time would be employment at the WTP. The construction workforce would then decrease until 2044, when only 4 FTEs would be required, except for two 3-year construction periods for the ETF replacements (2053–2055 and 2083–2085, as shown in Figure 4–23) when the construction workforce would briefly increase to 333 FTEs. Beginning in 2018, operations workers would make up the bulk of the workforce, remaining steady at 3,900 FTEs except for a spike up to 5,880 FTEs in 2040. The deactivation workforce would peak in 2044 (see Table 4–17), the majority (1,530 FTEs) committed to deactivating the WTP. After a spike from 2020 through 2022, the closure workforce would range from 59 to 468 FTEs under Alternative 6B, Base Case, and from 189 to 586 FTEs under Alternative 6B, Option Case.

The socioeconomic impacts of implementing the Base and Option Cases of this alternative would be similar. All construction, operations, and deactivation activities would occur during the same time periods and involve the identical workforce. Under the Option Case, higher workforce requirements for closure activities are projected.

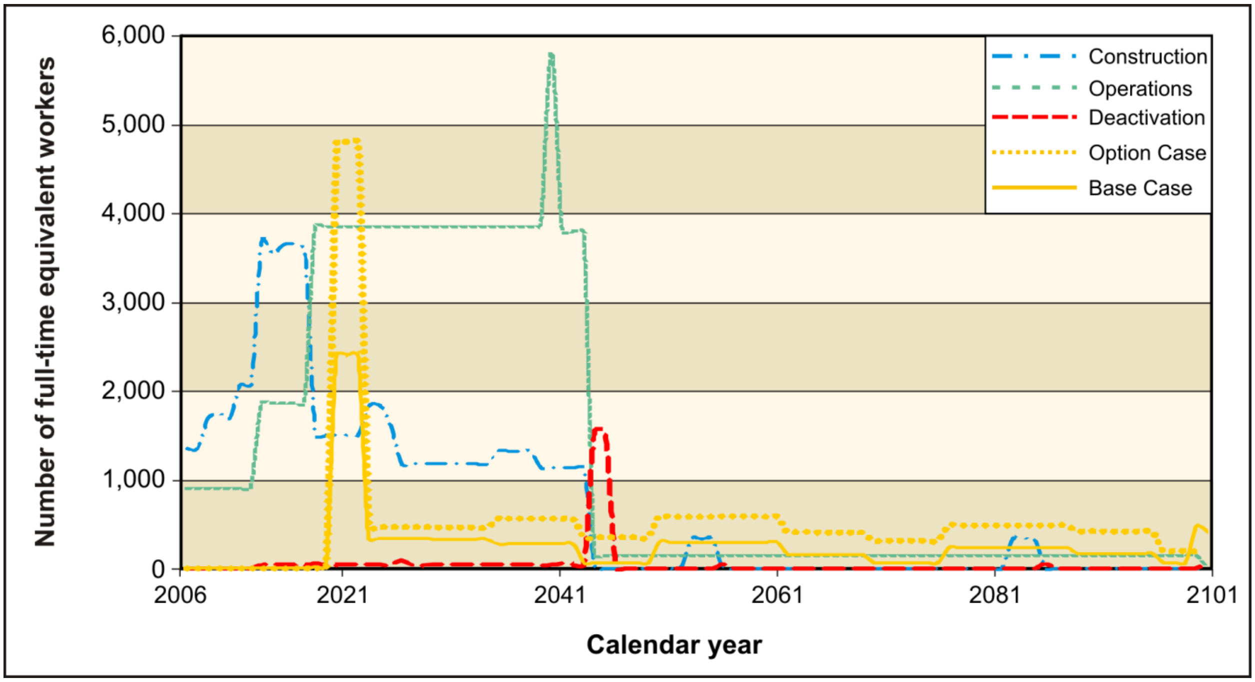


Figure 4–23. Tank Closure Alternative 6B, Base/Option Case, Annual Estimated Onsite Full-Time-Equivalent Workforce Requirements (2006–2101)

Table 4–17. Tank Closure Alternative 6B, Base/Option Case, Peak Annual Estimated Workforce Requirements

Work Activity	Peak Year(s)	Base Case Workforce Peak or Peak Range (FTEs)	Option Case Workforce Peak or Peak Range (FTEs)
Construction	2013–2017 2053–2055 2083–2085	3,540–3,690 333 333	Same
Operations	2018–2043	3,790–5,810	Same
Deactivation	2044–2045	1,530–1,540	Same
Closure	2020–2022 2100–2101	2,400 414–468	4,790 N/A

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate.
Key: FTE=full-time equivalent; N/A=not applicable.
Source: Appendix I; SAIC 2010a.

4.1.9.10.1 Regional Economic Characteristics

4.1.9.10.1.1 Base Case

Implementing the Base Case under Alternative 6B would alter the economic characteristics of the region by increasing demands for goods and services in the Tri-Cities area over an extended period of time (i.e., approximately 90 years) due to increases in expenditures, income, and employment (direct and indirect) at Hanford. It is estimated that the peak workforce, up to 7,860 FTEs, would occur from 2021 through 2022. These near-term peaks represent approximately 5.2 percent of the projected labor force in the ROI (150,000) in 2021.

4.1.9.10.1.2 Option Case

The socioeconomic impacts of implementing the Option Case would be higher than those of implementing the Base Case. The number of closure workers under the Option Case would be almost double that under the Base Case. The peak workforce estimate for 2021 and 2022 (10,200 FTEs) represents 6.8 percent of the projected labor force in the ROI.

4.1.9.10.2 Demographic Characteristics

While this alternative would draw some workers from the local labor force, the demand for operations workers would compel drawing from outside the region. The in-migration of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region. The increased number of closure workers under the Option Case during the later years (after 2045) represents from one-third to more than double the total number of workers under the Base Case. Nevertheless, the impacts on the demographic characteristics of the ROI would be virtually the same under the Base and Option Cases because the total workforce would be small compared with the projected labor force in the ROI (201,000) in 2046.

4.1.9.10.3 Housing and Community Services

Implementation of Alternative 6B for both the Base and Option Cases would increase the demand for housing and would impact schools and other community services within the ROI. The demand for housing by construction and operations workers would impact the cost and availability of houses and rental units. School enrollment is expected to increase, and utilities and police and fire services may need to be expanded.

4.1.9.10.4 Local Transportation

Implementation of this alternative for both the Base and Option Cases is expected to have an impact on the local transportation system, especially during the commute periods. The local transportation system has additional capacity during noncommute periods, but has no additional capacity during the morning and afternoon peaks. It is expected that all new commute period trips would impact the regionally established LOS, reducing it to a level below the minimum acceptable (“D”) LOS (Perteet, Thomas/Lane, and SCM 2001).

4.1.9.10.4.1 Commuter Traffic

Under Alternative 6B for both the Base and Option Cases, the peak years of construction and operations activities at the site would occur from 2013 through 2043. The projected increase in commuter traffic to and from the site during this period would be primarily due to construction and operation of the expanded WTP and retrieval systems. These activities would increase the number of site personnel to over 10,200 FTEs from 2021 through 2022 under Alternative 6B, Option Case. Assuming an average of 1.25 persons per passenger vehicle, this personnel increase could represent over 8,100 commuter vehicles per day traveling to and from the site. Under the Base Case during the same time period (2021–2022), over 6,200 commuter vehicles could travel to and from the site each day.

4.1.9.10.4.2 Truck Traffic

Under both the Base and Option Cases, an average of over 2,200 offsite truck trips per year (8 trips per day) from 2006 through 2017 is projected to ship in construction materials, primarily for construction projects. The heaviest period of offsite truck activity would occur from 2018 through 2043 during WTP operations and closure activities. At its peak in 2040, there would be an estimated

17,200 (under Alternative 6B, Base Case) and 21,600 (under Alternative 6B, Option Case) truck trips per year (66 and 83 trips per day, respectively).

Onsite trucking under Alternative 6B, Base Case, would be at its highest in 2100 due to construction of the modified RCRA Subtitle C barrier for landfill closure of the remaining tank farms in the SST system. At its peak, there would be an estimated 48,800 truck trips (188 trips per day). Under Alternative 6B, Option Case, the peak would occur in 2023 and 2024, with up to 45,400 truck trips per year (175 trips per day). These periods of onsite truck activity would support construction and closure activities under Alternative 6B.

4.1.9.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

Under Alternative 6C, total onsite workforce requirements would be essentially the same as those under Alternative 2B (see Figure 4–16). The construction workforce of 11 FTEs from 2016 through 2043 for the ILAW Canister Storage Building would be required under Alternative 6C only. Peak employment numbers and years (see Table 4–18 and Figure 4–24) would be identical to those under Alternative 2B.

Table 4–18. Tank Closure Alternative 6C Peak Annual Estimated Workforce Requirements

Work Activity	Peak Year(s)	Workforce Peak or Peak Range (FTEs)
Construction	2013–2017	3,080–3,240
Operations	2018–2043	3,400–5,540
Deactivation	2044–2045	1,530–1,540
Closure	2039–2045	394–412

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate.
Key: FTE=full-time equivalent.
Source: Appendix I; SAIC 2010a.

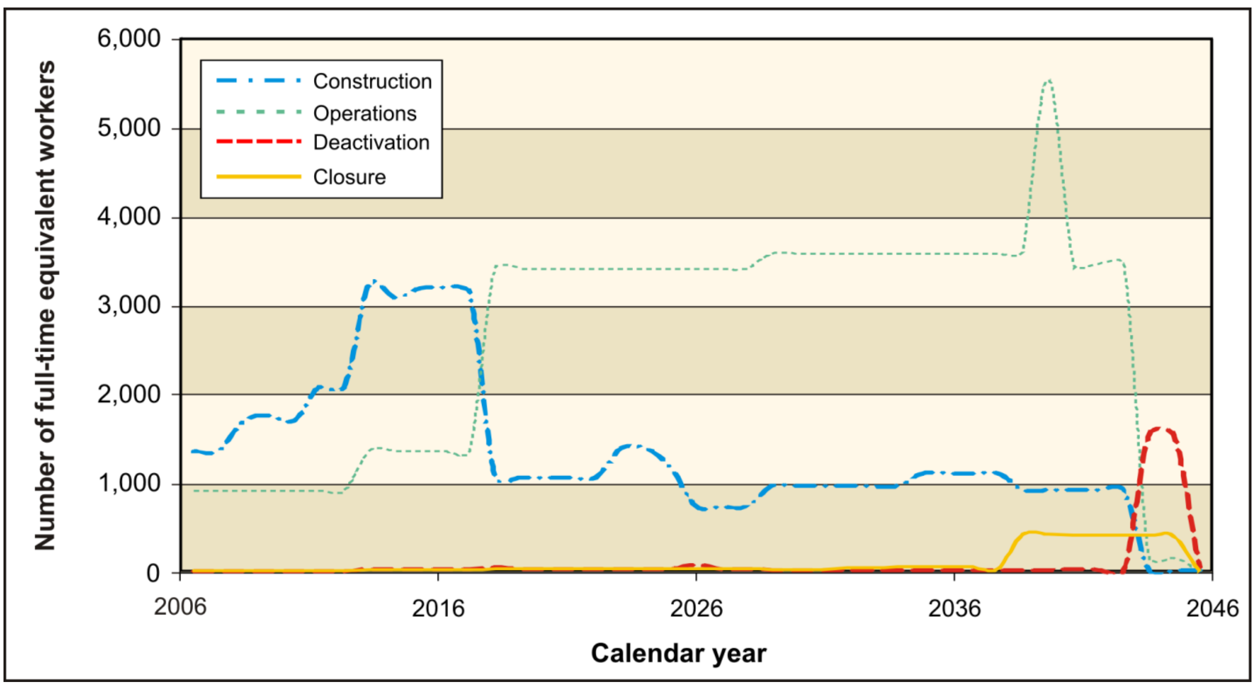


Figure 4–24. Tank Closure Alternative 6C Annual Estimated Onsite Full-Time-Equivalent Workforce Requirements (2006–2046)

4.1.9.11.1 Regional Economic Characteristics

Implementing Alternative 6C would alter the economic characteristics of the region by temporarily (for 30 years) increasing demands for goods and services in the Tri-Cities area due to increases in expenditures, income, and employment (direct and indirect) at Hanford. The peak workforce estimate of 6,870 FTEs would occur in 2040. This estimate would be approximately 3.6 percent of the projected labor force in the ROI (189,000) in 2040, compared with approximately 10 percent in 2006. The increase in demand would be followed by an abrupt decrease in expenditures, income, and employment.

4.1.9.11.2 Demographic Characteristics

While this alternative would draw some workers from the local labor force, the continuing demand for operations workers would draw from outside the region. The in-migration of new workers and their families would increase the overall population within the Tri-Cities area and could alter the demographic characteristics of the region.

4.1.9.11.3 Housing and Community Services

Implementation of this alternative would increase the demand for housing and would impact schools and other community services within the ROI. The demand for housing by construction and operations workers would impact the cost and availability of houses and rental units. School enrollment is expected to increase, and utilities and police and fire services may need to be expanded.

4.1.9.11.4 Local Transportation

Implementation of this alternative is expected to have an impact on the local transportation system, especially during the commute periods. The local transportation system has additional capacity during noncommute periods, but has no additional capacity during the morning and afternoon peaks. It is expected that all new commute period trips would impact the regionally established LOS, reducing it to a level below the minimum acceptable (“D”) LOS (Perteet, Thomas/Lane, and SCM 2001).

4.1.9.11.4.1 Commuter Traffic

Under Alternative 6C, the peak years of construction and operations activities at the site would begin in 2013. The projected increase in commuter traffic to and from the site would be primarily due to activities for the expanded WTP. These and other activities would increase the number of site personnel to about 6,900 FTEs in 2040. Assuming an average of 1.25 persons per passenger vehicle, this personnel increase could represent about 5,500 commuter vehicles per day traveling to and from the site.

4.1.9.11.4.2 Truck Traffic

According to projections, from 2006 through 2017, an average of 2,200 offsite truck trips per year (8 trips per day) would be required to ship in construction materials. The heaviest period of offsite truck activity would occur from 2018 through 2043 during construction of the WRFs and the IHLW Interim Storage Modules, operations of the WTP, and some closure activities. It is projected that an average of 7,400 truck trips per year (29 trips per day) would be required to ship in materials during this time. At its peak in 2040, truck activity would reach an estimated 13,000 truck trips per year (50 trips per day).

Under Alternative 6C, onsite trucking would be at its highest during the period of modified RCRA Subtitle C landfill barrier construction; construction of the ILAW Interim Storage Facility; and the onsite movement of concrete aggregate materials, other borrow materials, and excavated soil supporting closure activities. This period of onsite truck activity would require an estimated 56,800 truck trips per year (218 trips per day) during its peak from 2039 through 2045.

4.1.10 Public and Occupational Health and Safety—Normal Operations

Activities to retrieve and treat tank waste and close tank farms could result in radiological and chemical exposures. Details of the assessment methodology for determining radiological exposure of workers and members of the public are presented in Appendix K. Radiological impacts are presented for three public receptors: the general population (approximately 560,000[1]) living within 80 kilometers (50 miles) of the Hanford 200 Areas, a maximally exposed individual (MEI) living near Hanford, and an onsite MEI. Impacts on the general population are evaluated for a residential scenario whereby people are exposed to radioactive materials emitted from project facilities. Radiological exposure occurs through inhalation, direct exposure to the radioactive plume and material deposited on the ground, and ingestion of contaminated products from animals raised locally and fruits and vegetables grown in a family garden (DOE 1995). Impacts on the offsite MEI are evaluated for a scenario that includes the same exposure pathways assumed for the general population, but with an increased amount of time spent outdoors and a higher rate of contaminated food consumption. Impacts on the onsite MEI, identified as a member of the public who works at the Columbia Generating Station, LIGO, or the US Ecology Commercial Low-Level Radioactive Waste Disposal Site (US Ecology), would be from inhalation and exposure to the plume and material deposited on the ground. Doses are presented as total effective doses.

The radiological impacts on members of the public are presented for each alternative in terms of impacts over the life of the project (the operational life of the project during which radioactive air emissions would occur) and peak annual impacts. Impacts over the life of the project are the total estimated radiation doses that would be incurred by members of the public over the duration of an alternative. The peak annual impacts are the estimated annual radiation doses that would be incurred by members of the public during the year(s) of largest radiation dose. Under all of the alternatives, the dose to an onsite MEI would be lower than the dose to an offsite MEI located near the Hanford boundary because the onsite MEI would be exposed for a shorter time (only during the workday) and through fewer pathways (e.g., no ingestion pathway).

In addition to members of the public, workers directly involved in the activities associated with each alternative and nearby noninvolved workers may receive radiation doses or chemical exposures. Doses to an involved worker are calculated based on an FTE employee. It was assumed for the purposes of this dose evaluation that an FTE involved worker has a 2,080-hour work year. In practice, the number of workers who could receive a radiation dose may be larger than the number assumed in this analysis, resulting in a smaller average dose per worker. A noninvolved worker is a person working at the site who is incidentally exposed due to the radioactive air emissions associated with the alternatives considered. The location selected for the noninvolved worker is a facility that is expected to be staffed on a daily basis and that is near the assumed emission sources.

The impacts of radionuclide releases from construction, operations, deactivation and cleanup, and postclosure care of each facility required under each of the Tank Closure alternatives were evaluated. Based on the data presented in the following subsections, radiological exposure of members of the public is expected to result in a single latent cancer fatality (LCF) among the population within an 80-kilometer (50-mile) radius under all alternatives except Alternative 1. The cumulative impacts associated with these alternatives in combination with Fast Flux Test Facility (FFTF) decommissioning, waste management operations, and other onsite, local, and regional activities are discussed in Chapter 6.

Under all Tank Closure alternatives except Alternative 1, the MEI would be about 13.1 kilometers (8.1 miles) east of the 200 Areas. Under Alternative 1, the MEI would be to the east-northeast, about

[1] The approximate population is based on populations of 542,324, 546,746, and 589,668 people residing within 80 kilometers (50 miles) of the WTP, STTS-East, and STTS-West, respectively.

11 kilometers (6.8 miles) from the 200 Areas. The annual dose to the MEI is not expected to exceed the regulatory limit of 10 millirem per year (40 CFR 61, Subpart H). In those cases where projections indicate that doses would be at or approaching 10 millirem per year, DOE would take action to ensure that emissions are controlled so that the total site impact remains below the regulatory limit. Americium-241, carbon-14, cesium-137, strontium-90, and plutonium-239 and -240 emitted from the WTP would be the primary contributors of the dose to members of the public over the life of the project under the Tank Closure action alternatives. The onsite MEI would receive an annual dose of 1.7 millirem or less.

Maximum annual impacts calculated for all Tank Closure alternatives except Alternative 1 would be determined by the treatment at the WTP of the materials from the strontium and cesium capsules. As currently described in the alternatives, all of the strontium and cesium would be processed in a 1-year timeframe following completion of tank waste processing. Under all alternatives, the year of strontium and cesium processing is the year of maximum impact on the public from radioactive air emissions. An alternate management strategy of distributing the treatment of the strontium and cesium materials over a period of years would reduce maximum annual impacts.

The potential dose to a noninvolved worker would result from exposure to, and inhalation of, radioactive contaminants released to the atmosphere from tank farm management, tank waste retrieval and treatment, and tank closure activities. The highest radioactive releases associated with the tank closure activities would be from the WTP and 200 Area fugitive emissions and diffuse sources. In the 200-East Area, the noninvolved worker was assumed to be at the 242-A Evaporator, 1,090 meters (3,580 feet) north-northwest of the 200-East Area source. In the 200-West Area, the noninvolved worker was assumed to be at the Environmental Restoration Disposal Facility (ERDF), about 950 meters (3,120 feet) east of the 200-West Area source. Radiation doses to noninvolved workers were calculated to remain below 3.6 millirem per year.

Based on the data presented in the following subsections, the average radiation dose to an FTE worker would be well below the Administrative Control Level of 500 millirem per year (DOE 2006a, 2007a) under Alternatives 1, 2A, 2B, 3A, 3B, 3C, 5, and 6C. The annual administrative control level would be approached or could be exceeded on the basis of exposure of an average FTE worker if Alternative 4, 6A, or 6B (Base or Option Cases) were implemented because these alternatives include exhumation of tank farms and contaminated soil underlying the tanks, activities that would result in comparatively large worker doses per hour worked.

Worker doses should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit them. Due to the number of years required to complete some alternatives, the dose over the life of the project would be distributed over several generations of workers. In addition, worker dose would be limited to less than 5 rem total effective dose equivalent per year (10 CFR 835). This regulatory limit would be further constrained by the application of administrative controls. DOE Standard 1098-2008, *Radiological Control*, recommends that the annual dose does not exceed 2 rem, unless explicitly authorized by DOE management (e.g., for emergency situations), and that the dose generally be controlled at a level below 500 millirem (0.5 rem) per year.

In practice, worker exposure would be controlled by use of engineering and administrative controls to keep doses below administrative limits and as low as is reasonably achievable. With the large amount of work resulting in exposure to radiation, all alternatives except Alternative 1 would result in large doses to the worker population that would result in the probability of LCFs occurring in the worker population. Potential doses and resulting LCFs to involved workers should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit individual worker dose, as discussed in Section 4.1.10.2.2. In summary, radiation doses to individual workers would be managed and mitigated to minimize impacts. Such measures were not taken into account in this analysis.

4.1.10.1 Alternative 1: No Action

4.1.10.1.1 Radiological Impacts on the Public

Table 4–19 presents estimated doses to the general population and the MEI under Alternative 1. Activities under this alternative that would generate radioactive air emissions would occur from 2006 through 2107. Due to the long timeframe involved, the doses over the life of the project would not be received by the same members of the population or the same MEI, but are presented to provide a basis for comparison with other alternatives.

Table 4–19. Tank Closure Alternative 1 Normal Operations Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
		Dose (person-rem)	**Number of Latent Cancer Fatalities[b]**	**Year of Maximum Impact**	**Dose (person-rem per year)**	**Number of Latent Cancer Fatalities[b]**
General population	WTP	0			0	
	200-East Area	37			0.40	
	200-West Area	37			0.39	
	Total	**74**	**0 (4×10^{-2})**	**2008**	**0.78**	**0 (5×10^{-4})**
		Dose[c] (millirem)	**Lifetime Risk of a Latent Cancer Fatality[d]**	**Year of Maximum Impact**	**Dose (millirem per year)**	**Lifetime Risk of a Latent Cancer Fatality[d]**
Maximally exposed individual	WTP	0			0	
	200-East Area	2.3			0.026	
	200-West Area	1.3			0.015	
	Total	**3.6**	**2×10^{-6}**	**2008**	**0.041**	**2×10^{-8}**
Onsite MEI	**Total**	**3.2**	**2×10^{-6}**	**2008**	**0.033**	**2×10^{-8}**

a Impacts accrued over the operational life of the project analyzed in this alternative.

b The reported value is the projected number of latent cancer fatalities (LCFs) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses (see Appendix K, Section K.1.1.6).

c Impacts are provided for comparison to other alternatives. The life-of-project dose would not be received by one individual person due to the duration of this alternative. The MEI dose from 70 years of exposure at the average dose rate would be 2.5 millirem, with a corresponding lifetime risk of an LCF of 1×10^{-6}; the onsite MEI dose from 40 years of exposure would be 1.3 millirem, with a lifetime LCF risk of 8×10^{-7}.

d Probability of an LCF in the MEI is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.2.1.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 74 person-rem,[2] and the MEI would receive a cumulative dose of 3.6 millirem. Given the risk factor of 0.0006 LCFs per rem (DOE 2003h), no LCFs are expected in the general population as a result of this alternative. There would be a probability of 2×10^{-6} (1 chance in 500,000)

[2] Person-rem=a unit of collective radiation dose applied to populations or groups of individuals; that is, a unit for expressing the dose when summed across all persons in a specified population or group.

of the MEI developing an LCF, assuming the same MEI was exposed over the life of the project. Radioactive air emissions would remain fairly constant over the duration of the alternative, not accounting for radioactive decay, with an annual population dose of 0.78 person-rem and an annual MEI dose of 0.041 millirem. The primary contributor to offsite doses would be tank farm emissions of uranium and, to a lesser extent, hydrogen-3 (tritium).

An onsite MEI who spends a normal workday at US Ecology would receive a maximum annual dose of 0.033 millirem. The increased risk of an LCF from this dose would be 2×10^{-8} (1 chance in 50 million).

4.1.10.1.2 Radiological Impacts on Workers

Table 4–20 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 140 millirem, lower than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a dose of 5,700 millirem, corresponding to a risk of 3×10^{-3} (1 chance in 300) of developing an LCF.

Table 4–20. Tank Closure Alternative 1 Normal Operations Radiological Impacts on Worker

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	140 millirem	9×10^{-5}
Impact over life of project[b]	5,700 millirem	3×10^{-3}
Life-of-Project Worker Population	280 person-rem	0 (2×10^{-1})
Noninvolved Worker (Year of Maximum Impact)		
At the 242-A Evaporator (2008)	0.097 millirem	6×10^{-8}
At the Environmental Restoration Disposal Facility (2008)	0.27 millirem	2×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.1.

The total effective dose equivalent to the involved worker population from the 102 years of occupational exposure under this alternative was estimated to be 280 person-rem. Given the risk factor of 0.0006 LCFs per person-rem, no LCFs are expected to result from the dose associated with this alternative. A majority of the worker dose under this alternative (190 person-rem, or 68 percent) would be associated with 100 years of administrative control of the tank farms.

Estimated doses and risks to the noninvolved workers at the 242-A Evaporator or the ERDF in the year of maximum impact are shown in Table 4–20. Doses to noninvolved workers would be a small fraction of the DOE-recommended Administrative Control Level of 500 millirem per year.

4.1.10.2 Alternative 2A: Existing WTP Vitrification; No Closure

4.1.10.2.1 Radiological Impacts on the Public

Table 4–21 presents estimated doses to the general population and the MEI under Alternative 2A. Activities that would generate radioactive air emissions would occur from 2006 through 2193. Due to the long timeframe involved, doses over the life of the project would not be received by the same members of the population or the same MEI, but are presented to provide a basis for comparison with other alternatives.

Table 4–21. Tank Closure Alternative 2A Normal Operations Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
General population		**Dose (person-rem)**	**Number of Latent Cancer Fatalities[b]**	**Year of Maximum Impact**	**Dose (person-rem per year)**	**Number of Latent Cancer Fatalities[b]**
	WTP	1,600			280	
	200-East Area	39			0.000000064	
	200-West Area	39			0	
	Total	**1,700**	**1 (1)**	**2093**	**280**	**0 (2×10^{-1})**
Maximally exposed individual		**Dose[c] (millirem)**	**Lifetime Risk of a Latent Cancer Fatality[d]**	**Year of Maximum Impact**	**Dose (millirem per year)**	**Lifetime Risk of a Latent Cancer Fatality[d]**
	WTP	42			8.5	
	200-East Area	2.2			0.0000000066	
	200-West Area	1.3			0	
	Total	**46**	**3×10^{-5}**	**2093**	**8.5**	**5×10^{-6}**
Onsite MEI	**Total**	**12**	**7×10^{-6}**	**2093**	**1.4**	**8×10^{-7}**

a Impacts accrued over the operational life of the project analyzed in this alternative.

b The reported value is the projected number of latent cancer fatalities (LCFs) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses (see Appendix K, Section K.1.1.6).

c Impacts are provided for comparison to other alternatives. The life-of-project dose would not be received by one individual person due to the duration of this alternative. The MEI dose from 70 years of exposure at the average dose rate would be 17 millirem, with a corresponding lifetime risk of an LCF of 1×10^{-5}; the onsite MEI dose from 40 years of exposure would be 2.6 millirem, with a lifetime LCF risk of 2×10^{-6}.

d Probability of an LCF in the MEI is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.2.1.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 1,700 person-rem. Doses from this alternative could result in 1 LCF in the general population. For the purposes of comparing the alternatives, a dose was calculated for an MEI, although the same individual could not be exposed over the duration of this alternative. The MEI would receive a cumulative dose of 46 millirem. There would be a probability of 3×10^{-5} (1 chance in 33,000) of the MEI developing an LCF, assuming the same MEI was exposed over the life of the project. The main sources of radioactive air emissions would be the WTP during its operations from 2018 through 2093 and fugitive and diffuse emissions from tank farms continuing at a low level over the administrative control period that extends to 2193. The year of maximum impact would be 2093, with a population dose of 280 person-rem and an MEI dose of 8.5 millirem.

An onsite MEI who spends a normal workday at US Ecology would receive a maximum annual dose of 1.4 millirem. The increased risk of an LCF from this dose would be 8×10^{-7} (1 chance in 1.3 million).

4.1.10.2.2 Radiological Impacts on Workers

Table 4–22 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 170 millirem, lower than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a cumulative dose of 6,900 millirem, corresponding to a risk of 4×10^{-3} (1 chance in 250) of developing an LCF.

Table 4–22. Tank Closure Alternative 2A Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	170 millirem	1×10^{-4}
Impact over life of project[b]	6,900 millirem	4×10^{-3}
Life-of-Project Worker Population	22,000 person-rem	13
Noninvolved Worker (Year[s] of Maximum Impact)		
At the 242-A Evaporator (2094–2095)	3.0 millirem	2×10^{-6}
At the Environmental Restoration Disposal Facility (2094–2095)	0.90 millirem	5×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.1.

The total effective dose equivalent to the involved worker population from the 188 years of occupational exposure under this alternative was estimated to be 22,000 person-rem. Given the risk factor of 0.0006 LCFs per person-rem, an estimated 13 LCFs would occur in the worker population. This number should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit worker dose, as discussed in Section 4.1.10. Due to the number of years required to complete this alternative, the cumulative dose would be distributed over several generations of workers. Most of the collective worker dose under this alternative (19,000 person-rem, or 86 percent) would be associated with the WTP, routine tank farm, and ETF operations. Even though the large worker population dose implies a number of LCFs, the operational controls used by DOE and its contractors would limit the dose that individual workers would receive and, therefore, their risk of an LCF.

Estimated doses and risks to noninvolved workers at the 242-A Evaporator and the ERDF in the year of maximum impact are shown in Table 4–22. Doses to noninvolved workers would be a small fraction of the Administrative Control Level of 500 millirem per year.

4.1.10.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

4.1.10.3.1 Radiological Impacts on the Public

Table 4–23 presents estimated doses to the general population and the MEI under Alternative 2B. Activities that would generate radioactive air emissions would occur from 2006 through 2045.

Table 4–23. Tank Closure Alternative 2B Normal Operations Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
General population		**Dose (person-rem)**	**Number of Latent Cancer Fatalities[b]**	**Year of Maximum Impact**	**Dose (person-rem per year)**	**Number of Latent Cancer Fatalities[b]**
	WTP	1,600			330	
	200-East Area	0.93			0.026	
	200-West Area	0.91			0.025	
	Total	**1,600**	**1 (1)**	**2040**	**330**	**0 (2×10^{-1})**
Maximally exposed individual		**Dose (millirem)**	**Lifetime Risk of a Latent Cancer Fatality[c]**	**Year of Maximum Impact**	**Dose (millirem per year)**	**Lifetime Risk of a Latent Cancer Fatality[c]**
	WTP	43			10	
	200-East Area	0.11			0.0030	
	200-West Area	0.063			0.0017	
	Total	**43**	**3×10^{-5}**	**2040**	**10**	**6×10^{-6}**
Onsite MEI	**Total**	**9.2**	**6×10^{-6}**	**2040**	**1.7**	**1×10^{-6}**

a Impacts accrued over the operational life of the project analyzed in this alternative.
b The reported value is the projected number of latent cancer fatalities (LCFs) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses (see Appendix K, Section K.1.1.6).
c Probability of an LCF in the maximally exposed individual is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.2.1.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 1,600 person-rem, and the MEI would receive a cumulative dose of 43 millirem. Doses from this alternative could result in 1 LCF in the general population. There would be a probability of 3×10^{-5} (1 chance in 33,000) of the MEI developing an LCF. The main source of radioactive air emissions would be the WTP during its operations from 2018 through 2043. Fugitive and diffuse emissions of uranium from tank farms and other sources in the 200 Areas would also be significant contributors to dose over the life of the project. The year of maximum impact would be 2040, with a population dose of 330 person-rem and an MEI dose of 10 millirem.

An onsite MEI who spends a normal workday at US Ecology would receive a maximum annual dose of 1.7 millirem. The increased risk of an LCF from this dose would be 1×10^{-6} (1 chance in 1 million).

4.1.10.3.2 Radiological Impacts on Workers

Table 4–24 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 160 millirem, lower than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a cumulative dose of 6,400 millirem, corresponding to a risk of 4×10^{-3} (1 chance in 250) of developing an LCF.

Table 4–24. Tank Closure Alternative 2B Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	160 millirem	1×10^{-4}
Impact over life of project[b]	6,500 millirem	4×10^{-3}
Life-of-Project Worker Population	11,000 person-rem	7
Noninvolved Worker (Year of Maximum Impact)		
At the 242-A Evaporator (2040)	3.4 millirem	2×10^{-6}
At the Environmental Restoration Disposal Facility (2040)	1.1 millirem	7×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated for table entries due to rounding.

Source: Appendix K, Section K.2.1.

The total effective dose equivalent to the involved worker population from the 41 years of occupational exposure under this alternative was estimated to be 11,000 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem to this population dose yields an estimate of 7 LCFs. This number should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit worker dose, as discussed in Section 4.1.10. Most of the collective worker dose under this alternative (7,600 person-rem, or 69 percent) would be associated with WTP, routine tank farm, and ETF operations.

Estimated doses and risks to noninvolved workers at the 242-A Evaporator and the ERDF in the year of maximum impact are shown in Table 4–24. Doses to noninvolved workers would be a small fraction of the DOE-recommended Administrative Control Level of 500 millirem per year.

4.1.10.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

4.1.10.4.1 Radiological Impacts on the Public

Table 4–25 presents estimated doses to the general population and the MEI under Alternative 3A. Activities that would generate radioactive air emissions would occur from 2006 through 2042. No radioactive air emissions are expected during the remainder of the project.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 1,600 person-rem, and the MEI would receive a dose of 43 millirem. Doses from this alternative could result in 1 LCF in the general population. There would be a probability of 3×10^{-5} (1 chance in 33,000) of the MEI developing an LCF. The main source of radioactive air emissions contributing to offsite doses would be the WTP during its operations from 2018 through 2040. Another significant contribution to offsite doses would be carbon-14 emissions from operation of the Bulk Vitrification Facilities. The year of maximum impact would be 2040, with a population dose of 280 person-rem and an MEI dose of 8.6 millirem.

An onsite MEI who spends a normal workday at LIGO would receive a maximum annual dose of 1.4 millirem. The increased risk of an LCF from this dose would be 8×10^{-7} (1 chance in 1.25 million).

Table 4–25. Tank Closure Alternative 3A Normal Operations Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
		Dose (person-rem)	Number of Latent Cancer Fatalities[b]	Year of Maximum Impact	Dose (person-rem per year)	Number of Latent Cancer Fatalities[b]
General population	WTP	1,200			280	
	200-East Area	220			1.0	
	200-West Area	200			0.90	
	Total	**1,600**	**1 (1)**	**2040**	**280**	**0 (2×10^{-1})**
Maximally exposed individual		Dose (millirem)	Lifetime Risk of a Latent Cancer Fatality[c]	Year of Maximum Impact	Dose (millirem per year)	Lifetime Risk of a Latent Cancer Fatality[c]
	WTP	33			8.5	
	200-East Area	6.0			0.027	
	200-West Area	3.7			0.016	
	Total	**43**	**3×10^{-5}**	**2040**	**8.6**	**5×10^{-6}**
Onsite MEI	**Total**	**8.9**	**5×10^{-6}**	**2040**	**1.4**	**8×10^{-7}**

[a] Impacts accrued over the operational life of the project analyzed in this Tank Closure alternative.

[b] The reported value is the projected number of latent cancer fatalities (LCFs) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses (see Appendix K, Section K.1.1.6).

[c] Probability of an LCF in the maximally exposed individual is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.2.1.

4.1.10.4.2 Radiological Impacts on Workers

Table 4–26 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 160 millirem, lower than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 38 years would receive a cumulative dose of 6,100 millirem, corresponding to a risk of 4×10^{-3} (1 chance in 250) of developing an LCF.

The total effective dose equivalent to the involved worker population from the 38 years of occupational exposure under this alternative was estimated to be 10,000 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem to this population dose yields an estimate of 6 LCFs. This number should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit worker dose, as discussed in Section 4.1.10. Most of the collective worker dose under this alternative (5,800 person-rem, or 58 percent) would be associated with WTP, routine tank farm, and ETF operations. Approximately 1,200 person-rem, or 12 percent, of the collective worker dose would result from closure activities such as removal of contaminated soil from the BX and SX tank farms, decontamination and decommissioning activities, and installation of a modified RCRA Subtitle C barrier over the tank farms.

Estimated doses and risks to noninvolved workers at the 242-A Evaporator and the ERDF in the years of maximum impact are shown in Table 4–26. Doses to noninvolved workers would be a small fraction of the DOE-recommended Administrative Control Level of 500 millirem per year.

Table 4–26. Tank Closure Alternative 3A Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	160 millirem	1×10^{-4}
Impact over life of project[b]	6,100 millirem	4×10^{-3}
Life-of-Project Worker Population	10,000 person-rem	6
Noninvolved Worker (Year[s] of Maximum Impact)		
At the 242-A Evaporator (2040)	3.0 millirem	2×10^{-6}
At the Environmental Restoration Disposal Facility (2018–2019)	0.93 millirem	6×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by 38 years of occupational exposure.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.1.

4.1.10.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

4.1.10.5.1 Radiological Impacts on the Public

Table 4–27 presents estimated doses to the general population and the MEI under Alternative 3B. Activities that would generate radioactive air emissions would occur from 2006 through 2042. No radioactive air emissions are expected during the period of institutional control following tank closure that extends to 2141.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 1,200 person-rem, and the MEI would receive a cumulative dose of 33 millirem. Doses from this alternative could result in 1 LCF in the general population. There would be a probability of 2×10^{-5} (1 chance in 50,000) of the MEI developing an LCF. The main source of radioactive air emissions would be the WTP during its operations from 2018 through 2040. Lower radioactive emissions would come from the nonthermal supplemental treatment technology of this alternative and result in lower offsite dose impacts as compared with the thermal supplemental treatment technologies of Alternatives 3A and 3C. The year of maximum impact would be 2040, with a population dose of 280 person-rem and an MEI dose of 8.5 millirem.

An onsite MEI who spends a normal workday at US Ecology would receive a maximum annual dose of 1.4 millirem. The increased risk of an LCF from this dose would be 8×10^{-7} (1 chance in 1.3 million).

Table 4–27. Tank Closure Alternative 3B Normal Operations Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
		Dose (person-rem)	Number of Latent Cancer Fatalities[b]	Year of Maximum Impact	Dose (person-rem per year)	Number of Latent Cancer Fatalities[b]
General population	WTP	1,200			280	
	200-East Area	1.1			0.000041	
	200-West Area	0.98			0.00074	
	Total	**1,200**	**1 (7×10^{-1})**	**2040**	**280**	**0 (2×10^{-1})**
		Dose (millirem)	Lifetime Risk of a Latent Cancer Fatality[c]	Year of Maximum Impact	Dose (millirem per year)	Lifetime Risk of a Latent Cancer Fatality[c]
Maximally exposed individual	WTP	33			8.5	
	200-East Area	0.12			0.0000035	
	200-West Area	0.068			0.000049	
	Total	**33**	**2×10^{-5}**	**2040**	**8.5**	**5×10^{-6}**
Onsite MEI	**Total**	**8.3**	**5×10^{-6}**	**2040**	**1.4**	**8×10^{-7}**

a Impacts accrued over the operational life of the project analyzed in this alternative.

b The reported value is the projected number of latent cancer fatalities (LCFs) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses (see Appendix K, Section K.1.1.6).

c Probability of an LCF in the maximally exposed individual is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.2.1.

4.1.10.5.2 Radiological Impacts on Workers

Table 4–28 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 160 millirem, lower than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 38 years would receive a cumulative dose of 6,100 millirem, corresponding to a risk of 4×10^{-3} (1 chance in 250) of developing an LCF.

The total effective dose equivalent to the involved worker population from the 38 years of occupational exposure under this alternative was estimated to be 9,800 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem to this population dose yields an estimate of 6 LCFs. This number should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit worker dose, as discussed in Section 4.1.10. Most of the collective worker dose under this alternative (5,800 person-rem, or 59 percent) would be associated with WTP, routine tank farm, and ETF operations. Approximately 1,200 person-rem, or 12 percent, of the collective worker dose would result from closure activities such as removal of contaminated soil from the BX and SX tank farms, decontamination and decommissioning activities, and installation of a modified RCRA Subtitle C barrier over the tank farms.

Table 4–28. Tank Closure Alternative 3B Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	160 millirem	1×10^{-4}
Impact over life of project[b]	6,100 millirem	4×10^{-3}
Life-of-Project Worker Population	9,800 person-rem	6
Noninvolved Worker (Year[s] of Maximum Impact)		
At the 242-A Evaporator (2040)	3.0 millirem	2×10^{-6}
At the Environmental Restoration Disposal Facility (2018–2019)	0.90 millirem	5×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by 38 years of occupational exposure.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.1.

Estimated doses and risks to noninvolved workers at the 242-A Evaporator and the ERDF in the years of maximum impact are shown in Table 4–28. Doses to noninvolved workers would be a small fraction of the DOE-recommended Administrative Control Level of 500 millirem per year.

4.1.10.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

4.1.10.6.1 Radiological Impacts on the Public

Table 4–29 presents estimated doses to the general population and the MEI under Alternative 3C. Activities that would generate radioactive air emissions would occur from 2006 through 2042. No radioactive air emissions are expected during the period of institutional control following tank closure that extends to 2141.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 1,700 person-rem, and the MEI would receive a cumulative dose of 49 millirem. Doses from this alternative could result in 1 LCF in the general population. There would be a probability of 3×10^{-5} (1 chance in 33,000) of the MEI developing an LCF. The main source of radioactive air emissions would be the WTP during its operations from 2018 through 2039. The year of maximum impact would be 2040, with a population dose of 280 person-rem and an MEI dose of 8.6 millirem.

An onsite MEI who spends a normal workday at US Ecology would receive a maximum annual dose of 1.4 millirem. The increased risk of an LCF from this dose would be 8×10^{-7} (1 chance in 1.3 million).

Table 4–29. Tank Closure Alternative 3C Normal Operations Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
		Dose (person-rem)	**Number of Latent Cancer Fatalities[b]**	**Year of Maximum Impact**	**Dose (person-rem per year)**	**Number of Latent Cancer Fatalities[b]**
General population	WTP	1,200			280	
	200-East Area	250			1.1	
	200-West Area	230			1.0	
	Total	**1,700**	**1 (1)**	**2040**	**280**	**0 (2×10^{-1})**
		Dose (millirem)	**Lifetime Risk of a Latent Cancer Fatality[c]**	**Year of Maximum Impact**	**Dose (millirem per year)**	**Lifetime Risk of a Latent Cancer Fatality[c]**
Maximally exposed individual	WTP	33			8.5	
	200-East Area	9.8			0.044	
	200-West Area	5.7			0.025	
	Total	**49**	**3×10^{-5}**	**2040**	**8.6**	**5×10^{-6}**
Onsite MEI	**Total**	**9.1**	**5×10^{-6}**	**2040**	**1.4**	**8×10^{-7}**

a Impacts accrued over the operational life of the project analyzed in this alternative.

b The reported value is the projected number of latent cancer fatalities (LCFs) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses (see Appendix K, Section K.1.1.6).

c Probability of an LCF in the maximally exposed individual is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.2.1.

4.1.10.6.2 Radiological Impacts on Workers

Table 4–30 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 160 millirem, lower than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 38 years would receive a cumulative dose of 6,100 millirem, corresponding to a risk of 4×10^{-3} (1 chance in 250) of developing an LCF.

The total effective dose equivalent to the involved worker population from the 38 years of occupational exposure under this alternative was estimated to be about 11,000 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem to this population dose yields an estimate of 6 LCFs. This number should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit worker dose, as discussed in Section 4.1.10. Most of the collective worker dose under this alternative (5,800 person-rem, or 53 percent) would be associated with WTP, routine tank farm, and ETF operations. Approximately 1,200 person-rem, or 11 percent, of the collective worker dose would result from closure activities such as removal of contaminated soil from the BX and SX tank farms, decontamination and decommissioning activities, and installation of a modified RCRA Subtitle C barrier over the tank farms.

Table 4–30. Tank Closure Alternative 3C Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	160 millirem	1×10^{-4}
Impact over life of project[b]	6,100 millirem	4×10^{-3}
Life-of-Project Worker Population	11,000 person-rem	6
Noninvolved Worker (Year[s] of Maximum Impact)		
At the 242-A Evaporator (2040)	3.0 millirem	2×10^{-6}
At the Environmental Restoration Disposal Facility (2018–2019)	0.94 millirem	6×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by 38 years of occupational exposure.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.1.

Estimated doses and risks to noninvolved workers at the 242-A Evaporator and the ERDF in the years of maximum impact are shown in Table 4–30. Doses to noninvolved workers would be a small fraction of the DOE-recommended Administrative Control Level of 500 millirem per year.

4.1.10.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

4.1.10.7.1 Radiological Impacts on the Public

Table 4–31 presents estimated doses to the general population and the MEI under Alternative 4. Activities that would generate radioactive air emissions would occur from 2006 through 2045. No radioactive air emissions are expected during the period of institutional control following tank closure that extends to 2144.

Over the operational life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 1,400 person-rem, and the MEI would receive a cumulative dose of 37 millirem. Doses from this alternative could result in 1 LCF in the general population. There would be a probability of 2×10^{-5} (1 chance in 50,000) of the MEI developing an LCF. The main sources of radioactive air emissions would be the WTP and the supplemental treatment facilities during their operations from 2009 through 2030. The year of maximum impact would be 2043, with a population dose of 280 person-rem and an MEI dose of 8.5 millirem.

An onsite MEI who spends a normal workday at US Ecology would receive a maximum annual dose of 1.4 millirem. The increased risk of an LCF from this dose would be 8×10^{-7} (1 chance in 1.3 million).

Table 4–31. Tank Closure Alternative 4 Normal Operations Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
		Dose (person-rem)	Number of Latent Cancer Fatalities[b]	Year of Maximum Impact	Dose (person-rem per year)	Number of Latent Cancer Fatalities[b]
General population	WTP	1,200			280	
	200-East Area	2.2			0.0048	
	200-West Area	200			0.0049	
	Total	**1,400**	**1 (8×10^{-1})**	**2043**	**280**	**0 (2×10^{-1})**
Maximally exposed individual		Dose (millirem)	Lifetime Risk of a Latent Cancer Fatality[c]	Year of Maximum Impact	Dose (millirem per year)	Lifetime Risk of a Latent Cancer Fatality[c]
	WTP	33			8.5	
	200-East Area	0.27			0.00061	
	200-West Area	3.9			0.00038	
	Total	**37**	**2×10^{-5}**	**2043**	**8.5**	**5×10^{-6}**
Onsite MEI	**Total**	**9.2**	**6×10^{-6}**	**2043**	**1.4**	**8×10^{-7}**

a Impacts accrued over the operational life of the project analyzed in this alternative.

b The reported value is the projected number of latent cancer fatalities (LCFs) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses (see Appendix K, Section K.1.1.6).

c Probability of an LCF in the maximally exposed individual is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.2.1.

4.1.10.7.2 Radiological Impacts on Workers

Table 4–32 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 530 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a cumulative dose of 21,000 millirem, corresponding to a risk of 1×10^{-2} (1 chance in 100) of developing an LCF. The high average FTE worker dose would be due to the exhumation of the BX and SX tank farms and the underlying contaminated soils. As noted in Section 4.1.10, work would be controlled in accordance with regulations and worker protection practices to maintain worker doses below established limits so an actual worker would not receive the doses calculated for the average FTE worker.

The total effective dose equivalent to the involved worker population from the 41 years of occupational exposure under this alternative was estimated to be 43,000 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem to this population dose yields an estimate of 26 LCFs. This number should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit worker dose, as discussed in Section 4.1.10. Most of the collective worker dose under this alternative (32,000 person-rem, or 74 percent) would be associated with deep soil removal from the SX tank farm.

Table 4–32. Tank Closure Alternative 4 Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	530 millirem	3×10^{-4}
Impact over life of project[b]	21,000 millirem	1×10^{-2}
Life-of-Project Worker Population	43,000 person-rem	26
Noninvolved Worker (Year[s] of Maximum Impact)		
At the 242-A Evaporator (2043)	3.0 millirem	2×10^{-6}
At the Environmental Restoration Disposal Facility (2034–2039)	0.91 millirem	5×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.1.

Estimated doses and risks to noninvolved workers at the 242-A Evaporator and the ERDF in the years of maximum impact are shown in Table 4–32. Doses to noninvolved workers would be a small fraction of the DOE-recommended Administrative Control Level of 500 millirem per year.

4.1.10.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

4.1.10.8.1 Radiological Impacts on the Public

Table 4–33 presents estimated doses to the general population and the MEI under Alternative 5. Activities that would generate radioactive air emissions would occur from 2006 through 2036. No radioactive air emissions are expected during operations or deactivation of storage facilities or during the period of institutional control following tank closure that extends to 2139.

Over the operational life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 1,400 person-rem, and the MEI would receive a cumulative dose of 37 millirem. Doses from this alternative could result in 1 LCF in the general population. There would be a probability of 2×10^{-5} (1 chance in 50,000) of the MEI developing an LCF. The main source of radioactive air emissions would be the WTP, which includes the contribution from sulfate removal associated with pretreatment under this alternative. Another large source of radioactive air emissions would be Bulk Vitrification Facility operations in the 200-West Area. The year of maximum impact would be 2034, with a population dose of 280 person-rem and an MEI dose of 8.6 millirem.

An onsite MEI who spends a normal workday at US Ecology would receive a maximum annual dose of 1.4 millirem. The increased risk of an LCF from this dose would be 8×10^{-7} (1 chance in 1.3 million).

Table 4–33. Tank Closure Alternative 5 Normal Operations Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
		Dose (person-rem)	**Number of Latent Cancer Fatalities[b]**	**Year of Maximum Impact**	**Dose (person-rem per year)**	**Number of Latent Cancer Fatalities[b]**
General population	WTP	1,200			280	
	200-East Area	0.88			0.000019	
	200-West Area	180			1.1	
	Total	**1,400**	**1 (8×10^{-1})**	**2034**	**280**	**0 (2×10^{-1})**
		Dose (millirem)	**Lifetime Risk of a Latent Cancer Fatality[c]**	**Year of Maximum Impact**	**Dose (millirem per year)**	**Lifetime Risk of a Latent Cancer Fatality[c]**
Maximally exposed individual	WTP	34			8.6	
	200-East Area	0.10			0.0000017	
	200-West Area	3.4			0.021	
	Total	**37**	**2×10^{-5}**	**2034**	**8.6**	**5×10^{-6}**
Onsite MEI	**Total**	**8.4**	**5×10^{-6}**	**2034**	**1.4**	**8×10^{-7}**

[a] Impacts accrued over the operational life of the project analyzed in this alternative.

[b] The reported value is the projected number of latent cancer fatalities (LCFs) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses (see Appendix K, Section K.1.1.6).

[c] Probability of an LCF in the maximally exposed individual is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.2.1.

4.1.10.8.2 Radiological Impacts on Workers

Table 4–34 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 150 millirem, lower than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 34 years would receive a cumulative dose of 5,100 millirem, corresponding to a risk of 3×10^{-3} (1 chance in 250) of developing an LCF.

The total effective dose equivalent to the involved worker population from the 34 years of occupational exposure under this alternative was estimated to be 8,500 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem to this population dose yields an estimate of 5 LCFs. This number should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit worker dose, as discussed in Section 4.1.10. The largest contributor to the collective worker dose under this alternative (3,200 person-rem, or 38 percent) would be WTP operations.

Estimated doses and risks to noninvolved workers at the 242-A Evaporator and the ERDF in the years of maximum impact are shown in Table 4–34. Doses to noninvolved workers would be a small fraction of the DOE-recommended Administrative Control Level of 500 millirem per year.

Table 4–34. Tank Closure Alternative 5 Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	150 millirem	9×10^{-5}
Impact over life of project[b]	5,100 millirem	3×10^{-3}
Life-of-Project Worker Population	8,500 person-rem	5
Noninvolved Worker (Year[s] of Maximum Impact)		
At the 242-A Evaporator (2034)	3.0 millirem	2×10^{-6}
At the Environmental Restoration Disposal Facility (2018–2019)	0.94 millirem	6×10^{-7}

a For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).

b Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by 34 years of occupational exposure.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.1.

4.1.10.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

4.1.10.9.1 Radiological Impacts on the Public

4.1.10.9.1.1 Base Case

Table 4–35 presents estimated doses to the general population and the MEI under Alternative 6A, Base Case. Activities under this case that would generate radioactive air emissions would occur from 2006 through 2166. Due to the long timeframe involved, the doses over the life of the project would not be received by the same members of the population or the same MEI, but are presented to provide a basis for comparison with other alternatives.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 1,700 person-rem, and the MEI would receive a cumulative dose of 49 millirem. Doses from this alternative could result in 1 LCF in the general population. There would be a probability of 3×10^{-5} (1 chance in 33,000) of the MEI developing an LCF. The main source of radioactive air emissions would be the WTP during its operations from 2018 through 2163. The year of maximum impact would be 2163, with a population dose of 280 person-rem and an MEI dose of 8.6 millirem.

An onsite MEI who spends a normal workday at US Ecology would receive a maximum annual dose of 1.4 millirem. The increased risk of an LCF from this dose would be 8×10^{-7} (1 chance in 1.3 million).

Table 4–35. Tank Closure Alternative 6A, Base Case, Normal Operations Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
		Dose (person-rem)	Number of Latent Cancer Fatalities[b]	Year of Maximum Impact	Dose (person-rem per year)	Number of Latent Cancer Fatalities[b]
General population	WTP	1,700			280	
	200-East Area	36			0.041	
	200-West Area	0.55			0.039	
	Total	**1,700**	**1 (1)**	**2163**	**280**	**0 (2×10^{-1})**
Maximally exposed individual		Dose[c] (millirem)	Lifetime Risk of a Latent Cancer Fatality[d]	Year of Maximum Impact	Dose (millirem per year)	Lifetime Risk of a Latent Cancer Fatality[d]
	WTP	45			8.5	
	200-East Area	4.1			0.0046	
	200-West Area	0.042			0.0027	
	Total	**49**	**3×10^{-5}**	**2163**	**8.6**	**5×10^{-6}**
Onsite MEI	**Total**	**10**	**6×10^{-6}**	**2163**	**1.4**	**8×10^{-7}**

a Impacts accrued over the operational life of the project analyzed in this alternative.

b The reported value is the projected number of latent cancer fatalities (LCFs) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses (see Appendix K, Section K.1.1.6).

c Impacts are provided for comparison to other alternatives. The life-of-project dose would not be received by one individual person due to the duration of this alternative. The MEI dose from 70 years of exposure at the average dose rate would be 21 millirem, with a corresponding lifetime risk of an LCF of 1×10^{-5}; the onsite MEI dose from 40 years of exposure would be 2.5 millirem, with a lifetime LCF risk of 2×10^{-6}.

d Probability of an LCF in the MEI is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.2.1.

4.1.10.9.1.2 Option Case

Table 4–36 presents estimated doses to the general population and the MEI under Alternative 6A, Option Case. Activities under this case that would generate radioactive air emissions would occur from 2006 through 2166. As with the Base Case, due to the long timeframe involved, the doses over the life of the project would not be received by the same members of the population or the same MEI, but are presented to provide a basis for comparison with other alternatives.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 1,800 person-rem, and the MEI would receive a cumulative dose of 53 millirem. Doses in this case could result in 1 LCF in the general population. There would be a probability of 3×10^{-5} (1 chance in 33,000) of the MEI developing an LCF. The main source of radioactive air emissions would be the WTP during its operations from 2018 through 2163. The higher dose over the life of the project of the Option Case compared with the Base Case under Alternative 6A is primarily due to excavating the B and T Area cribs and trenches (ditches) and processing the contaminated soil in the PPF. The year of maximum impact would be 2163, with a population dose of 280 person-rem and an MEI dose of 8.6 millirem.

Table 4–36. Tank Closure Alternative 6A, Option Case, Normal Operations Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
		Dose (person-rem)	Number of Latent Cancer Fatalities[b]	Year of Maximum Impact	Dose (person-rem per year)	Number of Latent Cancer Fatalities[b]
General population	WTP	1,700			280	
	200-East Area	45			0.052	
	200-West Area	45			0.050	
	Total	**1,800**	**1 (1)**	**2163**	**280**	**0 (2×10^{-1})**
Maximally exposed individual		Dose[c] (millirem)	Lifetime Risk of a Latent Cancer Fatality[d]	Year of Maximum Impact	Dose (millirem per year)	Lifetime Risk of a Latent Cancer Fatality[d]
	WTP	45			8.5	
	200-East Area	5.0			0.0056	
	200-West Area	3.1			0.0033	
	Total	**53**	**3×10^{-5}**	**2163**	**8.6**	**5×10^{-6}**
Onsite MEI	**Total**	**15**	**9×10^{-6}**	**2163**	**1.4**	**8×10^{-7}**

a Impacts accrued over the operational life of the project analyzed in this alternative.

b The reported value is the projected number of latent cancer fatalities (LCFs) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses (see Appendix K, Section K.1.1.6).

c Impacts are provided for comparison to other alternatives. The life-of-project dose would not be received by one individual person due to the duration of this alternative. The MEI dose from 70 years of exposure at the average dose rate would be 23 millirem, with a corresponding lifetime risk of an LCF of 1×10^{-5}; the onsite MEI dose from 40 years of exposure would be 3.7 millirem, with a lifetime LCF risk of 2×10^{-6}.

d Probability of an LCF in the MEI is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.2.1.

An onsite MEI who spends a normal workday at US Ecology would receive a maximum annual dose of 1.4 millirem. The increased risk of an LCF from this dose would be 8×10^{-7} (1 chance in 1.3 million).

4.1.10.9.2 Radiological Impacts on Workers

4.1.10.9.2.1 Base Case

Table 4–37 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 420 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a cumulative dose of 17,000 millirem, corresponding to a risk of 1×10^{-2} (1 chance in 100) of developing an LCF. The high average FTE worker dose would be due to exhumation of the tank farms and underlying contaminated soils. As noted in Section 4.1.10, work would be controlled in accordance with regulations and worker protection practices to maintain worker doses below established limits so an actual worker would not receive the doses calculated for the average FTE worker.

Table 4–37. Tank Closure Alternative 6A, Base Case, Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	420 millirem	2×10^{-4}
Impact over life of project[b]	17,000 millirem	1×10^{-2}
Life-of-Project Worker Population	120,000 person-rem	72
Noninvolved Worker (Year[s] of Maximum Impact)		
At the 242-A Evaporator (2163)	3.0 millirem	2×10^{-6}
At the Environmental Restoration Disposal Facility (2054–2061)	0.93 millirem	6×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.1.

The total effective dose equivalent to the involved worker population from the 161 years of occupational exposure under this alternative was estimated to be 120,000 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem to this population dose yields an estimate of 72 LCFs. This number should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit worker dose, as discussed in Section 4.1.10. A large contributor to the collective worker dose (38,000 person-rem, or 32 percent) under this alternative would be the WTP's 146 years of operation. Other large contributors to collective worker dose (69,000 person-rem, or 58 percent) would be PPF operations and deep soil removal from the T, TX, and SX tank farms.

Estimated doses and risks to noninvolved workers at the 242-A Evaporator and the ERDF in the years of maximum impact are shown in Table 4–37. Doses to noninvolved workers would be a small fraction of the DOE-recommended Administrative Control Level of 500 millirem per year.

4.1.10.9.2.2 Option Case

Table 4–38 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 400 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a cumulative dose of 16,000 millirem, corresponding to a risk of 1×10^{-2} (1 chance in 100) of developing an LCF. The high average FTE worker dose would be due to exhumation of the tank farms and underlying contaminated soils. Although exhuming the B and T Area cribs and trenches (ditches) would add to the collective worker dose, the associated dose rate for this work would be comparatively low, thus lowering the average FTE worker dose. As noted in Section 4.1.10, work would be controlled in accordance with regulations and worker protection practices to maintain worker doses below established limits so an actual worker would not receive the doses calculated for the average FTE worker.

Table 4–38. Tank Closure Alternative 6A, Option Case, Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	400 millirem	2×10^{-4}
Impact over life of project[b]	16,000 millirem	1×10^{-2}
Life-of-Project Worker Population	120,000 person-rem	75
Noninvolved Worker (Year[s] of Maximum Impact)		
At the 242-A Evaporator (2163)	3.0 millirem	2×10^{-6}
At the Environmental Restoration Disposal Facility (2138–2140)	0.96 millirem	6×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.1.

The total effective dose equivalent to the involved worker population from the 161 years of occupational exposure under this alternative was estimated to be 120,000 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem to this population dose yields an estimate of 75 LCFs. This number should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit worker dose, as discussed in Section 4.1.10. A large contributor to the collective worker dose (38,000 person-rem, or 32 percent) under this alternative would be the WTP's 146 years of operation. Other large contributors to collective worker dose (73,000 person-rem, or 61 percent) would be PPF operations and deep soil removal from the T, TX, and SX tank farms.

Estimated doses and risks to noninvolved workers at the 242-A Evaporator and the ERDF in the years of maximum impact are shown in Table 4–38. Doses to noninvolved workers would be a small fraction of the DOE-recommended Administrative Control Level of 500 millirem per year.

4.1.10.10 Alternative 6B: All Vitrification with Separations; Clean Closure

4.1.10.10.1 Radiological Impacts on the Public

4.1.10.10.1.1 Base Case

Table 4–39 presents estimated doses to the general population and the MEI under Alternative 6B, Base Case. Activities that would generate radioactive air emissions would occur from 2006 through 2100. Due to the long timeframe involved, the doses over the life of the project would not be received by the same members of the population or the same MEI, but are presented to provide a basis for comparison with other alternatives.

Table 4–39. Tank Closure Alternative 6B, Base Case, Normal Operations Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
		Dose (person-rem)	**Number of Latent Cancer Fatalities[b]**	**Year of Maximum Impact**	**Dose (person-rem per year)**	**Number of Latent Cancer Fatalities[b]**
General population	WTP	1,600			320	
	200-East Area	33			0.50	
	200-West Area	34			0.47	
	Total	**1,700**	**1 (1)**	**2040**	**320**	**0 (2×10^{-1})**
Maximally exposed individual		**Dose[c] (millirem)**	**Lifetime Risk of a Latent Cancer Fatality[d]**	**Year of Maximum Impact**	**Dose (millirem per year)**	**Lifetime Risk of a Latent Cancer Fatality[d]**
	WTP	42			9.7	
	200-East Area	3.8			0.060	
	200-West Area	2.3			0.033	
	Total	**49**	**3×10^{-5}**	**2040**	**9.8**	**6×10^{-6}**
Onsite MEI	**Total**	**12**	**7×10^{-6}**	**2040**	**1.7**	**1×10^{-6}**

[a] Impacts accrued over the operational life of the project analyzed in this alternative.

[b] The reported value is the projected number of latent cancer fatalities (LCFs) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses (see Appendix K, Section K.1.1.6).

[c] Impacts are provided for comparison to other alternatives. The life-of-project dose would not be received by one individual person due to the duration of this alternative. The MEI dose from 70 years of exposure at the average dose rate would be 36 millirem, with a corresponding lifetime risk of an LCF of 2×10^{-5}; the onsite MEI dose from 40 years of exposure would be 5.1 millirem, with a lifetime LCF risk of 3×10^{-6}.

[d] Probability of an LCF in the MEI is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.2.1.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 1,700 person-rem, and the MEI would receive a dose of 49 millirem. One LCF is expected in the general population as a result of this alternative. There would be a probability of 3×10^{-5} (1 chance in 33,000) of the MEI developing an LCF. The main source of the doses would be radioactive air emissions from the WTP during its operations from 2018 through 2043. The year of maximum impact would be 2040, with a population dose of 320 person-rem and an MEI dose of 9.8 millirem.

An onsite MEI who spends a normal workday at US Ecology would receive a maximum annual dose of 1.7 millirem. The increased risk of an LCF from this dose would be 1×10^{-6} (1 chance in 1 million).

4.1.10.10.1.2 Option Case

Table 4–40 presents estimated doses to the general population and the MEI for the Alternative 6B, Option Case. Activities that would have radioactive air emissions would occur from 2006 through 2100. Due to the long timeframe involved, the doses over the life of the project would not be received by the same members of the population or the same MEI, but are presented to provide a basis for comparison with other alternatives.

Table 4–40. Tank Closure Alternative 6B, Option Case, Normal Operations Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
		Dose (person-rem)	**Number of Latent Cancer Fatalities[b]**	**Year of Maximum Impact**	**Dose (person-rem per year)**	**Number of Latent Cancer Fatalities[b]**
General population	WTP	1,600			320	
	200-East Area	42			0.65	
	200-West Area	42			0.57	
	Total	**1,700**	**1 (1)**	**2040**	**320**	**0 (2×10^{-1})**
		Dose[c] (millirem)	**Lifetime Risk of a Latent Cancer Fatality[d]**	**Year of Maximum Impact**	**Dose (millirem per year)**	**Lifetime Risk of a Latent Cancer Fatality[d]**
Maximally exposed individual	WTP	42			9.7	
	200-East Area	4.7			0.075	
	200-West Area	2.9			0.039	
	Total	**50**	**3×10^{-5}**	**2040**	**9.8**	**6×10^{-6}**
Onsite MEI	**Total**	**15**	**9×10^{-6}**	**2040**	**1.7**	**1×10^{-6}**

[a] Impacts accrued over the operational life of the project analyzed in this alternative.

[b] The reported value is the projected number of latent cancer fatalities (LCFs) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses (see Appendix K, Section K.1.1.6).

[c] Impacts are provided for comparison to other alternatives. The life-of-project dose would not be received by one individual person due to the duration of this alternative. The MEI dose from 70 years of exposure at the average dose rate would be 37 millirem, with a corresponding lifetime risk of an LCF of 2×10^{-5}; the onsite MEI dose from 40 years of exposure would be 6.2 millirem, with a lifetime LCF risk of 4×10^{-6}.

[d] Probability of an LCF in the MEI is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.2.1.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 1,700 person-rem, and the MEI would receive a dose of 50 millirem. One LCF is expected in the general population as a result of this alternative. There would be a probability of 3×10^{-5} (1 chance in 33,000) of the MEI developing an LCF. The main source of the doses would be radioactive air emissions from the WTP during its operations from 2018 through 2043. The higher dose over the life of the project of the Option Case compared with that of the Base Case under Alternative 6B is primarily due to excavating the B and T Area cribs and trenches (ditches) and processing the contaminated soil in the PPF. The year of maximum impact would be 2040, with a population dose of 320 person-rem and an MEI dose of 9.8 millirem.

An onsite MEI who spends a normal workday at US Ecology would receive a maximum annual dose of 1.7 millirem. The increased risk of an LCF from this dose would be 1×10^{-6} (1 chance in 1 million).

4.1.10.10.2 Radiological Impacts on Workers

4.1.10.10.2.1 Base Case

Table 4–41 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 890 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a cumulative dose of 36,000 millirem, corresponding to a risk of 2×10^{-2} (1 chance in 50) of developing an LCF. The high average FTE worker dose would be due to exhumation of tank farms and underlying contaminated soils. The average FTE worker dose would be higher under Alternative 6B, Base and Option Cases, than under Alternative 6A, Base and Option Cases, because of the shorter duration of the project. Activities with lower average dose rates under Alternative 6A go on for a much longer time; the effect is a lower average dose across the entire project. As noted in Section 4.1.10, work would be controlled in accordance with regulations and worker protection practices to maintain worker doses below established limits so an actual worker would not receive the doses calculated for the average FTE worker.

Table 4–41. Tank Closure Alternative 6B, Base Case, Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	890 millirem	5×10^{-4}
Impact over life of project[b]	36,000 millirem	2×10^{-2}
Life-of-Project Worker Population	82,000 person-rem	49
Noninvolved Worker (Year of Maximum Impact)		
At the 242-A Evaporator (2040)	3.5 millirem	2×10^{-6}
At the Environmental Restoration Disposal Facility (2040)	1.4 millirem	9×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.1.

The total effective dose equivalent to the involved worker population from the 96 years of occupational exposure under this alternative was estimated to be 82,000 person-rem. The lower collective worker dose under Alternative 6B (both cases) compared with that under Alternative 6A would primarily be due to the shorter period of WTP and routine tank farm operations. Applying the risk factor of 0.0006 LCFs per person-rem to this population dose yields an estimate of 49 LCFs. This number should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit worker dose, as discussed in Section 4.1.10. Large contributors to the worker population dose under this alternative (69,000 person-rem, or 84 percent) would be PPF operations and deep soil removal from the T, TX, and SX tank farms.

Estimated doses and risks to noninvolved workers at the 242-A Evaporator and the ERDF in the years of maximum impact are shown in Table 4–41. Doses to noninvolved workers would be a small fraction of the DOE-recommended Administrative Control Level of 500 millirem per year.

4.1.10.10.2.2 Option Case

Table 4–42 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 800 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a cumulative dose of 32,000 millirem, corresponding to a risk of 2×10^{-2} (1 chance in 50) of developing an LCF. The high average FTE worker dose would be due to exhumation of the tank farms and underlying contaminated soils. Although exhuming the B and T Area cribs and trenches (ditches) would add to the collective worker dose, the associated dose rate for this work would be comparatively low, thus lowering the average FTE worker dose. As noted in Section 4.1.10, work would be controlled in accordance with regulations and worker protection practices to maintain worker doses below established limits so an actual worker would not receive the doses calculated for the average FTE worker.

Table 4–42. Tank Closure, Alternative 6B, Option Case, Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	800 millirem	5×10^{-4}
Impact over life of project[b]	32,000 millirem	2×10^{-2}
Life-of-Project Worker Population	85,000 person-rem	51
Noninvolved Worker (Year of Maximum Impact)		
At the 242-A Evaporator (2040)	3.6 millirem	2×10^{-6}
At the Environmental Restoration Disposal Facility (2040)	1.7 millirem	1×10^{-6}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.1.

The total effective dose equivalent to the involved worker population from the 96 years of occupational exposure under this alternative was estimated to be 85,000 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem to this population dose yields an estimate of 51 LCFs. This number should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit individual worker dose, as discussed in Section 4.1.10. Large contributors to the worker population dose under this alternative (71,000 person-rem, or 84 percent) would be PPF operations and deep soil removal from the T, SX, and TX tank farms.

Estimated doses and risks to noninvolved workers at the 242-A Evaporator and the ERDF in the years of maximum impact are shown in Table 4–42. Doses to noninvolved workers would be a small fraction of the DOE-recommended Administrative Control Level of 500 millirem per year.

4.1.10.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

4.1.10.11.1 Radiological Impacts on the Public

Table 4–43 presents estimated doses to the general population and the MEI under Alternative 6C. Activities that would generate radioactive air emissions would occur from 2006 through 2045.

Table 4–43. Tank Closure Alternative 6C Normal Operations Public Health Impacts of Atmospheric Radionuclide Releases

Receptor	Facility	Impacts over Life of Project[a]		Peak Annual Impacts		
		Dose (person-rem)	**Number of Latent Cancer Fatalities[b]**	**Year of Maximum Impact**	**Dose (person-rem per year)**	**Number of Latent Cancer Fatalities[b]**
General population	WTP	1,600			320	
	200-East Area	0.93			0.026	
	200-West Area	0.91			0.025	
	Total	**1,600**	**1 (1)**	**2040**	**320**	**0 (2×10^{-1})**
		Dose (millirem)	**Lifetime Risk of a Latent Cancer Fatality[c]**	**Year of Maximum Impact**	**Dose (millirem per year)**	**Lifetime Risk of a Latent Cancer Fatality[c]**
Maximally exposed individual	WTP	42			9.7	
	200-East Area	0.11			0.0030	
	200-West Area	0.063			0.0017	
	Total	**43**	**3×10^{-5}**	**2040**	**9.7**	**6×10^{-6}**
Onsite MEI	**Total**	**9.1**	**5×10^{-6}**	**2040**	**1.6**	**1×10^{-6}**

a Impacts accrued over the operational life of the project analyzed in this alternative.

b The reported value is the projected number of latent cancer fatalities (LCFs) among the population and is therefore presented as a whole number. The result, calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem), is shown in parentheses (see Appendix K, Section K.1.1.6).

c Probability of an LCF in the maximally exposed individual is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: MEI=maximally exposed individual; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.2.1.

Over the life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 1,600 person-rem, and the MEI would receive a dose of 43 millirem. Given the risk factor of 0.0006 LCFs per rem (DOE 2003h), 1 LCF is expected in the general population as a result of this alternative. There would be a probability of 3×10^{-5} (1 chance in 33,000) of the MEI developing an LCF. The main source of radioactive air emissions would be the WTP during its operations from 2018 through 2043. The year of maximum impact would be 2040, with a population dose of 320 person-rem and an MEI dose of 9.7 millirem.

An onsite MEI who spends a normal workday at US Ecology would receive a maximum annual dose of 1.6 millirem. The increased risk of an LCF from this dose would be 1×10^{-6} (1 chance in 1 million).

4.1.10.11.2 Radiological Impacts on Workers

Table 4–44 presents dose and risk estimates for an involved FTE worker and a noninvolved FTE worker. The average annual FTE radiation worker dose would be 160 millirem, lower than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over the course of 40 years would receive a cumulative dose of 6,400 millirem, corresponding to a risk of 4×10^{-3} (1 chance in 250) of developing an LCF.

The total effective dose equivalent to the involved worker population from the 41 years of occupational exposure under this alternative was estimated to be 11,000 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem to this population dose yields an estimate of 7 LCFs. This number should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit worker dose, as discussed in Section 4.1.10. The largest contributor to the worker population dose under this alternative (6,300 person-rem, or 57 percent) is associated with operations at the WTP.

Table 4–44. Tank Closure Alternative 6C Normal Operations Radiological Impacts on Workers

Receptor	Dose	Latent Cancer Fatality Risk[a]
Average Involved Full-Time-Equivalent Worker		
Average annual impact	160 millirem	1×10^{-4}
Impact over life of project[b]	6,400 millirem	4×10^{-3}
Life-of-Project Worker Population	11,000 person-rem	7
Noninvolved Worker (Year of Maximum Impact)		
At the 242-A Evaporator (2040)	3.4 millirem	2×10^{-6}
At the Environmental Restoration Disposal Facility (2040)	1.1 millirem	7×10^{-7}

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).

[b] Impact over the life of the project is the average dose a full-time-equivalent radiation worker would receive working on this project. It is determined by multiplying the average annual dose by an assumed career length of 40 years.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.1.

Estimated doses and risks to noninvolved workers at the 242-A Evaporator and the ERDF in the year of maximum impact are shown in Table 4–44. Doses to noninvolved workers would be a small fraction of the DOE-recommended Administrative Control Level of 500 millirem per year.

4.1.10.12 Worker Chemical Risks

Workers involved in performing activities associated with the storage, retrieval, and processing of tank waste and the closure of tank farm facilities could be exposed to chemical vapors. Chemical exposure is a concern because the tanks are continuously vented to the atmosphere, and workers would need to access parts of the tank farm system to monitor or retrieve the waste. The primary route of chemical exposure to workers during routine operations was assumed to be inhalation.

Estimates of worker exposure to chemicals and resulting health effects are highly dependent on the modeling assumptions used. If a worker is assumed to be very close to the chemical emission point, the predicted consequences might vary from zero to extreme (severe, irreversible health effects), depending on the assumed duration of the release and exposure and the location of the worker with respect to the emission point and wind direction. Therefore, no attempt was made to estimate involved worker exposure to chemical releases associated with routine operations.

Based on historical reports of effects of tank farm exposures, workers exposed to tank farm vapors during waste retrieval, waste treatment, and tank closure activities could experience headaches, burning sensations in the nose and throat, nausea, and impaired pulmonary function. Past experience implies that if these impacts were experienced, they would be transient and would have no long-lasting deleterious effects. To avoid this potential health risk, workers in certain areas of the tank farms would be required to use supplied-air respirators. Through compliance with applicable requirements and the scrutiny provided by internal and external review of chemical exposure issues, it is expected that involved worker exposure would be maintained below the thresholds identified by the Occupational Safety and Health Administration and the American Conference of Governmental Industrial Hygienists.

4.1.11 Public and Occupational Health and Safety—Facility Accidents

This section addresses potential impacts on workers and the public associated with accidents that may occur under the alternatives. For each alternative, radiological impacts of postulated accident scenarios were quantified for an MEI living near Hanford, the offsite population living within 80 kilometers (50 miles) of the facility, and a noninvolved worker assumed to be 100 meters (110 yards) from the facility. Hazardous chemical impacts were also evaluated. For an involved worker, accident consequences were not quantified. While involved workers are expected to be near the Hanford tank farms during routine tank farm operations, as is the case under Tank Closure Alternative 1: No Action, or in the WTP or other waste treatment facilities during facility operations, their number and location relative to a postulated accident are unknown. In the event of an accident involving chemicals or radioactive materials, workers near an accident could be at risk of serious injury or fatality. Safety procedures, safety equipment, and protective barriers are typical features that would prevent or minimize worker impacts. Additionally, following initiation of accident/site emergency alarms, workers in adjacent areas of the facility would evacuate in accordance with the technical area and facility emergency operating procedures and training. Therefore, involved worker impacts are not discussed further relative to the alternatives. The impacts of selected intentional acts of destruction scenarios are addressed in Appendix K, Section K.3.11.

There would be no radiological accidents associated with facility construction, including construction of the WTP, under any action alternative. Further, any hazardous chemical accidents associated with facility construction would be typical of those normally associated with industrial construction materials, hazards, and practices. Projected operational accident consequences of each alternative are presented in the following sections. Details of the methodology for assessing the potential impacts on workers and the public associated with postulated accidents are presented in Appendix K, Section K.3.

4.1.11.1 Alternative 1: No Action

4.1.11.1.1 Radiological Impacts of Airborne Releases

Under Tank Closure Alternative 1, reasonably foreseeable accidents that could occur include (1) hydrogen burn in a waste storage tank and (2) tank dome collapse. The accident selected to represent a severe accident is the seismically induced waste tank dome collapse.

The consequences of a seismically induced waste tank dome collapse, if it were to occur, are shown in Table 4–45. The annual risks of LCFs for this accident, which were obtained by multiplying the consequences by the likelihood (frequency per year) that the accident would occur, are shown in Table 4–46.

Table 4–45. Tank Closure Alternative 1 Radiological Consequences of Accidents

Accident[a]	Maximally Exposed Individual		Offsite Population[c]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[b]
Seismically induced waste tank dome collapse – unmitigated (TK53)	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}

a The alphanumeric code following the accident's title (i.e., TK53) corresponds with the code in the accident's description in Appendix K, Section K.3.4.
b Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.
c Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area (see Appendix K, Section K.2.1.1.3.2).
d The reported value is the projected number of latent cancer fatalities (LCFs) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).
Key: LCF=latent cancer fatality.
Source: Appendix K, Section K.3.7.1.

Table 4–46. Tank Closure Alternative 1 Annual Cancer Risks from Accidents

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality		
		Maximally Exposed Individual[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}

a The alphanumeric code following the accident's title (i.e., TK53) corresponds with the code in the accident's description in Appendix K, Section K.3.4.
b Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.
c Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area (see Appendix K, Section K.2.1.1.3.2).
d The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).
Source: Appendix K, Section K.3.7.1.

4.1.11.1.2 Hazardous Chemical Impacts

Various hazardous chemicals exist in the waste tanks. Because the chemicals that exist in the tank waste are mixed with the radioactive material, any accident event is expected to release both hazardous chemicals and radioactive materials. Due to the quantity and nature of the radioactive material in the waste tanks, the human health consequences of an accidental release would be dominated by the impacts of the radioactive components. Therefore, hazardous chemical human health impacts were not analyzed separately.

4.1.11.2 Alternative 2A: Existing WTP Vitrification; No Closure

4.1.11.2.1 Radiological Impacts of Airborne Releases

Table 4–47 shows the consequences of the postulated set of accidents for the MEI, the general population (the offsite population within 80 kilometers [50 miles]), and a noninvolved worker. The consequences are the projected impacts assuming the accident occurs. Table 4–48 shows the accident risks, which were obtained by multiplying each accident's consequences by the likelihood (frequency per year) that the accident would occur. The accidents listed in these tables were selected from a spectrum of accidents described in Appendix K, Section K.3. The selection process ensures that the accidents chosen for evaluation in this EIS represent the range of impacts of reasonably foreseeable accidents that could occur at the facilities. Thus, if any other accident not evaluated in this EIS were to occur, its impacts on workers and the public should be within the range of the impacts evaluated.

Table 4–47. Tank Closure Alternative 2A Radiological Consequences of Accidents

Accident[a]	Maximally Exposed Individual		Offsite Population[c]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	0.0013	8×10^{-7}	7.6	0 (4×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	0.0070	4×10^{-6}	120	0 (7×10^{-2})	24	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	0.88	5×10^{-4}	15,000	9	2,900	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	0.011	7×10^{-6}	200	0 (1×10^{-1})	33	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	0.019	1×10^{-5}	320	0 (2×10^{-1})	63	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	0.000014	9×10^{-9}	0.25	0 (1×10^{-4})	0.043	3×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	4.3	3×10^{-3}	75,000	5×10^{1}	13,000	1
Seismically induced waste tank dome collapse – unmitigated (TK53)	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	0.00026	2×10^{-7}	4.6	0 (3×10^{-3})	0.91	5×10^{-4}

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b Increased likelihood of a latent cancer fatality, assuming the accident occurs, except at high individual doses (hundreds of rem or more), where acute radiation injury may cause death within weeks. Value cannot exceed 1.

c Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

d The reported value is the projected number of latent cancer fatalities (LCFs) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

Table 4–48. Tank Closure Alternative 2A Annual Cancer Risks from Accidents

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality: Maximally Exposed Individual[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	5×10^{-4}	4×10^{-12}	0 (7×10^{-8})	1×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

c Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

d The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

The accident with the highest radiological risk to the offsite population and onsite workers (see Table 4–48) is the seismically induced WTP collapse and failure (accident WT41). Taking the likelihood of this accident into account, the increased risk of a single LCF occurring in the offsite population would be 2×10^{-2} per year (about 1 chance in 50 per year). For the offsite MEI, the increased risk of an LCF would be 1×10^{-6} per year (about 1 chance in 770,000 per year). For a noninvolved worker, the increased risk of an LCF would be 8×10^{-3} per year (about 1 chance in 130 per year). For any involved or noninvolved worker closer than 100 meters (110 yards) to the accident's location, the exposure to radioactivity and risk of developing an LCF would depend on the distance and other factors, but generally would be higher. If this accident were to occur, it would have the highest consequences (see Table 4–47).

4.1.11.2.2 Hazardous Chemical Impacts

Various hazardous chemicals exist in the waste tanks, and others are used in the tank closure and waste treatment processes. The chemicals that exist in the tank waste are mixed with the radioactive material; thus, any accident event is expected to release both hazardous chemicals and radioactive materials. Due to the quantity and nature of the radioactive material in the waste tanks, the human health consequences of an accidental release would be dominated by the impacts of the radioactive components. Therefore, hazardous chemical human health impacts of concern are primarily associated with the tank closure and waste treatment processes.

Two chemicals used in the WTP processes, nitric acid and ammonia, whose impacts are considered representative of the impacts that may result from the accidental release of any other chemical associated with the tank closure and treatment processes, have been selected for accident analysis. The selection of these two chemicals is based on their large inventories, potential for release, chemical properties, and human health effects. For both chemicals, an accident scenario is postulated in which a break in a tank or piping occurs, allowing the chemical to be released over a short period. The cause of the break could be mechanical failure, corrosion, mechanical impact, malevolent act, or natural phenomenon. The frequency of these types of events is in the range of 0.001 to 0.01 per year. The nitric acid pools within a berm surrounding the storage tank and evaporates, forming a plume that disperses into the environment. Ammonia is stored as a liquid under pressure and is released from its storage tank in a gaseous form. In both cases, the plume moves away from the point of release in the direction of the prevailing wind and potentially impacts workers and the public.

Table 4–49 shows the estimated concentrations of each chemical at specified distances for comparison with the 60-minute Acute Exposure Guideline Levels (AEGLs) 2 and 3 (EPA 2007). The levels of concern for ammonia are 160 ppm for AEGL-2 and 1,100 ppm for AEGL-3. The levels of concern for nitric acid are 24 ppm for AEGL-2 and 92 ppm for AEGL-3. The results indicate that AEGL-2 and AEGL-3 thresholds are not exceeded beyond the nearest site boundary. For the noninvolved worker 100 meters (110 yards) from the accident, both the AEGL-2 and AEGL-3 thresholds would be exceeded for the ammonia release, but not for the nitric acid release.

Table 4–49. Tank Closure Alternatives Chemical Impacts of Accidents

Chemical	Quantity Released (liters)	AEGL-2[a]		AEGL-3[b]		Concentration (ppm)	
		Limit (ppm)	Distance to Limit (meters)	Limit (ppm)	Distance to Limit (meters)	Noninvolved Worker at 100 meters	Nearest Site Boundary at 8,600 meters
Ammonia	43,500	160	2,450	1,100	730	41,000	27.0
Nitric acid	64,400	24	<30	92	<30	4.7	0.004

[a] AEGL-2 is the airborne concentration (expressed as ppm or milligrams per cubic meter) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting, adverse health effects or an impaired ability to escape (EPA 2007).

[b] AEGL-3 is the airborne concentration (expressed as ppm or milligrams per cubic meters) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death (EPA 2007).

Note: To convert liters to gallons, multiply by 0.26417; meters to yards, by 1.0936.

Key: AEGL=Acute Exposure Guideline Level; ppm=parts per million.

Source: Appendix K, Section K.3.9.1.

4.1.11.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

4.1.11.3.1 Radiological Impacts of Airborne Releases

Table 4–50 shows the consequences of the postulated set of accidents for the MEI, the general population, and a noninvolved worker. The consequences are the projected impacts assuming the accident occurs. Table 4–51 shows the accident risks, which were obtained by multiplying each accident's consequences by the likelihood (frequency per year) that the accident would occur. The accidents listed in these tables were selected from a spectrum of accidents described in Appendix K, Section K.3. The selection process ensures that the accidents chosen for evaluation in this EIS represent the range of impacts of reasonably foreseeable accidents that could occur at the facilities. Thus, if any other accident not evaluated in this EIS were to occur, its impacts on workers and the public should be within the range of the impacts evaluated.

Table 4–50. Tank Closure Alternative 2B Radiological Consequences of Accidents

Accident[a]	Maximally Exposed Individual		Offsite Population[c]		Noninvolved Worker	
	Dose (rem)	**LCF[b]**	**Dose (person-rem)**	**LCF[d]**	**Dose (rem)**	**LCF[b]**
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	0.0013	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	0.0070	4×10^{-6}	120	0 (7×10^{-2})	24	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	0.88	5×10^{-4}	15,000	9	2,900	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	0.011	7×10^{-6}	200	0 (1×10^{-1})	33	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	0.019	1×10^{-5}	320	0 (2×10^{-1})	63	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (90 MTG/day)	0.000043	3×10^{-8}	0.74	0 (4×10^{-4})	0.13	8×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×90 MTG/day)	4.3	3×10^{-3}	75,000	5×10^{1}	13,000	1
Seismically induced waste tank dome collapse – unmitigated (TK53)	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	0.00026	2×10^{-7}	4.6	0 (3×10^{-3})	0.91	5×10^{-4}

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b Increased likelihood of a latent cancer fatality, assuming the accident occurs, except at high individual doses (hundreds of rem or more), where acute radiation injury may cause death within weeks. Value cannot exceed 1.

c Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

d The reported value is the projected number of latent cancer fatalities (LCFs) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatalities; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

Table 4–51. Tank Closure Alternative 2B Annual Cancer Risks from Accidents

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality		
		Maximally Exposed Individual[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (90 MTG/day)	5×10^{-4}	1×10^{-11}	0 (2×10^{-7})	4×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×90 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

[c] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[d] The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

The accident with the highest radiological risk to the offsite population and onsite workers (see Table 4–51) is the seismically induced WTP collapse and failure (accident WT41). Taking the likelihood of this accident into account, the increased risk of a single LCF occurring in the offsite population would be 2×10^{-2} per year (about 1 chance in 50 per year). For the offsite MEI, the increased risk of an LCF would be 1×10^{-6} per year (about 1 chance in 770,000 per year). For a noninvolved worker, the increased risk of an LCF would be 8×10^{-3} per year (about 1 chance in 130 per year). For any involved or noninvolved worker closer than 100 meters (110 yards) to the accident's location, the exposure to radioactivity and risk of developing an LCF would depend on the distance and other factors, but generally would be higher. If this accident were to occur, it would have the highest consequences (see Table 4–50).

4.1.11.3.2 Hazardous Chemical Impacts

Potential human health impacts of postulated chemical release scenarios are expected to be the same as those described under Tank Closure Alternative 2A in Section 4.1.11.2.2.

4.1.11.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

4.1.11.4.1 Radiological Impacts of Airborne Releases

Table 4–52 shows the consequences of the postulated set of accidents for the MEI, the general population, and a noninvolved worker. The consequences are the projected impacts assuming the accident occurs. Table 4–53 shows the accident risks, which were obtained by multiplying each accident's consequences by the likelihood (frequency per year) that the accident would occur. The accidents listed in these tables were selected from a spectrum of accidents described in Appendix K, Section K.3. The selection process ensures that the accidents chosen for evaluation in this EIS represent the range of impacts of reasonably foreseeable accidents that could occur at the facilities. Thus, if any other accident not evaluated in this EIS were to occur, its impacts on workers and the public should be within the range of the impacts evaluated.

The accident with the highest radiological risk to the offsite population and onsite workers (see Table 4–53) is the seismically induced WTP collapse and failure (accident WT41). Taking the likelihood of this accident into account, the increased risk of a single LCF occurring in the offsite population would be 2×10^{-2} per year (about 1 chance in 50 per year). For the offsite MEI, the increased risk of an LCF would be 1×10^{-6} per year (about 1 chance in 770,000 per year). For a noninvolved worker, the increased risk of an LCF would be 8×10^{-3} per year (about 1 chance in 130 per year). For any involved or noninvolved worker closer than 100 meters (110 yards) to the accident's location, the exposure to radioactivity and risk of developing an LCF would depend on the distance and other factors, but generally would be higher. If this accident were to occur, it would have the highest consequences (see Table 4–52).

4.1.11.4.2 Hazardous Chemical Impacts

Potential human health impacts of postulated chemical release scenarios are expected to be the same as those described under Tank Closure Alternative 2A in Section 4.1.11.2.2.

Table 4–52. Tank Closure Alternative 3A Radiological Consequences of Accidents

Accident[a]	Maximally Exposed Individual		Offsite Population[c]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	0.0013	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	0.0070	4×10^{-6}	120	0 (7×10^{-2})	24	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	0.88	5×10^{-4}	15,000	9	2,900	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	0.011	7×10^{-6}	200	0 (1×10^{-1})	33	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	0.019	1×10^{-5}	320	0 (2×10^{-1})	63	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	0.000014	9×10^{-9}	0.25	0 (1×10^{-4})	0.043	3×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	4.3	3×10^{-3}	75,000	5×10^{1}	13,000	1
Bulk vitrification waste receipt tank failure – unmitigated (200-East Area) (BV61)	0.000000028	2×10^{-11}	0.00049	0 (3×10^{-7})	0.000083	5×10^{-8}
Bulk vitrification waste receipt tank failure – unmitigated (200-West Area) (BV61)	0.0000035	2×10^{-9}	0.021	0 (1×10^{-5})	0.0032	2×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	0.0000022	1×10^{-9}	0.038	0 (2×10^{-5})	0.0025	1×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	0.0000066	4×10^{-9}	0.040	0 (2×10^{-5})	0.0024	1×10^{-6}
Seismically induced waste tank dome collapse – unmitigated (TK53)	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	0.00026	2×10^{-7}	4.6	0 (3×10^{-3})	0.91	5×10^{-4}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] Increased likelihood of a latent cancer fatality, assuming the accident occurs, except at high individual doses (hundreds of rem or more), where acute radiation injury may cause death within weeks. Value cannot exceed 1.

[c] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[d] The reported value is the projected number of latent cancer fatalities (LCFs) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatalities; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

Table 4–53. Tank Closure Alternative 3A Annual Cancer Risks from Accidents

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality		
		MEI[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	5×10^{-4}	4×10^{-12}	0 (7×10^{-8})	1×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Bulk vitrification waste receipt tank failure – unmitigated (200-East Area) (BV61)	5×10^{-4}	8×10^{-15}	0 (1×10^{-10})	3×10^{-11}
Bulk vitrification waste receipt tank failure – unmitigated (200-West Area) (BV61)	5×10^{-4}	1×10^{-12}	0 (6×10^{-9})	1×10^{-9}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	5×10^{-4}	6×10^{-13}	0 (1×10^{-8})	7×10^{-10}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	5×10^{-4}	2×10^{-12}	0 (1×10^{-8})	7×10^{-10}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

[c] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[d] The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; MEI=maximally exposed individual; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

4.1.11.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

4.1.11.5.1 Radiological Impacts of Airborne Releases

Table 4–54 shows the consequences of the postulated set of accidents for the MEI, the general population, and a noninvolved worker. The consequences are the projected impacts assuming the accident occurs. Table 4–55 shows the accident risks, which were obtained by multiplying each accident's consequences by the likelihood (frequency per year) that the accident would occur. The accidents listed in these tables were selected from a spectrum of accidents described in Appendix K, Section K.3. The selection process ensures that the accidents chosen for evaluation in this EIS represent the range of impacts of reasonably foreseeable accidents that could occur at the facilities. Thus, if any other accident not evaluated in this EIS were to occur, its impacts on workers and the public should be within the range of the impacts evaluated.

Table 4–54. Tank Closure Alternative 3B Radiological Consequences of Accidents

Accident[a]	Maximally Exposed Individual		Offsite Population[c]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	0.0013	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	0.0070	4×10^{-6}	120	0 (7×10^{-2})	24	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	0.88	5×10^{-4}	15,000	9	2,900	1
Seismically induced failure of HLW melter feeder preparation vessels – unmitigated (HL11) (6 MTG/day)	0.011	7×10^{-6}	200	0 (1×10^{-1})	33	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	0.019	1×10^{-5}	320	0 (2×10^{-1})	63	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	0.000014	9×10^{-9}	0.25	0 (1×10^{-4})	0.043	3×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	4.3	3×10^{-3}	75,000	5×10^{1}	13,000	1
Cast stone feed receipt tank failure – unmitigated (200-East Area) (CS71)	0.000000028	2×10^{-11}	0.00049	0 (3×10^{-7})	0.000083	5×10^{-8}
Cast stone feed receipt tank failure – unmitigated (200-West Area) (CS71)	0.0000035	2×10^{-9}	0.021	0 (1×10^{-5})	0.0032	2×10^{-6}
Mixed TRU waste/ MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	0.0000022	1×10^{-9}	0.038	0 (2×10^{-5})	0.0025	1×10^{-6}
Mixed TRU waste/ MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	0.0000066	4×10^{-9}	0.040	0 (2×10^{-5})	0.0024	1×10^{-6}
Seismically induced waste tank dome collapse – unmitigated (TK53)	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	0.00026	2×10^{-7}	4.6	0 (3×10^{-3})	0.91	5×10^{-4}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] Increased likelihood of a latent cancer fatality, assuming the accident occurs, except at high individual doses (hundreds of rem or more), where acute radiation injury may cause death within weeks. Value cannot exceed 1.

[c] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[d] The reported value is the projected number of latent cancer fatalities (LCFs) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

Table 4–55. Tank Closure Alternative 3B Annual Cancer Risks from Accidents

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality		
		MEI[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	$1.1×10^{-2}$	$8×10^{-9}$	0 ($5×10^{-5}$)	$9×10^{-6}$
Spray leak in transfer line during excavation – unmitigated (PT23)	$1×10^{-4}$	$4×10^{-10}$	0 ($7×10^{-6}$)	$3×10^{-6}$
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	$5×10^{-4}$	$3×10^{-7}$	0 ($5×10^{-3}$)	$2×10^{-3}$
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	$5×10^{-4}$	$3×10^{-9}$	0 ($6×10^{-5}$)	$2×10^{-5}$
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	$5×10^{-4}$	$6×10^{-9}$	0 ($1×10^{-4}$)	$4×10^{-5}$
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	$5×10^{-4}$	$4×10^{-12}$	0 ($7×10^{-8}$)	$1×10^{-8}$
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	$5×10^{-4}$	$1×10^{-6}$	0 ($2×10^{-2}$)	$8×10^{-3}$
Cast stone feed receipt tank failure – unmitigated (200-East Area) (CS71)	$5×10^{-4}$	$8×10^{-15}$	0 ($1×10^{-10}$)	$3×10^{-11}$
Cast stone feed receipt tank failure – unmitigated (200-West Area) (CS71)	$5×10^{-4}$	$1×10^{-12}$	0 ($6×10^{-9}$)	$1×10^{-9}$
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	$5×10^{-4}$	$6×10^{-13}$	0 ($1×10^{-8}$)	$7×10^{-10}$
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	$5×10^{-4}$	$2×10^{-12}$	0 ($1×10^{-8}$)	$7×10^{-10}$
Seismically induced waste tank dome collapse – unmitigated (TK53)	$5×10^{-4}$	$6×10^{-11}$	0 ($4×10^{-7}$)	$7×10^{-8}$
IHLW glass canister drop – unmitigated (SH91)	$1×10^{-3}$	$2×10^{-10}$	0 ($3×10^{-6}$)	$5×10^{-7}$

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the scenario's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

c Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

d The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; MEI=maximum exposed individual; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

The accident with the highest radiological risk to the offsite population and onsite workers (see Table 4–55) is the seismically induced WTP collapse and failure (accident WT41). Taking the likelihood of this accident into account, the increased risk of a single LCF occurring in the offsite population would be 2×10^{-2} per year (about 1 chance in 50 per year). For the offsite MEI, the increased risk of an LCF would be 1×10^{-6} per year (about 1 chance in 770,000 per year). For a noninvolved worker, the increased risk of an LCF would be 8×10^{-3} per year (about 1 chance in 130 per year). For any involved or noninvolved worker closer than 100 meters (110 yards) to the accident's location, the exposure to radioactivity and risk of developing an LCF would depend on the distance and other factors, but generally would be higher. If this accident were to occur, it would have the highest consequences (see Table 4–54).

4.1.11.5.2 Hazardous Chemical Impacts

Potential human health impacts of postulated chemical release scenarios are expected to be the same as those described under Tank Closure Alternative 2A in Section 4.1.11.2.2.

4.1.11.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

4.1.11.6.1 Radiological Impacts of Airborne Releases

Table 4–56 shows the consequences of the postulated set of accidents for the MEI, the general population, and a noninvolved worker. The consequences are the projected impacts assuming the accident occurs. Table 4–57 shows the accident risks, which were obtained by multiplying each accident's consequences by the likelihood (frequency per year) that the accident would occur. The accidents listed in these tables were selected from a spectrum of accidents described in Appendix K, Section K.3. The selection process ensures that the accidents chosen for evaluation in this EIS represent the range of impacts of reasonably foreseeable accidents that could occur at the facilities. Thus, if any other accident not evaluated in this EIS were to occur, its impacts on workers and the public should be within the range of the impacts evaluated.

The accident with the highest radiological risk to the offsite population and onsite workers (see Table 4–57) is the seismically induced WTP collapse and failure (accident WT41). Taking the likelihood of this accident into account, the increased risk of a single LCF occurring in the offsite population would be 2×10^{-2} per year (about 1 chance in 50 per year). For the offsite MEI, the increased risk of an LCF would be 1×10^{-6} per year (about 1 chance in 770,000 per year). For a noninvolved worker, the increased risk of an LCF would be 8×10^{-3} per year (about 1 chance in 130 per year). For any involved or noninvolved worker closer than 100 meters (110 yards) to the accident's location, the exposure to radioactivity and risk of developing an LCF would depend on the distance and other factors, but generally would be higher. If this accident were to occur, it would have the highest consequences (see Table 4–56).

Table 4–56. Tank Closure Alternative 3C Radiological Consequences of Accidents

Accident[a]	Maximally Exposed Individual		Offsite Population[c]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	0.0013	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	0.0070	4×10^{-6}	120	0 (7×10^{-2})	24	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	0.88	5×10^{-4}	15,000	9	2,900	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	0.011	7×10^{-6}	200	0 (1×10^{-1})	33	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	0.019	1×10^{-5}	320	0 (2×10^{-1})	63	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	0.000014	9×10^{-9}	0.25	0 (1×10^{-4})	0.043	3×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	4.3	3×10^{-3}	75,000	5×10^{1}	13,000	1
Steam reforming feed receipt tank failure – unmitigated (200-East Area) (SRF1)	0.000000028	2×10^{-11}	0.00049	0 (3×10^{-7})	0.000083	5×10^{-8}
Steam reforming feed receipt tank failure – unmitigated (200-West Area) (SRF1)	0.0000035	2×10^{-9}	0.021	0 (1×10^{-5})	0.0032	2×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	0.0000022	1×10^{-9}	0.038	0 (2×10^{-5})	0.0025	1×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	0.0000066	4×10^{-9}	0.040	0 (2×10^{-5})	0.0024	1×10^{-6}
Seismically induced waste tank dome collapse – unmitigated (TK53)	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	0.00026	2×10^{-7}	4.6	0 (3×10^{-3})	0.91	5×10^{-4}

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b Increased likelihood of a latent cancer fatality, assuming the accident occurs, except at high individual doses (hundreds of rem or more), where acute radiation injury may cause death within weeks. Value cannot exceed 1.

c Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

d The reported value is the projected number of latent cancer fatalities (LCFs) among t he population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatalities; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

Table 4–57. Tank Closure Alternative 3C Annual Cancer Risks from Accidents

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality		
		MEI[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT 23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	5×10^{-4}	4×10^{-12}	0 (7×10^{-8})	1×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Steam reforming feed receipt tank failure – unmitigated (200-East Area) (SRF1)	5×10^{-4}	8×10^{-15}	0 (1×10^{-10})	3×10^{-11}
Steam reforming feed receipt tank failure – unmitigated (200-West Area) (SRF1)	5×10^{-4}	1×10^{-12}	0 (6×10^{-9})	1×10^{-9}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	5×10^{-4}	6×10^{-13}	0 (1×10^{-8})	7×10^{-10}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	5×10^{-4}	2×10^{-12}	0 (1×10^{-8})	7×10^{-10}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b Increased risk of a latent cancer fatality, taking into account the probability (frequency) of the accident.

c Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

d The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; MEI=maximally exposed individual; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

4.1.11.6.2 Hazardous Chemical Impacts

Potential human health impacts of postulated chemical release scenarios are expected to be the same as those described under Tank Closure Alternative 2A in Section 4.1.11.2.2.

4.1.11.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

4.1.11.7.1 Radiological Impacts of Airborne Releases

Table 4–58 shows the consequences of the postulated set of accidents for the MEI, the general population, and a noninvolved worker. The consequences are the projected impacts assuming the accident occurs. Table 4–59 shows the accident risks, which were obtained by multiplying each accident's consequences by the likelihood (frequency per year) that the accident would occur. The accidents listed in these tables were selected from a spectrum of accidents described in Appendix K, Section K.3. The selection process ensures that the accidents chosen for evaluation in this EIS represent the range of impacts of reasonably foreseeable accidents that could occur at the facilities. Thus, if any other accident not evaluated in this EIS were to occur, its impacts on workers and the public should be within the range of the impacts evaluated.

The accident with the highest radiological risk to the offsite population and onsite workers (see Table 4–59) is the seismically induced WTP collapse and failure (accident WT41). Taking the likelihood of this accident into account, the increased risk of a single LCF occurring in the offsite population would be 2×10^{-2} per year (about 1 chance in 50 per year). For the offsite MEI, the increased risk of an LCF would be 1×10^{-6} per year (about 1 chance in 770,000 per year). For a noninvolved worker, the increased risk of an LCF would be 8×10^{-3} per year (about 1 chance in 130 per year). For any involved or noninvolved worker closer than 100 meters (110 yards) to the accident's location, the exposure to radioactivity and risk of developing an LCF would depend on the distance and other factors, but generally would be higher. If this accident were to occur, it would have the highest consequences (see Table 4–58).

4.1.11.7.2 Hazardous Chemical Impacts

Potential human health impacts of postulated chemical release scenarios are expected to be the same as those described under Tank Closure Alternative 2A in Section 4.1.11.2.2.

Table 4–58. Tank Closure Alternative 4 Radiological Consequences of Accidents

Accident[a]	Maximally Exposed Individual		Offsite Population[c]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	0.0013	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	0.0070	4×10^{-6}	120	0 (7×10^{-2})	24	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	0.88	5×10^{-4}	15,000	9	2,900	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	0.011	7×10^{-6}	200	0 (1×10^{-1})	33	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	0.019	1×10^{-5}	320	0 (2×10^{-1})	63	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	0.000014	9×10^{-9}	0.25	0 (1×10^{-4})	0.043	3×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	4.3	3×10^{-3}	75,000	5×10^{1}	13,000	1
Cast stone feed receipt tank failure – unmitigated (200-East Area) (CS71)	0.000000028	2×10^{-11}	0.00049	0 (3×10^{-7})	0.000083	5×10^{-8}
Bulk vitrification waste receipt tank failure – unmitigated (200-West Area) (BV61)	0.0000035	2×10^{-9}	0.021	0 (1×10^{-5})	0.0032	2×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	0.0000022	1×10^{-9}	0.038	0 (2×10^{-5})	0.0025	1×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	0.0000066	4×10^{-9}	0.040	0 (2×10^{-5})	0.0024	1×10^{-6}
Seismically induced waste tank dome collapse – unmitigated (TK53)	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	0.00026	2×10^{-7}	4.6	0 (3×10^{-3})	0.91	5×10^{-4}

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b Increased likelihood of a latent cancer fatality, assuming the accident occurs, except at high individual doses (hundreds of rem or more), where acute radiation injury may cause death within weeks. Value cannot exceed 1.

c Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

d The reported value is the projected number of latent cancer fatalities (LCFs) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatalities; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

Table 4–59. Tank Closure Alternative 4 Annual Cancer Risks from Accidents

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality		
		MEI[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	5×10^{-4}	4×10^{-12}	0 (7×10^{-8})	1×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Cast stone feed receipt tank failure – unmitigated (200-East Area) (CS71)	5×10^{-4}	8×10^{-15}	0 (1×10^{-10})	3×10^{-11}
Bulk vitrification waste receipt tank failure – unmitigated (200-West Area) (BV61)	5×10^{-4}	1×10^{-12}	0 (6×10^{-9})	1×10^{-9}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	5×10^{-4}	6×10^{-13}	0 (1×10^{-8})	7×10^{-10}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	5×10^{-4}	2×10^{-12}	0 (1×10^{-8})	7×10^{-10}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

[c] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[d] The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; MEI=maximally exposed individual; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

4.1.11.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

4.1.11.8.1 Radiological Impacts of Airborne Releases

Table 4–60 shows the consequences of the postulated set of accidents for the MEI, the general population, and a noninvolved worker. The consequences are the projected impacts assuming the accident occurs. Table 4–61 shows the accident risks, which were obtained by multiplying each accident's consequences by the likelihood (frequency per year) that the accident would occur. The accidents listed in these tables were selected from a spectrum of accidents described in Appendix K, Section K.3. The selection process ensures that the accidents chosen for evaluation in this EIS represent the range of impacts of reasonably foreseeable accidents that could occur at the facilities. Thus, if any other accident not evaluated in this EIS were to occur, its impacts on workers and the public should be within the range of the impacts evaluated.

Table 4–60. Tank Closure Alternative 5 Radiological Consequences of Accidents

Accident[a]	Maximally Exposed Individual		Offsite Population[c]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	0.0013	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	0.0070	4×10^{-6}	120	0 (7×10^{-2})	24	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	0.88	5×10^{-4}	15,000	9	2,900	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	0.011	7×10^{-6}	200	0 (1×10^{-1})	33	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	0.019	1×10^{-5}	320	0 (2×10^{-1})	63	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (45 MTG/day)	0.000021	1×10^{-8}	0.37	0 (2×10^{-4})	0.065	4×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×45 MTG/day)	4.3	3×10^{-3}	75,000	5×10^{1}	13,000	1
Cast stone feed receipt tank failure – unmitigated (200-East Area) (CS71)	0.000000028	2×10^{-11}	0.00049	0 (3×10^{-7})	0.000083	5×10^{-8}
Bulk vitrification waste receipt tank failure – unmitigated (200-West Area) (BV61)	0.0000035	2×10^{-9}	0.021	0 (1×10^{-5})	0.0032	2×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	0.0000022	1×10^{-9}	0.038	0 (2×10^{-5})	0.0025	1×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	0.0000066	4×10^{-9}	0.040	0 (2×10^{-5})	0.0024	1×10^{-6}
Seismically induced waste tank dome collapse – unmitigated (TK53)	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	0.00026	2×10^{-7}	4.6	0 (3×10^{-3})	0.91	5×10^{-4}

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b Increased likelihood of a latent cancer fatality, assuming the accident occurs, except at high individual doses (hundreds of rem or more), where acute radiation injury may cause death within weeks. Value cannot exceed 1.

c Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

d The reported value is the projected number of latent cancer fatalities (LCFs) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatalities; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

Table 4–61. Tank Closure Alternative 5 Annual Cancer Risks from Accidents

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality		
		MEI[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (45 MTG/day)	5×10^{-4}	6×10^{-12}	0 (1×10^{-7})	2×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×45 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Cast stone feed receipt tank failure – unmitigated (200-East Area) (CS71)	5×10^{-4}	8×10^{-15}	0 (1×10^{-10})	3×10^{-11}
Bulk vitrification waste receipt tank failure – unmitigated (200-West Area) (BV61)	5×10^{-4}	1×10^{-12}	0 (6×10^{-9})	1×10^{-9}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	5×10^{-4}	6×10^{-13}	0 (1×10^{-8})	7×10^{-10}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	5×10^{-4}	2×10^{-12}	0 (1×10^{-8})	7×10^{-10}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

[c] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[d] The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; MEI=maximally exposed individual; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

The accident with the highest radiological risk to the offsite population and onsite workers (see Table 4–61) is the seismically induced WTP collapse and failure (accident WT41). Taking the likelihood of this accident into account, the increased risk of a single LCF occurring in the offsite population would be 2×10^{-2} per year (about 1 chance in 50 per year). For the offsite MEI, the increased risk of an LCF would be 1×10^{-6} per year (about 1 chance in 770,000 per year). For a noninvolved worker, the increased risk of an LCF would be 8×10^{-3} per year (about 1 chance in 130 per year). For any involved or noninvolved worker closer than 100 meters (110 yards) to the accident's location, the exposure to radioactivity and risk of developing an LCF would depend on the distance and other factors, but generally would be higher. If this accident were to occur, it would have the highest consequences (see Table 4–60).

4.1.11.8.2 Hazardous Chemical Impacts

Potential human health impacts of postulated chemical release scenarios are expected to be the same as those described under Tank Closure Alternative 2A in Section 4.1.11.2.2.

4.1.11.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

4.1.11.9.1 Radiological Impacts of Airborne Releases

4.1.11.9.1.1 Base Case

Table 4–62 shows the consequences of the postulated set of accidents for the MEI, the general population, and a noninvolved worker. The consequences are the projected impacts assuming the accident occurs. Table 4–63 shows the accident risks, which were obtained by multiplying each accident's consequences by the likelihood (frequency per year) that the accident would occur. The accidents listed in these tables were selected from a spectrum of accidents described in Appendix K, Section K.3. The selection process ensures that the accidents chosen for evaluation in this EIS represent the range of impacts of reasonably foreseeable accidents that could occur at the facilities. Thus, if any other accident not evaluated in this EIS were to occur, its impacts on workers and the public should be within the range of the impacts evaluated.

Table 4–62. Tank Closure Alternative 6A Radiological Consequences of Accidents

Accident[a]	Maximally Exposed Individual		Offsite Population[c]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	0.0013	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (15 MTG/day)	0.029	2×10^{-5}	500	0 (3×10^{-1})	83	1×10^{-1}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (15 MTG/day)	0.046	3×10^{-5}	810	0 (5×10^{-1})	160	2×10^{-1}
Seismically induced WTP collapse and failure – unmitigated (WT41) (15×0 MTG/day)	0.058	4×10^{-5}	1,000	0 (6×10^{-1})	180	2×10^{-1}
Seismically induced waste tank dome collapse – unmitigated (TK53)	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	0.00026	2×10^{-7}	4.6	0 (3×10^{-3})	0.91	5×10^{-4}

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b Increased likelihood of a latent cancer fatality, assuming the accident occurs, except at high individual doses (hundreds of rem or more), where acute radiation injury may cause death within weeks. Value cannot exceed 1.

c Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

d The reported value is the projected number of latent cancer fatalities (LCFs) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LCF=latent cancer fatalities; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

Table 4–63. Tank Closure Alternative 6A Annual Cancer Risks from Accidents

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality		
		MEI[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (15 MTG/day)	5×10^{-4}	9×10^{-9}	0 (1×10^{-4})	5×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (15 MTG/day)	5×10^{-4}	1×10^{-8}	0 (2×10^{-4})	9×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (15×0 MTG/day)	5×10^{-4}	2×10^{-8}	0 (3×10^{-4})	1×10^{-4}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

c Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

d The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; MEI=maximally exposed individual; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

The accident with the highest radiological risk to the offsite population and onsite workers (see Table 4–63) is the seismically induced WTP collapse and failure (accident WT41). Taking the likelihood of this accident into account, the increased risk of a single LCF occurring in the offsite population would be 3×10^{-4} per year (about 1 chance in 3,600 per year). For the offsite MEI, the increased risk of an LCF would be 2×10^{-8} per year (about 1 chance in 55 million per year). For a noninvolved worker, the increased risk of an LCF would be 1×10^{-4} per year (about 1 chance in 9,000 per year). For any involved or noninvolved worker closer than 100 meters (110 yards) to the accident's location, the exposure to radioactivity and risk of developing an LCF would depend on the distance and other factors, but generally would be higher. If this accident were to occur, it would have the highest consequences (see Table 4–62).

4.1.11.9.1.2 Option Case

The radiological impacts of accidental airborne releases associated with the Option Case would be the same as those associated with the Base Case.

4.1.11.9.2 Hazardous Chemical Impacts

Potential human health impacts of postulated chemical release scenarios under the Base and Option Cases are expected to be the same as those described under Tank Closure Alternative 2A in Section 4.1.11.2.2.

4.1.11.10 Alternative 6B: All Vitrification with Separations; Clean Closure

4.1.11.10.1 Radiological Impacts of Airborne Releases

4.1.11.10.1.1 Base Case

Table 4–64 shows the consequences of the postulated set of accidents for the MEI, the general population, and a noninvolved worker. The consequences are the projected impacts assuming the accident occurs. Table 4–65 shows the accident risks, which were obtained by multiplying each accident's consequences by the likelihood (frequency per year) that the accident would occur. The accidents listed in these tables were selected from a spectrum of accidents described in Appendix K, Section K.3. The selection process ensures that the accidents chosen for evaluation in this EIS represent the range of impacts of reasonably foreseeable accidents that could occur at the facilities. Thus, if any other accident not evaluated in this EIS were to occur, its impacts on workers and the public should be within the range of the impacts evaluated.

Table 4–64. Tank Closure Alternative 6B Radiological Consequences of Accidents

Accident[a]	Maximally Exposed Individual		Offsite Population[c]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	0.0013	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	0.0070	4×10^{-6}	120	0 (7×10^{-2})	24	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	0.88	5×10^{-4}	15,000	9	2,900	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	0.011	7×10^{-6}	200	0 (1×10^{-1})	33	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	0.019	1×10^{-5}	320	0 (2×10^{-1})	63	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (90 MTG/day)	0.000043	3×10^{-8}	0.74	0 (4×10^{-4})	0.13	8×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×90 MTG/day)	4.3	3×10^{-3}	75,000	5×10^{1}	13,000	1
Seismically induced waste tank dome collapse – unmitigated (TK53)	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	0.00026	2×10^{-7}	4.6	0 (3×10^{-3})	0.91	5×10^{-4}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] Increased likelihood of a latent cancer fatality, assuming the accident occurs, except at high individual doses (hundreds of rem or more), where acute radiation injury may cause death within weeks. Value cannot exceed 1.

[c] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[d] The reported value is the projected number of latent cancer fatalities (LCFs) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatalities; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

The accident with the highest radiological risk to the offsite population and onsite workers (see Table 4–65) is the seismically induced WTP collapse and failure (accident WT41). Taking the likelihood of this accident into account, the increased risk of a single LCF occurring in the offsite population would be 2×10^{-2} per year (about 1 chance in 50 per year). For the offsite MEI, the increased risk of an LCF would be 1×10^{-6} per year (about 1 chance in 770,000 per year). For a noninvolved worker, the increased risk of an LCF would be 8×10^{-3} per year (about 1 chance in 130 per year). For any involved or noninvolved worker closer than 100 meters (110 yards) to the accident's location, the exposure to radioactivity and risk of developing an LCF would depend on the distance and other factors, but generally would be higher. If this accident were to occur, it would have the highest consequences (see Table 4–64).

Table 4–65. Tank Closure Alternative 6B Annual Cancer Risks from Accidents

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality		
		MEI[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (90 MTG/day)	5×10^{-4}	1×10^{-11}	0 (2×10^{-7})	4×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×90 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

c Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

d The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; MEI=maximally exposed individual; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

4.1.11.10.1.2 Option Case

The radiological impacts of accidental airborne releases associated with the Option Case would be the same as those associated with the Base Case.

4.1.11.10.2 Hazardous Chemical Impacts

4.1.11.10.2.1 Base and Option Cases

Potential human health impacts of postulated chemical release scenarios for the Base and Option Cases are expected to be the same as those described under Tank Closure Alternative 2A in Section 4.1.11.2.2.

4.1.11.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

4.1.11.11.1 Radiological Impacts of Airborne Releases

Table 4–66 shows the consequences of the postulated set of accidents for the MEI, the general population, and a noninvolved worker. The consequences are the projected impacts assuming the accident occurs. Table 4–67 shows the accident risks, which were obtained by multiplying each accident's consequences by the likelihood (frequency per year) that the accident would occur. The accidents listed in these tables were selected from a spectrum of accidents described in Appendix K, Section K.3. The selection process ensures that the accidents chosen for evaluation in this EIS represent the range of impacts of reasonably foreseeable accidents that could occur at the facilities. Thus, if any other accident not evaluated in this EIS were to occur, its impacts on workers and the public should be within the range of the impacts evaluated.

The accident with the highest radiological risk to the offsite population and onsite workers (see Table 4–67) is the seismically induced WTP collapse and failure (accident WT41). Taking the likelihood of this accident into account, the increased risk of a single LCF occurring in the offsite population would be 2×10^{-2} per year (about 1 chance in 50 per year). For the offsite MEI, the increased risk of an LCF would be 1×10^{-6} per year (about 1 chance in 770,000 per year). For a noninvolved worker, the increased risk of an LCF would be 8×10^{-3} per year (about 1 chance in 130 per year). For any involved or noninvolved worker closer than 100 meters (110 yards) to the accident's location, the exposure to radioactivity and risk of developing an LCF would depend on the distance and other factors, but generally would be higher. If this accident were to occur, it would have the highest consequences (see Table 4–66).

Table 4–66. Tank Closure Alternative 6C Radiological Consequences of Accidents

Accident[a]	Maximally Exposed Individual		Offsite Population[c]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	0.0013	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	0.0070	4×10^{-6}	120	0 (7×10^{-2})	24	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	0.88	5×10^{-4}	15,000	9	2,900	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	0.011	7×10^{-6}	200	0 (1×10^{-1})	33	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	0.019	1×10^{-5}	320	0 (2×10^{-1})	63	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (90 MTG/day)	0.000043	3×10^{-8}	0.74	0 (4×10^{-4})	0.13	8×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×90 MTG/day)	4.3	3×10^{-3}	75,000	5×10^{1}	13,000	1
Seismically induced waste tank dome collapse – unmitigated (TK53)	0.00021	1×10^{-7}	1.3	0 (8×10^{-4})	0.22	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	0.00026	2×10^{-7}	4.6	0 (3×10^{-3})	0.91	5×10^{-4}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "*Z* by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] Increased likelihood of a latent cancer fatality, assuming the accident occurs, except at high individual doses (hundreds of rem or more), where acute radiation injury may cause death within weeks. Value cannot exceed 1.

[c] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[d] The reported value is the projected number of latent cancer fatalities (LCFs) among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatalities; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

Table 4–67. Tank Closure Alternative 6C Annual Cancer Risks from Accidents

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality		
		MEI[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (90 MTG/day)	5×10^{-4}	1×10^{-11}	0 (2×10^{-7})	4×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×90 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Appendix K, Section K.3.4. The term "*Z*×*Y* MTG/day," read as "Z by *Y* MTG/day," refers to a WTP design capacity of *Z* MTG/day of HLW and *Y* MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] Increased risk of a latent cancer fatality to the individual, taking into account the probability (frequency) of the accident.

[c] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[d] The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; MEI=maximally exposed individual; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Source: Appendix K, Section K.3.7.1.

4.1.11.11.2 Hazardous Chemical Impacts

The potential human health impacts of the postulated chemical release scenarios are expected to be the same as those described under Tank Closure Alternative 2A in Section 4.1.11.2.2.

4.1.11.12 Intentional Destructive Acts

This section addresses potential impacts of intentional destructive acts at tank farm and WTP facilities. To protect against such actions, safeguards and security measures are employed at all DOE facilities. In accordance with DOE orders, DOE conducts vulnerability assessments and risk analyses of facilities and equipment under its jurisdiction to evaluate the physical protection elements, technologies, and administrative controls needed to protect DOE assets. DOE also protects against espionage, sabotage, and theft of radioactive, chemical, or biological materials; classified information and matter; non-nuclear weapon components; and critical technologies. Before startup of any new or substantially modified operations, DOE would conduct an in-depth, site-specific safeguards and security inspection to ensure that existing programs satisfy DOE requirements. Any inadequacies would be resolved before startup of operations. Release scenarios and impacts resulting from intentional destructive acts may be similar to a number of the accident scenarios analyzed in this EIS. Additional scenarios representing intentional destructive acts that may not be represented by the accident analyses were also considered. The potential for and consequences of the intentional destructive act scenarios would be essentially the same under each of the alternatives, except for Alternative 1: No Action, for which the scenarios involving the WTP would not apply.

Explosive Device in Underground Waste Tank. It was postulated that intentionally initiated explosions occur that displace a large portion of the soil overburden, breach the tank dome, and disperse a portion of the tank waste into the atmosphere. In accordance with the recommendation from *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vol. 1, *Analysis of Experimental Data* (DOE Handbook 3010-94), the respirable release would be less than the TNT [trinitrotoluene]-equivalent weight of the explosive charge. Analysis results indicate that the radiological impacts of an explosive device in an underground waste tank would be about four times greater than the impacts of the most severe accident scenario that involved the same inventory of radioactive material (TK53, seismically induced waste tank dome collapse). The offsite population dose was estimated to be 4.9 person-rem, with no (3×10^{-3}) resulting additional LCFs. The MEI dose would be 0.00083 rem, corresponding to an increased risk of an LCF of 5×10^{-7}. The noninvolved worker dose would be 0.88 rem, corresponding to an increased risk of an LCF of 5×10^{-4}.

Aircraft or Ground Vehicle Impact on WTP. A vehicle or aircraft crash and/or explosions initiated by an insider were postulated. It was assumed that these acts would be sufficiently energetic to breach a portion of the HLW Vitrification Facility exterior wall and the radiation shield wall that protects the two HLW melter feed preparation vessels. For purposes of this analysis, it was postulated that the two vessels were breached, causing the contents to spill into the cell. At the same time, aircraft or vehicle fuel was assumed to enter the cell and burn. The spilled radioactive waste slurry was assumed to heat to the boiling point, and radioactive material was assumed to be released to the environment through holes in the building walls. Analysis results indicate that the radiological impacts would be less than one-tenth of those calculated for the most severe accident scenario that involved the same inventory of radioactive material (WT41, seismically induced WTP collapse and failure – unmitigated). The offsite population dose was estimated to be 4,400 person-rem, which would result in 3 additional LCFs. The MEI dose would be 0.25 rem with an increased risk of an LCF of 2×10^{-4}. The noninvolved worker dose would be 860 rem, which could result in a near-term fatality.

Intentional Breach of WTP Ammonia Tank. An intentional destructive act was postulated whereby an explosion causes massive damage to the WTP ammonia tank. The entire 43,500 liters (11,500 gallons) of liquid ammonia were assumed to vaporize over a period of 1 minute. Under this scenario, exposed persons could experience life-threatening health effects or death at distances up to 8 kilometers (5 miles), about 10 times farther than for the accident scenario that involved the same chemical inventory (tank failure with release of entire contents in 30 minutes).

The impacts and mitigation of intentional destructive acts are discussed in more detail in Appendix K, Section K.3.11.

4.1.12 Public and Occupational Health and Safety—Transportation

Impacts of transporting radioactive materials are predominantly categorized as radiological or nonradiological impacts. Radiological impacts are those associated with the accidental release of radioactive materials and the effects of low levels of radiation emitted during normal (incident-free) transportation. Nonradiological impacts are those associated with transportation, regardless of the nature of the cargo, such as accidents resulting in death or injury when there is no release of radioactive material.

Packages containing radioactive materials emit low levels of radiation during incident-free transportation. The amount of radiation emitted depends on the kind and amount of material being transported. U.S. Department of Transportation (DOT) regulations require that packages containing radioactive materials have sufficient radiation shielding to limit the radiation to an acceptable level of 10 millirems per hour at 2 meters (6.6 feet) from the transporter. For incident-free transportation, the potential human health impacts of the radiation field surrounding the transportation packages were estimated for transportation workers and the general population along the route (off traffic, or off-link), people sharing the route (in traffic, or on-link), people at rest areas, and people at stops along the route. The RADTRAN computer program (Weiner et al. 2009) was used to estimate the incident-free impacts on transportation workers and populations, as well as the impact on an MEI (for example, a person stuck in traffic, a gas station attendee, an inspector) who could be a worker or a member of the public.

Transportation accidents involving radioactive materials present both nonradiological and radiological risks to workers and the public. Nonradiological impacts of potential transportation accidents include traffic accident fatalities. A release of radioactive material during transportation accidents would occur only when the package carrying the material is subjected to accident forces that exceed the package design standard. The impact of a specific radiological accident is expressed in terms of probabilistic risk, which is defined as the accident probability (i.e., accident frequency) multiplied by the accident consequences. The overall risk is obtained by summing the individual risks from all accident severities, irrespective of their likelihood of occurrence. The analysis of accident risks takes into account a spectrum of accident severities ranging from high-probability accidents of low severity (e.g., fender bender) to hypothetical high-severity accidents that have a low probability of occurrence. Only as a result of a severe fire and/or a powerful collision, which are of extremely low probability, could a transportation package of the type used to transport radioactive material off site under the alternatives of this EIS be damaged to the extent that there could be a release of radioactivity to the environment with substantial consequences.

In addition to calculating the radiological risks that would result from all accidents during transportation of radioactive waste, DOE assessed the highest consequences of a maximum reasonably foreseeable accident with a radioactive release frequency greater than 1×10^{-7} (1 chance in 10 million) per year along the route. The consequences of the maximum reasonably foreseeable accident were determined for prevailing atmospheric conditions. The analysis used the RISKIND computer program to estimate doses to individuals and populations (Yuan et al. 1995). Results from this analysis are presented in Appendix H, Sections H.7.1 through H.7.3.

Incident-free health impacts and radiological accident health impacts are expressed in terms of additional LCFs, and nonradiological accident risk is expressed as additional immediate (traffic) fatalities. LCFs associated with radiological exposure were estimated by multiplying the occupational (worker) and public dose by 0.0006 LCFs per person-rem of exposure.

In determining transportation risks, per-shipment risk factors were calculated for incident-free and radiological accident conditions using RADTRAN in conjunction with the TRAGIS [Transportation Routing Analysis Geographic Information System] computer program (Johnson and Michelhaugh 2003) to choose transportation routes in accordance with DOT regulations. The TRAGIS program calculates transportation routes in terms of distances traveled in rural, urban, and suburban areas. It provides 2000 census–based population density estimates for each area along the routes to determine population radiological risk factors. The population densities were updated to be representative of 2010 using data from the 2010 census (Census 2010). For incident-free operations, the affected population includes individuals living within 800 meters (0.5 miles) of each side of the road or rail line. For radiological accident conditions, the affected population includes individuals living within 80 kilometers (50 miles) of the accident, and the MEI was assumed to be an individual located 100 meters (330 feet) directly downwind from the accident. Additional details on the analysis approach and on modeling and parameter selections are provided in Appendix H.

Table 4–68 provides the estimated number of waste shipments under each alternative by waste type. A shipment is defined as the amount of waste transported on a single truck or a single railcar.

Table 4–68. Tank Closure Alternatives – Estimated Number of Radioactive Waste Shipments

	Number of Shipments									
	Offsite Shipments		Onsite Shipments							
Alternative	CH-TRU Waste[a]	RH-TRU Waste[a]	IHLW[b]	ILAW Glass	Bulk Vit. Waste	Cast Stone Waste	Steam Reforming Waste	CH-TRU Waste	RH-TRU Waste	Other Wastes[c]
2A	N/A	N/A	12,300	92,300	N/A	N/A	N/A	N/A	N/A	30
2B	N/A	N/A	12,300	92,300	N/A	N/A	N/A	N/A	N/A	23,600
3A	170	3,400	9,000	28,500	6,000	N/A	N/A	180	730	23,600
3B	170	3,400	9,000	28,500	N/A	23,300	N/A	180	730	23,600
3C	170	3,400	9,000	28,500	N/A	N/A	58,000	180	730	23,600
4	170	3,400	11,100	28,700	2,400	14,400	N/A	180	740	84,600
5	160	3,100	8,100	31,100	2,200	8,100[d]	N/A	160	660	10
6A Base Case	N/A	N/A	172,000	820	N/A	N/A	N/A	N/A	N/A	250,000
6A Option Case	N/A	N/A	172,000	18,400	N/A	N/A	N/A	N/A	N/A	684,000
6B Base Case	N/A	N/A	12,300	93,800	N/A	N/A	N/A	N/A	N/A	250,000
6B Option Case	N/A	N/A	12,300	111,000	N/A	N/A	N/A	N/A	N/A	684,000
6C	N/A	N/A	12,300	92,300	N/A	N/A	N/A	N/A	N/A	23,600

[a] Values are for truck shipments. Rail shipments are one-half of the values given.
[b] The IHLW canisters include 340 cesium and strontium high-level radioactive waste canisters.
[c] Other wastes include high-activity waste (equipment and soils), contaminated soil and grout from the Preprocessing Facility, and end-of-life WTP LAW melters, as applicable.
[d] This number includes 6,120 shipments of sulfate grout.

Note: No radioactive waste would be transported under Alternative 1. Transportation impacts under Alternative 1 are limited to those activities involving transport of construction materials (see Section 4.1.12.1). The number of shipments is rounded to the nearest ten between 10 and 1,000 shipments, and nearest hundred between 1,000 and 100,000 shipments.

Key: CH=contact-handled; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; N/A=not applicable; RH=remote-handled; TRU=transuranic; Vit.=vitrification; WTP=Waste Treatment Plant.

Source: Appendix H, Section H.7.1.

Table 4–69 summarizes the total offsite and onsite transportation impacts expected under each Tank Closure alternative. This table shows that the dose to the population along the offsite routes (see column 6 of Table 4–69: offsite rows) is expected to be between the lowest expected dose of about 170 person-rem under Tank Closure Alternative 5, and the highest expected dose of about 190 person-rem, associated with the transport of TRU waste to the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, under Tank Closure Alternatives 3A, 3B, 3C, and 4. The additional LCFs that are expected from such exposures to the general population would be less than 1 for all alternatives, ranging from 0.10 to 0.11. Similarly, the lowest expected dose to the crew transporting wastes to offsite disposal facilities (see column 4 of Table 4–69: offsite rows) would be under Alternative 5 (about 570 person-rem), while the highest would be under Alternative 4 (about 630 person-rem). The additional LCFs expected among the exposed transportation crews would be less than 1, ranging from 0.34 to 0.38. Under all of the alternatives, no combination of transports (off site and on site) is expected to result in an LCF among the exposed population or transportation crews. The expected number of offsite traffic fatalities from accidents involving radioactive material transport is 0 (0.35). Considering that the durations of alternatives range from 20 to over 150 years, and that traffic fatalities in the United States average about 40,000 per year, the expected risk of a traffic fatality is small.

Table 4–69. Tank Closure Alternatives – Risks of Transporting Radioactive Waste

Alternative	Transport	Number of Shipments[a]	Incident-Free: Crew: Dose (person-rem)	Incident-Free: Crew: Risk[b]	Incident-Free: Population: Dose (person-rem)	Incident-Free: Population: Risk[b]	Accident: Rad. Risk[b, c]	Accident: Nonrad. Risk[b]	One-Way Offsite Travel (10^6 km)
2A	Off site	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	On site	105,000	260	0.16	73	0.04	1.6×10^{-13}	0.04	N/A
2B	Off site	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	On site	128,000	260	0.16	73	0.04	2.1×10^{-9}	0.05	N/A
3A	Off site	3,600	620	0.37	190	0.11	4.3×10^{-5}	0.34	11.0
	On site	68,000	220	0.13	160	0.09	8.8×10^{-8}	0.03	N/A
3B	Off site	3,600	620	0.37	190	0.11	4.3×10^{-5}	0.34	11.0
	On site	85,300	460	0.28	77	0.05	8.8×10^{-8}	0.04	N/A
3C	Off site	3,600	620	0.37	190	0.11	4.3×10^{-5}	0.34	11.0
	On site	120,000	600	0.36	150	0.09	8.8×10^{-8}	0.05	N/A
4	Off site	3,600	630	0.38	190	0.11	4.3×10^{-5}	0.34	11.1
	On site	142,000	460	0.27	110	0.07	1.0×10^{-7}	0.06	N/A
5	Off site	3,200	570	0.34	170	0.10	3.9×10^{-5}	0.31	10.0
	On site	50,300	220	0.13	85	0.05	7.8×10^{-8}	0.02	N/A
6A Base	Off site	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	On site	423,000	450	0.27	60	0.04	6.5×10^{-8}	0.15	N/A
6A Option	Off site	N/A	N/A	N/A	N/A	N/A	N/A	0.00	N/A
	On site	874,000	870	0.52	100	0.06	9.4×10^{-8}	0.35	N/A
6B Base	Off site	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	On site	356,000	560	0.34	89	0.05	6.5×10^{-8}	0.15	N/A
6B Option	Off site	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	On site	808,000	980	0.59	130	0.08	9.4×10^{-8}	0.35	N/A
6C	Off site	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	On site	128,000	260	0.16	73	0.04	2.1×10^{-9}	0.05	N/A

[a] Offsite shipments are based on truck transport of transuranic waste (current practice for transport to Waste Isolation Pilot Plant).

[b] Risk is expressed in terms of latent cancer fatalities, except for the nonradiological, where it refers to the number of accident fatalities.

[c] To calculate accident population dose (person-rem), divide the values in this column by 0.0006. For additional insight on how this dose is calculated, see the text in Section 4.1.12.

Note: No radioactive waste would be transported under Alternative 1. Transportation impacts under Alternative 1 are limited to those activities involving transport of construction materials (see Section 4.1.12.1). To convert kilometers to miles, multiply by 0.6214.

Key: km=kilometers; N/A=not applicable; nonrad.=nonradiological; rad.=radiological.

Source: Appendix H, Section H.7.1.

The risks to different receptors under incident-free transportation conditions were estimated on a per-trip or per-event basis because it is unlikely that the same person would be exposed to multiple events; for those that could have multiple exposures, the dose over the duration of transportation activities could be calculated by multiplying by the number of events or trips. The dose to the maximally exposed transportation worker is discussed for each alternative below. For a receptor who is a member of the public residing along a transportation route, the dose over the duration of transportation activities would depend on the number of truck or rail shipments passing a particular point and would be independent of the actual route being considered. The maximum dose to this resident, if all the materials were shipped along this route, would be about 1 millirem for all action alternatives. Refer to Appendix H, Table H–9, for additional results.

Table 4–70 summarizes the impacts of transporting nonradioactive feed and support materials required to construct new facilities, as well as materials required to immobilize, vitrify, or solidify the liquid waste and transport it to storage or burial locations. The construction materials considered are concrete, cement, sand/gravel/dirt, asphalt, steel, and piping. The materials required for waste solidification and transport include glass formers, fly ash, blast furnace slag, canisters, cylinders, and boxes. The table shows the impacts in terms of total kilometers, accidents, and fatalities for each alternative. The results in Table 4–70 indicate that, for the Tank Closure alternatives, the potential for traffic fatalities would be the largest under Alternative 6A, Option Case, which would have the potential for nine fatalities, followed by Alternative 3C and Alternative 6A, Base Case, which would have the potential for approximately five and four fatalities, respectively. Considering that the duration of Alternative 6A is over 150 years, the estimated annual fatality is very small.

Table 4–70. Tank Closure Alternatives – Estimated Impacts of Construction and Operational Material Transport

Alternative	Total Distance Traveled (million kilometers)	Number of Accidents	Number of Traffic Fatalities
1	1.0	0.21	0.01
2A	50	10	0.65
2B	64	13	0.84
3A	91	18	1.2
3B	93	19	1.2
3C	410	82	5.3
4	120	24	1.6
5	88	18	1.2
6A Base	290	60	3.8
6A Option	700	140	9.2
6B Base	140	28	1.8
6B Option	270	55	3.5
6C	71	14	0.92

Note: To convert kilometers to miles, multiply by 0.6214.
Source: Appendix H, Section H.8.

4.1.12.1 Alternative 1: No Action

Under Tank Closure Alternative 1, transportation impacts would be limited to those activities involving transport of construction materials from onsite and/or offsite (local and regional) locations to Hanford to support construction activities, tank farm infrastructure and tank upgrades, and administrative control activities. The transportation impacts of these activities would be 1.0 million kilometers (0.6 million miles) traveled, 0 (0.21) traffic accidents, and 0 (0.01) traffic fatalities (see Table 4–70).

4.1.12.2 Alternative 2A: Existing WTP Vitrification; No Closure

Under this alternative, no offsite radioactive waste shipments would be made. However, 105,000 truck shipments would be made to transport radioactive wastes to onsite storage and burial grounds (see Table 4–69).

4.1.12.2.1 Impacts of Incident-Free Transportation

The dose to transportation workers from all transportation activities on site under this alternative was estimated at about 260 person-rem (see column 4 of Table 4–69); the dose to the public would be about 73 person-rem (see column 6 of Table 4–69). Accordingly, incident-free transportation of radioactive material would result in 0 (0.16) LCFs among transportation workers and 0 (0.04) LCFs in the total affected population over the duration of transportation activities. LCFs associated with radiological exposure were estimated by multiplying the occupational (worker) and public dose by 6.0×10^{-4} LCFs per person-rem. Note that the maximum annual dose to a transportation crewmember would be 100 millirem, unless the individual is a trained radiation worker, in which case the maximum annual dose would be 2 rem (DOE Standard 1098-2008). The potential for a trained radiation worker to develop a latent fatal cancer from the maximum annual exposure is 1.2×10^{-3}. Therefore, an individual transportation worker is not expected to develop a latent fatal cancer from exposures during these activities during his or her lifetime.

4.1.12.2.2 Impacts of Accidents During Transportation

As stated earlier, two sets of analyses were performed for the evaluation of transportation accident impacts: impacts of maximum reasonably foreseeable accidents and impacts of all foreseeable accidents (total transportation accidents).

Because no offsite radioactive waste shipments would be made under this alternative, the maximum reasonably foreseeable offsite transportation accident would have a probability of occurrence of less than 1 chance in 10 million per year. Therefore, no further impacts analyses have been performed.

The estimated total transportation accident risks under this alternative are a radiation dose risk to the population of 2.7×10^{-10} person-rem, resulting in 1.6×10^{-13} LCFs, and traffic accidents resulting in 0 (0.04) fatalities.

4.1.12.2.3 Impacts of Construction and Operational Material Transport

The impacts of transporting construction materials (e.g., concrete, gravel/sand/soil, asphalt, steel, piping) and materials for the production and transport of waste (e.g., glass-forming materials, grout, fly ash, containers, boxes, canisters) were evaluated. The impacts in terms of total distance traveled, accidents, and traffic fatalities under this alternative would be 50 million kilometers (30.9 million miles), 10 traffic accidents, and 1 (0.65) fatality over the entire period from construction through deactivation. Considering that the duration of this alternative is about 75 years, the estimated annual impact is very small.

4.1.12.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

Under this alternative, no offsite radioactive waste shipments would be made. However, 128,000 truck shipments would be made to transport various radioactive wastes to onsite storage and burial grounds (see Table 4–69).

4.1.12.3.1 Impacts of Incident-Free Transportation

The dose to transportation workers from all transportation activities on site under this alternative was estimated at about 260 person-rem; the dose to the public would be about 73 person-rem. Accordingly, incident-free transportation of radioactive material would result in 0 (0.16) LCFs among transportation workers and 0 (0.04) LCFs in the total affected population over the duration of transportation activities.

4.1.12.3.2 Impacts of Accidents During Transportation

The maximum reasonably foreseeable offsite transportation accident under this alternative has a probability of occurrence of less than 1 in 10 million per year. The consequences of such an accident would be similar to those described under Alternative 2A.

The estimated total transportation accident risks under this alternative are a radiation dose risk to the population (on site) of 3.5×10^{-6} person-rem, resulting in 2.1×10^{-9} LCFs, and traffic accidents resulting in 0 (0.05) fatalities.

4.1.12.3.3 Impacts of Construction and Operational Material Transport

The impacts of transporting construction materials (e.g., concrete, gravel/sand/soil, asphalt, steel, piping) and feed materials for the production and transport of waste (e.g., glass-forming materials, grout, fly ash, containers, boxes, canisters) were evaluated. The transportation impacts under this alternative would be about 64 million kilometers (40 million miles) traveled, 13 accidents, and 1 (0.84) fatality over the entire period from construction through deactivation and closure (see Table 4–70).

4.1.12.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

Under this alternative, about 3,600 truck[3] shipments of remote-handled (RH) and contact-handled (CH) TRU waste would be made to WIPP. In addition, 68,000 truck shipments would be made on site to transport various radioactive wastes to local storage and burial grounds. The total distance traveled on public roads and rail carrying radioactive waste materials would be about 11 million kilometers (6.8 million miles) (see Table 4–69).

4.1.12.4.1 Impacts of Incident-Free Transportation

The dose to transportation workers from all transportation activities (both off site and on site) under this alternative was estimated at about 840 person-rem; the dose to the public would be about 350 person-rem. Accordingly, incident-free transportation of radioactive material would result in 1 (0.50) LCF among transportation workers and 0 (0.20) LCFs in the total affected population over the duration of transportation activities. Note that the maximum annual dose to a transportation crewmember would be 100 millirem, unless the individual is a trained radiation worker, in which case the maximum annual dose would be 2 rem (DOE Standard 1098-2008). The potential for a trained radiation worker to develop a latent fatal cancer from the maximum annual exposure is 1.2×10^{-3}. Therefore, an individual transportation worker is not expected to develop a latent fatal cancer from exposures during these activities during his or her lifetime.

4.1.12.4.2 Impacts of Accidents During Transportation

The maximum reasonably foreseeable offsite transportation accident under this alternative (with a probability of occurrence of more than 1 in 10 million per year) would involve a shipment of RH-TRU waste. The consequences of such an accident in terms of population dose in the rural, suburban, and urban zones would be 0.38, 16.2, and 110 person-rem, respectively. The likelihood of occurrence of such consequences over the entire duration of transport is less than 1.6×10^{-3}, 3.2×10^{-5}, and 9.4×10^{-7} in rural, suburban, and urban zones, respectively. This accident could result in a dose of about 0.03 rem to an individual hypothetically exposed to the accident plume for 2 hours at a distance of 100 meters (330 feet), with a corresponding LCF risk of 1.6×10^{-5}.

The estimated total transportation accident risks under this alternative are a radiation dose risk to the population of 0.07 person-rem, resulting in 4.3×10^{-5} LCFs, and traffic accidents resulting in 0 (0.37) fatalities. Nearly all of the risks would result from shipping waste to WIPP.

[3] Truck transportation is the preferred mode for transporting TRU waste to WIPP (DOE 1997).

4.1.12.4.3 Impacts of Construction and Operational Material Transport

The impacts of transporting construction materials (e.g., concrete, gravel/sand/soil, asphalt, steel, piping) and materials for the production and transport of waste (e.g., glass-forming materials, grout, fly ash, containers, boxes, canisters) were evaluated. The transportation impacts under this alternative would be 91 million kilometers (57 million miles) traveled, 18 accidents, and 1 (1.2) fatality over the entire period from construction through deactivation and closure (see Table 4–70).

4.1.12.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

Under this alternative, about 3,600 truck shipments of RH- and CH-TRU waste would be made to WIPP. In addition, 85,300 truck shipments would be made on site to transport various radioactive wastes to local storage and burial grounds. The total distance traveled on public roads and rail carrying radioactive waste materials would be about 11 million kilometers (6.8 million miles) (see Table 4–69).

4.1.12.5.1 Impacts of Incident-Free Transportation

The dose to transportation workers from all transportation activities (both off site and on site) under this alternative was estimated at about 1,080 person-rem; the dose to the public would be about 267 person-rem. Accordingly, incident-free transportation of radioactive material would result in 1 (0.65) LCF among transportation workers and 0 (0.16) LCFs in the total affected population over the duration of transportation activities. Note that the maximum annual dose to a transportation crewmember would be 100 millirem, unless the individual is a trained radiation worker, in which case the maximum annual dose would be 2 rem (DOE Standard 1098-2008). The potential for a trained radiation worker to develop a latent fatal cancer from the maximum annual exposure is 1.2×10^{-3}. Therefore, an individual transportation worker is not expected to develop a latent fatal cancer from exposures during these activities during his or her lifetime.

4.1.12.5.2 Impacts of Accidents During Transportation

The maximum reasonably foreseeable offsite transportation accident under this alternative (with a probability of occurrence of more than 1 in 10 million per year) would involve a shipment of RH-TRU waste. The consequences of such an accident would be similar to those described under Tank Closure Alternative 3A.

The estimated total transportation accident risks under this alternative are a radiation dose risk to the population of 0.07 person-rem, resulting in 4.3×10^{-5} LCFs, and traffic accidents resulting in 0 (0.38) fatalities. Nearly all of the risks would result from shipping waste to WIPP.

4.1.12.5.3 Impacts of Construction and Operational Material Transport

The impacts of transporting construction materials (e.g., concrete, gravel/sand/soil, asphalt, steel, piping) and materials for the production and transport of waste (e.g., glass-forming materials, grout, fly ash, containers, boxes, canisters) were evaluated. The transportation impacts under this alternative would be 93 million kilometers (58 million miles) traveled, 19 accidents, and 1 (1.2) fatality over the entire period from construction through deactivation and closure (see Table 4–70).

4.1.12.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

Under this alternative, about 3,600 truck shipments of RH- and CH-TRU waste would be made to WIPP. In addition, 120,000 truck shipments would be made on site to transport various radioactive wastes to local storage and burial grounds. The total distance traveled on public roads and rail carrying radioactive waste materials would be about 11 million kilometers (6.8 million miles) (see Table 4–69).

4.1.12.6.1 Impacts of Incident-Free Transportation

The dose to transportation workers from all transportation activities (both off site and on site) under this alternative was estimated at about 1,220 person-rem; the dose to the public would be about 340 person-rem. Accordingly, incident-free transportation of radioactive material would result in 1 (0.73) LCF among transportation workers and 0 (0.20) LCFs in the total affected population over the duration of transportation activities. As stated earlier, note that the maximum annual dose to a transportation crewmember would be 100 millirem, unless the individual is a trained radiation worker, in which case the maximum annual dose would be 2 rem (DOE Standard 1098-2008). The potential for a trained radiation worker to develop a latent fatal cancer from the maximum annual exposure is 1.2×10^{-3}. Therefore, an individual transportation worker is not expected to develop a latent fatal cancer from exposures during these activities during his or her lifetime.

4.1.12.6.2 Impacts of Accidents During Transportation

The maximum reasonably foreseeable offsite transportation accident under this alternative (with a probability of occurrence of more than 1 in 10 million per year) would involve a shipment of RH-TRU waste. The consequences of such an accident would be similar to those described under Tank Closure Alternative 3A.

The estimated total transportation accident risks under this alternative are a radiation dose risk to the population of 0.07 person-rem, resulting in 4.3×10^{-5} LCFs, and traffic accidents resulting in 0 (0.39) fatalities. Nearly all of the risks would result from shipping waste to WIPP.

4.1.12.6.3 Impacts of Construction and Operational Material Transport

The impacts of transporting construction materials (e.g., concrete, gravel/sand/soil, asphalt, steel, piping) and materials for the production and transport of waste (e.g., glass-forming materials, grout, fly ash, containers, boxes, canisters) were evaluated. The transportation impacts under this alternative would be about 410 million kilometers (255 million miles) traveled, 82 accidents, and 5 (5.3) fatalities over the entire period from construction through deactivation and closure (see Table 4–70).

4.1.12.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

Under this alternative, about 3,600 truck shipments of TRU waste would be made to WIPP. In addition, 142,000 truck shipments would be made on site to transport various radioactive wastes to local storage and burial grounds. The total distance traveled on public roads and rail carrying radioactive waste materials would be about 11.1 million kilometers (6.9 million miles) (see Table 4–69).

4.1.12.7.1 Impacts of Incident-Free Transportation

The dose to transportation workers from all transportation activities (both off site and on site) under this alternative was estimated at about 1,090 person-rem; the dose to the public would be about 300 person-rem. Accordingly, incident-free transportation of radioactive material would result in 1 (0.65) LCF among transportation workers and 0 (0.18) LCFs in the total affected population over the duration of transportation activities. As stated earlier, note that the maximum annual dose to a transportation crewmember would be 100 millirem, unless the individual is a trained radiation worker, in which case the maximum annual dose would be 2 rem (DOE Standard 1098-2008). The potential for a trained radiation worker to develop a latent fatal cancer from the maximum annual exposure is 1.2×10^{-3}. Therefore, an individual transportation worker is not expected to develop a latent fatal cancer from exposures during these activities during his or her lifetime.

4.1.12.7.2 Impacts of Accidents During Transportation

The maximum reasonably foreseeable offsite transportation accident under this alternative (with a probability of occurrence of more than 1 chance in 10 million per year) would involve a shipment of RH-TRU waste. The consequences of such an accident would be similar to those described under Tank Closure Alternative 3A.

The estimated total transportation accident risks under this alternative are a radiation dose risk to the population of 0.07 person-rem, resulting in 4.3×10^{-5} LCFs, and traffic accidents resulting in 0 (0.40) fatalities. Nearly all of the risks would result from shipping waste to WIPP.

4.1.12.7.3 Impacts of Construction and Operational Material Transport

The impacts of transporting construction materials (e.g., concrete, gravel/sand/soil, asphalt, steel, piping) and materials for the production and transport of waste (e.g., glass-forming materials, grout, fly ash, containers, boxes, canisters) were evaluated. The transportation impacts under this alternative would be about 120 million kilometers (74.7 million miles) traveled, 24 accidents, and 2 (1.6) fatalities over the entire period from construction through deactivation and closure (see Table 4–70).

4.1.12.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

Under this alternative, 3,200 truck shipments of TRU waste would be made to WIPP. In addition, 50,300 truck shipments would be made on site to transport various radioactive wastes to local storage and burial grounds. The total distance traveled on public roads and rail carrying radioactive waste materials would be about 10 million kilometers (6.2 million miles) (see Table 4–69).

4.1.12.8.1 Impacts of Incident-Free Transportation

The dose to transportation workers from all transportation activities (both on and off site) under this alternative was estimated at about 790 person-rem; the dose to the public would be about 255 person-rem. Accordingly, incident-free transportation of radioactive material would result in 0 (0.47) LCFs among transportation workers and 0 (0.15) LCFs in the total affected population over the duration of transportation activities.

4.1.12.8.2 Impacts of Accidents During Transportation

The maximum reasonably foreseeable offsite transportation accident under this alternative (with a probability of occurrence of more than 1 chance in 10 million per year) would involve a shipment of RH-TRU waste. The consequences of such an accident would be similar to those described under Tank Closure Alternative 3A.

The estimated total transportation accident risks under this alternative are a radiation dose risk to the population of 0.07 person-rem, resulting in 3.9×10^{-5} LCFs, and traffic accidents resulting in 0 (0.33) fatalities. Nearly all of the risks would result from shipping waste to WIPP.

4.1.12.8.3 Impacts of Construction and Operational Material Transport

The impacts of transporting construction materials (e.g., concrete, gravel/sand/soil, asphalt, steel, piping) and materials for the production and transport of waste (e.g., glass-forming materials, grout, fly ash, containers, boxes, canisters) were evaluated. The transportation impacts under this alternative would be about 88 million kilometers (55 million miles) traveled, 18 accidents, and 1 (1.2) fatality over the entire period from construction through deactivation and closure (see Table 4–70).

4.1.12.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

Under both the Base Case and the Option Case of this alternative, no offsite radioactive waste shipments would be made. However, about 423,000 and 874,000 truck shipments would be made on site to transport various radioactive wastes to local storage and burial grounds under the Base Case and Option Case, respectively (see Table 4–69).

4.1.12.9.1 Impacts of Incident-Free Transportation

4.1.12.9.1.1 Base Case

The dose to transportation workers from all transportation activities on site under this alternative was estimated at about 450 person-rem; the dose to the public would be about 60 person-rem. Accordingly, incident-free transportation of radioactive material would result in 0 (0.27) LCFs among transportation workers and 0 (0.04) LCFs in the total affected population over the duration of transportation activities.

4.1.12.9.1.2 Option Case

The dose to transportation workers from all transportation activities (on site) under this alternative was estimated at about 870 person-rem; the dose to the public would be about 100 person-rem. Accordingly, incident-free transportation of radioactive material would result in 0 (0.52) LCFs among transportation workers and 0 (0.06) LCFs in the total affected population over the duration of transportation activities.

4.1.12.9.2 Impacts of Accidents During Transportation

4.1.12.9.2.1 Base Case

Because no offsite radioactive waste shipments would be made under this alternative, the maximum reasonably foreseeable offsite transportation accident would have a probability of occurrence of less than 1 chance in 10 million per year. Therefore, no further impact analyses have been performed.

The estimated total transportation accident risks under this alternative are a radiation dose risk to the population of 0.0001 person-rem, resulting in 6.5×10^{-8} LCFs, and traffic accidents resulting in 0 (0.15) fatalities.

4.1.12.9.2.2 Option Case

The estimated total transportation accident risks under this alternative are a radiation dose risk to the population of 0.0002 person-rem, resulting in 9.4×10^{-8} LCFs, and traffic accidents resulting in 0 (0.35) fatalities.

4.1.12.9.3 Impacts of Construction and Operational Material Transport

4.1.12.9.3.1 Base Case

The impacts of transporting construction materials (e.g., concrete, gravel/sand/soil, asphalt, steel, piping) and materials for the production and transport of waste (e.g., glass-forming materials, grout, fly ash, containers, boxes, canisters) were evaluated. The transportation impacts under this alternative would be about 290 million kilometers (180 million miles) traveled, 60 accidents, and 4 (3.8) fatalities over the entire period from construction through deactivation and closure (see Table 4–70).

4.1.12.9.3.2 Option Case

The impacts of transporting construction materials and materials for the production and transport of waste were evaluated. The transportation impacts under this alternative would be about 700 million kilometers (435 million miles) traveled, 140 accidents, and 9 (9.2) fatalities over the entire period from construction through deactivation and closure (see Table 4–70).

4.1.12.10 Alternative 6B: All Vitrification with Separations; Clean Closure

Under both cases of this alternative, no offsite radioactive waste shipments would be made. However, about 356,000 and 808,000 truck shipments would be made on site to transport various radioactive wastes to local storage and burial grounds under the Base Case and Option Case, respectively (see Table 4–69).

4.1.12.10.1 Impacts of Incident-Free Transportation

4.1.12.10.1.1 Base Case

The dose to transportation workers from all transportation activities on site under this alternative was estimated at about 560 person-rem; the dose to the public would be about 89 person-rem. Accordingly, incident-free transportation of radioactive material would result in 0 (0.34) LCFs among transportation workers and 0 (0.05) LCFs in the total affected population over the duration of transportation activities.

4.1.12.10.1.2 Option Case

The dose to transportation workers from all transportation activities on site under this alternative was estimated at about 980 person-rem; the dose to the public would be about 130 person-rem. Accordingly, incident-free transportation of radioactive material would result in 0 (0.59) LCFs among transportation workers and 0 (0.08) LCFs in the total affected population over the duration of transportation activities.

4.1.12.10.2 Impacts of Accidents During Transportation

4.1.12.10.2.1 Base Case

The maximum reasonably foreseeable offsite transportation accident and its consequences would be similar to those described under Alternative 6A (see Section 4.1.12.9.2).

The estimated total transportation accident risks under this alternative are a radiation dose risk to the population of 0.0001 person-rem, resulting in 6.5×10^{-8} LCFs, and traffic accidents resulting in 0 (0.15) fatalities.

4.1.12.10.2.2 Option Case

The estimated total transportation accident risks under this alternative are a radiation dose risk to the population of 0.0002 person-rem, resulting in 9.4×10^{-8} LCFs, and traffic accidents resulting in 0 (0.35) fatalities.

4.1.12.10.3 Impacts of Construction and Operational Material Transport

4.1.12.10.3.1 Base Case

The impacts of transporting construction materials (e.g., concrete, gravel/sand/soil, asphalt, steel, piping) and materials for the production and transport of waste (e.g., glass-forming materials, grout, fly ash, containers, boxes, canisters) were evaluated. The transportation impacts under this alternative would be about 140 million kilometers (87 million miles) traveled, 28 accidents, and 2 (1.8) fatalities over the entire period from construction through deactivation and closure (see Table 4–70).

4.1.12.10.3.2 Option Case

The impacts of transporting construction materials and materials for the production and transport of waste were evaluated. The transportation impacts under this alternative would be about 270 million kilometers (170 million miles) traveled, 55 accidents, and 4 (3.5) fatalities over the entire period from construction through deactivation and closure (see Table 4–70).

4.1.12.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

Under this alternative, no offsite radioactive waste shipments would be made. However, 128,000 truck shipments would be made to transport various radioactive wastes to local storage facilities and burial grounds (see Table 4–69).

4.1.12.11.1 Impacts of Incident-Free Transportation

The dose to transportation workers from all transportation activities on site under this alternative was estimated at about 260 person-rem; the dose to the public would be about 73 person-rem. Accordingly, incident-free transportation of radioactive material would result in 0 (0.16) LCFs among transportation workers and 0 (0.04) LCFs in the total affected population over the duration of transportation activities.

4.1.12.11.2 Impacts of Accidents During Transportation

The maximum reasonably foreseeable offsite transportation accident and its consequences are similar to those described under Alternative 2B (see Section 4.1.12.3.2).

The estimated total transportation accident risks under this alternative are a radiation dose risk to the population of 3.5×10^{-6} person-rem, resulting in 2.1×10^{-9} LCFs, and traffic accidents resulting in 0 (0.05) fatalities.

4.1.12.11.3 Impacts of Construction and Operational Material Transport

The impacts of transporting construction materials (e.g., concrete, gravel/sand/soil, asphalt, steel, piping) and feed materials for the production and transport of waste (e.g., glass-forming materials, grout, fly ash, containers, boxes, canisters) were evaluated. The transportation impacts under this alternative would be 71 million kilometers (44 million miles) traveled, 14 accidents, and 1 (0.92) fatality over the entire period from construction through deactivation and closure (see Table 4–70).

4.1.13 Environmental Justice

Per Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, DOE seeks to ensure that no group of people bears a disproportionate share of negative environmental consequences resulting from the proposed actions under the Tank Closure alternatives and options. This section addresses potential short-term impacts on minority, American Indian, Hispanic or Latino, and low-income populations. Public access to Hanford is restricted, so the majority of impacts would be associated with onsite activities and would not affect populations residing off site; thus, the potential for environmental justice concerns is small. Potential impacts on resource areas that could affect populations residing off site include public and occupational health and safety (during both normal operations and facility accidents) and air quality. Impacts on these resource areas were analyzed because of the potential for short-term environmental justice concerns. Definitions of terms associated with environmental justice and a description of the analysis methodology used are included in Appendix J.

4.1.13.1 Alternative 1: No Action

Section 4.1.10.1.1 discusses short-term impacts on the public resulting from normal operations under Tank Closure Alternative 1. The radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic or Latino, and low-income populations was compared with the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–71 summarizes the average individual total doses for the life of the project under this alternative. There were no appreciable differences between average individual total doses. Therefore, Tank Closure Alternative 1 would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–71. Tank Closure Alternative 1 Average Individual Total Dose from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	Remainder of Population
Minority	0.12	0.14
American Indian	0.08	0.13
Hispanic or Latino	0.12	0.14
Low-income	0.12	0.13

Source: Appendix J, Section J.5.7.1.1.

Section 4.1.10.1.1 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under Tank Closure Alternative 1, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than one-sixth of that received by the MEI from the general population. Therefore, Alternative 1 would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 4.1.11.1.1 discusses radiological impacts of airborne releases for facility accidents under Tank Closure Alternative 1. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Alternative 1 would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to accident consequences.

Air quality impacts under Tank Closure Alternative 1 are discussed in Section 4.1.4.1. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; because there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.1.12.1 discusses the potential human health risks of transporting construction materials from onsite and/or offsite (local and regional) locations to Hanford. The impacts of transporting construction materials to Hanford under this alternative would be very small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.1.13.2 Alternative 2A: Existing WTP Vitrification; No Closure

Section 4.1.10.2.1 discusses short-term impacts on the public resulting from normal operations under Tank Closure Alternative 2A. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic or Latino, and low-income populations was compared with the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–72 summarizes the average individual total doses for the life of the project under this alternative. There were no appreciable differences between average individual total doses. Therefore, Alternative 2A would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–72. Tank Closure Alternative 2A Average Individual Total Dose from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	**Remainder of Population**
Minority	2.9	3.4
American Indian	1.8	3.2
Hispanic or Latino	2.8	3.4
Low-income	2.8	3.2

Source: Appendix J, Section J.5.7.1.1.

Section 4.1.10.2.1 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations under Tank Closure Alternative 2A. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under Alternative 2A, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than one-sixth of that received by the MEI from the general population. Therefore, Alternative 2A would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 4.1.11.2.1 discusses radiological impacts of airborne releases for facility accidents under Tank Closure Alternative 2A. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Alternative 2A would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic or Latino, or low-income populations due to accident consequences.

Air quality impacts are discussed in Section 4.1.4.2. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts. There would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations; the same would be true for nonradioactive air emissions.

Section 4.1.12.2 discusses the potential human health risks of transporting radioactive waste on site at Hanford and construction materials from onsite and/or offsite (local and regional) locations to Hanford. Examination of the risks shows that there would be essentially no LCFs among the offsite population (which includes minority, American Indian, Hispanic or Latino, and low-income individuals) residing along the transportation routes. The impacts of transporting construction materials to Hanford would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.1.13.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

Section 4.1.10.3.1 discusses short-term impacts on the public resulting from normal operations under Tank Closure Alternative 2B. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic or Latino, and low-income populations was compared with the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–73 summarizes the average individual cumulative doses for the life of the project under this alternative. There were no appreciable differences between the average individual total doses. Therefore, Alternative 2B would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–73. Tank Closure Alternative 2B Average Individual Cumulative Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	Remainder of Population
Minority	2.8	3.3
American Indian	1.7	3.1
Hispanic or Latino	2.7	3.3
Low-income	2.7	3.1

Source: Appendix J, Section J.5.7.1.1.

Section 4.1.10.3.1 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations under Tank Closure Alternative 2B. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under Alternative 2B, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than one-sixth of that received by the MEI from the general population. Therefore, Alternative 2B would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 4.1.11.3.1 discusses radiological impacts of airborne releases for facility accidents under Tank Closure Alternative 2B. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Alternative 2B would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic or Latino, or low-income populations due to accident consequences.

Air quality impacts are discussed in Section 4.1.4.3. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; because there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.1.12.3 discusses the potential human health risks of transporting radioactive waste on site at Hanford and construction materials from onsite and/or offsite (local and regional) locations to Hanford. Examination of the risks shows that there would be essentially no LCFs among the offsite population (which includes minority, American Indian, Hispanic or Latino, and low-income individuals) residing along the transportation routes. The impacts of transporting construction materials to Hanford would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.1.13.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

Section 4.1.10.4.1 discusses short-term impacts on the public resulting from normal operations under Tank Closure Alternative 3A. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic or Latino, and low-income populations was compared with the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–74 summarizes the average individual cumulative doses for the life of the project under this alternative. There were no appreciable differences between average individual total doses. Therefore, Alternative 3A would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–74. Tank Closure Alternative 3A Average Individual Cumulative Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	Remainder of Population
Minority	2.6	3.1
American Indian	1.7	2.9
Hispanic or Latino	2.6	3.1
Low-income	2.6	3.0

Source: Appendix J, Section J.5.7.1.1.

Section 4.1.10.4.1 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations under Tank Closure Alternative 3A. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under Alternative 3A, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than one-sixth of that received by the MEI from the general population. Therefore, Alternative 3A would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 4.1.11.4.1 discusses radiological impacts of airborne releases for facility accidents under Tank Closure Alternative 3A. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Tank Closure Alternative 3A would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic or Latino, or low-income populations due to accident consequences.

Air quality impacts are discussed in Section 4.1.4.4. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; because there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.1.12.4 discusses the potential human health risks of transporting radioactive waste on site at Hanford and TRU waste to WIPP, as well as the risks of transporting construction materials from onsite and/or offsite (local and regional) locations to Hanford. Examination of the radiological transport risks shows that there would be essentially no LCFs among the offsite population (which includes minority, American Indian, Hispanic or Latino, and low-income individuals) residing along the transportation routes. The impacts of transporting construction materials to Hanford would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.1.13.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

Section 4.1.10.5.1 discusses short-term impacts on the public resulting from normal operations under Tank Closure Alternative 3B. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive air emissions from normal operations, the total dose to an average individual of minority, American Indian, Hispanic or Latino, and low-income populations was compared with the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–75 summarizes the average individual cumulative doses for the life of the project under this alternative. There were no appreciable differences between average individual total doses. Therefore, Alternative 3B would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–75. Tank Closure Alternative 3B Average Individual Cumulative Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	Remainder of Population
Minority	2.0	2.3
American Indian	1.2	2.2
Hispanic or Latino	1.9	2.3
Low-income	1.9	2.2

Source: Appendix J, Section J.5.7.1.1.

Section 4.1.10.5.1 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations under Tank Closure Alternative 3B. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under Alternative 3B, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than one-sixth of that received by the MEI from the general population. Therefore, Alternative 3B would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 4.1.11.5.1 discusses radiological impacts of airborne releases for facility accidents under Tank Closure Alternative 3B. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Alternative 3B would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to accident consequences.

Air quality impacts are discussed in Section 4.1.4.5. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; because there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.1.12.5 discusses the potential human health risks of transporting radioactive waste on site at Hanford and TRU waste to WIPP, as well as the risks of transporting construction materials from onsite and/or offsite (local and regional) locations to Hanford. Examination of the radiological transport risks shows that there would be essentially no LCFs among the offsite population (which includes minority, American Indian, Hispanic or Latino, and low-income individuals) residing along the transportation routes. The impacts of transporting construction materials to Hanford would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.1.13.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

Section 4.1.10.6.1 discusses short-term impacts on the public resulting from normal operations under Tank Closure Alternative 3C. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive air emissions from normal operations, the total dose to an average individual of minority, American Indian, Hispanic or Latino, and low-income populations was compared with the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–76 summarizes the average individual cumulative doses for the life of the project under this alternative. There were no appreciable differences between average individual total doses. Therefore, Alternative 3C would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–76. Tank Closure Alternative 3C Average Individual Cumulative Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	**Remainder of Population**
Minority	2.7	3.2
American Indian	1.7	3.0
Hispanic or Latino	2.7	3.2
Low-income	2.6	3.1

Source: Appendix J, Section J.5.7.1.1.

Section 4.1.10.6.1 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations under Tank Closure Alternative 3C. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under Alternative 3C, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than one-sixth of that received by the MEI from the general population. Therefore, Alternative 3C would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 4.1.11.6.1 discusses radiological impacts of airborne releases for facility accidents under Tank Closure Alternative 3C. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Alternative 3C would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic or Latino, or low-income populations due to accident consequences.

Air quality impacts are discussed in Section 4.1.4.6. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; because there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.1.12.6 discusses the potential human health risks of transporting radioactive waste on site at Hanford and TRU waste to WIPP, as well as the risks of transporting construction materials from onsite and/or offsite (local and regional) locations to Hanford. Examination of the radiological transport risks shows that there would be essentially no LCFs among the offsite population (which includes minority, American Indian, Hispanic or Latino, and low-income individuals) residing along the transportation routes. The impacts of transporting construction materials to Hanford would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.1.13.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

Section 4.1.10.7.1 discusses short-term impacts on the public resulting from normal operations under Tank Closure Alternative 4. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic or Latino, and low-income populations was compared with the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–77 summarizes the average individual cumulative doses for the life of the project under this alternative. There were no appreciable differences between average individual total doses. Therefore, Alternative 4 would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–77. Tank Closure Alternative 4 Average Individual Cumulative Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	Remainder of Population
Minority	2.3	2.7
American Indian	1.4	2.5
Hispanic or Latino	2.2	2.7
Low-income	2.2	2.6

Source: Appendix J, Section J.5.7.1.1.

Section 4.1.10.7.1 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations under Tank Closure Alternative 4. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under Alternative 4, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than one-sixth of that received by the MEI from the general population. Therefore, Alternative 4 would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 4.1.11.7.1 discusses radiological impacts of airborne releases for facility accidents under Tank Closure Alternative 4. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Alternative 4 would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to accident consequences.

Air quality impacts are discussed in Section 4.1.4.7. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; because there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.1.12.7 discusses the potential human health risks of transporting radioactive waste on site at Hanford and TRU waste to WIPP, as well as the risks of transporting construction materials from onsite and/or offsite (local and regional) locations to Hanford. Examination of the radiological transport risks shows that there would be essentially no LCFs among the offsite population (which includes minority, American Indian, Hispanic or Latino, and low-income individuals) residing along the transportation routes. The impacts of transporting construction materials to Hanford would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.1.13.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

Section 4.1.10.8.1 discusses short-term impacts on the public resulting from normal operations under Tank Closure Alternative 5. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic or Latino, and low-income populations was compared with the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–78 summarizes the average individual cumulative doses for the life of the project under this alternative. There were no appreciable differences between average individual total doses. Therefore, Alternative 5 would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–78. Tank Closure Alternative 5 Average Individual Cumulative Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	Remainder of Population
Minority	2.3	2.8
American Indian	1.5	2.6
Hispanic or Latino	2.3	2.8
Low-income	2.3	2.7

Source: Appendix J, Section J.5.7.1.1.

Section 4.1.10.8.1 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations under Tank Closure Alternative 5. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under Alternative 5, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than one-sixth of that received by the MEI from the general population. Therefore, Alternative 5 would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 4.1.11.8.1 discusses radiological impacts of airborne releases from facility accidents under Tank Closure Alternative 5. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Alternative 5 would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to accident consequences.

Air quality impacts are discussed in Section 4.1.4.8. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; because there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.1.12.8 discusses the potential human health risks of transporting radioactive waste on site at Hanford and TRU waste to WIPP, as well as the risks of transporting construction materials from onsite and/or offsite (local and regional) locations to Hanford. Examination of the radiological transport risks shows that there would be essentially no LCFs among the offsite population (which includes minority, American Indian, Hispanic or Latino, and low-income individuals) residing along the transportation routes. The impacts of transporting construction materials to Hanford would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority and low-income populations residing along the transportation routes.

4.1.13.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

4.1.13.9.1 Base Case

Section 4.1.10.9.1.1 discusses short-term impacts on the public resulting from normal operations under Tank Closure Alternative 6A, Base Case. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic or Latino, and low-income populations was compared with the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–79 summarizes the average individual cumulative doses for the life of the project under this alternative. There were no appreciable differences between average individual total doses. Therefore, Alternative 6A, Base Case, would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–79. Tank Closure Alternative 6A, Base Case, Average Individual Cumulative Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	Remainder of Population
Minority	2.9	3.4
American Indian	1.8	3.2
Hispanic or Latino	2.8	3.4
Low-income	2.8	3.3

Source: Appendix J, Section J.5.7.1.1.

Section 4.1.10.9.1.1 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations under Tank Closure Alternative 6A, Base Case. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under Alternative 6A, Base Case, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than one-sixth of that received by the MEI from the general population. Therefore, Alternative 6A, Base Case, would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 4.1.11.9.1.1 discusses radiological impacts for airborne releases from facility accidents under Tank Closure Alternative 6A, Base Case. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Alternative 6A, Base Case, would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to accident consequences.

Air quality impacts are discussed in Section 4.1.4.9.1. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; because there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.1.12.9 discusses the potential human health risks of transporting radioactive waste on site at Hanford and construction materials from onsite and/or offsite (local and regional) locations to Hanford. Examination of the risks shows that there would be essentially no LCFs among the offsite population (which includes minority, American Indian, Hispanic or Latino, and low-income individuals) residing along the transportation routes. The impacts of transporting construction materials to Hanford would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority and low-income populations residing along the transportation routes.

4.1.13.9.2 Option Case

Section 4.1.10.9.1.2 discusses short-term impacts on the public resulting from normal operations under Tank Closure Alternative 6A, Option Case. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic or Latino, and low-income populations was compared with the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–80 summarizes the average individual cumulative doses for the life of the project under this alternative. There were no appreciable differences between average individual total doses. Therefore, Alternative 6A, Option Case, would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–80. Tank Closure Alternative 6A, Option Case, Average Individual Cumulative Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	Remainder of Population
Minority	3.0	3.6
American Indian	1.9	3.3
Hispanic or Latino	2.9	3.5
Low-income	2.9	3.4

Source: Appendix J, Section J.5.7.1.1.

Section 4.1.10.9.1.2 discusses radiological impacts on the offsite MEI at the far side of Columbia River opposite Hanford as a result of normal operations under Tank Closure Alternative 6A, Option Case. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under Alternative 6A, Option Case, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than one-sixth of that received by the MEI from the general population. Therefore, Alternative 6A, Option Case, would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 4.1.11.9.1.2 discusses radiological impacts of airborne releases from facility accidents under Tank Closure Alternative 6A, Option Case. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Alternative 6A, Option Case, would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to accident consequences.

Air quality impacts are discussed in Section 4.1.4.9.2. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; because there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.1.12.9 discusses the potential human health risks of transporting radioactive waste on site at Hanford and construction materials from onsite and/or offsite (local and regional) locations to Hanford. Examination of the risks shows that there would be essentially no LCFs among the offsite population (which includes minority, American Indian, Hispanic or Latino, and low-income individuals) residing along the transportation routes. The impact of transporting construction materials to Hanford would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority and low-income populations residing along the transportation routes.

4.1.13.10 Alternative 6B: All Vitrification with Separations; Clean Closure

4.1.13.10.1 Base Case

Section 4.1.10.10.1.1 discusses short-term impacts on the public resulting from normal operations under Tank Closure Alternative 6B, Base Case. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic or Latino, and low-income populations was compared with the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–81 summarizes the average individual cumulative doses for the life of the project under this alternative. There were no appreciable differences between average individual total doses. Therefore, Alternative 6B, Base Case, would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–81. Tank Closure Alternative 6B, Base Case, Average Individual Cumulative Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	Remainder of Population
Minority	2.8	3.4
American Indian	1.8	3.2
Hispanic or Latino	2.8	3.4
Low-income	2.8	3.2

Source: Appendix J, Section J.5.7.1.1.

Section 4.1.10.10.1.1 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations under Tank Closure Alternative 6B, Base Case. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under Alternative 6B, Base Case, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than one-sixth of that received by the MEI from the general population. Therefore, Alternative 6B, Base Case, would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 4.1.11.10.1.1 discusses radiological impacts of airborne releases from facility accidents under Tank Closure Alternative 6B, Base Case. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Alternative 6B, Base Case, would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to accident consequences.

Air quality impacts are discussed in Section 4.1.4.10.1. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; because there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.1.12.10 discusses the potential human health risks of transporting radioactive waste on site at Hanford and construction materials from onsite and/or offsite (local and regional) locations to Hanford. Examination of the risks shows that there would be essentially no LCFs among the offsite population (which includes minority, American Indian, Hispanic or Latino, and low-income individuals) residing along the transportation routes. The impact of transporting construction materials to Hanford would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.1.13.10.2 Option Case

Section 4.1.10.10.1.2 discusses short-term impacts on the public resulting from normal operations under Tank Closure Alternative 6B, Option Case. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic or Latino, and low-income populations was compared to the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–82 summarizes the average individual cumulative doses for the life of the project under this alternative. There were no appreciable differences between average individual total doses. Therefore, Alternative 6B, Option Case, would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–82. Tank Closure Alternative 6B, Option Case, Average Individual Cumulative Doses from Radioactive Air Emissions over the Life of the Project

	Average Individual Dose (millirem)	
Subset Population	**Subset Population**	**Remainder of Population**
Minority	2.8	3.4
American Indian	1.8	3.2
Hispanic or Latino	2.8	3.4
Low-income	2.8	3.2

Source: Appendix J, Section J.5.7.1.1.

Section 4.1.10.10.1.2 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations under Tank Closure Alternative 6B, Option Case. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under Alternative 6B, Option Case, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than one-sixth of that received by the MEI from the general population. Therefore, Alternative 6B, Option Case, would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 4.1.11.10.1.2 discusses radiological impacts of airborne releases from facility accidents under Tank Closure Alternative 6B, Option Case. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Alternative 6B, Option Case, would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to accident consequences.

Air quality impacts are discussed in Section 4.1.4.10.2. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; because there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.1.12.10 discusses the potential human health risks of transporting radioactive waste on site at Hanford and construction materials from onsite and/or offsite (local and regional) locations to Hanford. Examination of the risks shows that there would be essentially no LCFs among the offsite population (which includes minority, American Indian, Hispanic or Latino, and low-income individuals) residing along the transportation routes. The impact of transporting construction materials to Hanford would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.1.13.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

Section 4.1.10.11.1 discusses short-term impacts on the public resulting from normal operations under Tank Closure Alternative 6C. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive air emissions from normal operations, the total dose to an average individual of the minority, American Indian, Hispanic or Latino, and low-income populations was compared with the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–83 summarizes the average individual cumulative doses for the life of the project under this alternative. There were no appreciable differences between these average individual total doses. Therefore, Alternative 6C would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–83. Tank Closure Alternative 6C Average Individual Cumulative Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	Remainder of Population
Minority	2.7	3.2
American Indian	1.7	3.0
Hispanic or Latino	2.7	3.2
Low-income	2.7	3.1

Source: Appendix J, Section J.5.7.1.1.

Section 4.1.10.11.1 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations under Tank Closure Alternative 6C. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under Alternative 6C, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be the equivalent of less than one-sixth of that received by the MEI from the general population. Therefore, Alternative 6C would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 4.1.11.11.1 discusses radiological impacts of airborne releases from facility accidents under Tank Closure Alternative 6C. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Alternative 6C would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to accident consequences.

Air quality impacts are discussed in Section 4.1.4.11. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; because there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.1.12.11 discusses the potential human health risks of transporting radioactive waste on site at Hanford and construction materials from onsite and/or offsite (local and regional) locations to Hanford. Examination of the risks shows that there would be essentially no LCFs among the offsite population (which includes minority, American Indian, Hispanic or Latino, and low-income individuals) residing along the transportation routes. The impact of transporting construction materials to Hanford would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority and low-income populations residing along the transportation routes.

4.1.14 Waste Management

This section evaluates the impacts of waste generation associated with the various Tank Closure alternatives on the waste management infrastructure at Hanford. As summarized in Section 4.3 and detailed in Chapter 2, Waste Management alternatives were developed to manage the various waste volumes projected to be generated under the alternatives for Tank Closure, FFTF Decommissioning, and Waste Management. Section 4.3.14 of this EIS evaluates the impacts of waste generation associated with the construction, operations, deactivation, and closure of the waste management facilities.

The following analysis is consistent with DOE policy and DOE Manual 435.1-1, which require that DOE radioactive waste shall be treated, stored, and, in the case of low-level radioactive waste (LLW), disposed of at the site where the waste is generated, if practical, or at another DOE facility. The analysis of these Tank Closure alternatives is based on disposal of LLW, MLLW, and WTP LAW melters at Hanford. However, if DOE determines that use of Hanford's or another DOE site's waste management facilities is not practical or cost-effective, DOE may approve the use of non-DOE (i.e., commercial) facilities to store, treat, and dispose of such waste.

Included in this section is a discussion of the waste inventories generated under each of the Tank Closure alternatives. The inventories are divided into primary waste and secondary waste. Appendix D describes the development of the contaminant inventories of these waste streams.

PRIMARY WASTE

Under all Tank Closure alternatives except Alternative 1: No Action, primary waste would be produced. This primary waste could include HLW, including IHLW canisters, IHLW cesium and strontium canisters, other HLW, and in the case of Alternatives 6A and 6B, LAW melters; treated LAW, including ILAW canisters, bulk vitrification glass, cast stone waste, sulfate grout, steam reforming waste, RH-TRU waste, and CH-TRU waste; and melters, including HLW melters, LAW melters, and PPF melters.

HIGH-LEVEL RADIOACTIVE WASTE

Under Tank Closure Alternatives 2A, 2B, 3A, 3B, 3C, 4, 5, 6A (Base and Option Cases), 6B (Base and Option Cases), and 6C, HLW would result as part of the retrieval of the tank waste.

Waste in the form of liquid, salt cake, and sludge is stored in 177 large and 61 smaller underground storage tanks in the Hanford 200 Areas. Most of the waste in the tanks is categorized as HLW, although some tanks are currently considered to contain only mixed TRU waste. Operationally, the tank farms are managed as if all of the waste were HLW. Waste retrieved from the storage tanks would be processed in the WTP Pretreatment Facility to separate it into a high-activity stream containing most of the radionuclides requiring long-term isolation and a low-activity stream containing most of the waste volume and the remaining radionuclides. In the WTP, the high-activity stream would be mixed with glass-forming materials and heated in an HLW melter to form a molten glass, a process called vitrification. The molten glass would then be poured into stainless steel canisters, where it would solidify into a solid form called IHLW. These alternatives would treat and dispose of existing waste and additional waste generated from the processing of the HLW.

However, under Tank Closure Alternatives 6A, 6B and 6C, all of the tank farm waste would be managed as if it were HLW. Under Alternative 6A all waste would be treated in HLW melters without pretreatment. Under Alternatives 6B and 6C, the LAW stream that is separated in the Pretreatment Facility would be sent to a separate vitrification facility, the LAW Vitrification Facility. The molten glass from the LAW melter would be poured into canisters of a different design than those used for high-activity waste (see Chapter 2, Section 2.3.2.1), where it would solidify into ILAW glass. The ILAW glass would be managed as HLW and placed into storage.

DOE expects that the IHLW canisters, and in the case of Tank Closure Alternatives 6B and 6C ILAW canisters, would be stored on site.

Storage of IHLW and ILAW would require ongoing facility maintenance and monitoring. Storage of IHLW and ILAW canisters is expected to result in no releases to the environment. Facilities with sufficient canister storage capacity would be constructed on site; impacts of constructing and operating storage facilities for IHLW and ILAW canisters are evaluated in the appropriate sections of this EIS.

Also under Tank Closure Alternatives 6A, 6B and 6C, all SSTs and associated ancillary equipment would be removed and considered HLW. The additional HLW would be stored on site in shielded boxes. Impacts of constructing and operating facilities with sufficient storage capacity are evaluated in the appropriate sections of this EIS. Storage of this HLW is expected to result in no releases to the environment; it would require ongoing facility maintenance and monitoring.

CESIUM AND STRONTIUM CAPSULES

The cesium and strontium capsules were generated at Hanford during the 1970s and 1980s, when cesium and strontium isotopes were separated from other tank waste, converted to cesium chloride and strontium fluoride, and then encapsulated for long-term storage. Currently, there are 1,335 cesium capsules and 601 strontium capsules stored in the Waste Encapsulation and Storage Facility (WESF) pool cells. Most of the capsules are composed of an inner and outer capsule. Under all Tank Closure alternatives except Alternative 1, the cesium and strontium capsules would be processed for de-encapsulating and preparing the waste into a suitable WTP slurry feed. The waste slurry would then be stored in a DST prior to treatment through the WTP. This EIS analyzes the immobilization of the cesium and strontium slurry feed as a separate, 1-year long WTP campaign; however, the cesium and strontium slurry feed could be mixed with the late-stage tank waste feed for consistency.

Under Tank Closure Alternative 1, the cesium and strontium capsules would be stored indefinitely in the WESF, in a manner similar to the present; therefore, construction of a Cesium and Strontium Capsule Processing Facility would be unnecessary. Under all other alternatives analyzed in this EIS, the cesium and strontium waste would be vitrified in the WTP. The immobilization of cesium and strontium capsule waste would take place during a separate campaign, after the treatment of all tank HLW is completed in the WTP. The cesium and strontium WTP campaign is expected to add 1 year of processing time to the WTP HLW melters. The Cesium and Strontium Capsule Processing Facility would be built such that processing of cesium canisters could begin approximately 14 months prior to the completion of the WTP's processing of tank HLW.

Based on estimated production rates, the Cesium and Strontium Capsule Processing Facility would require 26 months to de-encapsulate all cesium and strontium capsules and prepare the cesium and strontium slurry feed. The WTP requires an estimated 12 months to vitrify the slurry feed. Thus, to maintain a continuous WTP feed, the Cesium and Strontium Capsule Processing Facility must begin operations 14 months in advance of the cesium and strontium campaign and pre-store this WTP feed in the DSTs. It was estimated that an additional 340 canisters would be produced during the cesium and strontium treatment campaign (CEES 2006).

TREATED LOW-ACTIVITY TANK WASTE

Under Tank Closure Alternatives 2A and 2B, the LAW that is separated in the WTP Pretreatment Facility would be sent to the LAW Vitrification Facility for treatment, where it would be treated to create an immobilized waste form, ILAW. The impacts of providing treatment are evaluated in the appropriate sections of this EIS. The ILAW glass would be sent directly to an onsite Integrated Disposal Facility (IDF), a permitted landfill at Hanford with separate, expandable cells—one for the disposal of LLW and another for the disposal of MLLW. The disposal facility would include an RCRA-compliant liner and leachate collection system; upon closure it would be covered with a modified RCRA Subtitle C barrier (see Appendix E, Section E.3.4.1). The facility would be similar in configuration to the ERDF.

Under Tank Closure Alternatives 3A, 3B, 3C, and 4, additional waste forms other than ILAW glass would be created from immobilizing tank LAW using the supplemental treatment technologies of bulk vitrification (Alternative 3A), cast stone (Alternative 3B), or steam reforming (Alternative 3C) (see Chapter 2, Section 2.3.2), or both bulk vitrification and cast stone (Alternative 4). The LAW stream treated in the supplemental treatment facilities would result from the pretreatment separation of tank waste into high- and low-activity waste streams. In the 200-East Area, the separation would occur in the WTP Pretreatment Facility; in the 200-West Area, it would occur in a Solid-Liquid Separations Facility. A Bulk Vitrification Facility, a Cast Stone Facility, or a Steam Reforming Facility would be built in both the 200-East and 200-West Areas; in the case of Alternative 4, a Cast Stone Facility would be built in the 200-East Area and a Bulk Vitrification Facility would be built in the 200-West Area. Facilities with sufficient treatment capacity to immobilize the LAW would be provided under each of these technologies. The WTP and bulk vitrification glass, cast stone waste, or steam reforming waste would be sent directly to an onsite IDF. The disposal facility would include an RCRA-compliant liner and leachate collection system; upon closure it would be capped with a modified RCRA Subtitle C barrier (see Appendix E, Section E.3.4.1). The facility would be similar in configuration to the ERDF. The impacts of providing treatment are evaluated in the appropriate sections of this EIS. There would be no impacts on the existing Hanford waste management system. Some of the other tank waste, currently considered to be TRU waste, would be processed to become a solid mixed TRU waste form that would meet the WIPP Waste Acceptance Criteria.

Under Tank Closure Alternative 5, the LAW would be treated the same as under Alternative 4 with an additional pretreatment step in the Pretreatment Facility that would yield sulfate grout waste. Like Alternative 4, some of the tank waste would be processed to cast stone waste and some to bulk vitrification glass. The LAW stream that is separated in the Pretreatment Facility would be further processed to remove sulfate (see Chapter 2, Section 2.3.2.6). The sulfate waste stream would be solidified with cementitious material to create sulfate grout. The remaining LAW stream would be sent to and processed in the LAW Vitrification Facility. Sufficient treatment capacity to immobilize the sulfate waste stream and the LAW would be provided under this Tank Closure alternative. The impacts of providing treatment are evaluated in the appropriate sections of this EIS. The ILAW glass, bulk vitrification glass, cast stone waste, and sulfate grout waste would be sent directly to an onsite IDF. The disposal facility would include an RCRA-compliant liner and leachate collection system; upon closure it would be capped with a modified RCRA Subtitle C barrier (see Appendix E, Section E.3.4.1). The facility would be similar in configuration to the ERDF.

Under Tank Closure Alternatives 6B and 6C, the LAW stream that is separated in the Pretreatment Facility would be managed as HLW, as discussed above under "High-Level Radioactive Waste."

WASTE TREATMENT PLANT MELTERS

Under all alternatives except Alternative 1, WTP HLW melters, LAW melters, and, in the case of Alternatives 6A, 6B, and 6C, PPF melters would become a waste stream following service. WTP HLW and LAW melters that reach the end of their useful lives or fail may be treated by size reduction before being disposed of or placed in storage. Because WTP melters would be minimally treated (size reduction) before disposal or storage, impacts of this waste treatment on the existing Hanford waste management system would be negligible.

It is anticipated that the HLW melters would require long-term storage. The LAW melters would be disposed of as MLLW under Tank Closure Alternatives 2A, 2B, 3A, 3B, 3C, 4, and 5, and as HLW under Alternatives 6B and 6C. Storage of HLW melters is expected to result in no releases to the environment. Impacts of constructing and operating facilities with sufficient storage capacity under these Tank Closure alternatives for the WTP HLW and LAW melters are evaluated in the appropriate sections of this EIS. For more on WTP melters, see Appendix E, Section E.1.2.4.4.

For the LAW melters disposed of as MLLW, disposal would take place in an RCRA-compliant, onsite IDF. The impacts of providing such disposal capacity in an IDF are addressed under the corresponding Waste Management alternatives. The long-term impacts of radioactive and chemical releases from disposed LAW melters on groundwater quality and human health are evaluated in Chapter 5, Sections 5.1.1 and 5.1.2, respectively. For more on LAW melters, see Appendix E, Section E.1.2.4.4.

The retired PPF melters used in processing soils contaminated by past tank leaks would be disposed of on site in an IDF. Disposal of the retired PPF melters is addressed under the corresponding Waste Management alternatives. Long-term impacts of retired PPF melter disposal on groundwater quality and human health are evaluated in Chapter 5, Sections 5.1.1 and 5.1.2, respectively.

MIXED TRANSURANIC WASTE

Under Tank Closure Alternatives 3A, 3B, 3C, 4, and 5, some of the waste stored in tanks in the 200 Area, currently considered mixed TRU waste (see Chapter 2, Section 2.3.2.4), is expected to have a low activity level, allowing it to be managed as CH-waste. This waste would be treated and packaged using mobile units provided by this project. The remainder of the TRU waste has a high level of activity, necessitating use of a shielded facility and remote processing for treatment. A single facility for remotely processing the high-activity waste would be constructed in the 200-East Area. Impacts of constructing and operating facilities with additional TRU waste treatment and certification capacity are evaluated in the appropriate sections of this EIS.

The *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement (WIPP SEIS-II)* analyzed the receipt and disposal at WIPP of 57,000 cubic meters (2.01 million cubic feet) of CH-TRU waste and 29,000 cubic meters (1.02 million cubic feet) of RH-TRU waste from Hanford (DOE 1997:S-10). The CH-TRU and RH-mixed TRU waste generated from solidifying tank waste under these Tank Closure alternatives would be within the WIPP-analyzed capacities allocated to Hanford. As reported in the *WIPP SEIS-II*, the Consultation and Cooperation Agreement with the State of New Mexico currently limits the total volume of RH-TRU waste shipped to WIPP from all DOE sites to 7,080 cubic meters (250,000 cubic feet) (DOE 1997:S-7).

SECONDARY WASTE

Under all Tank Closure alternatives, secondary waste would be produced. This secondary waste could include LLW (including closure waste), MLLW (including closure waste), mixed TRU waste, hazardous waste, nonhazardous waste, and liquid process waste; Alternatives 6A, 6B, and 6C would produce PPF glass, another form of secondary waste.

LOW-LEVEL AND MIXED LOW-LEVEL RADIOACTIVE WASTES

The secondary LLW (e.g., personal protective equipment, tools, filters, empty containers) would be generated during routine operations and the administrative control period. LLW is typically not treated or only minimally treated (e.g., compacted) before disposal. Therefore, this waste treatment would cause no impacts on the Hanford waste management system. The LLW would be sent directly to disposal. Therefore, long-term storage facilities would not be required.

The secondary MLLW (e.g., personal protective equipment, tools, job waste, soil [in the case of closure activities]) would be generated during operations, deactivation, and closure. Through a combination of on- and offsite capabilities, secondary MLLW would be treated to meet RCRA land-disposal-restriction treatment standards prior to disposal.

PPF glass canisters generated from the treatment of the soils in the PPF are also included as MLLW under Alternatives 6A and 6B. The process would generate a liquid waste stream that has the radionuclides and chemicals removed from the soils. A melter cell would be installed in the PPF to process this liquid waste into a PPF glass suitable for onsite disposal. This waste would be disposed of as MLLW on site in an IDF. The long-term impacts on groundwater and human health of radioactive and chemical releases from the PPF glass are evaluated in Chapter 5, Sections 5.1.1 and 5.1.2.

Under Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, and 6C, Waste Management Alternative 2, Disposal Group 1, or Waste Management Alternative 3, Disposal Group 1, would be chosen for the disposal of treated LAW (except under Alternative 6C) and all other LLW and MLLW. As described under Waste Management Alternative 2, an IDF would be constructed and operated in the 200-East Area IDF (IDF-East) for the disposal of tank waste and all other LLW and MLLW; under Waste Management Alternative 3, two IDFs would be constructed and operated: IDF-East for tank waste only and a 200-West

Area IDF (IDF-West) for the other LLW and MLLW. The RPPDF would be constructed and operated for disposal of equipment and soils associated with clean closure activities that are not highly contaminated. Under Waste Management Alternative 2, Disposal Group 1, IDF-East and RPPDF operations would be completed in 2050, with IDF capacity at 1.2 million cubic meters (1.6 million cubic yards) and RPPDF capacity at 1.08 million cubic meters (1.41 million cubic yards). Under Waste Management Alternative 3, Disposal Group 1, IDF-East, IDF-West, and RPPDF operations would be completed in 2050. IDF-East's capacity would be at 1.1 million cubic meters (1.43 million cubic yards); IDF-West's, at 90,000 cubic meters (118,000 cubic yards); and the RPPDF's, at 1.08 million cubic meters (1.41 million cubic yards). Under Waste Management Alternatives 2 and 3, the IDF(s) and RPPDF would be covered with engineered modified RCRA Subtitle C barriers to reduce water infiltration and potential for intrusion. A 100-year postclosure care period would follow.

Under Tank Closure Alternatives 2A and 6B, Waste Management Alternative 2, Disposal Group 2, or Waste Management Alternative 3, Disposal Group 2, would be chosen for disposal of treated LAW (except under Alternative 6B) and all other LLW and MLLW. As described under Waste Management Alternative 2, IDF-East would be constructed and operated for the disposal of tank waste and all other LLW and MLLW; under Waste Management Alternative 3, two IDFs would be constructed and operated: IDF-East for tank waste only and IDF-West for the other LLW and MLLW. Under Alternative 6B, the RPPDF would be constructed and operated for disposal of equipment and soils resulting from clean closure activities. Under Waste Management Alternative 2, Disposal Group 2, IDF-East and RPPDF operations would be completed in 2100, with IDF capacity at 425,000 cubic meters (556,000 cubic yards) and RPPDF capacity at 8.37 million cubic meters (10.45 million cubic yards). Under Waste Management Alternative 3, Disposal Group 2, IDF-East and RPPDF operations would be completed in 2100 and IDF-West operations in 2050. IDF-East's capacity would be at 340,000 cubic meters (445,000 cubic yards); IDF-West's, at 90,000 cubic meters (118,000 cubic yards); and the RPPDF's, at 8.37 million cubic meters (10.9 million cubic yards). Under both Waste Management action alternatives, the IDF(s) and RPPDF would be covered with engineered modified RCRA Subtitle C barriers to reduce water infiltration and potential for intrusion. A 100-year postclosure care period would follow.

Under Tank Closure Alternative 6A, Waste Management Alternative 2, Disposal Group 3, or Waste Management Alternative 3, Disposal Group 3, would be chosen for disposal of tank waste and all other LLW and MLLW. As described under Waste Management Alternative 2, IDF-East would be constructed and operated for the disposal of tank waste and all other LLW and MLLW; under Waste Management Alternative 3, two IDFs would be constructed and operated: IDF-East for tank waste only and IDF-West for the other LLW and MLLW. Under Alternative 6C, the RPPDF would be constructed and operated for disposal of equipment and soils resulting from clean closure activities. Under Waste Management Alternative 2, Disposal Group 3, IDF-East and RPPDF operations would be completed in 2100, with IDF capacity at 425,000 cubic meters (556,000 cubic yards) and RPPDF capacity at 8.37 million cubic meters (10.9 million cubic yards). Under Waste Management Alternative 3, Disposal Group 3, IDF-East and RPPDF operations would be completed in 2165 and IDF-West operations in 2050. IDF-East's capacity would be at 340,000 cubic meters (445,000 cubic yards); IDF-West's, at 90,000 cubic meters (118,000 cubic yards); and the RPPDF's, at 8.37 million cubic meters (10.9 million cubic yards). Under both Waste Management Alternatives 2 and 3, the IDF(s) and RPPDF would be covered with engineered modified RCRA Subtitle C barriers to reduce water infiltration and potential for intrusion. A 100-year postclosure care period would follow.

Under Tank Closure Alternatives 1, 2, and 3, trenches 31 and 34 in the existing low-level radioactive waste burial grounds (LLBGs) would continue to receive LLW and MLLW from onsite, non-Comprehensive Environmental Response, Compensation, and Liability Act (non-CERCLA) generators. Under Tank Closure Alternative 1, waste would be received until 2035, and under Tank Closure Alternatives 2 and 3, waste would be received until filled to capacity, but not later than 2050. No construction activities would be necessary because the trenches are currently in operation.

MIXED TRANSURANIC WASTE

Secondary mixed TRU waste (e.g., equipment, tools, filters, empty containers) would be generated during waste retrieval and operations of treatment facilities and tanks.

Under all Tank Closure alternatives except Alternative 1, Waste Management Alternatives 2 and 3 analyze the management of mixed TRU waste at Hanford, including the secondary mixed TRU waste generated under the Tank Closure alternatives. Waste Management Alternatives 2 and 3 analyze the construction and operations of a new storage facility in Building 2403-WD that has a capacity of 17,500 drums, as well as two expansions of the Waste Receiving and Processing Facility (WRAP): (1) additional LLW, MLLW, and CH-TRU waste processing capability at the Central Waste Complex (CWC) to match existing capability at the current WRAP, assuming the current rate of 300 containers per month for LLW, MLLW, and CH-TRU waste processing needs would be doubled; and (2) RH-TRU waste processing capability at WRAP, assuming this expansion is required and would match the current WRAP throughput of 300 containers per month using two full-shift operations. The secondary mixed TRU waste would be treated if necessary, packaged, certified (at WRAP or a mobile facility) for disposal at WIPP, and placed into storage.

It is anticipated that TRU waste would be disposed of at WIPP. The *WIPP SEIS-II* analyzed the receipt and disposal at WIPP of 57,000 cubic meters (2.01 million cubic feet) of CH-TRU waste and 29,000 cubic meters (1.02 million cubic feet) of RH-TRU waste from Hanford (DOE 1997:S-10). The 206 cubic meters (7,270 cubic feet) of TRU waste generated under the Tank Closure alternatives would be within the capacity allocated to Hanford and less than the amount evaluated in this EIS.

HAZARDOUS WASTE

Hazardous waste is dangerous waste as defined in the *Washington Administrative Code* (WAC 173-303). Hazardous waste generated during construction and operations would be packaged in DOT-approved containers and shipped off site to permitted commercial recycling, treatment, and disposal facilities. Hanford shipped 182,177 kilograms (401,632 pounds) of hazardous waste off site in 2005 (Poston et al. 2006). Under all Tank Closure alternatives except Alternative 1, during the period of active construction, operations, and closure, the average annual hazardous waste generation would include 2 peak years with generation of approximately 31,500 cubic meters (1.11 million cubic feet). Management of the additional waste generated under the Tank Closure alternatives would require additional planning, coordination, and establishment of satellite accumulation areas, but because the waste would be treated and disposed of at offsite commercial facilities, the additional waste load would have a minor impact at Hanford.

NONHAZARDOUS WASTE

Any nonhazardous solid waste generated during facility construction, operations, deactivation, and closure under the Tank Closure alternatives would be packaged and transported in conformance with standard industrial practice. Solid waste such as office paper, metal cans, and plastic and glass bottles that can be recycled would be sent off site for that purpose. The remaining nonhazardous solid waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

LIQUID PROCESS WASTE

Process waste, including liquid secondary LLW, would be generated by the activities performed to retrieve, separate, and treat tank waste. Process liquids with substantial levels of radioactivity would be returned to the DST system for management. Dilute process waste such as cooling waters or steam condensates would be routed to the Hanford facilities whose mission it is to manage such wastes. It was assumed that the ETF and the TEDF, or their equivalents, would continue to be available to manage dilute process liquids generated under the Tank Closure alternatives. Wastewater management is further discussed in Section 4.1.6.

WASTE MINIMIZATION

In 2006, Hanford recycled 1,115 metric tons (1,230 tons) of sanitary and hazardous wastes. Affirmative procurement at Hanford achieved 100 percent of the 2006 goal. Hanford generated 4,278 cubic meters (5,595 cubic yards) of cleanup and stabilization goal waste (i.e., LLW, MLLW, and hazardous waste) (Poston et al. 2006).

All Tank Closure alternatives would result in additional waste generation. Closure and cleanup waste generation activities would be scrutinized to identify opportunities for waste minimization at Hanford. Waste would be minimized where feasible by (1) reusing or recycling material; (2) processing waste to reduce its quantity, volume, or toxicity; (3) substituting materials or processes that generate hazardous waste with others that result in less hazardous waste; and (4) segregating waste materials to prevent contamination of nonradioactive and nonhazardous materials.

4.1.14.1 Alternative 1: No Action

This section describes the impacts of Tank Closure Alternative 1 on the waste management system at Hanford. As described in Chapter 2, Section 2.4.2, no new facilities would be constructed to process tank waste. Activities under way to construct the WTP and Canister Storage Building would be terminated. The environmental and socioeconomic impacts of ongoing activities and subsequent administrative control activities are evaluated in the applicable sections of this EIS.

Under this Tank Closure alternative, Waste Management Alternative 1, No Action, would be chosen. The scope of Waste Management Alternative 1 is based on the requirements of DOE's January 6, 2006, Settlement Agreement with the State of Washington (as amended on June 5, 2008) regarding *State of Washington v. Bodman*, Civil No. 2:03-cv-05018-AAM, signed by DOE, Ecology, the Washington State Attorney General's Office, and the U.S. Department of Justice; the January 6, 2006, Memorandum of Understanding between DOE and Ecology (DOE and Ecology 2006); and the June 30, 2004, "Record of Decision for the Solid Waste Program, Hanford Site, Richland, WA: Storage and Treatment of Low-Level Waste and Mixed Low-Level Waste; Disposal of Low-Level Waste and Mixed Low-Level Waste, and Storage, Processing, and Certification of Transuranic Waste for Shipment to the Waste Isolation Pilot Plant" (69 FR 39449).

4.1.14.1.1 Waste Inventories

Table 4–84 presents the estimated waste volumes generated under Tank Closure Alternative 1.

4.1.14.1.2 High-Level Radioactive Waste

Under Tank Closure Alternative 1, the WTP would not be completed. Therefore, no IHLW canisters would be generated. The waste in the DSTs and SSTs would continue to be monitored over a 100-year administrative control period.

4.1.14.1.3 Treated Low-Activity Tank Waste

The low-activity fraction of the tank waste would not be separated under this alternative. Therefore, no treated low-activity, tank-derived waste would be generated.

4.1.14.1.4 Waste Treatment Plant Melters

The WTP for vitrifying HLW and tank LAW would not be completed under Tank Closure Alternative 1. Therefore, no WTP melters requiring storage or disposal would be generated.

4.1.14.1.5 Secondary Waste

4.1.14.1.5.1 Mixed Transuranic Waste

Secondary mixed TRU waste would not be generated by cessation of current WTP construction or by routine operations and monitoring activities that would occur during the administrative control period.

4.1.14.1.5.2 Low-Level Radioactive Waste

As shown in Table 4–84, 35 cubic meters (1,240 cubic feet) of LLW would be generated under Tank Closure Alternative 1; this amount is consistent with that accounted for under Waste Management Alternative 1. The waste would be processed at the CWC and would be disposed of in LLBG 218-W-5 trenches 31 and 34. No barriers would be constructed over trenches 31 and 34, the CWC, WRAP, or the T Plant complex. There would be a 100-year administrative control period through 2135.

4.1.14.1.5.3 Mixed Low-Level Radioactive Waste

Secondary MLLW would be generated during the period of routine operations. Mixed waste would require treatment to meet land-disposal-restriction requirements prior to disposal. The amount of MLLW generated under this Tank Closure alternative is consistent with that accounted for under Waste Management Alternative 1.

Table 4–84. Tank Closure Alternative 1 Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation	
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year
High-Level Radioactive Waste							
IHLW (0 canisters)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Treated Low-Activity Tank Waste							
ILAW (0 canisters)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bulk vitrification glass	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cast stone waste	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Steam reforming waste	N/A	N/A	N/A	N/A	N/A	N/A	N/A
RH-TRU waste	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CH-TRU waste	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WTP Melters							
HLW melters (0 melters)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LAW melters (0 melters)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Secondary Waste							
LLW	N/A	21	14	N/A	35	2008	7
MLLW	N/A	21	N/A	N/A	21	2006–2008	7
Mixed TRU waste	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hazardous waste[a]	12	N/A	N/A	N/A	12	2006–2008	4
Nonradioactive-nonhazardous waste[b]	N/A	N/A	307	N/A	307	2008–2107	3

[a] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.

[b] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters. To convert cubic meters to cubic feet, multiply by 35.315.

Key: CH=contact-handled; HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; N/A=not applicable; RH=remote-handled; TRU=transuranic; WTP=Waste Treatment Plant.

Source: SAIC 2010a.

4.1.14.1.5.4 Hazardous Waste

Hazardous waste generated during the cessation of construction would be packaged in DOT-approved containers and shipped off site to permitted commercial recycling, treatment, and disposal facilities.

4.1.14.1.5.5 Nonhazardous Waste

A small amount (307 cubic meters [10,800 cubic feet]) of nonhazardous waste would be generated from cessation of current WTP construction or by routine operations and monitoring activities that would occur during the administrative control period. This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

4.1.14.1.5.6 Liquid Process Waste

No liquid process waste would be generated from cessation of current WTP construction or by routine operations and monitoring activities that would occur during the administrative control period.

4.1.14.2 Alternative 2A: Existing WTP Vitrification; No Closure

4.1.14.2.1 Waste Inventories

Table 4–85 presents the estimated waste volumes generated under Alternative 2A.

4.1.14.2.2 High-Level Radioactive Waste

As shown in Table 4–85, 14,200 cubic meters (501,000 cubic feet) of IHLW canisters and 400 cubic meters (14,100 cubic feet) of cesium and strontium canisters would be generated. DOE expects that the IHLW canisters would be stored on site.

4.1.14.2.3 Treated Low-Activity Tank Waste

As shown in Table 4–85, the 213,000 cubic meters (7.52 million cubic feet) of ILAW glass that would be generated under this Tank Closure alternative is within the capacity of Waste Management Alternative 2, Disposal Group 2, and Waste Management Alternative 3, Disposal Group 2. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 2, and Waste Management Alternative 3, Disposal Group 2.

4.1.14.2.4 Waste Treatment Plant Melters

As shown in Table 4–85, the volume of HLW melters generated is 3,680 cubic meters (130,000 cubic feet). DOE expects that the HLW melters would be stored on site.

The volume of LAW melters generated under this Tank Closure alternative would be 7,700 cubic meters (272,000 cubic feet). This amount is within the capacity of Waste Management Alternative 2, Disposal Group 2, and Waste Management Alternative 3, Disposal Group 2. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 2, and Waste Management Alternative 3, Disposal Group 2.

Table 4–85. Tank Closure Alternative 2A Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)[a]
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
High-Level Radioactive Waste								
IHLW (12,000 canisters)	N/A	14,200	N/A	N/A	14,200	2018–2092	190	N/A
Cesium and strontium (340 canisters)[b]	N/A	400	N/A	N/A	400	2093	400	N/A
Treated Low-Activity Tank Waste								
ILAW (92,250 canisters)	N/A	213,000	N/A	N/A	213,000	2018–2092	2,840	213,000
WTP Melters								
HLW melters (30 melters)	N/A	3,680	N/A	N/A	3,680	Various	245	N/A
LAW melters (30 melters)	N/A	7,700	N/A	N/A	7,700	Various	513	7,700
Secondary Waste								
LLW	N/A	31,700	1,240	1,330	34,300	2018–2193	536	34,300
MLLW	N/A	31,700	3,270	4,200	39,200	2078–2192	840	39,300
Mixed TRU waste	N/A	219	N/A	N/A	219	2053–2092	3	N/A
Hazardous waste[c]	193	63,300	15,700	N/A	79,200	2092–2094	31,400	N/A
Nonradioactive-nonhazardous waste[d]	N/A	254	2,390	540	3,190	2094	320	N/A
Liquid LLW (liters)	N/A	N/A	N/A	9,690	9,690	2018–2028	881	N/A
IDF capacities: Waste Management Alternative 2, Disposal Group 2: 200-East Area 425,000 m^3 Waste Management Alternative 3, Disposal Group 2: 200-East Area 1,080,000 m^3, 200-West Area 90,000 m^3					Total waste to IDF(s): 294,200 m^3			

[a] Construction of the RPPDF is not required for this Tank Closure alternative.

[b] Disposition of the cesium and strontium capsules will be determined under a separate National Environmental Policy Act process. However, for analysis purposes, they were assumed to be HLW.

[c] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.

[d] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal. Total may not equal the sum of the contributions due to rounding.

Note: All values are in cubic meters except as noted. To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, by 0.26417.

Key: HLW=high-level radioactive waste; IDF=Integrated Disposal Facility; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low activity waste; LLW=low-level radioactive waste; m^3=cubic meters; MLLW=mixed low-level radioactive waste; N/A=not applicable; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix E, Table E–10; SAIC 2010a.

4.1.14.2.5 Secondary Waste

4.1.14.2.5.1 Mixed Transuranic Waste

As shown in Table 4–85, the estimated volume of mixed TRU waste would be less than the waste volume assumed under both Waste Management Alternative 2, Disposal Group 2, and Waste Management Alternative 3, Disposal Group 2; therefore, this volume should not impact existing TRU waste treatment and storage facilities and would be within the capacity allocated to Hanford for disposal at WIPP (DOE 1997:S-10).

4.1.14.2.5.2 Low-Level and Mixed Low-Level Radioactive Wastes

As shown in Table 4–85, Tank Closure Alternative 2A accounts for the disposal of 34,300 cubic meters (1.21 million cubic feet) of LLW and 39,200 cubic meters (1.38 million cubic feet) of MLLW that would be generated by the tank closure program. LLW and MLLW would be disposed of in an IDF. The amount of LLW and MLLW generated under this Tank Closure alternative is consistent with that accounted for under Waste Management Alternative 2, Disposal Group 2, and Waste Management Alternative 3, Disposal Group 2. Therefore, no long-term storage capacity would be needed; the impacts of treating and disposing of this waste in an IDF(s) are evaluated under Waste Management Alternative 2, Disposal Group 2, and Waste Management Alternative 3, Disposal Group 2.

4.1.14.2.5.3 Hazardous Waste

As shown in Table 4–85, a total of 79,200 cubic meters (2.80 million cubic feet) of hazardous waste would be generated during construction and operations. For 3 peak years (2092–2094), hazardous waste would be generated at 31,400 cubic meters (1.11 million cubic feet) per year.

4.1.14.2.5.4 Nonhazardous Waste

As shown in Table 4–85, the estimated volume of nonhazardous waste would be 3,190 cubic meters (113,000 cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

4.1.14.2.5.5 Liquid Process Waste

As shown in Table 4–85, the estimated volume of low-level radioactive liquid process waste would be 9,690 liters (2,560 gallons). This waste would be treated on site.

4.1.14.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

4.1.14.3.1 Waste Inventories

Table 4–86 presents the estimated waste volumes generated under Alternative 2B. Under this Tank Closure alternative, closure activities would include the removal of ancillary equipment and the top 4.6 meters (15 feet) of soil from two tank farms. This tank closure waste would be disposed of in the new RPPDF.

4.1.14.3.2 High-Level Radioactive Waste

As shown in Table 4–86, 14,200 cubic meters (501,000 cubic feet) of IHLW canisters and 400 cubic meters (14,100 cubic feet) of cesium and strontium canisters would be generated. DOE expects that the IHLW canisters would be stored on site.

Table 4–86. Tank Closure Alternative 2B Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
High-Level Radioactive Waste								
IHLW (12,000 canisters)	N/A	14,200	N/A	N/A	14,200	2018–2039	547	N/A
Cesium and strontium (340 canisters)[a]	N/A	400	N/A	N/A	400	2040	400	N/A
Treated Low-Activity Tank Waste								
ILAW (92,250 canisters)	N/A	213,000	N/A	N/A	213,000	2018–2043	8,190	213,000 (IDF)
WTP Melters								
HLW melters (11 melters)	N/A	1,350	N/A	N/A	1,350	Various	245	N/A
LAW melters (31 melters)	N/A	8,000	N/A	N/A	8,000	Various	1,540	8,000 (IDF)
Secondary Waste								
LLW	N/A	27,500	968	9,180	37,600	2040	2,800	37,600 (IDF)
MLLW	N/A	27,500	2,870	6,580	36,900	2040	3,020	36,900 (IDF)
Closure LLW[b]	N/A	N/A	N/A	679	679	2038–2040	226	679 (RPPDF)
Closure MLLW[c]	N/A	N/A	N/A	468,000	468,000	2032–2037	78,000	468,000 (RPPDF)
Mixed TRU waste	N/A	206	N/A	N/A	206	2029–2043	8	N/A
Hazardous waste[d]	170	63,300	16,100	106	79,600	2039–2040	31,400	N/A
Nonradioactive-nonhazardous waste[e]	N/A	254	976	677	1,910	2044	594	N/A
Liquid LLW (liters)	N/A	N/A	N/A	9,690	9,690	2018–2028	881	N/A
IDF and RPPDF capacities: Waste Management Alternative 2, Disposal Group 1: IDF-E 1,200,000 m^3, RPPDF 1,080,000 m^3; Waste Management Alternative 3, Disposal Group 1: IDF-E 1,100,000 m^3, IDF-W 90,000 m^3, RPPDF 1,080,000 m^3					Total waste to IDF(s)/RPPDF: 296,000 m^3/469,000 m^3			

[a] Disposition of the cesium and strontium capsules will be determined under a separate National Environmental Policy Act process. However, for analysis purposes, they were assumed to be HLW.

[b] Closure LLW is the waste from decontamination and decommissioning of the containment structure over the tank farms after soil removal is complete.

[c] Closure MLLW includes soil, rubble, and equipment removed during closure of the tank farms.

[d] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.

[e] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters except as noted. To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, by 0.26417. Total may not equal the sum of the contributions due to rounding.

Key: HLW=high-level radioactive waste; IDF=Integrated Disposal Facility; IDF-E=200-East Area Integrated Disposal Facility; IDF-W=200-West Area Integrated Disposal Facility; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; LLW=low-level radioactive waste; m^3=cubic meters; MLLW=mixed low-level radioactive waste; N/A=not applicable; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix E, Table E–10; SAIC 2010a.

4.1.14.3.3 Treated Low-Activity Tank Waste

As shown in Table 4–86, the 213,000 cubic meters (7.52 million cubic feet) of ILAW glass that would be generated under this Tank Closure alternative is included in the capacity of Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Long-term impacts of radioactive and chemical releases from disposed ILAW are evaluated in Chapter 5.

4.1.14.3.4 Waste Treatment Plant Melters

As shown in Table 4–86, the volume of LAW melters generated under this Tank Closure alternative would be 8,000 cubic meters (283,000 cubic feet); this volume is included in the capacity of Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. As shown in Table 4–86, the volume of HLW melters generated under this Tank Closure alternative would be 1,350 cubic meters (47,700 cubic feet). DOE expects that the HLW melters would be stored on site.

4.1.14.3.5 Secondary Waste

4.1.14.3.5.1 Mixed Transuranic Waste

As shown in Table 4–86, the 206 cubic meters (7,280 cubic feet) of mixed TRU waste would be less than the waste volume assumed under both Waste Management Alternatives 2 and 3; therefore, this volume should not impact existing TRU waste treatment and storage facilities and would be within the capacity allocated to Hanford for disposal at WIPP (DOE 1997:S-10).

4.1.14.3.5.2 Low-Level and Mixed Low-Level Radioactive Wastes

As shown in Table 4–86, Tank Closure Alternative 2B accounts for the disposal of 37,600 cubic meters (1.33 million cubic feet) of LLW, 679 cubic meters (24,000 cubic feet) of LLW generated by tank closure, and 36,900 cubic meters (1.3 million cubic feet) of MLLW generated by tank closure. LLW and MLLW would be disposed of in an IDF. The amount of LLW and MLLW generated under this Tank Closure alternative is consistent with that accounted for under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, no long-term storage capacity would be needed; the impacts of treating and disposing of this waste in an IDF are evaluated under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

4.1.14.3.5.3 Closure Mixed Low-Level Radioactive Waste

Under this Tank Closure alternative, large quantities of MLLW would be generated by the removal of ancillary equipment and the excavation of contaminated soil to a depth of approximately 4.6 meters (15 feet) from selected tank farms. This large quantity of tank closure MLLW (468,000 cubic meters [16.5 million cubic feet]) is included as a waste stream under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1, for disposal in a new disposal facility, the RPPDF, located between the 200-East and 200-West Areas, after confirmation that the waste stream meets the appropriate land-disposal-restriction treatment standards, such as the alternative soil treatment standards (40 CFR 268.49). Land use, transportation, groundwater, and long-term human health impacts of closure waste disposal in the RPPDF under this Tank Closure alternative are evaluated in the appropriate sections of this EIS.

4.1.14.3.5.4 Hazardous Waste

A total of 79,600 cubic meters (2.81 million cubic feet) of hazardous waste would be generated during construction and operations. For 2 peak years (2039–2040), hazardous waste would be generated at 31,400 cubic meters (1.11 million cubic feet) per year.

4.1.14.3.5.5 Nonhazardous Waste

The estimated volume of nonhazardous waste would be 1,910 cubic meters (67,300 cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

4.1.14.3.5.6 Liquid Process Waste

The estimated volume of low-level radioactive liquid process waste would be 9,690 liters (2,560 gallons). This waste would be treated on site.

4.1.14.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

4.1.14.4.1 Waste Inventories

Table 4–87 presents the estimated waste volumes generated under Alternative 3A. Under this Tank Closure alternative, closure activities would include the removal of ancillary equipment and the top 4.6 meters (15 feet) of soil from two tank farms. This tank closure waste would be disposed of in the new RPPDF.

4.1.14.4.2 High-Level Radioactive Waste

As shown in Table 4–87, 10,300 cubic meters (364,000 cubic feet) of IHLW canisters and 400 cubic meters (14,100 cubic feet) of cesium and strontium canisters would be generated. DOE expects that the IHLW canisters would be stored on site.

4.1.14.4.3 Treated Low-Activity Tank Waste

As shown in Table 4–87, the 168,800 cubic meters (5.96 million cubic feet) of ILAW generated by the two treatment processes under this Tank Closure alternative is included in the capacity of Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Long-term impacts of radioactive and chemical releases from WTP and bulk vitrification glass on groundwater quality and human health are evaluated in Chapter 5.

4.1.14.4.3.1 Mixed Transuranic Waste

The 1,500 cubic meters (53,000 cubic feet) of CH-mixed and 2,140 cubic meters (75,600 cubic feet) of RH-mixed TRU waste generated from solidifying tank waste under this Tank Closure alternative would be within the WIPP-analyzed capacities allocated to Hanford.

Table 4–87. Tank Closure Alternative 3A Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
High-Level Radioactive Waste								
IHLW (8,700 canisters)	N/A	10,300	N/A	N/A	10,300	2018–2039	469	N/A
Cesium and strontium (340 canisters)[a]	N/A	400	N/A	N/A	400	2040	400	N/A
Treated Low-Activity Tank Waste								
ILAW (28,510 canisters)	N/A	65,800	N/A	N/A	65,800	2018–2039	2,990	65,800 (IDF)
Bulk vitrification glass	N/A	103,000	N/A	N/A	103,000	2018–2039	4,670	103,000 (IDF)
CH-TRU waste	N/A	1,500	N/A	N/A	1,500	2009–2010	750	N/A
RH-TRU waste	N/A	2,140	N/A	N/A	2,140	2015–2019	428	N/A
WTP Melters								
HLW melters (9 melters)	N/A	1,100	N/A	N/A	1,100	Various	245	N/A
LAW melters (9 melters)	N/A	2,260	N/A	N/A	2,260	Various	513	2,260 (IDF)
Secondary Waste								
LLW	N/A	17,400	1,980	9,180	28,600	2035	1,750	28,600 (IDF)
MLLW	N/A	31,200	3,920	6,580	41,700	2040	2,500	41,700 (IDF)
Closure LLW[b]	N/A	N/A	N/A	679	679	2034–2036	226	679 (IDF)
Closure MLLW[c]	N/A	N/A	N/A	468,000	468,000	2028–2033	78,000	468,000 (RPPDF)
Mixed TRU waste	N/A	206	N/A	N/A	206	2027–2039	9	206 (RPPDF)
Hazardous waste[d]	196	63,300	16,100	106	79,700	2039	31,400	N/A
Nonradioactive-nonhazardous waste[e]	N/A	254	723	677	1,660	2041	356	N/A
Liquid LLW (liters)	N/A	N/A	N/A	9,690	9,690	2018–2028	881	N/A
IDF and RPPDF capacities: Waste Management Alternative 2, Disposal Group 1: IDF-E 1,200,000 m^3, RPPDF 1,080,000 m^3 Waste Management Alternative 3, Disposal Group 1: IDF-E 1,100,000 m^3, IDF-W 90,000 m^3, RPPDF 1,080,000 m^3					Total waste to IDF(s)/RPPDF: 242,000 m^3/468,000 m^3			

[a] Disposition of the cesium and strontium capsules will be determined under a separate National Environmental Policy Act process. However, for analysis purposes, they were assumed to be HLW.
[b] Closure LLW is the waste from decontamination and decommissioning of the containment structure over the tank farms after soil removal is complete.
[c] Closure MLLW includes soil, rubble, and equipment removed during closure of the tank farms.
[d] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.
[e] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters except as noted. To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, by 0.26417. Total may not equal the sum of the contributions due to rounding.

Key: CH=contact handed; HLW=high-level radioactive waste; IDF=Integrated Disposal Facility; IDF-E=200-East Area Integrated Disposal Facility; IDF-W=200-West Area Integrated Disposal Facility; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; LLW=low-level radioactive waste; m^3=cubic meters; MLLW=mixed low-level radioactive waste; N/A=not applicable; RH=remote-handled; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix E, Table E–10; SAIC 2010a.

4.1.14.4.4 Waste Treatment Plant Melters

As shown in Table 4–87 the volume of LAW melters generated under this Tank Closure alternative would be 2,260 cubic meters (79,800 cubic feet); this volume is included in the capacity of Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

As shown in Table 4–87, the volume of HLW melters generated under this Tank Closure alternative would be 1,100 cubic meters (47,700 cubic feet). DOE expects that the HLW melters would be stored on site.

4.1.14.4.5 Secondary Waste

4.1.14.4.5.1 Mixed Transuranic Waste

As shown in Table 4–87, the estimated volume of mixed TRU waste would be less than the waste volume assumed under both Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1; therefore, this volume should not impact existing TRU waste treatment and storage facilities and would be within the capacity allocated to Hanford for disposal at WIPP (DOE 1997:S-10).

4.1.14.4.5.2 Low-Level and Mixed Low-Level Radioactive Wastes

As shown in Table 4–87, Tank Closure Alternative 3A accounts for the disposal of 28,600 cubic meters (1.01 million cubic feet) of LLW, 679 cubic meters (24,000 cubic feet) of LLW generated by tank closure, and 41,700 cubic meters (1.47 million cubic feet) of MLLW generated by tank closure. LLW and MLLW would be disposed of in an IDF. The amount of LLW and MLLW generated under this Tank Closure alternative is consistent with that accounted for under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, no long-term storage capacity would be needed; the impacts of treating and disposing of this waste in an IDF are evaluated under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

4.1.14.4.5.3 Closure Mixed Low-Level Radioactive Waste

Under this Tank Closure alternative, large quantities of MLLW would be generated by the removal of ancillary equipment and the excavation of contaminated soil to a depth of approximately 4.6 meters (15 feet) from selected tank farms. This large quantity of tank closure MLLW (468,000 cubic meters [16.5 million cubic feet]) is included as a waste stream under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1, for disposal in a new disposal facility, the RPPDF, located between the 200-East and 200-West Areas, after confirmation that the waste stream meets the appropriate land-disposal-restriction treatment standards, such as the alternative soil treatment standards (40 CFR 268.49).

4.1.14.4.5.4 Hazardous Waste

A total of 79,700 cubic meters (2.81 million cubic feet) of hazardous waste would be generated during construction and operations. For 1 peak year (2039), hazardous waste would be generated at 31,400 cubic meters (1.11 million cubic feet) per year.

4.1.14.4.5.5 Nonhazardous Waste

The estimated volume of nonhazardous waste would be 1,660 cubic meters (58,600 cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

4.1.14.4.5.6 Liquid Process Waste

The estimated volume of low-level radioactive liquid process waste would be 9,690 liters (2,560 gallons). This waste would be treated on site.

4.1.14.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

4.1.14.5.1 Waste Inventories

Table 4–88 presents the estimated waste volumes generated under Alternative 3B. Under this Tank Closure alternative, closure activities would include the removal of ancillary equipment and the top 4.6 meters (15 feet) of soil from two tank farms. This tank closure waste would be disposed of in the new RPPDF.

4.1.14.5.2 High-Level Radioactive Waste

As shown in Table 4–88, 10,300 cubic meters (364,000 cubic feet) of IHLW canisters and 400 cubic meters (14,100 cubic feet) of cesium and strontium canisters would be generated. DOE expects that the IHLW canisters would be stored on site.

4.1.14.5.3 Treated Low-Activity Tank Waste

As shown in Table 4–88, the 299,000 cubic meters (10.6 million cubic feet) of ILAW generated by the two treatment processes under this Tank Closure alternative is within the capacity of Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

4.1.14.5.3.1 Mixed Transuranic Waste

Under this Tank Closure alternative, 1,500 cubic meters (53,000 cubic feet) of CH-mixed and 2,140 cubic meters (75,600 cubic feet) of RH-mixed TRU waste would be generated. This volume would be within the WIPP-analyzed capacities allocated to Hanford.

4.1.14.5.4 Waste Treatment Plant Melters

As shown in Table 4–88, the 2,260 cubic meters (79,800 cubic feet) of LAW melters generated under this Tank Closure alternative is included in the capacity of Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

As shown in Table 4–88, the volume of HLW melters generated under this Tank Closure alternative would be 1,100 cubic meters (38,800 cubic feet). DOE expects that the HLW melters would be stored on site.

Table 4–88. Tank Closure Alternative 3B Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
High-Level Radioactive Waste								
IHLW (8,700 canisters)	N/A	10,300	N/A	N/A	10,300	2018–2039	469	N/A
Cesium and strontium (340 canisters)[a]	N/A	400	N/A	N/A	400	2040	400	N/A
Treated Low-Activity Tank Waste								
ILAW (28,510 canisters)	N/A	65,800	N/A	N/A	65,800	2018–2039	2,990	65,800 (IDF)
Cast stone waste	N/A	233,000	N/A	N/A	233,000	2018–2039	10,600	233,000 (IDF)
CH-TRU waste	N/A	1,500	N/A	N/A	1,500	2009–2010	750	N/A
RH-TRU waste	N/A	2,140	N/A	N/A	2,140	2015–2019	428	N/A
WTP Melters								
HLW melters (9 melters)	N/A	1,100	N/A	N/A	1,100	Various	245	N/A
LAW melters (9 melters)	N/A	2,260	N/A	N/A	2,260	Various	513	2,260 (IDF)
Secondary Waste								
LLW	N/A	10,900	2,020	9,180	22,100	2035	1,680	22,100 (IDF)
MLLW	N/A	24,500	4,000	6,580	35,100	2040	2,550	35,100 (IDF)
Closure LLW[b]	N/A	N/A	N/A	679	679	2034–2036	226	679 (RPPDF)
Closure MLLW[c]	N/A	N/A	N/A	468,000	468,000	2028–2032	76,900	468,000 (RPPDF)
Mixed TRU waste	N/A	206	N/A	N/A	206	2027–2039	9	N/A
Hazardous waste[d]	196	63,300	16,100	106	79,700	2039	31,400	N/A
Nonradioactive-nonhazardous waste[e]	N/A	N/A	698	677	1,380	2041	343	N/A
Liquid LLW (liters)	N/A	N/A	N/A	9,690	9,690	2018–2028	881	N/A
IDF and RPPDF capacities: Waste Management Alternative 2, Disposal Group 1: IDF-E 1,200,000 m^3, RPPDF 1,080,000 m^3 Waste Management Alternative 3, Disposal Group 1: IDF-E 1,100,000 m^3, IDF-W 90,000 m^3, RPPDF 1,080,000 m^3					Total waste to IDF(s)/RPPDF: 358,000 m^3/469,000 m^3			

[a] Disposition of the cesium and strontium capsules will be determined under a separate National Environmental Policy Act process. However, for analysis purposes, they were assumed to be HLW.
[b] Closure LLW is the waste from the decontamination and decommissioning of the containment structure over the tank farms after soil removal is complete.
[c] Closure MLLW includes soil, rubble, and equipment removed during closure of the tank farms.
[d] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.
[e] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters except as noted. To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, by 0.26417. Total may not equal the sum of the contributions due to rounding.

Key: CH=contact-handled; HLW=high-level radioactive waste; IDF=Integrated Disposal Facility; IDF-E=200-East Area Integrated Disposal Facility; IDF-W=200-West Area Integrated Disposal Facility; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; LLW=low-level radioactive waste; m^3=cubic meters; MLLW=mixed low-level radioactive waste; N/A=not applicable; RH=remote-handled; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix E, Table E–10; SAIC 2010a.

4.1.14.5.5 Secondary Waste

4.1.14.5.5.1 Mixed Transuranic Waste

As shown in Table 4–88, the estimated volume of mixed TRU waste would be less than the waste volume assumed under both Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1; therefore, this volume should not impact existing TRU waste treatment and storage facilities and would be within the capacity allocated to Hanford for disposal at WIPP (DOE 1997:S-10).

4.1.14.5.5.2 Low-Level and Mixed Low-Level Radioactive Wastes

As shown in Table 4–88, Tank Closure Alternative 3B accounts for the disposal of 22,100 cubic meters (780,000 cubic feet) of LLW, 679 cubic meters (24,000 cubic feet) of LLW generated by tank closure, and 35,100 cubic meters (1.24 million cubic feet) of MLLW generated by tank closure. LLW and MLLW would be disposed of in an IDF. The amount of LLW and MLLW generated under this Tank Closure alternative is consistent with that accounted for under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, no long-term storage capacity would be needed; the impacts of treating and disposing of this waste in an IDF are evaluated under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

4.1.14.5.5.3 Closure Mixed Low-Level Radioactive Waste

Under this Tank Closure alternative, large quantities of MLLW would be generated by the removal of ancillary equipment and the excavation of contaminated soil to a depth of approximately 4.6 meters (15 feet) from selected tank farms. This large quantity of tank closure MLLW (468,000 cubic meters [16.5 million cubic feet]) is included as a waste stream under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1, for disposal in a new disposal facility, the RPPDF, located between the 200-East and 200-West Areas, after confirmation that the waste stream meets the appropriate land-disposal-restriction treatment standards, such as the alternative soil treatment standards (40 CFR 268.49). Land use, transportation, groundwater, and long-term human health impacts of closure waste disposal in the RPPDF under this Tank Closure alternative are evaluated in the appropriate sections of this *TC & WM EIS*.

4.1.14.5.5.4 Hazardous Waste

A total of 79,300 cubic meters (2.8 million cubic feet) of hazardous waste would be generated during construction and operations. For 1 peak year (2039), hazardous waste would be generated at 31,400 cubic meters (1.11 million cubic feet) per year.

4.1.14.5.5.5 Nonhazardous Waste

The estimated volume of nonhazardous waste would be 1,380 cubic meters (48,700 cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

4.1.14.5.5.6 Liquid Process Waste

The estimated volume of low-level radioactive liquid process waste would be 9,690 liters (2,560 gallons). This waste would be treated on site.

4.1.14.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

4.1.14.6.1 Waste Inventories

Table 4–89 presents the estimated waste volumes generated under Alternative 3C. Under this Tank Closure alternative, closure activities would include the removal of ancillary equipment and the top 4.6 meters (15 feet) of soil from two tank farms. This tank closure waste would be disposed of in the new RPPDF.

4.1.14.6.2 High-Level Radioactive Waste

As shown in Table 4–89, 10,300 cubic meters (364,000 cubic feet) of IHLW canisters and 400 cubic meters (14,100 cubic feet) of cesium and strontium canisters would be generated. DOE expects that the IHLW canisters would be stored on site.

4.1.14.6.3 Treated Low-Activity Tank Waste

As shown in Table 4–89, the 327,000 cubic meters (11.5 million cubic feet) of ILAW generated by the two treatment processes under this Tank Closure alternative is included in the capacity of Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Long-term impacts of radioactive and chemical releases from WTP and steam reforming waste on groundwater quality and human health are evaluated in Chapter 5.

4.1.14.6.3.1 Mixed Transuranic Waste

The 1,500 cubic meters (53,000 cubic feet) of CH-mixed and 2,140 cubic meters (75,600 cubic feet) of RH-mixed TRU waste generated from solidifying tank waste under this Tank Closure alternative would be within the WIPP-analyzed capacities allocated to Hanford.

4.1.14.6.4 Waste Treatment Plant Melters

As shown in Table 4–89, the 2,260 cubic meters (79,800 cubic feet) of LAW melters generated under this Tank Closure alternative is included in the capacity of Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

As shown in Table 4–89, the volume of HLW melters generated under this Tank Closure alternative would be 1,100 cubic meters (38,800 cubic feet). DOE expects that the HLW melters would be stored on site.

Table 4–89. Tank Closure Alternative 3C Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
High-Level Radioactive Waste								
IHLW (8,700 canisters)	N/A	10,300	N/A	N/A	10,300	2018–2039	469	N/A
Cesium and strontium (340 canisters)[a]	N/A	400	N/A	N/A	400	2040	400	N/A
Treated Low-Activity Tank Waste								
ILAW (28,510 canisters)	N/A	65,800	N/A	N/A	65,800	2018–2039	2,990	65,800 (IDF)
Cast stone waste	N/A	261,000	N/A	N/A	261,000	2018–2039	11,900	261,000 (IDF)
CH-TRU waste	N/A	1,500	N/A	N/A	1,500	2009–2010	750	N/A
RH-TRU waste	N/A	2,140	N/A	N/A	2,140	2015–2019	428	N/A
WTP Melters								
HLW melters (9 melters)	N/A	1,100	N/A	N/A	1,100	Various	245	N/A
LAW melters (9 melters)	N/A	2,260	N/A	N/A	2,260	Various	513	2,260 (IDF)
Secondary Waste								
LLW	N/A	10,700	1,980	9,180	21,800	2040	1,650	21,800 (IDF)
MLLW	N/A	10,900	3,650	6,580	21,100	2040	2,180	21,100 (IDF)
Closure LLW[b]	N/A	N/A	N/A	679	679	2034–2036	226	679 (RPPDF)
Closure MLLW[c]	N/A	N/A	N/A	468,000	468,000	2028–2033	78,000	468,000 (RPPDF)
Mixed TRU waste	N/A	206	N/A	N/A	206	2027–2039	9	N/A
Hazardous waste[d]	196	63,300	16,100	106	79,700	2039	31,400	N/A
Nonradioactive-nonhazardous waste[e]	N/A	254	765	677	1,700	2041	377	N/A
Liquid LLW (liters)	N/A	N/A	N/A	9,690	9,690	2018–2028	881	N/A
IDF and RPPDF capacities: Waste Management Alternative 2, Disposal Group 1: IDF-E 1,200,000 m^3, RPPDF 1,080,000 m^3 Waste Management Alternative 3, Disposal Group 1: IDF-E 1,100,000 m^3, IDF-W 90,000 m^3, RPPDF 1,080,000 m^3					Total waste to IDF(s)/RPPDF: 372,000 m^3/469,000 m^3			

[a] Disposition of the cesium and strontium capsules will be determined under a separate National Environmental Policy Act process. However, for analysis purposes, they were assumed to be HLW.
[b] Closure LLW is the waste from decontamination and decommissioning of the containment structure over the tank farms after soil removal is complete.
[c] Closure MLLW includes soil, rubble, and equipment removed during closure of the tank farms.
[d] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.
[e] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters except as noted. To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, by 0.26417. Total may not equal the sum of the contributions due to rounding.

Key: CH=contact-handled; HLW=high-level radioactive waste; IDF=Integrated Disposal Facility; IDF-E=200-East Area Integrated Disposal Facility; IDF-W=200-West Area Integrated Disposal Facility; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; LLW=low-level radioactive waste; m^3=cubic meters; MLLW=mixed low-level radioactive waste; N/A=not applicable; RH=remote-handled; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix E, Table E–10; SAIC 2010a.

4.1.14.6.5 Secondary Waste

4.1.14.6.5.1 Mixed Transuranic Waste

As shown in Table 4–89, the estimated volume of mixed TRU waste would be less than the waste volume assumed under both Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1; therefore, this volume should not impact existing TRU waste treatment and storage facilities and would be within the capacity allocated to Hanford for disposal at WIPP (DOE 1997:S-10).

4.1.14.6.5.2 Low-Level and Mixed Low-Level Radioactive Wastes

As shown in Table 4–89, Tank Closure Alternative 3C accounts for the disposal of 21,800 cubic meters (770,000 cubic feet) of LLW, 679 cubic meters (24,000 cubic feet) of LLW generated by tank closure, and 21,100 cubic meters (746,000 cubic feet) of MLLW generated by tank closure. LLW and MLLW would be disposed of in an IDF. The amount of LLW and MLLW generated under this Tank Closure alternative is consistent with that accounted for under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, no long-term storage capacity would be needed; the impacts of treating and disposing of this waste in an IDF are evaluated under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

4.1.14.6.5.3 Closure Mixed Low-Level Radioactive Waste

Under this Tank Closure alternative, large quantities of MLLW would be generated by the removal of ancillary equipment and the excavation of contaminated soil to a depth of approximately 4.6 meters (15 feet) from selected tank farms. This large quantity of tank closure MLLW (468,000 cubic meters [16.5 million cubic feet]) is included as a waste stream under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1, for disposal in a new disposal facility, the RPPDF, located between the 200-East and 200-West Areas, after confirmation that the waste stream meets the appropriate land-disposal-restriction treatment standards, such as the alternative soil treatment standards (40 CFR 268.49). Land use, transportation, groundwater, and long-term human health impacts of closure waste disposal in the RPPDF under this Tank Closure alternative are evaluated in the appropriate sections of this EIS.

4.1.14.6.5.4 Hazardous Waste

A total of 79,700 cubic meters (2.81 million cubic feet) of hazardous waste would be generated during construction and operations. For 1 peak year (2039), hazardous waste would be generated at 31,400 cubic meters (1.11 million cubic feet) per year.

4.1.14.6.5.5 Nonhazardous Waste

The estimated volume of nonhazardous waste would be 1,700 cubic meters (60,000 cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

4.1.14.6.5.6 Liquid Process Waste

The estimated volume of low-level radioactive liquid process waste would be 9,690 liters (2,560 gallons). This waste would be treated on site.

4.1.14.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

4.1.14.7.1 Waste Inventories

Table 4–90 presents the estimated waste volumes generated under Alternative 4. Under this Tank Closure alternative, closure activities would include removal from two tank farms of tanks and soils beneath the tanks that have been contaminated by past tank leaks. Some of these wastes would be sent to the PPF for treatment prior to disposal. The liquid waste streams from the treatment would be routed to the WTP and incorporated into the IHLW and ILAW glass streams. The majority of the waste volume from the closure wastes would be disposed of in the RPPDF.

4.1.14.7.2 High-Level Radioactive Waste

As shown in Table 4–90, 12,800 cubic meters (452,000 cubic feet) of IHLW canisters and 400 cubic meters (14,100 cubic feet) of cesium and strontium canisters would be generated. DOE expects that the IHLW canisters would be stored on site.

4.1.14.7.3 Treated Low-Activity Tank Waste

As shown in Table 4–90, the 251,000 cubic meters (8.86 million cubic feet) of ILAW generated by the three treatment processes under this Tank Closure alternative is within the capacity of Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

4.1.14.7.3.1 Mixed Transuranic Waste

The 1,510 cubic meters (53,300 cubic feet) of CH-mixed and 2,160 cubic meters (76,300 cubic feet) of RH-mixed TRU waste generated from solidifying tank waste under this Tank Closure alternative would be within the WIPP-analyzed capacities allocated to Hanford.

4.1.14.7.4 Waste Treatment Plant Melters

As shown in Table 4–90, the 2,570 cubic meters (90,800 cubic feet) of LAW melters generated under this Tank Closure alternative is within the capacity of Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

As shown in Table 4–90, the volume of HLW melters generated under this Tank Closure alternative would be 1,230 cubic meters (43,400 cubic feet). DOE expects that the HLW melters would be stored on site.

Table 4–90. Tank Closure Alternative 4 Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
High-Level Radioactive Waste								
IHLW (10,800 canisters)	N/A	12,800	N/A	N/A	12,800	2018–2042	512	N/A
Cesium and strontium (340 canisters)[a]	N/A	400	N/A	N/A	400	2043	400	N/A
Treated Low-Activity Tank Waste								
ILAW (28,690 canisters)	N/A	66,200	N/A	N/A	66,200	2018–2042	2,650	66,200 (IDF)
Cast stone waste	N/A	144,000	N/A	N/A	144,000	2018–2039	6,540	144,000 (IDF)
Bulk vitrification glass	N/A	40,500	N/A	N/A	40,500	2018–2039	1,840	40,500 (IDF)
CH-TRU waste	N/A	1,510	N/A	N/A	1,510	2009–2010	755	N/A
RH-TRU waste	N/A	2,160	N/A	N/A	2,160	2015–2019	432	N/A
WTP Melters								
HLW melters (10 melters)	N/A	1,230	N/A	N/A	1,230	Various	245	N/A
LAW melters (10 melters)	N/A	2,570	N/A	N/A	2,570	Various	513	2,570 (IDF)
Secondary Waste								
LLW	N/A	14,900	2,590	21,300	38,800	2043	2,230	38,800 (IDF)
MLLW	N/A	14,600	5,080	23,800	43,500	2043	7,650	43,500 (IDF)
Closure LLW[b]	N/A	N/A	N/A	2,400	2,400	2022–2033	200	2,400 (RPPDF)
Closure MLLW[c]	N/A	N/A	N/A	1,010,000	1,010,000	2034–2041	101,000	1,010,000 (RPPDF)
Mixed TRU waste	N/A	412	N/A	N/A	412	2013–2042	14	N/A
Hazardous waste[d]	224	63,900	15,700	128	79,900	2042–2043	31,400	N/A
Nonradioactive-nonhazardous waste[e]	N/A	254	937	519,000	520,000	2022–2044	35,000	N/A
Liquid LLW (liters)	N/A	N/A	N/A	9,690	9,690	2018–2028	881	N/A
IDF and RPPDF capacities: Waste Management Alternative 2, Disposal Group 1: IDF-E 1,200,000 m^3, RPPDF 1,080,000 m^3 Waste Management Alternative 3, Disposal Group 1: IDF-E 1,100,000 m^3, IDF-W 90,000 m^3, RPPDF 1,080,000 m^3					Total waste to IDF(s)/RPPDF: 336,000 m^3/1,010,000 m^3			

[a] Disposition of the cesium and strontium capsules will be determined under a separate National Environmental Policy Act process. However, for analysis purposes, they were assumed to be HLW.
[b] Closure LLW is the waste from decontamination and decommissioning of the containment structure over the tank farms after soil removal is complete.
[c] Closure MLLW includes soil, rubble, and equipment removed during closure of the tank farms.
[d] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.
[e] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters except as noted. To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, by 0.26417. Total may not equal the sum of the contributions due to rounding.

Key: CH=contact-handled; HLW=high-level radioactive waste; IDF=Integrated Disposal Facility; IDF-E=200-East Area Integrated Disposal Facility; IDF-W=200-West Area Integrated Disposal Facility; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; LLW=low-level radioactive waste; m^3=cubic meters; MLLW=mixed low-level radioactive waste; N/A=not applicable; RH=remote-handled; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix E, Table E–10; SAIC 2010a.

4.1.14.7.5 Secondary Waste

4.1.14.7.5.1 Mixed Transuranic Waste

As shown in Table 4–90, the 412 cubic meters (14,500 cubic feet) of mixed TRU waste would be less than the waste volume assumed under both Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1; therefore, this volume should not impact existing TRU waste treatment and storage facilities and would be within the capacity allocated to Hanford for disposal at WIPP (DOE 1997:S-10).

4.1.14.7.5.2 Low-Level and Mixed Low-Level Radioactive Wastes

As shown in Table 4–90, Tank Closure Alternative 4 accounts for the disposal of 38,800 cubic meters (1.4 million cubic feet) of LLW, 2,400 cubic meters (84,800 cubic feet) of LLW generated by tank closure, and 43,500 cubic meters (1.54 million cubic feet) of MLLW generated by tank closure. LLW and MLLW would be disposed of in an IDF. The amount of LLW and MLLW generated under this Tank Closure alternative is consistent with that accounted for under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, no long-term storage capacity would be needed; the impacts of treating and disposing of this waste in an IDF are evaluated under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

4.1.14.7.5.3 Closure Mixed Low-Level Radioactive Waste

Under this Tank Closure alternative, large quantities of MLLW would be generated by the clean closure of the BX and SX tank farms. This large quantity of tank closure MLLW (approximately 1.01 million cubic meters [35.7 million cubic feet]) is included as a waste stream under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1, for disposal of in a new disposal facility, the RPPDF, located between the 200-East and 200-West Areas, after confirmation that the waste stream meets the appropriate land-disposal-restriction treatment standards, such as the alternative soil treatment standards (40 CFR 268.49). Land use, transportation, groundwater, and long-term human health impacts of closure waste disposal in the RPPDF under this Tank Closure alternative are evaluated in the appropriate sections of this EIS.

4.1.14.7.5.4 Hazardous Waste

A total of 79,900 cubic meters (2.82 million cubic feet) of hazardous waste would be generated during construction and operations. For 2 peak years (2042–2043), hazardous waste would be generated at 31,400 cubic meters (1.11 million cubic feet) per year.

4.1.14.7.5.5 Nonhazardous Waste

The estimated volume of nonhazardous waste would be 520,000 cubic meters (18.4 million cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

4.1.14.7.5.6 Liquid Process Waste

The estimated volume of low-level radioactive liquid process waste would be approximately 9,690 liters (2,560 gallons). This waste would be treated on site.

4.1.14.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

4.1.14.8.1 Waste Inventories

Table 4–91 presents the estimated waste volumes generated under Tank Closure Alternative 5. Under this Tank Closure alternative, the SST system at Hanford would be closed as an RCRA hazardous waste landfill unit under WAC-173-303 and DOE Order 435.1, as applicable, or decommissioned under DOE Order 430.1B. No contaminated soil would be removed at the BX or SX tank farm.

4.1.14.8.2 High-Level Radioactive Waste

As shown in Table 4–91, 9,240 cubic meters (326,000 cubic feet) of IHLW canisters and 400 cubic meters (14,100 cubic feet) of cesium and strontium canisters would be generated. DOE expects that the IHLW canisters would be stored on site.

4.1.14.8.3 Treated Low-Activity Tank Waste

As shown in Table 4–91, the 178,200 cubic meters (6.3 million cubic feet) of ILAW generated by the four treatment processes under this Tank Closure alternative is within the capacity of Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Long-term impacts of radioactive and chemical constituents from the ILAW glass, bulk vitrification glass, cast stone waste, and sulfate grout waste on groundwater quality and human health are evaluated in Sections 4.6.6.3 and 4.6.13, respectively.

4.1.14.8.3.1 Mixed Transuranic Waste

Under this alternative, 39 cubic meters (1,380 cubic feet) of CH-mixed and 55 cubic meters (1,940 cubic feet) of RH-mixed TRU waste would be generated. This amount is within the WIPP-analyzed capacities allocated to Hanford.

4.1.14.8.4 Waste Treatment Plant Melters

As shown in Table 4–91, the volume of LAW melters generated under this Tank Closure alternative would be 2,460 cubic meters (86,900 cubic feet); this volume is included in the capacity of Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

As shown in Table 4–91, the volume of HLW melters generated under this Tank Closure alternative would be 858 cubic meters (30,300 cubic feet). DOE expects that the HLW melters would be stored on site.

Table 4–91. Tank Closure Alternative 5 Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
High-Level Radioactive Waste								
IHLW (7,800 canisters)	N/A	9,240	N/A	N/A	9,240	2018–2033	578	N/A
Cesium and strontium (340 canisters)[a]	N/A	400	N/A	N/A	400	2034	400	N/A
Treated Low-Activity Tank Waste								
ILAW (31,100 canisters)	N/A	71,800	N/A	N/A	71,800	2018–2033	4,490	71,800 (IDF)
Bulk vitrification glass	N/A	36,600	N/A	N/A	36,600	2018–2033	2,290	36,600 (IDF)
Cast stone waste	N/A	50,000	N/A	N/A	50,000	2018–2033	3,130	50,000 (IDF)
Sulfate grout	N/A	19,800	N/A	N/A	19,800	2018–2033	1,240	19,800 (IDF)
CH-TRU waste	N/A	39	N/A	N/A	39	2009–2010	19	N/A
RH-TRU waste	N/A	55	N/A	N/A	55	2015–2019	11	N/A
WTP Melters								
HLW melters (7 melters)	N/A	858	N/A	N/A	858	Various	245	N/A
LAW melters (10 melters)	N/A	2,460	N/A	N/A	2,460	Various	770	2,460 (IDF)
Secondary Waste								
LLW	N/A	14,800	2,130	3,750	20,600	2034	1,940	20,600 (IDF)
MLLW	N/A	14,600	4,290	3,670	22,600	2034	2,550	22,600 (IDF)
Closure MLLW[b]	N/A	N/A	3,060	N/A	3,060	2012–2022	278	3,060 (RPPDF)
Mixed TRU waste	N/A	183	N/A	N/A	183	2024–2033	10	N/A
Hazardous waste[c]	204	63,200	15,700	48	79,200	2033–2034	31,400	N/A
Nonradioactive-nonhazardous waste[d]	N/A	254	1,630	138	2,030	2035	409	N/A
Liquid LLW (liters)	N/A	N/A	N/A	9,690	9,690	2012–2022	881	N/A
IDF and RPPDF capacities: Waste Management Alternative 2, Disposal Group 1: IDF-E 1,200,000 m^3, RPPDF 1,080,000 m^3 Waste Management Alternative 3, Disposal Group 1: IDF-E 1,100,000 m^3, IDF-W 90,000 m^3, RPPDF 1,080,000 m^3					Total waste to IDF(s)/RPPDF: 224,000 m^3/3,060 m^3			

[a] Disposition of the cesium and strontium capsules will be determined under a separate National Environmental Policy Act process. However, for analysis purposes, they were assumed to be HLW.
[b] Closure MLLW includes soil, rubble, and equipment removed during closure of the tank farms.
[c] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.
[d] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters except as noted. To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, by 0.26417. Total may not equal the sum of the contributions due to rounding.

Key: CH=contact-handled; HLW=high-level radioactive waste; IDF=Integrated Disposal Facility; IDF-E=200-East Area Integrated Disposal Facility; IDF-W=200-West Area Integrated Disposal Facility; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; LLW=low-level radioactive waste; m^3=cubic meters; MLLW=mixed low-level radioactive waste; N/A=not applicable; RH=remote-handled; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix E, Table E–10; SAIC 2010a.

4.1.14.8.5 Secondary Waste

4.1.14.8.5.1 Mixed Transuranic Waste

As shown in Table 4–91, 183 cubic meters (6,460 cubic feet) of mixed TRU waste would be less than the waste volume assumed under both Waste Management Alternatives 2 and 3; therefore, this volume should not impact existing TRU waste treatment and storage facilities and would be within the capacity allocated to Hanford for disposal at WIPP (DOE 1997:S-10).

4.1.14.8.5.2 Low-Level and Mixed Low-Level Radioactive Wastes

As shown in Table 4–91, Tank Closure Alternative 5 accounts for the disposal of 20,600 cubic meters (727,000 cubic feet) of LLW and 22,600 cubic meters (798,000 cubic feet) of MLLW generated by tank closure. LLW and MLLW would be disposed of in an IDF. The amount of LLW and MLLW generated under this Tank Closure alternative is consistent with that accounted for under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, no long-term storage capacity would be needed; the impacts of treating and disposing of this waste in an IDF are evaluated under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

4.1.14.8.5.3 Closure Mixed Low-Level Radioactive Waste

Under this Tank Closure alternative, ancillary equipment would not be removed and soil would not be excavated from tank farms. The quantity of MLLW (3,060 cubic meters [108,000 cubic feet]) generated by decontamination and decommissioning of the structures over the tank farms is included as a waste stream under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1, for disposal in a new disposal facility, the RPPDF, located between the 200-East and 200-West Areas, after confirmation that the waste stream meets the appropriate land-disposal-restriction treatment standards, such as the alternative soil treatment standards (40 CFR 268.49). Land use, transportation, groundwater, and long-term human health impacts of closure waste disposal in the RPPDF under this Tank Closure alternative are evaluated in the appropriate sections of this EIS.

4.1.14.8.5.4 Hazardous Waste

A total of 79,200 cubic meters (280,000 cubic feet) of hazardous waste would be generated during construction and operations. For 2 peak years (2033–2034), hazardous waste would be generated at 31,400 cubic meters (111,000 cubic feet) per year.

4.1.14.8.5.5 Nonhazardous Waste

The estimated volume of nonhazardous waste would be 2,030 cubic meters (71,700 cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

4.1.14.8.5.6 Liquid Process Waste

The estimated volume of low-level radioactive liquid process waste would be 9,690 liters (2,560 gallons). This waste would be treated on site.

4.1.14.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

4.1.14.9.1 Waste Inventories

4.1.14.9.1.1 Base and Option Cases

Tables 4–92 and 4–93 present the estimated waste volumes generated under Tank Closure Alternative 6A, Base Case and Option Case, respectively. Under this Tank Closure alternative, closure activities include clean closure of all 12 SST farms in the 200-East and 200-West Areas. Clean closure of the tank farms would encompass extensive tank and ancillary equipment removal, all of which would be managed as HLW.

Tank closure waste that is not treated as HLW would be disposed of in the new RPPDF, to be located between the 200-East and 200-West Areas. The RPPDF would be similar to the IDF(s).

4.1.14.9.2 High-Level Radioactive Waste

4.1.14.9.2.1 Base and Option Cases

As shown in Tables 4–92 and 4–93, under both the Base Case and the Option Case, 203,000 cubic meters (7.17 million cubic feet) of IHLW canisters, 400 cubic meters (14,100 cubic feet) of cesium and strontium canisters, and 337,000 cubic meters (11.9 million cubic feet) of additional HLW would be generated. DOE expects that the IHLW canisters would be stored on site. The additional HLW would be stored on site in shielded boxes.

4.1.14.9.3 Treated Low-Activity Tank Waste

4.1.14.9.3.1 Base and Option Cases

Under this alternative the tank waste stream would not be separated in the Pretreatment Facility, and all waste would be managed as HLW.

4.1.14.9.4 Waste Treatment Plant Melters

4.1.14.9.4.1 Base and Option Cases

As shown in Tables 4–92 and 4–93, the volume of HLW melters generated under this Tank Closure alternative would be 17,800 cubic meters (629,000 cubic feet) under both the Base Case and the Option Case. DOE expects that the HLW melters would be stored on site.

Also shown in Tables 4–92 and 4–93, the volume of PPF melters generated under this Tank Closure alternative is 3,060 cubic meters (4,010 cubic yards) under the Base Case and 17,900 cubic meters (632,000 cubic feet) under the Option Case. This amount is within the IDF capacities of Waste Management Alternative 2, Disposal Group 3, and Waste Management Alternative 3, Disposal Group 3. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 3, and Waste Management Alternative 3, Disposal Group 3.

Table 4–92. Tank Closure Alternative 6A, Base Case, Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
High-Level Radioactive Waste								
IHLW (171,300 canisters)	N/A	203,000	N/A	N/A	203,000	2018–2162	1,410	N/A
Cesium and strontium (340 canisters)[a]	N/A	400	N/A	N/A	400	2163	400	N/A
Other HLW	N/A	N/A	N/A	337,000	337,000	2088–2099	6,410	N/A
WTP Melters								
HLW melters (145 melters)	N/A	17,800	N/A	N/A	17,800	Various	613	N/A
PPF melters (25 melters)	N/A	N/A	N/A	3,060	3,060	Various	123	3,060 (IDF)
Secondary Waste								
PPF glass (700 canisters)	N/A	N/A	N/A	1,600	1,600	2042–2162	13	1,600 (IDF)
LLW	N/A	17,900	4,560	70,300	93,000	2138–2140	1,110	93,000 (IDF)
MLLW	N/A	15,900	20,300	72,900	109,000	2163	3,160	109,000 (IDF)
Closure LLW[b]	N/A	N/A	N/A	4,070	4,070	(c)	194	4,070 (RPPDF)
Closure MLLW[d]	N/A	N/A	N/A	2,410,000	2,410,000	2054–2061	90,100	2,410,000 (RPPDF)
Mixed TRU waste	N/A	530	N/A	N/A	530	2013–2162	4	N/A
Hazardous waste[e]	1,980	64,200	15,700	317	82,200	2162–2163	31,400	N/A
Nonradioactive-nonhazardous waste[f]	N/A	254	13,600	2,580,000	2,590,000	2088–2099	44,100	N/A
Liquid LLW (liters)	N/A	N/A	N/A	9,690	9,690	2018–2028	881	N/A
IDF and RPPDF capacities: Waste Management Alternative 2, Disposal Group 3: IDF-E 425,000 m^3, RPPDF 8,370,000 m^3 Waste Management Alternative 3, Disposal Group 3: IDF-E 340,000 m^3, IDF-W 90,000 m^3, RPPDF 8,370,000 m^3					Total waste to IDF(s)/RPPDF: 207,000 m^3/2,414,000 m^3			

[a] Disposition of the cesium and strontium capsules will be determined under a separate National Environmental Policy Act process. However, for analysis purposes, they were assumed to be HLW.
[b] Closure LLW is the waste from decontamination and decommissioning of the containment structure over the tank farms after soil removal is complete.
[c] Peak generation coincides with deactivation of the containment structures during 2062–2064; 2085–2087; 2108–2110; 2123–2125; 2138–2140; 2146–2148; and 2162–2164.
[d] Closure MLLW includes soil, rubble, and equipment removed during closure of the tank farms.
[e] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.
[f] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters except as noted. To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, by 0.26417. Total may not equal the sum of the contributions due to rounding.

Key: HLW=high-level radioactive waste; IDF=Integrated Disposal Facility; IDF-E=200-East Area Integrated Disposal Facility; IDF-W=200-West Area Integrated Disposal Facility; IHLW=immobilized high-level radioactive waste; LLW=low-level radioactive waste; m^3=cubic meters; MLLW=mixed low-level radioactive waste; N/A=not applicable; PPF=Preprocessing Facility; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix E, Table E–10; SAIC 2010a.

Table 4–93. Tank Closure Alternative 6A, Option Case, Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
High-Level Radioactive Waste								
IHLW (171,330 canisters)	N/A	203,000	N/A	N/A	203,000	2018–2162	1,410	N/A
Cesium and strontium (340 canisters)[a]	N/A	400	N/A	N/A	400	2163	400	N/A
Other HLW	N/A	N/A	N/A	337,000	337,000	2088–2099	6,410	N/A
WTP Melters								
HLW melters (145 melters)	N/A	17,800	N/A	N/A	17,800	Various	613	N/A
PPF melters (146 melters)	N/A	N/A	N/A	17,900	17,900	Various	735	17,900 (IDF)
Secondary Waste								
PPF glass (18,320 canisters)	N/A	N/A	N/A	42,300	42,300	2042–2162	349	42,300 (IDF)
LLW	N/A	16,600	5,200	114,000	136,000	2146–2148	1,730	136,000 (IDF)
MLLW	N/A	15,400	19,700	117,000	152,000	2139–2140	3,180	152,000 (IDF)
Closure LLW[b]	N/A	N/A	N/A	5,430	5,430	2085–2087 2146–2148	420	5,430 (RPPDF)
Closure MLLW[c]	N/A	N/A	N/A	8,310,000	8,310,000	2054–2061	175,000	8,310,000 (RPPDF)
Mixed TRU waste	N/A	530	N/A	N/A	530	2013–2041	4	N/A
Hazardous waste[d]	1,730	64,200	15,700	430	82,000	2162–2163	31,400	N/A
Nonradioactive-nonhazardous waste[e]	N/A	254	13,600	3,240,000	3,250,000	2065–2076	52,100	N/A
Liquid LLW (liters)	N/A	N/A	N/A	9,690	9,690	2018–2028	881	N/A
IDF and RPPDF capacities: Waste Management Alternative 2, Disposal Group 3: IDF-E 425,000 m^3, RPPDF 8,370,000 m^3 Waste Management Alternative 3, Disposal Group 3: IDF-E 340,000 m^3, IDF-W 90,000 m^3, RPPDF 8,370,000 m^3					Option Case total waste to IDF(s)/ RPPDF: 348,000 m^3/8,320,000 m^3			

[a] Disposition of the cesium and strontium capsules will be determined under a separate National Environmental Policy Act process. However, for analysis purposes, they were assumed to be HLW.

[b] Closure LLW is the waste from decontamination and decommissioning of the containment structure over the tank farms after soil removal is complete.

[c] Closure MLLW includes soil, rubble, and equipment removed during closure of the tank farms.

[d] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.

[e] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters except as noted. To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, by 0.26417. Total may not equal the sum of the contributions due to rounding.

Key: HLW=high-level radioactive waste; IDF=Integrated Disposal Facility; IDF-E=200-East Area Integrated Disposal Facility; IDF-W=200-West Area Integrated Disposal Facility; IHLW=immobilized high-level radioactive waste; LLW=low-level radioactive waste; m^3=cubic meters; MLLW=mixed low-level radioactive waste; N/A=not applicable; PPF=Preprocessing Facility; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix E, Table E–10; SAIC 2010a.

4.1.14.9.5 Secondary Waste

4.1.14.9.5.1 Mixed Transuranic Waste

As shown in Tables 4–92 and 4–93, the estimated volume of mixed TRU waste would be less than the waste volume assumed under both Waste Management Alternative 2, Disposal Group 3, and Waste Management Alternative 3, Disposal Group 3; therefore, this volume should not impact existing TRU waste treatment and storage facilities and would be within the capacity allocated to Hanford for disposal at WIPP (DOE 1997:S-10).

4.1.14.9.5.2 Low-Level and Mixed Low-Level Radioactive Wastes

As shown in Tables 4–92 and 4–93, under Tank Closure Alternative 6A, 93,400 cubic meters (3.3 million cubic feet) of LLW would be generated under the Base Case and 136,000 cubic meters (4.80 million cubic feet) of LLW, under the Option Case; 4,070 cubic meters (144,000 cubic feet) of closure LLW would be generated under the Base Case and 5,430 cubic meters (192,000 cubic feet) of closure LLW, under the Option Case; and 109,000 cubic meters (3.85 million cubic feet) of MLLW would be generated under the Base Case and 152,000 cubic meters (5.4 million cubic feet) of MLLW, under the Option Case by tank closure.

LLW and MLLW would be disposed of in an IDF. The amount of LLW and MLLW generated under this Tank Closure alternative is consistent with that accounted for under Waste Management Alternative 2, Disposal Group 3, and Waste Management Alternative 3, Disposal Group 3. Therefore, no long-term storage capacity would be needed; the impacts of treating and disposing of this waste in an IDF are evaluated under Waste Management Alternative 2, Disposal Group 3, and Waste Management Alternative 3, Disposal Group 3.

4.1.14.9.5.3 Closure Mixed Low-Level Radioactive Waste

Under this Tank Closure alternative, large quantities of MLLW would be generated by the removal of ancillary equipment and the excavation of contaminated soil from selected tank farms. This large quantity of tank closure waste includes approximately 2.41 million cubic meters (approximately 85.1 million cubic feet) of MLLW under the Base Case and approximately 8.3 million cubic meters (approximately 293 million cubic feet) of MLLW under the Option Case. Under both cases, the contaminated soil would be disposed of in the RPPDF. Land use, transportation, groundwater, and long-term human health impacts of disposing of the closure wastes in the RPPDF under this Tank Closure alternative are evaluated under Waste Management Alternative 2, Disposal Group 3, and Waste Management Alternative 3, Disposal Group 3.

PPF treatment of the soils would generate 1,880 cubic meters (66,400 cubic feet) of PPF glass under the Base Case and 42,300 cubic meters (1.49 million cubic feet) under the Option Case. These canisters would be disposed of in an onsite IDF.

4.1.14.9.5.4 Hazardous Waste

A total of 82,200 cubic meters (2.90 million cubic feet) of hazardous waste under the Base Case and 82,000 cubic meters (2.90 million cubic feet) under the Option Case would be generated during construction and operations. For 2 peak years (2162–2163), hazardous waste would be generated at 31,400 cubic meters (1.11 million cubic feet) per year under either case.

4.1.14.9.5.5 Nonhazardous Waste

The estimated volume of nonhazardous waste would be approximately 2.59 million cubic meters (approximately 91.5 million cubic feet) under the Base Case and approximately 3.25 million cubic meters (approximately 155 million cubic feet) under the Option Case. This waste will be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

4.1.14.9.5.6 Liquid Process Waste

The estimated volume of low-level radioactive liquid process waste would be 9,690 liters (2,560 gallons) under both the Base Case and the Option Case. This waste would be treated on site.

4.1.14.10 Alternative 6B: All Vitrification with Separations; Clean Closure

4.1.14.10.1 Waste Inventories

4.1.14.10.1.1 Base and Option Cases

Tables 4–94 and 4–95 present the estimated waste volumes generated under Tank Closure Alternative 6B, Base Case and Option Case, respectively. Under this Tank Closure alternative, closure activities include clean closure of all 12 SST farms in the 200-East and 200-West Areas following deactivation. Clean closure of the tank farms would encompass extensive tank and ancillary equipment removal, all of which would be managed as HLW.

Tank closure waste that is not treated as HLW would be disposed of in the new RPPDF, to be located between the 200-East and 200-West Areas. The RPPDF would be similar to the IDF(s).

4.1.14.10.2 High-Level Radioactive Waste

4.1.14.10.2.1 Base and Option Cases

As shown in Tables 4–94 and 4–95, under both the Base Case and the Option Case, 14,200 cubic meters (501,000 cubic feet) of IHLW canisters, 400 cubic meters (14,100 cubic feet) of cesium and strontium canisters, and 337,000 cubic meters (11.9 million cubic feet) of additional HLW would be generated. DOE expects that the IHLW canisters would be stored on site. The additional HLW would be stored on site in shielded boxes.

4.1.14.10.3 Treated Low-Activity Tank Waste

4.1.14.10.3.1 Base and Option Cases

The LAW stream that is separated in the Pretreatment Facility would be managed as HLW under this Tank Closure alternative.

Table 4–94. Tank Closure Alternative 6B, Base Case, Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
High-Level Radioactive Waste								
IHLW (12,000 canisters)	N/A	14,200	N/A	N/A	14,200	2018–2039	646	N/A
Cesium and strontium (340 canisters)[a]	N/A	400	N/A	N/A	400	2040	400	N/A
ILAW (93,000 canisters)[b]	N/A	215,000	N/A	N/A	215,000	2018–2043	8,250	N/A
Other HLW	N/A	N/A	N/A	337,000	337,000	2023–2034	11,100	N/A
WTP Melters								
HLW melters (11 melters)	N/A	1,350	N/A	N/A	1,350	Various	245	N/A
LAW melters (31 melters)	N/A	8,000	N/A	N/A	8,000	Various	1,540	N/A
PPF melters (16 melters)	N/A	N/A	N/A	1,960	1,960	Various	123	1,960 (IDF)
Secondary Waste								
PPF glass (700 canisters)	N/A	N/A	N/A	1,600	1,600	2023–2099	21	1,600 (IDF)
LLW	N/A	27,800	1,690	70,400	99,900	2040	2,910	99,900 (IDF)
MLLW	N/A	27,800	4,090	72,700	105,000	2040	2,980	105,000 (IDF)
Closure LLW[c]	N/A	N/A	N/A	4,070	4,070	(d)	388	4,070 (RPPDF)
Closure MLLW[e]	N/A	N/A	N/A	2,410,000	2,410,000	2035–2042	124,000	2,410,000 (RPPDF)
Mixed TRU waste	N/A	412	N/A	N/A	412	2013–2043	13	N/A
Hazardous waste[f]	1,010	63,900	15,700	317	80,900	2039–2040	31,400	N/A
Nonradioactive-nonhazardous waste[g]	N/A	254	976	2,480,000	2,480,000	2023–2028	68,400	N/A
Liquid LLW (liters)	N/A	N/A	N/A	9,690	9,690	2018–2028	881	N/A
IDF and RPPDF capacities: Waste Management Alternative 2, Disposal Group 2: IDF-E 425,000 m^3, RPPDF 8,370,000 m^3 Waste Management Alternative 3, Disposal Group 2: IDF-E 340,000 m^3, IDF-W 90,000 m^3, RPPDF 8,370,000 m^3					Total waste to IDF(s)/RPPDF: 208,000 m^3/2,410,000 m^3			

[a] Disposition of the cesium and strontium capsules will be determined under a separate National Environmental Policy Act process. However, for analysis purposes, they were assumed to be HLW.
[b] All ILAW to be managed as HLW.
[c] Closure LLW is the waste from decontamination and decommissioning of the containment structure over the tank farms after soil removal is complete.
[d] Peak occurs twice: 2043–2045 and 2097–2099.
[e] Closure MLLW includes soil, rubble, and equipment removed during closure of the tank farms.
[f] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.
[g] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters except as noted. To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, by 0.26417. Total may not equal the sum of the contributions due to rounding.

Key: HLW=high-level radioactive waste; IDF=Integrated Disposal Facility; IDF-E=200-East Area Integrated Disposal Facility; IDF-W=200-West Area Integrated Disposal Facility; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; LLW=low-level radioactive waste; m^3=cubic meters; MLLW=mixed low-level radioactive waste; N/A=not applicable; PPF=Preprocessing Facility; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix E, Table E–10; SAIC 2010a.

Table 4–95. Tank Closure Alternative 6B, Option Case, Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
High-Level Radioactive Waste								
IHLW (12,000 canisters)	N/A	14,200	N/A	N/A	14,200	2018–2039	678	N/A
Cesium and strontium (340 canisters)[a]	N/A	400	N/A	N/A	400	2040	400	N/A
ILAW (93,000 canisters)[b]	N/A	215,000	N/A	N/A	215,000	2018–2043	8,260	N/A
Other HLW	N/A	N/A	N/A	337,000	337,000	2023–2034	11,100	N/A
WTP Melters								
HLW melters (11 melters)	N/A	1,350	N/A	N/A	1,350	Various	245	N/A
LAW melters (31 melters)	N/A	8,000	N/A	N/A	8,000	Various	1,540	N/A
PPF melters (93 melters)	N/A	N/A	N/A	11,400	11,400	Various	735	11,400 (IDF)
Secondary Waste								
PPF glass (18,320 canisters)	N/A	N/A	N/A	42,300	42,300	2023–2099	549	42,300 (IDF)
LLW	N/A	27,800	1,690	114,000	143,000	2040	3,630	143,000 (IDF)
MLLW	N/A	27,800	4,090	117,000	149,000	2040	3,700	149,000 (IDF)
Closure LLW[c]	N/A	N/A	N/A	5,430	5,430	2097–2099	614	5,430 (RPPDF)
Closure MLLW[d]	N/A	N/A	N/A	8,310,000	8,310,000	2035–2042	227,000	8,310,000 (RPPDF)
Mixed TRU waste	N/A	412	N/A	N/A	412	2013–2043	13	N/A
Hazardous waste[e]	1,010	63,900	15,700	430	81,000	2039–2040	31,400	N/A
Nonradioactive-nonhazardous waste[f]	N/A	254	1,200	3,240,000	3,240,000	2050–2061	79,600	N/A
Liquid LLW (liters)	N/A	N/A	N/A	9,690	9,690	2018–2028	881	N/A
IDF and RPPDF capacities: Waste Management Alternative 2, Disposal Group 2: IDF-E 425,000 m^3, RPPDF 8,370,000 m^3; Waste Management Alternative 3, Disposal Group 2: IDF-E 340,000 m^3, IDF-W 90,000 m^3, RPPDF 8,370,000 m^3					Total waste to IDF(s)/RPPDF: 346,000 m^3/8,315,000 m^3			

[a] Disposition of the cesium and strontium capsules will be determined under a separate National Environmental Policy Act process. However, for analysis purposes, they were assumed to be HLW.
[b] All ILAW to be managed as HLW.
[c] Closure LLW is the waste from decontamination and decommissioning of the containment structure over the tank farms after soil removal is complete.
[d] Closure MLLW includes soil, rubble, and equipment removed during closure of the tank farms.
[e] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.
[f] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters except as noted. To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, by 0.26417. Total may not equal the sum of the contributions due to rounding.

Key: HLW=high-level radioactive waste; IDF=Integrated Disposal Facility; IDF-E=200-East Area Integrated Disposal Facility; IDF-W=200-West Area Integrated Disposal Facility; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; LLW=low-level radioactive waste; m^3=cubic meters; MLLW=mixed low-level radioactive waste; N/A=not applicable; PPF=Preprocessing Facility; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix E, Table E–10; SAIC 2010a.

4.1.14.10.4 Waste Treatment Plant Melters

4.1.14.10.4.1 Base and Option Cases

As shown in Tables 4–94 and 4–95, the volume of HLW melters generated under this Tank Closure alternative would be 1,350 cubic meters (47,700 cubic feet) under both the Base Case and the Option Case. The volume of LAW melters generated under this Tank Closure alternative would be 8,000 cubic meters (283,000 cubic feet) under both the Base Case and the Option Case. DOE expects that the HLW and LAW melters would be stored on site.

Also shown in Tables 4–94 and 4–95, the volume of PPF melters generated under this Tank Closure alternative is 1,960 cubic meters (69,200 cubic feet) under the Base Case and 11,400 cubic meters (403,000 cubic feet) under the Option Case. This amount is within the IDF capacities of Waste Management Alternative 2, Disposal Group 2, and Waste Management Alternative 3, Disposal Group 2. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 2, and Waste Management Alternative 3, Disposal Group 2.

4.1.14.10.5 Secondary Waste

4.1.14.10.5.1 Mixed Transuranic Waste

As shown in Tables 4–94 and 4–95, the estimated volume of mixed TRU waste would be less than the waste volume assumed under both Waste Management Alternative 2, Disposal Group 2, and Waste Management Alternative 3, Disposal Group 2; therefore, this volume should not impact existing TRU waste treatment and storage facilities and would be within the capacity allocated to Hanford for disposal at WIPP (DOE 1997:S-10).

4.1.14.10.5.2 Low-Level and Mixed Low-Level Radioactive Wastes

As shown in Tables 4–94 and 4–95, under Tank Closure Alternative 6B, LLW and MLLW volumes generated by tank closure under the Base and Option Cases, respectively, would be 99,800 and 143,000 cubic meters (3.52 million and 5.05 million cubic feet) of LLW; 4,070 and 5,430 cubic meters (144,000 and 192,000 cubic feet) of closure LLW; and 105,000 and 149,000 cubic meters (3.71 million and 5.26 million cubic feet) of MLLW.

LLW and MLLW would be disposed of in an IDF. The amount of LLW and MLLW generated under this Tank Closure alternative is consistent with that accounted for under Waste Management Alternative 2, Disposal Group 2, and Waste Management Alternative 3, Disposal Group 2. Therefore, no long-term storage capacity would be needed; the impacts of treating and disposing of this waste in an IDF are evaluated under Waste Management Alternative 2, Disposal Group 2, and Waste Management Alternative 3, Disposal Group 2.

4.1.14.10.5.3 Closure Mixed Low-Level Radioactive Waste

Under this Tank Closure alternative, large quantities of MLLW would be generated by the removal of ancillary equipment and the excavation of contaminated soil from selected tank farms. This large quantity of tank closure waste includes approximately 2.41 million cubic meters (approximately 85 million cubic feet) of MLLW under the Base Case and approximately 8.31 million cubic meters (approximately 293 million cubic feet) of MLLW under the Option Case. Under both cases, the contaminated soil would be disposed of in the RPPDF. Land use, transportation, groundwater, and long-term human health impacts of disposing of the closure wastes in the RPPDF under this Tank Closure alternative are evaluated under Waste Management Alternative 2, Disposal Group 2, and Waste Management Alternative 3, Disposal Group 2.

PPF treatment of the soils would generate 1,960 cubic meters (69,216 cubic feet) of PPF glass under the Base Case and 42,300 cubic meters (1.49 million cubic feet) under the Option Case. These canisters would be disposed of in an onsite IDF.

4.1.14.10.5.4 Mixed Transuranic Waste

As shown in Tables 4–94 and 4–95, the estimated volume of mixed TRU waste would be less than the waste volume assumed under both Waste Management Alternative 2, Disposal Group 2, and Waste Management Alternative 3, Disposal Group 2; therefore, this volume should not impact existing TRU waste treatment and storage facilities.

4.1.14.10.5.5 Hazardous Waste

A total of 80,900 cubic meters (2.86 million cubic feet) of hazardous waste under the Base Case and 80,000 cubic meters (2.83 million cubic feet) under the Option Case would be generated during construction and operations. For 2 peak years (2092–2093), hazardous waste would be generated at 31,400 cubic meters (1.11 million cubic feet) per year under the Base Case and 31,000 cubic meters (1,090,000 cubic feet) per year under the Option Case.

4.1.14.10.5.6 Nonhazardous Waste

The estimated volume of nonhazardous waste would be approximately 2.48 million cubic meters (approximately 87.6 million cubic feet) under the Base Case and approximately 3.24 million cubic meters (approximately 1.14 million cubic feet) under the Option Case. This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

4.1.14.10.5.7 Liquid Process Waste

The estimated volume of low-level radioactive liquid process waste would be 9,690 liters (2,560 gallons) under both the Base Case and the Option Case. This waste would be treated on site.

4.1.14.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

4.1.14.11.1 Waste Inventories

Table 4–96 presents the estimated waste volumes generated under Alternative 6C. Under this Tank Closure alternative, closure activities include removal of ancillary equipment and the top 4.6 meters (15 feet) of soil from two tank farms. This tank closure waste would be disposed of in the new RPPDF, to be located between the 200-East and 200-West Areas. The RPPDF would be similar to the IDF(s).

4.1.14.11.2 High-Level Radioactive Waste

As shown in Table 4–96, 14,200 cubic meters (501,000 cubic feet) of IHLW canisters and 400 cubic meters (14,100 cubic feet) of cesium and strontium canisters would be generated. DOE expects that the IHLW canisters would be stored on site.

4.1.14.11.3 Treated Low-Activity Tank Waste

The LAW stream that is separated in the Pretreatment Facility would be managed as HLW under this Tank Closure alternative.

Table 4–96. Tank Closure Alternative 6C Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation		Total Waste Volume to IDF(s)/RPPDF
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Waste Volume/Year	
High-Level Radioactive Waste								
IHLW (12,000 canisters)	N/A	14,200	N/A	N/A	14,200	2018–2039	646	N/A
Cesium and strontium (340 canisters)[a]	N/A	400	N/A	N/A	400	2040	400	N/A
ILAW (92,250 canisters)	N/A	213,000	N/A	N/A	213,000	2018–2043	8,190	N/A
WTP Melters								
HLW melters (11 melters)	N/A	1,350	N/A	N/A	1,350	Various	245	N/A
LAW melters (31 melters)	N/A	8,000	N/A	N/A	8,000	Various	1,540	8,000 (IDF)
Secondary Waste								
LLW	N/A	27,500	968	6,170	34,700	2040	2,820	34,700 (IDF)
MLLW	N/A	27,500	2,870	9,630	40,000	2040	3,020	40,000 (IDF)
Closure LLW[b]	N/A	N/A	N/A	53	53	2038–2040	18	53 (RPPDF)
Closure MLLW[c]	N/A	N/A	N/A	468,000	468,000	2032–2037	78,000	468,000 (RPPDF)
Mixed TRU waste	N/A	206	N/A	N/A	206	2029–2043	8	N/A
Hazardous waste[d]	634	63,300	15,700	106	79,700	2039–2040	31,400	N/A
Nonradioactive-nonhazardous waste[e]	N/A	254	1,340	677	2,270	2044	594	N/A
Liquid LLW (liters)	N/A	N/A	N/A	9,690	9,690	2018–2028	881	N/A
IDF and RPPDF capacities: Waste Management Alternative 2, Disposal Group 1: IDF-E 1,200,000 m^3, RPPDF 1,080,000 m^3 Waste Management Alternative 3, Disposal Group 1: IDF-E 1,100,000 m^3, IDF-W 90,000 m^3, RPPDF 1,080,000 m^3					Total waste to IDF(s)/RPPDF: 82,700 m^3/468,000 m^3			

[a] Disposition of the cesium and strontium capsules will be determined under a separate National Environmental Policy Act process. However, for analysis purposes, they were assumed to be HLW.

[b] Closure LLW is the waste from decontamination and decommissioning of the containment structure over the tank farms after soil removal was complete.

[c] Closure MLLW includes soil, rubble, and equipment removed during closure of the tank farms.

[d] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.

[e] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.

Note: All values are in cubic meters except as noted. To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, by 0.26417. Total may not equal the sum of the contributions due to rounding.

Key: HLW=high-level radioactive waste; IDF=Integrated Disposal Facility; IDF-E=200-East Area Integrated Disposal Facility; IDF-W=200-West Area Integrated Disposal Facility; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; LLW=low-level radioactive waste; m^3=cubic meters; MLLW=mixed low-level radioactive waste; N/A=not applicable; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Appendix E, Table E–10; SAIC 2010a.

4.1.14.11.4 Waste Treatment Plant Melters

As shown in Table 4–96, the volume of HLW melters generated under this Tank Closure alternative would be 1,350 cubic meters (47,700 cubic feet). The volume of LAW melters generated under this Tank Closure alternative would be 8,000 cubic meters (283,000 cubic feet). DOE expects that the HLW melters would be stored on site. The LAW melters would be disposed of in an IDF. This amount is within the IDF capacities of Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, the impacts of providing disposal capacity in an IDF are included under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

4.1.14.11.5 Secondary Waste

4.1.14.11.5.1 Mixed Transuranic Waste

As shown in Table 4–96, the estimated volume of mixed TRU waste would be less than the waste volume assumed under both Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1; therefore, this volume should not impact existing TRU waste treatment and storage facilities.

4.1.14.11.5.2 Low-Level Radioactive Waste

As shown in Table 4–96, under Tank Closure Alternative 6C, 34,700 cubic meters (1.23 million cubic feet) of LLW and 53 cubic meters (1,870 cubic feet) of closure LLW would be generated. The amount of LLW generated under this Tank Closure alternative is consistent with that accounted for under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1. Therefore, the impacts of providing disposal capacity in an IDF are evaluated under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1.

4.1.14.11.5.3 Mixed Low-Level Radioactive Waste

As shown in Table 4–96, under Tank Closure Alternative 6C, 40,000 cubic meters (1.41 million cubic feet) of MLLW would be generated. The amount of MLLW generated under this Tank Closure alternative is consistent with that accounted for under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1; therefore, the impacts of treating and disposing of this waste in an onsite IDF have already been evaluated.

4.1.14.11.5.4 Closure Mixed Low-Level Radioactive Waste

Under this Tank Closure alternative, large quantities of MLLW would be generated by the removal of ancillary equipment and the excavation of contaminated soil to a depth of approximately 4.6 meters (15 feet) from selected tank farms. This large quantity of tank closure MLLW (468,000 cubic meters [16.6 million cubic feet]) is included as a waste stream under Waste Management Alternative 2, Disposal Group 1, and Waste Management Alternative 3, Disposal Group 1, for disposal in the RPPDF.

4.1.14.11.5.5 Hazardous Waste

A total of 79,700 cubic meters (2.81 million cubic feet) of hazardous waste would be generated during construction and operations. For 2 peak years (2039–2040), hazardous waste would be generated at 31,400 cubic meters (1.11 million cubic feet) per year.

4.1.14.11.5.6 Nonhazardous Waste

The estimated volume of nonhazardous waste would be 2,270 cubic meters (80,200 cubic feet). This waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

4.1.14.11.5.7 Liquid Process Waste

The estimated volume of low-level radioactive liquid process waste would be 9,690 liters (2,560 gallons). This waste would be treated on site.

4.1.15 Industrial Safety

Illness, injury, and death are possible outcomes of any industrial accident. The accepted standard for measuring the outcome of an industrial accident is the number of total recordable cases (TRCs) of illness, injury, and death. This section addresses potential impacts of illness, injury, and death associated with implementation of each of the alternatives. Appendix K, Section K.4, contains a description of the technique used to calculate the TRCs and fatalities, as well as definitions and other information used to perform this analysis.

A review of the data from 2001 through 2006 indicates that occupational injuries and illnesses incurred at Hanford have decreased. The TRC rate (2.0) for the DOE Office of River Protection was chosen because the work conducted up to this point is expected to be similar to work in the future. It is also expected that the safety practices, programs, and procedures will remain in place in the future. The DOE and contractor fatality incident rate was chosen because it represents all work conducted by DOE. Table 4–97 provides a list of the relevant TRC and fatality rates used in this analysis. These rates are based on DOE Office of River Protection and DOE-wide data reported in the Computerized Accident/Incident Reporting System, as well as private industry data maintained by the U.S. Bureau of Labor Statistics.

Table 4–97. Total Recordable Cases and Fatality Incident Rates

Labor Category	Total Recordable Case Rate[a]	Fatality Rate[b]
DOE and contractor	1.88	0.26
Construction (DOE and contractor)	2.4	0.0
Operations/production (DOE and contractor)	1.3	0.0
DOE Office of River Protection	2.0	0.0
Idaho Operations Office	1.5	0.0
Private industry (BLS)	5.0	4.0
Construction (private industry) (BLS)	6.7	11.8

[a] Average illness and injury cases per 200,000 labor hours from 2001–2006.
[b] Average fatality rate per 200 million labor hours from 2001–2006.
Key: BLS=U.S. Bureau of Labor Statistics; DOE=U.S. Department of Energy.
Source: BLS 2008, 2009; DOE 2007a, 2007b.

Using these incident rates and the projected labor hours, industrial safety impacts associated with each of the alternatives were determined (see Table 4–98). There are inherent uncertainties in estimating the number of TRCs and fatalities associated with future activities. Currently, there are no weighting factors assigned to the phases of an alternative that allow for normalizing the risks under each alternative. Therefore, when averaging the rate over all phases, this approach can result in slightly higher values for project operation and closure phases and lower values for activities that have higher risk of injury and illness.

Table 4–98. Tank Closure Alternatives – Industrial Safety Impacts

Alternative	Labor Category	Million Labor Hours	Total Recordable Case Rate per 200,000 Labor Hours	Projected Total Recordable Cases	Fatality Rate per 200 Million Labor Hours	Projected Fatalities
1	Construction	8.80	2.0	88.0	0.26	0.0114
	Operations	4.53	2.0	45.3	0.26	0.0059
	Deactivation	3.0	2.0	30.0	0.26	0.0039
	Closure	0	2.0	0.0	0.26	0.0
	Total	**16.3**		**163**		**0.02**
2A	Construction	186	2.0	1,860	0.26	0.24
	Operations	503	2.0	5,030	0.26	0.65
	Deactivation	18.9	2.0	189	0.26	0.025
	Closure	0.27	2.0	2.7	0.26	0.0004
	Total	**708.0**		**7,080**		**0.92**
2B	Construction	145	2.0	1,450	0.26	0.19
	Operations	228	2.0	2,280	0.26	0.30
	Deactivation	7.86	2.0	78.6	0.26	0.01
	Closure	7.48	2.0	74.8	0.26	0.01
	Total	**388.0**		**3,880**		**0.50**
3A	Construction	126	2.0	1,260	0.26	0.16
	Operations	206	2.0	2,060	0.26	0.27
	Deactivation	9.41	2.0	94.1	0.26	0.01
	Closure	7.48	2.0	74.8	0.26	0.01
	Total	**349**		**3,490**		**0.45**
3B	Construction	125	2.0	1,250	0.26	0.16
	Operations	202	2.0	2,020	0.26	0.26
	Deactivation	9.24	2.0	92.4	0.26	0.01
	Closure	7.48	2.0	74.8	0.26	0.01
	Total	**344**		**3,440**		**0.45**
3C	Construction	128	2.0	1,280	0.26	0.16
	Operations	212	2.0	2,120	0.26	0.28
	Deactivation	9.71	2.0	97.1	0.26	0.01
	Closure	7.48	2.0	74.8	0.26	0.01
	Total	**357**		**3,570**		**0.46**
4	Construction	156	2.0	1,560	0.26	0.20
	Operations	249	2.0	2,490	0.26	0.32
	Deactivation	10.3	2.0	103	0.26	0.01
	Closure	34.3	2.0	343	0.26	0.04
	Total	**450**		**4,500**		**0.59**

Table 4–98. Tank Closure Alternatives – Industrial Safety Impacts (*continued*)

Alternative	Labor Category	Million Labor Hours	Total Recordable Case Rate per 200,000 Labor Hours	Projected Total Recordable Cases	Fatality Rate per 200 Million Labor Hours	Projected Fatalities
5	Construction	129	2.0	1,290	0.26	0.17
	Operations	175	2.0	1,750	0.26	0.23
	Deactivation	10.1	2.0	101	0.26	0.01
	Closure	11.0	2.0	110	0.26	0.01
	Total	**325**		**3,250**		**0.42**
6A Base	Construction	513	2.0	5,130	0.26	0.67
	Operations	1,460	2.0	14,600	0.26	1.90
	Deactivation	26.8	2.0	268	0.26	0.03
	Closure	59.7	2.0	597	0.26	0.08
	Total	**2,060**		**20,600**		**2.67**
6A Option	Construction	513	2.0	5,130	0.26	0.67
	Operations	1,460	2.0	14,600	0.26	1.90
	Deactivation	26.7	2.0	267	0.26	0.03
	Closure	134	2.0	1,340	0.26	0.17
	Total	**2,130**		**21,300**		**2.77**
6B Base	Construction	180	2.0	1,800	0.26	0.23
	Operations	271	2.0	2,710	0.26	0.35
	Deactivation	9.05	2.0	90.5	0.26	0.01
	Closure	54.8	2.0	548	0.26	0.07
	Total	**515**		**5,150**		**0.67**
6B Option	Construction	180	2.0	1,800	0.26	0.23
	Operations	271	2.0	2,710	0.26	0.35
	Deactivation	9.05	2.0	90.5	0.26	0.01
	Closure	112	2.0	1,120	0.26	0.15
	Total	**572**		**5,720**		**0.74**
6C	Construction	146	2.0	1,460	0.26	0.19
	Operations	228	2.0	2,280	0.26	0.30
	Deactivation	7.86	2.0	78.6	0.26	0.01
	Closure	7.48	2.0	74.8	0.26	0.01
	Total	**389**		**3,890**		**0.51**

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate. Totals may not equal the sum of the contributions due to rounding.

Source: Labor hours compiled from Appendix I.

As shown in Figure 4–25, the higher industrial safety impacts are associated with those alternatives that require higher numbers of labor hours.

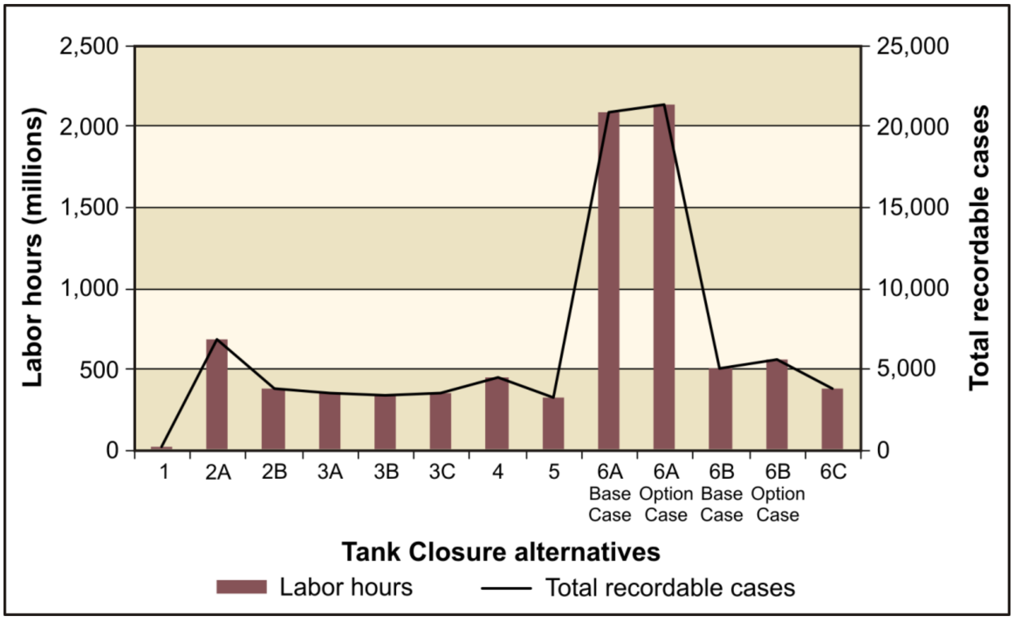


Figure 4–25. Total Recordable Cases and Labor Hours by Alternative

4.1.15.1 Alternative 1: No Action

It is anticipated that, under this alternative, there would be less than 200 TRCs and no fatalities.

4.1.15.2 Alternative 2A: Existing WTP Vitrification; No Closure

Projected impacts on worker safety under this alternative are 7,080 TRCs. A fatality as a result of an occupational accident is not anticipated. A value greater than 1 in the "Projected Fatalities" column of Table 4–98 indicates a death is anticipated. This value is based on the fatality incident rates (deaths per 200 million labor hours) recorded from 2001 through 2006. This alternative would require about 708 million labor hours, with the greater portion required during the peak periods of construction and operations.

4.1.15.3 Alternative 2B: Expanded WTP Vitrification; Landfill Closure

During all phases of the alternative, the projected impact is 3,880 TRCs and no fatalities. The greatest number of labor hours would be spent during the construction and operations phases.

4.1.15.4 Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

There is a total of 349 million labor hours for this alternative during all phases (construction, operations, decommissioning, and closure) of the project. Given the selected TRC rates for illness and injury, 3,490 TRCs are anticipated. No fatalities are anticipated during any phase of this alternative.

4.1.15.5 Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

Under this alternative, 344 million hours of work would occur during the construction, operations, deactivation, and closure phases. Given the selected incident rates for illness and injury, it is anticipated that 3,440 TRCs would occur. No fatalities are projected.

4.1.15.6 Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

Given the selected incident rates for illness and injury, it is anticipated that 3,570 TRCs would occur. No fatalities are projected.

4.1.15.7 Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

This alternative involves work requiring 450 million hours. It is anticipated that work under this alternative would generate approximately 4,500 TRCs. No fatalities are anticipated during any phase of the alternative.

4.1.15.8 Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

A total of 325 million labor hours are identified under this alternative. It is anticipated that about 3,250 TRCs would be generated by this alternative. No fatalities are expected during any phase of the alternative.

4.1.15.9 Alternative 6A: All Vitrification/No Separations; Clean Closure

Alternative 6A would impact occupational safety. Factors influencing this impact include the total labor hours required and the historical incident rate. There are two variations under Alternative 6A: the Base Case and the Option Case. The estimated impacts are addressed separately.

4.1.15.9.1 Base Case

Alternative 6A, Base Case, would require 2,160 million labor hours for the completion of all relevant tasks. About 21,600 TRCs and between two and three fatalities are projected to result annually.

4.1.15.9.2 Option Case

Alternative 6A, Option Case, would require 2,130 million labor hours that would generate 21,300 TRCs. Three fatalities are anticipated annually.

4.1.15.10 Alternative 6B: All Vitrification with Separations; Clean Closure

Alternative 6B would impact occupational safety. Factors influencing this impact include the total labor hours required and the historical incident rate. There are two variations under Alternative 6B: the Base Case and the Option Case. The estimated impacts are addressed separately.

4.1.15.10.1 Base Case

A total of 515 million labor hours would be required to accomplish all tasks under Alternative 6B, Base Case. Given the incident rate and total labor hours, about 5,150 TRCs and no fatalities are projected.

4.1.15.10.2 Option Case

Under Alternative 6B, Option Case, 572 million labor hours would be required to complete all relevant tasks. Given the total labor hours and incident rates for illness, injuries, and fatalities, about 5,720 TRCs and no fatalities are projected.

4.1.15.11 Alternative 6C: All Vitrification with Separations; Landfill Closure

Alternative 6C would require 389 million labor hours to complete all the tasks identified. Given application of the incident rate to the total labor hours, approximately 3,890 TRCs and no fatalities are projected.

4.2 FFTF DECOMMISSIONING ALTERNATIVES

This section describes the potential short-term environmental and human health impacts associated with implementation of alternatives considered for decommissioning of FFTF and its auxiliary facilities at Hanford; management of waste from the decommissioning process, including waste designated as remote-handled special components (RH-SCs); and disposition of the Hanford inventory of radioactively contaminated bulk sodium from FFTF, as well as other facilities on site. Three FFTF Decommissioning alternatives are considered and analyzed in this EIS: (1) FFTF Decommissioning Alternative 1: No Action, (2) FFTF Decommissioning Alternative 2: Entombment, and (3) FFTF Decommissioning Alternative 3: Removal.

Under FFTF Decommissioning Alternative 1: No Action, only certain deactivation activities at FFTF would be conducted, consistent with previous DOE National Environmental Policy Act actions. FFTF Decommissioning Alternative 2: Entombment would involve removing all aboveground structures within the 400 Area Property Protected Area (PPA), as well as minimal removal of below-grade structures, equipment, and materials as necessary to comply with regulatory standards. An RCRA-compliant barrier would be constructed over the remains of the Reactor Containment Building (RCB) and any other remaining below-grade structures (including the reactor vessel) that contain residual radioactive and treated hazardous materials. FFTF Decommissioning Alternative 3: Removal would involve removing all above-grade structures within the 400 Area PPA, as well as all contaminated below-grade structures, equipment, and materials. Associated construction, operations, deactivation, closure, and decommissioning activities were assessed, as applicable, under each alternative.

Under each action alternative (FFTF Decommissioning Alternatives 2 and 3), two options (a Hanford and an Idaho option) were evaluated for disposition of RH-SCs and processing of bulk sodium. For RH-SCs, the Hanford Option would involve treating the waste in a new Remote Treatment Project (RTP) at Hanford's T Plant, followed by disposal of the treated components and residuals along with other Hanford waste in the 200 Areas. Under the Idaho Option, RH-SCs would be shipped to an existing facility at the Idaho National Laboratory (INL) Idaho Nuclear Technology and Engineering Center (INTEC). Following treatment at INTEC, the FFTF components and residuals would be disposed of with other INL waste at the Nevada National Security Site (NNSS) (formerly the Nevada Test Site) or returned to Hanford for disposal in an IDF. For processing of bulk sodium under the Hanford Reuse Option, the bulk sodium would be stored in its current locations until it is shipped for processing to a new Sodium Reaction Facility (SRF) to be built in the 400 Area. The bulk sodium would be converted to a caustic sodium hydroxide solution for product reuse in processing tank waste at the WTP or for supporting Hanford tank corrosion controls. Under the Idaho Reuse Option, the bulk sodium would be stored in its current locations until it is shipped to the INL Materials and Fuels Complex (MFC) for processing in the existing Sodium Processing Facility (SPF). Following processing, the caustic solution would be returned to Hanford for product reuse. These alternatives and options are described further in Chapter 2, Section 2.5.3.

4.2.1 Land Resources

4.2.1.1 Alternative 1: No Action

4.2.1.1.1 Land Use

4.2.1.1.1.1 Facility Disposition

Under the No Action Alternative, the FFTF RCB and the rest of the buildings and structures within the 18-hectare (44.5-acre) FFTF PPA would remain in place (see Figure 4–26). Thus, the industrial nature of the 400 Area would not change and the presence of the FFTF RCB and associated facilities would preclude use of the area for other industrial purposes in the foreseeable future.

Any waste to be disposed of under this alternative would be placed in trenches 31 and 34 of LLBG 218-W-5 or in IDF-East (see Figure 4–1). As the 200 Areas have been designated Industrial-Exclusive, disposal associated with this alternative would not affect Hanford land use. Additional geologic material would not be needed under this alternative; thus, there would be no need to excavate geologic material from Borrow Area C.

4.2.1.1.1.2 Disposition of Remote-Handled Special Components

Under this alternative, RH-SCs would be removed from the FFTF RCB. They would be packaged and stored within the 400 Area. Thus, there would be no change in land use within the 400 Area.

4.2.1.1.1.3 Disposition of Bulk Sodium

Under the No Action Alternative, the Hanford bulk sodium inventory would remain stored untreated in its current Hanford locations; FFTF bulk sodium would remain within the Sodium Storage Facility (SSF) within the 400 Area (see Figure 4–26). As only existing facilities would be used, there would be no change in land use under this alternative.

4.2.1.1.2 Visual Resources

4.2.1.1.2.1 Facility Disposition

The FFTF RCB and associated buildings and structures would remain in place under the No Action Alternative. Thus, there would be no change in the appearance of the site or the current BLM Visual Resource Management Class IV rating for the 400 Area.

The minimal volume of waste to be disposed of under this alternative would be placed within trenches 31 and 34 of LLBG 218-W-5 or IDF-East. The use of either of these facilities would not change the overall visual appearance of the 200 Areas; thus, there would be no change in the BLM Visual Resource Management Class IV rating for the area.

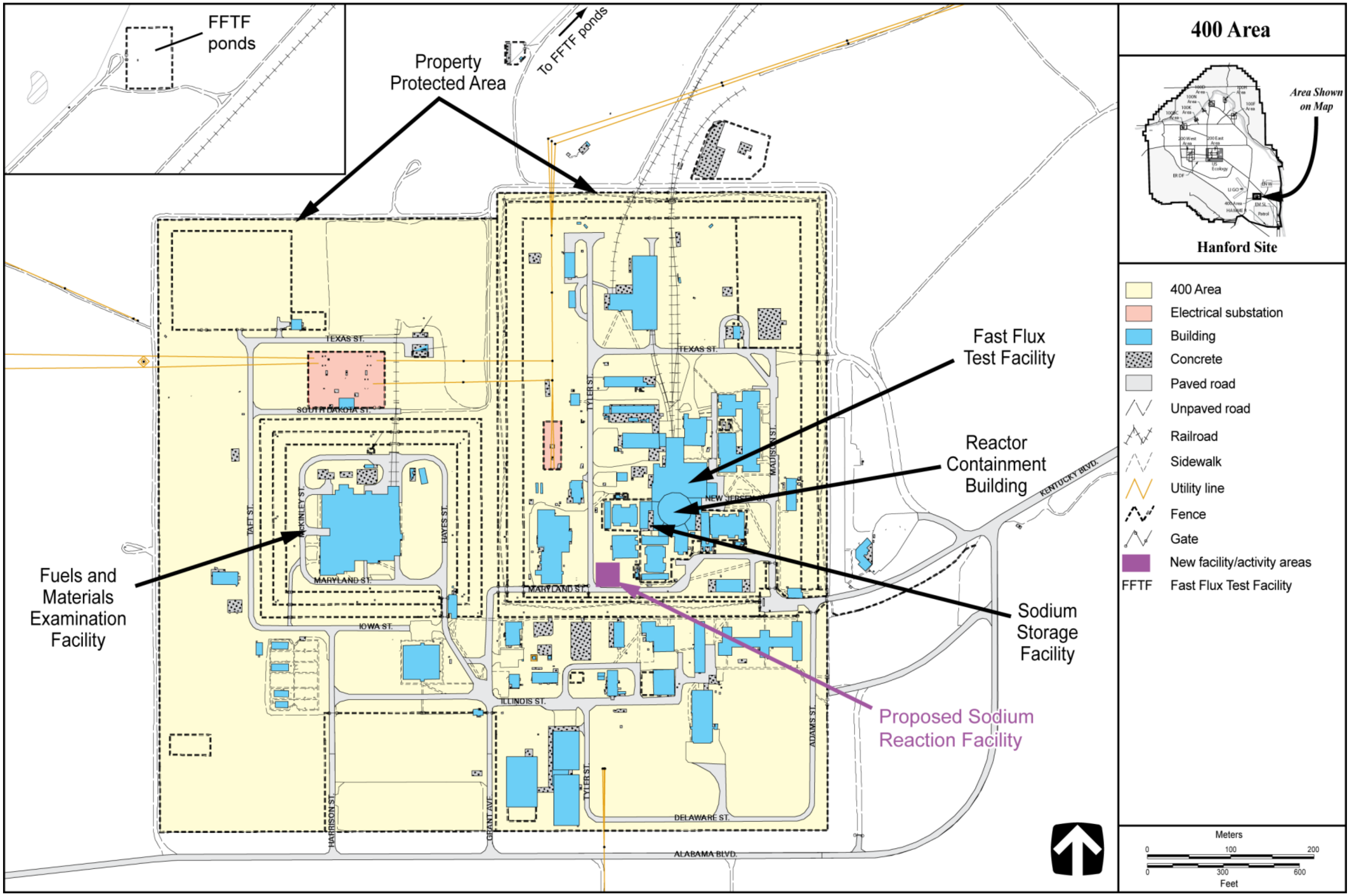


Figure 4–26. 400 Area Facility Location

4.2.1.1.2.2 Disposition of Remote-Handled Special Components

Under the No Action Alternative, RH-SCs would be removed and packaged for storage in the 400 Area. Thus, there would be no impact on the visual environment of the 400 Area and, consequently, no change in the Visual Resource Management Class IV rating of the area.

4.2.1.1.2.3 Disposition of Bulk Sodium

Under the No Action Alternative, FFTF sodium would be stored in the SSF, which is located within the 400 Area, and other bulk sodium would remain in place in the 200 Areas. Thus, there would be no impact on visual resources and no change in the Visual Resource Management Class IV rating of either area.

4.2.1.2 Alternative 2: Entombment

4.2.1.2.1 Land Use

4.2.1.2.1.1 Facility Disposition

Under Alternative 2, the FFTF RCB and immediately adjacent support facilities would be dismantled to below grade, and a 0.7-hectare (1.7-acre) modified RCRA Subtitle C barrier would be placed over the site. Other facilities within the PPA would be dismantled to grade. After appropriate preparation, 2.1 hectares (5.3 acres) of the site, including the barrier, would be revegetated. Thus, under this alternative, the PPA would be available for future development. Under this alternative, the Industrial designation of the 400 Area would not change.

Debris and other waste not placed in the RCB or used as backfill would be transported to trenches 31 and 34 of LLBG 218-W-5 or to IDF-East for disposal. Impacts on land use of constructing this IDF are addressed in Section 4.3.1.2.1.

Under this alternative, there would be a need to supply geologic material for grout and the modified RCRA Subtitle C barrier. This material would come from Borrow Area C, which is located to the south of State Route 240. The volume of material needed would necessitate the excavation of 2.8 hectares (7 acres), or 0.3 percent, of Borrow Area C. As Borrow Area C has a land use designation of Conservation (Mining), the removal of this material would be consistent with the current site land use plan.

4.2.1.2.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Under this option, RH-SCs would be stored, treated, and disposed of at Hanford. As both storage and disposal facilities currently exist within the 200 Areas and are presently used for similar purposes, their use under this option would not affect land use. Treatment of RH-SCs would involve construction of a new RTP at the T Plant complex located in the 200-West Area. This facility would encompass 0.1 hectares (0.3 acres) of land. As the 200-West Area has been designated as Industrial-Exclusive, the new facility would be in keeping with current land use.

IDAHO OPTION

Under this option, RH-SCs removed from the FFTF RCB would be stored at Hanford prior to shipment to INL, where they would be treated in an existing facility at INTEC. As a treatment facility currently exists and there would be no new construction, there would be no change to the existing land use. Treated components would be returned to Hanford or sent to NNSS for disposal, where they would be placed in existing disposal facilities. Thus, there would be no impact on land use at Hanford, INL, or NNSS from this element of the Idaho Option.

4.2.1.2.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Under the Hanford Reuse Option, sodium from FFTF would be sent to a new SRF to be built in the 400 Area. Construction of this new facility would require about 0.1 hectares (0.2 acres) of land near the SSF. As the new SRF would be constructed within the already highly developed 400 Area, which is designated as Industrial, there would be no impact on land use. The treated sodium would be stored in an existing facility within the 200 Areas; thus, there also would be no impact on land use from this element of the Hanford Reuse Option.

IDAHO REUSE OPTION

Under this option, sodium from FFTF and other sodium would be transported to INL for treatment in the SPF. Although the SPF is an existing facility within the MFC, its use would require a minor, external modification to accommodate a sodium offload system. However, this modification would not alter land use within the MFC. Further, there would be no change in land use in the 400 Area and 200 Areas at Hanford from implementation of this option because only existing facilities would be used.

4.2.1.2.2 Visual Resources

4.2.1.2.2.1 Facility Disposition

Under the Entombment Alternative, a 0.7-hectare (1.7-acre) modified RCRA Subtitle C barrier would be placed over FFTF and adjacent support facilities following their dismantlement to below grade. Remaining structures within the PPA would also be dismantled, but a barrier would not be used. Disturbed areas within the PPA would be revegetated. Thus, under this alternative, there would be an initial overall improvement in the visual character of the 400 Area. However, if the site were to accommodate industrial facilities in the future, its appearance could return to one similar to today's. Regardless, the overall BLM Visual Resource Management Class IV rating of the 400 Area would remain unchanged due to other development in the immediate area.

Some debris would be placed in the RCB or used as backfill. Remaining waste would be transported to trenches 31 and 34 of LLBG 218-W-5 or to IDF-East for disposal. Impacts on visual resources of constructing this IDF are addressed in Section 4.3.1.2.2.

Although only a limited area (2.8 hectares [7 acres]) would be developed within Borrow Area C to supply geologic material under this alternative, excavation activities would impact the view from State Route 240 and nearby higher elevations. As Borrow Area C would be visible and would attract the attention of the viewer, the BLM visual resource management rating would be lowered from Class II to Class III.

4.2.1.2.2.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Under this option, RH-SCs would be stored, treated, and disposed of at Hanford. As both storage and disposal facilities currently exist within the 200 Areas, their use under this option would not alter the visual environment. Treatment of RH-SCs would involve construction of a new RTP, which, when complete, would require less than 0.1 hectares (0.3 acres) of land. This facility would be constructed within the T Plant complex in the 200-West Area. As this area is presently industrial, the new facility would not meaningfully alter the visual environment. Thus, under this option, the BLM Visual Resource Management Class IV rating of the 200-West Area would not change.

IDAHO OPTION

Under this option, RH-SCs removed from the FFTF RCB would be stored at Hanford prior to shipment to INL, where they would be treated in an existing facility at INTEC. As INTEC is currently industrial in nature and an existing facility would be used, there would be no change in the existing visual environment. Treated components would be returned to Hanford or sent to NNSS for disposal, where they would be placed in existing disposal facilities. Thus, there would be no change in the BLM Visual Resource Management Class IV rating of involved areas at Hanford, INL, or NNSS under this alternative.

4.2.1.2.2.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Under this option, sodium from FFTF would be sent to a new SRF to be built in the 400 Area. This new facility, which would occupy 0.1 hectares (0.2 acres) of land, would be constructed near the SSF. As the SRF would be constructed within the already highly developed 400 Area, there would be minimal impact on visual resources. The treated sodium would be stored within an existing facility within the 200 Areas; thus, there would be no impact on the visual environment from this element of the Hanford Reuse Option. The BLM Visual Resource Management Class IV rating for each involved area would not change under this option.

IDAHO REUSE OPTION

Under the Idaho Reuse Option, sodium from FFTF and other sodium would be transported to INL for treatment in the SPF. As the SPF is an existing facility within the MFC that would require only a minor external modification to accommodate a sodium offload system, its use would not change the visual environment of the MFC. There also would be no change to visual impacts in the 400 Area and 200 Areas at Hanford from implementation of this option because only existing facilities would be used. Thus, the BLM Visual Resource Management Class IV rating for each involved area would not change.

4.2.1.3 Alternative 3: Removal

4.2.1.3.1 Land Use

4.2.1.3.1.1 Facility Disposition

Under this alternative, the FFTF RCB and adjacent support facilities would be removed to 0.9 meters (3 feet) below grade; however, an engineered barrier would not be needed because the reactor vessel and other radioactively contaminated equipment would be removed. A 1-meter-thick (3.3-foot-thick) layer of soil would be placed over the site to permit the growth of vegetation. In total, 2.4 hectares (6 acres) of the 400 Area would be revegetated under this alternative. Thus, as is the case under Alternative 2, the PPA would become available for future development. Under this alternative, the Industrial designation of the 400 Area would not change.

Debris and other waste would be handled in the same manner as under Alternative 2 (see Section 4.2.1.2.1.1); thus, there would be no impact on land use at Hanford. Additionally, it would be necessary to develop 3.2 hectares (8 acres), or 0.3 percent, of Borrow Area C to supply the geologic material needed under this alternative. As Borrow Area C is designated Conservation (Mining), this action would be consistent with the current site land use plan.

4.2.1.3.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

The steps involved in the disposition of RH-SCs under the Hanford Option of this alternative are identical to those under the Entombment Alternative. Thus, the impacts on land use from disposition-related activities would be the same as those discussed under the Hanford Option in Section 4.2.1.2.1.2.

IDAHO OPTION

Similar to the Hanford Option, the actions taken at INL would be the same under this alternative as those under the Entombment Alternative. Thus, the impacts on land use would be the same as those discussed under the Idaho Option in Section 4.2.1.2.1.2.

4.2.1.3.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

The steps involved in processing bulk sodium under the Hanford Reuse Option of this alternative would be identical to those under the Entombment Alternative. Thus, the impacts on land use from processing activities would be the same as those discussed under the Hanford Reuse Option in Section 4.2.1.2.1.3.

IDAHO REUSE OPTION

Similar to the Hanford Reuse Option, the steps involved in the processing of bulk sodium at INL would be the same under this alternative as those under the Entombment Alternative. Thus, the impacts on land use would be the same as those discussed under the Idaho Reuse Option in Section 4.2.1.2.1.3.

4.2.1.3.2 Visual Resources

4.2.1.3.2.1 Facility Disposition

The Removal Alternative would result in the dismantling and removal of the FFTF RCB and all associated structures within the PPA. Although an engineered barrier would not be used, the FFTF RCB site would be covered with a 1-meter-thick (3.3-foot-thick) layer of soil to permit the growth of vegetation. Overall, the visual impacts of this alternative would be similar to those under the Entombment Alternative because disturbed areas would be recontoured and revegetated. As under the Entombment Alternative, any future development would return the site to an industrial appearance. Regardless of future development, due to other industrial nature of the 400 Area, there would be no change in the BLM Visual Resource Management Class IV rating of the area.

Placement of debris and other waste resulting from removal activities in trenches 31 and 34 of LLBG 218-W-5 or in IDF-East is not expected to alter the overall appearance of either facility or the BLM Visual Resource Management Class IV rating of the 200 Areas. Although slightly more land would be affected, the visual impact of developing 3.2 hectares (8 acres) of Borrow Area C would be minimal, as described in Section 4.2.1.2.2.1.

4.2.1.3.2.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

The steps involved in the disposition of RH-SCs under the Hanford Option of the Removal Alternative are identical to those under the Entombment Alternative. Thus, the impacts on visual resources of disposition-related activities would be the same as those discussed under the Hanford Option in Section 4.2.1.2.2.2.

IDAHO OPTION

Similar to the Hanford Option, the actions taken at INL would be the same under this alternative as under the Entombment Alternative. Thus, impacts on visual resources would be the same as those discussed under the Idaho Option in Section 4.2.1.2.2.2.

4.2.1.3.2.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

The steps involved in the processing of bulk sodium under the Hanford Reuse Option of the Removal Alternative would be identical to those under the Entombment Alternative. Thus, the impacts on visual resources of processing activities would be the same as those discussed under the Hanford Reuse Option in Section 4.2.1.2.2.3.

IDAHO REUSE OPTION

Similar to the Hanford Reuse Option, the steps involved in the processing of bulk sodium at INL would be the same under this alternative as those under the Entombment Alternative. Thus, the impacts on visual resources would be the same as those discussed under the Idaho Reuse Option in Section 4.2.1.2.2.3.

4.2.2 Infrastructure

This subsection presents the potential impacts of FFTF Decommissioning alternatives and their associated options for disposition of RH-SCs and processing of bulk sodium on key utility infrastructure resources, including projected activity demands for electricity, fuel, and water. Total and peak annual utility infrastructure requirements are projected for each alternative and option, as well as for applicable component project phases (i.e., construction, operations, deactivation, closure, and decommissioning).

The key underlying assumptions used to project utility infrastructure demands under each of the FFTF Decommissioning alternatives and associated options are similar to those described in Section 4.1.2 for the Tank Closure alternatives. For example, it was assumed for analysis purposes that liquid fuels are not capacity-limiting resources because supplies would be replenished from offsite sources to support each alternative and provided at the point of use as needed.

Hanford's site utility infrastructure is described in Chapter 3, Section 3.2.2, and INL's is described in Chapter 3, Section 3.3.2. Table 4–99 summarizes the projected utility infrastructure resource requirements for the FFTF Decommissioning alternatives and associated options. Projected demands for key utility infrastructure resources and impacts on the respective utility systems from implementation of each of the alternatives and options are further discussed in the following sections.

Table 4–99. FFTF Decommissioning Alternatives and Options – Summary of Utility Infrastructure Requirements

Alternatives and Options	Activity Phase	Electricity (M megawatt-hours)	Diesel Fuel[a] (M liters)	Gasoline (M liters)	Water (M liters)
Alternative 1: No Action	Deactivation	0.60	0.0	0.11	795
	Total[b]	**0.60**	**0.0**	**0.11**	**795**
	Peak (Year)	**0.006 (2008–2107)**	**N/A**	**0.0011 (2008–2107)**	**7.95 (2008–2107)**
Alternative 2: Facility Disposition-Entombment	Decommissioning	0.0032	2.28	0.075	8.24
	Closure	0.0	1.74	0.29	11.4
	Total[b]	**0.0032**	**4.02**	**0.36**	**19.6**
	Peak (Year)	**0.0032 (2017)**	**1.74 (2021)**	**0.098 (2021)**	**11.4 (2021)**
Alternative 3: Facility Disposition-Removal	Decommissioning	0.0064	2.64	0.16	8.38
	Closure	0.0	1.11	0.22	10.5
	Total[b]	**0.0064**	**3.76**	**0.37**	**18.9**
	Peak (Year)	**0.0032 (2013–2014)**	**1.11 (2021)**	**0.050 (2013–2014)**	**10.5 (2021)**
Alternative 2 or 3: Disposition of RH-SCs (Hanford Option for remote treatment)	Construction	0.0	0.24	0.090	7.50
	Operations	0.00000071	0.00020	0.0	0.69
	Deactivation	0.00000036	0.00006	0.0	0.35
	Total[b]	**0.00000107**	**0.24**	**0.090**	**8.53**
	Peak (Year)	**0.00000071 (2017)**	**0.12 (2015–2016)**	**0.045 (2015–2016)**	**3.75 (2015–2016)**
Alternative 2 or 3: Disposition of RH-SCs (Idaho Option for remote treatment)	Construction	0.0	0.0	0.0	0.0
	Operations	0.00000071	0.0020	0.0	0.69
	Deactivation	0.00000036	0.00006	0.0	0.35
	Total[b]	**0.00000107**	**0.002**	**0.0**	**1.04**
	Peak (Year)	**0.00000071 (2017)**	**0.0020 (2017)**	**N/A**	**0.693 (2017)**
Alternative 2 or 3: Disposition of Bulk Sodium (Hanford Reuse Option)	Construction	0.0	0.95	0.36	0.17
	Operations	0.0013	0.011	0.0034	2.72
	Deactivation	0.0	0.13	0.051	0.032
	Total[b]	**0.0013**	**1.09**	**0.42**	**2.92**
	Peak (Year)	**0.00069 (2017)**	**0.47 (2015–2016)**	**0.18 (2015–2016)**	**1.36 (2017–2018)**
Alternative 2 or 3: Disposition of Bulk Sodium (Idaho Reuse Option)	Construction	0.0	0.015	0.0088	0.0
	Operations	0.0013	0.11	0.0034	2.72
	Deactivation	0.0	0.0	0.0	0.0
	Total[b]	**0.0013**	**0.12**	**0.012**	**2.72**
	Peak (Year)	**0.00068 (2015)**	**0.058 (2015)**	**0.0088 (2014)**	**1.36 (2015–2016)**

[a] Assumed to be inclusive of all No. 2 diesel fuel, including road diesel and heating fuel oil.

[b] Totals may not equal the sum of the contributions due to rounding.

Note: To convert liters to gallons, multiply by 0.26417. Values presented in the table have been rounded to no more than three significant digits, where appropriate.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; M=million; N/A=not applicable; RH-SCs=remote-handled special components.

Source: SAIC 2010b.

4.2.2.1 Alternative 1: No Action

Following the completion of deactivation activities for the FFTF complex and support buildings in the Hanford 400 Area under this alternative, utility infrastructure demands during the subsequent 100-year administrative control period would be very small and limited to usage levels necessary to maintain safety- and environmental–protection related systems, such as those for fire protection; heating, ventilating, and air conditioning; emergency lighting; and environmental monitoring, and to perform periodic facility inspections and system testing.

4.2.2.1.1 Electricity

Under Alternative 1, annual electrical energy demand to support FFTF complex surveillance activities over the 100-year administrative control period would remain relatively constant and would represent a small fraction (about 3.5 percent) of the 0.17 million megawatt-hours of electricity currently used annually at Hanford. The projected peak annual electricity demand of 0.006 million megawatt-hours during the administrative control period would be comparable to the 0.0051 million megawatt-hours used in fiscal year 2006 during FFTF deactivation.

4.2.2.1.2 Fuel

Annualized liquid fuel consumption (diesel fuel and gasoline) during the 100-year administrative control period for the FFTF complex would be a very small fraction (less than 0.03 percent) of the 4.3 million liters (1.1 million gallons) of liquid fuels currently used annually at Hanford.

4.2.2.1.3 Water

Annualized water demands in the 400 Area over the 100-year administrative control period would be a relatively small fraction, less than 1 percent, of the approximately 816.6 million liters (215.7 million gallons) of water used annually at Hanford. The projected annual water demand of 7.95 million liters (2.1 million gallons) would be about 6.8 percent of the 116 million liters (30.6 million gallons) of groundwater used in the 400 Area in fiscal year 2006 during FFTF deactivation.

4.2.2.2 Alternative 2: Entombment

4.2.2.2.1 Electricity, Fuel, and Water

4.2.2.2.1.1 Facility Disposition

Planning for the projected 8-year active decommissioning period under the Entombment Alternative calls for utility systems in the 400 Area PPA to be shut down as they are no longer needed. Deactivation of the office and maintenance buildings would be delayed until just prior to their scheduled demolition, so their utility infrastructure could be used to support overall entombment activities. As decommissioning activities proceeded, all equipment, piping, ducting, and electrical components would be removed by demolition personnel from building interiors prior to final demolition. Remaining underground utilities–electric, water, sewer, and communications–would be abandoned and capped at 3 feet (0.9 meters) below grade (BREI 2003:23, 29, 30, 31). Thus, existing utility infrastructure would be used to the extent possible and would then be supplemented or replaced by portable, temporary facilities as work progresses.

Electrical energy requirements under the Entombment Alternative would peak in 2017, driven by the demand for grout facility operations to grout the RCB and associated facilities. The peak electrical energy demand of 0.0032 million megawatt-hours (approximating an electric load of 0.37 megawatts) would be about 0.18 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system and about 0.54 percent of the 400 Area substation distribution capacity of 0.59 million megawatt-hours (67-megawatt load capacity).

Peak liquid fuel consumption under the Entombment Alternative would total about 1.74 million liters (0.46 million gallons) in 2021, primarily driven by surface barrier construction and related final site-closure activities.

Peak water demands would also occur in 2021, driven by water use for site regrading activities in conjunction with surface barrier construction. The projected peak water demand of 11.4 million liters (3.01 million gallons) would be about 0.06 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 9.8 percent of the 116 million liters (30.6 million gallons) of groundwater used in the 400 Area in fiscal year 2006.

4.2.2.2.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Impacts of construction, operations, and deactivation of the RTP, which would be used to treat RH-SCs, would be minimal compared with those of the FFTF disposition efforts. The new RTP would be located adjacent to Hanford's T Plant and would utilize existing utility tie-ins to the extent possible; operationally, the RTP would have a relatively short lifespan of 1 year. For facility construction, it was assumed that electric power requirements would be minimal; any required electricity would be produced via fuel-fired generators. The peak annual electrical energy demand of 0.00000071 million megawatt-hours (approximating an electric load of about 0.00008 megawatts) in 2017, driven by facility operations, would be about 0.00004 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system and about 0.00012 percent of the 400 Area substation distribution capacity of 0.59 million megawatt-hours (67-megawatt load capacity). Total liquid fuel demands of 0.33 million liters (0.087 million gallons) in 2015–2016 would primarily be limited to the amount necessary to operate construction equipment and transport RH-SCs by truck from the 400 Area to the T Plant. Water would be required to support both facility construction and operations. Total estimated water requirements would peak in the 2015–2016 timeframe at 3.75 million liters (0.991 million gallons), driven primarily by the need for dust control during facility construction.

IDAHO OPTION

Construction impacts under this option would be minimal to none because this option would involve modifications to an existing facility at INL's INTEC. Utility resources under this option would be limited to operations and deactivation activities. The peak annual electrical energy demand would be the same as discussed above under the Hanford Option. Total liquid fuel (diesel only) demands of 0.0020 million liters (0.0005 million gallons) in 2017 would come mainly from operations activities and would represent about 6 percent of the 0.033 million liters (0.0087 million gallons) of diesel fuel used annually at INTEC and 0.06 percent of the 3.5 million liters (0.92 million gallons) of total liquid fuel used at INTEC. The peak water demand of 0.693 million liters (0.183 million gallons) would occur in 2017 during operations and deactivation of the facility. This water requirement would be about 0.14 percent of the 500 million liters (132 million gallons) used annually at INTEC.

4.2.2.2.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Construction, operations, and deactivation of the SRF, which would be used to process Hanford bulk sodium and would be located in the 400 Area, would require relatively small quantities of utility resources as compared with the facility disposition efforts.

It was assumed that a fuel-fired generator would be used to supply electric power during facility construction. The peak electrical energy demand of 0.00069 million megawatt-hours (approximating an electric load of 0.080 megawatts) in 2017 during the first year of facility operations would be about 0.04 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system and about 0.12 percent of the 400 Area substation distribution capacity of 0.59 million megawatt-hours (67-megawatt load capacity).

Peak liquid fuel consumption under this option would total about 0.65 million liters (0.17 million gallons) in 2015–2016, associated with facility construction. Water requirements would peak in 2017–2018 at 1.36 million liters (0.359 million gallons) annually, driven by sodium processing operations. This water demand would be a small fraction (about 1.2 percent) of the 116 million liters (30.6 million gallons) of groundwater used in the 400 Area in fiscal year 2006.

IDAHO REUSE OPTION

Construction impacts on utility infrastructure under this option would be negligible as compared with those under the Hanford Reuse Option because this option would only involve modifications to an existing facility at INL's INTEC to receive and process Hanford sodium. Operational demands for utility resources would be very similar to those under the Hanford Reuse Option, except diesel fuel consumption for operations alone would be higher due to the need to transport Hanford sodium to and from INL. Total utility resource requirements would be less under this option.

4.2.2.3 Alternative 3: Removal

4.2.2.3.1 Electricity, Fuel, and Water

4.2.2.3.1.1 Facility Disposition

Similar to the situation previously described (see Section 4.2.2.2.1.1), utility systems in the closure area would be shut down as they are no longer needed and supplemented or replaced by portable, temporary facilities as site work progresses. Decommissioning activities involving the removal of major components, piping, and materials from the RCB under the Removal Alternative would drive overall utility resource demands under this alternative. Nevertheless, total utility infrastructure demands under this alternative would be similar to those projected above under the Entombment Alternative (see Table 4–99). This similarity is attributable to the fact that, while decommissioning requirements for the FFTF complex would be greater under this alternative, most utility resource needs to support final site closure would be markedly lower because, as under the Entombment Alternative, no surface barriers would need to be constructed.

Peak electrical energy requirements under the Removal Alternative would occur in 2013–2014, associated with grout facility operations as part of decommissioning. The peak electrical energy demand of 0.0032 million megawatt-hours (approximating an electric load of 0.37 megawatts) would be about 0.18 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system and about 0.54 percent of the 400 Area substation distribution capacity of 0.59 million megawatt-hours (67-megawatt load capacity).

Peak liquid fuel consumption under the Removal Alternative would total about 1.16 million liters (0.31 million gallons) in 2021, primarily driven by equipment operations in support of site regrading and revegetation activities. Similarly, peak water demands would also occur in 2021, driven by water use for final site activities including regrading and revegetation. The projected peak water demand of 10.5 million liters (2.77 million gallons) would be about 0.06 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 9.1 percent of the 116 million liters (30.6 million gallons) of the groundwater used in the 400 Area in fiscal year 2006.

4.2.2.3.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Utility resource demands under this option would be the same as those discussed in Section 4.2.2.2.1.2 under the Hanford Option.

IDAHO OPTION

Utility resource demands under this option would be the same as those discussed in Section 4.2.2.2.1.2 under the Idaho Option.

4.2.2.3.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Utility resource demands under this option would be the same as those discussed in Section 4.2.2.2.1.3 under the Hanford Reuse Option.

IDAHO REUSE OPTION

Utility resource demands under this option would be the same as those discussed in Section 4.2.2.2.1.3 under the Idaho Reuse Option.

4.2.3 Noise and Vibration

Facility construction, operations, decommissioning, deactivation, and closure activities, as applicable to each alternative, would result in minor noise impacts of employee vehicles, trucks, construction equipment, generators, and other equipment. The offsite noise levels from activities in the 200 and 400 Areas would be negligible due to the distance to the Hanford boundary. Heavy diesel equipment used for construction under most of the alternatives is expected to cause the highest noise levels. For example, if an estimated 67 items of construction equipment were operating at FFTF during the regrading closure and revegetation activities for Alternative 2 with a sound pressure level of 88 dBA at 15 meters (50 feet), the contribution to the sound level at the nearest site boundary would be 28 dBA (SAIC 2010b). During a normal daytime shift, the estimated maximum sound level at the site boundary from construction equipment operation would be well below the Washington State standard daytime maximum noise level limit of 60 dBA for industrial sources impacting residential receptors (WAC 173-60). Noise levels from decommissioning, operations, deactivation, and construction are expected to be less than those from this regrading closure activity.

Some disturbance of wildlife near the 200 and 400 Areas could occur as a result of noise from construction-type activities during decommissioning, construction, deactivation, and closure, as applicable to each alternative. Mitigation of impacts on special status species is discussed in Section 4.2.7.

The number of employee vehicles and trucks moving materials for various phases of FFTF decommissioning activities will vary over the duration of the project and by FFTF Decommissioning alternative. The increase in the number of employee vehicle and truck trips is discussed below for each FFTF Decommissioning alternative.

Activities at Hanford associated with the FFTF Decommissioning alternatives that would involve excavation, earthmoving, transport of fill material, and other vehicle traffic through Hanford could result in ground vibration that could affect LIGO operations. Most of the activities that have been identified to have impacts on this facility would be activities in which heavy vehicles or large construction equipment were used. It is expected that blasting would also have an impact on this facility if it is required for mining. Although DOE would coordinate vibration-producing activities with LIGO, the impacts of such activities are expected to result in some interference with the operations of this facility.

4.2.3.1 Alternative 1: No Action

The increase in the number of employee vehicle and truck trips under FFTF Decommissioning Alternative 1 is expected to result in an increase of less than 1 dBA in traffic noise levels along routes to the site. This increase would occur primarily during peak traffic hours. An increase of less than 2 or 3 dBA would be barely discernible to many listeners. Through use of the information cited in the discussion of local traffic in Section 4.2.9, the increase in employee and truck traffic was compared with the existing average traffic volume (see Chapter 3, Sections 3.2.9.4 and 3.3.9.4). For the purpose of comparing the alternatives, the increase in traffic noise level was estimated from the ratio of the projected traffic volume to the existing traffic volume (see Appendix F, Section F.3).

4.2.3.2 Alternative 2: Entombment

4.2.3.2.1 Facility Disposition

The increase in the number of employee vehicle and truck trips for facility disposition under Alternative 2 is expected to result in an increase of less than 1 dBA in traffic noise levels along routes to the site. This increase would occur primarily during peak traffic hours. An increase of less than 2 or 3 dBA would be barely discernible to many listeners. This assessment and conclusion is similar to that previously described under Alternative 1 (see Section 4.2.3.1).

4.2.3.2.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

The increase in the number of employee vehicle and truck trips for disposition of RH-SCs under FFTF Decommissioning Alternative 2, Hanford Option, is expected to result in an increase of less than 1 dBA in traffic noise levels along routes to the site. This increase would occur primarily during peak traffic hours. An increase of less than 2 or 3 dBA would be barely discernible to many listeners. This assessment and conclusion is similar to that previously described under Alternative 1 (see Section 4.2.3.1).

IDAHO OPTION

The increase in the number of employee vehicle and truck trips for disposition of RH-SCs at INL under FFTF Decommissioning Alternative 2, Idaho Option, is expected to result in an increase of less than 1 dBA in traffic noise levels along routes to the site. This increase would occur primarily during peak traffic hours. An increase of less than 2 or 3 dBA would be barely discernible to many listeners. This assessment and conclusion is similar to that previously described under Alternative 1 (see Section 4.2.3.1).

4.2.3.2.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

The increase in the number of employee vehicle and truck trips for disposition of bulk sodium under FFTF Decommissioning Alternative 2, Hanford Reuse Option, is expected to result in an increase of less than 1 dBA in traffic noise levels along routes to the site. This increase would occur primarily during peak traffic hours. An increase of less than 2 or 3 dBA would be barely discernible to many listeners. This assessment and conclusion is similar to that previously described under Alternative 1 (see Section 4.2.3.1).

IDAHO REUSE OPTION

The increase in the number of employee vehicle and truck trips for disposition of bulk sodium at INL under FFTF Decommissioning Alternative 2, Idaho Reuse Option, is expected to result in an increase of less than 1 dBA in traffic noise levels along routes to the site. This increase would occur primarily during peak traffic hours. An increase of less than 2 or 3 dBA would be barely discernible to many listeners. This assessment and conclusion is similar to that previously described under Alternative 1 (see Section 4.2.3.1).

4.2.3.3 Alternative 3: Removal

4.2.3.3.1 Facility Disposition

The increase in the number of employee vehicle and truck trips for facility disposition at Hanford under FFTF Decommissioning Alternative 3, is expected to result in an increase of less than 1 dBA in traffic noise levels along routes to the site. This increase would occur primarily during peak traffic hours. An increase of less than 2 or 3 dBA would be barely discernible to many listeners. This assessment and conclusion is similar to that previously described under Alternative 1 (see Section 4.2.3.1).

4.2.3.3.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

The impacts on traffic noise levels under this option would be the same as those discussed in Section 4.2.3.2.2 under the Hanford Option.

IDAHO OPTION

The impacts on traffic noise levels under this option would be the same as those discussed in Section 4.2.3.2.2 under the Idaho Option.

4.2.3.3.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

The impacts on traffic noise levels under this option would be the same as those discussed in Section 4.2.3.2.3 under the Hanford Reuse Option.

IDAHO REUSE OPTION

The impacts on traffic noise levels under this option would be the same as those discussed in Section 4.2.3.2.3 under the Idaho Reuse Option.

4.2.4 Air Quality

Activities under the various FFTF Decommissioning alternatives would result in some air quality impacts due to air pollutant emissions from employee vehicles, trucks, and construction equipment, and, as applicable under some FFTF Decommissioning alternatives, from heating equipment, generators, and process equipment. Criteria pollutant concentrations for the activities associated with each FFTF Decommissioning alternative were modeled, and the year with peak concentrations for each alternative, pollutant, and averaging time was identified (see Appendix G). These concentrations are presented in Table 4–100 and compared with the ambient concentration standards. The maximum concentrations that would result from these activities under each FFTF Decommissioning alternative would be below the ambient concentration standards, except possibly for $PM_{2.5}$ and nitrogen dioxide under Alternatives 2 and 3. The peak period identified for each FFTF Decommissioning alternative and the primary contributing activities are discussed for each alternative below. Maximum air quality impacts are expected to occur along State Route 240 or along or near the Hanford boundary to the east, south, or west. The concentration estimates for PM are high due to the high emissions estimates. PM concentrations would be reduced by applying appropriate dust control measures (see Chapter 7, Section 7.1).

Construction activities considered in estimating PM emissions include general construction equipment activity, windblown particulates from disturbed areas, resuspension of road dust, fuel combustion in construction equipment, and grout facility operations. For the Idaho Options under Alternatives 2 and 3, the maximum concentrations would be below the ambient standards. As described in Section 4.1.4, the emissions calculations result in a substantial overestimate of PM_{10} and $PM_{2.5}$ emissions. A refined analysis of emissions, based on more-detailed engineering of the construction activities and application of appropriate control technologies, is expected to result in substantially lower estimates of emissions and ambient concentrations from the major construction activities under any of the alternatives.

The sulfur dioxide emission factor used for fuel-burning sources was based on the use of equipment burning a distillate fuel with a sulfur content of about 0.0015 percent (15 ppm), which is being phased in beginning in 2007. No adjustment was made for more-restrictive emission standards for nitrogen dioxide and PM, which were scheduled to be phased in beginning in 2007. In future years pollutant emissions and impacts are expected to be smaller than estimated in this analysis, as better fuels, combustion technologies, emission controls, and alternative energy sources are developed.

Contributions to the total ambient concentrations from sources in the region and existing and reasonably anticipated sources at Hanford that are unrelated to FFTF activities are expected to change over the period of the activities evaluated in this EIS and are addressed in the cumulative impacts section. The existing contributions of Hanford sources and regional monitored concentrations are discussed in Chapter 3, Section 3.2.4. Existing contributions of INL sources and regional monitored concentrations are discussed in Chapter 3, Section 3.3.4.

Table 4–100. FFTF Decommissioning Alternatives – Maximum Incremental Criteria Pollutant Concentrations at the Hanford Site

Pollutant and Averaging Period	Standard[a] (micrograms per cubic meter)	Maximum Modeled Increment (micrograms per cubic meter)						
			Alternative 2			Alternative 3		
		Alternative 1	Facility Disposition	Disposition of Remote-Handled Special Components	Disposition of Bulk Sodium	Facility Disposition	Disposition of Remote-Handled Special Components	Disposition of Bulk Sodium
Carbon Monoxide								
8-hour	10,000[b]	4.35	60.6	5.47	719	53.0	5.47	719
1-hour	40,000[b]	31.3	435	39.3	5,160	381	39.3	5,160
Nitrogen Dioxide								
Annual	100[b]	0.00066	2.91	(c)	(c)	2.09	(c)	(c)
1-hour	188	0.812	**3,590**	(c)	(c)	**2,570**	(c)	(c)
PM_{10}[d]								
Annual	50[e]	0.0000405	0.466	0.623	0.334	1.07	0.623	0.334
24-hour	150[b]	0.00272	31.3	41.9	22.5	72	41.9	22.5
$PM_{2.5}$[d]								
Annual	15[d]	0.0000405	0.466	0.623	0.334	1.07	0.623	0.334
24-hour	35[d]	0.00272	31.3	**41.9**	22.5	72	41.9	22.5
Sulfur Dioxide								
Annual	50[e]	0.000034	0.0249	0.0000504	0.00566	0.0409	(c)	(c)
24-hour	260[e]	0.00229	1.67	0.00339	0.381	2.75	(c)	(c)
3-hour	1,300[b]	0.014	10.2	0.0207	2.32	16.8	(c)	(c)
1-hour	197[e]	0.0419	30.6	0.062	6.97	50.4	(c)	(c)

a The more stringent of the Federal and Washington State standards is presented if both exist for the averaging period. The NAAQS (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The annual $PM_{2.5}$ standard is met when the 3-year average of the annual means is less than or equal to the standard. The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the 98th percentile 24-hour averages is less than or equal to the standard. The 1-hour nitrogen dioxide standard is met when the 3-year average 98th percentile of the daily maximum 1-hour average does not exceed the standard value.

b Federal and Washington State standard.

c There is no disposition of remote-handled special components or bulk sodium in the peak year for this pollutant.

d The Federal standards for $PM_{2.5}$ are 15 micrograms per cubic meter annual average and 35 micrograms per cubic meter 24-hour average. No specific data for $PM_{2.5}$ were available, but for analysis purposes, concentrations were assumed to be the same as PM_{10}.

e Washington State standard.

Note: NAAQS also includes standards for lead and ozone. No sources of lead emissions have been identified for the alternatives evaluated. Washington State also has ambient standards for fluorides. Concentrations in **bold** text indicate potential exceedance of the standard.

Key: FFTF=Fast Flux Test Facility; NAAQS=National Ambient Air Quality Standards; PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

Source: Appendix G, Section G.3.

The Clean Air Act, as amended, requires that Federal actions conform to the host state's "state implementation plan" (see Appendix G, Section G.4). The final rule, "Determining Conformity of General Federal Actions to State or Federal Implementation Plans," requires a conformity determination for certain-size projects in nonattainment areas. Hanford and INL are within areas currently designated as in attainment for criteria air pollutants. Therefore, a conformity determination for these alternatives is not necessary to meet the requirements of the final rule (40 CFR 93, Subpart B).

Both carcinogenic and noncarcinogenic toxic pollutant concentrations were evaluated. Exposure of members of the public to airborne pollutants would be sourced from process emissions released during operations and from equipment used during construction, operations, and decommissioning. Selected air toxics were modeled because they represent toxic constituents associated with emissions from operation of gasoline- and diesel-fueled equipment. Maximum concentrations for each alternative and the Washington State acceptable source impact levels are presented in Table 4–101. These concentrations are below the acceptable source impact levels for all of the alternatives. The acceptable source impact levels are used by the state in the permitting process and represent concentrations sufficiently low to protect human health and safety from potential carcinogenic and other toxic effects (WAC 173-460).

Table 4–101. FFTF Decommissioning Alternatives – Maximum Incremental Toxic Chemical Concentrations at the Hanford Site

Pollutant	Averaging Period	Acceptable Source Impact Level[a] (micrograms per cubic meter)	Maximum Modeled Increment (micrograms per cubic meter)						
			Alternative 1	Alternative 2			Alternative 3		
				FD	Disposition of RH-SCs	DBS	FD	Disposition of RH-SCs	DBS
Ammonia	24-hour	70.8	0.000132	0.196	0.0157	14.0	0.0264	0.0157	14.0
Benzene	Annual	0.0345	0.00000327	0.0109	(b)	(b)	0.0109	(b)	(b)
1,3-Butadiene	Annual	0.00588	0.0000000183	0.000229	(b)	(b)	0.000119	(b)	(b)
Formaldehyde	Annual	0.167	0.0000011	0.00367	(b)	(b)	0.00367	(b)	(b)
Mercury	24-hour	0.09	0	0	0	0	0	0	0
Toluene	24-hour	5,000	0.00338	11.3	(b)	(b)	11.3	(b)	(b)
Xylene	24-hour	(c)	0.000954	3.18	(b)	(b)	3.18	(b)	(b)

[a] WAC 173-460. Acceptable source impact levels were updated in this environmental impact statement.
[b] There is no disposition of RH-SCs or bulk sodium in the peak year for this pollutant.
[c] Not listed in WAC 173-460.
Key: DBS=Disposition of Bulk Sodium; FD=Facility Disposition; FFTF=Fast Flux Test Facility; RH-SCs=remote-handled special components.
Source: Appendix G, Section G.3.

For noninvolved workers at nearby facilities, the highest annual concentration for each toxic chemical was used to estimate the Hazard Quotient for each chemical, as described in Appendix G. The Hazard Quotients were summed to provide the Hazard Index from noncarcinogenic chemicals associated with the alternative. A Hazard Index of less than 1 indicates that adverse health effects of non-cancer-causing agents are not expected. Hazard Indices for each alternative are summarized in Table 4–102. For carcinogens, the highest annual concentration was used to estimate the increased cancer risk from a chemical. Cancer risks from nonradioactive toxic pollutant emissions for each alternative are summarized in Table 4–103.

Table 4–102. FFTF Decommissioning Alternatives – Nonradioactive Airborne Toxic Chemical Hazard Index for the Nearest Noninvolved Worker at the Hanford Site

	Hazard Quotient						
		Alternative 2			Alternative 3		
Chemical	**Alternative 1**	**Facility Disposition**	**Disposition of Remote-Handled Special Components**	**Disposition of Bulk Sodium**	**Facility Disposition**	**Disposition of Remote-Handled Special Components**	**Disposition of Bulk Sodium**
Ammonia	1.67×10^{-8}	1.35×10^{-4}	1.77×10^{-3}	1.78×10^{-3}	1.17×10^{-4}	1.99×10^{-6}	1.78×10^{-3}
Mercury	0	0	0	0	0	0	0
Toluene	8.56×10^{-9}	2.94×10^{-5}	1.37×10^{-6}	1.76×10^{-6}	2.92×10^{-5}	2.34×10^{-9}	1.76×10^{-6}
Xylene	1.21×10^{-7}	4.17×10^{-4}	1.96×10^{-5}	2.52×10^{-5}	4.13×10^{-4}	8.16×10^{-8}	2.51×10^{-5}
Hazard Index	1.46×10^{-7}	5.81×10^{-4}	1.79×10^{-3}	1.81×10^{-3}	5.59×10^{-4}	2.07×10^{-6}	1.80×10^{-3}

Key: FFTF=Fast Flux Test Facility.
Source: Appendix G, Section G.3.

Table 4–103. FFTF Decommissioning Alternatives – Nonradioactive Airborne Toxic Chemical Cancer Risk for the Nearest Noninvolved Worker

		Alternative 2			Alternative 3		
Chemical	**Alternative 1**	**Facility Disposition**	**Disposition of Remote-Handled Special Components**	**Disposition of Bulk Sodium**	**Facility Disposition**	**Disposition of Remote-Handled Special Components**	**Disposition of Bulk Sodium**
Benzene	2.17×10^{-11}	8.16×10^{-8}	4.54×10^{-9}	6.04×10^{-9}	7.91×10^{-8}	2.08×10^{-10}	5.83×10^{-9}
1,3-Butadiene	4.69×10^{-13}	8.30×10^{-9}	2.51×10^{-10}	3.55×10^{-10}	5.21×10^{-9}	3.35×10^{-11}	3.22×10^{-10}
Formaldehyde	1.22×10^{-11}	5.43×10^{-8}	4.24×10^{-9}	5.88×10^{-9}	5.12×10^{-8}	4.39×10^{-10}	5.44×10^{-9}

Key: FFTF=Fast Flux Test Facility.
Source: Appendix G, Section G.3.

4.2.4.1 Alternative 1: No Action

Criteria pollutant concentrations from activities under FFTF Decommissioning Alternative 1 are presented in Table 4–100. The peak concentrations of all criteria pollutants would occur from 2008 through 2107. The peak period concentration would result from administrative control activities.

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–101. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–102 and 4–103. A Hazard Index of less than 1 indicates that adverse health effects of non-cancer-causing agents are not expected.

4.2.4.2 Alternative 2: Entombment

Criteria pollutant concentrations from facility disposition, disposition of RH-SCs, and disposition of bulk sodium under FFTF Decommissioning Alternative 2 at Hanford are presented in Table 4–100. The peak concentrations occur in 2016 for all pollutants except nitrogen dioxide, which peaks in 2021. The peak period concentration would result primarily from Hanford SRF construction (for carbon monoxide); from Hanford SRF and RTP construction (for PM); from grout facility construction (for sulfur dioxide); and from modified RCRA Subtitle C barrier construction and site regrading (for nitrogen dioxide). Figure 4–27 shows the 24-hour PM_{10} concentration over the project duration, including the Hanford options for disposition of RH-SCs and bulk sodium, as well as the contribution of major activities to these concentrations at Hanford.

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–101. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–102 and 4–103.

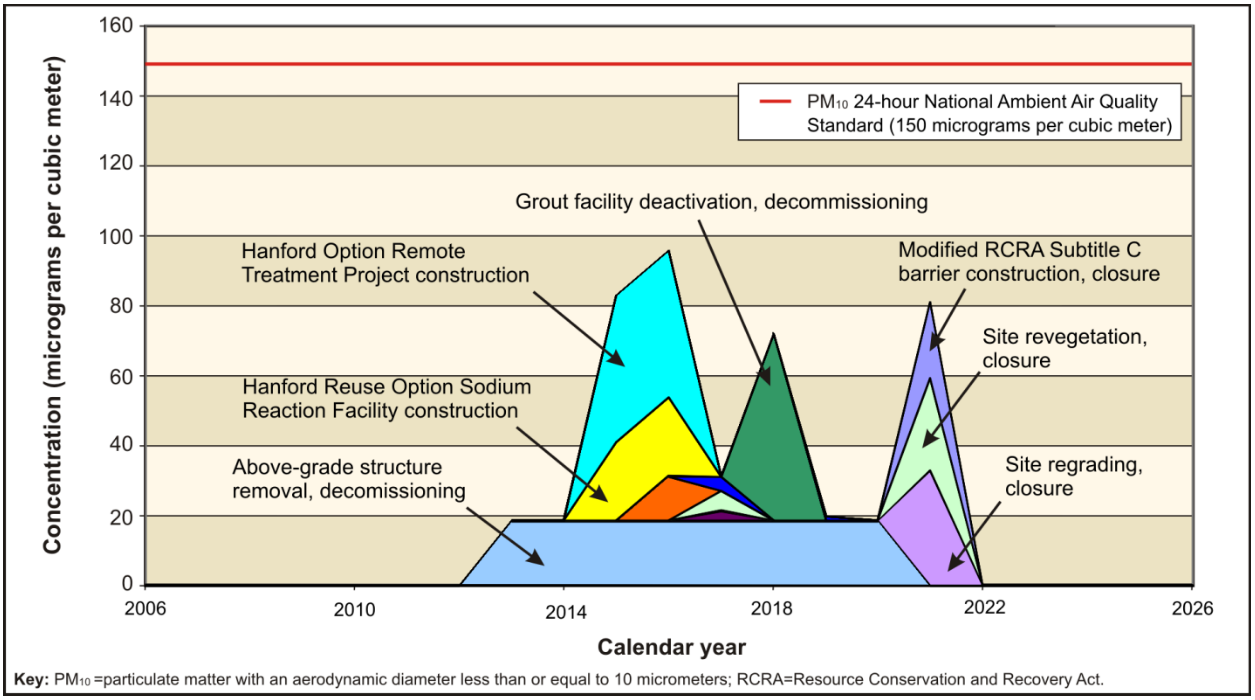


Figure 4–27. FFTF Decommissioning Alternative 2
PM_{10} Maximum 24-Hour Concentration at the Hanford Site

4.2.4.2.1 Facility Disposition

Decommissioning activities, especially above-grade structure and equipment removal and onsite grout facility construction and operations, would be the primary contributors to air pollutant impacts of facility disposition because of the amount of equipment used and earthmoving activity. Peak year facility disposition concentrations are shown in Tables 4–100 and 4–101.

4.2.4.2.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Disposition of RH-SCs under the Hanford Option would result in air pollutant impacts due to construction and operations of the RTP at Hanford. Peak year concentrations from disposition of RH-SCs are shown in Tables 4–100 and 4–101.

IDAHO OPTION

Operation of the RTP would not produce criteria or toxic air pollutant emissions.

4.2.4.2.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Processing bulk sodium under the Hanford Reuse Option would result in air pollutant impacts due to construction and operations of an SRF in the 400 Area. Peak year concentrations from disposition of bulk sodium are shown in Tables 4–100 and 4–101.

IDAHO REUSE OPTION

Processing bulk sodium under the Idaho Reuse Option would result in air pollutant impacts of modification of the existing SPF at INL. Peak year concentrations from modifying SPF are shown in Tables 4–104 and 4–105. Operation of the SPF would not produce criteria or toxic air pollutant emissions.

Table 4–104. FFTF Decommissioning Alternatives – Maximum Incremental Criteria Pollutant Concentrations from Disposition of Bulk Sodium at Idaho National Laboratory

Pollutant and Averaging Period	Standard[a] (micrograms per cubic meter)	Maximum Modeled Increment (micrograms per cubic meter)	
		Alternative 2	Alternative 3
Carbon Monoxide			
8-hour	10,000[b]	46.6	46.6
1-hour	40,000[b]	66.6	66.6
Nitrogen Dioxide			
Annual	100[b]	0.772	0.772
1-hour	188[b]	9.64	9.64
PM_{10}[c]			
24-hour	150[b]	13.5	13.5
$PM_{2.5}$[c]			
Annual	15[c]	2.71	2.71
24-hour	35[c]	13.5	13.5
Sulfur Dioxide			
Annual	80[b]	0.00717	0.00717
24-hour	365[b]	0.0358	0.0358
3-hour	1,300[b]	0.0807	0.0807
1-hour	197[b]	0.0896	0.0896

a The more stringent of the Federal and Idaho State standards is presented if both exist for the averaging period. The NAAQS (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The annual $PM_{2.5}$ standard is met when the 3-year average of the annual means is less than or equal to the standard. The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the 98th percentile 24-hour averages is less than or equal to the standard. The 1-hour nitrogen dioxide standard is met when the 3-year average 98th percentile of the daily maximum 1-hour average does not exceed the standard value.

b Federal and Idaho State standard.

c The standards for $PM_{2.5}$ are 15 micrograms per cubic meter annual average and 35 micrograms per cubic meter 24-hour average. No specific data for $PM_{2.5}$ were available, but for analysis purposes, concentrations were assumed to be the same as PM_{10}.

Note: NAAQS also includes standards for lead and ozone. No sources of lead emissions have been identified for the alternatives evaluated.

Key: FFTF=Fast Flux Test Facility; NAAQS=National Ambient Air Quality Standards; PMn=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

Source: Appendix G, Section G.3.

Table 4–105. FFTF Decommissioning Alternatives – Maximum Incremental Toxic Chemical Concentrations from Disposition of Bulk Sodium at Idaho National Laboratory

Pollutant	Averaging Period	Acceptable Ambient Concentration[a] (micrograms per cubic meter)	Maximum Modeled Increment (micrograms per cubic meter)	
			Alternative 2	Alternative 3
Ammonia	24-hour	0.3	0.007	0.007
Benzene	Annual	0.12	0.000805	0.000805
1,3-Butadiene	Annual	0.0036	0.00000936	0.00000936
Formaldehyde	Annual	0.077	0.000395	0.000395
Mercury	24-hour	2.5	0	0
Toluene	24-hour	18,800	0.0517	0.0517
Xylene	24-hour	21,800	0.0147	0.0147

a IDAPA 58.01.01.585 and 58.01.01.586.

Key: FFTF=Fast Flux Test Facility.

Source: Appendix G, Section G.3.

4.2.4.3 Alternative 3: Removal

Criteria pollutant concentrations from facility disposition, disposition of RH-SCs, and disposition of bulk sodium activities under FFTF Decommissioning Alternative 3 are presented in Table 4–100. Peak concentrations of carbon monoxide, PM, and nitrogen dioxide would occur in 2015. The peak concentration of sulfur dioxide would occur in 2012. These peak period concentrations would result primarily from Hanford SRF construction and above-grade structure and equipment removal (for carbon monoxide); site regrading (for nitrogen dioxide); grout facility deactivation and Hanford RTP construction (for PM); and grout facility construction (for sulfur dioxide). Figure 4–28 shows the 24-hour PM_{10} concentration over the project duration, including the Hanford options for disposition of RH-SCs and bulk sodium, as well as the contribution of major activities to these concentrations at Hanford.

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–101. No impacts on the public due to projected nonradioactive toxic pollutant emissions are anticipated. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–102 and 4–103.

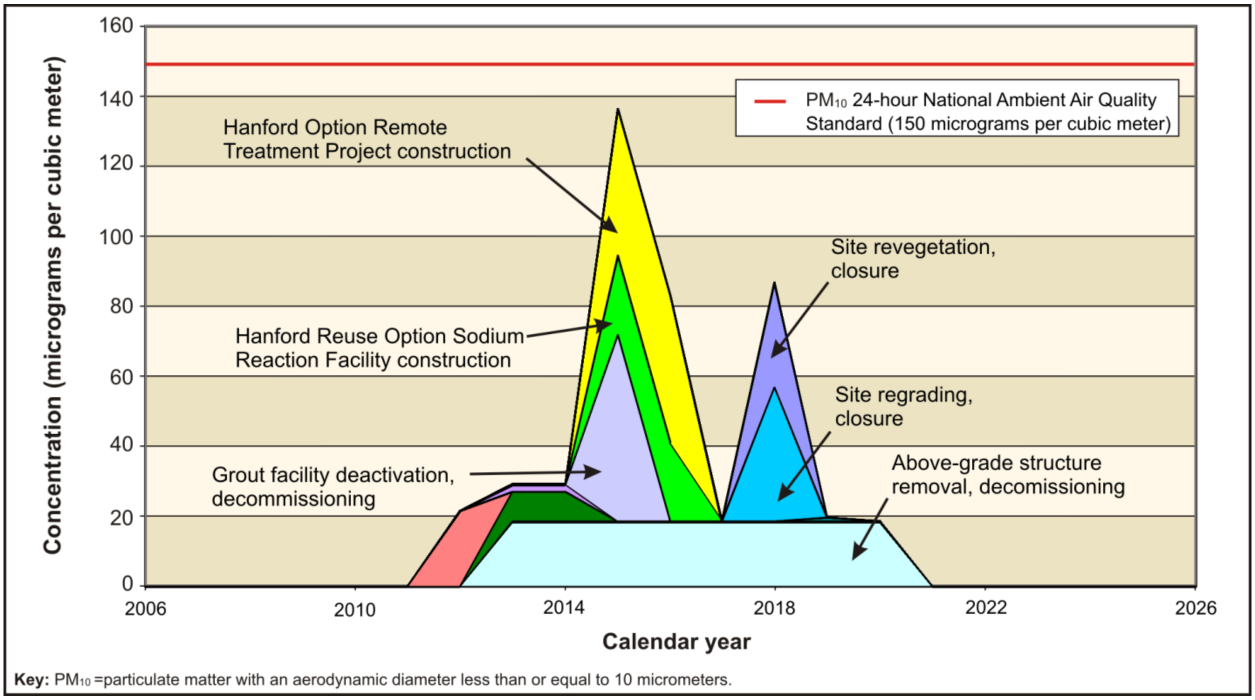


Figure 4–28. FFTF Decommissioning Alternative 3
PM_{10} Maximum 24-Hour Concentration at the Hanford Site

4.2.4.3.1 Facility Disposition

Decommissioning activities, especially above-grade structure and equipment removal and onsite grout facility construction and deactivation, would be the primary contributors to the air pollutant impacts of facility disposition because of the amount of equipment used and earthmoving activity. Peak year facility disposition concentrations are shown in Tables 4–100 and 4–101.

4.2.4.3.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Disposition of RH-SCs under the Hanford Option would result in air pollutant impacts due to construction and operations of the RTP at Hanford. Peak year concentrations from disposition of RH-SCs are shown in Tables 4–100 and 4–101.

IDAHO OPTION

Operation of the RTP would not produce criteria or toxic air pollutant emissions.

4.2.4.3.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Processing bulk sodium under the Hanford Reuse Option would result in air pollutant impacts due to construction and operations of an SRF in the 400 Area. Peak year concentrations from constructing and operating SRF are shown in Tables 4–100 and 4–101.

IDAHO REUSE OPTION

Processing bulk sodium under the Idaho Reuse Option would result in air pollutant impacts due to modification of the existing SPF at INL. Peak year concentrations from modifying SPF are shown in Tables 4–104 and 4–105. Operation of the SPF would not produce criteria or toxic pollutant emissions.

4.2.5 Geology and Soils

Impacts on geology and soils would generally be directly proportional to the total area of land disturbed by facility decommissioning and demolition, site grading, excavation work, and construction of facilities to support facility disposition and related waste treatment options under the FFTF Decommissioning alternatives and options. Consumption of geologic resources, including rock, mineral, and soil resources, would constitute the major indirect impact on geologic and soil resources, as summarized in Table 4–106 for each of the alternatives and options. The key underlying assumptions used to analyze the potential environmental impacts on geology and soils and the acquisition and use of geologic resources in support of the FFTF Decommissioning alternatives and options were similar to those described in Section 4.1.5 for the Tank Closure alternatives.

4.2.5.1 Alternative 1: No Action

4.2.5.1.1 Facility Disposition

No facility demolition or related ground-disturbing activities would be conducted during the 100-year administrative control period under the No Action Alternative. In addition, no geologic resources would be consumed as part of related surveillance and monitoring activities at FFTF. Therefore, there would be no incremental impact on geologic and soil resources in the 400 Area of Hanford under the No Action Alternative because the FFTF RCB and other structures within the FFTF PPA would remain in place.

Hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions with the potential to affect Hanford facilities are summarized in Chapter 3, Section 3.2.5.1.4. Maximum considered earthquake ground motions for Hanford encompass those that may cause substantial structural damage to buildings (equivalent to an MMI of VII and up), thus presenting safety concerns for occupants. Ground shaking of MMI VII associated with postulated earthquakes is possible and is supported by the historical record for the region. However, this level of ground motion is primarily expected to affect the integrity of inadequately designed or nonreinforced structures (see Appendix F, Table F–7). Little or no damage is expected in reinforced structures such as the FFTF RCB. DOE Order 420.1B requires nuclear and nonnuclear facilities to be designed, constructed, and operated so that the public, workers, and environment are protected from adverse impacts of natural phenomena hazards, including earthquakes. The order stipulates natural phenomena hazards mitigation for DOE facilities and specifically provides for reevaluation and upgrade of existing DOE facilities when there is a significant degradation in the safety basis for the facility. DOE Standard 1020-2002 implements DOE Order 420.1B and provides criteria for the design of new structures, systems, and components, as well as the evaluation, modification, and upgrade of existing structures, systems, and components, so that DOE facilities can safely withstand the effects of natural phenomena hazards, such as earthquakes. Analyses of the potential effects of a beyond-design-basis earthquake on human health and the environment are provided in Section 4.2.11.1.1.

Table 4–106. FFTF Decommissioning Alternatives – Summary of Major Geologic and Soil Resource Impact Indicators and Requirements

Parameter/Resource	Alternatives and Options						
	Alternative 1: No Action	**Alternative 2: Facility Disposition-Entombment**	**Alternative 3: Facility Disposition-Removal**	**Disposition of RH-SCs (Hanford Option for Remote Treatment)**	**Disposition of RH-SCs (Idaho Option for Remote Treatment)**	**Disposition of Bulk Sodium (Hanford Reuse Option)**	**Disposition of Bulk Sodium (Idaho Reuse Option)**
New, permanent land disturbance[a]	0.0	3.5	3.2	0.1	0.0	0.1	<0.1
Construction Materials							
Concrete	0.0	0.0	0.0	2,900	0.0	79.9	31.7
Cement[b]	0.0	0.0	0.0	719	0.0	16.3	6.46
Sand[b]	0.0	0.0	0.0	1,410	0.0	38.8	15.4
Gravel[b]	0.0	0.0	0.0	1,840	0.0	50.6	20.1
Other Borrow Materials[c]							
Rock/basalt	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sand	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gravel	0.0	0.0	0.0	1,390	0.0	112	0.0
Soil (specification backfill)	0.0	80,400	121,000	37.8	0.0	0.0	0.0
Decommissioning and Closure-Specific Materials							
Grout[d]	0.0	24,900	24,900	0.0	0.0	0.0	0.0
Cement	0.0	188	188	0.0	0.0	0.0	0.0
Sand[e]	0.0	22,600	22,600	0.0	0.0	0.0	0.0
Barrier materials[f]	0.0	19,300	0.0	0.0	0.0	0.0	0.0
Total[g]	**0.0**	**122,000**	**143,000**	**4,670**	**0.0**	**202**	**35.5**

[a] Reflects land area assumed to be permanently disturbed for new facilities. The value also includes land area excavated from Borrow Area C or elsewhere to supply geologic materials listed in the table.

[b] Components of concrete.

[c] Resources for miscellaneous uses not exclusively tied to facility construction, operations, or closure, such as site grading and backfill for excavations.

[d] Grout comprises cement, sand, fly ash, and other materials.

[e] Principal component of grout that would be obtained from onsite deposits.

[f] Volume includes soil, sand, gravel, rock, and asphalt for construction of a modified Resource Conservation and Recovery Act Subtitle C barrier.

[g] Excludes concrete, cement, and grout. Totals may not equal the sum of the contributions due to rounding.

Note: All values are expressed in cubic meters except land disturbance, which is in hectares. Values presented in the table have been rounded to no more than three significant digits, where appropriate. To convert cubic meters to cubic yards, multiply by 1.308; hectares to acres, multiply by 2.471.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; RH-SCs=remote-handled special components.

Source: SAIC 2010b.

4.2.5.1.2 Disposition of Remote-Handled Special Components

Storage of removed RH-SCs within the 400 Area would have no incremental impact on geology and soils and would not entail any demand for geologic resources.

4.2.5.1.3 Disposition of Bulk Sodium

Storage of FFTF bulk sodium in the 400 Area SSF, as well as ongoing storage of the Hallam Reactor and Sodium Reactor Experiment (SRE) sodium in existing facilities within the 200-West Area, would have no incremental impact on geology and soils.

4.2.5.2 Alternative 2: Entombment

4.2.5.2.1 Facility Disposition

Under the Entombment Alternative, all above-grade (ground-level) structures associated with the FFTF RCB, two adjacent service buildings, and five other immediately adjacent facilities composing the FFTF complex would be dismantled and removed. Floors and walls, along with other demolition debris, would be collapsed into below-grade spaces to the extent possible, except that wood and large steel components would be removed. Waste not suitable for consolidation into below-grade spaces would be categorized and removed for proper disposal. While contaminated structures, systems, and components would remain below grade in the RCB and two adjacent service buildings, hazardous and radioactive material would be removed from all other buildings. Except for the RCB and two adjacent service buildings, the building demolition sites and remaining below-grade void spaces would then be backfilled with soil. For the RCB and adjacent service buildings, an onsite grout facility would be constructed and operated to fill the below-grade spaces with grout to prevent subsidence and to immobilize remaining hazardous and radioactive constituents. Subsequently, a modified RCRA Subtitle C barrier would be emplaced over the RCB and adjacent service buildings to entomb them and any residual hazardous and radioactive constituents. The 2.7-meter-thick (9-foot-thick) engineered barrier would be composed of layers of topsoil in the upper part, which would support a mixed perennial grass ground cover, and underlain by layers of sand, gravel, asphalt, and/or riprap in the lower part, as previously described in Section 4.1.5 for the Tank Closure alternatives. In total, the entombment barrier would encompass an approximately 0.7-hectare (1.7-acre) area of the FFTF complex. In addition to the area encompassed by this barrier, an additional 2.8 hectares (7 acres) would also be excavated from Borrow Area C, making a total of 3.5 hectares (8.7 acres) of new, permanent land disturbance.

All other ancillary buildings within the 400 Area PPA would be demolished to grade as described above, with the exception that all demolition debris and soils would first be excavated to a depth of 1 meter (3 feet) and removed for disposal prior to backfilling. Upon completion of all building demolition and barrier construction, the land surface of the entire 2.1-hectare (5.3-acre) site would be regraded with topsoil, recontoured, and revegetated, including the modified RCRA Subtitle C barrier.

Because excavation work would be minimal and the 400 Area PPA is already disturbed, the direct impact of facility decommissioning activities on geology and soils would be minimal. As with any ground-disturbing activity, denuded surface soils and unconsolidated sediments in excavations and graded areas would be subject to wind and water erosion if left exposed over an extended period of time. Adherence to standard best management practices for soil erosion and sediment control during construction would minimize soil erosion and loss. During the 8-year facility decommissioning and demolition phase, prior to final regrading and revegetation of the site, temporary seeding, mulching, and the use of geotextile covers and similar best management practices would be employed to minimize soil erosion in disturbed areas.

FFTF decommissioning and closure activities would not preclude the use of rare or otherwise valuable geologic or soil resources. Geologic resources would be required to produce grout to stabilize below-grade structures, to backfill demolished facility sites, and to construct engineered barriers as part of final site closure. Total geologic resource requirements under Alternative 2 are projected to be 122,000 cubic meters (160,000 cubic yards), with little or no geologic resources expected to be required during the 100-year postclosure care period (see Table 4–106). It is expected that this volume would be supplied by Borrow Area C, as further described in Section 4.1.5.

4.2.5.2.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Direct impacts on site geology and soils under this option would be limited to the construction of a new RTP to treat RH-SCs at a location adjacent to the existing T Plant in the 200-West Area (see Figure 4–2). Construction activities would permanently disturb about 0.1 hectares (0.3 acres) of land for the new facility. The proposed RTP would have a below-grade service level that would require excavation to a depth of approximately 6 meters (20 feet) (ANL-W 2004:27). The uppermost Hanford formation sediments across the 400 Area attain a thickness of up to 55 meters (180 feet), so the lateral and vertical extent of this unit would not be greatly impacted by facility construction and sublevel excavation.

Although the area has been previously disturbed and native soils may have been altered by fill placement, denuded surface soils and unconsolidated sediments in excavations would be subject to wind and water erosion if left exposed over an extended period of time. Adherence to standard best management practices for soil erosion and sediment control during construction would minimize soil erosion and loss. To reduce the risk of exposing contaminated soils, areas in which new facilities would be constructed under this alternative would be surveyed prior to any ground disturbance. Any contamination would be remediated as necessary. After construction, the previously disturbed areas would not be subject to long-term soil erosion.

Geologic resources would be required for new facility construction under this option, including aggregate (sand and gravel), cement, and soil for engineered backfill. Total geologic resource requirements under this option are projected to be 4,670 cubic meters (6,100 cubic yards) (see Table 4–106). It is expected that this volume would be supplied by Borrow Area C, as further described in Section 4.1.5.

As referenced and described in Section 4.2.5.1.1, hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions with the potential to affect Hanford facilities have been evaluated. As stated in DOE Order 420.1B, DOE requires nuclear and nonnuclear facilities to be designed, constructed, and operated so that the public, workers, and environment are protected from adverse impacts of natural phenomena hazards, including earthquakes. DOE Standard 1020-2002 implements DOE Order 420.1B and provides criteria for the design of new structures, systems, and components, as well as the evaluation, modification, and upgrade of existing structures, systems, and components, so that DOE facilities can safely withstand the effects of natural phenomena hazards, such as earthquakes. As the RTP would be a Performance Category 3 facility (ANL-W 2004:39), a probabilistic seismic hazard assessment would be required to determine the seismic design basis for RTP structures, systems, and components.

IDAHO OPTION

Under the Idaho Option, direct or indirect geologic and soils impacts would not occur. RH-SCs removed from the FFTF RCB would be stored at Hanford prior to shipment to INL, where these materials would be treated in an existing facility at INTEC. As a treatment facility currently exists, there would be no new construction, no geologic resources would be required, and no new facilities would be subject to potential seismically induced ground shaking. Treated components would be returned to Hanford or sent to NNSS for disposal, where these materials would be placed in existing disposal facilities.

4.2.5.2.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Under the Hanford Reuse Option, direct impacts on site geology and soils would be limited to ground disturbance associated with construction of the new SRF in the Hanford 400 Area. Specifically, the facility would be constructed in a previously disturbed area near the existing SSF. The new SRF would permanently occupy about 0.1 hectares (0.2 acres) of land when completed. As the SRF would be constructed with a reinforced concrete slab floor and without a basement (ANL-W and Fluor Hanford 2002:19, 57), excavation work would be minimal, and the lateral and vertical extent of the Hanford Formation sediments underlying the 400 Area would not be greatly impacted.

Although the area has been previously disturbed and native soils may have been altered by fill placement, denuded surface soils and unconsolidated sediments in excavations would be subject to wind and water erosion if left exposed over an extended period of time. Adherence to standard best management practices for soil erosion and sediment control during construction would minimize soil erosion and loss. To reduce the risk of exposing contaminated soils, areas in which new facilities would be constructed under this alternative would be surveyed prior to any ground disturbance. Any contamination would be remediated as necessary. After construction, the previously disturbed areas would not be subject to long-term soil erosion.

Geologic resources required for new facility construction under this option would be relatively small and limited to aggregate (sand and gravel) and cement for concrete and gravel for slab foundation construction. Total geologic resource requirements under this option are projected to be 202 cubic meters (264 cubic yards) (see Table 4–106). It is expected that this volume would be supplied by Borrow Area C, as further described in Section 4.1.5.

As referenced and described in Section 4.2.5.1.1, hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions with the potential to affect Hanford facilities have been evaluated. As stated in DOE Order 420.1B, DOE requires nuclear and nonnuclear facilities to be designed, constructed, and operated so that the public, workers, and environment are protected from the adverse impacts of natural phenomena hazards, including earthquakes. DOE Standard 1020-2002 implements DOE Order 420.1B and provides criteria for the design of new structures, systems, and components, as well as the evaluation, modification, and upgrade of existing structures, systems, and components, so that DOE facilities can safely withstand the effects of natural phenomena hazards, such as earthquakes. As the SRF presumably would be a Performance Category 3 facility, a probabilistic seismic hazard assessment would be required to determine the seismic design basis for SRF structures, systems, and components.

IDAHO REUSE OPTION

The type and intensity of anticipated direct impacts on geology and soils under this option would be somewhat less than those described above under the Hanford Reuse Option. Under this option, ground-disturbing activity would be limited to modifications to the existing SPF at INL's MFC to enable it to receive and process Hanford sodium. Facility modifications that could impact geologic strata would mainly be limited to constructing an enclosed concrete pad adjacent to the existing SPF (ANL-W and Fluor Hanford 2002:37).

Geologic resources required for SPF modifications at INL under this option would be relatively small and limited to aggregate (sand and gravel) and cement for concrete. Total geologic resource requirements under this option are projected to be about 36 cubic meters (47 cubic yards) (see Table 4–106). This volume would be supplied by one of a number of quarries at INL (see Chapter 3, Section 3.3.5.1.3).

As described in Chapter 3, Section 3.3.5.1.4, hazards from large-scale geologic conditions (such as earthquakes and volcanic activity) and site-specific geologic conditions with the potential to affect INL facilities have been extensively studied and evaluated. Design consideration of hazards to the modified SPF at INL from large-scale geologic conditions would be substantially the same as those described above under the Hanford Reuse Option.

4.2.5.3 Alternative 3: Removal

4.2.5.3.1 Facility Disposition

Decommissioning activities and associated impacts on geology and soils under the Removal Alternative would be somewhat greater than those described in Section 4.2.5.2.1 for the Entombment Alternative. All above-grade (ground-level) structures associated with the FFTF RCB, two adjacent service buildings, and five other immediately adjacent facilities would be dismantled and removed. In addition, all other ancillary buildings within the 400 Area PPA would be demolished and removed to a depth of 1 meter (3 feet) below grade prior to backfilling the removed facilities with soil and restoring the site, as further described under the Entombment Alternative. However, under the Removal Alternative, instead of being left in place, the RCB reactor vessel and its internal piping and equipment would be filled with grout, removed, and packaged for transport to an IDF for onsite disposal. As under the Entombment Alternative, an onsite grout facility would be constructed and operated to grout and stabilize the reactor vessel prior to its removal and to fill the below-grade spaces associated with the RCB and adjacent service buildings before backfilling them with soil. While no engineered barrier would be constructed under this alternative, due to decommissioning activities, the demand for backfill soil would be higher than under the Entombment Alternative. To support these activities, about 3.2 hectares (8 acres) would be excavated from Borrow Area C. Upon completion of all building demolition, the entire 2.4-hectare (6.0-acre) site would be regraded with topsoil, recontoured, and revegetated.

As described in Section 4.2.5.2.1, adherence to standard best management practices for soil erosion and sediment control during construction would minimize soil erosion and loss during facility decommissioning and final site closure.

Total geologic resource requirements under Alternative 3 are projected to be 143,000 cubic meters (187,000 cubic yards), with little or no geologic resources expected to be required during the 100-year site institutional control period (see Table 4–106). It is expected that this volume would be supplied by Borrow Area C, as stated above and as further described in Section 4.1.5.

4.2.5.3.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Direct impacts on geology and soils and geologic resource demands under this option would be the same as those discussed in Section 4.2.5.2.2 under the Hanford Option.

IDAHO OPTION

Direct impacts on geology and soils and geologic resource demands under this option would be the same as those discussed in Section 4.2.5.2.2 under the Idaho Option.

4.2.5.3.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Direct impacts on geology and soils and geologic resource demands under this option would be the same as those discussed in Section 4.2.5.2.3 under the Hanford Reuse Option.

IDAHO REUSE OPTION

Direct impacts on geology and soils and geologic resource demands under this option would be the same as those discussed in Section 4.2.5.2.3 under the Idaho Reuse Option.

4.2.6 Water Resources

4.2.6.1 Alternative 1: No Action

4.2.6.1.1 Surface Water

No facility demolition would be conducted during the 100-year administrative control period under the No Action Alternative, so there would be no construction-related impacts on surface-water resources, including stormwater quality.

Utility systems necessary to maintain safety-related functions across the FFTF complex would be left operational following the completion of deactivation activities in the 400 Area. Water use and wastewater generation would likely be limited to levels necessary to maintain and test critical systems, such as fire protection, as part of surveillance and monitoring. Projected water use under FFTF Decommissioning Alternative 1 and the impact on site utility infrastructure are discussed in Section 4.2.2.1.3. There would be no process wastewater discharges from the 400 Area following deactivation, and any sanitary wastewater generation would be a small fraction of the amount generated during standby operations and would be discharged to the existing treatment system that serves the 400 Area (see Chapter 3, Section 3.2.6.1.3).

4.2.6.1.2 Vadose Zone and Groundwater

Under FFTF Decommissioning Alternative 1, residual sodium would continue to be stored in the 400 Area SSF. Periodic facility inspections and necessary maintenance activities would be conducted to ensure the structural integrity of storage facilities. Adherence to appropriate spill prevention and emergency response plans and procedures would help ensure that any spills, should they occur, do not reach soils or surfaces where they could be conveyed to surface water or groundwater.

Maintenance of the FFTF reactor vessel, related piping and equipment, RH-SCs, and tanks under an inert gas blanket through the 100-year administrative control period would ensure there would be no direct impact on the vadose zone and groundwater in the short term. Emergency mitigative actions would be undertaken to address the failure of a system or component that could pose a threat to public health and safety or the environment. Following the administrative control period, remaining hazardous and radioactive materials, including residual sodium, would be available for potential release to the environment. Long-term impacts on water resources, including contaminant release to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.2.1.1.

4.2.6.2 Alternative 2: Entombment

4.2.6.2.1 Surface Water, Vadose Zone, and Groundwater

4.2.6.2.1.1 Facility Disposition

Facility decommissioning activities associated with the Entombment Alternative would have little or no direct impact on surface-water features or surface-water quality because there are no natural, perennial, surface-water drainages in the 400 Area.

Demolition-related land disturbance, as well as barrier construction and site regrading work, would expose soils and sediments to possible erosion by infrequent heavy rainfall or wind. Stormwater runoff from exposed areas could convey soil, sediments, and other pollutants (e.g., contaminated demolition debris; spilled materials, such as petroleum, oils, and lubricants from heavy equipment) from demolition and other work sites and staging areas. Any potential for this runoff to impact runoff quality beyond the confines of the 400 Area is low, and the Columbia River is located approximately 6.3 kilometers (3.9 miles) away. Nevertheless, appropriate soil erosion and sediment control measures (e.g., sediment fences, staked haybales, mulch), as well as spill prevention and waste management practices, would be employed to minimize suspended sediment and other deleterious material transport and any potential water-quality impacts. Further, all demolition and ground-disturbing activities would be conducted in accordance with current NPDES and appropriate state waste discharge general permits for stormwater discharges associated with construction and industrial activities, both of which are issued by Ecology. The NPDES permit specifically requires the development and implementation of a stormwater pollution prevention plan.

Nonhazardous sanitary wastewater (sewage) would be minimal during facility decommissioning and final site closure and would be managed via existing sanitary wastewater collection and treatment systems early on and via portable sanitary facilities as existing utility infrastructure is decommissioned and closed (see Section 4.2.2.2.1.1). Waste generation and management activities under this alternative are further discussed in Section 4.2.14.2.

Potable and raw water demand to support decommissioning and closure activities would primarily be driven by the need to provide dust control and mix concrete and grout during construction of the modified RCRA Subtitle C barrier. Potable and raw water would possibly be needed to aid soil compaction in backfilled areas and equipment washdown. Water to support demolition activities would be trucked to the point of use, but could also be supplied via temporary utility service connections until the 400 Area's three water supply wells are closed and the support buildings demolished. Portable sanitary facilities would be provided to meet the workday potable and sanitary needs of decommissioning personnel, which would constitute a relatively small percentage of the total water demand. Projected water use under FFTF Decommissioning Alternative 2 and its impact on site utility infrastructure are discussed in Section 4.2.2.2.1.1.

Hazardous and radioactive material would be removed from many buildings within the 400 Area PPA under the Entombment Alternative, as described above. Contaminated structures, systems, and components in the RCB and two adjacent service buildings would remain below grade, but would be grouted. A modified RCRA Subtitle C barrier would be emplaced over the RCB and adjacent service buildings. The modified RCRA Subtitle C barrier is designed for a 500-year performance period. Nevertheless, this barrier would degrade over time, allowing infiltration and contaminant migration from the 400 Area. Long-term impacts on water resources, including contaminant release to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.2.1.2.

4.2.6.2.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Construction of an RTP to treat RH-SCs would likely have little direct impact on surface-water features or surface-water quality because the facility would be constructed in a previously disturbed and developed part of the 200-West Area, where no surface-water features or surface-water drainages are located (see Figure 4–2). Any effects on stormwater runoff quality would likely be highly localized and of short duration. Nevertheless, appropriate soil erosion and sediment control measures (e.g., sediment fences, staked haybales, mulch), as well as spill prevention and waste management practices, would be employed to minimize suspended sediment and other deleterious material transport from the construction site and any potential water-quality impacts. Further, ground-disturbing activities would be conducted in accordance with current NPDES and state waste discharge general permits for stormwater discharges associated with construction activities, both of which are issued by Ecology. The NPDES permit specifically requires the development and implementation of a stormwater pollution prevention plan. The completed facility would incorporate appropriate stormwater management controls to collect, detain, and convey stormwater from the building and other impervious surfaces to minimize water-quality impacts during operations.

During RTP operations, there would be no direct discharge of effluents to either surface water or groundwater. Process wastewater generated from operation of the new facility, including any radioactive liquid effluents, would be discharged to existing treatment facilities that already service the 200 Areas, as described in Section 4.1.6.2.1. Nonhazardous sanitary wastewater (sewage) would be managed via appropriate sanitary wastewater collection and treatment systems.

Water would be required during construction for soil compaction, dust control, and other uses, including concrete production. Standard construction practices dictate that, at least initially, construction water would be trucked to construction locations on an as-needed basis for these uses until water supply and wastewater treatment utilities are in place. During operations, water would be required to support process makeup requirements and facility cooling, as well as the potable and sanitary needs of the operations workforce, among other uses. Some water would also be required during deactivation for use in activities such as facility decontamination. Projected water use under the Hanford Option and its impact on site utility infrastructure are further discussed in Section 4.2.2.2.1.2.

No impact on the Hanford vadose zone or groundwater is expected from operation of the RTP in the Hanford 200-West Area. There would be no direct discharge of effluents to either surface water or the groundwater, as described above. Following completion of the facility's mission, the facility would be deactivated and all residual waste and any hazardous or radioactive materials would be removed for disposal. Waste generation and management activities under this alternative and option case are further discussed in Section 4.2.14.2.

IDAHO OPTION

Under the Idaho Option, construction-related impacts on water resources would not occur. RH-SCs removed from the FFTF RCB would be stored at Hanford prior to shipment to INL, where these materials would be treated in an existing facility at INTEC. As a treatment facility currently exists, there would be no new construction and associated water-quality impacts. Treated components would be returned to Hanford or sent to NNSS for disposal, where these materials would be placed in existing disposal facilities.

During treatment at the existing INTEC facility, there would be no direct discharge of effluents to either surface water or groundwater at INL. Process wastewater generated from operation of the treatment facility, including any radioactive liquid effluents, would be discharged to existing treatment facilities.

Radioactive liquid waste would be conveyed to the Radioactive Liquid Waste Treatment Facility, while nonhazardous process wastewater would flow to an industrial waste pond. Nonhazardous sanitary wastewater (sewage) would be managed via the existing site sanitary sewer system. All liquid waste would be managed similar to the method described in the *Idaho National Laboratory, Conceptual Design Report for the Remote Treatment Project, Annex to the Hot Fuel Examination Facility* (ANL-W 2004).

Groundwater is the source of water at the existing INTEC facility and across INL. Water would be required during operations and deactivation of the facility. Projected water use under the Idaho Option and its impact on INL's utility infrastructure are further discussed in Section 4.2.2.2.1.2.

No impact on the INL vadose zone or groundwater is expected from operation of the INTEC facility. There would be no direct discharge of effluents to either surface water or groundwater, as previously described. Following completion of the facility's mission, the facility would be deactivated and all residual waste and any hazardous or radioactive materials would be removed for disposal. Waste generation and management activities under this alternative and option case would be completed in accordance with the *Final Environmental Assessment for the Remote-Handled Waste Disposition Project* (DOE 2009) and as further discussed in Section 4.2.14.2.

4.2.6.2.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

There would be little direct impact on surface water from construction of the SRF adjacent to the SSF in the Hanford 400 Area because no surface-water features would be impacted and stormwater generation from the construction site would be minimal. Any effect on stormwater runoff quality would likely be highly localized and of short duration. Nevertheless, appropriate soil erosion and sediment control measures (e.g., sediment fences, staked haybales, mulch), as well as spill prevention and waste management practices, would be employed to minimize suspended sediment and other deleterious material transport from the construction site and any potential water-quality impacts. Further, ground-disturbing activities would be conducted in accordance with current NPDES and state waste discharge general permits for stormwater discharges associated with construction activities, both of which are issued by Ecology. The NPDES permit specifically requires the development and implementation of a stormwater pollution prevention plan. The completed facility would incorporate appropriate stormwater management controls to collect, detain, and convey stormwater from the building and other impervious surfaces so as to minimize water-quality impacts during operations.

During RTP operations, there would be no direct discharge of effluents to surface water or groundwater. Process wastewater generation would be minimal, with any waste collected and transported for storage or disposal at appropriate onsite facilities. Nonhazardous sanitary wastewater (sewage) would be managed via the existing sanitary wastewater collection and treatment system that serves the 400 Area.

Water would be required during construction for soil compaction, dust control, and other uses, including concrete production. Construction water would be trucked to the point of use or supplied via temporary connection to existing nearby utilities. Most water use would occur during the operations period to process the bulk sodium into caustic solution for product reuse at Hanford. Some water would also be required during deactivation for activities such as facility decontamination. Projected water use under the Hanford Reuse Option and its impact on site utility infrastructure are further discussed in Section 4.2.2.2.1.3.

No impact on the Hanford vadose zone or groundwater is expected from operation of the SRF in the Hanford 400 Area. There would be no direct discharge of effluents to either surface water or groundwater, as described above. Following completion of the facility's mission, the facility would be deactivated and all residual waste and any hazardous or radioactive materials would be removed for disposal. Waste generation and management activities under this alternative and option case are further discussed in Section 4.2.14.2.

IDAHO REUSE OPTION

No direct impact on surface-water resources is expected from constructing modifications to the existing SPF at INL's MFC. Due to the relatively minor nature and duration of construction, the potential for stormwater runoff from construction areas to impact downstream surface-water quality is low. Surface-water drainages in the vicinity of the MFC are poorly defined and ephemeral, while infiltration to the subsurface is relatively rapid on unconsolidated sediment. Further, the closest major surface-water drainage is more than 20 kilometers (12 miles) west of the MFC. Any effect on runoff quality would likely be highly localized and of short duration. Regardless, appropriate soil erosion and sediment control measures (e.g., sediment fences, staked haybales, mulch), as well as spill prevention and waste management practices would be employed as previously discussed under the Hanford Reuse Option. Specifically, in accordance with INL's General Permit for Storm Water Discharges from Construction Sites, the INL Storm Water Pollution Prevention Plan for Construction Activities establishes measures and controls to prevent pollution of stormwater from construction activities at INL (see Chapter 3, Section 3.3.6.1.1).

Operation of the modified Idaho SPF to process Hanford bulk sodium would result in no direct discharge of effluents to surface water or groundwater. Any wastewater generated from operation of the new facility would be discharged to existing treatment facilities that already service the MFC. Nonhazardous sanitary wastewater (sewage) would be managed via the existing site sanitary sewer system (ANL-W 2004:66, 67). Waste generation and management activities under this alternative and option case are further discussed in Section 4.2.14.2.

Overall water demands required to implement this option would be less than those described for the Hanford Reuse Option. Projected water use under the Idaho Reuse Option and its impact on site utility infrastructure are further discussed in Section 4.2.2.2.1.3.

No impact on the INL vadose zone or groundwater is expected from operation of the modified SPF in the INL MFC. There would be no direct discharge of untreated effluents to surface water or groundwater as previously described. Waste generation and management activities under this alternative and option case are further discussed in Section 4.2.14.2.

4.2.6.3 Alternative 3: Removal

4.2.6.3.1 Surface Water, Vadose Zone, and Groundwater

4.2.6.3.1.1 Facility Disposition

Facility decommissioning activities under the Removal Alternative would have little or no impacts on surface-water features or surface-water quality for the same reasons as previously described under the Entombment Alternative (see Section 4.2.6.2.1.1). Stormwater runoff and the potential for water-quality impacts would be somewhat greater under this alternative due to the greater area disturbed. Demolition-related land disturbance and stormwater runoff would also be similar to that described under the Entombment Alternative, except the reactor vessel and other contaminated equipment would be removed for disposal at an IDF under this alternative rather than being left in place. While no engineered barrier would be constructed under this alternative, a slightly larger area (2.4 hectares [6.0 acres]) of the 400 Area would be regraded with topsoil, recontoured, and revegetated. Nevertheless, application of the same soil erosion and sediment control measures and other practices described under the Entombment Alternative would apply under this alternative.

Any effluents generated during facility decommissioning would be managed as described under the Entombment Alternative (see Section 4.2.6.2.1.1). Waste generation and management activities under this alternative are further discussed in Section 4.2.14.3.

Potable and raw water demands to support decommissioning and closure activities would be very similar to those previously described under the Entombment Alternative. Projected water use under Alternative 3 and its impact on site utility infrastructure are discussed in Section 4.2.2.3.1.1.

Removal of the FFTF reactor vessel and other contaminated equipment and debris from the RCB is expected to have both short-term and long-term positive impacts on groundwater quality in the 400 Area because the major sources of residual contamination would not be available for release to the vadose zone and groundwater. Long-term impacts on water resources of this alternative, including contaminant release to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.2.1.3.

4.2.6.3.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Impacts of this option on water resources would be the same as those discussed in Section 4.2.6.2.1.2 under the Hanford Option.

IDAHO OPTION

Impacts of this option on water resources would be the same as those discussed in Section 4.2.6.2.1.2 under the Idaho Option.

4.2.6.3.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Impacts of this option on water resources would be the same as those discussed in Section 4.2.6.2.1.3 under the Hanford Reuse Option.

IDAHO REUSE OPTION

Impacts of this option on water resources would be the same as those discussed in Section 4.2.6.2.1.3 under the Idaho Reuse Option.

4.2.7 Ecological Resources

4.2.7.1 Alternative 1: No Action

Under the No Action Alternative, the FFTF RCB (including RH-SCs), along with the rest of the buildings and structures within the 400 Area PPA, would remain in place. Sodium would be drained from FFTF and stored in the SSF within the 400 Area; other sodium would continue to be stored at current locations. As FFTF would remain in place and existing facilities would be used for sodium storage, there would be no additional impact on terrestrial resources, wetlands, aquatic resources, or threatened and endangered species under this alternative.

Any waste disposed of under this alternative would be placed in trenches 31 and 34 of LLBG 218-W-5 or in IDF-East. As there would be no need to excavate geologic material from Borrow Area C under this alternative, there would be no impacts on ecological resources within Borrow Area C.

4.2.7.2 Alternative 2: Entombment

4.2.7.2.1 Terrestrial Resources

4.2.7.2.1.1 Facility Disposition

Under the Entombment Alternative, FFTF and adjacent support facilities would be dismantled to below grade, and a 0.7-hectare (1.7-acre) engineered barrier would be placed over the site. Other facilities within the PPA would be dismantled to grade. After appropriate preparation, disturbed areas (including the barrier) would be revegetated. Vegetation placed over the barrier would include shallow-rooted species to prevent root penetration. The ultimate future use of the remaining portions of the PPA would determine how those areas would be revegetated. As the site is located within an area designated Industrial, future development is a possibility. Thus, revegetation efforts under this alternative would likely seek to stabilize soil rather than recreate natural conditions. This stabilization approach would, in turn, limit wildlife use of the area. However, if future development is not planned, native plantings could be used, which would increase the ecological diversity of the area.

Debris and other waste not placed in the RCB or used as backfill would be transported to trenches 31 and 34 of LLBG 218-W-5 or to IDF-East. Similar to the No Action Alternative, impacts associated with construction and use of this IDF are addressed in Section 4.3.7.

The Entombment Alternative would require excavation of a limited amount of geologic material from Borrow Area C. The amount of material required would necessitate the development of 2.8 hectares (7 acres) of Borrow Area C, which would have a minimal impact on terrestrial resources. Limited development should avoid the ecologically important needle-and-thread grass/Indian ricegrass community.

4.2.7.2.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Under this option, RH-SCs would be stored, treated, and disposed of at Hanford. As storage facilities currently exist within the 200 Areas and are used for similar purposes, their use under this option would not affect terrestrial resources. Treatment of RH-SCs would involve construction of a new RTP. This facility, which would be constructed in a disturbed portion of the 200-West Area at the T Plant complex, would occupy 0.1 hectares (0.3 acres) of land and would not impact terrestrial resources at Hanford. Treated components would be disposed of in IDF-East.

IDAHO OPTION

RH-SCs removed from the FFTF RCB would be stored at Hanford prior to shipment to INL, where they would be treated in an existing facility at INTEC. As this area is currently industrial in nature and an existing facility would be used, there would be no impacts on terrestrial resources at INTEC or INL. Treated components would be returned to Hanford or sent to NNSS for disposal. As an existing waste site would be used at NNSS, there would be no impacts on terrestrial resources at the site. If returned to Hanford, waste would be placed in IDF-East.

4.2.7.2.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Under the Hanford Reuse Option, sodium from FFTF would be sent to a new SRF to be built in the 400 Area. This facility would be constructed on less than 0.4 hectares (1 acre) of land within the already highly developed 400 Area near the SSF. Thus, there would be no impacts on terrestrial resources within the 400 Area or at Hanford. As treated sodium would be stored in an existing facility within the 200 Areas, again there would be no impacts on terrestrial resources from this element of the Hanford Reuse Option.

IDAHO REUSE OPTION

Under this option, sodium from FFTF would be transported to INL for treatment in the SPF. The SPF is an existing facility within the MFC. Use of this facility would not alter existing terrestrial resources at the MFC or INL. There would also be no change in terrestrial resources at the 400 Area and 200 Areas at Hanford from implementation of this option because only existing facilities would be used.

4.2.7.2.2 Wetlands

4.2.7.2.2.1 Facility Disposition

Although the Entombment Alternative would involve removing aboveground portions of FFTF and dismantling associated buildings and structures, this alternative would not affect wetlands because these resources do not occur within either the 400 Area or 200 Areas. Neither disposal of waste at IDF-East nor excavation of 2.8 hectares (7 acres) of Borrow Area C would impact wetlands because none are present within these areas.

4.2.7.2.2.2 Disposition of Remote-Handled Special Components

HANFORD OPTION AND IDAHO OPTION

Actions involving the storage, treatment, and disposal of RH-SCs carried out under both options would not impact wetlands at either Hanford or INL because wetlands are not located within any of the areas affected by disposition activities.

4.2.7.2.2.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION AND IDAHO REUSE OPTION

Wetlands would not be affected by actions taken under either the Hanford or Idaho Reuse Options because none are located within any of the areas potentially impacted.

4.2.7.2.3 Aquatic Resources

4.2.7.2.3.1 Facility Disposition

Although the Entombment Alternative would involve removing aboveground portions of FFTF and dismantling associated buildings and structures, this alternative would not affect aquatic resources because these resources do not occur within either the 400 Area or 200 Areas. Neither disposal of waste at IDF-East nor excavation of 2.8 hectares (7 acres) of Borrow Area C would impact aquatic resources because none are present within these areas.

4.2.7.2.3.2 Disposition of Remote-Handled Special Components

HANFORD OPTION AND IDAHO OPTION

Actions involving the storage, treatment, and disposal of RH-SCs carried out under both options would not impact aquatic resources at Hanford or INL because aquatic resources are not located within any of the areas affected by disposition activities.

4.2.7.2.3.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION AND IDAHO REUSE OPTION

Aquatic resources would not be affected by actions taken under either the Hanford or Idaho Reuse Options because none are located within any of the areas potentially impacted.

4.2.7.2.4 Threatened and Endangered Species

4.2.7.2.4.1 Facility Disposition

Although the Entombment Alternative would involve removing aboveground portions of the FFTF RCB and dismantling associated buildings and structures, this alternative would not affect any special status species, including threatened and endangered species, as none have been recorded within the 400 Area. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with this alternative, including development of Borrow Area C, designated critical habitat would not be adversely affected.

Debris and other waste not placed in the RCB or used as backfill would be disposed of in IDF-East. Impacts associated with construction and operation of this IDF are addressed in Section 4.3.7.2.3.

As noted in Chapter 3, Section 3.2.7.4, surveys have identified Piper's daisy (state sensitive), stalked-pod milkvetch (state watch), crouching milkvetch (state watch), and the long-billed curlew (state monitor) within the boundaries of Borrow Area C. Although mitigation would not be required for the state watch or state monitor species, they should be considered during project planning. Impacts on state sensitive species, which are considered Level III resources under the *Hanford Site Biological Resources Management Plan*, would require mitigation. When avoidance and minimization are not possible or are insufficient, mitigation via rectification or compensation is recommended (DOE 2001b:4.9, 8.11). However, due to the limited land requirement under this alternative (i.e., 2.8 hectares [7 acres]), it is likely that impacts on listed species could be avoided. If impacts were likely to occur, a comprehensive mitigation action plan would be developed prior to construction (DOE 2003f:43).

4.2.7.2.4.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Under this option, RH-SCs would be stored, treated, and disposed of at Hanford. As storage facilities currently exist within the 200 Areas and are used for similar purposes, their use under this option would not affect special status species. Treatment of RH-SCs would involve construction of a new RTP. As this facility would be constructed in a disturbed portion of the 200-West Area at the T Plant complex, it would not impact any listed species. Treated components would be disposed of in IDF-East.

IDAHO OPTION

RH-SCs removed from the FFTF RCB would be stored at Hanford prior to shipment to INL, where they would be treated in an existing facility at INTEC. Thus, there would be no impacts on threatened or endangered species. Treated components would be returned to Hanford or sent to NNSS for disposal. As an existing waste site would be used at NNSS, there would be no impacts on threatened or endangered species at the site. If returned to Hanford, waste would be placed in IDF-East.

4.2.7.2.4.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Under the Hanford Reuse Option, sodium from FFTF would be sent to a new SRF to be built in the 400 Area, and treated sodium would be stored in an existing facility within the 200 Areas. As there are no special status species within either of these areas, there would be no impact under this option.

IDAHO REUSE OPTION

Under this option, sodium from FFTF would be transported to the MFC for treatment in the existing SPF. Use of this facility would not impact threatened and endangered species because none are found within the MFC. There also would be no impacts on these species at Hanford because only existing facilities would be used.

4.2.7.3 Alternative 3: Removal

4.2.7.3.1 Terrestrial Resources

4.2.7.3.1.1 Facility Disposition

The Removal Alternative would result in the dismantlement and removal of the FFTF RCB and all associated buildings and structures within the PPA to or below grade. As all contaminated equipment would be removed from the RCB, an engineered barrier would not be needed; instead, the area would be covered with soil, recontoured, and revegetated using native species. Overall, impacts on terrestrial resources from this alternative would be similar to those described under the Entombment Alternative (see Section 4.2.7.2.1.1); however, revegetation of the FFTF site would not be limited to shallow-rooted species because the facility would no longer be contaminated. Future industrial development would be the determining factor in regard to long-term restoration of the site.

Under this alternative, debris and other waste would be handled in the same manner as under the Entombment Alternative (see Section 4.2.7.2.1.1). Impacts of the construction and use of IDF-East are addressed in Section 4.3.7.

The Removal Alternative would require a limited amount of geologic material to be excavated from Borrow Area C. The amount of material required would necessitate the development of 3.2 hectares (8 acres) of the area, which would have a minimal impact on terrestrial resources. Limited development should avoid the ecologically important needle-and-thread grass/Indian ricegrass community.

4.2.7.3.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION AND IDAHO OPTION

The steps involved in the disposition of RH-SCs under both the Hanford and Idaho Options would be identical to those under the Entombment Alternative. Thus, the impacts on terrestrial resources from disposition-related activities would be the same as those discussed under that alternative (see Section 4.2.7.2.1.2).

4.2.7.3.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION AND IDAHO REUSE OPTION

The steps involved in the processing of bulk sodium under both the Hanford Reuse and Idaho Reuse Options under the Removal Alternative would be identical to those under the Entombment Alternative.

Thus, the impacts on terrestrial resources from processing activities would be the same as those discussed under that alternative (see Section 4.2.7.2.1.3).

4.2.7.3.2 Wetlands

The steps involved in facility disposition, disposition of RH-SCs, and processing of bulk sodium under the Removal Alternative would be identical to those under the Entombment Alternative. Further, there are no wetlands within any of the areas affected by these actions; thus, similar to the Entombment Alternative, there would be no impacts on wetlands under this alternative or the option cases.

4.2.7.3.3 Aquatic Resources

The steps involved in facility disposition, disposition of RH-SCs, and the processing of bulk sodium under this alternative would be identical to those under the Entombment Alternative. Further, there are no aquatic resources within any of the areas affected by these actions; thus, similar to the Entombment Alternative, there would be no impacts on aquatic resources under this alternative or the option cases.

4.2.7.3.4 Threatened and Endangered Species

4.2.7.3.4.1 Facility Disposition

This alternative would involve removing aboveground portions of the FFTF RCB and dismantling associated buildings and structures. As no special status species, including threatened and endangered species, are found within the 400 Area, actions associated with facility disposition would not impact this group of organisms. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with this alternative, including development of Borrow Area C, designated critical habitat would not be adversely affected.

Debris and other waste not placed in the RCB or used as backfill would be disposed of in IDF-East. Impacts associated with construction and operation of this IDF are addressed in Section 4.3.7.2.3.

Potential impacts on sensitive species resulting from the removal of geologic material from Borrow Area C would be similar to those described in Section 4.2.7.2.4.1 because nearly the same land area would be affected.

4.2.7.3.4.2 Disposition of Remote-Handled Special Components

HANFORD OPTION AND IDAHO OPTION

The steps involved in the disposition of RH-SCs under both the Hanford and Idaho Options would be identical to those under the Entombment Alternative. Further, because there are no threatened or endangered species within affected areas, there would be no impacts on this group of organisms from disposition-related activities (see Section 4.2.7.2.4.2).

4.2.7.3.4.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION AND IDAHO REUSE OPTION

The steps involved in processing bulk sodium under both the Hanford and Idaho Reuse Options would be identical to those of the Entombment Alternative. Further, because there are no threatened or endangered species within affected areas, there would be no impacts on this group of organisms from the sodium processing activities (see Section 4.2.7.2.4.3).

4.2.8 Cultural and Paleontological Resources

4.2.8.1 Alternative 1: No Action

Under the No Action Alternative, the FFTF RCB and the other buildings in the FFTF PPA would remain in place. There would be no change in the appearance of the site from Rattlesnake Mountain, Gable Mountain, or Gable Butte, all of which are important to American Indians for religious and other cultural purposes. No geologic material would be excavated from Borrow Area C. Minimal volumes of waste requiring disposal would be placed within trenches 31 and 34 of LLBG 218-W-5 or in IDF-East. The use of these facilities would not change the overall visual appearance of the 200 Areas, as further described in Section 4.2.1.1.2.1.

4.2.8.1.1 Prehistoric Resources

As there would be no construction in areas not already in use, there would be no impact on prehistoric resources within this area.

4.2.8.1.1.1 Disposition of Remote-Handled Special Components

There are no known prehistoric resources in the 400 Area, which is considered an area of low archaeological sensitivity. Under the No Action Alternative, RH-SCs would remain in place within the FFTF RCB. Therefore, there would be no impacts on prehistoric resources.

4.2.8.1.1.2 Disposition of Bulk Sodium

Under the No Action Alternative, FFTF sodium would be stored in the SSF, which is located in the 400 Area, and other bulk sodium would remain in place in the 200 Areas. There would be no impacts on prehistoric resources.

4.2.8.1.2 Historic Resources

The FFTF RCB, along with the other buildings in the FFTF PPA, would remain in place. As there would be no construction in areas not already in use, there would be no impacts on historic resources within this area.

4.2.8.1.2.1 Disposition of Remote-Handled Special Components

Under the No Action Alternative, RH-SCs would remain in place within the FFTF RCB. Therefore, there would be no impacts on historic resources located in this area.

4.2.8.1.2.2 Disposition of Bulk Sodium

Under the No Action Alternative, FFTF sodium would be stored in the SSF, which is located in the 400 Area, and other bulk sodium would remain in place in the 200 Areas. There would be no impacts on historic resources.

4.2.8.1.3 American Indian Interests

As there would be no construction in areas not already in use, and the overall visual appearance would not change, there would be no impacts on American Indian interests within this area.

4.2.8.1.3.1 Disposition of Remote-Handled Special Components

The 400 Area is not known to contain any American Indian areas of interest. Under the No Action Alternative, RH-SCs would remain in place within the FFTF RCB. Therefore, there would be no impacts on resources.

4.2.8.1.3.2 Disposition of Bulk Sodium

Under the No Action Alternative, FFTF sodium would be stored in the SSF, which is located in the 400 Area, and other bulk sodium would remain in place in the 200 Areas. There would be no impacts on American Indian interests.

4.2.8.1.4 Paleontological Resources

As there would be no construction in areas not already in use, there would be no impacts on paleontological resources within this area.

4.2.8.1.4.1 Disposition of Remote-Handled Special Components

No known paleontological resources have been reported in the 400 Area. Under the No Action Alternative, RH-SCs would remain in place within the FFTF RCB. Therefore, there would be no impacts on paleontological resources.

4.2.8.1.4.2 Disposition of Bulk Sodium

Under the No Action Alternative, FFTF sodium would be stored in the SSF, which is located in the 400 Area, and other bulk sodium would remain in place in the 200 Areas. There would be no impacts on paleontological resources.

4.2.8.2 Alternative 2: Entombment

4.2.8.2.1 Prehistoric Resources

4.2.8.2.1.1 Facility Disposition

Under this alternative, the FFTF RCB and adjacent support facilities would be dismantled, and a modified RCRA Subtitle C barrier would be placed over the site. The barrier would be revegetated, and the PPA would become available for future development. The Industrial designation of the 400 Area would not change. There are no known prehistoric resources in the 400 Area, which is considered an area of low archaeological sensitivity. Therefore, facility disposition activities would not impact known prehistoric resources.

An estimated 2.8 hectares (7 acres) of Borrow Area C would be excavated to supply geologic material to support this alternative. Removal of this material would be consistent with the current site land use plan. If prehistoric resources were discovered during facility disposition in the 400 Area or excavation of geologic material from Borrow Area C, appropriate guidance set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g) would be implemented.

4.2.8.2.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Treatment of RH-SCs would involve construction of a new RTP adjacent to the T Plant complex in the 200-West Area. This facility would encompass 0.1 hectares (0.3 acres) of land. Known prehistoric resources would not be disturbed by these activities. If prehistoric resources were discovered during construction of a new RTP, appropriate guidance set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g) would be implemented.

IDAHO OPTION

Under this option, RH-SCs would be stored at Hanford prior to shipment to INL, where they would be treated in an existing facility at INTEC. As an existing facility would be used and this area is industrial, there would be no impact on prehistoric resources at INTEC. Treated components would be returned to Hanford or sent to NNSS for disposal, where they would be placed in existing facilities. An existing waste site would be used at NNSS. If returned to Hanford, waste would be placed in IDF-East. Therefore, there would be no impacts on prehistoric resources at NNSS or Hanford.

4.2.8.2.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Under this option, sodium from FFTF would be sent to a new SRF to be built in the already highly developed 400 Area, which is considered an area of low archaeological sensitivity. The treated sodium would be stored in an existing facility within the 200 Areas. There would be no impacts on known prehistoric resources under this option. If prehistoric resources were discovered during construction of a new SRF, appropriate guidance set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g) would be implemented.

IDAHO REUSE OPTION

Under this option, sodium from FFTF would be transported to INL for treatment in the SPF, an existing facility within the MFC. There would be no impacts on prehistoric resources under this option.

4.2.8.2.2 Historic Resources

4.2.8.2.2.1 Facility Disposition

Under this alternative, the FFTF RCB and adjacent support facilities would be dismantled, and a modified RCRA Subtitle C barrier would be placed over the site. Disturbed areas within the PPA would be revegetated, providing an overall improvement in the appearance of the 400 Area. Some of the buildings to be dismantled are eligible for listing in the National Register as contributing properties within the Hanford Site Manhattan Project and Cold War Era Historic District. As required by the programmatic agreement with the Advisory Council on Historic Preservation and the Washington State Historic Preservation Office, DOE prepared written and photographic documentation and assessed the contents of the historic buildings and structures within FFTF. DOE also identified and tagged artifacts with interpretive and/or educational value and prepared a curation management plan (DOE 1996; Harvey 2002) (see Section 3.2.8.2.3).

An estimated 2.8 hectares (7 acres) of Borrow Area C would be excavated for geologic material to support this alternative. If historic resources were discovered during facility disposition in the 400 Area or excavation of geologic material from Borrow Area C, appropriate guidance set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g) would be implemented.

4.2.8.2.2.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Under this option, both storage and disposal facilities exist within the 200 Areas. A new RTP would be constructed, requiring 0.1 hectares (0.3 acres) in a presently industrial area. Known historic resources would not be disturbed by these activities. If historic resources were discovered during construction, appropriate guidance set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g) would be implemented.

IDAHO OPTION

Under this option, RH-SCs would be stored at Hanford prior to shipment to INL, where they would be treated in an existing facility at INTEC. As an existing facility would be used and this area is industrial, there would be no impact on historic resources at INTEC. Treated components would be returned to Hanford or sent to NNSS for disposal, where they would be placed in existing facilities. An existing waste site would be used at NNSS. If returned to Hanford, waste would be placed in IDF-East. Therefore, there would be no impacts on historic resources at NNSS or Hanford.

4.2.8.2.2.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Under this option, sodium from FFTF would be sent to a new SRF to be built in the already highly developed 400 Area, which is considered an area of low archaeological sensitivity. Sodium would be stored in an existing facility within the 200 Areas. Known historic resources would not be disturbed by these activities. If historic resources were uncovered during construction, appropriate guidance set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g) would be implemented.

IDAHO REUSE OPTION

Under this option, bulk sodium from FFTF and other sodium would be transported to INL for treatment in the existing SPF. There would be no impacts on historic resources.

4.2.8.2.3 American Indian Interests

4.2.8.2.3.1 Facility Disposition

Under this alternative, the FFTF RCB and adjacent support facilities would be dismantled, and a modified RCRA Subtitle C barrier would be placed over the site. The barrier would be revegetated, and the PPA would become available for future development. As described in Section 4.2.1.2.2.1, there would be an initial overall improvement in the visual character of the 400 Area, although it may return to a similar industrial view in the future. Therefore, the view from nearby higher elevations like Rattlesnake Mountain, Gable Mountain, and Gable Butte, all of which are important to American Indians for religious and other cultural purposes, would be largely unchanged from its current industrial nature.

Under the Entombment Alternative, a limited area of 2.8 hectares (7 acres) would be excavated from Borrow Area C. Excavation activities would impact the view from State Route 240 and higher elevations, including Rattlesnake Mountain, an area of cultural significance to American Indians. If there were visual impacts on American Indian interests, appropriate mitigation measures would be developed in consultation with area tribes.

4.2.8.2.3.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Under this option, a new RTP in the 200-West Area would not affect American Indian interests. If artifacts of importance to American Indians were discovered during construction, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented.

IDAHO OPTION

Under this option, RH-SCs would be stored at Hanford prior to shipment to INL, where they would be treated in an existing facility at INTEC. Treated components would be returned to Hanford or sent to NNSS for disposal, where they would be placed in existing facilities. An existing waste site would be used at NNSS. If returned to Hanford, waste would be placed in IDF-East. As there would be no new construction, there would be no impact on American Indian interests.

4.2.8.2.3.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Under this option, a new SRF would be built in an already highly developed part of the 400 Area; therefore, its construction would have no visual impact. If artifacts of importance to American Indians were discovered during construction of the facility, appropriate guidance set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g) would be implemented.

IDAHO REUSE OPTION

As there would be no new construction in areas not already in use, there would be no impacts on American Indian interests.

4.2.8.2.4 Paleontological Resources

4.2.8.2.4.1 Facility Disposition

There would be no impact on paleontological resources under this alternative or options because no such resources have been discovered within the affected areas. As is the case with cultural resources, if any paleontological resources were discovered, procedures in place to properly manage the discovery site would be implemented.

4.2.8.2.4.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

There would be no impacts on paleontological resources under this alternative or options because no such resources have been discovered within the affected areas. As is the case with cultural resources, if any paleontological resources were discovered, procedures in place to properly manage the discovery site would be implemented.

IDAHO OPTION

There would be no impacts on paleontological resources under this alternative or options because no such resources have been discovered within the affected areas. As is the case with cultural resources, if any paleontological resources were discovered, procedures in place to properly manage the discovery site would be implemented.

4.2.8.2.4.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

There would be no impacts on paleontological resources under this alternative or options because no such resources have been discovered within the affected areas. As is the case with cultural resources, if any paleontological resources were discovered, procedures in place to properly manage the discovery site would be implemented.

IDAHO REUSE OPTION

There would be no impacts on paleontological resources under this alternative or options because no such resources have been discovered within the affected areas. As is the case with cultural resources, if any paleontological resources were discovered, procedures in place to properly manage the discovery site would be implemented.

4.2.8.3 Alternative 3: Removal

4.2.8.3.1 Prehistoric Resources

4.2.8.3.1.1 Facility Disposition

The Removal Alternative would result in the dismantlement and removal of the FFTF RCB and all associated buildings and structures within the PPA to or below grade. The area would be covered with soil, recontoured, and revegetated. The PPA would become available for future development. The Industrial designation of the 400 Area would not change. There are no known prehistoric resources in the 400 Area, which is considered an area of low archaeological sensitivity. Therefore, facility disposition activities would not impact known prehistoric resources.

An area of about 3.2 hectares (8 acres) would also be excavated from Borrow Area C to support activities under this alternative. Removal of this material would be consistent with the current site land use plan. If prehistoric resources were discovered during facility disposition in the 400 Area or excavation in Borrow Area C, appropriate guidance set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g) would be implemented.

4.2.8.3.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION AND IDAHO OPTION

Activities under these options would be identical to those under the Entombment Alternative. Therefore, there would be no impacts on prehistoric resources.

4.2.8.3.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION AND IDAHO REUSE OPTION

Activities under these options would be identical to those under the Entombment Alternative. Therefore, there would be no impacts on prehistoric resources.

4.2.8.3.2 Historic Resources

4.2.8.3.2.1 Facility Disposition

Activities and potential impacts on historic resources would be similar to those described in Section 4.2.8.2.2.1 under the Entombment Alternative.

4.2.8.3.2.2 Disposition of Remote-Handled Special Components

HANFORD OPTION AND IDAHO OPTION

Disposition of RH-SCs under this option would not impact historic resources.

4.2.8.3.2.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION AND IDAHO REUSE OPTION

There are no known historic resources located within the areas that would be impacted by these options.

4.2.8.3.3 American Indian Interests

4.2.8.3.3.1 Facility Disposition

Activities and potential impacts on American Indian interests would be similar to those described in Section 4.2.8.2.3.1 under the Entombment Alternative.

4.2.8.3.3.2 Disposition of Remote-Handled Special Components

HANFORD OPTION AND IDAHO OPTION

There would be no impacts on American Indian interests under these options for the same reasons described in Section 4.2.8.2.3.2.

4.2.8.3.3.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION AND IDAHO REUSE OPTION

There would be no impacts on American Indian interests under these options for the same reasons described in Section 4.2.8.2.3.3.

4.2.8.3.4 Paleontological Resources

There would be no impacts on known paleontological resources under this alternative or options, as described in Section 4.2.8.2.4. No such resources have been discovered within the affected areas. As is the case with cultural resources, if any paleontological resources were discovered, procedures in place to properly manage the discovery site would be implemented.

4.2.9 Socioeconomics

The primary or direct impacts of FFTF decommissioning and disposition on employment, regional demographics, housing and community services, and local transportation in both the Hanford and Idaho regions were analyzed for this section of the EIS. The potential primary impacts were set forth by analyzing projected changes in employment (in terms of FTEs) and truck activity related to the activities in each alternative (see Appendix I). The projected changes in employment and truck activity have the potential to generate economic impacts that may affect the need for housing units and public services and local transportation in both regions.

The key underlying assumptions used to project changes in employment under each of the FFTF Decommissioning alternatives and associated options were similar to those described in Section 4.1.9 for the Tank Closure alternatives. Impacts of onsite truck trips, i.e., trips conducted solely on site, are included in the onsite analysis. Impacts of the onsite portion of truck trips to or from the site are included in the offsite analysis. Impacts on local commuter traffic were determined by calculating the daily number of vehicles driving to and from work. The conservative assumption used for employees commuting to work in the Idaho region was that employees would commute in single-occupancy vehicles. As in the socioeconomics analysis for tank closure activities (see Section 4.1.9), it was assumed that Hanford employees would commute with an average of 1.25 passengers in each vehicle (Malley 2007). FFTF Decommissioning alternatives consist of three distinct activities: FFTF disposition, disposition of RH-SCs, and disposition of bulk sodium. Table 4–107 summarizes the indicators used to analyze the socioeconomic impacts under each activity.

Table 4–107. FFTF Decommissioning Alternatives and Options – Summary of Peak Estimated Socioeconomic Indicators

Alternatives and Options	Peak Annual Workforce[a] (Peak Year)	Peak Daily Commuter Traffic	Peak Daily Truck Loads (Peak Year)	
			Off Site	On Site
Alternative 1: No Action	1 (2008–2107)	1	Less than 1 (2008–2107)	0
Alternative 2: Facility Disposition–Entombment	50 (2021)	40	3 (2017)	52 (2021)
Alternative 3: Facility Disposition–Removal	85 (2013–2014)	68	2 (2013–2014)	63 (2021)
Disposition of RH-SCs (Hanford Option for remote treatment)	53 (2015–2016)	43	1 (2015–2016)	2 (2015–2016)
Disposition of RH-SCs (Idaho Option for remote treatment)	40 (2017)	40	Less than 1 (2017)	0
Disposition of Bulk Sodium (Hanford Reuse Option)	65 (2017)	52	Less than 1 (2015–2016)	Less than 1 (2015–2016)
Disposition of Bulk Sodium (Idaho Reuse Option)	55 (2015)	55	Less than 1 (2015)	Less than 1 (2014)

[a] Workforce is rounded into full-time-equivalent quantities.

Note: Values presented in the table have been rounded to no more than two significant digits, where appropriate.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; RH-SCs=remote-handled special components.

Source: Appendix I; SAIC 2010b.

4.2.9.1 Alternative 1: No Action

Under Alternative 1, No Action, the total onsite employment of one FTE per year from 2008 through 2107 for the surveillance and maintenance period would have little or no impacts on regional economic characteristics, the demographic characteristics, or housing and community services. In addition, one truck trip per year along with a single commuter vehicle would have little or no impact on local transportation in the Hanford ROI.

4.2.9.2 Alternative 2: Entombment

Under Alternative 2, employment activity for all three activities shown in Table 4–107 would be limited to the period from 2013 through 2021. No workforce estimate would be above 65 workers per year during the active years, followed by a single FTE needed for institutional controls through 2121. In addition to these direct employees associated with the closure and cleanup of FFTF, indirect positions would likely be created in the ROI. The impact on the region of both sources of jobs together would be small. The heaviest truckload activity would result from FFTF site regrading activities at Hanford.

4.2.9.2.1 Regional Economic Characteristics

4.2.9.2.1.1 Facility Disposition

The decommissioning and closure activities pertaining to facility disposition would require a peak workforce of 50 FTEs in 2021. By comparison, the labor force in the Hanford ROI is projected to be about 150,000 in 2021 (BEA 2007).

4.2.9.2.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Disposition of RH-SCs at Hanford under this option would require a peak workforce of 53 FTEs from 2015 through 2016. By comparison, the labor force in the Hanford ROI is projected to be about 138,000 in 2015 (BEA 2007).

IDAHO OPTION

Disposition of RH-SCs at INL under this option would require a peak workforce of 40 FTEs in 2017. By comparison, the labor force in the Idaho ROI is projected to be about 182,000 in 2017 (BEA 2007).

4.2.9.2.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Processing bulk sodium at Hanford under this option would require a peak workforce of 65 FTEs in 2017. By comparison, the labor force in the Hanford ROI is projected to be about 142,000 in 2017 (BEA 2007).

IDAHO REUSE OPTION

Processing bulk sodium at INL under this option would require a peak workforce of 55 FTEs in 2015. By comparison, the labor force in the Idaho ROI is projected to be about 178,000 in 2015 (BEA 2007).

4.2.9.2.2 Demographic Characteristics

The majority of the peak decommissioning workforce would likely be drawn from the local labor force for each of the three activities, facility disposition, disposition of RH-SCs, and disposition of bulk sodium. There would likely be little in-migration of new workers and their families; thus, the demographic characteristics of the Hanford ROI and Idaho ROI would not be altered.

4.2.9.2.3 Housing and Community Services

For FFTF disposition, disposition of RH-SCs, and disposition of bulk sodium, the peak workforce required under this alternative would have little or no impacts on demands for housing, schools, and other community services within the Hanford ROI or Idaho ROI.

4.2.9.2.4 Local Transportation

4.2.9.2.4.1 Facility Disposition

Under Alternative 2, assuming an average of 1.25 persons per passenger vehicle (Malley 2007), up to 40 passenger vehicles per day are expected to commute to the site during the peak year of 2021. Based on predicted truck activity off site—up to 853 offsite truck trips per year (3 trips per day) in 2017—and predicted commuter traffic, the LOS on offsite roads in the Hanford area is not expected to change (see Chapter 3, Section 3.2.9.4). Onsite truck trips would peak in 2021, with up to 13,500 trips per year (52 trips per day) as a result of FFTF closure activities.

4.2.9.2.4.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Under Alternative 2, assuming an average of 1.25 persons per passenger vehicle (Malley 2007), up to 43 passenger vehicles per day are expected to commute to the site during the peak years of 2015 and 2016. Based on predicted truck activity off site—up to 272 offsite truck trips (1 truck trip per day) in 2015 and 2016—and predicted commuter traffic, the LOS on offsite roads in the Hanford area is not expected to change (see Chapter 3, Section 3.2.9.4). Onsite truck trips would peak in 2015 and 2016 with up to 545 trips per year (2 trips per day) as a result of the construction of the RTP.

IDAHO OPTION

Under Alternative 2, assuming an average of 1 person per passenger vehicle, up to 40 passenger vehicles per day are expected to commute to the site during 2017. Based on predicted truck activity off site—up to 4 offsite truck trips (less than 1 truck trip per day) in 2017—and predicted commuter traffic, the LOS on U.S. Highway 20 in the INL area is not expected to change (see Chapter 3, Section 3.3.9.4). There would be no onsite truck trips for this option.

4.2.9.2.4.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Under Alternative 2, assuming an average of 1.25 persons per passenger vehicle (Malley 2007), up to 52 passenger vehicles per day are expected to commute to the site during the peak year of 2017. Based on predicted truck activity off site—up to 35 offsite truck trips per year in 2015 and 2016—and predicted commuter traffic, the LOS on offsite roads in the Hanford area is not expected to change (see Chapter 3, Section 3.2.9.4). Onsite truck trips would peak in 2015 and 2016, with up to 23 trips per year as a result of the construction of the Hanford SRF.

IDAHO REUSE OPTION

Under Alternative 2, assuming an average of 1 person per passenger vehicle, up to 55 passenger vehicles per day are expected to commute to the site during the peak year of 2015. Based on predicted truck activity off site—up to 13 offsite truck trips per year in 2015—and predicted commuter traffic, the LOS on U.S. Highway 20 in the INL area is not expected to change (see Chapter 3, Section 3.3.9.4). Onsite truck trips would peak in 2014, with up to 13 trips per year as a result of the construction and operations of the INL SPF.

4.2.9.3 Alternative 3: Removal

Under Alternative 3, employment activity for all three activities shown in Table 4–107 would be limited to the period from 2012 through 2021. No workforce estimate would be above 85 workers per year during the active years, followed by a single FTE needed for institutional controls through 2121. In addition to these direct employees associated with the closure and cleanup of FFTF, indirect positions would likely be created in the ROI. The impact on the region of both sources of jobs together would be small. The heaviest truckload activity would result from FFTF site regrading activities at Hanford.

4.2.9.3.1 Regional Economic Characteristics

4.2.9.3.1.1 Facility Disposition

The decommissioning and closure activities pertaining to facility disposition would require a peak workforce of 85 FTEs from 2013 through 2014. By comparison, the labor force in the Hanford ROI is projected to be about 134,000 in 2013 (BEA 2007).

4.2.9.3.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Similar to the impacts under Alternative 2, disposition of RH-SCs at Hanford under this option would require a peak workforce of 53 FTEs from 2015 through 2016. By comparison, the labor force in the Hanford ROI is projected to be about 138,000 in 2015 (BEA 2007).

IDAHO OPTION

Similar to the impacts under Alternative 2, disposition of RH-SCs at INL under this option would require a peak workforce of 40 FTEs in 2017. By comparison, the labor force in the Idaho ROI is projected to be about 182,000 in 2017 (BEA 2007).

4.2.9.3.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Similar to the impacts under Alternative 2, processing bulk sodium at Hanford under this option would require a peak workforce of 65 FTEs in 2017. By comparison, the labor force in the Hanford ROI is projected to be about 142,000 in 2017 (BEA 2007).

IDAHO REUSE OPTION

Similar to the impacts under Alternative 2, processing bulk sodium at INL under this option would require a peak workforce of 55 FTEs in 2015. By comparison, the labor force in the Idaho ROI is projected to be about 178,000 in 2015 (BEA 2007).

4.2.9.3.2 Demographic Characteristics

Similar to Alternative 2, this alternative would likely draw the majority of its peak workforce for each of the three activities, FFTF disposition, disposition of RH-SCs, and disposition of bulk sodium, from the local labor force. There would likely be little in-migration of new workers and their families; thus, the demographic characteristics of the Hanford ROI and Idaho ROI would not be altered.

4.2.9.3.3 Housing and Community Services

For each of the three activities, FFTF disposition, disposition of RH-SCs, and disposition of bulk sodium, the peak workforce required under this alternative would have little or no impacts on demands for housing, schools, and other community services within the Hanford ROI or Idaho ROI.

4.2.9.3.4 Local Transportation

4.2.9.3.4.1 Facility Disposition

Under Alternative 3, assuming an average of 1.25 persons per passenger vehicle (Malley 2007), up to 68 passenger vehicles per day are expected to commute to the site during the peak years of 2013 and 2014. Based on predicted truck activity off site—up to 448 offsite truck trips per year (2 trips per day)—and predicted commuter traffic, the LOS on offsite roads in the Hanford area is not expected to change (see Chapter 3, Section 3.2.9.4). Onsite truck trips would peak in 2021, with up to 16,400 trips per year (63 trips per day) as a result of FFTF closure activities.

4.2.9.3.4.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Similar to Alternative 2, assuming an average of 1.25 persons per passenger vehicle, up to 43 passenger vehicles per day are expected to commute to the site during the peak years of 2015 and 2016. Based on predicted truck activity off site—up to 272 offsite truck trips per year (1 truck trip per day) in 2015 and 2016—and predicted commuter traffic, the LOS on offsite roads in the Hanford area is not expected to change (see Chapter 3, Section 3.2.9.4). Onsite truck trips would peak in 2015 and 2016, with up to 545 trips per year (2 trips per day) as a result of the construction of the RTP.

IDAHO OPTION

Similar to Alternative 2, assuming an average of 1 person per passenger vehicle, up to 40 passenger vehicles per day are expected to commute to the site in 2017. Based on predicted truck activity off site—up to 4 offsite truck trips per year (less than 1 truck trip per day) in 2017—and predicted commuter traffic, the LOS on U.S. Highway 20 in the INL area is not expected to change (see Chapter 3, Section 3.3.9.4). There would be no onsite truck trips for this option.

4.2.9.3.4.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Similar to Alternative 2, assuming an average of 1.25 persons per passenger vehicle, up to 52 passenger vehicles per day are expected to commute to the site during the peak year of 2017. Based on predicted truck activity off site—up to 35 offsite truck trips per year in 2015 and 2016—and predicted commuter traffic, the LOS on offsite roads in the Hanford area is not expected to change (see Chapter 3, Section 3.2.9.4). Onsite truck trips would peak in 2015 and 2016, with up to 23 trips per year as a result of the construction of the Hanford SRF.

IDAHO REUSE OPTION

Similar to Alternative 2, assuming an average of 1 person per passenger vehicle, up to 55 passenger vehicles per day are expected to commute to the site during the peak year of 2015. Based on predicted truck activity off site—up to 13 offsite truck trips per year in 2015—and predicted commuter traffic, the LOS on U.S. Highway 20 in the INL area is not expected to change (see Chapter 3, Section 3.3.9.4).

Onsite truck trips would peak in 2014, with up to 13 trips per year as a result of the construction and operations of the INL SPF.

4.2.10 Public and Occupational Health and Safety—Normal Operations

Details of the assessment methodology for determining radiological exposure to workers and members of the public are presented in Appendix K. Radiological impacts are presented for three public receptors: the general population living within 80 kilometers (50 miles) of the site (either Hanford or INL), an MEI living near the site boundary, and an onsite MEI. Impacts on the general population are evaluated for a residential scenario whereby people are exposed to radioactive materials emitted from project facilities. Radiological exposure occurs through inhalation, direct exposure to the radioactive plume and material deposited on the ground, and ingestion of contaminated food products from animals raised locally and fruits and vegetables grown in a family garden (DOE 1995:A-7). Impacts on the MEI are evaluated for a scenario that includes the same exposure pathways assumed for the general population, but with an increased amount of time spent outdoors and a higher rate of contaminated food consumption. Impacts on the onsite MEI, a worker at the Columbia Generating Station or LIGO, are evaluated for inhalation and exposure to the radioactive plume and material deposited on the ground. Doses are presented as total effective doses.

In addition to members of the public, workers directly involved in the activities associated with each alternative and nearby noninvolved workers may receive radiation doses. Doses to an involved worker are calculated based on an FTE employee. It was assumed for purposes of this dose evaluation that an FTE worker has a 2,080-hour work year. In practice, the number of workers who receive a radiation dose may be larger than the number assumed in this analysis, resulting in a smaller average dose per worker. A noninvolved worker is a person working at the site who is incidentally exposed due to the radioactive air emissions associated with the alternatives considered. The noninvolved worker was assumed to be about 100 meters (110 yards) away or at a nearby facility and was assumed to be there only during workdays.

Impacts of FFTF deactivation were previously evaluated in the *Environmental Assessment, Sodium Residuals Reaction/Removal and Other Deactivation Work Activities, Fast Flux Test Facility (FFTF) Project, Hanford Site, Richland, Washington (FFTF Deactivation EA)* (DOE 2006b). Those impacts included negligible doses to the public and conservatively estimated (overestimated) worker doses from the removal and treatment of sodium-contaminated equipment from the facility. The impacts of FFTF deactivation were assumed to occur independent of the actions evaluated in this EIS and are not included among the impacts of the FFTF Decommissioning alternatives. However, deactivation impacts are discussed in the following section for perspective.

Very small radiological impacts on the public are expected from any of the FFTF Decommissioning alternatives. The options for disposition of RH-SCs and bulk sodium at Hanford would have slightly higher offsite impacts than the options for these activities at INL. Implementing either the Entombment Alternative or the Removal Alternative would result in relatively small incremental worker doses over those estimated for deactivation activities, with the Removal Alternative having the higher dose. Worker doses from RH-SC and bulk sodium processing at Hanford vary only slightly from those at INL.

4.2.10.1 Alternative 1: No Action

4.2.10.1.1 Radiological Impacts on the Public

As discussed in Section 4.2.10, the *FFTF Deactivation EA* evaluated impacts of removing equipment and piping and processing the residual sodium. The document conservatively assumed that all of the tritium contamination in the sodium was released to the environment, and the resulting dose to an MEI was estimated to be about 0.00026 millirem per year (DOE 2006b). Based on the extremely low dose to the

MEI, doses to the offsite population would be very small and insubstantial. Completion of the FFTF deactivation activities is the assumed starting point of the alternatives evaluated in this EIS.

Under the No Action Alternative, radioactive emissions from FFTF were assumed to continue at a rate comparable to those in recent years (see Appendix K, Section K.2.2.1.3.3). The resulting annual dose would be 0.00027 person-rem to the population and 0.000017 millirem to an MEI. Over the 100 years of administrative control, the population dose would be 0.027 person-rem; no LCFs (a calculated risk of 0.00002) are expected as a result of this dose. An MEI exposed for 70 years would receive a dose of 0.0012 millirem; the increased risk of an LCF from this dose would be negligible (less than 1 in 1 billion).

4.2.10.1.2 Radiological Impacts on Workers

Worker doses would occur during the administrative control period. The worker population dose from deactivation activities was conservatively estimated to be about 576 person-rem (DOE 2006b). No additional LCFs are expected in the worker population as a result of the deactivation activities.

Table 4–108 presents dose and risk estimates for a worker involved in the 100 years of administrative control. The average annual FTE radiation worker dose would be 50 millirem, less than the Administrative Control Level of 500 millirem. A radiation worker who received the average annual dose over his or her career (assumed to be 40 years) would receive a dose of 2,000 millirem, corresponding to a risk of 1×10^{-3} (1 chance in 1,000) of developing an LCF.

Table 4–108. FFTF Decommissioning Alternative 1 Radiological Impacts on Workers

Activity	Life-of-Project Worker Population		Average Annual Involved Full-Time-Equivalent Worker		Annual Noninvolved Worker	
	Dose (person-rem)	LCF[a]	Dose (millirem per year)	LCF Risk[b]	Dose (millirem per year)	LCF Risk[b]
Administrative control	1	0 (6×10^{-4})	50	3×10^{-5}	0.00064	4×10^{-10}

a The reported value is the projected number of LCFs in the worker population and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

b The lifetime risk that the worker would develop an LCF based on the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: FFTF=Fast Flux Test Facility; LCF=latent cancer fatality.

Source: Appendix K, Section K.2.2.

Table 4–108 also shows the estimated collective worker dose for the 100-year administrative control period. The dose to the worker population would be about 1 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem, no LCFs are expected as a result of the dose associated with this activity.

The *FFTF Deactivation EA* estimated the dose to a noninvolved worker assumed to be 100 meters (110 yards) away during deactivation activities to be 0.16 millirem per year (DOE 2006b); a noninvolved worker beyond the vicinity of FFTF (for example, at the 300 Area) would receive a dose closer to that of the MEI—0.00026 millirem per year. The annual dose from administrative control activities at FFTF to a noninvolved worker, assumed to be in the Hanford 300 Area, would be 0.0000064 millirem. There would be essentially no risk of an LCF from this exposure.

4.2.10.2 Alternative 2: Entombment

4.2.10.2.1 Radiological Impacts on the Public

The radiological impacts of deactivation activities, as discussed in Section 4.2.10.1, would occur independent of the FFTF Decommissioning alternatives. Those activities were estimated to result in an MEI dose of 0.00026 millirem per year and no measurable increase in the collective offsite population dose. The following sections address the radiological doses and risks of the activities associated with this alternative. Table 4–109 presents public dose and risk estimates from disposition of FFTF, RH-SCs, and bulk sodium. The population doses shown in the table are for the entire duration of the activity, whereas the MEI doses are for the year of maximum impact.

Table 4–109. FFTF Decommissioning Alternative 2 Radiological Impacts on the Public

Activity	Offsite Population		Maximally Exposed Individual	
	Life-of-Project Dose (person-rem)	LCF[a]	Maximum Annual Dose (millirem per year)	LCF Risk[b]
Facility Disposition	0.00000067	0 (4×10^{-10})	0.000000058	3×10^{-14}
Disposition of Remote-Handled Special Components				
Hanford Option	0.00019	0 (1×10^{-7})	0.0000078	5×10^{-12}
Idaho Option	0.000048	0 (3×10^{-8})	0.0000044	3×10^{-12}
Disposition of Bulk Sodium				
Hanford Reuse Option	0.022	0 (1×10^{-5})	0.00046	3×10^{-10}
Idaho Reuse Option	0.0021	0 (1×10^{-6})	0.00037	2×10^{-10}

a The reported value is the projected number of LCFs among the population and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

b The lifetime risk that the maximally exposed individual would develop an LCF based on the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; LCF=latent cancer fatality.

Source: Appendix K, Section K.2.2.

4.2.10.2.1.1 Facility Disposition

Grouting of belowground structures while preparing FFTF for entombment would result in small amounts of radioactive air emissions. The population dose as a result of these emissions would be extremely small (0.00000067 person-rem). No excess LCFs are expected to occur in the offsite population as a result of this small dose. The maximum annual MEI dose from facility disposition activities would be about 0.000000058 millirem, which would result in essentially no additional risk of an LCF (a risk of much less than 1 chance in 1 million). The dose and risk to an onsite MEI would be less than those estimated for the MEI; this is because the onsite MEI would be exposed for a shorter time (only during the workday) and through fewer pathways (e.g., no ingestion pathway).

4.2.10.2.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Processing of RH-SCs to remove the sodium and prepare them for disposal would result in radioactive air emissions and a potential dose to the public, primarily from sodium-22 and cesium-137. Under the option of performing this work in a new RTP located in the Hanford 200-West Area, the offsite population would receive a collective dose of 0.00019 person-rem. This dose would be received over the 2-year period in which the RTP is operated and decommissioned. No additional LCFs are expected in the offsite population as a result of this activity. The maximum annual dose to an MEI of 0.0000078 millirem would occur during the year in which the RH-SCs would be processed. There would be essentially no risk of developing an LCF from this dose (a risk of much less than 1 chance in 1 million). The dose to an onsite MEI at US Ecology in the year of maximum impact would be 0.000018 millirem. There would be essentially no risk of developing an LCF from this dose (a risk of much less than 1 chance in 1 million).

IDAHO OPTION

Under the option of processing the RH-SCs at the INL's INTEC, the projected offsite population dose would be 0.000048 person-rem. The lower projected dose is due to a smaller exposed population and differences in population distribution and meteorology between Hanford and INL. No LCFs are expected among the population as a result of this dose. The maximum annual dose to an MEI would be 0.0000044 millirem, which would result in essentially no additional risk of an LCF (a risk of much less than 1 chance in 1 million).

4.2.10.2.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Processing the bulk sodium at a new SRF near FFTF would result in airborne releases of tritium, sodium-22, cesium-137, and uranium isotopes that occur as contaminants in the sodium. Under this option, the offsite population would receive a collective dose of 0.022 person-rem over the 3 years of processing the sodium and decommissioning the facility. No additional LCFs are expected in the offsite population as a result of this activity. The maximum annual dose to an MEI of 0.00046 millirem would occur during the years in which the sodium is processed. There would be essentially no risk of developing an LCF from this dose (a risk of much less than 1 chance in 1 million). The dose and risk to an onsite MEI would be less than those estimated for the MEI.

IDAHO REUSE OPTION

Under the option of processing bulk sodium at the INL MFC, the offsite population and MEI doses would be lower than those under the Hanford Reuse Option. The lower population dose is due to differences in total population, population distribution, and meteorology. The dose to the population received over the 3-year course of the activity would be 0.0021 person-rem. No additional LCFs are expected in the offsite population as a result of this activity. The maximum annual MEI dose would be 0.00037 millirem; there would be essentially no risk of developing an LCF from this dose (a risk of much less than 1 chance in 1 million).

4.2.10.2.2 Radiological Impacts on Workers

Radiological impacts on workers from facility deactivation (activities that would occur prior to implementing an FFTF Decommissioning alternative) would be the same as discussed in Section 4.2.10.1.2. The worker population dose from deactivation would be about 576 person-rem. No additional LCFs are expected in the worker population as a result of this dose (DOE 2006b). Radiological doses and risks under Alternative 2 are presented in Table 4–110. Worker population impacts presented in Table 4–110 are for the duration of the project; average worker impacts are for the year of maximum impact.

Table 4–110. FFTF Decommissioning Alternative 2 Radiological Impacts on Workers

Activity	Life-of-Project Worker Population		Average Annual Involved Full-Time-Equivalent Worker		Annual Noninvolved Worker	
	Dose (person-rem)	LCF[a]	Dose (millirem per year)	LCF Risk[b]	Dose (millirem per year)	LCF Risk[b]
Facility Disposition	0.37	0 (2×10^{-4})	100	6×10^{-5}	0.0000000059	4×10^{-15}
Disposition of Remote-Handled Special Components						
Hanford Option	1.2	0 (7×10^{-4})	20	1×10^{-5}	0.011	6×10^{-9}
Idaho Option	1.2	0 (7×10^{-4})	20	1×10^{-5}	0.00000029	1×10^{-14}
Disposition of Bulk Sodium						
Hanford Reuse Option	3.7	0 (2×10^{-3})	39	2×10^{-5}	0.00025	2×10^{-10}
Idaho Reuse Option	3.6	0 (2×10^{-3})	39	2×10^{-5}	0.069	4×10^{-8}

a The reported value is the projected number of LCFs in the worker population and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

b The lifetime risk that the worker would develop an LCF based on the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; LCF=latent cancer fatality.

Source: Appendix K, Section K.2.2.

4.2.10.2.2.1 Facility Disposition

Worker doses would result from facility disposition activities associated with stabilizing FFTF in preparation for entombment. The worker population would receive a dose of 0.37 person-rem during the preparation activities. No additional LCFs are expected in the worker population as a result of this dose. The average annual worker dose would be 100 millirem; this dose corresponds to an increased risk of an LCF of 6×10^{-5}, or about 1 chance in 17,000.

The annual dose from this activity to a noninvolved worker assumed to be in the Hanford 300 Area would be 0.0000000059 millirem. There would be essentially no risk of an LCF from this exposure.

4.2.10.2.2.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Processing of RH-SCs to remove the sodium and prepare them for disposal would result in a worker dose, primarily from sodium-22 and cesium-137 contaminants. Under the Hanford Option, the worker population would receive a collective dose of 1.2 person-rem. This dose would be received over the 2-year period in which the RTP is operated and decommissioned. No additional LCFs are expected in the worker population as a result of this activity. The maximum annual worker dose would occur during the year in which the RH-SCs are processed. The average worker dose in that year would be 20 millirem; this dose corresponds to an increased risk of an LCF of 1×10^{-5}, or less than 1 chance in 100,000.

The annual dose from this activity to a noninvolved worker assumed to be 100 meters (110 yards) away in the 200-West Area would be 0.011 millirem. There would be essentially no risk of an LCF from this exposure.

IDAHO OPTION

Under the Idaho Option, in which RH-SCs would be processed at the INL RTP, the involved worker doses and risks would be the same as those estimated for Hanford.

The annual dose from this activity to a noninvolved worker assumed to be about 100 meters (110 yards) away from the RTP at another INTEC facility would be 0.00000029 millirem. There would be essentially no risk of an LCF from this exposure.

4.2.10.2.2.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Processing of bulk sodium would result in a worker dose from contaminants in the sodium, primarily tritium, sodium-22, cesium-137, and uranium isotopes. Under the option of processing the sodium at a new SRF near FFTF, the worker population would receive a collective dose of 3.7 person-rem. This dose would be received over the 3-year period in which the SRF is operated and decommissioned. No additional LCFs are expected in the worker population as a result of this activity. The maximum annual worker dose would occur during each of the 2 years in which the sodium is processed. The average annual worker dose in those years would be 39 millirem; this dose corresponds to an increased risk of an LCF of 2×10^{-5}, or less than 1 chance in 50,000.

The annual dose from this activity to a noninvolved worker assumed to be in the Hanford 300 Area would be 0.00025 millirem. There would be essentially no risk of an LCF from this exposure.

IDAHO REUSE OPTION

Under the option of processing the sodium at the INL SPF, the projected collective worker doses would be slightly less than that estimated for Hanford because the SPF would not be decommissioned under this project, but rather would remain available for processing sodium from other sources. The worker population would receive a collective dose of 3.6 person-rem over the 3-year duration of the activity, and the average worker would receive a maximum annual dose of 39 millirem. No additional LCFs are expected among the workers as a result of the dose, and the risk of an LCF in the average worker would be 2×10^{-5} (1 chance in 50,000).

The annual dose from this activity to a noninvolved worker assumed to be about 100 meters (110 yards) away at another facility in the MFC would be 0.069 millirem. There would be essentially no risk of an LCF from this exposure.

4.2.10.3 Alternative 3: Removal

4.2.10.3.1 Radiological Impacts on the Public

Radiological impacts of deactivation activities, as discussed in Section 4.2.10.1, would occur independent of all FFTF Decommissioning alternatives. Those activities were estimated to result in an MEI dose of 0.00026 millirem per year and no measurable increase in the collective offsite population dose. The following sections address the radiological doses and risks for the activities associated with this alternative. Table 4–111 presents the public dose and risk estimates for this alternative. The population dose in the table is for the entire duration of the activity, whereas the MEI dose is for the year of maximum impact.

Table 4–111. FFTF Decommissioning Alternative 3 Radiological Impacts on the Public

Activity	Offsite Population		Maximally Exposed Individual	
	Life-of-Project Dose (person-rem)	LCF[a]	Maximum Annual Dose (millirem per year)	LCF Risk[b]
Facility Disposition	Negligible	0	Negligible	0
Disposition of Remote-Handled Special Components				
Hanford Option	0.00019	0 (1×10^{-7})	0.0000078	5×10^{-12}
Idaho Option	0.000048	0 (3×10^{-8})	0.0000044	3×10^{-12}
Disposition of Bulk Sodium				
Hanford Reuse Option	0.022	0 (1×10^{-5})	0.00046	3×10^{-10}
Idaho Reuse Option	0.0021	0 (1×10^{-6})	0.00037	2×10^{-10}

a The reported value is the projected number of LCFs among the population and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

b The lifetime risk that the maximally exposed individual would develop an LCF based on the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; LCF=latent cancer fatality.

Source: Appendix K, Section K.2.2.

4.2.10.3.1.1 Facility Disposition

Facility disposition would result in minimal releases of radioactivity; therefore, doses to the offsite public and the MEI would be negligible. No substantive increase in exposure beyond that from other site activities is expected.

4.2.10.3.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Doses and risks to members of the public from disposition of the RH-SCs at Hanford would be the same under this alternative as those under Alternative 2, Entombment.

IDAHO OPTION

Doses and risks to members of the public from disposition of the RH-SCs at INL would be the same under this alternative as those under Alternative 2, Entombment.

4.2.10.3.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Doses and risks to members of the public from processing the bulk sodium at Hanford would be the same under this alternative as those under Alternative 2, Entombment.

IDAHO REUSE OPTION

Doses and risks to members of the public from processing the bulk sodium at INL would be the same under this alternative as those under Alternative 2, Entombment.

4.2.10.3.2 Radiological Impacts on Workers

Radiological doses and risks under Alternative 3 are presented in Table 4–112. Worker population impacts presented in Table 4–112 are for the duration of the project; average worker impacts are for the year of maximum impact.

Table 4–112. FFTF Decommissioning Alternative 3 Radiological Impacts on Workers

Activity	Life-of-Project Worker Population		Average Annual Involved Full-Time-Equivalent Worker		Annual Noninvolved Worker	
	Dose (person-rem)	LCF[a]	Dose (millirem per year)	LCF Risk[b]	Dose (millirem per year)	LCF Risk[b]
Facility Disposition	6.3	0 (4×10^{-3})	100	6×10^{-5}	–	–
Disposition of Remote-Handled Special Components						
Hanford Option	1.2	0 (7×10^{-4})	20	1×10^{-5}	0.011	6×10^{-9}
Idaho Option	1.2	0 (7×10^{-4})	20	1×10^{-5}	0.00000029	1×10^{-14}
Disposition of Bulk Sodium						
Hanford Reuse Option	3.7	0 (2×10^{-3})	39	2×10^{-5}	0.00025	2×10^{-10}
Idaho Reuse Option	3.6	0 (2×10^{-3})	39	2×10^{-5}	0.069	4×10^{-8}

a The reported value is the projected number of LCFs in the worker population and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).
b The lifetime risk that the worker would develop an LCF based on the risk factor of 0.0006 LCFs per rem.
Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.
Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; LCF=latent cancer fatality.
Source: Appendix K, Section K.2.2.

4.2.10.3.2.1 Facility Disposition

Dismantling FFTF would result in a collective worker dose of 6.3 person-rem. No additional LCFs are expected in the worker population as a result of this dose. The average annual dose to an individual worker would be about 100 millirem per year; this dose correlates to a risk of 6×10^{-5}, or about 1 chance in 17,000 of an LCF.

4.2.10.3.2.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Worker doses and risks associated with disposition of the RH-SCs at Hanford would be the same under this alternative as those under Alternative 2, Entombment.

IDAHO OPTION

Worker doses and risks associated with disposition of the RH-SCs at INL would be the same under this alternative as those under Alternative 2, Entombment.

4.2.10.3.2.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Worker doses and risks associated with processing the bulk sodium at Hanford would be the same under this alternative as those under Alternative 2, Entombment.

IDAHO REUSE OPTION

Worker doses and risks associated with processing the bulk sodium at INL would be the same under this alternative as those under Alternative 2, Entombment.

4.2.11 Public and Occupational Health and Safety—Facility Accidents

This section addresses potential impacts on workers and the public associated with potential accidents under the FFTF Decommissioning alternatives and associated options for the disposition of RH-SCs and the processing of Hanford bulk sodium. For each FFTF Decommissioning alternative and applicable option, radiological impacts of postulated accident scenarios were quantified for an MEI living near Hanford, the offsite population as a whole, and a noninvolved worker. Hazardous chemical impacts were also evaluated. For an involved worker, accident consequences were not quantified because the number and location of personnel relative to a postulated accident are unknown. In the event of an accident involving chemicals or radioactive materials, workers near an accident could be at risk of serious injury or fatality. Safety procedures, safety equipment, and protective barriers are typical features that would prevent or minimize worker impacts. Additionally, following initiation of accident/site emergency alarms, workers in adjacent areas of the facility would evacuate in accordance with the technical area and facility emergency operating procedures and training. Therefore, involved worker impacts are not discussed further relative to the FFTF Decommissioning alternatives. The impacts of selected intentional destructive act scenarios are addressed in Appendix K, Section K.3.11.

There would be no radiological accidents associated with facility construction in support of decommissioning and closure activities under any action alternative. Further, any hazardous chemical accidents associated with facility construction would be typical of those normally associated with industrial construction materials, hazards, and practices. Projected accident consequences of each FFTF Decommissioning alternative and its options for treating RH-SCs and processing bulk sodium are presented in the following sections. Details of the methodology for assessing the potential impacts on workers and the public associated with postulated accidents are presented in Appendix K, Section K.3.

4.2.11.1 Alternative 1: No Action

4.2.11.1.1 Radiological Impacts of Airborne Releases

Under FFTF Decommissioning Alternative 1, reasonably foreseeable accidents that could occur include a fire in the FFTF SSF, failure of the SSF tanks, and fires involving the Hallam Reactor and SRE sodium stored in the 200-West Area. These accidents would all involve sodium that is stored at Hanford and could occur under any of the FFTF Decommissioning alternatives.

Table 4–113 shows the consequences of the postulated set of accidents for the public (offsite MEI and the general population living within 80 kilometers [50 miles] of the facility) and a noninvolved worker 100 meters (110 yards) from the facility. The accident that would have the highest consequences if it were to occur is the Hanford sodium storage tank failure (accident HSTF1). Table 4–114 shows the accident risks, which were obtained by multiplying each accident's consequences by the likelihood (frequency per year) that the accident would occur. The accidents listed in these tables were selected from a spectrum of accidents described in Appendix K, Section K.3. The selection process ensures that the accidents chosen for evaluation in this EIS represent the full range of impacts of reasonably foreseeable accidents that could occur at the facilities. The scenarios are attributed to a variety of initiating events, including aircraft crash, material defect, human error, and high winds. Each one might also be initiated by a seismic event of sufficient magnitude to cause severe damage to structures in which the sodium is stored. Thus, if any other accident not evaluated in this EIS were to occur, its impacts on workers and the public should be within the range of the impacts evaluated.

Table 4–113. FFTF Decommissioning Alternatives – Radiological Consequences of Accidents

	Maximally Exposed Individual		Offsite Population[c]		Noninvolved Worker	
Accident[a]	**Dose (rem)**	**LCF[b]**	**Dose (person-rem)**	**LCF[d]**	**Dose (rem)**	**LCF[b]**
Sodium Storage Facility fire (SSF1)	0.0000010	6×10^{-10}	0.0063	0 (4×10^{-6})	0.00000034	2×10^{-10}
Hanford sodium storage tank failure (HSTF1)	0.0000011	6×10^{-10}	0.0064	0 (4×10^{-6})	0.00000087	5×10^{-10}
Hallam Reactor sodium fire (HSF1)	0.00000000046	3×10^{-13}	0.0000077	0 (5×10^{-9})	0.00000000025	2×10^{-13}
Sodium Reactor Experiment sodium fire (SRE1)	0.000000045	3×10^{-11}	0.00076	0 (5×10^{-7})	0.00000011	7×10^{-11}

a The alphanumeric code following the accident's title (e.g., SSF1) corresponds with the code in the accident's description in Appendix K, Section K.3.5.

b Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.

c Based on populations of 445,002 persons residing within 80 kilometers (50 miles) of the 400 Area (SSF1 and HSTF1) and 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area (HSF1 and SRE1).

d The reported value is the projected number of LCFs among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; LCF=latent cancer fatality.

Source: Appendix K, Section K.3.7.2.

The accident with the highest radiological risk to the offsite population and onsite workers (see Table 4–114) is the SRE sodium fire (accident SRE1). For this accident, no LCFs are expected among the population; the risk to the offsite population would be an increase of about 5×10^{-9} per year in the likelihood of an LCF (1 chance in 220 million per year of a single LCF occurring among the population). For the offsite MEI, the increase in the likelihood of an LCF would be about 3×10^{-13} per year (i.e., 1 chance in 4 trillion per year). For a noninvolved worker 100 meters (110 yards) from the accident, the increase in the likelihood of an LCF would be 7×10^{-13} per year (i.e., about 1 chance in 1.5 trillion per year). For any involved or noninvolved worker closer than 100 meters (110 yards) to the accident's location, the risk of exposure to radioactivity resulting in eventual development of an LCF would depend on the distance and other factors, but would generally be higher.

Table 4–114. FFTF Decommissioning Alternatives – Annual Cancer Risks from Accidents

Accident[a]	Frequency (per year)	Risk of LCF		
		Maximally Exposed Individual[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Sodium Storage Facility fire (SSF1)	1×10^{-6}	6×10^{-16}	0 (4×10^{-12})	2×10^{-16}
Hanford sodium storage tank failure (HSTF1)	1×10^{-5}	6×10^{-15}	0 (4×10^{-11})	5×10^{-15}
Hallam Reactor sodium fire (HSF1)	2×10^{-5}	5×10^{-18}	0 (9×10^{-14})	3×10^{-18}
Sodium Reactor Experiment sodium fire (SRE1)	1×10^{-2}	3×10^{-13}	0 (5×10^{-9})	7×10^{-13}

a The alphanumeric code following the accident's title (e.g., SSF1) corresponds with the code in the accident's description in Appendix K, Section K.3.5.

b Increased risk of a latent cancer fatality to the individual.

c Based on populations of 445,002 persons residing within 80 kilometers (50 miles) of the 400 Area (SSF1 and HSTF1) and 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area (HSF1 and SRE1).

d The reported value is the projected number of LCFs among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; LCF=latent cancer fatality.

Source: Appendix K, Section K.3.7.2.

Under FFTF Decommissioning Alternative 1, the possibility of an accident involving the stored sodium inventory would exist for the entire 100-year period of analysis. For the accident with the largest consequence (accident HSTF1), over the life of the project the risk of a single LCF occurring in the offsite population would be 4×10^{-9}, the risk of an LCF to the MEI would be 6×10^{-13}, and the risk of an LCF to the noninvolved worker would be 5×10^{-13}.

4.2.11.1.2 Hazardous Chemical Impacts

During FFTF decommissioning activities, including activities under FFTF Decommissioning Alternative 1: No Action, the only chemical capable of creating a substantial airborne hazard resulting from an accidental release is sodium formerly used as a reactor coolant. Three inventories of bulk sodium are addressed. These inventories include FFTF bulk sodium stored in the SSF, Hallam Reactor sodium stored in the 2727-W Building, and SRE sodium stored in the South Alkali Metal Storage Modules in the 200-West Area. Under FFTF Decommissioning Alternative 1, bulk sodium inventories would be stored for the foreseeable future. Accidents involving the stored sodium could occur under any of the FFTF Decommissioning alternatives.

Bulk sodium in its solid or molten form does not represent a substantial airborne hazard. However, metallic sodium reacts violently with a broad range of materials, including water. On contact with water it will ignite and produce hydrogen. Metallic sodium is highly flammable and may ignite spontaneously on exposure to moisture in the air. If sodium is burned in air, the resulting combustion byproducts are mostly sodium oxide, with a small percentage of sodium carbonate and a very small percentage of sodium hydroxide. Because of the ability of sodium oxide to react with water in the air (or in the human respiratory tract) to form sodium hydroxide, all of the sodium released from a fire was assumed to be in the form of sodium hydroxide.

Because the sodium metal is contaminated with radioactive material, any airborne release caused by a fire would cause radiological as well as chemical impacts. For each sodium fire scenario analyzed as part of the radiological impacts of facility accidents, there is also a chemical impact. Therefore, the accident scenarios analyzed in this section of the EIS are the same as those analyzed and described in Section 4.2.11.1.1.

A sodium fire produces an opaque, white plume. Contact with the plume in high concentrations near the source of release is immediately irritating and can cause burns to the upper respiratory tract, exposed skin, and surface of the eyes. The recognizable and characteristic dense white plume, coupled with the immediate and severe health effects, create a self-evacuation effect for personnel in proximity to a release.

Table 4–115 shows the estimated concentrations of particulate sodium hydroxide for each accident scenario analyzed. As AEGL values have not been developed for sodium hydroxide, the American Industrial Hygiene Association Emergency Response Planning Guideline (ERPG) levels 2 and 3 will be compared with the concentrations at specific distances as an indicator of human health impact. The guideline levels for sodium hydroxide are 5 milligrams per cubic meter for ERPG-2 and 50 milligrams per cubic meter for ERPG-3 (Fluor Hanford 2006). The results indicate that for the Hanford sodium storage tank failure scenario, the ERPG-2 value would be slightly exceeded beyond the site boundary. For the remaining scenarios, the ERPG-2 and ERPG-3 thresholds would not be exceeded beyond the nearest site boundary. For the noninvolved worker 100 meters (110 yards) from an accident, both the ERPG-2 and ERPG-3 thresholds would be exceeded for all scenarios analyzed.

Table 4–115. Chemical Impacts of Fast Flux Test Facility Accidents at Hanford

Accident	Distance to Site Boundary (meters)	Release Rate (kg/hr)	ERPG-2[a]		ERPG-3[b]		Concentration (mg/m^3)	
			Limit (mg/m^3)	Distance to Limit (meters)	Limit (mg/m^3)	Distance to Limit (meters)	Noninvolved Worker at 100 meters	Site Boundary
Sodium Storage Facility fire (SSF1)	6,800	5,320	5	3,700	50	850	2,400	2.2
Hanford sodium storage tank failure (HSTF1)	6,800	13,800	5	7,350	50	1,520	6,200	5.6
Hallam Reactor sodium fire (HSF1)	4,300	531	5	855	50	233	240	0.41
Sodium Reactor Experiment sodium fire (SRE1)	3,500	139	5	395	50	113	63	0.14

[a] ERPG-2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their ability to take protective action.

[b] ERPG-3 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

Note: To convert meters to yards, multiply by 1.0936; kilograms to pounds, by 2.2046.

Key: ERPG=Emergency Response Planning Guideline; Hanford=Hanford Site; kg/hr=kilograms per hour; mg/m^3=milligrams per cubic meter.

Source: Appendix K, Section K.3.9.2.

4.2.11.2 Alternative 2: Entombment

4.2.11.2.1 Radiological Impacts of Airborne Releases

4.2.11.2.1.1 Facility Disposition

The accidents associated with facility disposition under FFTF Decommissioning Alternative 2 are the same as those addressed in Section 4.2.11.1 under Alternative 1. All scenarios would involve sodium stored at Hanford and could occur under any of the FFTF Decommissioning alternatives.

4.2.11.2.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

A postulated breach and fire involving RH-SCs could occur at Hanford during the removal, transport, or treatment of the component for disposal. For purposes of this analysis, the accident was assumed to involve the RH-SC containing the largest inventory of radioactivity, and the location of the accident is the 400 Area. Table 4–116 shows the consequences of the postulated accident for the public (offsite MEI and the general population living within 80 kilometers [50 miles] of the 400 Area) and a noninvolved worker 100 meters (110 yards) from the accident. Table 4–117 shows the accident risks, which were obtained by multiplying the accident's consequences by the likelihood (frequency per year) that the accident would occur.

Table 4–116. Radiological Consequences of Accidents Under the Hanford Option for Disposition of Remote-Handled Special Components

Accident[a]	Maximally Exposed Individual		Offsite Population[c]		Noninvolved Worker	
	Dose (rem)	LCF[b]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[b]
Remote-handled special component fire (RHSC1) at Hanford	0.00012	7×10^{-8}	4.3	0 (3×10^{-3})	0.00073	4×10^{-7}

[a] The alphanumeric code following the accident's title (i.e., RHSC1) corresponds with the code in the accident's description in Appendix K, Section K.3.5.

[b] Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.

[c] Based on a population of 445,002 persons residing within 80 kilometers (50 miles) of the 400 Area.

[d] The reported value is the projected number of LCFs among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: Hanford=Hanford Site; LCF=latent cancer fatality.

Source: Appendix K, Section K.3.7.2.

Table 4–117. Annual Cancer Risks from Accidents Under the Hanford Option for Disposition of Remote-Handled Special Components

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality		
		Maximally Exposed Individual[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Remote-handled special component fire (RHSC1) at Hanford	1×10^{-2}	7×10^{-10}	0 (3×10^{-5})	4×10^{-9}

[a] The alphanumeric code following the accident's title (i.e., RHSC1) corresponds with the code in the accident's description in Appendix K, Section K.3.5.

[b] Increased risk of a latent cancer fatality to the individual.

[c] Based on a population of 445,002 persons residing within 80 kilometers (50 miles) of the 400 Area.

[d] The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: Hanford=Hanford Site.

Source: Appendix K, Section K.3.7.2.

For this accident, no LCFs are expected among the population; the risk to the offsite population would be an increase of about 3×10^{-5} per year in the likelihood of an LCF (1 chance in 39,000 per year of a single LCF occurring among the population). For the offsite MEI, the increase in the likelihood of an LCF would be about 7×10^{-10} per year (1 chance in 1.5 billion per year). For a noninvolved worker 100 meters (110 yards) from the accident, the increase in the likelihood of an LCF would be about 4×10^{-9} per year (1 chance in 228 million per year). For any involved or noninvolved worker closer than 100 meters (110 yards) from the accident's location, the risk of exposure to radioactivity resulting in eventual development of an LCF would depend on the distance and other factors, but would generally be higher. The removal of the RH-SCs would be accomplished in less than 1 year; however, the components might be stored on site for several additional years pending construction of a treatment facility. The public would be at risk of exposure to radioactivity from an accident during that time. If the period of time from removal to completion of the treatment is assumed to be 5 years, the risk to the offsite population and onsite workers during the project period would be no increase (1×10^{-4}) in the number of LCFs occurring in the offsite population, a 4×10^{-9} increase in the likelihood of an LCF for the MEI, and a 2×10^{-8} increase in the likelihood of an LCF for the noninvolved worker.

IDAHO OPTION

A postulated breach and fire involving RH-SCs could occur at INL during the transport or treatment of the component. For purposes of this EIS analysis, the accident was assumed to involve the RH-SC containing the largest inventory of radioactivity, and the location of the accident is the INTEC at INL. Table 4–118 shows the consequences of the postulated accident for the public (offsite MEI and the general population living within 80 kilometers [50 miles] of the MFC) and a noninvolved worker 100 meters (110 yards) from the accident. Table 4–119 shows the accident risks, which were obtained by multiplying the accident's consequences by the likelihood (frequency per year) that the accident would occur.

Table 4–118. Radiological Consequences of Accidents Under the Idaho Option for Disposition of Remote-Handled Special Components

Accident[a]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[c]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[c]
Remote-handled special component fire (RHSC1) at Idaho National Laboratory	0.00025	2×10^{-7}	0.30	0 (2×10^{-4})	0.00018	1×10^{-7}

[a] The alphanumeric code following the accident's title (i.e., RHSC1) corresponds with the code in the accident's description in Appendix K, Section K.3.5.
[b] Based on a population of 152,493 persons residing within 80 kilometers (50 miles) of the Idaho Nuclear Technology and Engineering Center.
[c] Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.
[d] The reported value is the projected number of LCFs among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: LCF=latent cancer fatality.

Source: Appendix K, Section K.3.7.2.

Table 4–119. Annual Cancer Risks from Accidents Under the Idaho Option for Disposition of Remote-Handled Special Components

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality		
		Maximally Exposed Individual[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Remote-handled special component fire (RHSC1) at Idaho National Laboratory	1×10^{-2}	2×10^{-9}	0 (2×10^{-6})	1×10^{-9}

a The alphanumeric code following the accident's title (i.e., RHSC1) corresponds with the code in the accident's description in Appendix K, Section K.3.5.

b Increased risk of a latent cancer fatality to the individual.

c Based on a population of 152,493 persons residing within 80 kilometers (50 miles) of the Idaho Nuclear Technology and Engineering Center.

d The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Source: Appendix K, Section K.3.7.2.

For this accident, no LCFs are expected among the population; the risk to the offsite population would be an increase of about 2×10^{-6} per year in the likelihood of an LCF (1 chance in 580,000 per year of a single LCF occurring among the population). For the offsite MEI, the increase in the likelihood of an LCF would be about 2×10^{-9} per year (1 chance in 660 million per year). For a noninvolved worker 100 meters (110 yards) from the accident, the increase in the likelihood of an LCF would be about 1×10^{-9} per year (1 chance in 900 million per year). For any involved or noninvolved worker closer than 100 meters (110 yards) from the accident's location, the risk of exposure to radioactivity resulting in eventual development of an LCF would depend on the distance and other factors, but would generally be higher. The removal of the RH-SCs would be accomplished in less than 1 year; however, the components might be stored on site at INL for several additional years pending construction of a treatment facility. The public would be at risk of exposure to radioactivity from an accident throughout that time. If the period of time from arrival of the component at INL to completion of the treatment is assumed to be 5 years, the risk to the offsite population and onsite workers during the project period would be an increase of 9×10^{-6} in the likelihood of a single LCF occurring in the offsite population, an increase of 8×10^{-9} in the likelihood of an LCF for the MEI, and an increase of 6×10^{-9} in the likelihood of an LCF for the noninvolved worker.

4.2.11.2.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Processing the FFTF bulk sodium and the Hallam Reactor and SRE sodium in the 400 Area could result in accidents involving spills and fires comparable to those discussed under FFTF Decommissioning Alternative 1. Table 4–113 shows the consequences of the postulated set of accidents for the MEI, the general population (the offsite population within 80 kilometers [50 miles]), and a noninvolved worker 100 meters (110 yards) from the facility. Table 4–114 shows the accident risks, which were obtained by multiplying each accident's consequences by the likelihood (frequency per year) that the accident would occur.

Under this option, the possibility of an accident involving the stored sodium inventory would exist for 13 years until the sodium is processed. For the accident with the highest consequences (accident HSTF1), over the life of the project, the risk of a single LCF occurring in the offsite population would be 5×10^{-10}, the risk of an LCF to the MEI would be 8×10^{-14}, and the risk of an LCF to the noninvolved worker would be 7×10^{-14}.

IDAHO REUSE OPTION

A spill from the INL SPF storage tank was analyzed to represent a severe potential accident arising from the Idaho Reuse Option. Table 4–120 shows the consequences of the postulated accident for the MEI, the general population (the offsite population within 80 kilometers [50 miles]), and a noninvolved worker 100 meters (110 yards) from the facility. Table 4–121 shows the accident risks, which were obtained by multiplying its consequences by the likelihood (frequency per year) that the accident would occur.

Table 4–120. Radiological Consequences of Accidents Under the Idaho Reuse Option for Disposition of Bulk Sodium

Accident[a]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[c]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[b]
INL Sodium Processing Facility storage tank failure (INLSPF1)	0.000000030	2×10^{-11}	0.000058	0 (3×10^{-8})	0.0000000039	2×10^{-12}

[a] The alphanumeric code following the accident's title (i.e., INLSPF1) corresponds with the code in the accident's description in Appendix K, Section K.3.5.

[b] Based on a population of 250,838 persons residing within 80 kilometers (50 miles) of the Materials and Fuels Complex.

[c] Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.

[d] The reported value is the projected number of LCFs among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: INL=Idaho National Laboratory; LCF=latent cancer fatality.

Source: Appendix K, Section K.3.7.2.

Table 4–121. Annual Cancer Risks from Accidents Under the Idaho Reuse Option for Disposition of Bulk Sodium

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality		
		Maximally Exposed Individual[b]	Offsite Population[c, d]	Noninvolved Worker[b]
INL Sodium Processing Facility storage tank failure (INLSPF1)	1×10^{-5}	2×10^{-16}	0 (3×10^{-13})	2×10^{-17}

[a] The alphanumeric code following the accident's title (i.e., INLSPF1) corresponds with the code in the accident's description in Appendix K, Section K.3.5.

[b] Increased risk of a latent cancer fatality to the individual.

[c] Based on a population of 250,838 persons residing within 80 kilometers (50 miles) of the Materials and Fuels Complex.

[d] The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: INL=Idaho National Laboratory.

Source: Appendix K, Section K.3.7.2.

For this accident no LCFs are expected among the population; the risk to the offsite population would be an increase of about 3×10^{-13} per year in the likelihood of an LCF (1 chance in 3 trillion per year of a single LCF occurring among the population). For the offsite MEI, the increase in the likelihood of an LCF would be about 2×10^{-16} per year (1 chance in 6,000 trillion per year). For a noninvolved worker 100 meters (110 yards) from the accident, the increase in the likelihood of an LCF would be about 2×10^{-17} per year (1 chance in 40,000 trillion per year). For any involved or noninvolved worker closer than 100 meters (110 yards) from the accident's location, the risk of exposure to radioactivity resulting in eventual development of an LCF would depend on the distance and other factors, but would generally be higher.

Under Alternative 2, Idaho Reuse Option, the possibility of an accident involving the stored sodium inventory would exist for 9 years while the sodium is stored at Hanford and for 2 years while the sodium is being processed at INL. For the accident with the largest consequence (accident HSTF1), for the duration of time that the sodium was stored at Hanford, the risk of a single LCF occurring in the offsite population would be 3×10^{-10}, the risk of an LCF to the MEI would be 6×10^{-14}, and the risk of an LCF to the noninvolved worker would be 5×10^{-14}. Once the material was transferred to INL, over the 2 years of processing, the risk of a single LCF occurring in the offsite population would be 7×10^{-13}, the risk of an LCF to the MEI would be 4×10^{-16}, and the risk of an LCF to the noninvolved worker would be 5×10^{-17}.

4.2.11.2.2 Hazardous Chemical Impacts

4.2.11.2.2.1 Facility Disposition

As described in Section 4.2.11.1.2, accidents involving the three inventories of bulk sodium could occur under any of the FFTF Decommissioning alternatives. Chemical impacts of the analyzed accident scenarios are presented in Table 4–115.

4.2.11.2.2.2 Disposition of Remote-Handled Special Components

Potential hazardous chemical impacts associated with disposition of RH-SCs under the Hanford Option and Idaho Option would be encompassed by those analyzed in Section 4.2.11.1.2 for facility disposition.

4.2.11.2.2.3 Disposition of Bulk Sodium

Potential hazardous chemical impacts associated with disposition of bulk sodium under the Hanford Reuse Option would be encompassed by those analyzed in Section 4.2.11.1.2. Chemical impacts associated with disposition of bulk sodium under the Idaho Reuse Option are shown in Table 4–122.

Table 4–122. Chemical Impacts of Accidents Under the Idaho Reuse Option for Disposition of Bulk Sodium

Accident	Distance to Site Boundary (meters)	Release Rate (kg/hr)	ERPG-2[a]		ERPG-3[b]		Concentration (mg/m^3)	
			Limit (mg/m^3)	Distance to Limit (meters)	Limit (mg/m^3)	Distance to Limit (meters)	Noninvolved Worker at 100 Meters	Site Boundary
INL Sodium Processing Facility storage tank failure (INLSPF1)	5,500	1,380	5	1,530	50	390	620	0.75

[a] ERPG-2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

[b] ERPG-3 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

Note: To convert meters to yards, multiply by 1.0936; kilograms to pounds, by 2.2046.

Key: ERPG=Emergency Response Planning Guideline; INL=Idaho National Laboratory; kg/hr=kilograms per hour; mg/m^3=milligrams per cubic meter.

Source: Appendix K, Section K.3.9.2.

4.2.11.3 Alternative 3: Removal

4.2.11.3.1 Radiological Impacts of Airborne Releases

4.2.11.3.1.1 Facility Disposition

The accidents associated with facility disposition under FFTF Decommissioning Alternative 3 are the same as those addressed in Section 4.2.11.1 under Alternative 1. All scenarios would involve sodium stored at Hanford and could occur under any of the FFTF Decommissioning alternatives.

4.2.11.3.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Potential human health impacts of postulated radiological accidents would be the same as those discussed in Section 4.2.11.2.1.2 under the Hanford Option of FFTF Decommissioning Alternative 2.

IDAHO OPTION

Potential human health impacts of postulated radiological accidents would be the same as those discussed in Section 4.2.11.2.1.2 under the Idaho Option of FFTF Decommissioning Alternative 2.

4.2.11.3.1.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Potential human health impacts of postulated radiological accidents would be the same as those discussed in Section 4.2.11.2.1.3 under the Hanford Reuse Option of FFTF Decommissioning Alternative 2.

IDAHO REUSE OPTION

Potential human health impacts of postulated radiological accidents would be the same as those discussed in Section 4.2.11.2.1.3 under the Idaho Reuse Option of FFTF Decommissioning Alternative 2.

4.2.11.3.2 Hazardous Chemical Impacts

Potential human health impacts of postulated chemical release scenarios under FFTF Decommissioning Alternative 3, Removal, are expected to be the same as those described under the No Action Alternative in Section 4.2.11.1.2.

4.2.11.3.2.1 Disposition of Remote-Handled Special Components

HANFORD OPTION AND IDAHO OPTION

Potential hazardous chemical impacts associated with disposition of the RH-SCs under the Hanford Option and Idaho Option would be encompassed by those analyzed in Section 4.2.11.1.2 for facility disposition.

4.2.11.3.2.2 Disposition of Bulk Sodium

HANFORD REUSE OPTION AND IDAHO REUSE OPTION

Potential hazardous chemical impacts associated with disposition of bulk sodium under the Hanford Reuse Option and Idaho Reuse Option would be encompassed by those analyzed in Section 4.2.11.2.2.3 for FFTF Decommissioning Alternative 2.

4.2.11.4 Intentional Destructive Acts

This section addresses potential impacts of intentional destructive acts during FFTF decommissioning. Release scenarios and impacts resulting from intentional destructive acts may be similar to a number of the accident scenarios analyzed in this EIS. An additional intentional destructive act scenario was also considered. This scenario would apply to Alternatives 2 and 3, which include removal of RH-SCs.

Explosion in FFTF Primary Cold Trap. An intentional destructive act was postulated whereby the FFTF primary cold trap, containing 2,700 liters (710 gallons) of sodium, 470 curies of cesium-137, and 70 curies of cobalt-60, is destroyed by an explosive or incendiary device during removal or handling. All of the radioactive material was assumed to aerosolize and be released to the atmosphere. Analysis results indicate that the radiological impacts would be about three times those calculated for the accident scenario that would involve the same inventory of radioactive material (RHSC1, remote-handled special component fire). The resulting offsite population dose was estimated to be 11 person-rem, with no (7×10^{-3}) additional LCFs. The MEI dose would be 0.00033 rem, corresponding to an increased risk of an LCF of 2×10^{-7}. The noninvolved worker dose would be 0.0073 rem, corresponding to an increased risk of an LCF of 4×10^{-6}.

Impacts and mitigation of intentional destructive acts are discussed in more detail in Appendix K, Section K.3.11.

4.2.12 Public and Occupational Health and Safety—Transportation

Impacts of transporting radioactive materials are predominantly categorized as radiological impacts or nonradiological impacts. Radiological impacts are those associated with the accidental release of radioactive materials and the effects of low levels of radiation emitted during incident-free transportation. Nonradiological impacts are those associated with transportation, regardless of the nature of the cargo, such as accidents resulting in death or injury when there is no release of radioactive material.

Transportation impacts include the impacts of incident-free transportation, as well as transportation accidents. The impacts of both incident-free transportation and transportation accidents can be radiological and nonradiological. Incident-free transportation impacts include radiological impacts on the public and workers from the radiation field surrounding the transportation package. Nonradiological impacts of potential transportation accidents include traffic accident fatalities. The impact of a specific radiological accident is expressed in terms of probabilistic risk, which is defined as the accident probability (i.e., accident frequency) multiplied by the accident consequences. The overall risk is obtained by summing the individual risks from all accident severities, irrespective of their likelihood of occurrence. The analysis of accident risks takes into account a spectrum of accidents ranging from high-probability accidents of low severity (e.g., fender bender) to hypothetical high-severity accidents that have a low probability of occurrence. Additional information is provided in Section 4.1.12, and further details on modeling and parameter selections are provided in Appendix H.

Table 4–123 provides the estimated number of shipments of various wastes under each alternative by waste type. A shipment is defined as the amount of waste transported on a single truck or a single railcar. The values presented for offsite shipments in Table 4–123 are the estimated truck transports for the Idaho Option of treating RH-SCs at INL and the Idaho Reuse Option of treating bulk sodium at INL. If the Idaho options are selected for disposition of RH-SCs and bulk sodium, the treated RH-SCs would either be shipped to NNSS or transported back to Hanford for disposal, and the treated sodium in the form of 50 percent caustic solution would be transported back to Hanford.

Table 4–123. FFTF Decommissioning Alternatives – Estimated Number of Shipments

Alternative	Number of Shipments							
	Offsite Shipments[a]			Onsite Shipments				
	Sodium Metal	Caustic Solution	RH-SCs	Sodium Metal	Caustic Solution	RH-SCs	Reactor Vessel	Other Wastes[b]
Alternative 1: No Action	0	0	0	0	0	0	0	NA
Alternative 2: Entombment	80	190	9	10	190	5	0	6,300
Alternative 3: Removal	80	190	9	10	190	5	1	6,300

[a] These are estimates for truck transports. Rail transports would be one-half of the values given.

[b] Other wastes include components and decommissioning waste transported to an Integrated Disposal Facility and to sanitary and hazardous landfills.

Note: The number of shipments is rounded to the nearest ten between 10 and 1,000 shipments, and nearest hundred between 1,000 and 100,000 shipments.

Key: FFTF=Fast Flux Test Facility; NA=not analyzed; RH-SCs=remote-handled special components.

Source: Appendix H, Section H.7.2.

The FFTF Decommissioning action alternatives consist of three distinct activities: facility disposition, disposition of RH-SCs, and disposition of bulk sodium. Table 4–124 summarizes the risks of transportation under each type of disposition. The health impacts associated with the shipment of radioactive materials were calculated assuming that all offsite shipments would be transported using either truck or rail. The impacts of each alternative would include those of activities in facility disposition and the range of options for treatment and disposition of RH-SCs and sodium. The discussions for each alternative would include a range of impacts of treating these materials at either Hanford or INL.

Table 4–124 shows that, under all alternatives, the dose to the population along the routes (see column 6 of Table 4–124: INL rows) is expected to be between the lowest expected dose of 0.08 person-rem, which is associated with the transport of RH-SCs to INL for treatment and disposal at NNSS[4] using rail transport, and the highest expected dose of about 0.96 person-rem, which is associated with the transport of sodium metals to INL for treatment and return transport of caustic solutions to Hanford using trucks. The additional LCFs that are expected from such exposures to the general population would be very small for all activities, ranging from 4.8×10^{-5} to 5.7×10^{-4}. Similarly, the range of expected doses to the workers (see column 4 of Table 4–124: INL rows) would be 0.16 person-rem to 3.52 person-rem. Overall, the risks of transporting various radioactive materials under all alternatives are expected to result in zero fatalities.

The risks to different receptors under incident-free transportation conditions were estimated on a per-trip or per-event basis. This basis was used because it is unlikely that the same person would be exposed to multiple events; for those that could have multiple exposures, the dose over the duration of transportation activities could be calculated by multiplying by the number of events or trips. The maximum annual dose to a transportation worker would be administratively controlled to 100 millirem per year unless the individual is a trained radiation worker, in which case the administrative limit would be 2 rem per year

[4] These materials could also be returned to Hanford. Use of NNSS would maximize the impact.

(DOE Standard 1098-2008). The dose to a person stuck in traffic next to a shipment of RH-SCs for 30 minutes was calculated to be 19 millirem. For a receptor who is a member of the public residing along a transportation route, the dose over the duration of transportation activities would depend on the number of truck or rail shipments passing a particular point and would be independent of the actual route being considered. The maximum dose to this resident, if all the materials are shipped along this route, would be less than 0.2 millirem for all action alternatives. Refer to Appendix H, Table H–13, for additional results.

Table 4–124. FFTF Decommissioning Alternatives – Risks of Transporting Radioactive Waste

Disposition Activity	Location (transport mode)	Number of Shipments	Incident-Free: Crew: Dose (person-rem)	Incident-Free: Crew: Risk[a]	Incident-Free: Population: Dose (person-rem)	Incident-Free: Population: Risk[a]	Accident: Rad. Risk[a, b]	Accident: Nonrad. Risk[a]	One-Way Offsite Travel (10^5 km)
Facility disposition	Hanford (Alt 2)	6,300	(c)	(c)	(c)	(c)	(c)	0.004	N/A
	Hanford (Alt 3)	6,300	0.03	2.0×10^{-5}	0.003	1.5×10^{-6}	4.0×10^{-13}	0.004	N/A
Disposition of RH-SCs	INL (T)	9	0.84	5.0×10^{-4}	0.33	2.0×10^{-4}	5.3×10^{-10}	0.0003	0.10
	INL (R)	5	0.17	1.0×10^{-4}	0.08	4.8×10^{-5}	5.3×10^{-10}	0.0004	0.060
	Hanford	5	0.03	1.9×10^{-5}	0.005	2.9×10^{-6}	6.8×10^{-13}	0.000005	N/A
Disposition of bulk sodium	INL (T)	270	3.5	2.1×10^{-3}	0.96	5.7×10^{-4}	3.9×10^{-10}	0.008	2.6
	INL (R)	140	0.16	9.4×10^{-5}	0.20	1.2×10^{-4}	2.2×10^{-10}	0.02	1.4
	Hanford	200	0.12	6.9×10^{-5}	0.01	6.7×10^{-6}	7.1×10^{-14}	0.0001	N/A

[a] Risk is expressed in terms of latent cancer fatalities, except for the nonradiological, where it refers to the number of accident fatalities.
[b] To calculate accident population dose (person-rem), divide the values in this column by 0.0006. For additional insight on how this dose is calculated, see the text in Section 4.1.12.
[c] Not analyzed because all waste is sanitary or hazardous (not radioactive).
Note: To convert kilometers to miles, multiply by 0.6214.
Key: Alt 2=Alternative 2; Alt 3=Alternative 3; FFTF=Fast Flux Test Facility; Hanford=Hanford Site; INL=Idaho National Laboratory; km=kilometers; N/A=not applicable; nonrad.=nonradiological; R=rail transport; rad.=radiological; RH-SCs=remote-handled special components; T=truck transport.
Source: Appendix H, Section H.7.2.

Table 4–125 summarizes the impacts of transporting nonradioactive support materials required to construct new facilities, as well as materials required to treat RH-SCs and sodium and to transport decommissioned equipment to storage or burial locations. The construction materials considered include concrete, cement, sand/gravel/dirt, asphalt, steel, and piping, among others. The table shows the impacts in terms of total number of kilometers, accidents, and fatalities for all alternatives. The results in Table 4–125 indicate that for the FFTF Decommissioning alternatives, the potential for traffic fatalities is largest under Alternative 3. The absolute risk, however, is very small considering that the duration of the alternative is about 10 years.

4.2.12.1 Alternative 1: No Action

Under Alternative 1, the transportation impacts would be limited to the transport of materials between Hanford and local or regional locations in support of administrative and deactivation activities. The transportation impacts of these activities would be 31,000 kilometers (about 20,000 miles) traveled, 0 (0.006) traffic accidents, and 0 (0.0004) traffic fatalities (see Table 4–125).

Table 4–125. FFTF Decommissioning Alternatives – Estimated Impacts of Construction and Operational Material Transport

Alternatives/Options	Total Distance Traveled (million kilometers)	Number of Accidents	Number of Fatalities
Alternative 1: No Action	0.03	0.006	0.0004
Alternative 2: Entombment			
Facility disposition	1.9	0.38	0.03
Options at Hanford[a]	0.42	0.09	0.006
Disposition of bulk sodium	0.04	0.008	0.0005
Disposition of RH-SCs	0.38	0.08	0.005
Options at INL[b]	0.02	0.005	0.0003
Disposition of bulk sodium	0.02	0.004	0.0002
Disposition of RH-SCs[c]	0.004	0.0008	0.00005
Alternative 3: Removal			
Facility disposition	2.1	0.42	0.03
Options at Hanford[a]	0.35	0.07	0.005
Disposition of bulk sodium	0.04	0.008	0.0005
Disposition of RH-SCs	0.31	0.06	0.004
Options at INL[b]	0.02	0.005	0.0003
Disposition of bulk sodium	0.02	0.004	0.0002
Disposition of RH-SCs[c]	0.004	0.0008	0.00005

[a] Options include disposition of bulk sodium and RH-SCs at Hanford. These activities are common to Alternatives 2 and 3.
[b] Options include disposition of bulk sodium and RH-SCs at INL. These activities are common to Alternatives 2 and 3.
[c] An environmental assessment has been prepared at INL to evaluate construction of a Remote Treatment Project at INL (DOE 2009); therefore, these construction impacts are not included.

Note: To convert kilometers to miles, multiply by 0.6214.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; INL=Idaho National Laboratory; RH-SCs=remote-handled special components.

Source: Appendix H, Section H.8.

4.2.12.2 Alternative 2: Entombment

Under this alternative, if the treatment of RH-SCs and bulk sodium were performed at INL, about 145 offsite rail shipments would occur (see Table 4–124, INL (R) rows 4 and 7). If these materials were transported using trucks, about 279 offsite shipments would be made (see Table 4–124, INL (T) rows). In addition, 6,300 truck shipments would be made to transport decommissioning waste to onsite storage and burial grounds. The total distance traveled on rail or public roads carrying radioactive materials would range from 150,000 kilometers (93,200 miles) by rail to 270,000 kilometers (168,000 miles) by truck.

No offsite shipments are expected under the Hanford Option of treating RH-SCs or the Hanford Reuse Option of treating bulk sodium at Hanford. The number of onsite transports would be about 6,500 truck shipments (see Table 4–124: Hanford, rows 1, 5, and 8).

4.2.12.2.1 Impacts of Incident-Free Transportation

The dose to transportation workers from all transportation activities under this alternative (both offsite and onsite shipments if the treatment of RH-SCs and bulk sodium occurs at INL, and onsite shipments only if treatment occurs at Hanford) was estimated to range from 0.33 to 4.34 person-rem for treatment at INL and to be 0.15 person-rem for treatment at Hanford (see column 4 of Table 4–124). The total dose to the exposed population would range from 0.28 to 1.29 person-rem if this waste were treated at INL or would be 0.015 person-rem if this waste were treated at Hanford. Accordingly, incident-free transportation of radioactive material would result in maximums of 0 (0.0026) LCFs among transportation workers and 0 (0.00077) LCFs in the total affected population over the duration of the alternative.

4.2.12.2.1.1 Facility Disposition

Under this alternative, the irradiated components, such as reactor vessels, test assemblies and hardware, and Interim Examination and Maintenance cells, would be entombed. Aboveground contaminated materials would be transported to an IDF, and hazardous materials would be transported to offsite locations for disposal. Facility disposition waste would require about 6,300 truck shipments from FFTF to an IDF and an offsite hazardous waste facility (see Table 4–124).

4.2.12.2.1.2 Disposition of Remote-Handled Special Components

Two options for disposition of these materials were considered: treatment at Hanford or treatment at INL with the option of returning the treated material to Hanford or shipping it to NNSS for disposal.

HANFORD OPTION

Treatment of RH-SCs at Hanford would require transporting the treated components to an IDF for disposal and the caustic solution across the site for product reuse. This option would entail five onsite truck shipments with a potential exposure of 0.03 person-rem to transportation workers and 0.005 person-rem to the population. Accordingly, this option would result in 0 (1.9×10^{-5}) LCFs among transportation workers and 0 (2.9×10^{-6}) LCFs in the affected population.

IDAHO OPTION

This option would require four trucks or two rail shipments to transport RH-SCs to INL for treatment and four trucks or two rail shipments to transport the treated components to Hanford or NNSS for disposal. Transport to NNSS would result in higher transportation risks; therefore, it was included in the values presented in Table 4–124. This option would also require one truck for transport of caustic solution from treated sodium within the RH-SCs to Hanford for product reuse. Potential doses to transportation workers and the general population from rail shipments were estimated to be 0.17 and 0.08 person-rem, respectively. Potential doses to transportation workers and the general population from truck shipments were estimated to be 0.84 and 0.33 person-rem, respectively. Accordingly, this option would result in a maximum of 0 (0.0005) additional LCFs among workers and 0 (0.0002) additional LCFs among the exposed population.

4.2.12.2.1.3 Disposition of Bulk Sodium

Two options for disposition of bulk sodium were considered: treatment at Hanford or treatment at INL, with the return to Hanford of treated sodium in the form of caustic sodium hydroxide solution.

HANFORD REUSE OPTION

Under this option, the bulk sodium would be treated at Hanford and the caustic solution would be transported across Hanford for onsite reuse. This option would entail about 200 onsite shipments of bulk sodium and caustic sodium hydroxide solution, with a potential exposure of about 0.12 person-rem to transportation workers and 0.01 person-rem to the population. Accordingly, this option would result in 0 (6.9×10^{-5}) LCFs among transportation workers and 0 (6.7×10^{-6}) LCFs in the affected population.

IDAHO REUSE OPTION

This option would require about 270 truck shipments or 140 rail shipments to transport bulk sodium to INL and return the caustic product to Hanford for reuse. The potential exposures to transportation workers and the general population from rail shipments was estimated to be about 0.16 and 0.20 person-rem, respectively, and for truck shipments, about 3.5 and 0.96 person-rem, respectively. Accordingly, this option would result in a maximum of 0 (0.0021) additional LCFs among workers and 0 (0.00057) additional LCFs among the exposed population.

4.2.12.2.2 Impacts of Accidents During Transportation

As stated earlier, two sets of analyses were performed for the evaluation of transportation accident impacts: impacts of maximum reasonably foreseeable accidents and impacts of all accidents regardless of their severity or likelihood of occurrence.

For treatment options at INL, the maximum reasonably foreseeable offsite transportation accident under this alternative (with a probability of occurrence of more than 1 chance in 10 million per year) is a severe-impact, high-temperature fire involving a shipment of sodium metal. The consequences of such an accident in terms of population dose in the rural, suburban, and urban zones would be 0.22, 1.2, and 5.6 person-rem, respectively. The likelihood of occurrence of such consequences per transport is less than 1.3×10^{-6}, 2.5×10^{-7}, and 2.8×10^{-8} in rural, suburban, and urban zones, respectively. This accident could result in a dose of 0.002 rem to an individual hypothetically exposed to the accident plume for 2 hours at a distance of 100 meters (330 feet), with a corresponding LCF risk of 9.0×10^{-7}.

The estimated total transportation accident risks under this alternative are a maximum radiation dose risk to the population of 1.5×10^{-6} person-rem, resulting in 9.2×10^{-10} LCFs (see Table 4–124, INL, rows 3 and 6), and maximum traffic fatalities of 0 (0.022) (see Table 4–124, INL, rows 4 and 7). Nearly all of the radiological risks would result from shipping caustic solution to Hanford. These results indicate that the accident risks would be very small.

For treatment options at Hanford, the consequences of the most severe accidents would be encompassed by those of facility accidents. The estimated total transportation accident risks from onsite shipments are very small (see Table 4–124): a population dose of 1.3×10^{-9} person-rem, resulting in 7.5×10^{-13} LCFs, and traffic accidents resulting in 0 (0.0001) fatalities (see Table 4–124, rows 5 and 8).

4.2.12.2.2.1 Facility Disposition

It was estimated that the accident risks during transport of decommissioning waste could potentially result in 0 (0.004) traffic fatalities.

4.2.12.2.2.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Under this option, the estimated total transportation accident risks are a maximum radiation dose risk to the population of 1.13×10^{-9} person-rem, resulting in 6.8×10^{-13} LCFs, and traffic accidents resulting in 0 (0.000005) fatalities. These results indicate that the accident risks would be very small.

IDAHO OPTION

Under this option, the estimated total transportation accident risks are a maximum radiation dose risk to the population of 8.8×10^{-7} person-rem, resulting in 5.3×10^{-10} LCFs, and traffic accidents resulting in 0 (0.0004) fatalities. Nearly all of the radiological risks would result from shipping caustic solution to Hanford. These results indicate that the accident risks would be very small.

4.2.12.2.2.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Under this option, the estimated total transportation accident risks are a maximum radiation dose risk to the population of 1.2×10^{-10} person-rem, resulting in 7.1×10^{-14} LCFs, and traffic accidents resulting in 0 (0.0001) fatalities. These results indicate that the accident risks would be very small.

IDAHO REUSE OPTION

Under this option, the estimated total transportation accident risks are a maximum radiation dose risk to the population of 6.4×10^{-7} person-rem, resulting in 3.9×10^{-10} LCFs, and traffic accidents resulting in 0 (0.02) fatalities. Most of the radiological risks would result from shipping caustic solution to Hanford. These results indicate that the accident risks would be very small.

4.2.12.2.3 Impacts of Construction and Operational Material Transports

The impacts of transporting construction materials (e.g., concrete, gravel/sand/soil, asphalt, steel, piping) and feed materials for the production and transport of waste (e.g., grout, fly ash, containers, boxes, canisters) were evaluated. The range of transportation impacts under this alternative would be 1.92 to 2.32 million kilometers (1.19 to 1.44 million miles) traveled, 0 (0.385 to 0.470) accidents, and 0 (0.0303 to 0.036) fatalities over the entire period, from construction through deactivation and closure (see Table 4–125).

4.2.12.2.3.1 Facility Disposition

The impacts of transporting construction and operational material in support of facility disposition would be 1.9 million kilometers (1.2 million miles) traveled, 0 (0.38) accidents, and 0 (0.03) fatalities over the entire period.

4.2.12.2.3.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

The impacts of transporting construction and operational material to support treatment of RH-SCs would be about 380,000 kilometers (about 240,000 miles) traveled, 0 (0.08) accidents, and 0 (0.005) fatalities.

IDAHO OPTION

The impacts of transporting construction and operational material in support of treatment of RH-SCs would be about 4,000 kilometers (about 2,500 miles) traveled, 0 (0.0008) accidents, and 0 (0.00005) fatalities. An environmental assessment has been prepared at INL to evaluate construction of an RTP at INL (DOE 2009); therefore, these construction impacts are not included.

4.2.12.2.3.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

The impacts of transporting construction and operational material in support of bulk sodium disposition would be about 40,000 kilometers (about 25,000 miles) traveled, 0 (0.008) accidents, and 0 (0.0005) fatalities.

IDAHO REUSE OPTION

The impacts of transporting construction and operational material in support of bulk sodium disposition would be about 20,000 kilometers (about 12,000 miles) traveled, 0 (0.004) accidents, and 0 (0.0002) fatalities.

4.2.12.3 Alternative 3: Removal

The majority of activities under this alternative would be similar to those discussed under Alternative 2. This alternative would entail an additional 20 shipments of irradiated components such as reactor vessels, test assemblies and hardware, and Interim Examination and Maintenance cells to an IDF under facility disposition. These shipments would add a very small impact to the overall risks presented under Alternative 2 (see Table 4–124, Hanford, row 2).

Overall, if treatment of sodium metals and RH-SCs were performed at INL, about 140 offsite rail shipments would occur (see Table 4–124, INL (R) rows). If these materials were transported using trucks, about 279 offsite shipments would be made (see Table 4–124, INL (T) rows). In addition, about 6,300 truck shipments would be made to transport decommissioning waste to onsite storage and burial grounds. The total distance traveled carrying radioactive materials would range from 150,000 kilometers (93,200 miles) by rail to 270,000 kilometers (168,000 miles) by truck.

No offsite shipments are expected under the Hanford Option (treatment of RH-SCs at Hanford) or the Hanford Reuse Option (treatment of bulk sodium at Hanford). The number of onsite transports would be about 6,500 truck shipments (see Table 4–124, Hanford, rows 2, 5, and 8).

4.2.12.3.1 Impacts of Incident-Free Transportation

The dose to transportation workers from all transportation activities under this alternative (both offsite and onsite shipments if treatment of RH-SCs and bulk sodium occurred at INL, but onsite only if treatment occurred at Hanford) was estimated to range from 0.36 to 4.37 person-rem for treatment at INL, and the estimated dose would be 0.18 person-rem for treatment at Hanford (see column 4 of Table 4–124). The total dose to the exposed population would range from 0.283 to 1.293 person-rem for treatment at INL and would be 0.018 person-rem for treatment at Hanford. Accordingly, incident-free transportation of radioactive material would result in a maximum of 0 (0.00262) LCFs among transportation workers and 0 (0.00077) LCFs in the total affected population over the duration of the alternative.

4.2.12.3.1.1 Facility Disposition

Under this alternative, the irradiated components, such as reactor vessels, test assemblies and hardware, and Interim Examination and Maintenance cells, as well other aboveground decommissioning waste, would be transported to an IDF and offsite locations for disposal. Facility disposition waste would require about 6,300 truck shipments from FFTF to an IDF and an offsite hazardous waste facility (see Table 4–124).

4.2.12.3.1.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Transportation risks for activities under this option would be the same as those under Alternative 2.

IDAHO OPTION

Transportation risks for activities under this option would be the same as those under Alternative 2.

4.2.12.3.1.3 Disposition of Bulk Sodium

Two options for disposition of bulk sodium were considered: treatment at Hanford or treatment at INL, with the return to Hanford of treated sodium in the form of caustic sodium hydroxide solution.

HANFORD REUSE OPTION

Transportation risks for activities under this option would be the same as those under Alternative 2.

IDAHO REUSE OPTION

Transportation risks for activities under this option would be the same as those under Alternative 2.

4.2.12.3.2 Impacts of Accidents During Transportation

For treatment options at INL, the maximum reasonably foreseeable offsite transportation accident under Alternative 3 (with a probability of occurrence of more than 1 chance in 10 million per year) would be similar to that discussed under Alternative 2.

Estimates of the total transportation accident risks under this alternative are also similar to those described under Alternative 2. These results indicate the accident risks would be very small.

For treatment options at Hanford, the consequences of the most severe transportation accident would be encompassed by those of facility accidents. Estimates of the total transportation accident risks from onsite shipments are very small (see Table 4–124, column 8); the population dose was estimated to be 1.92×10^{-9} person-rem, resulting in 1.15×10^{-12} LCFs.

4.2.12.3.2.1 Facility Disposition

It was estimated that the transport of decommissioning and irradiated component wastes would potentially result in 0 (0.004) traffic fatalities. The total population dose from accidents involving irradiated materials was estimated to be 6.6×10^{-10} person-rem, resulting in 4.0×10^{-13} LCFs (see Table 4–124).

4.2.12.3.2.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Transportation risks for activities under this option would be the same as those under Alternative 2.

IDAHO OPTION

Transportation risks for activities under this option would be the same as those under Alternative 2.

4.2.12.3.2.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Transportation risks for activities under this option would be the same as those under Alternative 2.

IDAHO REUSE OPTION

Transportation risks for activities under this option would be the same as those under Alternative 2.

4.2.12.3.3 Impacts of Construction and Operational Material Transports

The impacts of transporting construction materials (e.g., concrete, gravel/sand/soil, asphalt, steel, piping) and feed materials for the production and transport of waste (e.g., grout, fly ash, containers, boxes, canisters) were evaluated. The range of transportation impacts under this alternative would be 2.12 to 2.45 million kilometers (1.32 to 1.52 million miles) traveled, 0 (0.425 to 0.49) accidents, and 0 (0.0303 to 0.035) fatalities over the entire period from construction through deactivation and closure (see Table 4–125).

4.2.12.3.3.1 Facility Disposition

The impacts of transporting construction and operational material in support of facility disposition would be about 2.1 million kilometers (1.3 million miles) traveled, 0 (0.42) accidents, and 0 (0.03) fatalities over the entire period.

4.2.12.3.3.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Transportation risks for activities under this option would be the same as those under Alternative 2.

IDAHO OPTION

Transportation risks for activities under this option would be the same as those under Alternative 2.

4.2.12.3.3.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Transportation risks for activities under this option would be the same as those under Alternative 2.

IDAHO REUSE OPTION

Transportation risks for activities under this option would be the same as those under Alternative 2.

4.2.13 Environmental Justice

4.2.13.1 Alternative 1: No Action

This section addresses potential short-term impacts on minority, American Indian, Hispanic or Latino, and low-income populations under FFTF Decommissioning Alternative 1. As public access to Hanford is restricted, the majority of impacts under this alternative would be associated with onsite activities and would not affect populations residing off site; thus, the potential for environmental justice concerns is small. Resource areas that could be impacted and that may affect populations residing off site include public and occupational health and safety due to normal operations and facility accidents, as well as air quality and transportation.

Section 4.2.10.1.1 discusses short-term impacts on the public resulting from normal operations under FFTF Decommissioning Alternative 1. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive air emissions from normal operations, total doses to average individuals of minority, American Indian, Hispanic or Latino, and low-income populations were compared to the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–126 summarizes the average individual total doses over the life of the project under this alternative. There are no appreciable differences between the average individual total doses. Therefore, FFTF Decommissioning Alternative 1 would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–126. FFTF Decommissioning Alternative 1 Average Individual Total Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Doses (millirem)	
	Subset Population	**Remainder of Population**
Minority	5.2×10^{-5}	6.8×10^{-5}
American Indian	4.0×10^{-5}	6.1×10^{-5}
Hispanic or Latino	4.9×10^{-5}	6.8×10^{-5}
Low-income	5.4×10^{-5}	6.2×10^{-5}

Key: FFTF=Fast Flux Test Facility.
Source: Appendix J, Section J.5.7.1.2.

Section 4.2.10.1 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under FFTF Decommissioning Alternative 1, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would account for less than 10 percent of the total dose received by the MEI from the general population. Therefore, FFTF Decommissioning Alternative 1 would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations.

Section 4.2.11.1.1 discusses the radiological impacts of airborne releases from facility accidents under Alternative 1. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Alternative 1 would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic or Latino, or low-income populations due to the radiological impacts of facility accidents.

Section 4.2.11.1.2 discusses the hazardous chemical impacts of facility accidents under FFTF Decommissioning Alternative 1. The Hanford sodium storage tank failure scenario could result in a hazardous plume slightly exceeding the site boundary to the east of the 400 Area, but it is not expected to reach the far side of the Columbia River. The potentially affected area is located in Franklin County, census tract 206.01, block group 2. This block group does not contain a meaningfully greater minority or low-income population. Therefore, Alternative 1 would not pose disproportionately high and adverse impacts on minority or low-income populations due to hazardous chemical impacts of facility accidents.

Air quality impacts are discussed in Section 4.2.4.1. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American

Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.2.12.1 discusses the potential human health risks of transporting construction and operational materials between local or regional locations and Hanford. The impacts of transporting construction and operational materials to Hanford under this alternative would be very small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.2.13.2 Alternative 2: Entombment

This section addresses potential short-term impacts on minority, American Indian, Hispanic or Latino, and low-income populations under Alternative 2. As public access to Hanford is restricted, the majority of impacts under this alternative would be associated with onsite activities and would not affect populations residing off site; thus, the potential for environmental justice concerns is small. Resource areas that could be impacted and that may affect populations residing off site include public and occupational health and safety due to normal operations and facility accidents, as well as air quality and transportation.

4.2.13.2.1 Facility Disposition

Section 4.2.10.2.1 discusses short-term radiological impacts on the public resulting from normal operations under Alternative 2. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

Under this alternative, radiological impacts on the public from normal operations would be minimal. Impacts of deactivation activities would be a fraction of those described under the No Action Alternative in Section 4.2.13.1. For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive emissions from normal operations, the average individual total dose to a member of the minority, American Indian, Hispanic or Latino, and low-income populations over the life of the project was compared with the average individual total dose to a member of the remainder of the population over the life of the project. These results are presented in Appendix J. Table 4–127 summarizes the average individual total doses over the life of the project under this alternative. There are no appreciable differences between the average individual total doses. Therefore, facility disposition under the Entombment Alternative would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Section 4.2.10.2.1 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations associated with facility disposition under the Entombment Alternative. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. The dose to an MEI located at the boundary of the Yakama Reservation would be less than one-tenth of that to the MEI from the general population. Therefore, facility disposition activities under the Entombment Alternative would not pose disproportionately high and adverse impacts on minority or low-income populations.

Table 4–127. FFTF Decommissioning Alternative 2, Facility Disposition, Average Individual Total Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	Remainder of Population
Minority	1.3×10^{-9}	1.7×10^{-9}
American Indian	9.3×10^{-10}	1.5×10^{-9}
Hispanic or Latino	1.2×10^{-9}	1.7×10^{-9}
Low-income	1.3×10^{-9}	1.6×10^{-9}

Key: FFTF=Fast Flux Test Facility.
Source: Appendix J, Section J.5.7.1.2.

Section 4.2.11.2.1.1 discusses the radiological impacts of airborne releases for facility accidents associated with facility disposition under the Entombment Alternative. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, facility disposition under the Entombment Alternative would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic or Latino, or low-income populations due to the radiological impacts of facility accidents.

Section 4.2.11.2.2.1 discusses the hazardous chemical impacts of accidents associated with facility disposition under the Entombment Alternative. The Hanford sodium storage tank failure scenario could result in a hazardous plume extending slightly beyond the site boundary to the east of the 400 Area, but it is not expected to reach the far side of the Columbia River. The potentially affected area is located in Franklin County, census tract 206.01, block group 2. This block group does not contain a meaningfully greater minority or low-income population. Therefore, facility disposition under the Entombment Alternative would not pose disproportionately high and adverse impacts on minority or low-income populations due to hazardous chemical impacts of facility accidents.

Air quality impacts of facility disposition under Alternative 2 are discussed in Section 4.2.4.2.1. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.2.12.2.2.1 discusses the potential human health risks of transportation related to facility disposition under the Entombment Alternative. The impacts of transporting contaminated and hazardous materials to offsite locations for disposal under this alternative are not expected to result in any additional LCFs in the offsite population. The impacts of transporting construction and operational materials would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.2.13.2.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Section 4.2.10.2.1.2 discusses short-term radiological impacts on the public from normal operations associated with disposition of RH-SCs at Hanford. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive emissions from normal operations, average individual total doses to members of the minority, American Indian, Hispanic or Latino, and low-income populations over the life of the project were compared to the average individual total dose to a member of the remainder of the population over the life of the project. These results are presented in Appendix J. Table 4–128 summarizes the average individual total doses over the life of the project under this option. There were no appreciable differences in average individual total doses. Therefore, disposition of RH-SCs at Hanford would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–128. FFTF Decommissioning Alternative 2, Hanford Option, Disposition of Remote-Handled Special Components, Average Individual Total Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	**Remainder of Population**
Minority	2.6×10^{-7}	3.7×10^{-7}
American Indian	1.7×10^{-7}	3.2×10^{-7}
Hispanic or Latino	2.5×10^{-7}	3.6×10^{-7}
Low-income	2.6×10^{-7}	3.3×10^{-7}

Key: FFTF=Fast Flux Test Facility.
Source: Appendix J, Section J.5.7.1.2.

Section 4.2.10.2.1.2 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations associated with disposition of RH-SCs at Hanford. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. The dose to an MEI located at the boundary of the Yakama Reservation would be approximately one-fifth of that to the MEI from the general population. Therefore, disposition of RH-SCs at Hanford would not pose disproportionately high and adverse impacts on minority or low-income populations.

Section 4.2.11.2.1.2 discusses the radiological impacts of airborne releases from facility accidents associated with disposition of RH-SCs at Hanford under the Entombment Alternative. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, disposition of RH-SCs at Hanford under the Entombment Alternative would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to the radiological impacts of facility accidents.

Section 4.2.11.2.2.2 discusses the hazardous chemical impacts of accidents associated with disposition of RH-SCs at Hanford under the Entombment Alternative. Potential impacts under this option would be encompassed by those analyzed in Section 4.2.13.2.1 under facility disposition.

Air quality impacts of disposition of RH-SCs at Hanford under Alternative 2 are discussed in Section 4.2.4.2.2. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.2.12.2.1.2 discusses the potential human health risks of transportation related to disposition of RH-SCs at Hanford under the Entombment Alternative. This option would not require any offsite shipments. Onsite shipments of treated components and caustic sodium hydroxide solution are not expected to result in any additional LCFs in the offsite population. The impacts of transporting construction and operational materials would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

IDAHO OPTION

Section 4.2.10.2.1.2 discusses short-term radiological impacts on the public from normal operations associated with disposition of RH-SCs at INL. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive emissions from normal operations, average individual total doses to members of the minority, American Indian, Hispanic or Latino, and low-income populations over the life of the project were compared with the average individual total dose to a member of the remainder of the population over the life of the project. These results are presented in Appendix J. Table 4–129 summarizes the average individual total doses over the life of the project under this option. The average individual total doses to minority and Hispanic or Latino individuals would slightly exceed the average individual total dose to the remainder of the population; however, there are no appreciable differences in the average individual total doses. Therefore, disposition of RH-SCs at INL would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–129. FFTF Decommissioning Alternative 2, Idaho Option, Disposition of Remote-Handled Special Components, Average Individual Total Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	Remainder of Population
Minority	3.3×10^{-7}	3.1×10^{-7}
American Indian	2.6×10^{-7}	3.2×10^{-7}
Hispanic or Latino	3.5×10^{-7}	3.1×10^{-7}
Low-income	3.2×10^{-7}	3.2×10^{-7}

Key: FFTF=Fast Flux Test Facility.
Source: Appendix J, Section J.5.7.1.2.

Section 4.2.10.2.1.2 discusses impacts on the offsite MEI located south of INTEC as a result of normal operations associated with disposition of RH-SCs at INL. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Fort Hall Reservation and an individual subsisting on fish and wildlife were evaluated. The dose to an MEI located at the boundary of the Fort Hall Reservation would be less than approximately one-tenth of that to the offsite MEI. Therefore, disposition of RH-SCs at INL would not pose disproportionately high and adverse impacts on minority or low-income populations.

Section 4.2.11.2.1.2 discusses the radiological impacts of airborne releases from facility accidents associated with disposition of RH-SCs at INL under the Entombment Alternative. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, disposition of RH-SCs at INL under the Entombment Alternative would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic or Latino, or low-income populations due to the radiological impacts of facility accidents.

Section 4.2.11.2.2.2 discusses the hazardous chemical impacts of accidents associated with disposition of RH-SCs at INL under the Entombment Alternative. Potential impacts under this option would be encompassed by those analyzed in Section 4.2.13.2.1 under facility disposition.

Air quality impacts of disposition of RH-SCs at INL under Alternative 2 are discussed in Section 4.2.4.2.2. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.2.12.2.1.2 discusses the potential human health risks of transportation related to disposition of RH-SCs at INL under the Entombment Alternative. The impacts of transporting RH-SCs between Hanford, INL, and NNSS, as well as transporting caustic sodium hydroxide solution from INL to Hanford for product reuse under this option, are not expected to result in any additional LCFs in the offsite population. The impacts of transporting construction and operational materials would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.2.13.2.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Section 4.2.10.2.1.3 discusses short-term radiological impacts on the public from normal operations associated with disposition of bulk sodium at Hanford. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive emissions from normal operations, average individual total doses to members of the minority, American Indian, Hispanic or Latino, and low-income populations over the life of the project were compared with the average individual total dose to a member of the remainder of the population over the life of the project. These results are presented in Appendix J. Table 4–130 summarizes the average individual total doses over the life of the project under this option. There are no appreciable differences between the average individual total doses. Therefore, disposition of bulk sodium at Hanford would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–130. FFTF Decommissioning Alternative 2, Hanford Option, Disposition of Bulk Sodium, Average Individual Total Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	**Remainder of Population**
Minority	4.1×10^{-5}	5.5×10^{-5}
American Indian	3.1×10^{-5}	4.9×10^{-5}
Hispanic or Latino	3.9×10^{-5}	5.5×10^{-5}
Low-income	4.3×10^{-5}	5.0×10^{-5}

Key: FFTF=Fast Flux Test Facility.
Source: Appendix J, Section J.5.7.1.2.

Section 4.2.10.2.1.3 discusses impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations associated with disposition of bulk sodium at Hanford. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. The dose to an MEI located at the boundary of the Yakama Reservation would be less than approximately one-tenth of that to the MEI from the general population. Therefore, disposition of bulk sodium at Hanford would not pose disproportionately high and adverse impacts on minority or low-income populations.

Section 4.2.11.2.1.3 discusses the radiological impacts of airborne releases from facility accidents associated with disposition of bulk sodium at Hanford under the Entombment Alternative. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, disposition of bulk sodium at Hanford under the Entombment Alternative would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to the radiological impacts of facility accidents.

Section 4.2.11.2.2.3 discusses the hazardous chemical impacts of accidents associated with disposition of bulk sodium at Hanford under the Entombment Alternative. Potential impacts under this option would be encompassed by those analyzed in Section 4.2.13.2.1 under facility disposition.

Air quality impacts of disposition of bulk sodium at Hanford under Alternative 2 are discussed in Section 4.2.4.2.3. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.2.12.2.1.3 discusses the potential human health risks of transportation related to disposition of bulk sodium at Hanford under the Entombment Alternative. This option would not require any offsite shipments. Onsite shipments of bulk sodium and caustic solution are not expected to result in any additional LCFs in the offsite population. The impacts of transporting construction and operational materials would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

IDAHO REUSE OPTION

Section 4.2.10.2.1.3 discusses short-term radiological impacts on the public from normal operations associated with disposition of bulk sodium at INL. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive emissions from normal operations, average individual total doses to members of the minority, American Indian, Hispanic or Latino, and low-income populations over the life of the project were compared with the average individual total dose to a member of the remainder of the population over the life of the project. These results are presented in Appendix J. Table 4–131 summarizes the average individual total doses over the life of the project under this option. The average individual total doses to minority, Hispanic or Latino, and low-income individuals would slightly exceed the average individual total dose to the remainder of the population; however there are no appreciable differences in the average individual total doses. Therefore, disposition of bulk sodium at INL would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Table 4–131. FFTF Decommissioning Alternative 2, Idaho Option, Disposition of Bulk Sodium, Average Individual Total Doses from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	Remainder of Population
Minority	9.2×10^{-6}	8.3×10^{-6}
American Indian	7.8×10^{-6}	8.4×10^{-6}
Hispanic or Latino	9.7×10^{-6}	8.2×10^{-6}
Low-income	8.5×10^{-6}	8.4×10^{-6}

Key: FFTF=Fast Flux Test Facility.
Source: Appendix J, Section J.5.7.1.2.

Section 4.2.10.2.1.3 discusses impacts on the offsite MEI located southwest of the MFC as a result of normal operations associated with disposition of bulk sodium at INL. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Fort Hall Reservation and an individual subsisting on fish and wildlife were evaluated. The dose to an MEI located at the boundary of the Fort Hall Reservation would be approximately one-tenth of that to the offsite MEI. Therefore, disposition of bulk sodium at INL would not pose disproportionately high and adverse impacts on minority or low-income populations.

Section 4.2.11.2.1.3 discusses the radiological impacts of airborne releases from facility accidents associated with disposition of bulk sodium at INL under the Entombment Alternative. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, disposition of bulk sodium at INL under the Entombment Alternative would not pose disproportionately high and adverse impacts on the minority, American Indian, Hispanic or Latino, or low-income populations due to the radiological impacts of facility accidents.

Section 4.2.11.2.2.3 discusses the hazardous chemical impacts of accidents associated with disposition of bulk sodium at INL under the Entombment Alternative. None of the accidents analyzed could result in a hazardous plume extending beyond the site boundary. Therefore, bulk sodium disposition at INL under the Entombment Alternative would not pose disproportionately high and adverse impacts on minority or low-income populations due to hazardous chemical impacts of facility accidents.

Air quality impacts of disposition of bulk sodium at INL under Alternative 2 are discussed in Section 4.2.4.2.3. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.2.12.2.1.3 discusses the potential human health risks of transportation related to disposition of bulk sodium at INL under the Entombment Alternative. The impacts of transporting bulk sodium from Hanford to INL, as well as transporting caustic sodium hydroxide solution from INL back to Hanford for product reuse under this option, are not expected to result in any additional LCFs in the offsite population. The impacts of transporting construction and operational materials would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.2.13.3 Alternative 3: Removal

This section addresses potential short-term impacts on minority, American Indian, Hispanic or Latino, and low-income populations under FFTF Decommissioning Alternative 3. As public access to Hanford is restricted, the majority of impacts under this alternative would be associated with onsite activities and would not affect populations residing off site; thus, the potential for environmental justice concerns is small. Resource areas that could be impacted and that may affect populations residing off site include public and occupational health and safety due to normal operations and facility accidents, as well as air quality and transportation.

4.2.13.3.1 Facility Disposition

Section 4.2.10.3.1.1 discusses short-term radiological impacts on the public from normal operations associated with facility disposition under the Removal Alternative. Facility disposition would result in minimal releases of radioactivity and, therefore, negligible doses to the offsite population and the MEI. Similarly, the doses to minority and low-income populations, as well as the MEI at the boundary of the Yakama Reservation, would also be negligible. Therefore, facility disposition under the Removal Alternative would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Section 4.2.11.3.1.1 discusses the radiological impacts of airborne releases for facility accidents associated with facility disposition under the Removal Alternative. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, facility disposition under the Removal Alternative would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to the radiological impacts of facility accidents.

Section 4.2.11.3.2 discusses the hazardous chemical impacts associated with facility disposition under the Removal Alternative. Hazardous chemical impacts under this alternative would be the same as those described in Section 4.2.13.2.1 under the Entombment Alternative.

Air quality impacts of facility disposition under Alternative 3 are discussed in Section 4.2.4.3.1. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.2.12.3.1.1 discusses the potential human health risks of transportation related to facility disposition under the Removal Alternative. The impacts of transporting contaminated and hazardous materials to offsite locations for disposal under this alternative are not expected to result in any additional LCFs in the offsite population. The impacts of transporting construction and operational materials would also be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.2.13.3.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Impacts of this option on aspects of environmental justice would be the same as those discussed in Section 4.2.13.2.2 under the Hanford Option.

IDAHO OPTION

Impacts of this option on aspects of environmental justice would be the same as those discussed in Section 4.2.13.2.2 under the Idaho Option.

4.2.13.3.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Impacts of this option on aspects of environmental justice would be the same as those discussed in Section 4.2.13.2.3 under the Hanford Reuse Option.

IDAHO REUSE OPTION

Impacts of this option on aspects of environmental justice would be the same as those discussed in Section 4.2.13.2.3 under the Idaho Reuse Option.

4.2.14 Waste Management

This section evaluates the impacts of waste generation associated with the various FFTF Decommissioning alternatives and options (see Section 4.2.1) on the waste management infrastructure at Hanford. As summarized in Section 4.3 and detailed in Chapter 2, Waste Management alternatives were developed to manage the various waste volumes projected to be generated under the alternatives for Tank Closure, FFTF Decommissioning, and Waste Management. Section 4.3.14 of this EIS evaluates the impacts of waste generation associated with the construction, operations, deactivation, and closure of the waste management facilities.

The following analysis is consistent with DOE policy and DOE Manual 435.1-1, which require that DOE radioactive waste shall be treated, stored, and, in the case of LLW, disposed of at the site where the waste is generated, if practical, or at another DOE facility. The analysis of these FFTF Decommissioning alternatives and options is based on disposal of LLW and MLLW at Hanford. However, if DOE determines that use of Hanford's or another DOE site's waste management facilities is not practical or cost-effective, DOE may approve the use of non-DOE (i.e., commercial) facilities to store, treat, and dispose of such waste.

Included in this section is a discussion of the waste inventories generated under each of the FFTF Decommissioning alternatives as a result of facility disposition and the options for disposition of RH-SCs and Hanford bulk sodium. The inventories include LLW, MLLW, hazardous waste, nonhazardous waste, liquid process waste, and 50 weight-percent sodium hydroxide.

LOW-LEVEL RADIOACTIVE WASTE

LLW and MLLW (e.g., personal protective equipment, tools, filters, empty containers) would be generated during activities such as routine operations, deactivation, decommissioning, and disposition of the SRF, the SPF, and the RTP under the action alternatives and options, as well as during routine surveillance and maintenance under FFTF Decommissioning Alternative 1, No Action. LLW is typically not treated or only minimally treated (e.g., compacted) before disposal. Through a combination of on- and offsite capabilities, secondary MLLW would be treated to meet RCRA land-disposal-restriction treatment standards prior to disposal. Therefore, this waste treatment would cause no or only minimal impacts on the Hanford waste management system. The LLW would be sent directly to disposal. The MLLW would be sent to disposal after treatment. All LLW and MLLW would be disposed of in an IDF.

HAZARDOUS WASTE

Hazardous waste is dangerous waste, as defined in the *Washington Administrative Code* (WAC 173-303). Hazardous waste generated during operations, deactivation, or monitoring would be packaged in DOT-approved containers and shipped off site to permitted commercial recycling, treatment, and disposal facilities. Hanford shipped 182,177 kilograms (402,000 pounds) of hazardous waste off site in 2005 (Poston et al. 2006). Management of the additional waste generated under the FFTF Decommissioning alternatives and options would require little, if any, additional planning. The waste would be treated and disposed of at offsite commercial facilities.

NONHAZARDOUS WASTE

Any nonhazardous solid waste generated from facility disposition activities or treatment facility construction, operations, or deactivation would be packaged and transported in conformance with standard industrial practices. Solid waste such as office paper, metal cans, and plastic and glass bottles that can be recycled would be sent off site for that purpose. The remaining nonhazardous solid waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

LIQUID PROCESS WASTE

Process waste would be generated by FFTF disposition activities and would possibly be generated in association with RH-SC treatment, bulk sodium disposition, and facility deactivation. Process liquids with substantial levels of radioactivity would be treated at the ETF or the TEDF or equivalent facilities at INL's MFC. Dilute process waste such as cooling waters or steam condensates would be routed to the Hanford or Idaho facilities, as applicable, whose mission it is to manage such wastes. It was assumed that the ETF and the TEDF, or their equivalents, would continue to be available to manage dilute process liquids generated under the FFTF Decommissioning alternatives. Wastewater management is further discussed in Section 4.2.6.

4.2.14.1 Alternative 1: No Action

FFTF Decommissioning Alternative 1, No Action, includes deactivation of the FFTF complex followed by 100 years of administrative controls.

Surveillance and maintenance activities associated with storage of bulk sodium in the 400 Area SSF and maintenance of the FFTF reactor vessel, related piping and equipment, RH-SCs, and tanks through the 100-year administrative control period would generate relatively small volumes of waste on an annualized basis. Table 4–132 presents the estimated waste volumes generated under FFTF Decommissioning Alternative 1.

4.2.14.2 Alternative 2: Entombment

4.2.14.2.1 Waste Inventories

4.2.14.2.2 Facility Disposition

FFTF Decommissioning Alternative 2, Entombment, provides for demolition of the FFTF RCB and immediately adjacent support facilities to below grade (other facilities within the PPA would be dismantled to grade), stabilization of below-grade spaces, and construction of a modified RCRA Subtitle C barrier to reduce infiltration, prevent intrusion, and isolate the below-grade portions of the reactor building. Accessible void spaces in the below-grade portions of the RCB would be grouted. These activities would produce a small quantity of secondary LLW and liquid LLW. Debris and other waste not placed in the RCB or used as backfill would be transported to trenches 31 and 34 of LLBG 218-W-5 or to IDF-East for disposal.

Table 4–132. FFTF Decommissioning Alternatives and Options – Summary of Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation	
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Annual Waste Volume
Alternative 1: No Action							
Low-level radioactive waste	N/A	N/A	1,700	N/A	1,700	2008–2017	17
Mixed low-level radioactive waste	N/A	N/A	57	N/A	57	2008–2017	1
Hazardous waste[a]	N/A	N/A	396	N/A	396	2008–2017	4
Nonradioactive/nonhazardous waste[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Liquid low-level radioactive waste (liters)	N/A	N/A	623,000	N/A	623,000	2008–2017	6,230
Alternative 2 Facility Disposition: Entombment							
Low-level radioactive waste	N/A	N/A	7	N/A	7	2017	7
Mixed low-level radioactive waste	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hazardous waste[a]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nonradioactive/nonhazardous waste[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Liquid low-level radioactive waste (liters)	N/A	N/A	182,000	N/A	182,000	2017	182,000
Alternative 3 Facility Disposition: Removal							
Low-level radioactive waste	N/A	N/A	692	N/A	692	2013–2014	346
Mixed low-level radioactive waste	N/A	N/A	8	N/A	8	2013–2014	4
Hazardous waste[a]	N/A	N/A	73	N/A	73	2013–2014	37
Nonradioactive/nonhazardous waste[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Liquid low-level radioactive waste (liters)	N/A	N/A	324,000	N/A	324,000	2013–2014	162,000
Disposition of RH-SCs: Hanford Option							
Low-level radioactive waste	N/A	8	60	N/A	68	2018	60
Mixed low-level radioactive waste	N/A	7	N/A	N/A	7	2017	7
Nonradioactive/nonhazardous waste[b]	N/A	N/A	4	N/A	4	2018	4
Liquid low-level radioactive waste (liters)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Disposition of RH-SCs: Idaho Option							
Low-level radioactive waste	N/A	8	60	N/A	68	2018	60
Mixed low-level radioactive waste	N/A	7	N/A	N/A	7	2017	7
Nonradioactive/nonhazardous waste[b]	N/A	N/A	4	N/A	4	2018	4
Liquid low-level radioactive waste (liters)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 4–132. FFTF Decommissioning Alternatives and Options – Summary of Waste Generation Volumes *(continued)*

Waste Type	Project Phase					Peak Annual Generation	
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Annual Waste Volume
Disposition of Bulk Sodium: Hanford Reuse Option							
Low-level radioactive waste	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mixed low-level radioactive waste	1	21	399	N/A	421	2019	399
Nonradioactive/nonhazardous waste[b]	N/A	N/A	454	N/A	454	2019	454
Liquid low-level radioactive waste (liters)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Disposition of Bulk Sodium: Idaho Reuse Option							
Low-level radioactive waste	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mixed low-level radioactive waste	3	21	251	N/A	275	2016	262
Nonradioactive/nonhazardous waste[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Liquid low-level radioactive waste (liters)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

[a] Hazardous waste is accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.
[b] Nonhazardous solid waste is shipped to offsite commercial facilities for recycling, treatment, and disposal.
Note: All values are in cubic meters except as noted. To convert cubic meters to cubic yards, multiply by 1.308; liters to gallons, by 0.26417.
Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; N/A=not applicable; RH-SCs=remote-handled special components.
Source: SAIC 2010b.

4.2.14.2.3 Disposition of Remote-Handled Special Components

HANFORD OPTION

Under this option, RH-SCs would be stored, treated, and disposed of at Hanford. This option would use storage and disposal facilities currently existing within the 200 Areas, thereby minimizing any impact. Treatment of RH-SCs would involve construction of a new RTP within the T Plant complex located in the 200-West Area. This option would generate waste from operations and deactivation of this facility.

IDAHO OPTION

RH-SCs removed from the FFTF RCB would be stored at Hanford prior to shipment to INL, where they would be treated. Treated components would be returned to Hanford or sent to NNSS for disposal, where they would be placed in existing disposal facilities. This option would generate waste from operations and deactivation of this facility.

4.2.14.2.4 Disposition of Bulk Sodium

The bulk sodium (approximately 1.14 million liters [300,000 gallons]) would be converted to a caustic sodium hydroxide solution for product reuse in processing tank waste at the WTP or support for Hanford tank corrosion controls. Two options were identified for conversion of the bulk sodium to liquid caustic.

HANFORD REUSE OPTION

Under the Hanford Reuse Option, sodium from FFTF would be sent to a new SRF to be built in the 400 Area. Construction, operations, and deactivation of this new facility would generate a small amount of waste.

IDAHO REUSE OPTION

Under this option, sodium from FFTF and other sodium would be transported to INL for treatment in the SPF. The SPF is an existing facility within the MFC. Modifications would have to be made to the current facility. Construction, operations, and deactivation of the modifications would generate a small amount of waste.

Table 4–132 presents the estimated waste volumes generated under FFTF Decommissioning Alternative 2.

4.2.14.3 Alternative 3: Removal

4.2.14.3.1 Waste Inventories

4.2.14.3.2 Facility Disposition

FFTF Decommissioning Alternative 3, Removal, provides for demolition of above-grade structures and disposal of the contaminated debris in an IDF similar to Alternative 2, except the reactor vessel would be stabilized with grout, removed, and disposed of at an IDF. Under this alternative, the FFTF RCB and adjacent support facilities would be removed to 0.9 meters (3 feet) below grade; however, an engineered barrier would not be needed because the reactor vessel and other radioactively contaminated equipment would also be removed.

Debris and other waste would be handled in the same manner as under the FFTF Decommissioning Entombment Alternative (see Section 4.2.14.2.2).

4.2.14.3.3 Disposition of Remote-Handled Special Components

HANFORD OPTION

The steps involved in disposition of RH-SCs under the Hanford Option of this alternative would be identical to those under the Entombment Alternative, as discussed under the Hanford Option in Section 4.2.14.2.3.

IDAHO OPTION

Similar to the Hanford Option, the actions taken at INL would be the same under this alternative as those under the Entombment Alternative, as discussed under the Idaho Option in Section 4.2.14.2.3.

4.2.14.3.4 Disposition of Bulk Sodium

HANFORD REUSE OPTION

The steps involved in the disposition of bulk sodium under the Hanford Reuse Option of this alternative would be identical to those under the Entombment Alternative, as discussed under the Hanford Reuse Option in Section 4.2.14.2.4.

IDAHO REUSE OPTION

Similar to the Hanford Reuse Option, the steps involved in disposition of bulk sodium at INL would be the same under this alternative as those under the Entombment Alternative, as discussed under the Idaho Reuse Option in Section 4.2.14.2.4.

Table 4–132 presents the estimated waste volumes generated under FFTF Decommissioning Alternative 3.

4.2.15 Industrial Safety

Illness, injury, and death are possible outcomes of any industrial accident. The accepted standard for measuring the outcome of an industrial accident is the number of TRCs of illness, injury, and death. This section addresses the potential impacts of illness, injury, and death that could be associated with implementation of each of the FFTF Decommissioning alternatives and options for disposition of RH-SCs and bulk sodium. Key underlying assumptions and industrial safety incident rates used in support of this analysis are the same as those described in Section 4.1.15 for the Tank Closure alternatives.

Using these incident rates and the projected labor hours, industrial safety impacts associated with each of the alternatives were determined (see Table 4–133). There are inherent uncertainties in estimating the number of TRCs and fatalities associated with future activities. Currently, there are no weighting factors assigned to the phases of an alternative that allow for normalizing the risks under each alternative. Therefore, when averaging the rate over all phases, this approach can result in slightly higher values for project operation and closure phases and lower values for activities that have higher risk of injury and illness.

As shown in Figure 4–29, more industrial safety impacts are associated with those alternatives that require higher numbers of labor hours.

Table 4–133. FFTF Decommissioning Alternatives – Industrial Safety Impacts

Alternative	Labor Category	Million Labor Hours	Total Recordable Case Rate per 200,000 Labor Hours	Projected Total Recordable Cases	Fatality Rate per 200,000 Labor Hours	Projected Fatalities
Alternative 1: No Action	Construction	0.0	2.0	0.0	0.26	0.0
	Operations	0.0	2.0	0.0	0.26	0.0
	Deactivation	0.042	2.0	0.42	0.26	0.00005
	Closure	0.0	2.0	0.0	0.26	0.0
	Total	**0.042**		**0.42**		**0.00005**
Alternative 2: Facility Disposition-Entombment	Construction	0.0	2.0	0.0	0.26	0.0
	Operations	0.0	2.0	0.0	0.26	0.0
	Deactivation	0.62	2.0	6.2	0.26	0.0008
	Closure	0.19	2.0	1.9	0.26	0.0002
	Total	**0.81**		**8.10**		**0.001**
Alternative 3: Facility Disposition-Removal	Construction	0.0	2.0	0.00	0.26	0.0
	Operations	0.0	2.0	0.00	0.26	0.0
	Deactivation	0.80	2.0	8.0	0.26	0.001
	Closure	0.15	2.0	1.5	0.26	0.0002
	Total	**0.95**		**9.50**		**0.0012**
Disposition of RH-SCs: Hanford Option	Construction	0.34	2.0	3.40	0.26	0.0004
	Operations	0.08	2.0	0.80	0.26	0.0001
	Deactivation	0.04	2.0	0.40	0.26	0.0001
	Closure	0.0	2.0	0.0	0.26	0.0
	Total	**0.47**		**4.70**		**0.0006**
Disposition of RH-SCs: Idaho Option	Construction	0.0	1.5	0.0	0.26	0.0
	Operations	0.08	1.5	0.6	0.26	0.0001
	Deactivation	0.04	1.5	0.3	0.26	0.00005
	Closure	0.0	1.5	0.0	0.26	0.0
	Total	**0.12**		**0.9**		**0.0002**
Disposition of Bulk Sodium: Hanford Reuse Option	Construction	0.27	2.0	2.70	0.26	0.0004
	Operations	0.26	2.0	2.60	0.26	0.0003
	Deactivation	0.05	2.0	0.50	0.26	0.0001
	Closure	0.0	2.0	0.00	0.26	0.0
	Total	**0.58**		**5.80**		**0.0008**
Disposition of Bulk Sodium: Idaho Reuse Option	Construction	0.05	1.5	0.38	0.26	0.00006
	Operations	0.22	1.5	1.65	0.26	0.0003
	Deactivation	0.001	1.5	0.01	0.26	0.000002
	Closure	0.0	1.5	0.00	0.26	0.0
	Total	**0.27**		**2.03**		**0.0003**

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate. Totals may not equal the sum of the contributions due to rounding.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; RH-SCs=remote-handled special components.

Source: Labor hours compiled from Appendix I.

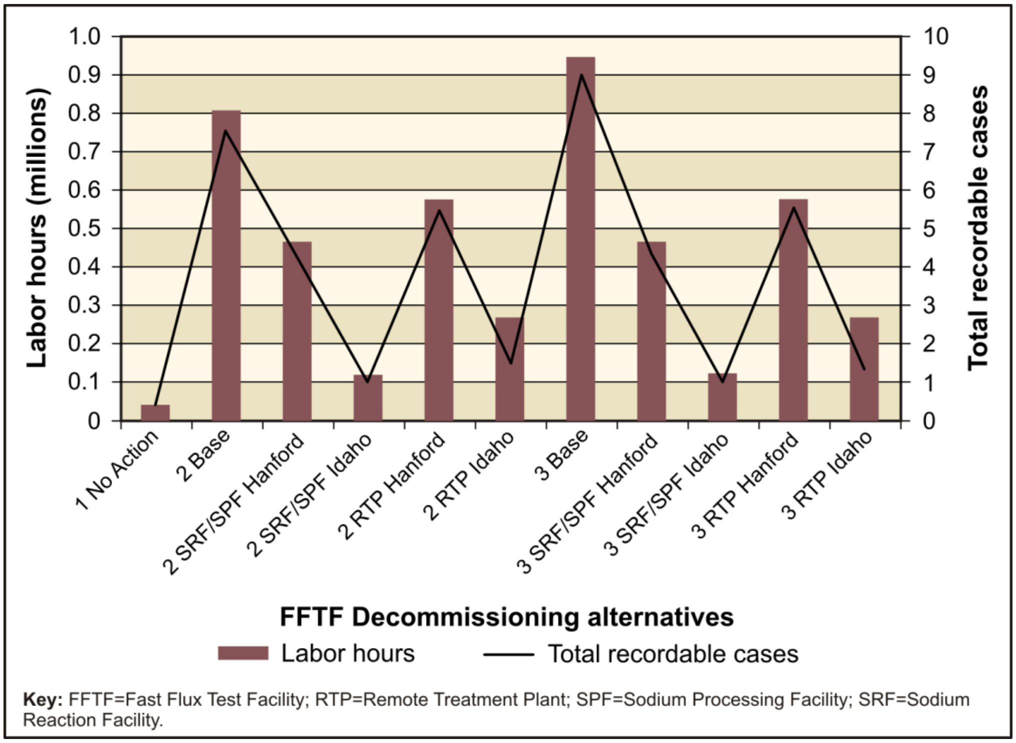


Figure 4–29. Total Recordable Cases and Labor Hours by Alternative

4.2.15.1 Alternative 1: No Action

Approximately one TRC and no fatalities are projected to result from work under this alternative, which would include administrative controls for 100 years.

4.2.15.2 Alternative 2: Entombment

4.2.15.2.1 Facility Disposition

Completing the work identified under this alternative would require 810,000 labor hours, including the postclosure care period of 100 years. Approximately eight TRCs and no fatalities are projected.

4.2.15.2.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Under this option, a facility would be built to process the RH-SCs removed from FFTF. Construction, operations, and deactivation would require 470,000 total labor hours over 4 years. Approximately five TRCs and no fatalities are projected.

IDAHO OPTION

Approximately one TRC and no fatalities are projected over the period when this work would be conducted. To calculate the number of potential TRCs, the average rate for Idaho operations from 2001 through 2006 (1.5 cases per 200,000 labor hours) was applied.

4.2.15.2.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Construction, operations, and deactivation of the SRF in the 400 Area of Hanford would require a total of 580,000 labor hours. Approximately six TRCs were projected to be generated under this alternative. No fatalities are projected during any phase of this alternative.

IDAHO REUSE OPTION

This option would require shipment of the sodium to a new facility at the MFC at INL for conversion to a form acceptable for use in the WTP. This work would take place over a 4-year period and would require a total of 270,000 labor hours to complete. Approximately two TRCs and no fatalities are projected under this option. To calculate the number of potential TRCs, the average rate for Idaho operations from 2001 through 2006 (1.5 cases per 200,000 labor hours) was applied.

4.2.15.3 Alternative 3: Removal

4.2.15.3.1 Facility Disposition

No more than 10 TRCs and no fatalities are projected to result from work conducted under this alternative.

4.2.15.3.2 Disposition of Remote-Handled Special Components

HANFORD OPTION

Industrial safety consequences from implementation of this option would be the same as those discussed in Section 4.2.15.2.2 under the Hanford Option.

IDAHO OPTION

Industrial safety consequences from implementation of this option would be the same as those discussed in Section 4.2.15.2.2 under the Idaho Option.

4.2.15.3.3 Disposition of Bulk Sodium

HANFORD REUSE OPTION

Industrial safety consequences from implementation of this option would be the same as those discussed in Section 4.2.15.2.3 under the Hanford Reuse Option.

IDAHO REUSE OPTION

Industrial safety consequences from implementation of this option would be the same as those discussed in Section 4.2.15.2.3 under the Idaho Reuse Option.

4.3 WASTE MANAGEMENT ALTERNATIVES

This section describes the potential short-term environmental and human health impacts associated with implementation of alternatives for administering ongoing solid waste management operations and proposed disposal of Hanford LLW and MLLW and a limited volume of offsite LLW and MLLW in an IDF to be located at Hanford. Specifically, some waste from tank closure activities (described in Section 4.1), as well as other LLW and MLLW from Hanford, including the waste resulting from FFTF decommissioning (described in Section 4.2) and waste from other DOE sites without appropriate disposal facilities, must be disposed of to facilitate cleanup of Hanford and other DOE sites. This section analyzes the impacts of expanding Hanford's waste disposal capacity to provide space for on- and offsite wastes. Associated storage, disposal, and closure activities, as well as facility-specific construction, operations, deactivation, and closure activities, are also analyzed.

Three Waste Management alternatives were considered and analyzed: (1) Waste Management Alternative 1: No Action Alternative, under which LLW, MLLW, and TRU waste would be stored and disposed of in existing Hanford facilities and no offsite waste would be received, construction/use of IDF-East would be discontinued, and IDF-East would be deactivated; (2) Waste Management Alternative 2: Disposal in IDF, 200-East Area only; and (3) Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas. Waste Management Alternative 2 would include storing LLW, MLLW, and TRU waste in the CWC prior to disposal in existing trenches 31 and 34, as well as conducting waste processing prior to disposal at new facilities or existing-facility expansions at the CWC, WRAP, and the T Plant. A total volume of 62,000 cubic meters (81,000 cubic yards) of LLW and 20,000 cubic meters (26,000 cubic yards) of MLLW from other DOE sites would be received for disposal under this alternative. Waste from tank closure and treatment operations, onsite non-CERCLA waste, FFTF decommissioning waste, waste management waste, and offsite waste from other DOE sites would be disposed of at IDF-East. A new RPPDF would be provided to dispose of equipment and soils resulting from tank farm clean closure activities that are not highly contaminated.

Waste Management Alternative 3 would involve the same waste storage and processing provisions as under Waste Management Alternative 2, and the same volume of offsite waste would be accepted for disposal; a new RPPDF would also be provided. However, an additional IDF would be provided in the 200-West Area. Waste from tank closure and treatment operations would be disposed of at IDF-East, while onsite non-CERCLA waste, FFTF decommissioning waste, waste management waste, and offsite waste from other DOE sites would be disposed of at IDF-West.

In addition, under each Waste Management action alternative (i.e., Alternatives 2 and 3), three disposal groups were analyzed: Disposal Group 1, Disposal Group 2, and Disposal Group 3. These disposal groups encompass the sizing requirements and associated construction, operations, and closure requirements for the IDF(s) and RPPDF that would be necessary to accommodate the varying waste volumes considered under each disposal configuration. These alternatives and options are described further in Chapter 2, Section 2.5.4, of this EIS.

4.3.1 Land Resources

4.3.1.1 Alternative 1: No Action

4.3.1.1.1 Land Use

Under the No Action Alternative, new facility construction would not be initiated within the 200 Areas. Storage and treatment activities would continue to take place within the CWC, WRAP complex, and T Plant complex. Disposal would also continue in LLBG 218-W-5 trenches 31 and 34. Barriers would not be used after closure of any of these facilities or trenches. Thus, there would be no change in land use within the 200 Areas under this alternative. As this alternative would not require geologic material to be excavated from Borrow Area C, there would be no impact on land use within that area.

4.3.1.1.2 Visual Resources

As noted above, there would be no construction under the No Action Alternative within the 200 Areas, and barriers would not be used after closure of facilities or trenches. Further, there would be no need to excavate geologic material from Borrow Area C. Thus, this alternative would have no impact on the visual environment.

However, ongoing construction, consolidation, operations, maintenance, and deactivation of facilities on Rattlesnake and Gable Mountains would occur under this alternative. Rattlesnake and Gable Mountains are within the viewshed of Borrow Area C and the 200 Areas, respectively, and ongoing activities would result in short-term adverse impacts on land and visual resources, including the development or use of previously undisturbed land. Visual impacts of existing structures and maintenance activities on Rattlesnake and Gable Mountains and land use for construction of new facilities are considered a short-term impact because, after a facility's mission has been completed, it would be deactivated and demolished, and vegetation and habitat would be restored to a natural state. However, the eventual consolidation or removal of unnecessary facilities/infrastructure on Rattlesnake and Gable Mountains would tend to improve the visual profile of the features, allow restoration of natural habitat, and enhance tribal religious and cultural experiences.

4.3.1.2 Alternative 2: Disposal in IDF, 200-East Area Only

4.3.1.2.1 Land Use

Under this alternative, a number of new facilities or existing-facility expansions would be constructed. These include expansion of the T Plant, construction of a new CWC storage facility, and two expansions of WRAP (both for treating nontank waste): (1) a CH-Mixed TRU/TRU waste facility at the CWC and (2) an RH-Mixed TRU/TRU waste facility at WRAP (see Figure 4–2). These facilities would be constructed within the 200-West Area and would require a total of 2.7 hectares (6.6 acres) of land. Because all work would take place within the 200-West Area, which is within the area designated Industrial-Exclusive, there would be no change in land use under this alternative from the construction and operations of new processing and storage facilities.

In addition to the facilities noted above, IDF-East and an RPPDF would be constructed between the 200-East and 200-West Areas (see Figure 4–1). Waste generated in connection with the Waste Management alternatives, as well as waste associated with the FFTF Decommissioning and Tank Closure alternatives, would also be placed in these disposal facilities. Thus, the sizes of IDF-East and the RPPDF would vary depending upon the volume of waste generated under the various alternative combinations. Accordingly, waste volumes have been placed in three disposal groups, which are addressed separately below (see Appendix E, Section E.4.2, for a complete discussion of the waste groupings). As IDF-East and the RPPDF would be located within the Industrial-Exclusive area, their construction would be consistent with the existing land use designation of the area.

Construction, operations, and closure of the various facilities associated with each of the disposal groups under this alternative would require the use of geologic material to produce grout, fill excavated areas, and cover waste sites. This material would come from Borrow Area C. The area needed to supply this material would vary depending on the volume required for each disposal group. The area of land needed within the borrow area and the land requirements for IDF-East and the RPPDF are addressed below. As Borrow Area C has been designated Conservation (Mining), use of the area for this purpose would be consistent with the current site land use plan.

4.3.1.2.1.1 Disposal Group 1

Disposal Group 1 would require that IDF-East and the RPPDF be 32.8 hectares (81 acres) and 29.5 hectares (73 acres) in size, respectively. Further, to support activities under this disposal group, a total of 41.7 hectares (103 acres) within Borrow Area C would be required to supply geologic material. Thus, including the land requirement of the expanded and new facilities noted above, a total of 107 hectares (264 acres) would be developed under this disposal group. Closure of IDF-East and the RPPDF would require an additional 1.6 hectares (4 acres) of land to accommodate modified RCRA Subtitle C barriers, making a total land commitment of 108 hectares (268 acres).

4.3.1.2.1.2 Disposal Groups 2 and 3

Although the time required for construction and operations would vary, the land requirements for IDF-East and the RPPDF under Disposal Groups 2 and 3 would be the same. Under each disposal group, IDF-East would require 11.3 hectares (28 acres) of land, while the RPPDF would need 228 hectares (564 acres). The land required within Borrow Area C to supply geologic material would be 159 hectares (392 acres). Thus, including the new facilities noted above, the total land requirement at Hanford for each disposal group would be 401 hectares (991 acres). Placement of the modified RCRA Subtitle C barriers over IDF-East and the RPPDF would require an additional 7.7 hectares (19 acres) of land, making a total land commitment of approximately 409 hectares (1,010 acres).

4.3.1.2.2 Visual Resources

As processing and storage facilities would be placed within the 200-West Area, an area that is already highly developed, and would occupy a relatively small area (2.7 hectares [6.6 acres]), impacts on visual resources from their construction and operations would be minimal. The BLM Visual Resource Management Class IV rating of the 200-West Area would not change under this alternative. The visual impacts of constructing the IDF-East and the RPPDF, as well as developing Borrow Area C, are addressed below for each disposal group.

Ongoing construction, consolidation, operations, maintenance, and deactivation of facilities on Rattlesnake and Gable Mountains would also occur under this alternative. Rattlesnake and Gable Mountains are within the viewshed of Borrow Area C and the 200 Areas, respectively, and ongoing activities would result in short-term adverse impacts on land and visual resources, including the development or use of previously undisturbed land. Visual impacts of existing structures and maintenance activities on Rattlesnake and Gable Mountains and land use for construction of new facilities are considered a short-term impact because, after a facility's mission has been completed, it would be deactivated and demolished, and vegetation and habitat would be restored to a natural state. However, the eventual consolidation or removal of unnecessary facilities/infrastructure on Rattlesnake and Gable Mountains would tend to improve the visual profile of the features, allow restoration of natural habitat, and enhance tribal religious and cultural experiences.

4.3.1.2.2.1 Disposal Group 1

As noted above (see Section 4.3.1.2.1.1), construction of the IDF and RPPDF would result in the conversion of 62.3 hectares (154 acres) to industrial use. During construction and operations, these changes would add noticeably to the overall industrial nature of the 200 Areas and would be visible from Rattlesnake Mountain, Gable Mountain, and Gable Butte. The viewscape from these areas is important to American Indians with cultural ties to Hanford (see Chapter 3, Section 3.2.8). Although there would be an overall increase in the industrial appearance of the 200 Areas, the BLM Visual Resource Management Class IV rating would not change.

Closure of the disposal facilities would involve constructing modified RCRA Subtitle C barriers over IDF-East and the RPPDF. These barriers would be slightly larger than the disposal sites and would be 2.7 meters (9 feet) high. The areas would be revegetated with native grasses, thus improving their postclosure appearance.

To supply geologic material under this disposal group, 41.7 hectares (103 acres) from Borrow Area C would be excavated. This excavation would change the existing visual setting of Borrow Area C from a predominantly natural setting with limited disturbance to one in which mining activities dominate. This impact would last for the duration of the project. It would also change the BLM visual resource management rating from Class II to Class IV. Excavation of the borrow area would change the viewscape from State Route 240 and Rattlesnake Mountain, an area important to American Indians with cultural ties to Hanford. Following closure, the area would be recontoured and revegetated with native plants to more closely resemble the predisturbance setting.

4.3.1.2.2.2 Disposal Groups 2 and 3

Disposal Groups 2 and 3 would require 240 hectares (592 acres) of undeveloped land for construction of IDF-East and the RPPDF. These changes would noticeably add to the overall industrial nature of the 200 Areas and would be visible from Rattlesnake Mountain, Gable Mountain, and Gable Butte. This alteration in the viewscape would last for the operational period of the disposal sites. Although there would be an overall increase in the industrial appearance of the 200 Areas, the BLM Visual Resource Management Class IV rating would not change.

Closure of IDF-East and the RPPDF would involve constructing modified RCRA Subtitle C barriers over both facilities. These barriers would be slightly larger than the disposal sites and would be about 2.7 meters (9 feet) high. The areas would be revegetated with native grasses, thus improving their postclosure appearance.

To supply geologic material under Disposal Groups 2 and 3, a total of 159 hectares (392 acres) within Borrow Area C would need to be excavated. This excavation would change the existing visual setting of Borrow Area C from a predominantly natural setting with limited disturbance to one in which mining activities would dominate for the duration of the project. It would also change the BLM visual resource management rating from Class II to Class IV. Excavation of the borrow area would be readily visible from State Route 240 and Rattlesnake Mountain, an area important to American Indians with cultural ties to Hanford. Following closure, the area would be recontoured and revegetated with native vegetation to more closely resemble the pre-disturbance setting.

4.3.1.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

4.3.1.3.1 Land Use

Under this Waste Management alternative, the same expanded or new facilities would be constructed as under Alternative 2 (see Section 4.3.1.2.1). These facilities would be built within the same locations in the 200-West Area and would require the same land (i.e., 2.7 hectares [6.6 acres]). Thus, because all work would take place within the area designated as Industrial-Exclusive, there would be no change in land use under this alternative.

In addition, under this Waste Management alternative, the RPPDF would be constructed between the 200-East and 200-West Areas; however, separate IDFs would be constructed within each area. Land requirements for the IDFs, RPPDF, and Borrow Area C are addressed below. Use of the 200 Areas and Borrow Area C, which are designated as Industrial-Exclusive and Conservation (Mining), respectively, would be consistent with the current site land use plan.

4.3.1.3.1.1 Disposal Group 1

Disposal Group 1 would require construction of a 29.9-hectare (74-acre) IDF-East and a 2.4-hectare (6-acre) IDF-West. Additionally, a 29.5-hectare (73-acre) RPPDF would be built between the 200-East and 200-West Areas. To supply the required volume of geologic material needed under this alternative, it would be necessary to excavate 36.8 hectares (91 acres) from Borrow Area C. Thus, the total land requirement at Hanford for Disposal Group 1 under this alternative, including the processing and storage facilities noted above, would be about 102 hectares (251 acres). Final closure of the disposal facilities under modified RCRA Subtitle C barriers would require an additional 15 hectares (37 acres) of land, making a total land commitment of approximately 117 hectares (288 acres).

4.3.1.3.1.2 Disposal Groups 2 and 3

Although the operational periods would vary for Disposal Groups 2 and 3, the land requirement would be identical. Thus, 9.3 hectares (23 acres) would be needed for IDF-East, 2.4 hectares (6 acres) for IDF-West, and 228 hectares (564 acres) for the RPPDF. In addition, excavation of 157 hectares (388 acres) of Borrow Area C would be needed to supply the required geologic material. Thus, including the land requirement of the expanded and new facilities noted above, a total of 400 hectares (988 acres) of land would be required for either of these disposal groups. Final closure of the disposal facilities under modified RCRA Subtitle C barriers would require an additional 12.5 hectares (31 acres) of land, making a total land commitment of approximately 413 hectares (1,020 acres).

4.3.1.3.2 Visual Resources

Impacts on the visual environment of construction and operations of the T Plant expansion; two WRAP expansions—a CH-Mixed TRU/TRU waste facility at the CWC and an RH-Mixed TRU/TRU waste facility at WRAP; and the new CWC storage facility would be similar to those described under Alternative 2 (see Section 4.3.1.2.2). As under Alternative 2, the RPPDF would be constructed between the 200-East and 200-West Areas; however, separate IDFs would be constructed within these areas. The visual impacts of constructing the IDFs and the RPPDF and of developing Borrow Area C under this alternative are addressed below for each disposal group.

Ongoing construction, consolidation, operations, maintenance, and deactivation of new or existing facilities on Rattlesnake and Gable Mountains would also occur under this alternative. These activities would have the same effects on visual resources as previously described in Section 4.3.1.2.2.

4.3.1.3.2.1 Disposal Group 1

Although this disposal group includes an IDF in both the 200-East Area and 200-West Area, the total land area disturbed is nearly identical to the area disturbed under Alternative 2. Additionally, the area required within Borrow Area C for geologic material would be similar to that required under Alternative 2. Thus, although the placement of IDF-West on 2.4 hectares (6 acres) of undeveloped land would minimally add to the total visual impact, the overall impacts would be similar to those described for Disposal Group 1 under Alternative 2 (see Section 4.3.1.2.2.1).

4.3.1.3.2.2 Disposal Groups 2 and 3

Under Disposal Groups 2 and 3 of Waste Management Alternative 3, the land required for IDF-East, IDF-West, the RPPDF, and Borrow Area C would be nearly the same as that needed under Alternative 2. Thus, although the placement of the IDF-West on 2.4 hectares (6 acres) of undeveloped land would minimally add to the total visual impact, the overall impacts would be similar to those described for Disposal Groups 2 and 3 under Alternative 2 (see Section 4.3.1.2.2.2).

4.3.2 Infrastructure

This subsection presents the potential impacts of the Waste Management alternatives and associated disposal groups on key utility infrastructure resources, including projected activity demands for electricity, fuel, and water. Total and peak annual utility infrastructure requirements were projected for each alternative and disposal group, as well as for applicable component project phases (i.e., construction, operations, deactivation, and closure). In general, Hanford waste treatment and storage activities and commensurate utility requirements would be identical under Alternatives 2 and 3. For the three disposal groups under each action alternative, utility infrastructure demands would vary primarily in direct relation to the size, number, and required lifespan of the disposal facilities (i.e., the IDF[s] and the RPPDF) constructed, operated, and ultimately closed under each disposal scenario.

The key underlying assumptions used to project utility infrastructure demands under each of the Waste Management alternatives and disposal groups were similar to those described in Section 4.1.2 under the Tank Closure alternatives. For example, it was assumed for analysis purposes that liquid fuels are not capacity-limiting resources because supplies would be replenished from offsite sources to support each alternative and would be provided at the point of use on an as-needed basis.

Hanford's site utility infrastructure is described in Chapter 3, Section 3.2.2, and INL's site utility infrastructure is described in Section 3.3.2. Table 4–134 summarizes the projected utility infrastructure resource requirements under the Waste Management alternatives and associated disposal groups. Projected demands on key utility infrastructure resources and the impacts on the respective utility systems from implementation of each of the alternatives and disposal groups are further discussed in the following sections.

Table 4–134. Waste Management Alternatives – Summary of Utility Infrastructure Requirements

Alternatives	Activity Phase	Electricity (M megawatt-hours)	Diesel Fuel[a] (M liters)	Gasoline (M liters)	Water (M liters)
Alternative 1: No Action	Operations	0.0056	4.22	0.035	10.6
	Deactivation	0.0	9.65	1.20	25.1
	Total[b]	**0.0056**	**13.9**	**1.23**	**35.7**
	Peak (Year)	**0.00019 (2007–2035)**	**3.46 (2009)**	**0.012 (2036–2135)**	**25.5 (2009)**
Alternatives 2 and 3: Treatment and Storage[c]	Construction	0.045	10.7	5.20	61.6
	Operations	0.50	31.1	3.24	364
	Deactivation	0.0068	0.28	0.044	4.98
	Total[b]	**0.55**	**42.0**	**8.48**	**430**
	Peak (Year)	**0.018 (2011–2012)**	**2.60 (2011–2012)**	**1.01 (2011–2012)**	**23.9 (2011–2012)**
Alternative 2: Disposal Group 1[d]	Construction	0.0	26.1	0.13	191
	Operations	0.0085	91.8	2.08	2,290
	Closure	0.0	97.5	11.0	134
	Total[b]	**0.0085**	**215**	**13.2**	**2,620**
	Peak (Year)	**0.00019 (2007–2050)**	**39.0 (2051–2052)**	**3.68 (2051–2052)**	**67.0 (2051–2052)**

Table 4–134. Waste Management Alternatives – Summary of Utility Infrastructure Requirements *(continued)*

Alternatives	Activity Phase	Electricity (M megawatt-hours)	Diesel Fuel[a] (M liters)	Gasoline (M liters)	Water (M liters)
Alternative 2: Disposal Group 2[d]	Construction	0.0	101	0.49	736
	Operations	0.0085	940	31.5	19,600
	Closure	0.0	377	42.6	517
	Total[b]	**0.0085**	**1,420**	**74.6**	**20,800**
	Peak (Year)	**0.00019 (2007–2050)**	**151 (2101–2102)**	**14.2 (2101–2102)**	**259 (2101–2102)**
Alternative 2: Disposal Group 3[d]	Construction	0.0	101	0.49	736
	Operations	0.0085	1,700	57.4	35,500
	Closure	0.0	377	42.6	517
	Total[b]	**0.0085**	**2,180**	**100**	**36,800**
	Peak (Year)	**0.00019 (2007–2050)**	**151 (2166–2167)**	**14.2 (2166–2167)**	**259 (2166–2167)**
Alternative 3: Disposal Group 1[d]	Construction	0.0	26.0	0.13	190
	Operations	0.0085	91.4	2.07	2,280
	Closure	0.0	97.1	11.0	133
	Total[b]	**0.0085**	**215**	**13.2**	**2,610**
	Peak (Year)	**0.00019 (2007–2050)**	**38.9 (2051–2052)**	**3.66 (2051–2052)**	**66.7 (2051–2052)**
Alternative 3: Disposal Group 2[d]	Construction	0.0	101	0.49	737
	Operations	0.0085	937	31.5	19,500
	Closure	0.0	377	42.6	518
	Total[b]	**0.0085**	**1,410**	**74.6**	**20,700**
	Peak (Year)	**0.00019 (2007–2050)**	**149 (2101–2102)**	**14.1 (2101–2102)**	**256 (2101–2102)**
Alternative 3: Disposal Group 3[d]	Construction	0.0	101	0.49	737
	Operations	0.0085	1,700	57.3	35,300
	Closure	0.0	377	42.6	518
	Total[b]	**0.0085**	**2,170**	**100**	**36,500**
	Peak (Year)	**0.00019 (2007–2050)**	**149 (2166–2167)**	**14.1 (2166–2167)**	**256 (2166–2167)**

[a] Assumed to be inclusive of all No. 2 diesel fuel, including road diesel and heating fuel oil.

[b] Totals may not equal the sum of the contributions due to rounding.

[c] The storage and treatment components of each alternative reflect the requirements to support ongoing storage and treatment of onsite and offsite waste through facility deactivation.

[d] Disposal Groups 1 through 3 encompass waste disposal facility construction, operations, and closure activities in support of ongoing waste management activities in addition to those related to FFTF disposition and select Tank Closure alternatives as follows: (1) Disposal Group 1 supports Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, and 6C; (2) Disposal Group 2 supports Tank Closure Alternatives 2A and 6B; and (3) Disposal Group 3 supports Tank Closure Alternative 6A only.

Note: To convert liters to gallons, multiply by 0.26417. Values presented in the table have been rounded to no more than three significant digits, where appropriate.

Key: FFTF=Fast Flux Test Facility; M=million.

Source: SAIC 2010c.

4.3.2.1 Alternative 1: No Action

4.3.2.1.1 Electricity, Fuel, and Water

Ongoing waste storage, treatment, and disposal activities under Waste Management Alternative 1 would continue to represent a relatively small fraction of total Hanford utility infrastructure demands through 2035.

Under Waste Management Alternative 1, annual electrical energy demand to support ongoing waste management activities would remain relatively constant at 0.00019 million megawatt-hours through 2035 to specifically support ongoing waste disposal in trenches 31 and 34 in LLBG 218-W-5 (see Table 4–134). This demand is negligible compared with the 1.74-million-megawatt-hour annual capacity (199-megawatts load capacity) of the Hanford electric power transmission system and would also be a very small fraction (about 0.1 percent) of the 0.17 million megawatt-hours of electricity currently used annually at Hanford.

Peak annual diesel fuel consumption of 3.46 million liters (0.91 million gallons) would occur in 2009 as a result of the ongoing operations of the LLBGs coinciding with deactivation of IDF-East. Gasoline consumption associated with mobile equipment operations during the 100-year postclosure care period for the LLBGs would not peak until 2036 and is projected to remain constant at 0.012 million liters (0.003 million gallons) annually. This ongoing fuel demand would be a small fraction (about 0.3 percent) of the 4.3 million liters (1.1 million gallons) of liquid fuels currently used annually at Hanford. Water requirements would also peak in 2009 at 25.5 million liters (6.74 million gallons). This projected peak water demand would be about 0.1 percent of 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 3.1 percent of the approximately 816.6 million liters (215.7 million gallons) of water used annually at Hanford.

4.3.2.2 Alternative 2: Disposal in IDF, 200-East Area Only

4.3.2.2.1 Electricity, Fuel, and Water

In support of ongoing Hanford waste treatment and storage activities under Waste Management Alternative 2, electrical energy requirements would peak in the 2011–2012 timeframe due to construction of the T Plant expansion; two WRAP expansions—a CH-Mixed TRU/TRU waste facility at the CWC and an RH-Mixed TRU/TRU waste facility at WRAP; and the new CWC storage facility in the 200-West Area. It was assumed that construction of these facility additions would utilize existing utility tie-ins to the extent possible, although construction-related electricity demands could also be met via fuel-fired generators. Subsequent facility operations would extend to the year 2050 using existing utility systems. Nevertheless, the peak annual electrical energy demand in 2011–2012 of 0.018 million megawatt-hours (approximating an electric load of about 2.05 megawatts) would be about 1.0 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system (see Table 4–134).

Peak liquid fuel consumption under Alternative 2 would total about 3.61 million liters (0.95 million gallons) in the 2011–2012 timeframe to support expanded treatment and storage facility construction.

Peak water demands would also occur in the 2011–2012 timeframe, driven by water use for facility construction. The projected peak water demand of 23.9 million liters (6.31 million gallons) would be about 0.1 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 2.9 percent of the approximately 816.6 million liters (215.7 million gallons) of water used annually at Hanford.

4.3.2.2.1.1 Disposal Group 1

Electrical energy requirements to support disposal facility construction, operations, and closure would be relatively minimal overall (see Table 4–134). For facility construction, it was assumed that any electric power required would be produced via fuel-fired generators. Under Waste Management Alternative 2, Disposal Group 1, activities, annual electrical energy demands are expected to remain relatively constant at 0.00019 million megawatt-hours through 2050 and limited to demands to support continued disposal operations in LLBG 218-W-5, as previously discussed under Alternative 1 (see Section 4.3.2.1.1). Neither operations nor eventual closure of IDF-East or the RPPDF between the 200-East and 200-West Areas is projected to require any electric power from the Hanford electric power distribution system because any demands would be met via fuel-fired generators.

Peak annual liquid fuel consumption for Disposal Group 1 activities would total about 42.7 million liters (11.3 million gallons) in the 2051–2052 timeframe, primarily associated with mobile equipment operations to effect landfill closure of IDF-East and the RPPDF using modified RCRA Subtitle C barriers. Similar to liquid fuel requirements, peak water demands would also occur in 2051–2052, driven by water use for dust control and soil compaction associated with IDF-East and RPPDF closure activities. The projected peak water demand of 67.0 million liters (17.7 million gallons) would be about 0.4 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 8.2 percent of the approximately 816.6 million liters (215.7 million gallons) of water used annually at Hanford.

4.3.2.2.1.2 Disposal Group 2

Under Disposal Group 2, total and peak electrical energy requirements would be the same as those discussed under Alternative 2, Disposal Group 1 (see Section 4.3.2.2.1.1 above).

Total and peak liquid fuel consumption would be greater under this disposal group than under Disposal Group 1 due to the much larger RPPDF that would be constructed and the longer period of disposal operations (until 2100). Peak annual liquid fuel consumption for Disposal Group 2 activities would be about 165 million liters (43.6 million gallons) in the 2101–2102 timeframe, driven by IDF-East and RPPDF closure activities.

As for liquid fuels, peak water demands would also occur in the 2101–2102 timeframe associated with disposal facility closure activities. The projected peak annual water demand of 259 million liters (68.4 million gallons) would be about 1.4 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 32 percent of the approximately 816.6 million liters (215.7 million gallons) of water used annually at Hanford.

4.3.2.2.1.3 Disposal Group 3

Under Alternative 2, Disposal Group 3, total and peak electrical energy requirements would be the same as those discussed in Section 4.3.2.2.1.1. Otherwise, activities under this Alternative 2 disposal group would have the highest total utility resource requirements due to the longer operational timeframe (until 2165) associated with IDF-East and the RPPDF. Still, the magnitude of the peak annual demands for liquid fuels and water is projected to be the same as that discussed under Alternative 2, Disposal Group 2 (see Section 4.3.2.2.1.2 and Table 4–134), but would occur later in time. Specifically, peak annual liquid fuel consumption for Disposal Group 3 activities would be about 165 million liters (43.6 million gallons) in the 2166–2167 timeframe, driven by IDF-East and RPPDF closure activities. The peak annual water demand of 259 million liters (68.4 million gallons) would also occur in the 2166–2167 timeframe associated with disposal facility closure activities.

4.3.2.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

4.3.2.3.1 Electricity, Fuel, and Water

Activities and associated utility infrastructure demands to support ongoing Hanford waste treatment and storage activities and proposed facility expansions under Waste Management Alternative 3 would be the same as those previously described in Section 4.3.2.2.1 under Alternative 2. While the Alternative 2 disposal groups assume construction of a single IDF in the 200-East Area, two IDFs would be constructed (one in the 200-East Area and the other in the 200-West Area), operated, and ultimately closed under all Alternative 3 disposal groups. Nevertheless, RPPDF considerations and related utility impacts would generally be identical to those under the Alternative 2 disposal scenarios.

4.3.2.3.1.1 Disposal Group 1

Electrical energy requirements to support disposal facility construction, operations, and closure would be relatively minimal overall (see Table 4–134); total and peak electrical requirements under Alternative 3, Disposal Group 1, would be the same as those previously described under Alternative 2, Disposal Group 1 (see Section 4.3.2.2.1.1).

Peak annual liquid fuel consumption under Alternative 3, Disposal Group 1, activities would total about 42.6 million liters (11.3 million gallons) in the 2051–2052 timeframe, primarily associated with mobile equipment operations to effect landfill closure of the two IDFs and the RPPDF using modified RCRA Subtitle C barriers. Peak water demands would also occur in 2051–2052, driven by water use for dust control and soil compaction associated with IDF and RPPDF closure activities. The projected peak water demand of 66.7 million liters (17.6 million gallons) would be about 0.4 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 8.2 percent of the approximately 816.6 million liters (215.7 million gallons) of water used annually at Hanford.

4.3.2.3.1.2 Disposal Group 2

Electrical energy requirements to support disposal facility construction, operations, and closure would be relatively minimal overall (see Table 4–134); total and peak electrical requirements under Alternative 3, Disposal Group 2, would be the same as those previously described under Alternative 2, Disposal Group 1 (see Section 4.3.2.2.1.1).

Alternative 3, Disposal Group 2, would entail peak annual liquid fuel consumption of approximately 163 million liters (43.0 million gallons) in the 2101–2102 timeframe, based on the projection that the larger of the two IDFs, IDF-East, and the RPPDF would be closed within that timeframe. Disposal facility closure is also projected to result in peak water demands in the same timeframe. The projected peak annual water demand of 256 million liters (67.6 million gallons) would be about 1.4 percent of 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 31 percent of the approximately 816.6 million liters (215.7 million gallons) of water used annually at Hanford.

4.3.2.3.1.3 Disposal Group 3

Electrical energy requirements to support disposal facility construction, operations, and closure would be relatively minimal overall (see Table 4–134); total and peak electrical requirements under Alternative 3, Disposal Group 3, would be the same as those previously described under Alternative 2, Disposal Group 1 (see Section 4.3.2.2.1.1). Nonetheless, activities under this Alternative 3 disposal group would have the highest total utility resource requirements due to the longer operational timeframe (until 2165) associated with the two IDFs and the RPPDF. However, the magnitude of the peak annual demands for liquid fuels and water is projected to be the same as that discussed under Alternative 3, Disposal Group 2 (see Section 4.3.2.3.1.2); however, peak demands would be shifted to the 2166–2167 timeframe (see Table 4–134).

4.3.3 Noise and Vibration

Facility construction, operations, decommissioning, deactivation, and closure activities, as applicable to each alternative, would result in minor noise impacts of employee vehicles, trucks, construction equipment, generators, and other equipment compared with the Tank Closure alternatives discussed in Section 4.1.3. The offsite noise levels from activities in the 200 and 400 Areas would be negligible due to the distance to the Hanford boundary. Use of heavy diesel equipment for construction and closure activities under most of the alternatives is expected to cause the highest noise levels. For example, if 488 items of construction equipment were operating at the RPPDF during its construction with a sound pressure level of 88 dBA at 15 meters (50 feet), the contribution to the sound level at the nearest site boundary would be 21 dBA (SAIC 2010c). During a normal daytime shift, the estimated maximum sound level at the site boundary from construction equipment operation would be well below the Washington State standard daytime maximum noise level limit of 60 dBA for industrial sources impacting residential receptors (WAC 173-60). Noise levels from deactivation, construction, operations, and closure activities are expected to be less than those from this RPPDF construction activity.

Some disturbance of wildlife near the 200 Areas could occur as a result of construction-type noise during construction, operations, deactivation, and closure activities, as applicable to each alternative. Mitigation of impacts on threatened and endangered species is discussed in Section 4.3.7.

The number of employee vehicles and trucks moving materials during various phases of waste management activities would vary over the duration of the project and by alternative. The increase in the number of employee vehicle and truck trips is discussed below under each alternative.

Activities at Hanford associated with Waste Management alternatives that would involve excavation, earthmoving, transporting fill material, and other vehicle traffic through Hanford could result in ground vibration that could affect operations of LIGO. Most of the activities identified to have impacts on this facility would be activities requiring the use of heavy vehicles or large construction equipment. It is expected that blasting would also have an impact on this facility if it is required for mining. Although DOE would coordinate vibration-producing activities with LIGO, the impacts of this type of activity under the alternatives are expected to result in some interference with the operations of this facility.

4.3.3.1 Alternative 1: No Action

The increase in the number of employee vehicle and truck trips under Waste Management Alternative 1 is expected to result in an increase in traffic noise levels of less than 1 dBA along routes to the site. This increase would occur primarily during the peak traffic hours. An increase of less than 2 or 3 dBA would be barely discernible to many listeners. The highest number of employee trips is expected to occur in year 2009 due to IDF-East deactivation (SAIC 2010c). The increase in employee and truck traffic from the discussion of local traffic (see Section 4.3.9) was compared to the existing average traffic volume (see Chapter 3, Section 3.2.9.4). For the purpose of comparison between the alternatives, increases in traffic noise levels can be estimated from the ratios of the projected traffic volumes to the existing traffic volume (see Appendix F, Section F.3).

4.3.3.2 Alternative 2: Disposal in IDF, 200-East Area Only

The increase in the number of employee vehicle and truck trips under Waste Management Alternative 2 at Hanford is expected to result in an increase of less than 1 dBA in traffic noise levels along routes to the site. This increase would occur primarily during the peak traffic hours. The highest number of employee trips is expected to occur during the period from 2019–2050 due to WRAP operations. Under Disposal Groups 1 through 3, activities would result in an increase of less than 1 dBA in traffic noise levels along routes to the site. An increase of less than 2 or 3 dBA would be barely discernible to many listeners. This assessment and conclusion is similar to that previously described under Alternative 1 (see Section 4.3.3.1). The highest number of employee trips is expected to occur in various years due to closure of the RPPDF and IDF-East.

4.3.3.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

The increase in the number of employee vehicle and truck trips under Waste Management Alternative 3 at Hanford is expected to result in an increase of less than 1 dBA in traffic noise levels along routes to the site. This increase would occur primarily during the peak traffic hours. The highest number of employee trips is expected to occur from 2019 through 2050 from WRAP operations (SAIC 2010c). Under Disposal Groups 1 through 3, activities would result in an increase of less than 2 dBA in traffic noise levels along routes to the site. An increase of less than 2 or 3 dBA would be barely discernible to many listeners. This assessment and conclusion is similar to that previously described under Alternative 1 (see Section 4.3.3.1). The higher numbers of employee trips are expected to occur in various years due to RPPDF closure under Disposal Groups 2 and 3 and closure of IDF-East and the RPPDF under Disposal Group 1.

4.3.4 Air Quality

Activities under the various Waste Management alternatives would result in some air quality impacts due to air pollutant emissions from employee vehicles, trucks, and construction equipment and, as applicable under some alternatives, heating equipment, generators, and process equipment. Criteria pollutant concentrations for the activities under each alternative were modeled, and the year with peak concentrations for each alternative, pollutant, and averaging time was identified (see Appendix G). These concentrations are presented in Table 4–135, where they are compared with the ambient standards. The maximum concentrations that would result from these activities under each alternative would be below the ambient standards, except for the annual standard for concentrations of PM_{10} under Disposal Groups 2 and 3 and the 24-hour standard under Alternatives 1, 2, and 3, Disposal Groups 1, 2, and 3. Standards could be exceeded similarly for $PM_{2.5}$ under all alternatives, the 1-hour nitrogen dioxide concentrations under all alternatives, the 1-hour carbon monoxide concentration under Alternatives 2 and 3, and the 8-hour carbon monoxide and 1-hour sulfur dioxide concentrations under Alternatives 2 and 3 for Disposal Groups 2 and 3. The peak period identified under each alternative and the primary contributing activities are discussed for each alternative below. Maximum air quality impacts are expected to occur along State Route 240 or along or near the Hanford boundary. The concentration estimates for PM are high as a result of the high estimated emissions. PM concentrations would be reduced by applying appropriate dust control measures (see Chapter 7, Section 7.1).

Construction activities considered in estimating PM emissions included general construction equipment activity, windblown particulates from disturbed areas, resuspension of road dust, and fuel combustion in construction equipment.

As described in Section 4.1.4, the emissions calculations resulted in a substantial overestimate of PM_{10} and $PM_{2.5}$ emissions. A refined analysis of emissions, based on more-detailed engineering of the construction activities and application of appropriate control technologies, is expected to result in substantially lower estimates of emissions and ambient concentrations from major construction activities under any of the alternatives.

Table 4–135. Waste Management Alternatives – Maximum Incremental Criteria Pollutant Concentrations at the Hanford Site

Pollutant and Averaging Period	Standard[a] (micrograms per cubic meter)	Maximum Modeled Increment (micrograms per cubic meter)								
			Alternative 2				Alternative 3			
		Alternative 1	T&S	DG1	DG2	DG3	T&S	DG1	DG2	DG3
Carbon Monoxide										
8-hour	10,000[b]	72.6	2,240	7,880	**41,200**	**41,200**	2,240	8,030	**41,000**	**41,000**
1-hour	40,000[b]	462	12,200	**49,800**	**257,000**	**257,000**	12,200	**50,300**	**256,000**	**256,000**
Nitrogen Dioxide										
Annual	100[b]	1.35	3.85	19.3	88.9	88.9	3.85	19.4	88.4	88.4
1-hour	188[c]	**2,020**	**6,940**	**34,600**	**179,000**	**179,000**	**6,940**	**35,000**	**178,000**	**178,000**
PM_{10}[d]										
Annual	50[e]	4.86	4.36	27.2	**124**	**124**	5.08	27.3	**124**	**124**
24-hour	150[b]	**507**	**717**	**3,360**	**17,200**	**17,200**	**717**	**3,420**	**17,300**	**17,300**
$PM_{2.5}$[d]										
Annual	15[d]	4.86	4.36	**27.2**	**124**	**124**	5.08	**27.3**	**124**	**124**
24-hour	35[d]	**507**	**717**	**3,360**	**17,200**	**17,200**	**717**	**3,420**	**17,300**	**17,300**
Sulfur Dioxide										
Annual	50[e]	0.000482	0.00915	0.0382	0.176	0.176	0.00915	0.0384	0.175	0.175
24-hour	260[e]	0.0494	1.29	4.70	24.5	24.5	1.29	4.78	24.4	24.4
3-hour	1,300[b]	0.26	6.36	23.7	120	120	6.36	24.0	120	120
1-hour	197[c]	0.723	16.5	68.4	**353**	**353**	16.5	69.2	**352**	**352**

[a] The more stringent of the Federal and Washington State standards is presented if both exist for the averaging period. The NAAQS (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on annual averages, would not be exceeded more than once per year. The 24-hour PM_{10} standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The annual $PM_{2.5}$ standard is met when the 3-year average of the annual means is less than or equal to the standard. The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the 98th percentile 24-hour averages is less than or equal to the standard. The 1-hour nitrogen dioxide standard is met when the 3-year average 98th percentile of the daily maximum 1-hour average does not exceed the standard value.

[b] Federal and Washington State standard.

[c] Federal standard.

[d] The Federal standards for $PM_{2.5}$ are 15 micrograms per cubic meter annual average and 35 micrograms per cubic meter 24-hour average. No specific data for $PM_{2.5}$ were available, but for analysis purposes, concentrations were assumed to be the same as PM_{10}.

[e] Washington State standard.

Note: NAAQS also includes standards for lead and ozone. No sources of lead emissions have been identified for the alternatives evaluated. Washington State also has ambient standards for fluorides. Concentrations in **bold** text indicate potential exceedance of the standard.

Key: DG=Disposal Group; NAAQS=National Ambient Air Quality Standards; PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; T&S=treatment and storage.

Source: Appendix G, Section G.3.

The sulfur dioxide emission factor used for fuel-burning sources was based on equipment burning a distillate fuel with a sulfur content of about 0.0015 percent (15 ppm), which is being phased in beginning in 2007. No adjustment was made for more-restrictive emission standards for nitrogen dioxide and PM, which were scheduled to be phased in beginning in 2007. In future years, pollutant emissions and impacts are expected to be smaller than estimated in this analysis, as better fuels, combustion technologies, emission controls, and alternative energy sources are developed.

The contributions to the total ambient concentrations from sources in the region and existing and reasonably anticipated sources at Hanford that are unrelated to waste management activities are expected to change over the period of the activities evaluated in this EIS and are addressed in the cumulative impacts section. The existing contributions of Hanford sources and regional monitored concentrations are discussed in Chapter 3, Section 3.2.4.

The Clean Air Act, as amended, requires Federal actions to conform to the host state's "state implementation plan" (see Appendix G, Section G.4). The final rule, "Determining Conformity of General Federal Actions to State or Federal Implementation Plans," requires a conformity determination for certain-size projects in nonattainment areas. Hanford is within an area currently designated as in attainment for criteria air pollutants. Therefore, a conformity determination for these alternatives is not necessary to meet the requirements of the final rule (40 CFR 93, Subpart B).

Both carcinogenic and noncarcinogenic toxic pollutant concentrations were evaluated. The exposure of members of the public to airborne pollutants would result from process emissions released during operations and from equipment used during construction and operations. Selected air toxics were modeled because they represent toxic constituents associated with emissions from operation of gasoline- and diesel-fueled equipment. Maximum concentrations for each alternative and the Washington State acceptable source impact levels are presented in Table 4–136. These concentrations were below the acceptable source impact levels for all alternatives. The acceptable source impact levels are used by the state in the permitting process and represent concentrations that are sufficiently low to protect human health and safety from potential carcinogenic and other toxic effects (WAC 173-460).

Table 4–136. Waste Management Alternatives – Maximum Incremental Toxic Chemical Concentrations at the Hanford Site

Pollutant	Averaging Period	Acceptable Source Impact Level[a] (micrograms per cubic meter)	Maximum Modeled Increment (micrograms per cubic meter)								
			Alternative 1	Alternative 2				Alternative 3			
				T&S	DG1	DG2	DG3	T&S	DG1	DG2	DG3
Ammonia	24-hour	70.8	0.216	0.874	3.84	20.0	20.0	0.874	3.91	19.9	19.9
Benzene	Annual	0.0345	0.000288	0.00128	0.00701	0.0323	0.0323	0.00128	0.00704	0.0321	0.0321
1,3-Butadiene	Annual	0.00588	0.000012	0.000067	0.000183	0.000842	0.000842	0.000067	0.000184	0.000837	0.000837
Formaldehyde	Annual	0.167	0.000362	0.00247	0.00603	0.0278	0.0278	0.00247	0.00606	0.0276	0.0276
Mercury	24-hour	0.09	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Toluene	24-hour	5,000	0.0265	1.84	6.00	31.2	31.2	1.84	6.1	31.1	31.1
Xylene	24-hour	(b)	0.00999	0.526	1.78	9.27	9.27	0.526	1.81	9.23	9.23

[a] WAC 173-460. Acceptable source impact levels were updated in this environmental impact statement.
[b] Not listed in WAC 173-460.

Key: DG=Disposal Group; T&S=treatment and storage.

Source: Appendix G, Section G.3.

For noninvolved workers at nearby facilities, the highest annual concentration of each toxic chemical was used to estimate the Hazard Quotient for each chemical, as described in Appendix G. The Hazard Quotients were summed to give the Hazard Index from noncarcinogenic chemicals associated with the alternative. A Hazard Index of less than 1 indicates that adverse health effects of non-cancer-causing agents are not expected. Hazard Indices for each alternative are summarized in Table 4–137. For carcinogens, the highest annual concentration was used to estimate the increased cancer risk from a chemical. Cancer risks from nonradioactive toxic pollutant emissions under each alternative are summarized in Table 4–138.

Table 4–137. Waste Management Alternatives – Nonradioactive Airborne Toxic Chemical Hazard Index for the Nearest Noninvolved Worker at the Hanford Site

Chemical	Hazard Quotient								
		Alternative 2				Alternative 3			
	Alternative 1	T&S	DG1	DG2	DG3	T&S	DG1	DG2	DG3
Ammonia	1.17×10^{-3}	2.32×10^{-3}	1.81×10^{-2}	7.13×10^{-2}	7.13×10^{-2}	2.32×10^{-3}	1.78×10^{-2}	7.11×10^{-2}	7.11×10^{-2}
Mercury	0	0	0	0	0	0	0	0	0
Toluene	3.03×10^{-6}	9.42×10^{-5}	4.63×10^{-4}	1.82×10^{-3}	1.82×10^{-3}	9.42×10^{-5}	4.52×10^{-4}	1.82×10^{-3}	1.82×10^{-3}
Xylene	7.13×10^{-5}	1.37×10^{-3}	6.95×10^{-3}	2.74×10^{-2}	2.74×10^{-2}	1.37×10^{-3}	6.80×10^{-3}	2.73×10^{-2}	2.73×10^{-2}
Hazard Index	1.24×10^{-3}	3.79×10^{-3}	2.55×10^{-2}	1.01×10^{-1}	1.01×10^{-1}	3.79×10^{-3}	2.50×10^{-2}	1.00×10^{-1}	1.00×10^{-1}

Key: DG=Disposal Group; T&S=treatment and storage.
Source: Appendix G, Section G.3.

Table 4–138. Waste Management Alternatives – Nonradioactive Airborne Toxic Chemical Cancer Risk for the Nearest Noninvolved Worker at the Hanford Site

Chemical	Alternative 1	Alternative 2				Alternative 3			
		T&S	DG1	DG2	DG3	T&S	DG1	DG2	DG3
Benzene	1.26×10^{-7}	4.14×10^{-7}	2.93×10^{-6}	1.16×10^{-5}	1.16×10^{-5}	4.14×10^{-7}	2.87×10^{-6}	1.15×10^{-5}	1.15×10^{-5}
1,3-Butadiene	1.98×10^{-8}	5.44×10^{-8}	3.16×10^{-7}	1.24×10^{-6}	1.24×10^{-6}	5.44×10^{-8}	3.10×10^{-7}	1.24×10^{-6}	1.24×10^{-6}
Formaldehyde	2.60×10^{-7}	8.83×10^{-7}	4.44×10^{-6}	1.75×10^{-5}	1.75×10^{-5}	8.83×10^{-7}	4.36×10^{-6}	1.75×10^{-5}	1.75×10^{-5}

Key: DG=Disposal Group; T&S=treatment and storage.
Source: Appendix G, Section G.3.

4.3.4.1 Alternative 1: No Action

Criteria pollutant concentrations from activities under Waste Management Alternative 1 are presented in Table 4–135. The peak concentrations occur in 2009 for all criteria pollutants. The peak period concentration would result primarily from IDF deactivation activities. PM_{10} would exceed the 24-hour standard in 2009. $PM_{2.5}$ concentrations would exceed the 24-hour emissions standard periodically from 2007 through 2035. Figure 4–30 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities.

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–136. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–137 and 4–138.

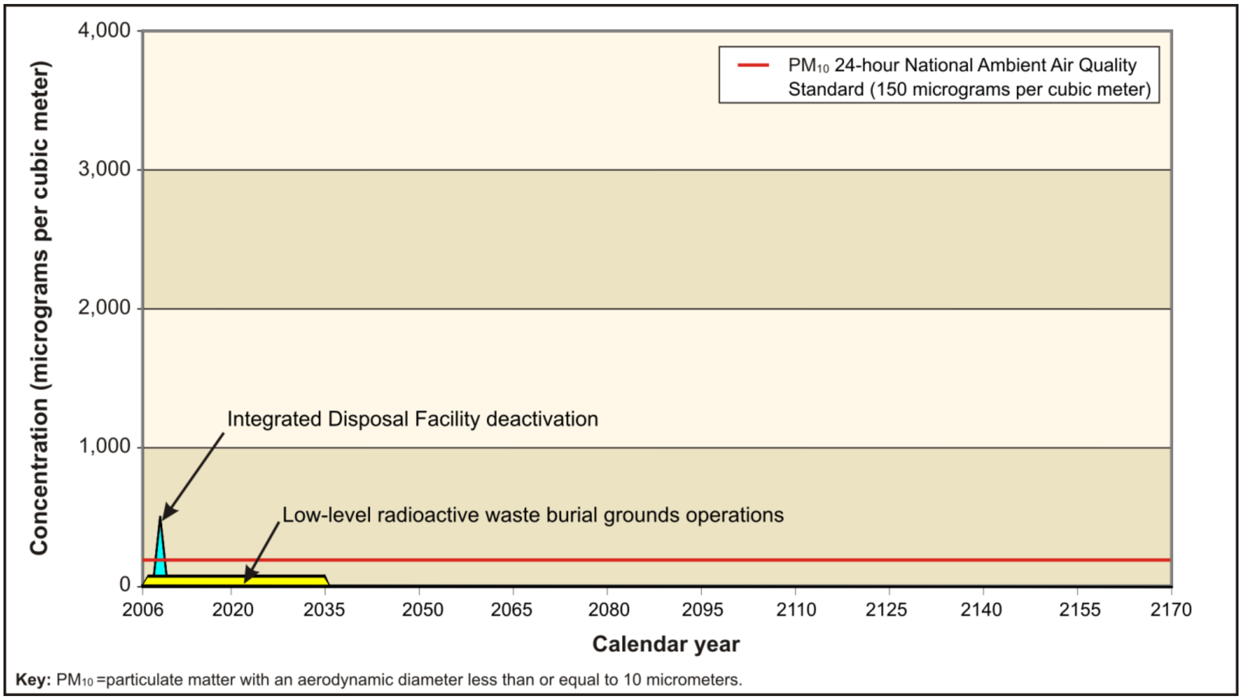
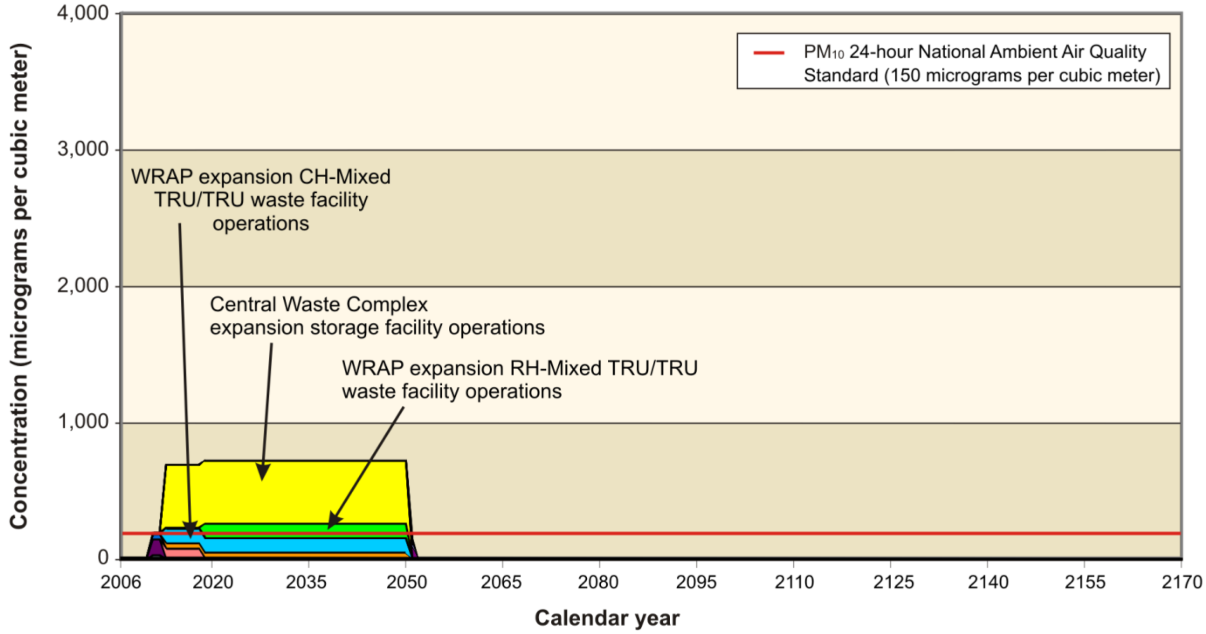


Figure 4–30. Waste Management Alternative 1 PM_{10} Maximum 24-Hour Concentration

4.3.4.2 Alternative 2: Disposal in IDF, 200-East Area Only

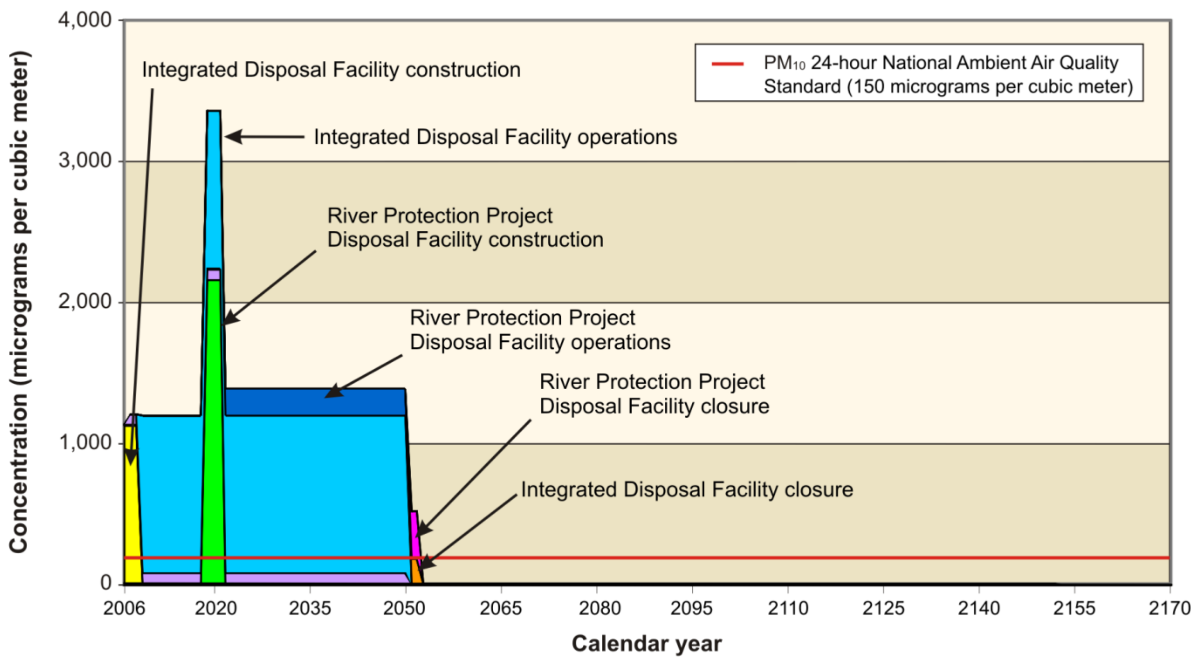
Criteria pollutant concentrations from activities under Waste Management Alternative 2, including treatment and storage and activities related to the three disposal groups, are presented in Table 4–135. Peak concentrations of carbon monoxide and sulfur dioxide would occur from 2011 through 2012. Peak concentrations of nitrogen oxide would occur from 2013 through 2018. Peak concentrations of PM would occur from 2019 through 2050. These peak period concentrations under Waste Management Alternative 2 would result primarily from the WRAP CH-Mixed TRU/TRU waste facility at CWC and CWC storage facility construction (for carbon monoxide and sulfur dioxide); from T Plant complex operations (for nitrogen dioxide); and from CWC storage facility, WRAP CH-Mixed TRU/TRU waste facility, and WRAP RH-Mixed TRU/TRU waste facility operations (for PM). PM_{10} concentrations would exceed the 24-hour ambient concentration standard from 2011 through 2050. $PM_{2.5}$ concentrations would exceed the 24-hour standard from 2011 through 2051. Figure 4–31 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities.

Under Disposal Group 1, the peak concentrations of carbon monoxide, nitrogen dioxide, and sulfur dioxide would occur from 2051 through 2052. Peak concentrations of PM would occur from 2019 through 2021. These peak period concentrations under Waste Management Alternative 2, Disposal Group 1, would result primarily from IDF-East and RPPDF closure (for carbon monoxide, nitrogen dioxide, and sulfur dioxide) and from RPPDF construction and IDF-East operations (for PM). PM_{10} and $PM_{2.5}$ concentrations would exceed the 24-hour ambient concentration standard from 2006 through 2052. Figure 4–32 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities.



Key: CH=contact-handled; PM_{10} =particulate matter with an aerodynamic diameter less than or equal to 10 micrometers; RH=remote-handled; TRU=transuranic; WRAP=Waste Receiving and Processing Facility.

Figure 4–31. Waste Management Alternative 2 (Treatment and Storage) PM_{10} Maximum 24-Hour Concentration



Key: PM_{10} =particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.

Figure 4–32. Waste Management Alternative 2, Disposal Group 1, PM_{10} Maximum 24-Hour Concentration

For Disposal Group 2, peak concentrations of carbon monoxide, nitrogen dioxide, and sulfur dioxide would occur from 2101 through 2102. Peak concentrations of PM would occur from 2019 through 2021. These peak period concentrations would result primarily from RPPDF and IDF-East closure (for carbon monoxide, nitrogen dioxide, and sulfur dioxide [annual averages]), and from RPPDF construction (for PM). PM_{10} and $PM_{2.5}$ concentrations would exceed the 24-hour ambient concentration standard from 2006 through 2102. Figure 4–33 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities.

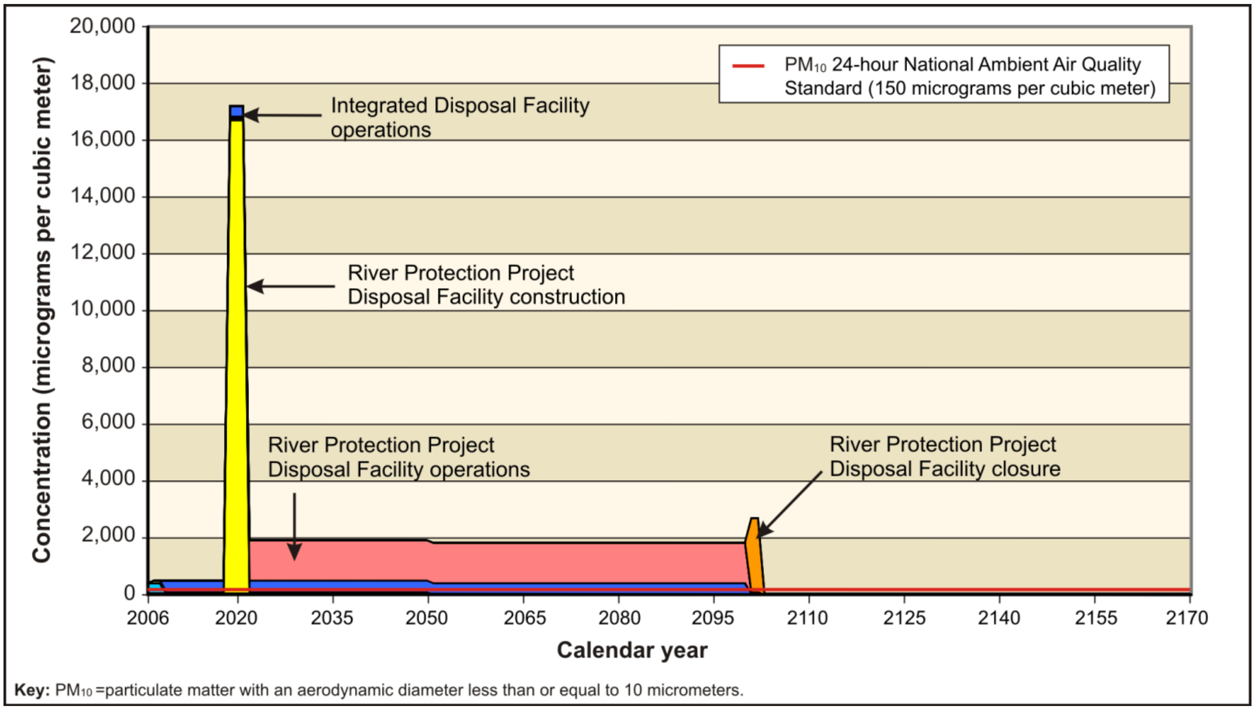


Figure 4–33. Waste Management Alternative 2, Disposal Group 2, PM_{10} Maximum 24-Hour Concentration

For Disposal Group 3, peak concentrations of carbon monoxide, nitrogen dioxide, and sulfur dioxide would occur from 2166 through 2167. Peak concentrations of PM would occur from 2019 through 2021. These peak concentrations would result from the same activities as discussed under Disposal Group 2. PM_{10} and $PM_{2.5}$ concentrations would exceed the 24-hour ambient concentration standard from 2006 through 2167. Figure 4–34 shows the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities.

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–136. The guidelines would not be exceeded. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–137 and 4–138.

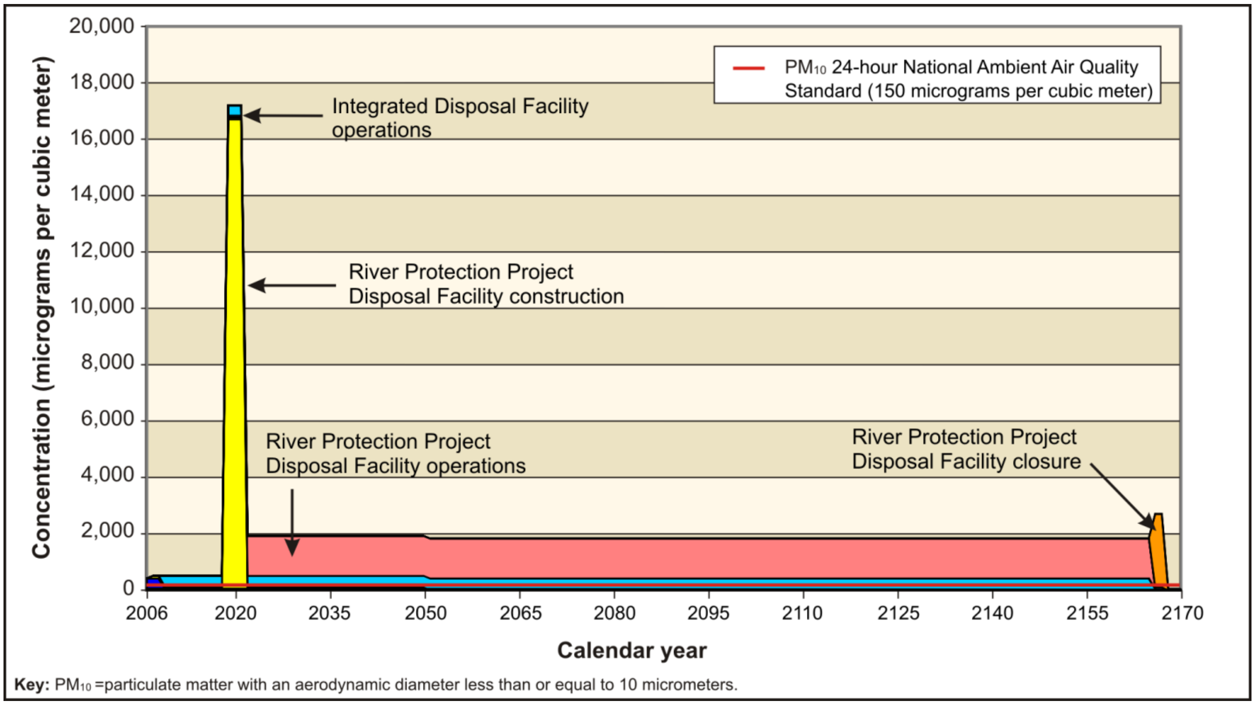


Figure 4–34. Waste Management Alternative 2, Disposal Group 3, PM_{10} Maximum 24-Hour Concentration

4.3.4.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

Criteria pollutant concentrations from activities under Waste Management Alternative 3 and activities related to the three disposal groups are presented in Table 4–135. The peak concentrations occur in the same years and arise from the same activities as discussed under Waste Management Alternative 2, Disposal Groups 2 and 3. PM_{10} concentrations would exceed the 24-hour ambient concentration standard for the same durations described under Alternative 2 and the three disposal groups. Figures 4–35 through 4–38 show the 24-hour PM_{10} concentrations over the project duration and the contribution of major activities.

Under Disposal Group 1, peak concentrations of carbon monoxide, nitrogen dioxide, and sulfur dioxide would occur from 2051 through 2052. Peak concentrations of PM would occur from 2019 through 2021. The peak period concentrations under Disposal Group 1 would result primarily from RPPDF, IDF-East, and IDF-West closure (for carbon monoxide, nitrogen dioxide, and sulfur dioxide) and from RPPDF construction and IDF-East operations (for PM).

Maximum concentrations of carcinogenic and noncarcinogenic toxic pollutants are presented in Table 4–136. The guidelines would not be exceeded. Hazardous chemical health effects on noninvolved workers are summarized in Tables 4–137 and 4–138.

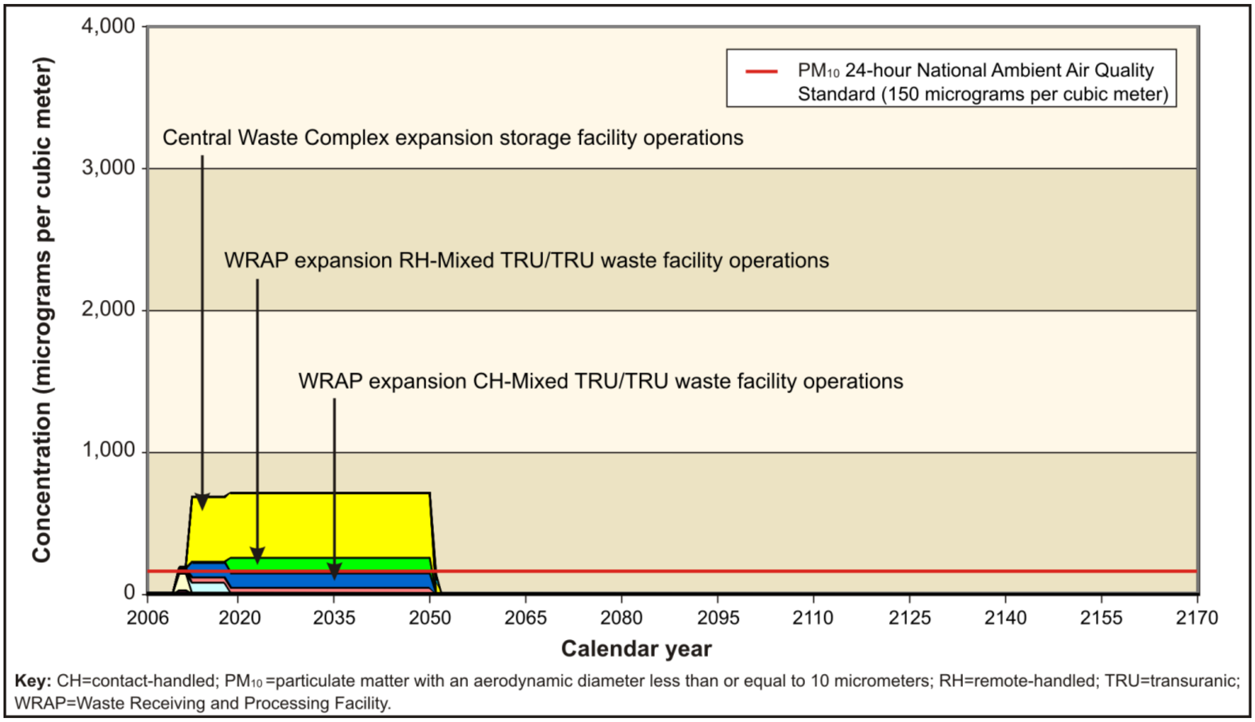


Figure 4–35. Waste Management Alternative 3 (Treatment and Storage) PM_{10} Maximum 24-Hour Concentration

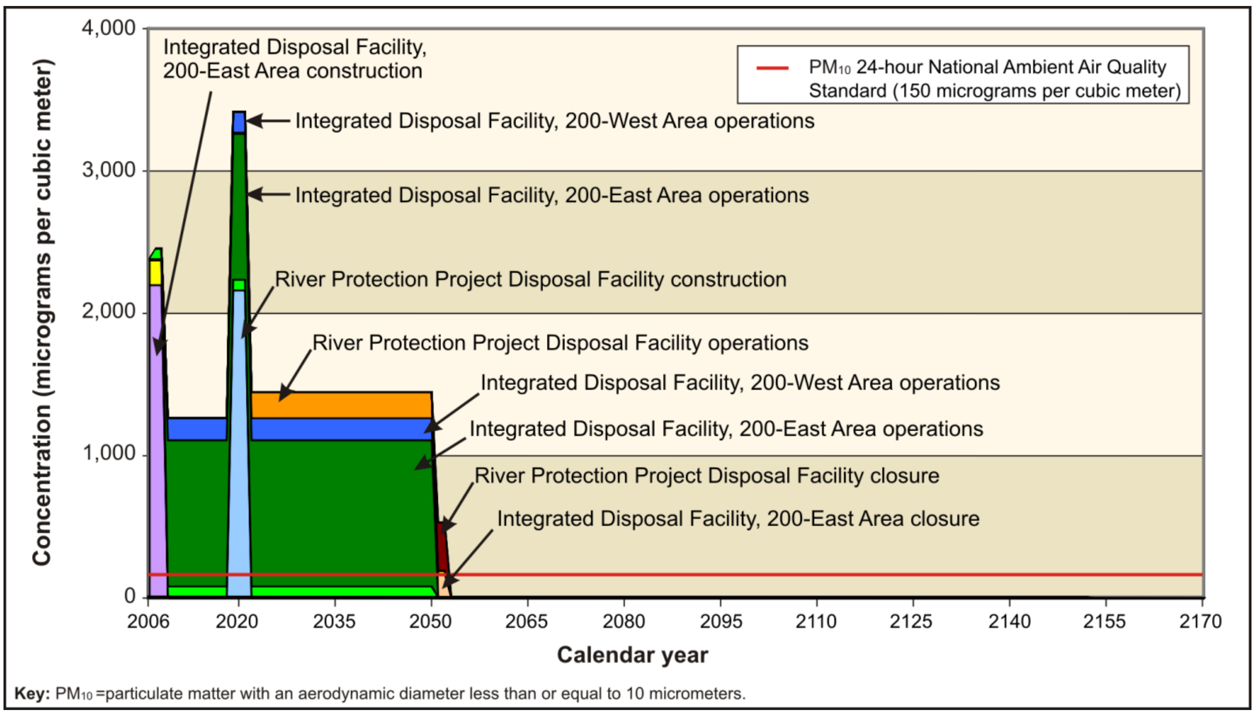


Figure 4–36. Waste Management Alternative 3, Disposal Group 1, PM_{10} Maximum 24-Hour Concentration

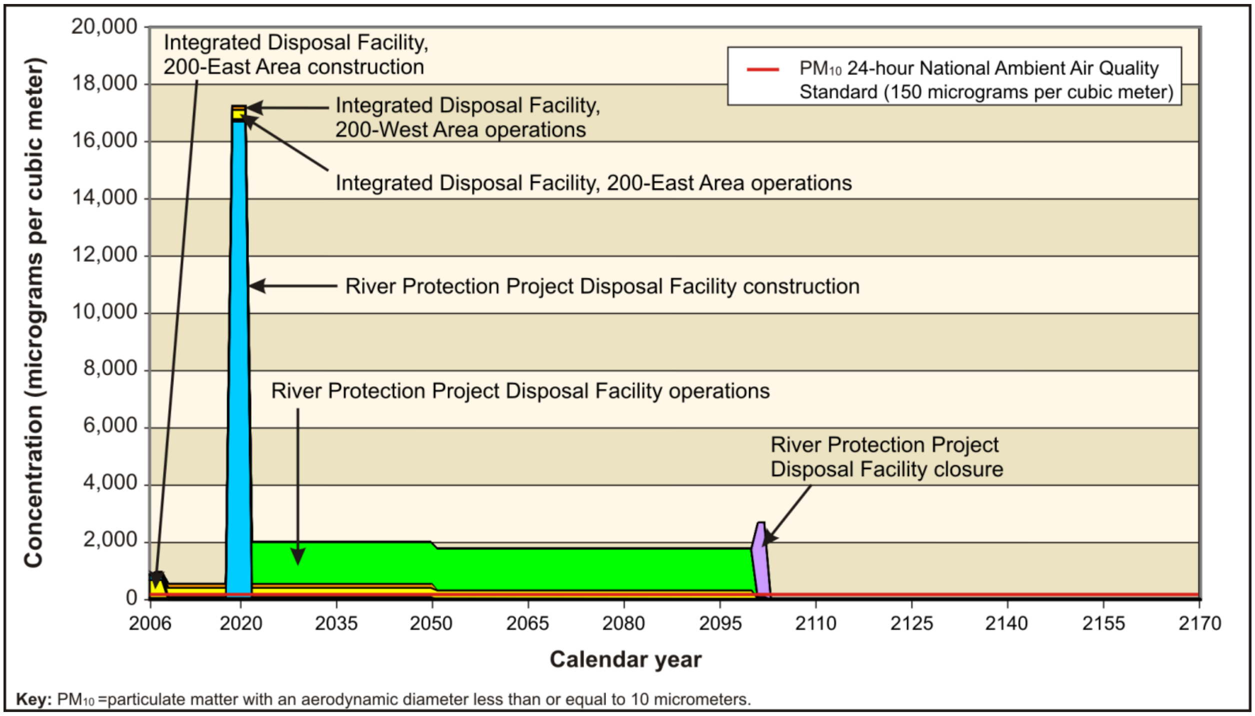


Figure 4–37. Waste Management Alternative 3, Disposal Group 2, PM_{10} Maximum 24-Hour Concentration

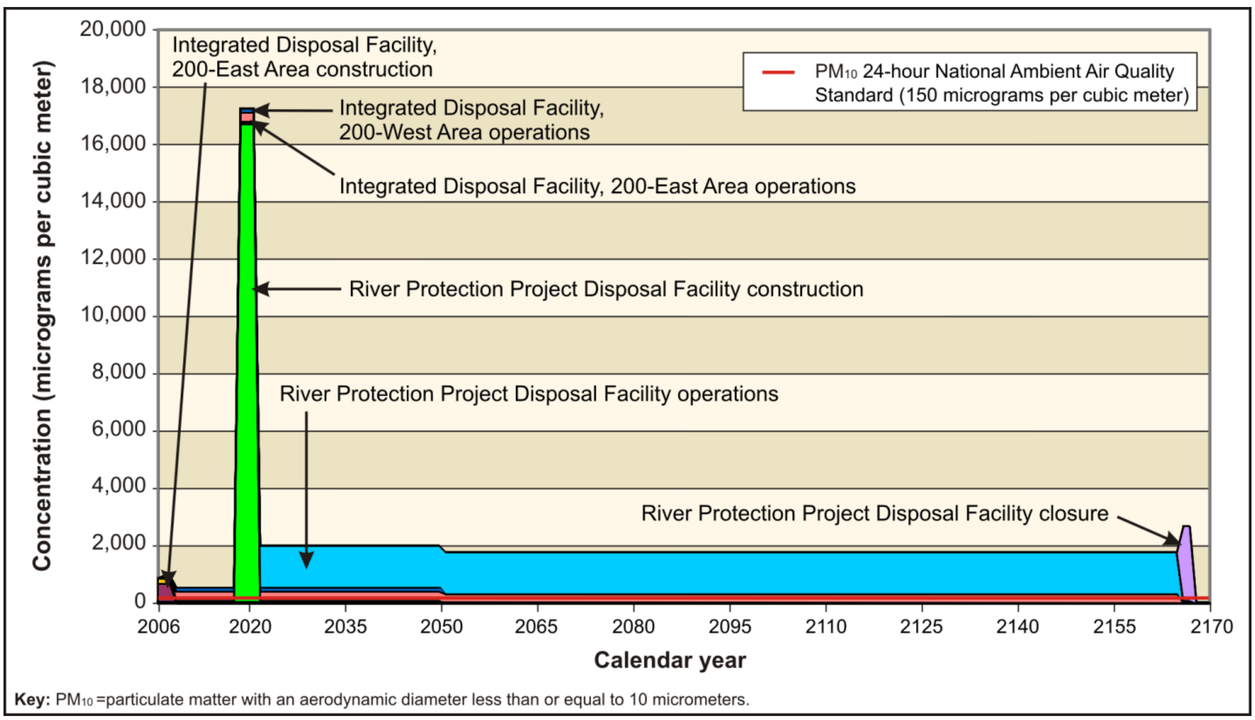


Figure 4–38. Waste Management Alternative 3, Disposal Group 3, PM_{10} Maximum 24-Hour Concentration

4.3.5 Geology and Soils

Impacts on geology and soils would generally be directly proportional to the total area of land disturbed by facility construction, as well as operations, deactivation, and closure activities associated with waste treatment, storage, and disposal. Consumption of geologic resources, including rock, mineral, and soil resources, would constitute the major indirect impact on geologic and soil resources, as summarized in Table 4–139 for each of the Waste Management alternatives and disposal groups. In general, Hanford waste treatment and storage activities and commensurate geologic resource requirements would be identical under Alternatives 2 and 3. For the three disposal groups under each action alternative, direct impacts on geology and soils and associated demand for geologic resources would vary primarily in direct relation to the size, number, and required lifespan of the disposal facilities (i.e., the IDF[s] and the RPPDF) that would be constructed, operated, and ultimately closed under each disposal scenario. For disposal facility operations, it was assumed that uncontaminated soils and sediments excavated during facility construction would typically be stockpiled on site for backfill or other uses. The other key underlying assumptions used to analyze the potential environmental impacts on geology and soils and the acquisition and use of geologic resources were similar to those described in Section 4.1.5 under the Tank Closure alternatives.

4.3.5.1 Alternative 1: No Action

Interim waste treatment, storage, and disposal activities under Alternative 1 would have little additional direct impact on geology and soils. No new facilities would be constructed or expanded under Alternative 1, although geologic resources would continue to be consumed in support of waste disposal operations in trenches 31 and 34 in LLBG 218-W-5 through 2035. Waste disposal operations there would consist partly of in-trench stabilization (encasement) of waste with concrete grout. Earthwork and ground disturbance would be required in association with deactivating IDF-East, which would occur in 2009 under the No Action Alternative. Entombment and ground disturbance would consist of backfilling the facility with previously excavated material. Following the cessation of waste disposal in LLBG 218-W-5 and filling it to grade with soil, the facility would be subject to a 100-year postclosure care period, but would not undergo closure. In support of postclosure care, sodium bentonite clay or grout would be required for completion of groundwater monitoring wells. Total geologic resource requirements under Alternative 1 are projected to be 6,230 cubic meters (8,150 cubic yards) (see Table 4–139). It is expected that this volume would be supplied by Borrow Area C, as further described in Section 4.1.5.

Hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions with the potential to affect Hanford facilities are summarized in Chapter 3, Section 3.2.5.1.4. Maximum considered earthquake ground motions for Hanford encompass those that may cause substantial structural damage to buildings (equivalent to an MMI of VII and up), thus presenting safety concerns for occupants. Ground shaking of MMI VII associated with postulated earthquakes is possible and is supported by the historical record for the region. However, this level of ground motion is expected to primarily affect the integrity of inadequately designed or nonreinforced structures (see Appendix F, Table F–7). DOE Order 420.1B requires nuclear and nonnuclear facilities to be designed, constructed, and operated so that the public, workers, and environment are protected from adverse impacts of natural phenomena hazards, including earthquakes. The order stipulates natural phenomena hazards mitigation for DOE facilities and specifically provides for reevaluation and upgrade of existing DOE facilities when there is a significant degradation in the safety basis for the facility. DOE Standard 1020-2002 implements DOE Order 420.1B and provides criteria for the design of new structures, systems, and components, as well as the evaluation, modification, and upgrade of existing structures, systems, and components, so that DOE facilities can safely withstand the effects of natural phenomena hazards, such as earthquakes. Analyses of the potential effects of a beyond-design-basis earthquake on existing facilities and activities under this alternative and the potential consequences for human health and the environment are provided in Section 4.3.11.1.

Table 4–139. Waste Management Alternatives – Summary of Major Geologic and Soil Resource Impact Indicators and Requirements

Parameter and Resource	Alternatives and Disposal Groups							
	Alternative 1: No Action	**Alternatives 2 and 3: Treatment and Storage**	**Alternative 2: Disposal Group 1**	**Alternative 2: Disposal Group 2**	**Alternative 2: Disposal Group 3**	**Alternative 3: Disposal Group 1**	**Alternative 3: Disposal Group 2**	**Alternative 3: Disposal Group 3**
New, permanent land disturbance[a]	0.0	2.7	108	409	409	117	413	413
Construction and Operations Materials								
Concrete	5,540	9,840	8,410	8,410	8,410	8,410	8,410	8,410
Cement[b]	1,370	2,000	2,090	2,090	2,090	2,090	2,090	2,090
Sand[b]	2,690	4,480	4,080	4,080	4,080	4,080	4,080	4,080
Gravel[b]	3,510	6,150	5,320	5,320	5,320	5,320	5,320	5,320
Other Borrow Materials[c]								
Sand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gravel	34.4	0.0	209,000	808,000	808,000	208,000	809,000	809,000
Soil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Closure-Specific Materials								
Grout[d]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sand[e]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Barrier materials[f]	0.0	0.0	1,760,000	6,800,000	6,800,000	1,540,000	6,730,000	6,730,000
Total[g]	**6,230**	**10,600**	**1,980,000**	**7,610,000**	**7,610,000**	**1,760,000**	**7,550,000**	**7,550,000**

[a] Reflects land area assumed to be permanently disturbed for new facilities. The value also includes land area excavated from Borrow Area C or elsewhere to supply geologic materials listed in the table.

[b] Component of concrete.

[c] Resources for miscellaneous uses not exclusively tied to facility construction, operations, or closure, such as site grading and backfill for excavations.

[d] Grout comprises cement, sand, fly ash, and other materials.

[e] Principal component of grout that would be obtained from onsite deposits.

[f] Volume includes soil, sand, gravel, rock, and asphalt for construction of modified Resource Conservation and Recovery Act Subtitle C barriers.

[g] Excludes concrete, cement, and grout. Totals may not equal the sum of the contributions due to rounding.

Note: All values are expressed in cubic meters except land disturbance, which is in hectares. To convert cubic meters to cubic yards, multiply by 1.308; hectares to acres, by 2.471. Values presented in the table have been rounded to no more than three significant digits, where appropriate.

Source: SAIC 2010c.

4.3.5.2 Alternative 2: Disposal in IDF, 200-East Area Only

Under this Waste Management alternative, ongoing Hanford waste treatment and storage would have limited, but direct, impacts on site geology and soils. Impacts would primarily be associated with construction of new facilities or existing-facility expansions, including a T Plant expansion, storage facility, and two expansions of WRAP: (1) a CH-Mixed TRU/TRU waste facility at the CWC, and (2) an RH-Mixed TRU/TRU waste facility at WRAP. Construction activities would permanently disturb about 2.7 hectares (6.6 acres) of land in the 200-West Area. In addition, a small area of Borrow Area C would be excavated to support this construction. Although the expanded facilities would generally be constructed at grade with concrete slab foundations, excavation to depths of up to 3 meters (10 feet) may be necessary, especially for reinforced concrete floor and wall construction for below-grade service areas. Nevertheless, the expansions would have little impact on the lateral and vertical extent of the Hanford formation, which composes the uppermost strata across the 200 Areas.

Although the 200-West Area has previously been disturbed and native soils may have been altered by fill placement, denuded surface soils and unconsolidated sediments in excavations would be subject to wind and water erosion if left exposed over an extended period of time. Adherence to standard best management practices for soil erosion and sediment control during construction would minimize soil erosion and loss. To reduce the risk of exposing contaminated soils, areas in which new facilities would be constructed under this alternative would be surveyed prior to any ground disturbance. Any contamination would be remediated as necessary. After construction, the previously disturbed areas would not be subject to long-term soil erosion. Operations and eventual deactivation of the expanded treatment and storage facilities are not expected to have any direct impact on geology and soils.

Geologic resources, mainly consisting of aggregate (sand and gravel) and cement for concrete work, would be required for expanded treatment and storage facility construction. Total geologic resource requirements under Alternative 2 are projected to be 10,600 cubic meters (13,900 cubic yards) (see Table 4–139). It is expected that this volume would be supplied by Borrow Area C, as stated above and further described in Section 4.1.5.

As described in Section 4.3.5.1, hazards from large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions with the potential to affect Hanford facilities were evaluated. As stated in DOE Order 420.1B, DOE requires nuclear and nonnuclear facilities to be designed, constructed, and operated so that the public, workers, and environment are protected from adverse impacts of natural phenomena hazards, including earthquakes. DOE Standard 1020-2002 implements DOE Order 420.1B and provides criteria for the design of new structures, systems, and components, as well as for the evaluation, modification, and upgrade of existing structures, systems, and components, so that DOE facilities can safely withstand the effects of natural phenomena hazards, such as earthquakes. Analyses of the potential effects of a beyond-design-basis earthquake affecting the expanded facilities and related activities and the potential consequences on human health and the environment are provided in Section 4.3.11.2.1.

4.3.5.2.1 Disposal Group 1

Excavation work associated with constructing an expanded IDF-East and the RPPDF between the 200-East and 200-West Areas would constitute the major direct impact on geology and soils under this alternative. Construction of IDF-East and the RPPDF would require excavation to a depth of approximately 14 meters (45 feet) (see Appendix E, Sections E.3.4 and E.3.5). Blasting should not be required to support construction of these facilities because the gravel, sand, and silt deposits of the Hanford formation, which compose the uppermost strata across the 200 Areas, are up to 65 meters (213 feet) thick across the 200 Areas. Coarse aggregate (gravel) would be used to construct drainage layers that are integral to each engineered disposal facility. Completed facilities would occupy about 62.3 hectares (154 acres) of land. An additional 41.7 hectares (103 acres) would also be excavated from Borrow Area C, for a total of 104 hectares (257 acres) of new, permanent land disturbance. At the end of their life cycles, the facilities would be closed with an engineered barrier that would extend over an additional 1.6 hectares (4 acres) of previously disturbed land, as further described below. As with any ground-disturbing activity, denuded surface soils and unconsolidated sediments in excavations and graded areas would be subject to wind and water erosion if left exposed over an extended period of time. Adherence to standard best management practices for soil erosion and sediment control during construction would minimize soil erosion and loss. During the 3-year construction period for each of the facilities, temporary seeding, mulching, and the use of geotextile covers and similar best management practices would be employed to minimize soil erosion in disturbed areas. After construction, the previously disturbed areas would not be subject to long-term soil erosion because the areas would either lie within the footprint of the completed structures or the temporarily disturbed areas would be revegetated.

Disposal facility operations through 2050 under this disposal scenario, including the continued operation of LLBG 218-W-5, are not expected to have any additional direct impact on geology and soils. Operations of IDF-East and the RPPDF would require the use of soil to cover each layer of emplaced waste. However, the soil would be derived from stockpiles excavated during facility construction. Similarly, disposal operations in trenches 31 and 34 in LLBG 218-W-5 would require the consumption of cement and aggregate (sand and gravel) to produce concrete for in-trench stabilization (encasement) of waste, until filled. Previously excavated soil also would be used for operational cover of emplaced waste until the trenches can be filled. Once filled, the LLBG 218-W-5 trenches would be backfilled with soil to grade to complete deactivation.

Following completion of disposal activities in IDF-East and the RPPDF, these engineered facilities would be closed with a modified RCRA Subtitle C barrier. The 2.7-meter-thick (9-foot-thick) engineered barrier would be composed of layers of topsoil in the upper part, which would support a mixed perennial grass ground cover, underlain by layers of sand, gravel, asphalt, and/or riprap in the lower part. Best management practices for soil erosion and sediment control would be employed during barrier construction, including watering to control fugitive dust. The final barriers would encompass approximately 63.9 hectares (158 acres), slightly larger than the footprints of the disposal facilities (see Section 4.3.1.2.1.1). During the 100-year postclosure care period for IDF-East and the RPPDF, sodium bentonite clay or grout would be required for completion of groundwater monitoring wells.

Alternative 2, Disposal Group 1, activities would not preclude the use of rare or otherwise valuable geologic or soil resources. The surficial soils, unconsolidated strata, and underlying basaltic bedrock of the 200 Areas are present elsewhere, both in the region and at Hanford. However, as described, relatively large quantities of geologic resources would be required to support facility construction and, more substantially, to construct engineered barriers to effect final landfill closure of IDF-East and the RPPDF. Total geologic resource requirements under Alternative 2, Disposal Group 1, are projected to be 1,980,000 cubic meters (2,590,000 cubic yards) (see Table 4–139). It is expected that this volume would be supplied by Borrow Area C, as stated above and further described in Section 4.1.5.

Design consideration of hazards associated with large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions that could potentially affect new and existing facilities under this alternative case would be substantially the same as those described in Section 4.3.5.2. Analyses of the potential effects of a beyond-design-basis earthquake on disposal facilities and related activities and the potential consequences on human health and the environment are provided in Section 4.3.11.2.1.

4.3.5.2.2 Disposal Group 2

The type and intensity of anticipated direct impacts on geology and soils under Waste Management Alternative 2, Disposal Group 2, including factors that could lead to increased wind and water erosion, would be somewhat greater than those described under Alternative 2, Disposal Group 1 (see Section 4.3.5.2.1 above). Under this alternative and disposal group, the RPPDF constructed would be substantially larger (by about a factor of eight) than that required under Disposal Group 1. Nevertheless, the size of IDF-East required under this disposal group would be only about one-third the size of that constructed under Alternative 2, Disposal Group 1. On the whole, the total scale of the direct impacts associated with new disposal facility construction would be greater under this disposal group. In total, the completed facilities would occupy about 240 hectares (592 acres) of land (see Section 4.3.1.2.1.2).

Both IDF-East and the RPPDF would operate until 2100 under this alternative and disposal grouping. Disposal operations in LLBG 218-W-5 would be identical to those described under Alternative 2, Disposal Group 1 (see Section 4.3.5.2.1). An additional 159 hectares (392 acres) would also be excavated from Borrow Area C, making a total of 398 hectares (984 acres) of new, permanent land disturbance.

Following completion of disposal activities in IDF-East and the RPPDF, each facility would be closed under a modified RCRA Subtitle C barrier, as described above in Section 4.3.5.2.1. The final barriers would encompass a total land area of about 247 hectares (611 acres) and would be subject to a 100-year postclosure care period.

Total geologic resource requirements under Alternative 2, Disposal Group 2, are projected to be 7,610,000 cubic meters (9,950,000 cubic yards), with the demand mainly driven by construction of the engineered barriers for landfill closure of IDF-East and the RPPDF (see Table 4–139). It is expected that this volume would be supplied by Borrow Area C, as stated above and further described in Section 4.1.5.

4.3.5.2.3 Disposal Group 3

Direct impacts on geology and soils from disposal facility construction, operations, and closure, as well as associated geologic resource demands, under this disposal grouping would be identical to those described above for Alternative 2, Disposal Group 2 (see Section 4.3.5.2.2). Although IDF-East and the RPPDF would be operated through 2165 before being landfill-closed under this disposal group, the larger operational period is not expected to measurably change the direct or indirect impacts.

4.3.5.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

Direct impacts on geology and soils and geologic resource demands associated with construction, operations, and deactivation of expanded Hanford waste treatment and storage facilities would be the same as those discussed under Waste Management Alternative 2 (see Section 4.3.5.2).

4.3.5.3.1 Disposal Group 1

Direct impacts on geology and soils and associated geologic resource requirements to support Waste Management Alternative 3, Disposal Group 1, activities would be very similar to those described under Alternative 2, Disposal Group 1 (see Section 4.3.5.2.1), despite the fact that two IDFs (in the 200-East and 200-West Areas) would be constructed under Alternative 3. The two IDFs together would be sized to provide approximately the same disposal capacity as the single IDF that would be constructed under Alternative 2, Disposal Group 1. IDF-East would be constructed in the same location as under Waste Management Alternative 2 and would receive only waste generated by the Tank Closure alternatives. IDF-West would be located north of WRAP and northwest of LLBG 218-W-5. It would be sized to receive the balance of the waste that would not be disposed of in IDF-East. Construction and operations activities associated with the two IDFs under this alternative and disposal group would be the same as those associated with the single IDF under Alternative 2, Disposal Group 1. Elements associated with construction and operations of the RPPDF under this alternative group and disposal operations in LLBG 218-W-5 would likewise be identical to those under Alternative 2, Disposal Group 1 (see Section 4.3.5.2.1). In total, the two IDFs and new RPPDF would occupy about 61.9 hectares (153 acres) of land. Following completion of disposal activities in the IDF(s) and the RPPDF, each facility would be closed under a modified RCRA Subtitle C barrier, as described above in Section 4.3.5.2.1. An additional 36.8 hectares (91 acres) would also be excavated from Borrow Area C, making a total of about 98.7 hectares (244 acres) of new, permanent land disturbance. The final barriers would encompass a slightly larger land area than the footprints of the three disposal facilities and total approximately 76.9 hectares (190 acres).

Total geologic resource requirements for Waste Management Alternative 3, Disposal Group 1, are projected to be 1.76 million cubic meters (2.3 million cubic yards), with the demand mainly driven by construction of the engineered barriers for landfill closure of the two IDFs and the RPPDF (see Table 4–139). It is expected that this volume would be supplied by Borrow Area C, as stated above and further described in Section 4.1.5.

Design consideration of hazards associated with large-scale geologic conditions (such as earthquakes) and site-specific geologic conditions that could potentially affect new and existing facilities under this alternative case would be substantially the same as those described in Section 4.3.5.2. Analyses of the potential effects of a beyond-design-basis earthquake affecting the disposal facilities and related activities and the potential consequences for human health and the environment are provided in Section 4.3.11.3.1.

4.3.5.3.2 Disposal Group 2

Under Waste Management Alternative 3, Disposal Group 2, direct and secondary impacts on geology and soils would be greater than those described under Alternative 3, Disposal Group 1 (see Section 4.3.5.3.1). Under this disposal group, the RPPDF that would be constructed would be substantially larger (by about a factor of eight) than that required under Disposal Group 1, although the combined size of IDF-East and IDF-West would be only about one-third the size of those constructed under Alternative 3, Disposal Group 1. On the whole, the total scale of direct impacts associated with new disposal facility construction would be greater under this disposal group. In total, the completed facilities would occupy about 240 hectares (593 acres) of land.

IDF-East and the RPPDF would operate until 2100 and IDF-West until 2050 under this alternative and disposal group. Disposal operations in LLBG 218-W-5 would be identical to those described under Alternative 2, Disposal Group 1 (see Section 4.3.5.2.1). An additional 157 hectares (388 acres) would also be excavated from Borrow Area C, making a total of 397 hectares (981 acres) of new, permanent land disturbance.

Following completion of disposal activities in IDF-East, IDF-West, and the RPPDF, each facility would be closed under a modified RCRA Subtitle C barrier, as previously described above in Section 4.3.5.2.1. The final barriers would encompass a total land area of about 253 hectares (624 acres) and would be subject to a 100-year postclosure care period.

Total geologic resource requirements under Alternative 3, Disposal Group 2, are projected to be 7.55 million cubic meters (9.88 million cubic yards), with the demand largely driven by construction of the engineered barriers (see Table 4–139). It is expected that this volume would be supplied by Borrow Area C, as stated above and further described in Section 4.1.5.

4.3.5.3.3 Disposal Group 3

Direct impacts on geology and soils from disposal facility construction, operations, and closure, as well as associated geologic resource demands, under this disposal grouping would be identical to those described above for Waste Management Alternative 3, Disposal Group 2 (see Section 4.3.5.3.2). Although IDF-East and the RPPDF would be operated through 2165 before being landfill-closed under this disposal group, compared with landfill closure in 2100 under Disposal Group 2, the additional operational years are not expected to measurably change the direct or indirect impacts.

4.3.6 Water Resources

4.3.6.1 Alternative 1: No Action

Interim waste storage, treatment, and disposal activities under Waste Management Alternative 1 are not expected to have any incremental impact on water resources over the short term. No facilities would be constructed or expanded under Alternative 1, although waste disposal operations in trenches 31 and 34 in LLBG 218-W-5 would continue through 2035. While the facility would not be closed under a barrier after cessation of waste disposal, it would be subject to a 100-year postclosure care period that would include groundwater monitoring.

Earthmoving would be involved in deactivating IDF-East in 2009, which would include backfilling the facility with previously excavated material. Stormwater runoff could convey soil, sediments, and other pollutants (e.g., site debris, petroleum, oils, lubricants from heavy equipment) from the work sites and staging areas. However, any such potential for runoff to impact water quality beyond the confines of the 200 Areas would be low. Nevertheless, appropriate soil erosion and sediment control measures (e.g., sediment fences, staked haybales, mulch), as well as spill prevention and waste management practices, would be employed to minimize suspended sediment and other deleterious material transport and any potential water-quality impacts. Projected water use under Alternative 1 and its impact on site utility infrastructure are discussed in Section 4.3.2.1.

Long-term impacts on water resources associated with ongoing waste management and disposal, including contaminant release to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.3.1.1.

4.3.6.2 Alternative 2: Disposal in IDF, 200-East Area Only

Direct impacts on surface-water resources and quality associated with construction of expanded Hanford waste treatment and storage facilities would be negligible. The expanded facilities would be constructed in previously developed portions of the 200-West Area where no surface-water features or surface-water drainages are located and the depth to groundwater is generally greater than about 50 meters (164 feet). Any effect on stormwater runoff quality would likely be highly localized and of short duration. Nevertheless, appropriate soil erosion and sediment control measures (e.g., sediment fences, staked haybales, mulch), as well as spill prevention and waste management practices, would be employed to minimize suspended sediment and other deleterious material transport from the construction site and potential water quality impacts. Further, ground-disturbing activities would be conducted in accordance with current NPDES and state waste discharge general permits for stormwater discharges associated with construction activities, both of which are issued by Ecology. These permits specifically require the development and implementation of a stormwater pollution prevention plan. The expanded facilities would incorporate appropriate stormwater management controls to collect, detain, and convey stormwater from the building and other impervious surfaces to minimize water quality impacts during operations.

There would be no direct discharge of effluents to either surface water or groundwater from facility operations. Process wastewater, including any radioactive liquid effluents, generated from operation of the expanded facilities would be discharged to existing treatment facilities that already service the 200 Areas, as described in Section 4.1.6.2.1. Nonhazardous sanitary wastewater (sewage) would be managed via appropriate sanitary wastewater collection and treatment systems.

Water would be required during construction for soil compaction, dust control, and other uses, including concrete production. Standard construction practices dictate that, at least initially, construction water would be trucked to construction locations on an as-needed basis for these uses until water supply and wastewater treatment utilities are in place. During operations, water would be required to support process makeup requirements and facility cooling, waste treatment processing, the potable and sanitary needs of the operations workforce, and other uses. Some water would also be required during deactivation for activities such as facility decontamination. Projected water use for these activities under Waste Management Alternative 2 and its impact on site utility infrastructure are further discussed in Section 4.3.2.2.

No incremental impact on the Hanford vadose zone or groundwater is expected from operation of these facilities in the 200-West Area. There would be no direct discharge of effluents to either surface water or the ground, as described above. Following completion of their mission in 2050, the facilities would be deactivated, and all residual waste and any hazardous or radioactive materials would be removed for disposal. Waste generation and management activities under this alternative are further discussed in Section 4.3.14.2.

Long-term impacts on water resources associated with ongoing waste management and disposal, including contaminant release to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.3.1.2.2.

4.3.6.2.1 Disposal Group 1

No direct impact on water resources is expected from constructing an expanded IDF-East and the RPPDF between the 200-East and 200-West Areas. No natural surface-water features would be impacted from construction of IDF-East in an area that has already been heavily disturbed. In the case of the relatively undeveloped area where the RPPDF would be constructed, natural drainage features across the area are very poorly defined or nonexistent, and flow is ephemeral, if it occurs at all.

Disposal facility construction is not expected to impact regional groundwater flow because the depth of the completed disposal facilities would not exceed about 13.1 meters (43 feet) and the depth of the water table beneath the 200 Areas is generally greater than about 50 meters (164 feet).

Site clearing, grading, and facility excavation work would expose soils and sediments to possible erosion from infrequent heavy rainfall or wind. Stormwater runoff from exposed areas could convey soil, sediments, and other pollutants (e.g., contaminated debris and spilled materials, such as petroleum, oils, and lubricants from heavy equipment) from construction and staging areas. Any such potential for runoff to impact runoff quality beyond the confines of the work areas would be low, and both disposal area locations are more than 11 kilometers (6.8 miles) from the Columbia River. Regardless, appropriate soil erosion and sediment control measures (e.g., sediment fences, staked haybales, mulching and seeding of temporarily disturbed areas), as well as spill prevention and waste management practices, would be employed to minimize suspended sediment and other deleterious material transport and any potential water quality impacts. In addition, during facility construction, temporary covers would be used as necessary to limit precipitation run-on into the disposal facilities. Further, all excavation work and related ground-disturbing activities during construction would be conducted in accordance with current NPDES and appropriate state waste discharge general permits for stormwater discharges associated with construction and industrial activities, both of which are issued by Ecology. These permits specifically require the development and implementation of a stormwater pollution prevention plan.

Normal disposal facility operations through 2050 under this disposal scenario, including the continued operation of trenches 31 and 34 in LLBG 218-W-5 until closed, as well as IDF-East and the RPPDF, are not expected to have any additional direct impact on water resources. Trenches 31 and 34 are lined, RCRA-compliant disposal facilities equipped with a leachate collection system (see Appendix E, Section E.3.3.2). There would be no direct discharge of effluents to either surface water or groundwater from facility operations. For continued operations of trenches 31 and 34 in LLBG 218-W-5, precipitation and snowmelt captured by the trench liner systems would be drained to a sump, pumped to a holding tank, and removed by tanker truck for treatment at the ETF.

The completed IDF-East and RPPDF would incorporate appropriate stormwater management engineering and operational controls to collect, detain, and convey stormwater away from disposal to minimize water-quality impacts during operations, including run-on of stormwater and precipitation that could otherwise infiltrate emplaced waste. To be specific, these new engineered facilities would include a redundant (double) liner system, a leachate collection and removal system, and a leak detection system to protect subsurface water quality (see Appendix E, Section E.3.4.1). As discussed for LLBG 218-W-5, leachate collected by the IDF-East and RPPDF systems would similarly be detained and trucked to the ETF for treatment and disposal. Additional operational controls could include the use of temporary roll-on/roll-off geomembrane covers to further limit infiltration and leachate generation during waste disposal.

Following completion of disposal activities in IDF-East and the RPPDF, each facility would be closed under a modified RCRA Subtitle C barrier, as previously described in Section 4.3.5.2.1. Similarly, the LLBG would also be backfilled to grade and ultimately closed. The modified RCRA Subtitle C barrier is designed for a 500-year performance period. During the DOE-administered 100-year postclosure care period for IDF-East and the RPPDF, proper operation and maintenance of the barrier, including installed groundwater-monitoring systems and barrier erosion control features, would ensure that postclosure impacts on surface-water hydrology and quality and on the Hanford vadose zone and groundwater are minimal. Nevertheless, this barrier would degrade over time, allowing infiltration and contaminant migration from disposal facilities and across the 200 Areas. Long-term impacts on water resources, including contaminant release to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.3.1.2.1. Waste generation and management activities under this alternative are further discussed in Section 4.3.14.2.

Potable and raw water demand to support waste management disposal activities would primarily be driven by the need to provide dust control during disposal facility construction, operations, and closure via construction of the modified RCRA Subtitle C barriers; water might also be needed to aid soil compaction. Portable sanitary facilities would be provided to meet the workday potable and sanitary needs of decommissioning personnel, which would constitute a relatively small percentage of the total water demand. Projected water use under Alternative 2, Disposal Group 1, and its impact on site utility infrastructure are discussed in Section 4.3.2.2.1.1.

4.3.6.2.2 Disposal Group 2

The potential for direct and secondary impacts on water resources under Alternative 2, Disposal Group 2, would be somewhat greater than those described under Alternative 2, Disposal Group 1 (see Section 4.3.6.2.1). While the construction, operation, and closure activities and associated impacts would be very similar, a substantially larger RPPDF would be constructed under this alternative and disposal group (see Section 4.3.5.2.2), and both IDF-East and the RPPDF would operate until 2100 instead of 2050. Disposal operations in LLBG 218-W-5 would be identical to those described under

Alternative 2, Disposal Group 1 (see Section 4.3.6.2.1). Following completion of disposal activities in IDF-East and the RPPDF, each facility would be closed under a modified RCRA Subtitle C barrier, the same as for Disposal Group 1. Overall, it is expected that the potential for direct and secondary impacts on water resources, including groundwater, over the short term would be small for the same reasons previously described in Section 4.3.6.2.1. Long-term impacts on water resources, including contaminant release to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.3.1.2.2. Total water use would be greater under this disposal group due to the demand for construction, operations, and closure of a larger RPPDF and the extension of disposal operations over a longer timeframe. Projected water use under Alternative 2, Disposal Group 2, and its impact on site utility infrastructure are further discussed in Section 4.3.2.2.1.2.

4.3.6.2.3 Disposal Group 3

Activities under this alternative would represent the maximum potential impacts on water resources from disposal facility construction, operations, and closure over the short term and would generally be similar in nature to those described under Alternative 2, Disposal Group 1 (see Section 4.3.6.2.1). The size of IDF-East and the RPPDF constructed under this alternative and the associated impact considerations would be identical to those considered under Alternative 2, Disposal Group 2 (see Section 4.3.5.2.2). However, IDF-East and the RPPDF would operate until 2165 instead of 2100, and disposal facility closure would consequently occur much later under this alternative and disposal group. Nonetheless, any potential for direct and secondary impacts on water resources is still expected to be relatively small. Long-term impacts on water resources, including contaminant release to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.3.1.2.3. Projected water use under Alternative 2, Disposal Group 3, and its impact on site utility infrastructure are discussed in Section 4.3.2.2.1.3.

4.3.6.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

Direct impacts on water resources associated with construction, operations, and deactivation of expanded Hanford waste treatment and storage facilities would be the same as those discussed under Waste Management Alternative 2 in Section 4.3.6.2.

4.3.6.3.1 Disposal Group 1

No direct impacts on water resources are expected from constructing an expanded IDF-East, a new IDF-West, and the RPPDF between the 200-East and 200-West Areas. No natural surface-water features would be impacted from construction of IDF-East because the area has already been heavily disturbed. In the case of the relatively undeveloped areas where IDF-West and the RPPDF would be constructed, natural drainage features across the affected areas are very poorly defined or nonexistent, and flow is ephemeral, if it occurs at all. In general, the nature and intensity of ground-disturbing activities, effects on water resources, and application of soil erosion, sediment control, and stormwater management provisions would generally be the same as those described under Alternative 2, Disposal Group 1 (see Section 4.3.6.2.1).

As described in Section 4.3.5.3.1, IDF-East would receive only waste generated by the Tank Closure alternatives. IDF-West would receive the balance of the waste. Segregation of the waste in this manner may have implications for long-term facility performance and contamination transport, but is not expected to have any differing operating impacts on water resources in the short term.

All other design considerations, operating parameters, closure considerations, and potential effects on water resources would be the same as those described under Alternative 2, Disposal Group 1 (see Section 4.3.6.2.1), because both the 200-East and 200-West IDFs and the RPPDF would operate through 2050 under this alternative and disposal group before being landfill-closed. Disposal operations in LLBG 218-W-5 would also be identical to those described under Alternative 2, Disposal Group 1. Long-term impacts on water resources, including contaminant release to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.3.1.3.1. Projected water use under Alternative 2, Disposal Group 3, and its impact on site utility infrastructure are discussed in Section 4.3.2.3.1.1.

4.3.6.3.2 Disposal Group 2

The potential for direct and secondary impacts on water resources under Waste Management Alternative 3, Disposal Group 2, would be somewhat greater than those described above under Alternative 3, Disposal Group 1. While the construction, operations, and closure activities and associated impacts would be very similar, a substantially larger RPPDF would be constructed under this alternative and disposal group (see Section 4.3.5.3.2). In addition, IDF-East and the RPPDF would operate until 2100 instead of 2050 under this alternative and disposal group. Disposal operations in LLBG 218-W-5 would be identical to those previously described. Following completion of disposal activities in IDF-East and the RPPDF, each facility would be closed under a modified RCRA Subtitle C barrier, the same as for Disposal Group 1. Construction, extended operations, and eventual closure of relatively larger disposal facilities would increase the potential for water-quality impacts in the short term. Still, it is expected that the potential for direct and secondary impacts on water resources, including groundwater, over the short term would be small for the same reasons previously described in Section 4.3.6.3.1. Long-term impacts on water resources, including contaminant release to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.3.1.3.2. Total water use would be greater under this disposal group due to the demand for construction, operations, and closure of a larger RPPDF and the extension of disposal operations over a longer timeframe. Projected water use under Alternative 3, Disposal Group 2, and its impact on site utility infrastructure are further discussed in Section 4.3.2.3.1.2.

4.3.6.3.3 Disposal Group 3

Potential direct and secondary impacts on water resources associated with disposal facility construction, operations, and closure activities would be somewhat greater than those under Alternative 3, Disposal Group 2 (see Section 4.3.6.3.2). Although the sizes of the two IDFs and the RPPDF constructed would be identical to the sizes described under Alternative 3, Disposal Group 2, IDF-East and the RPPDF would operate until 2165 instead of 2100, and disposal facility closure would occur much later as a consequence. Nonetheless, any potential for direct and secondary impacts on water resources is still expected to be relatively small based on the rationale summarized in Section 4.3.6.3.1. Long-term impacts on water resources, including contaminant release to and transport through the Hanford groundwater system, are evaluated in Chapter 5, Section 5.3.1.3.3. This alternative would have the highest total water use under Alternative 3 due to the extended operations period for IDF-East and the RPPDF. Projected water use under Alternative 3, Disposal Group 3, and its impact on site utility infrastructure are further discussed in Section 4.3.2.3.1.3.

4.3.7 Ecological Resources

4.3.7.1 Alternative 1: No Action

Under the No Action Alternative, no new facility construction would be initiated within the 200 Areas. Storage and treatment activities would continue to take place within the CWC, WRAP, and T Plant complex. Disposal would also continue in LLBG 218-W-5 trenches 31 and 34, and no barriers would be emplaced after closure of any of the facilities or trenches. Thus, there would be no additional impacts on ecological resources within the 200 Areas under this alternative. As this alternative would not require geologic material to be excavated from Borrow Area C, there would be no impacts on ecological resources within that area.

4.3.7.2 Alternative 2: Disposal in IDF, 200-East Area Only

4.3.7.2.1 Terrestrial Resources

Under this alternative, a number of new facilities or existing-facility expansions would be constructed in the 200-West Area. These include expansion of the T Plant; two expansions of WRAP: (1) a CH-Mixed TRU/TRU waste facility at the CWC, and (2) an RH-Mixed TRU/TRU waste facility at WRAP; and construction of a new CWC storage facility (see Figure 4–2). These facilities would require a total of 2.7 hectares (6.6 acres) of land. Of this total, up to 0.4 hectares (1 acre) of sagebrush habitat (and associated microbiotic crusts) could be disturbed by construction of the RH-Mixed TRU/TRU waste facility at WRAP. Hanford guidance would not require the replacement of this sagebrush habitat (DOE 2003f:21). Other facilities would be built on previously disturbed land. Operations are not expected to impact terrestrial resources.

4.3.7.2.1.1 Disposal Group 1

Disposal Group 1 would involve construction of IDF-East and the RPPDF between the 200-East and 200-West Areas (see Figures 4–1 and 4–2). The former would disturb 32.8 hectares (81 acres), while the latter would disturb 29.5 hectares (73 acres). Nearly all the land that would be disturbed by these facilities is sagebrush habitat. Disturbance of sagebrush habitat would destroy microbiotic crusts. Hanford guidance may require the replacement of sagebrush habitat within IDF-East at a ratio of 1:1 and the RPPDF at a ratio of 3:1. Specific measures to mitigate the loss of sagebrush habitat would be set forth in a mitigation action plan prior to initiation of construction (DOE 2003f:21, 43). Operations are not expected to impact terrestrial resources. Closure of IDF-East and the RPPDF would involve placement of barriers, which would encompass slightly more land (1.6 hectares [4 acres]) than the waste disposal facilities, resulting in sagebrush habitat disturbance totaling 63.9 hectares (158 acres).

Under this disposal group, 41.7 hectares (103 acres) of Borrow Area C would be excavated to supply needed geologic material. As noted in Chapter 3, Section 3.2.7.1, the two major plant communities present within the area are Sandberg's bluegrass/cheatgrass (782.3 hectares [1,933 acres]) and needle-and-thread grass/Indian ricegrass (107 hectares [265 acres]). The latter represents an unusual and relatively pristine community type at Hanford and thus is considered a more highly valued community than the former. It is not possible to determine the specific impacts on ecological resources of developing Borrow Area C because the particular portion of the site from which geologic material would be excavated is not known. However, most of Borrow Area C can be developed without substantial adverse impacts on species or habitats (Sackschewsky and Downs 2007:8). To the extent that it is possible, the needle-and-thread grass/Indian ricegrass community should be avoided.

4.3.7.2.1.2 Disposal Groups 2 and 3

As construction of IDF-East and the RPPDF under Disposal Groups 2 and 3 would disturb the same area (11.3 hectares [28 acres] and 228 hectares [564 acres], respectively) they are grouped together. Construction of both facilities could disturb up to their total area in sagebrush habitat depending on the exact placement of each. Disturbance of sagebrush habitat would destroy microbiotic crusts. Hanford guidance may require the replacement of sagebrush habitat within IDF-East at a ratio of 1:1 and the RPPDF at a ratio of 3:1. Specific measures to mitigate the loss of sagebrush habitat would be set forth in a mitigation action plan prior to construction (DOE 2003f:21, 43). Operations are not expected to impact terrestrial resources. Closure of IDF-East and the RPPDF would involve emplacement of barriers that would encompass slightly more land (7.7 hectares [19 acres]) than the waste disposal facilities. Sagebrush habitat disturbance could total 247 hectares (611 acres). The loss of any sagebrush habitat would be mitigated.

Under Disposal Groups 2 and 3, 159 hectares (392 acres) of Borrow Area C would be developed to supply needed geologic material. Impacts on terrestrial resources from the excavation of geologic material from the area would be somewhat greater than those described above for Disposal Group 1.

4.3.7.2.2 Wetlands and Aquatic Resources

There are no wetlands or aquatic resources within any of the areas where expanded or new facilities would be constructed in the 200-East Area, 200-West Area, or between these two areas. Additionally, these resources are not found within Borrow Area C. Thus, there would be no impacts on wetlands or aquatic resources under this alternative.

4.3.7.2.3 Threatened and Endangered Species

Construction and operations of the CWC, WRAP, and T Plant complex within the 200-West Area would not adversely affect any special status species because none have been recorded within the areas where these facilities would be built (Sackschewsky and Downs 2007:3). Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with this alternative, designated critical habitat would not be adversely affected.

4.3.7.2.3.1 Disposal Group 1

Under this disposal group, construction of IDF-East and the RPPDF would disturb a total of 62.3 hectares (154 acres) of sagebrush habitat. While no Federal or state threatened or endangered species were observed within either of the potential sites for these facilities, the sage sparrow (state candidate) was observed within IDF-East (see Chapter 3, Section 3.2.7.4). Surveys within the area to be occupied by the RPPDF identified the black-tailed jackrabbit, sage sparrow, and loggerhead shrike (all state candidates; the loggerhead shrike is also a Federal species of concern); one special status plant species, crouching milkvetch (state watch), was also observed. As noted above for construction and operations of the CWC, WRAP, and T Plant complex, designated critical habitat for the bull trout would not be affected by activities associated with this disposal group. Operations of new facilities within the 200 Areas are not expected to impact any federally or state-listed species.

State watch species should be considered during project planning, though mitigation would not be required. Impacts on state candidate species, which are considered Level III resources under the *Hanford Site Biological Resources Management Plan*, require mitigation where impacts would occur. When avoidance and minimization are not possible or are insufficient, mitigation via rectification or compensation is recommended (DOE 2001b:4.9, 8.11). A comprehensive mitigation action plan that would deal with impacts on listed species (as well as sagebrush habitat) would be developed prior to construction.

As noted in Chapter 3, Section 3.2.7.4, surveys have identified Piper's daisy, stalked-pod milkvetch (state watch), crouching milkvetch, and the long-billed curlew (state monitor) within the boundaries of Borrow Area C. Mitigation requirements for Piper's daisy and the two species of milkvetch are addressed above. Although avoidance and minimization of impacts on state monitor species is recommended, mitigation is not required (DOE 2001b:4.11). A mitigation action plan would be developed prior to excavation.

4.3.7.2.3.2 Disposal Groups 2 and 3

Under both Disposal Groups 2 and 3, IDF-East and the RPPDF would disturb a total of 240 hectares (592 acres) of sagebrush habitat. The same areas would be used for these facilities under these disposal groups as those under Disposal Group 1, so the same species could be affected. However, because more habitat would be disturbed, the potential to impact these species would be greater. Mitigation requirements would be similar to those noted above, including the need to prepare a mitigation action plan prior to the start of construction.

4.3.7.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

4.3.7.3.1 Terrestrial Resources

Under this Waste Management alternative, the same expanded and new facilities would be constructed in the same locations within the 200-West Area as under Alternative 2. Further, they would occupy the same area. Thus, the impacts on terrestrial resources under Alternative 3 would be the same as those discussed in Section 4.3.7.2.1.

4.3.7.3.1.1 Disposal Group 1

Although the RPPDF would be located in the same area and would be the same size (29.5 hectares [73 acres]) as under Alternative 2, two IDFs would be constructed under this alternative. IDF-East would be situated in the same location as under Alternative 2, but would be 29.9 hectares (74 acres) in size. IDF-West would be 2.4 hectares (6 acres) in size (see Figures 4–1 and 4–2). Due to the general similarity in size, impacts on the 200-East Area under this alternative would be essentially the same as those described above under Alternative 2 (see Section 4.3.7.2.1). The area where IDF-West would be located has been burned in the past and is presently considered recovering shrub-steppe habitat, and sagebrush has been replanted in the western portion of the site. However, its loss would not be mitigable according to the *Hanford Site Biological Resources Management Plan* (DOE 2001b; Sackschewsky and Downs 2007:4). Operations are not expected to impact terrestrial resources. Closure of IDF-East, IDF-West, and the RPDDF would encompass slightly more land (15 hectares [37 acres]) than the waste disposal facilities. Sagebrush habitat disturbance could total 76.9 hectares (190 acres). The loss of any additional sagebrush habitat would be mitigated.

To support activities under this disposal group, a total of 36.8 hectares (91 acres) within Borrow Area C would be required to supply geologic material. Although 4.9 hectares (12 acres) less land would be required under this alternative than under Alternative 2, the impacts on terrestrial resources of developing the site would be similar to those described in Section 4.3.7.2.1.1.

4.3.7.3.1.2 Disposal Groups 2 and 3

Under Waste Management Alternative 3, the RPPDF would be located and sized (228 hectares [564 acres]) as noted under Alternative 2; thus, the impacts related to Disposal Groups 2 and 3 would be the same (see Section 4.3.7.2.1.2). As under Disposal Group 1, two IDFs would be constructed under Disposal Groups 2 and 3. IDF-West would be located in the same area and would be the same size as under Disposal Group 1. However, IDF-East would be smaller (i.e., 9.3 hectares [23 acres] versus 29.9 hectares [74 acres]). Thus, the impacts of construction and operations of IDF-East under Disposal Groups 2 and 3 would be somewhat less than those described under Disposal Group 1. Closure of IDF-East, IDF-West, and the RPPDF would encompass slightly more land (12.5 hectares [31 acres]) than the waste disposal facilities. Sagebrush habitat disturbance could total 253 hectares (624 acres). The loss of any additional sagebrush habitat would be mitigated.

As the requirement for geologic material would be about the same under this alternative as under Alternative 2, nearly the same land area (i.e., 157 hectares [388 acres] under Alternative 3 versus 159 hectares [392 acres] under Alternative 2) would need to be excavated from Borrow Area C. Thus, the impacts of developing the site on terrestrial resources would be the same as those described in Section 4.3.7.2.1.2.

4.3.7.3.2 Wetlands and Aquatic Resources

There are no wetlands or aquatic resources within any of the areas where expanded or new facilities would be constructed in the 200-East Area, the 200-West Area, or between these two areas. Additionally, these resources are not found within Borrow Area C. Thus, there would be no impacts on wetlands or aquatic resources under this alternative.

4.3.7.3.3 Threatened and Endangered Species

As noted in Section 4.3.7.3.1, there would be no difference in the number and size of expanded or new facilities required under Waste Management Alternative 3 compared with Alternative 2 (see Section 4.3.7.2.3). As special status species have not been recorded within the areas where new facilities or existing-facility expansions of the CWC, WRAP, and T Plant complex would be built, there would be no adverse impacts on this group of organisms. Both the Columbia and Yakima Rivers adjacent to Hanford have been designated as critical habitat for the bull trout. However, as there would be no short-term impacts on either river from construction or operation of new facilities associated with this alternative, designated critical habitat would not be adversely affected.

4.3.7.3.3.1 Disposal Group 1

Impacts on threatened and endangered species resulting from construction of the RPPDF would be the same as those described above under Waste Management Alternative 2 because the facility would be located in the same area and would be the same size. In addition, impacts resulting from construction of IDF-East would be similar to those under Alternative 2 because the area to be disturbed would be only slightly smaller (2.8 hectares [7 acres]) (see Section 4.3.7.2.3.1). However, under this alternative, IDF-West would encompass 2.4 hectares (6 acres) within the 200-West Area. Surveys of the proposed site of IDF-West identified one listed species, the stalked-pod milkvetch (state watch) (see Chapter 3, Section 3.2.7.4). Although mitigation would not be required for this species, it should be considered during project planning.

As the requirement for geologic material would be about the same under this alternative as under Alternative 2, nearly the same land area would need to be excavated from Borrow Area C. Thus, the impacts on threatened and endangered species of developing the site would be the same as those described in Section 4.3.7.2.3.1.

4.3.7.3.3.2 Disposal Groups 2 and 3

Impacts on threatened and endangered species resulting from construction of the RPPDF would be the same as those described above under Waste Management Alternative 2 because the facility would be located in the same area and would be the same size. In addition, impacts resulting from construction of IDF-East would be similar to those under Alternative 2 because the area to be disturbed would be only slightly smaller. Similar to Disposal Group 1, under this alternative, IDF-West would encompass 2.4 hectares (6 acres) within the 200-West Area, resulting in possible disturbance of the stalked-pod milkvetch. While this species should be considered during project planning, mitigation would not be required.

As the requirement for geologic material would be about the same under this alternative as under Alternative 2, nearly the same land area would need to be excavated from Borrow Area C. Thus, the impacts on threatened and endangered species of developing the site would be the same as those described in Section 4.3.7.2.3.2.

4.3.8 Cultural and Paleontological Resources

4.3.8.1 Alternative 1: No Action

Under the No Action Alternative, there would be no new construction within the 200 Areas. Treatment activities and storage would resume within the CWC, WRAP complex, and T Plant complex, and waste disposal would continue in LLBG 218-W-5 trenches 31 and 34. In addition, there would be no need to excavate geologic material from Borrow Area C. Therefore, there would be no changes to the 200 Areas, and no known cultural or paleontological resources would be impacted.

4.3.8.1.1 Prehistoric Resources

Prehistoric resources located in the 200-East and 200-West Areas would not be disturbed under this alternative, as discussed above in Section 4.3.8.1.

4.3.8.1.2 Historic Resources

Historic resources located in the 200-East and 200-West Areas would not be disturbed under this alternative, as discussed above in Section 4.3.8.1.

4.3.8.1.3 American Indian Interests

Under this Waste Management alternative, there would be no impacts on American Indian interests.

4.3.8.1.4 Paleontological Resources

There would be no impacts on known paleontological resources under this Waste Management alternative, as discussed above in Section 4.3.8.1.

4.3.8.2 Alternative 2: Disposal in IDF, 200-East Area Only

4.3.8.2.1 Prehistoric Resources

Prehistoric resources located in the 200-East and 200-West Areas would not be disturbed under this Waste Management alternative because no known resources are located in the vicinity of the expanded storage and treatment and disposal facilities that would be constructed. If prehistoric resources were discovered during construction or excavation of geologic material, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented. This condition applies to all disposal groups.

4.3.8.2.1.1 Disposal Groups 1, 2, and 3

Potential impacts on prehistoric resources are described in Section 4.3.8.2.1 and would be similar under all disposal groups.

4.3.8.2.2 Historic Resources

Historic resources located in the 200-East and 200-West Areas would not be disturbed under this Waste Management alternative because no known resources are located in the vicinity of the expanded storage and treatment and disposal facilities that would be constructed. If historic resources were discovered during construction or excavation of geologic material, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented. This condition applies to all disposal groups.

4.3.8.2.2.1 Disposal Groups 1, 2, and 3

Potential impacts on historic resources are described in Section 4.3.8.2.2 and would be similar under all disposal groups.

4.3.8.2.3 American Indian Interests

Under this Waste Management alternative, there would be visual impacts on the viewscape from higher elevations such as Rattlesnake Mountain. If there were visual impacts on areas of interest, appropriate mitigation measures would be developed in consultation with area tribes. This condition applies to all disposal groups.

4.3.8.2.3.1 Disposal Group 1

Under Waste Management Alternative 2, Disposal Group 1, IDF expansion and construction of the RPPDF would affect 62.3 hectares (154 acres) of land in the 200 Areas. In addition, a modified RCRA Subtitle C barrier would be constructed over both IDF-East and the RPPDF, increasing the area of the viewscape. Construction and operations would be visible from Rattlesnake Mountain, Gable Mountain, and Gable Butte, all of which have cultural importance to American Indians. An additional 41.7 hectares (103 acres) of Borrow Area C would be excavated to supply geologic material. Excavation would change the viewscape from Rattlesnake Mountain. Following closure, the area would be recontoured and revegetated.

4.3.8.2.3.2 Disposal Groups 2 and 3

Waste Management Alternative 2, Disposal Group 2 or 3, would require 240 hectares (592 acres) of undeveloped land for construction of IDF-East and the RPPDF. This construction would noticeably change the area and be visible from Rattlesnake Mountain, Gable Mountain, and Gable Butte. This viewscape would last for the operational period of the sites.

Construction of modified RCRA Subtitle C barriers over other facilities during closure would increase the area of the viewscape. In addition, 159 hectares (392 acres) of land would be excavated from Borrow Area C. Excavated areas would be visible from Rattlesnake Mountain. Excavations in Borrow Area C would be recontoured and revegetated.

4.3.8.2.4 Paleontological Resources

There would be no impacts on paleontological resources under this alternative because no such resources have been discovered in the 200 Areas or Borrow Area C. As is the case with cultural resources, if any paleontological resources were discovered during construction or excavation of geologic material, procedures are in place to properly manage the discovery site.

4.3.8.2.4.1 Disposal Groups 1, 2, and 3

Potential impacts on paleontological resources are described in Section 4.3.8.2.4 and would be similar under all disposal groups.

4.3.8.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

4.3.8.3.1 Prehistoric Resources

Prehistoric resources located in the 200-East and 200-West Areas would not be disturbed under this Waste Management alternative because no known resources are located in the vicinity of the expanded storage and treatment and disposal facilities that would be constructed. If prehistoric resources were discovered during construction or excavation of geologic material, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented. This condition applies to all disposal groups.

4.3.8.3.1.1 Disposal Groups 1, 2, and 3

Potential impacts on prehistoric resources are described in Section 4.3.8.3.1 and would be similar under all disposal groups.

4.3.8.3.2 Historic Resources

Historic resources located in the 200-East and 200-West Areas would not be disturbed under this Waste Management alternative because no known resources are located in the vicinity of the expanded storage and treatment and disposal facilities that would be constructed. If historic resources were discovered during construction or excavation of geologic material, procedures set forth in the *Hanford Cultural Resources Management Plan* (DOE 2003g), which provides guidance for identifying, evaluating, recording, curating, and managing these resources, would be implemented. This condition applies to all disposal groups.

4.3.8.3.2.1 Disposal Groups 1, 2, and 3

Potential impacts on historic resources are described in Section 4.3.8.3.2 and would be similar under all disposal groups.

4.3.8.3.3 American Indian Interests

Under this Waste Management alternative, impacts on the viewscape from construction and operations of the T Plant expansion, two WRAP expansions, and the new CWC storage facility would be similar to those described under Alternative 2. There would be visual impacts on the viewscape from higher elevations such as Rattlesnake Mountain, Gable Mountain, and Gable Butte. If there were visual impacts on areas of interest, appropriate mitigation measures would be developed in consultation with area tribes.

4.3.8.3.3.1 Disposal Group 1

This disposal group includes an IDF in both the 200-East and 200-West Areas. The total land area disturbed and the land required within Borrow Area C for excavation of geologic material would be nearly the same as under Alternative 2. Therefore, the visual impact on Rattlesnake Mountain would be the same as that described under Alternative 2, Disposal Group 1 (see Section 4.3.8.2.3.1). The placement of IDF-West on 2.4 hectares (6 acres) of undeveloped land would minimally add to the visual impact.

4.3.8.3.3.2 Disposal Groups 2 and 3

Under Waste Management Alternative 3, Disposal Group 2 or 3, the land required for IDF-East, IDF-West, the RPPDF, and Borrow Area C would be nearly the same as that required under Alternative 2. Therefore, visual impacts on American Indian interests would be the same as those under Alternative 2 (see Section 4.3.8.2.3.2).

4.3.8.3.4 Paleontological Resources

There would be no impacts on paleontological resources under this Waste Management alternative because no such resources have been discovered in the 200 Areas or Borrow Area C. As is the case with cultural resources, if any paleontological resources were discovered during construction or excavation of geologic material, procedures in place to properly manage the discovery site would be implemented. This condition applies to all disposal groups.

4.3.8.3.4.1 Disposal Groups 1, 2, and 3

Potential impacts on paleontological resources are described in Section 4.3.8.3.4 and would be similar under all disposal groups.

4.3.9 Socioeconomics

The primary (direct) and secondary (indirect) impacts of waste disposal management on employment, regional demographics, housing and community services, and local transportation were analyzed for this section of this EIS. The potential primary impacts were identified by analyzing projected changes in employment (in terms of FTEs) and truck activity related to the activities under each alternative (see Appendix I). The projected changes in employment and truck activity have the potential to generate economic impacts that may affect the need for housing units, public services, and local transportation in the region.

The key underlying assumptions used to project changes in employment under each of the Waste Management alternatives and associated options were similar to those described in Section 4.1.9 under the Tank Closure alternatives. In addition to the No Action Alternative, the Waste Management alternatives propose various strategies for storage and treatment of both onsite and offsite waste. Waste Management Alternative 2 includes three disposal options that would use facilities located in the 200-East Area. Waste Management Alternative 3 includes three disposal options that would use facilities located in both the 200-East and 200-West Areas. Table 4–140 summarizes the indicators used to analyze the socioeconomic impacts under each alternative.

Table 4–140. Waste Management Alternatives and Options – Summary of Peak Estimated Socioeconomic Indicators

Alternatives and Options	Peak Annual Workforce[a] (Peak Year)	Peak Daily Commuter Traffic	Peak Daily Truck Loads (Peak Year)	
			Off Site	On Site
Alternative 1: No Action	109 (2009)	88	Less than 1 (2009)	6 (2009)
Alternatives 2 and 3: Waste Treatment and Storage	449 (2019–2050)	360	2 (2011–2012)	7 (2011–2012)
Alternative 2 – Disposal in IDF, 200-East Area Only				
Disposal Group 1	1,180 (2051–2052)	943	28 (2051–2052)	428 (2051–2052)
Disposal Group 2	4,540 (2101–2102)	3,640	34 (2101–2102)	1,500 (2101–2102)
Disposal Group 3	4,540 (2166–2167)	3,640	34 (2166–2167)	1,500 (2166–2167)
Alternative 3 – Disposal in IDF, 200-East and 200-West Areas				
Disposal Group 1	1,170 (2051–2052)	940	28 (2051–2052)	372 (2051–2052)
Disposal Group 2	4,500 (2101–2102)	3,600	33 (2101–2102)	1,480 (2101–2102)
Disposal Group 3	4,500 (2166–2167)	3,600	33 (2166–2167)	1,480 (2166–2167)

[a] Workforce is rounded into full-time-equivalent quantities.
Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate.
Key: IDF=Integrated Disposal Facility.
Source: Appendix I; SAIC 2010c.

4.3.9.1 Alternative 1: No Action

Because construction activities would be minimal under Alternative 1: No Action, the peak workforce was estimated to reach only 109 FTEs in 2009. This workforce, along with an additional 81 indirect jobs created as a secondary impact, would have little impact on regional economic characteristics, demographic characteristics, or housing and community services. In addition, the 114 offsite truck trips (less than 1 trip per day) and 1,460 onsite trips per year (approximately 6 trips per day), along with additional commuters (up to 88 vehicles per day in the peak year), would have little impact on local transportation in the ROI.

4.3.9.2 Alternative 2: Disposal in IDF, 200-East Area Only

Under Alternative 2, at a peak of 449 FTEs from 2019 through 2050 (see Table 4–140), employment activity would be dominated by the workforce required to operate WRAP. The existence of these direct jobs is expected to result in the creation of another 336 indirect jobs in the ROI during the peak years. During the same time period, there could be up to 360 additional vehicles per day during the commute times. Local offsite truck traffic could run as high as 504 trucks (2 trips per day) during the peak years 2011 and 2012. Construction of the expanded facilities at WRAP would account for the major portion of this offsite and onsite truck traffic (1,880 truckloads, or approximately 7 trips per day). The socioeconomic impacts below would be affected by this workforce and its use of local vehicles in addition to any workers and vehicles needed for each of the disposal group options discussed below.

4.3.9.2.1 Regional Economic Characteristics

4.3.9.2.1.1 Disposal Group 1

The projected workforce that would be needed for construction of the barriers over IDF-East and the RPPDF would dominate the total workforce in 2051 and 2052. The estimated peak of 1,180 FTEs is less than 1 percent of the projected labor force (about 211,000) in the ROI in 2051 (BEA 2007). In addition to the direct employees associated with constructing barriers for Disposal Group 1, approximately 880 indirect positions would likely be created as a secondary impact on the ROI.

4.3.9.2.1.2 Disposal Group 2

The projected workforce needed for construction of the barriers over IDF-East and the RPPDF would peak in 2101 and 2102. The estimated peak of 4,540 FTEs would be approximately 1.4 percent of the projected labor force (about 314,000) in the ROI in 2101, compared with approximately 10 percent in 2006 (BEA 2007). An additional 3,400 indirect jobs would be created in the ROI during 2101 and 2102.

4.3.9.2.1.3 Disposal Group 3

The projected workforce needed for construction of the barriers over IDF-East and the RPPDF would peak much later than under Disposal Group 2, beginning in 2166. The estimated peak of 4,540 FTEs would be approximately 1 percent of the projected labor force (about 447,000) in the ROI in 2166, compared with approximately 10 percent in 2006 (BEA 2007). Creation of an additional 3,400 indirect jobs in the ROI would also occur in 2166 and 2167.

4.3.9.2.2 Demographic Characteristics

4.3.9.2.2.1 Disposal Group 1

The vast majority of workers under Disposal Group 1 would come from the local workforce in the ROI. There would be little in-migration of new workers and their families; therefore, any changes in demographic characteristics of the Tri-Cities area and the ROI would be minimal.

4.3.9.2.2.2 Disposal Groups 2 and 3

The near-term impacts (less than 100 years) from the workforces under Disposal Groups 2 and 3 would have little impact on the local workforce in the ROI. There would be little in-migration of new workers and their families; therefore, any changes in demographic characteristics of the Tri-Cities area and the ROI would be minimal.

4.3.9.2.3 Housing and Community Services

For each of the three disposal groups, the peak workforce required would be relatively small compared with the local population and would have little or no impacts on demands for housing, schools, and other community services within the ROI.

4.3.9.2.4 Local Transportation

4.3.9.2.4.1 Disposal Group 1

Under Alternative 2, assuming an average of 1.25 persons per passenger vehicle (Malley 2007), up to 943 passenger vehicles per day are expected to commute to the site during the peak years of 2051 and 2052. Based on the predicted offsite truck activity of up to 7,210 truck trips per year (28 trips per day) in 2051 and 2052 and the predicted commuter traffic, the LOS on offsite roads in the

Hanford area is expected to be impacted (see Chapter 3, Section 3.2.9.4). Onsite truck trips would also peak in 2051 and 2052; up to 111,000 onsite truck trips per year (approximately 428 trips per day) would be needed to transport concrete aggregate materials and other borrow materials for construction of the barriers over IDF-East and the RPPDF.

4.3.9.2.4.2 Disposal Groups 2 and 3

Under Alternative 2, assuming an average of 1.25 persons per passenger vehicle (Malley 2007), up to 3,640 passenger vehicles per day are expected to commute to the site during the peak years of 2101 and 2102 for Disposal Group 2, and 2166 and 2167 for Disposal Group 3. Based on the predicted offsite truck activity of up to 8,840 truck trips (34 trips per day) in the peak years and the predicted commuter traffic, the LOS on offsite roads in the Hanford area is expected to be impacted (see Chapter 3, Section 3.2.9.4). Onsite truck trips would peak at 392,000 truck trips per year (approximately 1,500 trips per day) when concrete aggregate materials and other borrow materials are being transported to construct the barriers over IDF-East and the RPPDF.

4.3.9.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

As under Waste Management Alternative 2, the socioeconomic impacts under Alternative 3 would be affected by the workforce and local vehicles needed for treatment and storage of the waste as well as any workers and vehicles needed for each of the disposal group options below (see Table 4–140).

4.3.9.3.1 Regional Economic Characteristics

4.3.9.3.1.1 Disposal Group 1

Similar to Waste Management Alternative 2, the projected workforce needed for construction of the barriers over IDF-East and the RPPDF would dominate the total workforce for 2 years, beginning in 2051. The peak estimate of 1,170 FTEs would be less than 1 percent of the projected labor force of about 211,000 in 2051 in the ROI (BEA 2007). In addition to these direct employees, approximately 880 indirect positions would likely be created as a secondary impact on the ROI during the peak years.

4.3.9.3.1.2 Disposal Group 2

Similar to Waste Management Alternative 2, the projected workforce needed for construction of the barriers over IDF-East and the RPPDF would peak in 2101 and 2102. The peak estimate of 4,500 FTEs would be approximately 1.4 percent of the projected labor force of about 314,000 in the ROI in 2101, compared with approximately 10 percent in 2006 (BEA 2007). Approximately 3,400 indirect jobs in 2101 and 2102 would likely be created in the ROI in addition to these direct employees.

4.3.9.3.1.3 Disposal Group 3

Similar to Waste Management Alternative 2, the projected closure workforce needed for construction of the barriers over IDF-East and the RPPDF would peak much later than under Disposal Group 2, beginning in 2166. The estimated peak (4,500 FTEs) would be approximately 1 percent of the projected labor force (about 447,000) in the ROI in 2166, compared with approximately 10 percent in 2006 (BEA 2007). The existence of these jobs is expected to result in the creation of another 3,400 indirect jobs in the ROI.

4.3.9.3.2 Demographic Characteristics

4.3.9.3.2.1 Disposal Group 1

Similar to Waste Management Alternative 2, the vast majority of workers under Disposal Group 1 would come from the local workforce in the ROI. There would be little in-migration of new workers and their families; therefore, any changes in demographic characteristics of the Tri-Cities area and the ROI would be minimal.

4.3.9.3.2.2 Disposal Groups 2 and 3

Similar to Waste Management Alternative 2, the near-term impacts (less than 100 years) of the estimated workforces under Disposal Groups 2 and 3 would have little effect on the local workforce in the ROI. As there would be little in-migration of new workers and their families, any changes in demographic characteristics of the Tri-Cities area and the ROI would be minimal.

4.3.9.3.3 Housing and Community Services

For each of the three disposal groups, the peak workforce required would be relatively small compared to the local population and would have little or no impacts on demands for housing, schools, and other community services within the ROI.

4.3.9.3.4 Local Transportation

4.3.9.3.4.1 Disposal Group 1

Similar to Waste Management Alternative 2, under Alternative 3, assuming an average of 1.25 persons per passenger vehicle (Malley 2007), up to 940 passenger vehicles per day are expected to commute to the site during the peak years of 2051 and 2052. Based on the predicted offsite truck activity of up to 7,180 truck trips per year (28 trips per day) in 2051 and 2052 and the predicted commuter traffic, the LOS on offsite roads in the Hanford area is expected to be impacted (see Chapter 3, Section 3.2.9.4). Onsite truck trips would also peak in 2051 and 2052; up to 97,000 onsite truck trips per year (approximately 372 trips per day) would be needed to transport concrete aggregate materials and other borrow materials for construction of the barriers over IDF-East, IDF-West, and the RPPDF.

4.3.9.3.4.2 Disposal Groups 2 and 3

Under Waste Management Alternative 3, assuming an average of 1.25 persons per passenger vehicle (Malley 2007), up to about 3,600 passenger vehicles per day are expected to commute to the site during the peak years (2101–2102 for Disposal Group 2, and 2166–2167 for Disposal Group 3). Based on predicted offsite truck activity, up to 8,570 truck trips (33 trips per day) in peak years, and predicted commuter traffic, the LOS on offsite roads in the Hanford area is expected to be impacted (see Chapter 3, Section 3.2.9.4). Onsite truck trips would peak at 384,000 truck trips per year (approximately 1,480 trips per day) when concrete aggregate materials and other borrow materials are being transported for construction of the barriers over IDF-East, IDF-West, and the RPPDF.

4.3.10 Public and Occupational Health and Safety—Normal Operations

Details of the assessment methodology for determining radiological exposure to workers and members of the public are presented in Appendix K. Radiological impacts are presented for three public receptors: the general population living within 80 kilometers (50 miles) of Hanford, an MEI living near the site boundary, and an onsite member of the public who works at the Columbia Generating Station, LIGO, or US Ecology. Impacts on the general population were evaluated for a residential scenario whereby people are exposed to radioactive materials emitted from project facilities. Radiological exposure would occur through inhalation, direct exposure to the radioactive plume and material deposited on the ground, and ingestion of contaminated food products from animals raised locally and fruits and vegetables grown in a family garden (DOE 1995:A-7). Impacts on the offsite MEI were evaluated for a scenario that included the same exposure pathways assumed for the general population, but assuming a greater amount of time spent outdoors and a higher rate of contaminated food consumption. Impacts on an individual working at the Columbia Generating Station, LIGO, or US Ecology would occur due to inhalation and exposure to the plume and material deposited on the ground. The respective doses are presented as total effective doses.

In addition to members of the public, workers directly involved in activities associated with the Waste Management alternatives and nearby noninvolved workers may receive radiation doses. Doses to a worker were calculated based on an FTE worker. This dose evaluation assumed that an FTE worker has a 2,080-hour work year. In practice, the number of workers who might receive a radiation dose may be larger than the number assumed in this analysis, resulting in a smaller average dose per worker. A noninvolved worker is a person working at the site who is incidentally exposed to the radioactive air emissions associated with the alternatives considered. The noninvolved worker was assumed to be about 100 meters (110 yards) away or at a nearby facility only on workdays.

Small operational impacts on members of the public are expected from all of the Waste Management alternatives. Routine radioactive air emissions resulting from LLBG operations are expected to be negligible; the more likely source of emissions from waste management operations would be the waste processing facilities, where waste containers would be opened and waste sorted, reduced in size or otherwise treated, and repackaged. Consequently, the analyses of impacts on the public were based on the radioactive air emissions projected to occur from waste processing facilities such as a new facility at the T Plant or an expansion of WRAP.

4.3.10.1 Alternative 1: No Action

4.3.10.1.1 Radiological Impacts on the Public

Under the Waste Management No Action Alternative, there would be no incremental radiological impacts on the public due to operations. WRAP and T Plant emissions from current waste processing activities contribute to the offsite radioactive air emissions that make up the current affected environment. Therefore, they are accounted for in the offsite doses discussed in Chapter 3.

4.3.10.1.2 Radiological Impacts on Workers

Table 4–141 presents dose and risk estimates for an involved FTE worker receiving an average exposure. The average annual radiation worker dose would be 200 millirem, less than the Administrative Control Level of 500 millirem (DOE 2006a:2; Fluor Hanford 2006:2-1). A worker receiving the average annual radiation dose over the 29 years of this activity would receive a cumulative dose of 5,800 millirem, corresponding to a risk of about 3×10^{-3} (1 chance in 300) of developing an LCF.

The total effective dose equivalent to the worker population from the 29 years of occupational exposure under this alternative was estimated to be 37 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem, no LCFs due to occupational radiological exposure are expected in the worker population.

Table 4–141. Waste Management Alternative 1 Radiological Impacts on Workers

	Years[a]	Dose	Latent Cancer Fatality Risk[b]
Average Involved Full-Time-Equivalent Worker			
Average annual impact	2007–2035	200 millirem	1×10^{-4}
Impact over life of project[c]	2007–2035	5,800 millirem	3×10^{-3}
Life-of-Project Worker Population	2007–2035	37 person-rem	0 (2×10^{-2})

a Years indicate the portion of the project during which a worker dose is expected under this alternative.

b For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

c Impact over the life of the project is the average impact a full-time-equivalent radiation worker would receive while working on this project. It is determined by multiplying the average annual impact by the smaller of the project duration (29 years) or 40 years (assuming a worker spends a 40-year career supporting this project).

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.3.

4.3.10.2 Alternative 2: Disposal in IDF, 200-East Area Only

Under this Waste Management alternative, doses to the public would result from radioactive air emissions associated with waste processing in new or expanded facilities constructed at the T Plant and the CWC. Worker doses would result from waste processing facility and waste disposal operations.

4.3.10.2.1 Radiological Impacts on the Public

Table 4–142 presents estimated doses to the general population and the MEI under Alternative 2. Activities resulting in radioactive air emissions would occur from 2013 through 2051. Over the operational life of the project, the population within 80 kilometers (50 miles) of the 200 Areas would receive a cumulative dose of 0.000077 person-rem, and the MEI would receive a cumulative dose of 0.0000056 millirem. Using the risk factor of 0.0006 LCFs per person-rem (DOE 2003h:9), no LCFs are expected in the general population under this alternative. The probability of the MEI developing an LCF would be essentially zero (less than 1 chance in 300 billion). The MEI would be located across the river east-northeast of the 200-East Area. Radioactive air emissions would remain fairly constant over the duration of the alternative, with an annual population dose of 0.0000020 person-rem and an annual MEI dose of 0.00000015 millirem.

Radioactive air emissions from the 200 Area solid waste management facilities could also impact a member of the public who works at Hanford. The annual radiation dose to an individual at US Ecology who is exposed while at work would be 0.00000064 millirem. Over the 39-year period during which there would be radioactive emissions from waste management activities, a worker at US Ecology would receive a cumulative dose of 0.000025 millirem, with a corresponding risk of developing an LCF of essentially zero (about 1 chance in 100 billion).

Table 4–142. Waste Management Alternative 2 Radiological Impacts on the Public

Receptor	Impacts over Life of Project[a]		Peak Annual Impacts	
	Dose (person-rem)	**Latent Cancer Fatalities[b]**	**Dose (person-rem per year)**	**Latent Cancer Fatalities[b]**
General population	0.000077	0 (5×10^{-8})	0.0000020	0 (1×10^{-9})
	Dose (millirem)	**Lifetime Risk of a Latent Cancer Fatality[c]**	**Dose (millirem per year)**	**Lifetime Risk of a Latent Cancer Fatality[c]**
Maximally exposed individual	0.0000056	3×10^{-12}	0.00000015	9×10^{-14}
Maximally exposed onsite individual	0.000025	1×10^{-11}	0.00000064	4×10^{-13}

[a] Impacts accrued over the operational life of the project analyzed in this alternative, 2013–2051.

[b] The reported value is the projected number of latent cancer fatalities (LCFs) among the population and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

[c] The lifetime risk of developing an LCF is based on the risk factor of 0.0006 LCFs per rem.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.3.

4.3.10.2.2 Radiological Impacts on Workers

Radiological exposure of workers would occur from activities at the waste processing facilities and from LLBG operations. Table 4–143 presents dose and risk estimates for an involved and a noninvolved worker receiving an average exposure from activities at the waste processing facilities. Radiation doses to workers from LLBG operations of different durations are addressed in the following sections. The three different durations reflect the amounts of time when disposal capabilities would be needed to support various Tank Closure alternatives. Doses resulting from waste processing facility operations would be the same, regardless of the disposal group selected.

Table 4–143. Waste Management Alternative 2 Radiological Impacts on Workers

	Years[a]	Dose	Latent Cancer Fatality Risk[b]
Average Involved Full-Time-Equivalent Worker			
Average annual impact	2013–2051	200 millirem	1×10^{-4}
Impact over the life of project[c]	2013–2051	7,800 millirem	5×10^{-3}
Life-of-Project Worker Population	2013–2051	3,000 person-rem	2
Noninvolved Worker–Years of Maximum Impact			
100-meter distance	2013–2051	0.00039 millirem	2×10^{-10}

[a] Years indicate the portion of the project during which a worker dose is expected under this alternative.

[b] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).

[c] Impact over the life of the project is the average impact a full-time-equivalent radiation worker would receive while working on this project. It is determined by multiplying the average annual impact by the smaller of the project duration (39 years) or 40 years (assuming a worker spends a 40-year career supporting this project).

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.3.

The average annual radiation worker dose would be 200 millirem, less than the Administrative Control Level of 500 millirem. A worker receiving the average annual radiation dose over the 39 years of this activity would receive a cumulative dose of 7,800 millirem, corresponding to a risk of 5×10^{-3} (1 chance in 200) of developing an LCF.

The total effective dose equivalent to the worker population from 39 years of occupational exposure under this alternative was estimated to be 3,000 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem, 2 LCFs could be expected in the worker population. This number should be viewed in the context of the duration of the project and the DOE administrative controls that limit worker dose. Due to the duration of this activity, the cumulative dose would be distributed over a few generations of workers. Even though the worker population dose implies a number of LCFs, the operational controls used by DOE and its contractors would limit the dose that individual workers would receive and, therefore, the risk of developing an LCF. A majority of the worker population dose under this alternative (2,800 person-rem, or 93 percent) is associated with operation of WRAP.

The potential dose to a noninvolved worker would result from exposure to and inhalation of radioactive contaminants released to the atmosphere from waste processing activities. The potential dose to a noninvolved worker would be 0.00039 millirem per year, well less than the DOE recommended Administrative Control Level of 500 millirem per year (DOE 2006a:2; Fluor Hanford 2006:2-1). The annual risk of an LCF as a result of this exposure would be essentially zero (less than 1 chance in 4 trillion).

4.3.10.2.2.1 Disposal Group 1

Table 4–144 presents dose and risk estimates for a radiation worker involved in LLBG operations who would receive an average radiological exposure. LLBG operations would be conducted for 44 years under Disposal Group 1. The average annual dose would be 200 millirem, less than the Administrative Control Level of 500 millirem. A worker who received the average annual radiation dose over a 40-year career would receive a dose of 8,000 millirem, corresponding to a risk of 5×10^{-3} (1 chance in 200) of developing an LCF.

Table 4–144. Waste Management Alternative 2, Disposal Group 1, Radiological Impacts on Workers

	Years[a]	**Dose**	**Latent Cancer Fatality Risk[b]**
Average Involved Full-Time-Equivalent Worker			
Average annual impact	2007–2050	200 millirem	1×10^{-4}
Impact over the life of project[c]	2007–2050	8,000 millirem	5×10^{-3}
Life-of-Project Worker Population	2007–2050	360 person-rem	0 (2×10^{-1})

[a] Years indicate the portion of the project during which a worker dose is expected under this alternative and disposal group.

[b] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

[c] Impact over the life of the project is the average impact a full-time-equivalent radiation worker would receive while working on this project. It is determined by multiplying the average annual impact by the smaller of the project duration or 40 years (assuming a worker spends a 40-year career supporting this project).

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Appendix K, Section K.2.3.

The total effective dose equivalent to the worker population from 44 years of occupational exposure during disposal operations was estimated to be 360 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem, no LCFs due to occupational radiological exposure are expected in the worker population.

The total radiological impact on the worker population would be 3,360 person-rem, the combination of the doses from disposal operations (360 person-rem) and waste processing facility operations (3,000 person-rem) (see Section 4.3.10.2.2). Applying the risk factor of 0.0006 LCFs per person-rem, 2 LCFs could be expected in the worker population. This number should be viewed in the context of the duration of the project and the DOE administrative controls that limit worker dose. Due to the duration of this activity, the cumulative dose would be distributed over a few generations of workers. Even though the worker population dose implies a number of LCFs, the operational controls used by DOE and its contractors would limit the dose that individual workers would receive and, therefore, the risk of developing an LCF.

4.3.10.2.2.2 Disposal Group 2

Table 4–145 presents dose and risk estimates for a radiation worker involved in LLBG operations who would receive an average radiological exposure. LLBG operations would be conducted for 94 years under Disposal Group 2. The average annual dose would be 200 millirem, less than the Administrative Control Level of 500 millirem. A worker who received the average annual radiation dose over a 40-year career would receive a cumulative dose of 8,000 millirem, corresponding to a risk of 5×10^{-3} (1 chance in 200) of developing an LCF.

Table 4–145. Waste Management Alternative 2, Disposal Group 2, Radiological Impacts on Workers

	Years[a]	Dose	Latent Cancer Fatality Risk[b]
Average Involved Full-Time-Equivalent Worker			
Average annual impact	2007–2100	200 millirem	1×10^{-4}
Impact over the life of project[c]	2007–2100	8,000 millirem	5×10^{-3}
Life-of-Project Worker Population	2007–2100	3,600 person-rem	2

[a] Years indicate the portion of the project during which a worker dose is expected under this alternative.
[b] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).
[c] Impact over the life of the project is the average impact a full-time-equivalent radiation worker would receive while working on this project. It is determined by multiplying the average annual impact by the smaller of the project duration or 40 years (assuming a worker spends a 40-year career supporting this project).
Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.
Source: Appendix K, Section K.2.3.

The total effective dose equivalent to the worker population from 94 years of occupational exposure during disposal operations was estimated to be 3,600 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem, 2 LCFs due to occupational radiological exposure could be expected in the worker population. A majority of the worker population dose under this alternative (3,400 person-rem, or 94 percent) is associated with operation of the RPPDF.

The total radiological impact on the worker population would be 6,600 person-rem, the combination of the doses from disposal operations (3,600 person-rem) and waste processing facility operations (3,000 person-rem) (see Section 4.3.10.2.2). Applying the risk factor of 0.0006 LCFs per person-rem, 4 LCFs could be expected in the worker population. This number should be viewed in the context of the duration of the project and the DOE administrative controls that limit worker dose. Due to the duration of this activity, the cumulative dose would be distributed over several generations of workers. Even though the worker population dose implies a number of LCFs, the operational controls used by DOE and its contractors would limit the dose that individual workers would receive and, therefore, the risk of developing an LCF.

4.3.10.2.2.3 Disposal Group 3

Table 4–146 presents dose and risk estimates for a radiation worker involved in LLBG operations who would receive an average radiological exposure. LLBG operations would be conducted for 159 years under Disposal Group 3. The radiological impact on an individual worker would be the same as that under Disposal Group 2—an average annual dose of 200 millirem and a cumulative dose from 40 years of exposure of 8,000 millirem. The risk of developing an LCF associated with a dose of 8,000 millirem would be 5×10^{-3} (1 chance in 200).

The total effective dose equivalent to the worker population from 159 years of occupational exposure during Disposal Group 3 operations was estimated to be 6,400 person-rem. Applying the risk factor of 0.0006 LCFs per person-rem, 4 LCFs due to occupational radiological exposure could be expected in the worker population. A majority of the worker population dose under this alternative (6,200 person-rem, or 97 percent) would be associated with operation of the RPPDF.

Table 4–146. Waste Management Alternative 2, Disposal Group 3, Radiological Impacts on Workers

	Years[a]	Dose	Latent Cancer Fatality Risk[b]
Average Involved Full-Time-Equivalent Worker			
Average annual impact	2007–2165	200 millirem	1×10^{-4}
Impact over the life of project[c]	2007–2165	8,000 millirem	5×10^{-3}
Life-of-Project Worker Population	2007–2165	6,400 person-rem	4

[a] Years indicate the portion of the project during which a worker dose is expected under this alternative.
[b] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number (see Appendix K, Section K.1.1.6).
[c] Impact over the life of the project is the average impact a full-time-equivalent radiation worker would receive while working on this project. It is determined by multiplying the average annual impact by the smaller of the project duration or 40 years (assuming a worker spends a 40-year career supporting this project).
Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.
Source: Appendix K, Section K.2.3.

The total radiological impact on the worker population would be 9,400 person-rem, the combination of the doses from disposal operations (6,400 person-rem) and waste processing facility operations (3,000 person-rem) (see Section 4.3.10.2.2). Applying the risk factor of 0.0006 LCFs per person-rem, 6 LCFs could be expected in the worker population. This number should be viewed in the context of the duration of the project and the DOE administrative controls employed that limit worker dose. Due to the duration of this activity, the cumulative dose would be distributed over several generations of workers. Even though the worker population dose implies a number of LCFs, the operational controls used by DOE and its contractors would limit the dose that individual workers would receive and, therefore, the risk of developing an LCF.

4.3.10.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

Radiological impacts under this alternative would be the same as those under Alternative 2. Doses to the public would result from radioactive air emissions associated with waste processing in new or expanded facilities constructed at the T Plant and the CWC. Worker doses would result from waste processing facility and waste disposal operations.

4.3.10.3.1 Radiological Impacts on the Public

Radiological impacts on the public under this alternative would be the same as those under Alternative 2 (see Section 4.3.10.2.1).

4.3.10.3.2 Radiological Impacts on Workers

Radiological impacts on workers under this alternative would be the same as those under Waste Management Alternative 2 (see Section 4.3.10.2.2). Radiological exposure to workers would occur from waste processing facility activities and LLBG operations. Doses resulting from waste processing facility operations would be the same, regardless of the disposal group selected.

4.3.10.3.2.1 Disposal Group 1

Radiological impacts on workers from disposal operations under Waste Management Alternative 3, Disposal Group 1, would be the same as those under Alternative 2, Disposal Group 1 (see Section 4.3.10.2.2.1).

4.3.10.3.2.2 Disposal Group 2

Radiological impacts on the worker population from disposal operations for the duration of the project under Waste Management Alternative 3, Disposal Group 2, were estimated to be slightly smaller than those under Alternative 2. The collective worker population dose from 94 years of disposal operations would be about 3,500 person-rem. This small reduction in worker population dose would not change the estimated 2 LCFs that could occur in the worker population. The average annual worker dose would be the same as that under Alternative 2, Disposal Group 2 (see Section 4.3.10.2.2.2).

4.3.10.3.2.3 Disposal Group 3

Radiological impacts on workers from disposal operations under Waste Management Alternative 3, Disposal Group 3, would be the same as those under Alternative 2, Disposal Group 3 (see Section 4.3.10.2.2.3).

4.3.11 Public and Occupational Health and Safety—Facility Accidents

This section addresses impacts on workers and the public associated with potential accidents under the Waste Management alternatives and associated disposal groups. For each Waste Management alternative, the radiological impacts of postulated accident scenarios were quantified for an MEI living near Hanford, the offsite population as a whole, and a noninvolved worker. Hazardous chemical impacts were also evaluated. Accident consequences for an involved worker were not quantified. While involved workers are expected to be in or near waste treatment, storage, and disposal facilities analyzed under the Waste Management alternatives, the number and location of personnel relative to a postulated accident are unknown. In the event of an accident involving chemicals or radioactive materials, workers near an accident could be at risk of serious injury or fatality. Safety procedures, safety equipment, and protective barriers are typical features that would prevent or minimize worker impacts. Additionally, following initiation of accident/site emergency alarms, workers in adjacent areas of the facility would evacuate in accordance with the technical area and facility emergency operating procedures and training. Therefore, involved worker impacts are not discussed further relative to the Waste Management alternatives. The impacts of intentional destructive act scenarios would be comparable to those of scenarios Solid Waste Operations Complex (SWOC) FIR-4 (large fire of waste containers outside a facility) and SWOC EE-2 (aircraft crash).

There would be no radiological accidents associated with facility construction in support of Hanford waste treatment and storage activities or new disposal facility construction under the various disposal groups evaluated as part of Waste Management Alternatives 2 and 3. Any hazardous chemical accidents associated with facility construction (e.g., fuel spills) would be typical of those normally associated with industrial construction materials, hazards, and practices. The projected accident consequences under each Waste Management alternative are presented in the following sections. Details of the methodology for assessing the potential impacts on workers and the public associated with postulated accidents are presented in Appendix K, Section K.3.

4.3.11.1 Alternative 1: No Action

4.3.11.1.1 Radiological Impacts of Airborne Releases

Under Waste Management Alternative 1, reasonably foreseeable accidents include fires involving stored waste, spills of waste containers, external events, and natural phenomena. Table 4–147 shows the consequences of the accidents associated with the No Action Alternative. Table 4–148 shows the annual cancer risks for the accidents.

Table 4–147. Waste Management Alternative 1 Radiological Consequences of Accidents

Accident[a]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[c]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[b]
Single-drum deflagration (SWOC FIR-1)	0.00079	5×10^{-7}	4.7	0 (3×10^{-3})	0.84	5×10^{-4}
Medium fire inside facility (SWOC FIR-6)	0.015	9×10^{-6}	87	0 (5×10^{-2})	16	9×10^{-3}
Glovebox or greenhouse fire (SWOC FIR-8)	0.028	2×10^{-5}	170	0 (1×10^{-1})	30	4×10^{-2}
Large fire of waste containers outside facility (SWOC FIR-4)	0.25	1×10^{-4}	1,500	1	260	3×10^{-1}
Handling spill of single waste container (SWOC SP-2)	0.00015	9×10^{-8}	0.87	0 (5×10^{-4})	0.16	9×10^{-5}
Large handling spill of boxes or multiple waste containers (SWOC SP-3A)	0.00072	4×10^{-7}	4.3	0 (3×10^{-3})	0.77	5×10^{-4}
Spill of single large-diameter container (SWOC SP-4)	0.0070	4×10^{-6}	42	0 (3×10^{-2})	7.5	4×10^{-3}
Design-basis seismic event (SWOC NPH-1)	0.0068	4×10^{-6}	41	0 (2×10^{-2})	7.3	4×10^{-3}
Beyond-design-basis accident (SWOC NPH-2)	0.026	2×10^{-5}	160	0 (9×10^{-2})	28	3×10^{-2}
Range fire (SWOC EE-1)	0.12	7×10^{-5}	740	0 (4×10^{-1})	130	2×10^{-1}
Aircraft crash (SWOC EE-2)	0.28	2×10^{-4}	1,700	1	300	4×10^{-1}

[a] The alphanumeric code following the accident's title (e.g., SWOC FIR-1) corresponds with the code in the accident's description in Appendix K, Section K.3.6.

[b] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[c] Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.

[d] The reported value is the projected number of LCFs among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: LCF=latent cancer fatality; SWOC=Solid Waste Operations Complex.

Source: Appendix K, Section K.3.7.3.

The accident with the highest radiological risk to the offsite population and onsite workers (see Table 4–148) is the large fire of waste containers outside a facility (SWOC FIR-4). For this accident, no LCFs are expected to occur in the offsite population; however, there would be an increased risk of an LCF of about 9×10^{-3} per year (1 chance in 110 per year of a single LCF occurring among the population). For the MEI, the increase in the likelihood of an LCF would be about 1×10^{-6} per year (1 chance in 680,000 per year). For a noninvolved worker 100 meters (110 yards) from the accident, the increase in the likelihood of an LCF would be about 3×10^{-3} per year (1 chance in 320 per year). For any involved or noninvolved worker closer than 100 meters (110 yards) from the accident's location, the risk of exposure to radioactivity resulting in eventual development of an LCF would depend on the distance and other factors, but would generally be higher. The accident that would have the highest consequences would be the aircraft crash (SWOC EE-2). The consequences would be about 1.2 times those shown for the large fire of waste containers outside a facility (SWOC FIR-4).

Under Waste Management Alternative 1, operations would continue for a project period of 29 years; during this time period, workers and the public would be at risk of exposure to radiation from an accident. For the highest-risk accident (accident SWOC FIR-4) in Table 4–148, the annual cancer risks to the offsite population and noninvolved workers during this 29-year project period would be a zero (3×10^{-1}) increase in the number of LCFs in the offsite population, a 4×10^{-5} increase in the likelihood of an LCF for the MEI, and a 9×10^{-2} increase in the likelihood of an LCF for the noninvolved worker.

Table 4–148. Waste Management Alternative 1 Annual Cancer Risks from Accidents

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality		
		Maximally Exposed Individual[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Single-drum deflagration (SWOC FIR-1)	1×10^{-2}	5×10^{-9}	0 (3×10^{-5})	5×10^{-6}
Medium fire inside facility (SWOC FIR-6)	1×10^{-2}	9×10^{-8}	0 (5×10^{-4})	9×10^{-5}
Glovebox or greenhouse fire (SWOC FIR-8)	1×10^{-2}	2×10^{-7}	0 (1×10^{-3})	4×10^{-4}
Large fire of waste containers outside facility (SWOC FIR-4)	1×10^{-2}	1×10^{-6}	0 (9×10^{-3})	3×10^{-3}
Handling spill of single waste container (SWOC SP-2)	1×10^{-2}	9×10^{-10}	0 (5×10^{-6})	9×10^{-7}
Large handling spill of boxes or multiple waste containers (SWOC SP-3A)	1×10^{-2}	4×10^{-9}	0 (3×10^{-5})	5×10^{-6}
Spill of single large-diameter container (SWOC SP-4)	1×10^{-2}	4×10^{-8}	0 (3×10^{-4})	4×10^{-5}
Design-basis seismic event (SWOC NPH-1)	1×10^{-3}	4×10^{-9}	0 (2×10^{-5})	4×10^{-6}
Beyond-design-basis accident (SWOC NPH-2)	1×10^{-3}	2×10^{-8}	0 (9×10^{-5})	3×10^{-5}
Range fire (SWOC EE-1)	1×10^{-2}	7×10^{-7}	0 (4×10^{-3})	2×10^{-3}
Aircraft crash (SWOC EE-2)	3×10^{-5}	5×10^{-9}	0 (3×10^{-5})	1×10^{-5}

[a] The alphanumeric code following the accident's title (e.g., SWOC FIR-1) corresponds with the code in the accident's description in Appendix K, Section K.3.6.

[b] Increased risk of a latent cancer fatality to the individual.

[c] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[d] The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: SWOC=Solid Waste Operations Complex.

Source: Appendix K, Section K.3.7.3.

4.3.11.1.2 Hazardous Chemical Impacts

Hazardous waste exists in two major areas in the SWOC. The first is the toxic chemical contents of waste containers encountered during retrieval and handling of TRU waste containers and suspect TRU waste containers. The second toxic chemical within the SWOC is the sodium in storage modules at the CWC facility. The future disposition of the bulk sodium stored at the CWC is addressed in Section 4.2. The consequences of accidents involving the bulk sodium are addressed in Section 4.2.11.1.2.

To estimate the hazard significance and potential impacts of an accidental release of the hazardous chemicals within the SWOC waste containers, the containers were evaluated using the methodologies for identifying hazardous chemicals that should be subjected to quantitative analyses in both the DOE safety analysis and emergency management programs. The results of this evaluation are discussed in Appendix K; the results indicate that, except for sodium metal mentioned above, none of the chemicals listed exist in a form or quantity that represents a sufficiently high health hazard that would require analysis and inclusion in a documented facility safety analysis or an emergency preparedness hazards assessment.

The hazardous chemicals in the waste management containers are generally mixed together with the hazardous radioactive materials. Radiological accident scenarios are expected to release both radioactive materials and hazardous (toxic) chemicals. The scenario most likely to release a substantial quantity of hazardous chemicals is a fire event involving multiple waste containers. From the results reported in Appendix K for this type of event, the dose consequence to the noninvolved worker at 100 meters (110 yards) would be 210 rem; doses from the other fire scenarios analyzed ranged from approximately 1 rem to a maximum of 300 rem.

The evaluation of chemical exposures shows that exposures to the noninvolved worker do not exceed the AEGLs (i.e., 60-minute AEGL-2 value) established by the U.S. Environmental Protection Agency (EPA) and implemented by DOE as the trigger point for planning protective measures for the public in the event of a large release of hazardous chemicals. The equivalent radiological threshold established by EPA for planning protective measures in the event of a large release of radioactive material is 1 rem. From the results of the radiological analysis and the chemical evaluations, it is clear that the potential health impacts of the radioactive components of the waste far outweigh those of the chemical components. Therefore, further quantitative analysis to determine the potential human health impacts of an accidental release of hazardous chemicals from within the mixed waste is not necessary.

4.3.11.2 Alternative 2: Disposal in IDF, 200-East Area Only

4.3.11.2.1 Radiological Impacts of Airborne Releases

Table 4–149 shows the consequences of the accidents associated with Alternative 2. Table 4–150 shows the annual cancer risks for the accidents. In addition to the accident scenarios evaluated under Alternative 1, two new accident scenarios involving ILAW containers disposed of in IDF-East are possible under Alternative 2.

The accident with the highest radiological risk to the offsite population and onsite workers (see Table 4–150) is the large fire of waste containers outside a facility (SWOC FIR-4). For this accident, no LCFs are expected in the offsite population; however, there would be an increased risk of an LCF of about 9×10^{-3} per year (about 1 chance in 110 per year of a single LCF) occurring among the population. For the MEI, the increased likelihood of an LCF would be about 1×10^{-6} per year (about 1 chance in 680,000 per year). For a noninvolved worker located 100 meters (110 yards) from the accident, the increased likelihood of an LCF would be about 3×10^{-3} per year (about 1 chance in 320 per year). For any involved or noninvolved worker closer than 100 meters (110 yards) from the accident's location, the risk of exposure to radioactivity resulting in eventual development of an LCF would depend on the distance and other factors, but would generally be higher. The accident that would have the highest consequences would be the aircraft crash (SWOC EE-2). The consequences would be about 1.2 times those shown for the large fire of waste containers outside a facility.

Table 4–149. Waste Management Alternatives 2 and 3 Radiological Consequences of Accidents

Accident[a]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[c]	Dose (person-rem)	LCF[d]	Dose (rem)	LCF[b]
Single-drum deflagration (SWOC FIR-1)	0.00079	5×10^{-7}	4.7	0 (3×10^{-3})	0.84	5×10^{-4}
Medium fire inside facility (SWOC FIR-6)	0.015	9×10^{-6}	87	0 (5×10^{-2})	16	9×10^{-3}
Glovebox or greenhouse fire (SWOC FIR-8)	0.028	2×10^{-5}	170	0 (1×10^{-1})	30	4×10^{-2}
Large fire of waste containers outside facility (SWOC FIR-4)	0.25	1×10^{-4}	1,500	1	260	3×10^{-1}
Handling spill of single waste container (SWOC SP-2)	0.00015	9×10^{-8}	0.87	0 (5×10^{-4})	0.16	9×10^{-5}
Large handling spill of boxes or multiple waste containers (SWOC SP-3A)	0.00072	4×10^{-7}	4.3	0 (3×10^{-3})	0.77	5×10^{-4}
Spill of single large-diameter container (SWOC SP-4)	0.0070	4×10^{-6}	42	0 (3×10^{-2})	7.5	4×10^{-3}
Design-basis seismic event (SWOC NPH-1)	0.0068	4×10^{-6}	41	0 (2×10^{-2})	7.3	4×10^{-3}
Beyond-design-basis accident (SWOC NPH-2)	0.026	2×10^{-5}	160	0 (9×10^{-2})	28	3×10^{-2}
Range fire (SWOC EE-1)	0.12	7×10^{-5}	740	0 (4×10^{-1})	130	2×10^{-1}
Aircraft crash (SWOC EE-2)	0.28	2×10^{-4}	1,700	1	300	4×10^{-1}
Earthmover shears tops off six ILAW containers (ILAW1)	0.0000034	2×10^{-9}	0.020	0 (1×10^{-5})	0.0036	2×10^{-6}
Crushing of ILAW containers by falling crane boom (ILAW2)	0.000031	2×10^{-8}	0.18	0 (1×10^{-4})	0.033	2×10^{-5}

a The alphanumeric code following the accident's title (e.g., SWOC FIR-1) corresponds with the code in the accident's description in Appendix K, Section K.3.6.

b Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively (see Appendix K, Section K.2.1.1.3.2).

c Increased likelihood of latent cancer fatality for an individual, assuming the accident occurs.

d The reported value is the projected number of LCFs among the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: ILAW=immobilized low-activity waste; LCF=latent cancer fatality; SWOC=Solid Waste Operations Complex.

Source: Appendix K, Section K.3.7.3.

4.3.11.2.1.1 Disposal Group 1

Under Disposal Group 1, disposal operations would continue for 44 years. For the highest-risk accident shown in Table 4–150 (SWOC FIR-4), there would be no (4×10^{-1}) additional LCFs in the offsite population as a consequence of the 44-year project period. As a result of the 44-year duration of the project, there would be an increased risk of an LCF for an MEI of about 6×10^{-5} (1 chance in 15,000) and an increased risk of an LCF for the noninvolved worker of about 1×10^{-1} (1 chance in 7).

Table 4–150. Waste Management Alternatives 2 and 3 Annual Cancer Risks from Accidents

Accident[a]	Frequency (per year)	Risk of Latent Cancer Fatality: Maximally Exposed Individual[b]	Offsite Population[c, d]	Noninvolved Worker[b]
Single-drum deflagration (SWOC FIR-1)	1×10^{-2}	5×10^{-9}	0 (3×10^{-5})	5×10^{-6}
Medium fire inside facility (SWOC FIR-6)	1×10^{-2}	9×10^{-8}	0 (5×10^{-4})	9×10^{-5}
Glovebox or greenhouse fire (SWOC FIR-8)	1×10^{-2}	2×10^{-7}	0 (1×10^{-3})	4×10^{-4}
Large fire of waste containers outside facility (SWOC FIR-4)	1×10^{-2}	1×10^{-6}	0 (9×10^{-3})	3×10^{-3}
Handling spill of single waste container (SWOC SP-2)	1×10^{-2}	9×10^{-10}	0 (5×10^{-6})	9×10^{-7}
Large handling spill of boxes or multiple waste containers (SWOC SP-3A)	1×10^{-2}	4×10^{-9}	0 (3×10^{-5})	5×10^{-6}
Spill of single large-diameter container (SWOC SP-4)	1×10^{-2}	4×10^{-8}	0 (3×10^{-4})	4×10^{-5}
Design-basis seismic event (SWOC NPH-1)	1×10^{-3}	4×10^{-9}	0 (2×10^{-5})	4×10^{-6}
Beyond-design-basis accident (SWOC NPH-2)	1×10^{-3}	2×10^{-8}	0 (9×10^{-5})	3×10^{-5}
Range fire (SWOC EE-1)	1×10^{-2}	7×10^{-7}	0 (4×10^{-3})	2×10^{-3}
Aircraft crash (SWOC EE-2)	3×10^{-5}	5×10^{-9}	0 (3×10^{-5})	1×10^{-5}
Earthmover shears tops off six ILAW containers (ILAW1)	1×10^{-1}	2×10^{-10}	0 (1×10^{-6})	2×10^{-7}
Crushing of ILAW containers by falling crane boom (ILAW2)	1×10^{-1}	2×10^{-9}	0 (1×10^{-5})	2×10^{-6}

[a] The alphanumeric code following the accident's title (e.g., SWOC FIR-1) corresponds with the code in the accident's description in Appendix K, Section K.3.6.

[b] Increased risk of a latent cancer fatality to the individual.

[c] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively (see Appendix K, Section K.2.1.1.3.2).

[d] The reported value is the projected number of latent cancer fatalities (LCFs) among the population, based on the probability (frequency) of the accident occurring, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

Key: ILAW=immobilized low-activity waste; SWOC=Solid Waste Operations Complex.

Source: Appendix K, Section K.3.7.3.

4.3.11.2.1.2 Disposal Group 2

Under Disposal Group 2, disposal operations would continue for 94 years. For the highest-risk accident shown in Table 4–150 (SWOC FIR-4), there would be a risk of about 1 (8×10^{-1}) additional LCF in the offsite population as a consequence of the 94-year project period. As a result of the 94-year duration of the project, there would be an increased risk of an LCF for an MEI of about 1×10^{-4} (1 chance in 7,000) and an increased risk of an LCF for the noninvolved worker of about 3×10^{-1} (1 chance in 3). This risk to an MEI or noninvolved worker is theoretical because the same individual would not be present for the duration of the project.

4.3.11.2.1.3 Disposal Group 3

Under Disposal Group 3, disposal operations would continue for 159 years. For the highest-risk accident shown in Table 4–150 (SWOC FIR-4), there would be a risk of 1 (1.4) additional LCF in the offsite population as a consequence of the 159-year project period. As a result of the 159-year duration of the project, there would be an increased risk of an LCF for an MEI of about 2×10^{-4} (1 chance in 4,300) and an increased risk of an LCF for the noninvolved worker of about 5×10^{-1} (1 chance in 2). This risk to an MEI or noninvolved worker is theoretical because the same individual would not be present for the duration of the project.

4.3.11.2.2 Hazardous Chemical Impacts

The hazardous chemical impacts of accidents under Alternative 2 (including Disposal Groups 1, 2, and 3) would be the same as those addressed under Alternative 1 (see Section 4.3.11.1.2).

4.3.11.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

4.3.11.3.1 Radiological Impacts of Airborne Releases

The accident scenarios under Alternative 3 are the same as those addressed under Alternative 2. The consequences and annual risks of the accidents are presented in Tables 4–149 and 4–150.

4.3.11.3.1.1 Disposal Groups 1, 2, and 3

The radiological impacts of reasonably anticipated accidents under Alternative 3, Disposal Groups 1, 2, and 3, would be the same as those addressed under Alternative 2 (see Sections 4.3.11.2.1.1, 4.3.11.2.1.2, and 4.3.11.2.1.3).

4.3.11.3.2 Hazardous Chemical Impacts

The hazardous chemical impacts of accidents under Alternative 3 (including Disposal Groups 1, 2, and 3) would be the same as those addressed under Alternative 1 (see Section 4.3.11.1.2).

4.3.11.4 Intentional Destructive Acts

This section addresses potential impacts of intentional destructive acts at waste management facilities. Release scenarios and impacts resulting from intentional destructive acts may be similar to a number of the accidents scenarios analyzed in this EIS. An additional intentional destructive act scenario was also considered. This scenario would apply to all Waste Management alternatives.

Large Aircraft Crash at Solid Waste Operations Complex Storage Building. Impacts of the aircraft crash accident scenario (SWOC EE-2) were extrapolated to reflect the potential impacts of an intentional destructive act that could involve a large aircraft, substantial amounts of fuel, and damage to a large number of containers in a SWOC storage building. The radiological impacts would be about 18 times greater than those calculated for the accident scenario. The offsite population dose was estimated to be 31,000 person-rem, which would result in 19 additional LCFs. The MEI dose would be 5.0 rem, corresponding to an increased risk of an LCF of 3×10^{-3}. The noninvolved worker dose would be 5,400 rem, which could result in a near-term fatality.

The impacts and mitigation of intentional destructive acts are discussed in more detail in Appendix K, Section K.3.11.

4.3.12 Public and Occupational Health and Safety—Transportation

Impacts of transporting radioactive materials are predominantly categorized as radiological impacts or nonradiological impacts. Radiological impacts are those associated with the accidental release of radioactive materials and the effects of low levels of radiation emitted during incident-free transportation. Nonradiological impacts are those associated with transportation, regardless of the nature of the cargo, such as accidents resulting in death or injury when there is no release of radioactive material.

Transportation impacts include the impacts of incident-free transportation, as well as those of transportation accidents. The impacts of both incident-free transportation and transportation accidents can be radiological and nonradiological. Incident-free transportation impacts include radiological impacts on the public and workers from the radiation field surrounding the transportation package. Nonradiological impacts of potential transportation accidents include traffic accident fatalities. The impact of a specific radiological accident is expressed in terms of probabilistic risk, which is defined as the accident probability (i.e., accident frequency) multiplied by the accident consequences. The overall risk is obtained by summing the individual risks from all accident severities, irrespective of their likelihood of occurrence. The analysis of accident risks takes into account a spectrum of accidents ranging from high-probability accidents of low severity (e.g., fender benders) to hypothetical high-severity accidents that have a low probability of occurrence. Additional information is provided in Section 4.1.12, and further details on modeling and parameter selections are provided in Appendix H.

Table 4–151 provides the estimated number of shipments of various wastes under each alternative by waste type. A shipment is defined as the amount of waste transported on a single truck or a single railcar. The values presented for offsite shipments in Table 4–151 are the estimated number of shipments required to transport about 75,500 cubic meters (99,000 cubic yards) of LLW and MLLW from DOE facilities. This activity is common to both Alternatives 2 and 3. The values presented for the offsite-waste shipments in Table 4–151 are estimated truck transports. Offsite rail shipments were assumed to be one-half of the values given.

Table 4–151. Waste Management Alternatives – Estimated Number of Shipments

Alternative	Number of Shipments			
	Offsite Shipments[a]		Onsite Shipments	
	LLW[b]	MLLW[b]	LLW[b]	MLLW[b]
Alternative 1	0	0	810	200
Alternative 2	12,800	1,300	810	200
Alternative 3	12,800	1,300	810	200

[a] These are estimates for truck transports. Rail transports would be one-half of the values given.
[b] These include both the contact- and remote-handled wastes.
Key: LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste.
Source: Appendix H, Section H.7.3.

Table 4–152 summarizes the transportation risks under each alternative and shows that the dose to the population along the routes (see column 6 of Table 4–152: offsite) would be between the lowest expected dose of about 140 person-rem, which is associated with rail transport of offsite waste to Hanford, and the highest expected dose of about 350 person-rem, which is associated with truck transport of offsite waste to Hanford. The additional LCFs expected from such exposures to the general population would be less than 1 for all alternatives, ranging from 0.08 to 0.21. Rail transport would lead to lower doses to the general population due to the smaller number of transports and lower exposure of the people in the vicinity of stations where the reclassification and inspections would take place. Almost half of the doses to the general population resulting from truck transports would result from exposures at rest areas, gas stations, and stops along the route.

The lowest expected dose to workers transporting wastes (see column 4 of Table 4–152: offsite) would be about 49 person-rem for offsite rail shipments, and the highest would be 2,500 person-rem for offsite truck shipments. The additional LCFs among the exposed crew would range from 0 (0.03) to 2 (1.5). Rail transport would result in lower doses to rail crews because they would be located farther away from the waste packages than the truck crews. Note that the maximum annual dose to a transportation crewmember would be 100 millirem per year, unless the individual is a trained radiation worker, in which case the maximum annual dose would be 2 rem (DOE Standard 1098-2008). The potential for a trained radiation worker to develop a latent fatal cancer from the maximum annual exposure of 2 rem is 0.0012 (about 1 chance in 833). Therefore, an individual transportation worker is not expected to develop a latent fatal cancer from exposures during these activities during his or her lifetime.

Table 4–152. Waste Management Alternatives – Risks of Transporting Radioactive Waste

Alternative	Location (transport mode)	Number of Shipments	Incident-Free: Crew Dose (person-rem)	Incident-Free: Crew Risk[a]	Incident-Free: Population Dose (person-rem)	Incident-Free: Population Risk[a]	Accident: Rad. Risk[a, b]	Accident: Nonrad. Risk[a]	One-Way Offsite Travel (10^6 km)
Alternative 1	Off site	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	On site	1,000	2.6	0.002	0.08	0.00005	7.6×10^{-11}	0.0004	N/A
Alternative 2	Off site (T)	14,200	2,500	1.5	350	0.21	1.2×10^{-5}	1.7	51.3
	Off site (R)	7,100	49	0.03	140	0.08	1.8×10^{-6}	4.1	26.1
	On site	1,000	4.3	0.003	0.14	0.00008	1.6×10^{-10}	0.0006	N/A
Alternative 3	Off site (T)	14,200	2,500	1.5	350	0.21	1.2×10^{-5}	1.7	51.3
	Off site (R)	7,100	49	0.03	140	0.08	1.8×10^{-6}	4.1	26.1
	On site	1,000	2.6	0.002	0.08	0.00005	7.6×10^{-11}	0.0004	N/A

[a] Risk is expressed in terms of latent cancer fatalities, except for the nonradiological, where it refers to the number of accident fatalities.
[b] To calculate population dose (person-rem), divide the values in this column by 0.0006. For additional insight on how this dose is calculated, see the text in Section 4.1.12.

Note: To convert kilometers to miles, multiply by 0.6214.

Key: km=kilometers; N/A=not applicable—(no offsite waste would be accepted at the Hanford Site); nonrad.=nonradiological; R=rail transport; rad.=radiological; T=truck transport.

Source: Appendix H, Section H.7.3.

The risks to different receptors under incident-free transportation conditions were estimated on a per-trip or per-event basis. This basis was used because it is unlikely that the same person would be exposed to multiple events; for those that could have multiple exposures, the dose over the duration of transportation activities could be calculated by multiplying by the number of events or trips. The dose to a person stuck in traffic next to a shipment of RH-waste in a Type B cask for 30 minutes was calculated to be about 10 millirem. For a receptor who is a member of the public residing along a transportation route, the dose over the duration of transportation activities would depend on the number of truck or rail shipments passing a particular point and would be independent of the actual route being considered. The maximum dose to this resident, if all the materials are shipped along this route, would be less than 5 millirem under all of the action alternatives. Refer to Appendix H, Table H–17, for additional results.

The expected number of traffic fatalities from accidents involving radioactive material transport would range from 2 (1.7) for truck shipments and 4 (4.1) for rail shipments. Considering that the duration of acceptance of offsite waste would be about 30 years and the average number of traffic fatalities in the U.S. is about 40,000 per year, the expected risk of a traffic fatality under all of the alternatives is small.

Table 4–153 summarizes the impacts of transporting the nonradioactive support materials required to construct new facilities, materials required to support operational activities, and waste en route to storage or burial locations. The construction materials considered include concrete, cement, sand/gravel/dirt, asphalt, steel, and piping, among others. The table shows the impacts in terms of the total numbers of kilometers, accidents, and fatalities for all alternatives. The results in Table 4–153 indicate that, under the Waste Management alternatives, the potential for traffic fatalities would be the largest under Disposal Group 3. However, the absolute risk would be small, considering that the operational period for this disposal group would be over 120 years.

Table 4–153. Waste Management Alternatives – Estimated Impacts of Construction and Operational Material Transport

Alternatives/Disposal Groups	Total Distance Traveled (million kilometers)	Number of Accidents	Number of Fatalities
Alternative 1	0.42	0.09	0.006
Alternative 2	4.2	0.84	0.05
Disposal Group 1	8.2	1.7	0.11
Disposal Group 2	29	5.9	0.38
Disposal Group 3	37	7.5	0.49
Alternative 3	4.2	0.84	0.05
Disposal Group 1	7.4	1.5	0.10
Disposal Group 2	29	5.9	0.38
Disposal Group 3	37	7.6	0.49

Note: To convert kilometers to miles, multiply by 0.6214.
Source: Appendix H, Section H.8.

4.3.12.1 Alternative 1: No Action

Under this alternative, transportation activities would be limited to shipments of onsite waste to the active burial grounds in the 200-West Area. About 1,000 shipments would be transported from various facilities at Hanford to the 200-West Area of Hanford for disposal (see Table 4–151). These transports would mostly use onsite roads.

4.3.12.1.1 Impacts of Incident-Free Transportation

The dose to transportation workers from all onsite transportation activities would be 2.6 person-rem, and the dose to the exposed population would be 0.08 person-rem. Accordingly, incident-free transportation of radioactive material would result in 0 (0.002) LCFs among transportation workers and 0 (0.00005) LCFs among the exposed population (see Table 4–152).

4.3.12.1.2 Impacts of Accidents During Transportation

As stated earlier, two sets of analyses were performed to evaluate the transportation accident impacts: analyses of the impacts of maximum reasonably foreseeable accidents and analyses of the impacts of all accidents, regardless of their severity or likelihood of occurrence.

The maximum reasonably foreseeable offsite transportation accident under this alternative (with a probability of occurrence of more than 1 chance in 10 million per year) would not lead to a release. The consequences of the most severe onsite accident that could release the content of the waste were estimated to have a likelihood of less than 1 chance in 1 billion per year.

Estimates of the total transportation accident risks under this alternative included a radiation dose risk to the population of 1.3×10^{-7} person-rem, resulting in 7.6×10^{-11} LCFs (1 chance in 13 billion), and traffic accidents resulting in 0 (0.0004) fatalities (see Table 4–152).

4.3.12.1.3 Impacts of Construction and Operational Material Transports

The impacts of transporting construction materials (e.g., concrete, gravel/sand/soil, asphalt, steel, piping) and feed materials for the production and transport of waste (e.g., grout, fly ash, containers, boxes, canisters) were evaluated. The impacts of transport activities under this alternative would be 420,000 kilometers (261,000 miles) traveled, 0 (0.09) accidents, and 0 (0.006) fatalities over the entire period from construction through deactivation and closure (see Table 4–153). No disposal groups were analyzed under this alternative.

4.3.12.2 Alternative 2: Disposal in IDF, 200-East Area Only

Under this alternative, limited offsite waste would be accepted for disposal. This waste would require about 7,100 rail shipments or about 14,200 truck shipments. In addition, about 1,000 truck shipments would be made to transport onsite waste to storage locations and burial grounds. The total distance traveled carrying radioactive materials would be 26.1 million kilometers (16.2 million miles) on public rail or 51.3 million kilometers (20.8 million miles) on public roads.

4.3.12.2.1 Impacts of Incident-Free Transportation

The dose to transportation workers from offsite transportation activities was estimated to be about 49 person-rem for rail shipments and 2,500 person-rem for truck shipments. The additional LCFs among the transportation workers would range from 0 (0.03) to 2 (1.5). The dose to transportation workers from onsite transport activity was estimated to be 4.3 person-rem, resulting in 0 (0.003) additional LCFs (see Table 4–152). As stated under Alternative 2, the maximum annual dose to a transportation worker would be 100 millirem, unless the individual is a trained radiation worker, in which case the maximum annual dose would be 2 rem (DOE Standard 1098-2008). Therefore, an individual transportation worker is not expected to develop a latent fatal cancer from exposures during these activities during his or her lifetime.

The expected cumulative dose to the general population during offsite transportation of waste by truck would be about 350 person-rem, resulting in 0 (0.21) additional LCFs. The expected doses to the general population during offsite transportation of waste by rail would be about 140 person-rem, resulting in 0 (0.08) additional LCFs. Rail transport would lead to lower doses to the general population due to the smaller number of transports and lower exposure of the people in the vicinity of stations where the reclassification and inspections would take place. Almost half of the doses to the general population resulting from truck transports would result from exposures at rest areas, gas stations, and stops along the route.

4.3.12.2.1.1 Disposal Group 1

The estimates of the incident-free operational risks during transport of waste materials for this disposal group have already been accounted for, as discussed in Sections 4.1.12, 4.2.12, and 4.3.12.2.1.

4.3.12.2.1.2 Disposal Group 2

The estimates of the incident-free operational risks during transport of waste materials for this disposal group have already been accounted for, as discussed in Sections 4.1.12, 4.2.12, and 4.3.12.2.1.

4.3.12.2.1.3 Disposal Group 3

The estimates of the incident-free operational risks during transport of waste materials for this disposal group have already been accounted for, as discussed in Sections 4.1.12, 4.2.12, and 4.3.12.2.1.

4.3.12.2.2 Impacts of Accidents During Transportation

The maximum reasonably foreseeable offsite transportation accident under this alternative (with a probability of occurrence of more than 1 chance in 10 million per year) is a severe-impact, high-temperature-fire rail accident involving a shipment of RH-LLW. The consequences of such an accident in terms of population dose in the rural, suburban, and urban zones are 1.6, 25, and 120 person-rem, respectively. The likelihood of occurrence of such consequences per shipment is less than 2.5×10^{-7}, 2.8×10^{-8}, and 5.3×10^{-9} in rural, suburban, and urban zones, respectively. This accident could result in a dose of 0.00031 rem to an individual hypothetically exposed to the accident plume for 2 hours at a distance of 100 meters (330 feet), with a corresponding LCF risk of 1.9×10^{-7}.

Estimates of the total transportation accident risks (both on and off site) under this alternative are a radiation dose risk to the population ranging from 0.003 to 0.02 person-rem, resulting in 1.8×10^{-6} to 1.2×10^{-5} LCFs, and traffic accidents resulting in 2 (1.7) to 4 (4.1) fatalities for rail or truck shipments, respectively (see Table 4–152). All of the risks would result from offsite shipment of wastes to Hanford. These results indicate that the annual accident risks would be small, considering that the duration of these activities would be 35 years.

4.3.12.2.2.1 Disposal Group 1

The estimates of the accident risks during transport of waste materials for this disposal group have already been accounted for, as discussed in Sections 4.1.12, 4.2.12, and 4.3.12.2.1.

4.3.12.2.2.2 Disposal Group 2

The estimates of the accident risks during transport of waste materials for this disposal group have already been accounted for, as discussed in Sections 4.1.12, 4.2.12, and 4.3.12.2.1.

4.3.12.2.2.3 Disposal Group 3

The estimates of the accident risks during transport of waste materials for this disposal group have already been accounted for, as discussed in Sections 4.1.12, 4.2.12, and 4.3.12.2.1.

4.3.12.2.3 Impacts of Construction and Operational Material Transports

The impacts of transporting construction materials (e.g., concrete, gravel/sand/soil, asphalt, steel, piping) and feed materials for the production and transport of waste (e.g., grout, fly ash, containers, boxes, canisters) were evaluated. In addition, under this alternative, three different combinations of waste capacities (disposal groups) that would be allocated to IDF-East and the RPPDF over varying operational timeframes to accommodate the waste generated under the various Tank Closure, FFTF Decommissioning, and Waste Management alternatives were evaluated. The transportation impacts under this alternative would consist of two parts: (1) transports in support of construction and operation of the disposal group IDF, and (2) transports in support of activities within the alternative (see Table 4–153). The impacts of transportation activities under the disposal groups would range from 8.2 to 37 million kilometers (5.1 to 23 million miles) traveled and 2 (1.7) to 8 (7.6) accidents, and would result in 0 (0.11 to 0.49) fatalities over the entire period, from IDF construction through deactivation and closure. The impacts of transport activities under this alternative would be 4.2 million kilometers (2.6 million miles) traveled, 1 (0.84) accident, and 0 (0.05) fatalities over the entire period from IDF construction through deactivation and closure (see Table 4–153).

4.3.12.2.3.1 Disposal Group 1

The impacts of transportation activities under this disposal group would be 8.2 million kilometers (5.1 million miles) traveled, 2 (1.7) accidents, and 0 (0.11) fatalities over the entire period from IDF construction through deactivation and closure.

4.3.12.2.3.2 Disposal Group 2

The impacts of transportation activities under this disposal group would be 29 million kilometers (18 million miles) traveled, 6 (5.9) accidents, and 0 (0.38) fatalities over the entire period from IDF construction through deactivation and closure.

4.3.12.2.3.3 Disposal Group 3

The impacts of transportation activities under this disposal group would be 37 million kilometers (23 million miles) traveled, 8 (7.5) accidents, and 0 (0.49) fatalities over the entire period from IDF construction through deactivation and closure.

4.3.12.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

Under this alternative, as explained under Alternative 2, limited offsite waste would be accepted for disposal. This waste would require about 7,100 rail shipments or 14,200 truck shipments. In addition, about 1,000 truck shipments would be made to transport onsite waste to storage locations and burial grounds (see Table 4–152). The total distance traveled carrying radioactive materials would be 26.1 million kilometers (16.2 million miles) on public rail or 51.3 million kilometers (31.9 million miles) on public roads.

4.3.12.3.1 Impacts of Incident-Free Transportation

The doses to transportation workers and the population from offsite transportation activities would be similar to those described under Alternative 2. The dose to transportation workers and the exposed population from onsite transport activity was estimated to be 2.6 and 0.08 person-rem, respectively, resulting in 0 (0.002) additional LCFs among the transportation workers and 0 (0.0005) additional LCFs among the exposed population. These doses would be slightly lower than those under Alternative 2 because of the shorter distance between the generator and disposal location.

4.3.12.3.1.1 Disposal Group 1

The estimates of the incident-free operational risks during transport of waste materials under this disposal group have already been accounted for, as discussed in Sections 4.1.12, 4.2.12, and 4.3.12.3.1.

4.3.12.3.1.2 Disposal Group 2

The estimates of the incident-free operational risks during transport of waste materials under this disposal group have already been accounted for, as discussed in Sections 4.1.12, 4.2.12, and 4.3.12.3.1.

4.3.12.3.1.3 Disposal Group 3

The estimates of the incident-free operational risks during transport of waste materials under this disposal group have already been accounted for, as discussed in Sections 4.1.12, 4.2.12, and 4.3.12.3.1.

4.3.12.3.2 Impacts of Accidents During Transportation

The maximum reasonably foreseeable offsite transportation accident and the corresponding consequences under this alternative would be similar to those described under Alternative 2.

The estimated total transportation accident risks (both on and off site) under this alternative would be similar to those described under Alternative 2.

4.3.12.3.2.1 Disposal Group 1

The estimates of the accident risks during transport of waste materials under this disposal group have already been accounted for, as discussed in Sections 4.1.12, 4.2.12, and 4.3.12.3.1.

4.3.12.3.2.2 Disposal Group 2

The estimates of the accident risks during transport of waste materials under this disposal group have already been accounted for, as discussed in Sections 4.1.12, 4.2.12, and 4.3.12.3.1.

4.3.12.3.2.3 Disposal Group 3

The estimates of the accident risks during transport of waste materials under this disposal group have already been accounted for, as discussed in Sections 4.1.12, 4.2.12, and 4.3.12.3.1.

4.3.12.3.3 Impacts of Construction and Operational Material Transports

The impacts of transporting construction and operational materials under this alternative would be similar to those described under Alternative 2 (see Table 4–153). In addition, similar to Alternative 2, under this alternative, three different combinations of waste capacities (disposal groups) that would be allocated to IDF-East, IDF-West, and the RPPDF over varying operational timeframes to accommodate the waste generated under the various Tank Closure, FFTF Decommissioning, and Waste Management alternatives were evaluated. The impacts of transportation activities under the disposal groups would range from 7.4 to 37 million kilometers (4.6 to 23 million miles) traveled and 2 (1.5) to 8 (7.6) accidents, and would result in 0 (0.10 to 0.49) fatalities over the entire period from facility construction through deactivation and closure.

4.3.12.3.3.1 Disposal Group 1

The impacts of transportation activities under this disposal group would be 7.4 million kilometers (4.6 million miles) traveled, 2 (1.5) accidents, and 0 (0.10) fatalities over the entire period from facility construction through deactivation and closure.

4.3.12.3.3.2 Disposal Group 2

The impacts of transportation activities under this disposal group would be 29 million kilometers (18 million miles) traveled, 6 (5.9) accidents, and 0 (0.38) fatalities over the entire period from facility construction through deactivation and closure.

4.3.12.3.3.3 Disposal Group 3

The impacts of transportation activities under this disposal group would be 37 million kilometers (23 million miles) traveled, 8 (7.6) accidents, and 0 (0.49) fatalities over the entire period from facility construction through deactivation and closure.

4.3.13 Environmental Justice

4.3.13.1 Alternative 1: No Action

This section addresses potential short-term impacts on minority, American Indian, Hispanic or Latino, and low-income populations under Waste Management Alternative 1. Because public access to Hanford is restricted, the majority of impacts under this Waste Management alternative would be associated with onsite activities and would not affect populations residing off site; thus, the potential for environmental justice concerns would be small. Resource areas that could be impacted and that may affect populations residing off site include public and occupational health and safety due to normal operations and facility accidents, as well as air quality and transportation.

Section 4.3.10.1.1 discusses short-term impacts on the public resulting from normal operations under Waste Management Alternative 1. Radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

Under this alternative, there would be no incremental radiological impacts on the public or the offsite MEI due to normal operations. Therefore, Waste Management Alternative 1 would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations.

Section 4.3.11.1.1 discusses the radiological impacts of airborne releases for facility accidents under Waste Management Alternative 1. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, activities under the No Action Alternative would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to the radiological impacts of facility accidents.

Section 4.3.11.1.2 discusses the hazardous chemical impacts of facility accidents under Waste Management Alternative 1. The potential risks of hazardous chemical impacts of reasonably foreseeable accidents would be encompassed by those discussed in Section 4.2.11.1.2 under the FFTF Decommissioning No Action Alternative.

Air quality impacts are discussed in Section 4.3.4.1. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.3.12.1 discusses the potential human health risks of transporting radioactive waste on site at Hanford and transporting construction materials from onsite and/or offsite (local and regional) locations to Hanford. Examination of the risks shows that there would be essentially no LCFs for the offsite population (which includes minority, American Indian, Hispanic or Latino, and low-income individuals) residing along the transportation routes. The impact of transporting construction materials to Hanford under this Waste Management alternative would be very small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.3.13.2 Alternative 2: Disposal in IDF, 200-East Area Only

This section addresses potential short-term impacts on minority, American Indian, Hispanic or Latino, and low-income populations under Waste Management Alternative 2. Because public access to Hanford is restricted, the majority of impacts under this Waste Management alternative would be associated with onsite activities and would not affect populations residing off site; thus, the potential for environmental justice concerns would be small. Resource areas that could be impacted and that may affect populations residing off site include public and occupational health and safety due to normal operations and facility accidents, as well as air quality and transportation.

Section 4.3.10.2.1 discusses short-term impacts on the public resulting from normal operations under Waste Management Alternative 2. The radiological impacts of normal operations on minority, American Indian, Hispanic or Latino, and low-income populations were determined by applying the same methodology used to determine the public (total population) impacts of normal operations. The exposure scenario used to model minority, American Indian, Hispanic or Latino, and low-income population exposures assumes that these groups would be exposed in the same manner as the general population—by external exposure to radioactive materials and by internal exposure from inhalation and ingestion of radioactively contaminated produce and animal products.

For the purpose of evaluating the potential for disproportionately high and adverse impacts caused by radioactive emissions from normal operations, the total doses to average individuals of the minority, American Indian, Hispanic or Latino, and low-income populations were compared with the total dose to an average individual of the remainder of the population. These results are presented in Appendix J. Table 4–154 summarizes the average individual total doses over the life of the project under this Waste Management alternative. There were no appreciable differences between average individual total doses. Therefore, Waste Management Alternative 2 would not pose disproportionately high and adverse impacts on minority or low-income populations due to normal operations. The radiological impacts on the offsite population would be the same, regardless of the disposal group.

Table 4–154. Waste Management Alternative 2 Average Individual Total Dose from Radioactive Air Emissions over the Life of the Project

Subset Population	Average Individual Dose (millirem)	
	Subset Population	Remainder of Population
Minority	1.1×10^{-7}	1.5×10^{-7}
American Indian	7.0×10^{-8}	1.3×10^{-7}
Hispanic or Latino	1.0×10^{-7}	1.5×10^{-7}
Low-income	1.1×10^{-7}	1.4×10^{-7}

Source: Appendix J, Section J.5.7.1.3.

Section 4.3.10.2.1 discusses radiological impacts on the offsite MEI at the far side of the Columbia River opposite Hanford as a result of normal operations under Alternative 2. To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation and an individual subsisting on fish and wildlife were evaluated. These results are tabulated in Appendix J. Under Waste Management Alternative 2, the total dose received by an individual residing at the point of greatest impact along the reservation boundary would be less than approximately one-fourth of the total dose received by the MEI from the general population. Therefore, Alternative 2 would not pose disproportionately high and adverse impacts on the American Indian population due to normal operations. These impacts would be the same, regardless of the disposal group.

Section 4.3.11.2.1 discusses the radiological impacts of airborne releases from facility accidents under Waste Management Alternative 2. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, facility disposition under Waste Management Alternative 2 would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to the radiological impacts of facility accidents. The accident scenarios analyzed in Section 4.3.11.2.1 encompass the range of waste management storage and disposal activities. The radiological impacts of accidents would be the same, regardless of the disposal group.

Section 4.3.11.2.2 discusses the hazardous chemical impacts of facility accidents under Waste Management Alternative 2. The potential risks of hazardous chemical impacts of reasonably foreseeable accidents would be the same as those addressed under Alternative 1. The hazardous chemical impacts of accidents would be the same, regardless of the disposal group.

Air quality impacts are discussed in Section 4.3.4.2. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.3.12.2 discusses the potential human health risks of transporting offsite waste for disposal at Hanford and transporting construction materials from onsite and/or offsite (local and regional) locations to Hanford. Examination of the risks shows that there would be essentially no LCFs among the offsite population (including minority, American Indian, Hispanic or Latino, and low-income individuals) residing along the transportation routes. The radiological impacts of offsite waste transportation would be the same, regardless of the disposal group. The impacts of transporting construction materials to Hanford under all disposal groups would be small. Therefore, this alternative would not pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.3.13.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

This section addresses the potential short-term impacts on minority, American Indian, Hispanic or Latino, and low-income populations under Waste Management Alternative 3. Because public access to Hanford is restricted, the majority of impacts under this alternative would be associated with onsite activities and would not affect populations residing off site; thus, the potential for environmental justice concerns is small. Resource areas that could be impacted include public and occupational health and safety due to normal operations and facility accidents, as well as air quality. These impacts could affect populations residing off site.

Section 4.3.10.3 discusses short-term radiological impacts on the public resulting from normal operations under Waste Management Alternative 3. Under this alternative, radiological impacts on the general public, minority and low-income populations, the offsite MEI, and an MEI residing at the boundary of the Yakama Reservation would be the same as those described under Waste Management Alternative 2 in Section 4.3.13.2, regardless of the disposal group (see Table 4–154).

Section 4.3.11.3.1 discusses the radiological impacts of airborne releases for facility accidents under Waste Management Alternative 3. Examination of the risks shows that there would be essentially no LCFs per year among the offsite population, including minority, American Indian, Hispanic or Latino, and low-income populations. Therefore, Waste Management Alternative 3 would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to the radiological impacts of facility accidents. The accident scenarios analyzed in Section 4.3.11.3.1 encompass the range of waste management storage and disposal activities. The radiological impacts of accidents would be the same, regardless of the disposal group.

Section 4.3.11.3.2 discusses the hazardous chemical impacts of facility accidents under Waste Management Alternative 3. The potential risks of hazardous chemical impacts of reasonably foreseeable accidents would be the same as those addressed under Alternative 2. The hazardous chemical impacts of accidents would be the same, regardless of the disposal group.

Air quality impacts are discussed in Section 4.3.4.3. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.3.12.3 discusses the potential human health risks of transporting offsite waste for disposal at Hanford, transporting radioactive waste on site at Hanford, and transporting construction materials from onsite and/or offsite (local and regional) locations to Hanford. The radiological risks would be the same as those described under Waste Management Alternative 2. Similar to Waste Management Alternative 2, the risks of transporting construction and operational materials to Hanford under all disposal groups would be small. Therefore, this Waste Management alternative would not pose disproportionately high and adverse impacts on minority, American Indian, Hispanic or Latino, and low-income populations residing along the transportation routes.

4.3.14 Waste Management

This section evaluates the impacts of waste generation associated with implementation of each of the various Waste Management alternatives and disposal groups, as applicable, on the waste management infrastructure at Hanford. As summarized in Section 4.3 and detailed in Chapter 2, these Waste Management alternatives and disposal groups were developed to manage the various waste volumes projected to be generated under the alternatives for Tank Closure, FFTF Decommissioning, and Waste Management. In general, the disposal groups vary primarily in direct relation to the required size, number, and lifespan of the disposal facilities (i.e., IDF-East, IDF-West, and the RPPDF) that would be constructed, operated, and ultimately closed under each disposal scenario. This section also evaluates the impacts of waste generation associated with the construction, operations, deactivation, and closure of the expanded waste treatment and storage facilities and new waste disposal, in addition to the existing waste management activities analyzed under Waste Management Alternative 1: No Action. Under both Waste Management Alternatives 2 and 3, Hanford waste treatment and storage activities would be expanded at the CWC, T Plant, and WRAP to provide greater capacity and throughput. In addition, under all three Waste Management alternatives, trenches 31 and 34 would continue operations to dispose of LLW/MLLW until filled. The remaining space in the two trenches is 17,200 cubic meters (approximately 22,500 cubic yards), and the fiscal year 2007 projected emplacement rate in the two trenches is approximately 476 cubic meters (approximately 623 cubic yards). Given this emplacement rate, the remaining time the trenches will operate is approximately 36 years, or through 2043. For analysis purposes, this EIS assumes the trenches will operate through 2050.

The following analysis is consistent with DOE policy and DOE Manual 435.1-1, which requires that DOE radioactive waste shall be treated, stored, and, in the case of LLW, disposed of at the site where the waste is generated, if practical, or at another DOE facility. The analysis of these Waste Management alternatives and options is based on disposal of LLW and MLLW at Hanford. However, if DOE determines that use of Hanford's or another DOE site's waste management facilities is not practical or cost-effective, DOE may approve the use of non-DOE (commercial) facilities to store, treat, and dispose of such waste.

Included in this section is a discussion of the waste inventories projected to be generated under each of the Waste Management alternatives, as summarized in Table 4–155 for each of the Waste Management alternatives and disposal groups. These inventories would include secondary LLW, MLLW, and hazardous waste. WRAP and T Plant operations would produce small amounts of LLW and MLLW. No TRU waste or liquid LLW is expected to be generated by facility construction, operations, deactivation, or closure.

LOW-LEVEL RADIOACTIVE WASTE

LLW would be generated during routine operations at the two MLLW trenches (trenches 31 and 34) in LLBG 218 W-5 and during operations of WRAP and the T Plant. LLW is typically not treated or only minimally treated (e.g., via compaction) before disposal. Therefore, this waste treatment would cause no impacts on the Hanford waste management system. The LLW would be sent directly to disposal. Therefore, long-term storage facilities would not be required. All LLW would be disposed of in an IDF.

MIXED LOW-LEVEL RADIOACTIVE WASTE

MLLW would be generated during routine operations at WRAP and the T Plant. Through a combination of on- and offsite capabilities, MLLW would be treated to meet all RCRA land-disposal-restriction treatment standards prior to disposal. All MLLW would be disposed of in an IDF.

HAZARDOUS WASTE

Hazardous waste is dangerous waste as defined in the *Washington Administrative Code* (WAC 173-303). Hazardous waste generated during operations at the two MLLW trenches (trenches 31 and 34) in LLBG 218-W-5 and during postclosure care of the IDF(s) would be packaged in DOT-approved containers and shipped off site to permitted commercial recycling, treatment, and disposal facilities. Hanford shipped 182,177 kilograms (402,000 pounds) of hazardous waste off site in 2005 (Poston et al. 2006). Management of the additional waste generated under the Waste Management alternatives would require little, if any, additional planning. The waste would be treated and disposed of at offsite commercial facilities.

4.3.14.1 Alternative 1: No Action

4.3.14.1.1 Waste Inventories

Under Waste Management Alternative 1: No Action, no new facility construction would be initiated. Storage and treatment of LLW, MLLW, and TRU waste at the CWC, WRAP, and T Plant complex would continue. Disposal actions would continue at the lined disposal trenches, trenches 31 and 34, in LLBG 218-W-5 through 2035. No offsite shipments of TRU waste or LLW/MLLW would be received. Administrative controls would be implemented for a period of 100 years following disposal operations (2036 through 2135). Table 4–155 presents the estimated waste volumes that would be generated under Waste Management Alternative 1.

Table 4–155. Waste Management Alternatives – Summary of Waste Generation Volumes

Waste Type	Project Phase					Peak Annual Generation	
	Construction	Operations	Deactivation	Closure	Total	Year(s) of Peak	Annual Waste Volume
Alternative 1: No Action							
Low-level radioactive waste	N/A	38	N/A	N/A	38	2007–2035	1
Hazardous waste[a]	N/A	38	N/A	N/A	38	2007–2035	1
Alternatives 2 and 3: Treatment and Storage							
Low-level radioactive waste	N/A	1,460	N/A	N/A	1,460	2019–2050	40
Mixed low-level radioactive waste	N/A	98	N/A	N/A	98	2019–2050	3
Alternative 2: Disposal Group 1							
Low-level radioactive waste	N/A	58	N/A	N/A	58	2007–2050	1
Hazardous waste[a]	N/A	58	N/A	89	147	2007–2050	1
Alternative 2: Disposal Group 2							
Low-level radioactive waste	N/A	58	N/A	N/A	58	2007–2050	1
Hazardous waste[a]	N/A	58	N/A	343	401	2103–2202	3
Alternative 2: Disposal Group 3							
Low-level radioactive waste	N/A	58	N/A	N/A	58	2007–2050	1
Hazardous waste[a]	N/A	58	N/A	343	401	2168–2267	3
Alternative 3: Disposal Group 1							
Low-level radioactive waste	N/A	58	N/A	N/A	58	2007–2050	1
Hazardous waste[a]	N/A	58	N/A	90	147	2007–2050	1
Alternative 3: Disposal Group 2							
Low-level radioactive waste	N/A	58	N/A	N/A	58	2007–2050	1
Hazardous waste[a]	N/A	58	N/A	344	402	2103–2202	3
Alternative 3: Disposal Group 3							
Low-level radioactive waste	N/A	58	N/A	N/A	58	2007–2050	1
Hazardous waste[a]	N/A	58	N/A	344	402	2168–2267	3

[a] Hazardous waste would be accumulated on site for less than 90 days and then shipped to offsite commercial facilities for treatment and/or disposal.

Note: All values are in cubic meters. To convert cubic meters to cubic yards, multiply by 1.308.

Key: N/A=not applicable.

Source: SAIC 2010c.

4.3.14.2 Alternative 2: Disposal in IDF, 200-East Area Only

Waste Management Alternative 2 includes continued storage and treatment of LLW, MLLW, and TRU waste. Existing waste management facilities at the CWC, T Plant, and WRAP would be expanded, as summarized above. Waste management operations at the expanded facilities would produce a small amount of waste, as shown in Table 4–155.

Under this alternative, no additional offsite TRU waste would be received. Offsite shipments of waste to Hanford would be limited to 82,000 cubic meters (2.9 million cubic feet) of LLW and MLLW. Construction, operations, deactivation, and closure of two disposal facilities would provide for disposal of tank waste, onsite non-CERCLA waste, FFTF decommissioning waste, waste management waste streams, and LLW/MLLW received from other DOE sites. Disposal facilities would include a single IDF in the 200-East Area and an RPPDF. The RPPDF would be used to dispose of equipment and soils resulting from clean closure of the tank farm that are not highly contaminated. The IDF would be used for disposal of all other waste streams.

As mentioned in Section 4.3.14 and under Alternative 2, three disposal groups were developed to accommodate the different waste volumes generated by Tank Closure, FFTF Decommissioning, and Waste Management alternative activities. Within each disposal group, the largest waste volume was utilized to size the disposal facilities (IDF and RPPDF). These three disposal groups are described further in Chapter 2, Section 2.5, of this EIS.

Closure actions would include construction of a modified RCRA Subtitle C barrier over IDF-East and the RPPDF. Closure actions at the CWC, WRAP, T Plant, and LLBG (trenches 31 and 34) are not included under this alternative.

4.3.14.2.1 Waste Inventories

Table 4–155 presents the estimated waste volumes that would be generated under Waste Management Alternative 2.

4.3.14.2.2 Disposal Groups 1, 2, and 3

Under all disposal groups, MLLW and LLW would be generated from operations of WRAP and the T Plant, and LLW would be generated from operations of the LLBG (trenches 31 and 34). All waste would be disposed of in IDF-East.

4.3.14.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

Waste Management Alternative 3 includes continued storage and treatment of LLW, MLLW, and TRU waste. Existing waste management facilities at the CWC, WRAP, and T Plant would be expanded, as under Alternative 2. Waste management operations at the expanded facilities would produce a small amount of waste, as shown in Table 4–155.

Under this alternative, no additional offsite TRU waste would be received. Offsite shipments of waste to Hanford would be limited to 82,000 cubic meters (2.9 million cubic feet) of LLW and MLLW. Construction, operations, deactivation, and closure of two IDFs and one RPPDF would provide for disposal of tank waste, onsite non-CERCLA waste, FFTF decommissioning waste, waste management waste streams, and offsite LLW/MLLW received from other DOE sites. Disposal facilities would consist of one IDF in the 200-East Area, which would be used for tank waste only; one IDF in the 200-West Area, which would be used for onsite non-CERCLA waste, offsite LLW/MLLW received from other DOE sites, FFTF decommissioning waste, and waste management waste streams; and an RPPDF. The RPPDF would be used for disposal of equipment and soils associated with clean closure of the tank farms, as under Waste Management Alternative 2. The IDFs would be used for disposal of all other waste streams. As mentioned in Section 4.3.14 and under Alternative 2, three disposal groups were developed to accommodate the different waste volumes generated by Tank Closure, FFTF Decommissioning, and Waste Management alternative activities. Within each disposal group, the largest waste volume was utilized to size the disposal facilities (IDF-East, IDF-West, and the RPPDF). These three disposal groups are described further in Chapter 2, Section 2.5, of this EIS.

Closure actions would include construction of a modified RCRA Subtitle C barrier over each IDF and RPPDF. Closure actions at the CWC, WRAP, T Plant, and LLBG (trenches 31 and 34) are not included under this alternative.

4.3.14.3.1 Waste Inventories

Table 4–155 presents the estimated waste volume generated under Waste Management Alternative 3.

4.3.14.3.2 Disposal Groups 1, 2, and 3

Under all disposal groups, LLW and MLLW would be generated from operations of WRAP and the T Plant; LLW also would be generated from operations of the LLBG. All waste would be disposed of in an IDF.

4.3.15 Industrial Safety

Illness, injury, and death are possible outcomes of any industrial accident. The accepted standard for measuring the outcome of an industrial accident is the number of TRCs of illness, injury, and death. This section addresses the potential impacts on workers that could result from implementation of each of the Waste Management alternatives and disposal groups. The key underlying assumptions and industrial safety incident rates used in support of this analysis are the same as those described in Section 4.1.15 for the Tank Closure alternatives.

Using these incident rates and the projected labor hours, industrial safety impacts associated with each of the alternatives were determined (see Table 4–156). There are inherent uncertainties in estimating the number of TRCs and fatalities associated with future activities. Currently, there are no weighting factors assigned to the phases of an alternative that allow for normalizing the risks under each alternative. Therefore, when averaging the rate over all phases, this approach can result in slightly higher values for project operation and closure phases and lower values for activities that have higher risk of injury and illness.

As shown in Figure 4–39, higher numbers of TRCs are associated with those alternatives that would require higher numbers of labor hours.

4.3.15.1 Alternative 1: No Action

About 1 million total labor hours were identified under this alternative. Using the selected TRC rate of 2.0 and total labor hours, it is anticipated that there will be 10 reportable cases of illness or injury and no fatalities.

4.3.15.2 Alternative 2: Disposal in IDF, 200-East Area Only

Under Alternative 2, three separate disposal groups are associated with disposal activities, and construction, operations, and deactivation of several new and expanded facilities would be required to support ongoing Hanford waste treatment and storage activities. Consequently, the construction, operations, deactivation, and closure of IDF-East and the RPPDF, in addition to ongoing LLBG 218-W-5 activities, were evaluated. Given the total labor hours (37.9 million) and the incident rate (2.0), it is anticipated that approximately 379 TRCs would occur. Fatalities are not expected based on the number of workers and total labor hours.

Table 4–156. Waste Management Alternatives – Industrial Safety Impacts

Alternative	Labor Category	Million Labor Hours	Total Recordable Case Rate per 200,000 Labor Hours	Projected Total Recordable Cases	Fatality Rate per 200 Million Labor Hours	Projected Fatalities
Alternative 1: No Action	Construction	0.0	2.0	0.0	0.26	0.0
	Operations	0.69	2.0	6.9	0.26	0.0009
	Deactivation	0.31	2.0	3.1	0.26	0.0004
	Closure	0.0	2.0	0.0	0.26	0.0
	Total	**1.01**		**10.1**		**0.001**
Alternatives 2 and 3: Treatment and Storage	Construction	3.51	2.0	35.1	0.26	0.005
	Operations	33.9	2.0	339	0.26	0.04
	Deactivation	0.47	2.0	4.70	0.26	0.0006
	Closure	0.0	2.0	0.0	0.26	0.0
	Total	**37.9**		**379**		**0.05**
Alternative 2: Disposal Group 1	Construction	2.05	2.0	20.5	0.26	0.003
	Operations	11.7	2.0	117	0.26	0.015
	Deactivation	0.0	2.0	0.0	0.26	0.0
	Closure	6.12	2.0	61.2	0.26	0.008
	Total	**19.9**		**199**		**0.026**
Alternative 2: Disposal Group 2	Construction	8.89	2.0	88.9	0.26	0.012
	Operations	95.1	2.0	951	0.26	0.12
	Deactivation	0.0	2.0	0.00	0.26	0.0
	Closure	23.7	2.0	237	0.26	0.03
	Total	**128**		**1,280**		**0.17**
Alternative 2: Disposal Group 3	Construction	8.89	2.0	88.9	0.26	0.012
	Operations	171	2.0	1,710	0.26	0.22
	Deactivation	0.0	2.0	0.00	0.26	0.0
	Closure	23.7	2.0	237	0.26	0.03
	Total	**204**		**2,040**		**0.27**
Alternative 3: Disposal Group 1	Construction	3.68	2.0	36.8	0.26	0.005
	Operations	11.6	2.0	116	0.26	0.015
	Deactivation	0.0	2.0	0.0	0.26	0.0
	Closure	6.11	2.0	61.1	0.26	0.008
	Total	**21.4**		**214**		**0.03**
Alternative 3: Disposal Group 2	Construction	10.5	2.0	105	0.26	0.014
	Operations	94.6	2.0	946	0.26	0.123
	Deactivation	0.0	2.0	0.00	0.26	0.0
	Closure	23.7	2.0	237	0.26	0.03
	Total	**129**		**1,290**		**0.17**

Table 4–156. Waste Management Alternatives – Industrial Safety Impacts *(continued)*

Alternative	Labor Category	Million Labor Hours	Total Recordable Case Rate per 200,000 Labor Hours	Projected Total Recordable Cases	Fatality Rate per 200 Million Labor Hours	Projected Fatalities
Alternative 3: Disposal Group 3	Construction	10.5	2.0	105	0.26	0.01
	Operations	171	2.0	1,710	0.26	0.22
	Deactivation	0.0	2.0	0.0	0.26	0.0
	Closure	23.7	2.0	237	0.26	0.03
	Total	**205**		**2,050**		**0.27**

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate. Totals may not equal the sum of the contributions due to rounding.
Source: Labor hours compiled from Appendix I.

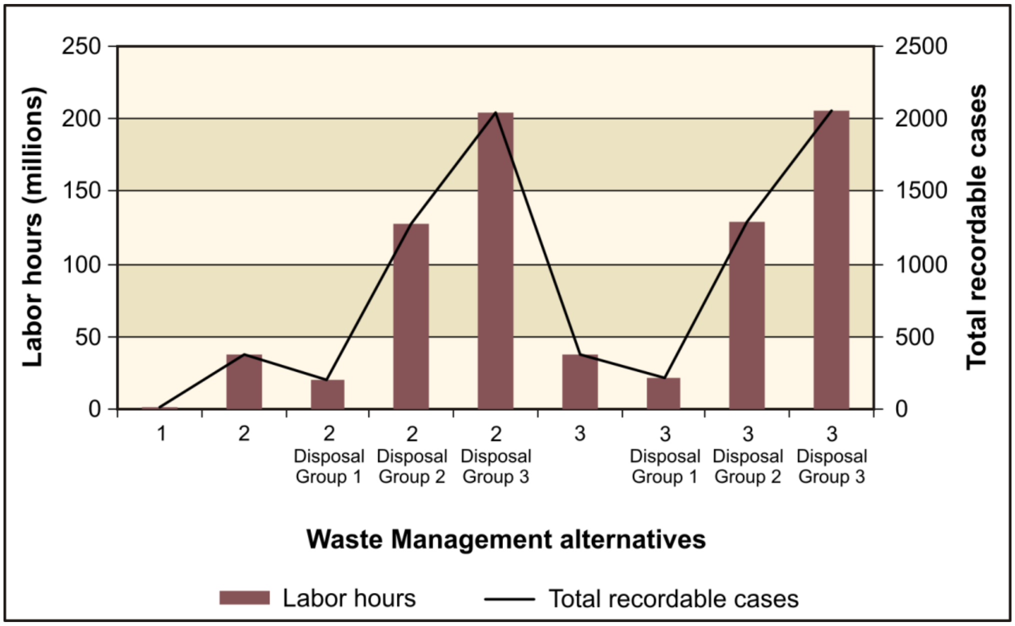


Figure 4–39. Total Recordable Cases and Labor Hours by Alternative

4.3.15.2.1 Disposal Group 1

The work specified in this group would require 19.9 million labor hours to complete. Applying the TRC rate of 2.0, 199 TRCs can be expected. No fatalities are anticipated.

4.3.15.2.2 Disposal Group 2

Work under this disposal group would require approximately 128 million total labor hours, generating 1,280 TRCs. Based on the projected labor hours and incident rate, no fatalities are anticipated.

4.3.15.2.3 Disposal Group 3

Under this disposal group, about 204 million total labor hours would be required, generating 2,040 TRCs. No fatalities are anticipated.

4.3.15.3 Alternative 3: Disposal in IDF, 200-East and 200-West Areas

Waste Management Alternative 3 would require construction of IDFs in the 200-East and 200-West Areas of Hanford, in addition to use of the RPPDF and continued LLBG 218-W-5 activities. As under Alternative 2, several Hanford waste treatment and storage facilities would also be expanded. Construction, operations, and deactivation of these waste treatment and storage facilities would require roughly 38 million labor hours. Applying the 2.0 TRC rate per 200,000 labor hours results in a projected 379 TRCs over the life of the project. Applying the fatality (0.26) rate per 200 million labor hours returns a value of 0.05. A fatality is not projected to occur over the period of this project. The following paragraphs evaluate the impacts of the three disposal groups associated with the closure of waste tanks and decommissioning of FFTF.

4.3.15.3.1 Disposal Group 1

This disposal group would require about 21 million hours to complete and would generate 214 TRCs. No fatalities are expected.

4.3.15.3.2 Disposal Group 2

This disposal group would require a total of about 129 million labor hours. Approximately 1,290 TRCs are anticipated. No fatalities are expected.

4.3.15.3.3 Disposal Group 3

This disposal group would require about 205 million hours and would generate 2,050 TRCs. No fatalities are expected.

4.4 COMBINATION OF ALTERNATIVES

The potential short-term environmental and human health impacts associated with implementation of the alternatives and options for (1) tank waste retrieval, treatment, and disposal and SST system closure at Hanford; (2) decommissioning of FFTF and auxiliary facilities (i.e., FFTF decommissioning); and (3) management of waste resulting from other Hanford activities and limited volumes from other DOE sites (i.e., waste management) are presented separately in Sections 4.1, 4.2, and 4.3, respectively. The individual Tank Closure, FFTF Decommissioning, and Waste Management alternatives and options, as applicable, are described in detail in Chapter 2. This section presents the potential short-term, combined impacts on key air and groundwater resource indicators of implementing selected alternatives and options associated with the three sets of proposed actions.

To focus on those measures that provide the most meaningful and useful assessment of potential impacts, key resource indicators were selected from the total range of impact measures presented for each resource area or discipline (analyzed elsewhere in this chapter). Combined-impact analyses were not performed for the following resource areas or disciplines: noise and the facility accident component of public and occupational health and safety. As presented in this section, the combined-impact analyses provide a basis for determining the potential peak and/or total impact on an environmental resource area or human health indicator associated with implementation of the alternatives and options from each set of proposed actions analyzed in this EIS. For purposes of these combined-impact analyses, the impacts of disposition of RH-SCs at INL were counted in the combination total for Hanford, even though the work would not occur at Hanford.

Several hundred impact scenarios could result from the potential combinations of the 11 Tank Closure, 3 FFTF Decommissioning, and 3 Waste Management alternatives when factored with their associated option cases and waste disposal groups. For analysis purposes, the following combinations of alternatives were chosen to represent key points along the range of actions and associated overall impacts that could result from full implementation of the three sets of proposed actions:

- **Alternative Combination 1:** all No Action Alternatives
- **Alternative Combination 2:** Tank Closure Alternative 2B (Expanded WTP Vitrification; Landfill Closure); FFTF Decommissioning Alternative 2 (Entombment) with the Idaho Option for disposition of RH-SCs and the Hanford Reuse Option for disposition of bulk sodium; and Waste Management Alternative 2 (Disposal in IDF, 200-East Area Only) with Disposal Group 1, Subgroup 1-A
- **Alternative Combination 3:** Tank Closure Alternative 6B (All Vitrification with Separations; Clean Closure), Base Case; FFTF Decommissioning Alternative 3 (Removal) with the Idaho Option for disposition of RH-SCs and the Hanford Reuse Option for disposition of bulk sodium; and Waste Management Alternative 2 (Disposal in IDF, 200-East Area Only) with Disposal Group 2, Subgroup 2-B

Alternative Combination 1 represents the potential short-term impacts resulting from minimal DOE action and the greatest long-term impact with respect to groundwater. Alternative Combination 2 is a midrange case representative of DOE's Preferred Alternative(s), as addressed in Chapter 2, Section 2.12. Alternative Combination 3 reflects the most conservative estimate of impacts for most resource areas in terms of the intensity of the potential impact; therefore, on the whole, it represents a combination that would result in maximum potential short-term impacts, but would likely have the lowest long-term impacts on groundwater. For some resource areas, an alternative combination that included Alternative 6A, Option Case, would result in maximum short-term impacts. Selection of these three alternative combinations for detailed analysis in this EIS was done only to establish overall impact-level reference cases for stakeholders and decisionmakers to consider and does not preclude the selection and implementation of different combinations of the various alternatives in support of final agency decisions.

4.4.1 Land Resources

4.4.1.1 Land Use

The land use impacts of implementing the various Tank Closure, FFTF Decommissioning, and Waste Management alternatives are presented in Sections 4.1.1, 4.2.1, and 4.3.1. Those analyses evaluated the land requirements of each alternative and the compatibility of the proposed facilities and actions with the guidelines established by the *Hanford Comprehensive Land-Use Plan EIS* and the 2008 supplement analysis (DOE 1999, 2008) and RODs (64 FR 61615, 73 FR 55824). Although previously undisturbed land would be developed in some cases, the analyses established that, with one exception (see Section 4.1.1.9.1.1), proposed facilities and actions would be compatible with site land-use guidelines; thus, this issue is not addressed further in this section. However, because the land needed for facility construction would be additive, the total land requirement for each of the three alternative combinations is addressed below.

To determine the combined land requirement at Hanford, the area needed for each component within each alternative combination was added together (see Table 4–157). As not all facilities would be constructed and not all activities would occur within previously disturbed areas, the table also presents the area of undeveloped land that would be required. No new land would be disturbed at INL under any of the alternative combinations.

As noted in Table 4–157, Alternative Combination 1 would require the least amount of land (2 hectares [5 acres]), all of which would be undisturbed land within Borrow Area C. Alternative Combination 2 would require a total of 308 hectares (761 acres), 67 percent of which is undeveloped. The total land area needed under Alternative Combination 3 would be 797 hectares (1,970 acres), 94 percent of which is undeveloped. Under Alternative Combination 2, about two-thirds of the undeveloped land would be within Borrow Area C; under Alternative Combination 3, about one-half.

Table 4–157. Combined Hanford Site Land Use Requirements

Alternative Combination and Components	Alternative	Land Area Required (hectares)	
		Total Land	**Undeveloped Land**
Alternative Combination 1			
Tank Closure	No Action	2.0	2.0
FFTF Decommissioning	No Action	0	0
Waste Management	No Action	0	0
Total		**2.0**	**2.0**
Alternative Combination 2			
Tank Closure	2B	196	98.3
FFTF Decommissioning	2, Idaho Option, Hanford Reuse Option	3.6	2.8
Waste Management	2, DG 1	108	106
Total		**308**	**207**
Alternative Combination 3			
Tank Closure	6B, Base Case	384	342
FFTF Decommissioning	3, Idaho Option, Hanford Reuse Option	3.3	3.2
Waste Management	2, DG 2	409	406
Total		**797**	**753**

Note: To convert hectares to acres, multiply by 2.471. Totals may not equal the sum of the contributions due to rounding.

Key: DG=Disposal Group; FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory.

Source: Compiled from Sections 4.1.1.1.1–4.1.1.12.1, 4.2.1.1.1–4.2.1.3.1, 4.3.1.1.1–4.3.1.3.1.

Although not addressed in Table 4–157, the greatest land area would be required under an alternative combination that included Tank Closure Alternative 6A, Option Case; FFTF Decommissioning Alternative 3 (with all facilities to be built at Hanford); and Waste Management Alternative 3 (with waste Disposal Group 2 or 3). Under this alternative combination, a total of 1,110 hectares (2,740 acres) would be needed, 95 percent of which is currently undeveloped.

4.4.1.2 Visual Resources

The impact on visual resources under these *TC & WM EIS* alternative combinations would depend on a number of factors. Among these would be the area of undeveloped land disturbed by new facilities, as analyzed in Section 4.4.1.1 above. Thus, the values for undeveloped land found in Table 4–157 provide a guide to the range of visual impacts that could be expected under the various alternative combinations. Additionally, the size of the area to be disturbed, the location of new facilities relative to public points of observation (i.e., public roadways or nearby higher elevations), and the proximity of new development to present industrial development must also be considered when evaluating combined visual impacts.

The least amount of undeveloped land (2 hectares [5 acres]) would be required under Alternative Combination 1. In this case, all development would occur within Borrow Area C, an area that, except for an access road, is undisturbed grassland at present. This alternative combination would disturb about 0.2 percent of Borrow Area C. Alternative Combination 2 would require 207 hectares (512 acres) of undeveloped land, and Alternative Combination 3 would require 753 hectares (1,860 acres) of undeveloped land. Under Alternative Combination 2, about two-thirds of this land would be within Borrow Area C; under Alternative Combination 3, about one-half.

The facilities and actions likely to have the greatest overall impact on visual resources are those that would require larger areas (e.g., over 20 hectares [50 acres]). Facilities needing less land would generally be located within built-up areas and, thus, would tend to blend in with existing development. None of the facilities that would be constructed under Alternative Combination 1 would require more than 20 hectares (50 acres) of land. Under Alternative Combination 2, expansion of IDF-East, construction of the RPPDF, and mining activities within Borrow Area C would each require over 20 hectares (50 acres). While IDF-East and the RPPDF could be visible from nearby higher elevations, they would be either minimally or not at all visible from Route 240. The disturbance to Borrow Area C would be readily visible from State Route 240, as well as Rattlesnake Mountain, an area important to American Indians (see Chapter 3, Section 3.2.8.3). In addition to the facilities noted for Alternative Combination 2, Alternative Combination 3 would require construction of the ILAW Interim Storage Facilities and the HLW Debris Storage Facilities. Alternative Combination 3 would require 401 hectares (992 acres) within Borrow Area C, nearly triple the land requirement of Alternative Combination 2 (140 hectares [345 acres]).

As is the case for land use (see Section 4.4.1.1), the greatest impact on visual resources would result from a combination of *TC & WM EIS* alternatives that is not represented in Table 4–157: Tank Closure Alternative 6A, Option Case; FFTF Decommissioning Alternative 3 (with all facilities to be built at Hanford); and Waste Management Alternative 3 (with waste Disposal Group 2 or 3). This alternative combination would require a total of 1,110 hectares (2,740 acres) of undeveloped land, including 619 hectares (1,530 acres) within Borrow Area C, as well as large areas between the 200-East and 200-West Areas and adjacent to the 200-East Area.

Regardless of the alternative combination being evaluated, construction within the 200 Areas would not change the BLM Visual Resource Management Class IV rating. However, the BLM rating for Borrow Area C would be lowered to Class III under Alternative Combination 1 and Class IV under Alternative Combinations 2 and 3.

4.4.2 Infrastructure

The utility infrastructure impacts of implementing the various Tank Closure, FFTF Decommissioning, and Waste Management alternatives are presented in Sections 4.1.2, 4.2.2, and 4.3.2. This section summarizes the overall demands on utility infrastructure and resource requirements of the three alternative combinations. Table 4–158 presents the projected peak annual and total demands for electricity, liquid fuels, and water under each alternative combination. Under each alternative combination, the peaks for each component could potentially occur during different time periods without overlap. To determine the potential maximum impact of each alternative combination, the peaks of each component were totaled together, even when the peak impacts are projected to occur in different timeframes. The resulting total projections are overly conservative and represent the upper limits for utility resource requirements.

As shown in Table 4–158, the tank closure component would be the most significant contributor to combined peak and combined total utility demands under all alternative combinations, although surveillance and monitoring activities associated with the FFTF Decommissioning No Action Alternative would incur higher total demands for electricity than those associated with the Tank Closure No Action Alternative during the 100-year administrative control period. For electricity, gasoline, and water, both the highest combined peak and combined total demands would occur under Alternative Combination 3 due to the requirements associated with Tank Closure Alternative 6B, Base Case, combined with those of Waste Management Alternative 2, Disposal Group 2. Combined peak demands would be highest under Alternative Combination 3 despite the fact that Tank Closure Alternative 2B under Alternative Combination 2 would have higher peak annual demands for diesel fuel, gasoline, and water than Alternative 6B, Base Case.

Overall, combined peak annual electrical energy demands could range from 0.04 million megawatt-hours under Alternative Combination 1 to as high as 1.27 million megawatt-hours under Alternative Combination 3, with the total combined energy requirements ranging from 0.72 to 21.7 million megawatt-hours over the entire duration of alternatives. The peak electrical energy demand of 1.27 million megawatt-hours (approximating an electric load of 145 megawatts) under Alternative Combination 3 would be about 73 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system.

For liquid fuels (diesel fuel and gasoline), combined peak annual requirements could range from about 16.3 million liters (4.3 million gallons) under Alternative Combination 1 to as high as 432 million liters (114 million gallons) under Alternative Combination 3, with the total combined liquid fuel requirements ranging from 55.8 million liters (14.7 million gallons) to 6,120 million liters (1,620 million gallons) over the entire duration of alternatives. It was assumed for analysis purposes that liquid fuels are not capacity-limiting resources because supplies would be replenished from offsite sources to support each alternative and provided at the point of use on an as-needed basis.

Table 4–158. Combined Utility Infrastructure Requirements

Alternative Combination and Components	Alternative	Electricity Use (M megawatt-hours)	Diesel Fuel Use (M liters)	Gasoline Use (M liters)	Water Use (M liters)
		Peak Use [Peak Year(s)][a] *Total Use*	Peak Use [Peak Year(s)][a] *Total Use*	Peak Use [Peak Year(s)][a] *Total Use*	Peak Use [Peak Year(s)][a] *Total Use*
Alternative Combination 1					
Tank Closure	No Action	0.035 [2008] *0.12*	11.8 [2008] *35.9*	1.0 [2008] *4.61*	1,090 [2008] *3,300*
FFTF Decommissioning	No Action	0.006 [2008–2107] *0.60*	0 *0*	0.0011 [2008–2107] *0.11*	7.95 [2008–2107] *795*
Waste Management	No Action	0.00019 [2007–2035] *0.0056*	3.46 [2009] *13.9*	0.012 [2036–2135] *1.23*	25.5 [2009] *35.7*
Combined Peak[b]		**0.04**	**15.3**	**1.02**	**1,120**
Combined Total[b]		**0.72**	**49.8**	**5.96**	**4,130**
Alternative Combination 2					
Tank Closure	2B	1.18 [2040] *17.9*	271 [2040] *4,040*	8.23 [2040] *156*	3,590 [2040] *86,300*
FFTF Decommissioning	2, Idaho Option, Hanford Reuse Option	0.0039 [2017] *0.0045*	2.21 [2015–2021] *5.12*	0.28 [2015–2021] *0.78*	12.8 [2017–2021] *23.6*
Waste Management	2, DG 1	0.018 [2007–2050] *0.56*	41.6 [2011–2052] *257*	4.69 [2011–2052] *21.7*	90.8 [2011–2052] *3,050*
Combined Peak[b]		**1.20**	**315**	**13.2**	**3,690**
Combined Total[b]		**18.5**	**4,300**	**179**	**89,400**
Alternative Combination 3					
Tank Closure	6B, Base Case	1.25 [2040] *21.1*	255 [2040] *4,360*	6.61 [2040] *216*	3,530 [2040] *92,600*
FFTF Decommissioning	3, Idaho Option, Hanford Reuse Option	0.0039 [2013–2017] *0.0077*	1.59 [2015–2021] *4.85*	0.23 [2013–2016] *0.79*	11.9 [2017–2021] *22.9*
Waste Management	2, DG 2	0.018 [2007–2050] *0.56*	154 [2011–2102] *1,460*	15.2 [2011–2102] *83.1*	283 [2011–2102] *21,200*
Combined Peak[b]		**1.27**	**410**	**22.1**	**3,830**
Combined Total[b]		**21.7**	**5,820**	**300**	**114,000**

[a] Year(s) in brackets denotes the timeframe over which the listed peak value could theoretically occur based on projected timeframes for contributing activities associated with each component.

[b] The combined peaks and combined totals may not equal the sum of the contributions due to rounding.

Note: To convert liters to gallons, multiply by 0.26417.

Key: DG=Disposal Group; FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; M=million.

Source: Compiled from Tables 4–2, 4–99, and 4–134.

Water requirements could entail a combined peak annual demand ranging from about 1,120 million liters (296 million gallons) under Alternative Combination 1 to 3,830 million liters (1,000 million gallons) under Alternative Combination 3, with total combined water requirements ranging from 4,130 million liters (1,090 million gallons) to 114,000 million liters (30,115 million gallons) over the duration of the alternatives. The projected peak annual water demand of 3,830 million liters (1,000 million gallons) under Alternative Combination 3 would be about 21 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 17 percent of the 200 Areas' historical average annual water use of more than 22,700 million liters (6,000 million gallons).

As discussed above, none of the three alternative combinations would exceed the capacity of a Hanford utility system. While Alternative Combination 3 reflects the upper end of the three combinations, it would not represent the limit for infrastructure resource demands. An alternative combination that would include Tank Closure Alternative 6A, Option Case, instead of Alternative 6B, Base Case, along with FFTF Decommissioning Alternative 2 (with all facilities to be built at Hanford) and Waste Management Alternative 2 (with waste Disposal Group 3), would have the greatest combined impact on utility infrastructure.

Under such an alternative combination, the combined peak annual electrical energy demand could be 1.99 million megawatt-hours, with a total combined energy requirement of 188 million megawatt-hours over the entire duration of the alternatives. The peak electrical energy demand of 1.99 million megawatt-hours (approximating an electric load of 227 megawatts) would be about 114 percent of the 1.74-million-megawatt-hour annual capacity (199-megawatt load capacity) of the Hanford electric power distribution system, exceeding its capacity. For water, the combined peak annual water demand could be about 6,880 million liters (1,820 million gallons), with a total combined water requirement of approximately 681,000 million liters (180,000 million gallons). The projected peak annual water demand of 6,880 million liters (1,820 million gallons) under this alternative combination would be about 37 percent of the 18,500 million liter (4,890 million gallon) annual capacity of the Hanford Export Water System and about 30 percent of the 200 Areas' historical average annual water use of more than 22,700 million liters (6,000 million gallons).

4.4.3 Air Quality

The nonradioactive air pollutant impacts of implementing the various Tank Closure, FFTF Decommissioning, and Waste Management alternatives are presented in Sections 4.1.4, 4.2.4, and 4.3.4. This section summarizes the overall impacts of the three alternative combinations. Table 4–159 provides the peak incremental concentrations for selected pollutants and averaging periods under the three alternative combinations.

Under each alternative combination, the peaks for each pollutant and component could potentially occur during different time periods. For analysis purposes, the incremental concentrations during the peak year for each component and averaging period were totaled together. The resulting conservative total estimates represent the upper limit of the concentrations that could be realized.

Under Alternative Combination 1, the projected air pollutant concentrations would be dominated by the Tank Closure alternative. Under Alternative Combination 2, the Waste Management alternative would dominate for carbon monoxide, and the Tank Closure and Waste Management alternatives would have similar contributions for the other pollutants. Under Alternative Combination 3, the Waste Management alternative would dominate for all pollutants.

Table 4–159. Combined Criteria Air Pollutant Concentrations

Alternative Combination and Components	Alternative	Maximum Average Concentration (micrograms per cubic meter)			
		Carbon Monoxide (8 hours)	**Nitrogen Dioxide (annual)**	**PM_{10} (24 hours)**	**Sulfur Dioxide (1 hour)**
Alternative Combination 1					
Tank Closure	No Action	3,410	8.19	**546**	24.0
FFTF Decommissioning	No Action	4.35	0.00066	0.00272	0.0419
Waste Management	No Action	72.6	1.35	**507**	0.723
Total		3,490	9.5	1,050	24.8
Alternative Combination 2					
Tank Closure	2B	6,330	20.5	**4,910**	105
FFTF Decommissioning	2, Idaho Option, Hanford Reuse Option	780	2.91	53.8	37.6
Waste Management	2, DG 1	**10,100**	23.2	**4,080**	84.9
Total		17,200	46.6	9,040	228
Alternative Combination 3					
Tank Closure	6B, Base Case	5,770	14.2	**5,510**	71.5
FFTF Decommissioning	3, Idaho Option, Hanford Reuse Option	772	2.09	94.5	50.4
Waste Management	2, DG 2	**43,400**	92.8	**17,900**	**370**
Total		49,900	109	23,500	492
Most stringent standard or guideline		10,000	100	150	197

Note: Exceedances are shown in **bold** text. Totals may not equal the sum of the contributions due to rounding.

Key: DG=Disposal Group; FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; PM_{10}=particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.

Source: Compiled from Tables 4–3, 4–100, and 4–135.

When added this way, the total incremental concentrations would not exceed the ambient standards, except for PM, which would exceed ambient standards under all three alternative combinations; carbon monoxide and sulfur dioxide, which would exceed ambient standards under Alternative Combinations 2 and 3; and nitrogen dioxide, which would exceed ambient standards under Alternative Combination 3. As discussed previously, the PM emissions for all activities were conservatively estimated, and no controls were assumed in the estimates, but the methodology was consistently applied so that alternatives could be compared. Actual concentrations from tank closure, FFTF decommissioning, and waste management activities would be appropriately controlled such that the ambient standards would not be exceeded.

4.4.4 Geology and Soils

The geologic and soil resource requirements for implementing the various Tank Closure, FFTF Decommissioning, and Waste Management alternatives are presented in Sections 4.1.5, 4.2.5, and 4.3.5. This section summarizes the overall demands for, and projected consumption of, geologic and soil resources under the three alternative combinations. Table 4–160 provides the volumes of selected geologic and soil materials and total material requirements under the three alternative combinations. Representative geologic resources were selected from certain categories (e.g., construction, borrow/backfill, closure) to facilitate meaningful comparison of demands for alternative components within each alternative combination. As previously described in Section 4.1.5 and elsewhere, it is expected that these materials would be excavated from Borrow Area C. The volumes in Table 4–160 conservatively reflect the combined impact of obtaining required materials from onsite reserves.

Table 4–160. Combined Geologic and Soil Resource Requirements

Alternative Combination and Components	Alternative	Representative Resource Demands (cubic meters)			Total Requirements[a] (cubic meters)
		Construction Gravel	Borrow-Soil	Closure-Barrier Materials	
Alternative Combination 1					
Tank Closure	No Action	21,100	55,100	0	92,800
FFTF Decommissioning	No Action	0	0	0	0
Waste Management	No Action	3,510	0	0	6,230
Total		**24,600**	**55,100**	**0**	**99,000**
Alternative Combination 2					
Tank Closure	2B	268,000	782,000	2,300,000[b]	4,360,000
FFTF Decommissioning	2, Idaho Option, Hanford Reuse Option	50	80,400	19,300	122,000
Waste Management	2, DG 1	11,500	0	1,760,000[c]	1,990,000
Total		**281,000**	**863,000**	**4,080,000**	**6,470,000**
Alternative Combination 3					
Tank Closure	6B, Base Case	889,000	8,550,000	689,000[d]	10,900,000
FFTF Decommissioning	3, Idaho Option, Hanford Reuse Option	50	121,000	0	143,000
Waste Management	2, DG 2	11,500	0	6,800,000[c]	7,620,000
Total		**902,000**	**8,670,000**	**7,490,000**	**18,700,000**

[a] Reflects total requirements for all resources for all component activities in addition to and including the representative resources included in the table.

[b] Volume includes soil, sand, gravel, rock, and asphalt for construction of modified Resource Conservation and Recovery Act Subtitle C barriers for landfill closure of all tank farms and six sets of cribs and trenches (ditches).

[c] Volume includes soil, sand, gravel, rock, and asphalt for construction of modified Resource Conservation and Recovery Act Subtitle C barriers for landfill closure of IDF-East and the RPPDF.

[d] Volume includes soil, sand, gravel, rock, and asphalt for construction of modified Resource Conservation and Recovery Act Subtitle C barriers for landfill closure of the six sets of cribs and trenches (ditches) in the B and T Areas.

Note: To convert cubic meters to cubic yards, multiply by 1.308. Totals may not equal the sum of the contributions due to rounding.

Key: DG=Disposal Group; FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; IDF-East=200-East Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility.

Source: Compiled from Tables 4–7, 4–106, and 4–139.

Total geologic resource requirements could range from approximately 99,000 cubic meters (130,000 cubic yards) of material under Alternative Combination 1 to as much as 18.7 million cubic meters (24.5 million cubic yards) under Alternative Combination 3 (see Table 4–160). While the tank closure component generally would have the highest geologic resource demands and associated potential for indirect impacts on geology and soils, the waste management component would have roughly comparable total demands, driven by the requirements for disposal facility construction, operations, and closure. In contrast to tank closure and waste management activities, FFTF decommissioning activities would have relatively insignificant geologic resource requirements under any of the alternative combinations.

As discussed above, it is expected that required materials would be excavated from Borrow Area C at Hanford. Further, it was estimated that Borrow Area C could yield 42.6 million cubic meters (55.7 million cubic yards) of borrow material. In addition, gravel pit No. 30, located between the 200-East and 200-West Areas, is an approximately 54-hectare (134-acre) borrow site that is currently in operation. Aggregate reserves at pit No. 30 are estimated at 15.3 million cubic meters (20 million cubic yards) of material (see Section 4.1.5).

Based on the estimates above, the geologic resources demands associated with all of the alternative combinations considered could be supplied via Hanford's onsite resource reserves; gravel pit No. 30 alone would be able to supply the demands of Alternative Combinations 1 and 2 without the need to develop Borrow Area C to a significant degree.

However, a more conservative alternative combination that would include Tank Closure Alternative 6A, Option Case, instead of Alternative 6B, Base Case, along with FFTF Decommissioning Alternative 3 (with all facilities to be built at Hanford) and Waste Management Alternative 2 or 3 (with waste Disposal Group 3), would have the greatest combined geologic resource requirements. In this case, the combined geologic resource requirements could be as high as 33.8 million cubic meters (44.2 million cubic yards). Assuming that this material would be exclusively obtained from Borrow Area C, the demand to support such an alternative combination would require excavation of approximately 79 percent, on a volumetric basis, of Borrow Area C.

4.4.5 Water Resources

The water resource impacts of implementing the various Tank Closure, FFTF Decommissioning, and Waste Management alternatives are presented in Sections 4.1.6, 4.2.6, and 4.3.6. The analysis of water resources in the aforementioned sections focuses on direct, short-term impacts on surface water, the vadose zone, and groundwater from activities such as new facility construction and closure, which could impact stormwater runoff, surface water, or groundwater hydrology or quality. This section summarizes the impacts on water resources of the three alternative combinations. In general, potential impacts are expected to vary proportionally with the total amount of land that would be disturbed and, more importantly, in relation to the land that would be disturbed in the same general timeframe.

Overall, component activities under the three alternative combinations are not expected to have any direct impact on major surface-water features, including the Columbia River, because there are no natural, perennial surface-water drainages on the Central Plateau of Hanford. All construction- and closure-related land disturbance, especially for new facility construction, would expose soils and sediments to possible erosion by infrequent, heavy rainfall or wind. Stormwater runoff would be unlikely to reach surface-water features, as discussed above, because it would be controlled via application of best management practices and other measures. Stormwater runoff from exposed areas, however, could convey soil, sediments, and other pollutants (e.g., construction waste materials and spilled materials, such as petroleum, oils, and lubricants from construction equipment) from the construction footprint and laydown areas. As described in Section 4.4.1.1, Alternative Combination 2 would have a total land requirement of about 308 hectares (761 acres). The total land area needed under Alternative Combination 3 would be about 797 hectares (1,970 acres). Further, the only component activity with the potential to directly impact surface-water hydrology would be excavation work in Borrow Area C, which could impact the areas surrounding Cold Creek, but would be conducted to minimize any direct impacts. Excavation activities, and thus potential impacts on this surface-water feature, would be greatest under Alternative Combination 3, as indicated above. The relative intensity of the excavation impacts associated with meeting the geologic resources demands are further described in Section 4.4.4.

Any component activity that would contribute to the disturbance of a larger land area would have a greater potential for short-term impacts on water resources than the three alternative combinations discussed herein.

4.4.6 Ecological Resources

4.4.6.1 Terrestrial Resources

The ecological resource impacts of implementing the various Tank Closure, FFTF Decommissioning, and Waste Management alternatives are presented in Sections 4.1.7, 4.2.7, and 4.3.7. The analysis of terrestrial resources focused on those projects and activities that would result in a loss of habitat within undeveloped areas of Hanford, with special attention to the loss of sagebrush habitat. To determine the area of terrestrial habitat that would be affected under each alternative combination, the total area of undeveloped land for each component was added together. Similarly, the area of sagebrush habitat affected was also summed. The results are presented in Table 4–161. As no new facilities would be built at INL under any alternative combination, there would be no impacts on terrestrial habitat at the site.

Table 4–161. Combined Hanford Ecological Resource Disturbance

Alternative Combination and Components	Alternative	Land Area (hectares)	
		Terrestrial Habitat	Sagebrush Habitat
Alternative Combination 1			
Tank Closure	No Action	2.0	0
FFTF Decommissioning	No Action	0	0
Waste Management	No Action	0	0
Total		**2.0**	**0**
Alternative Combination 2			
Tank Closure	2B	98.3	1.2
FFTF Decommissioning	2, Idaho Option, Hanford Reuse Option	2.8	0
Waste Management	2, DG 1	106	64.3
Total		**207**	**65.5**
Alternative Combination 3			
Tank Closure	6B, Base Case	342	100
FFTF Decommissioning	3, Idaho Option, Hanford Reuse Option	3.2	0
Waste Management	2, DG 2	406	248
Total		**753**	**348**

Note: To convert hectares to acres, multiply by 2.471. Totals may not equal the sum of the contributions due to rounding.
Key: DG=Disposal Group; FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory.
Source: Compiled from Sections 4.1.7.3.1, 4.1.7.10.1, 4.2.7.1, 4.2.7.2.1, 4.2.7.3.1, 4.3.7.1, 4.3.7.2.1, and 4.3.7.3.1.

Under Alternative Combination 1, a total of 2 hectares (5 acres) of terrestrial habitat would be disturbed. All of this habitat is classified as grassland and is found within Borrow Area C; no sagebrush habitat would be affected under this alternative combination. Alternative Combination 2 would involve disturbance of 207 hectares (512 acres), 32 percent of which is sagebrush habitat. In the case of Alternative Combination 3, a total of 753 hectares (1,860 acres) of terrestrial habitat would be impacted by project facilities and activities. Of this total, 46 percent would be sagebrush habitat. Mitigation measures relative to the disturbance of sagebrush habitat are addressed earlier in this chapter under each alternative.

Although not addressed in Table 4–161, the greatest impact on terrestrial habitat would occur under an alternative combination that includes Tank Closure Alternative 6A, Option Case; FFTF Decommissioning Alternative 3 (with all facilities to be built at Hanford); and Waste Management Alternative 3 (with waste Disposal Group 2 or 3). Such an alternative combination would disturb a total of up to 1,060 hectares (2,610 acres) of terrestrial habitat, 41 percent of which would be sagebrush.

4.4.6.2 Wetlands and Aquatic Resources

As there are no wetlands or aquatic resources within any of the areas potentially disturbed by alternatives proposed under any of the three *TC & WM EIS* components, there would be no impacts on these resources from any of the alternative combinations.

4.4.6.3 Threatened and Endangered Species

The impacts of the Tank Closure, FFTF Decommissioning, and Waste Management alternatives analyzed in this EIS on threatened and endangered species, including other federally or state-listed special status species, are evaluated in Sections 4.1.7, 4.2.7, and 4.3.7. The analyses in those sections that focused on listed species potentially affected by the proposed projects and actions were based on those species' observed presence, as well as the amounts of undeveloped land, especially sagebrush habitat, that potentially would be disturbed.

For the combined impacts analyses, the numbers of special status species observed or potentially present within those areas affected by the three *TC & WM EIS* alternative combinations were determined. While none of the alternative combinations would impact federally or state-listed threatened or endangered species or designated critical habitat for the bull trout, each could affect a number of state-listed species with other special status designations. Under Alternative Combination 1, three state-listed species (all of which occur within Borrow Area C) could be impacted. These include Piper's daisy (state sensitive), stalked-pod milkvetch (state watch), and long-billed curlew (state monitor). In addition to the three special status species, black-tailed jackrabbit (state candidate) could also be affected under Alternative Combination 2. Under Alternative Combination 3, as many as seven special status species could be impacted, including the loggerhead shrike (Federal species of concern and state candidate); sage sparrow (state candidate); and black-tailed jackrabbit, long-billed curlew, Piper's daisy, stalked-pod milkvetch, and crouching milkvetch (state watch). As the potential to cause disturbance to these species would be greater as habitat disturbance increased, especially sagebrush habitat, the overall potential to impact special status species would increase from Alternative Combination 1 to Alternative Combination 3.

Although not among the identified alternative combinations evaluated, a combination that included Tank Closure Alternative 6A, Option Case; FFTF Decommissioning Alternative 3 (with all facilities to be built at Hanford); and Waste Management Alternative 2 or 3 (with waste Disposal Group 2 or 3) would have the greatest potential to impact special status species. This alternative combination could affect the same seven species affected under Alternative Combination 3. However, the overall potential to impact these species would be greater under this alternative combination due to the greater area of terrestrial habitat, including sagebrush habitat, that would be impacted (see Section 4.4.6.1).

4.4.7 Cultural and Paleontological Resources

4.4.7.1 Prehistoric Resources

The cultural and paleontological resource impacts of implementing the various Tank Closure, FFTF Decommissioning, and Waste Management alternatives are presented in Sections 4.1.8, 4.2.8, and 4.3.8. This section summarizes the overall impacts on cultural and paleontological resources of the three alternative combinations. Potential impacts on cultural and paleontological resources would be directly related to the acreage and location of land disturbed (see Table 4–155), as well as the visual impacts expected from these alternative combinations.

Alternative Combination 1 would require the least acreage of undeveloped land and would involve the least land disturbance. Geologic material would be excavated from Borrow Area C to support construction, operations, deactivation, decommissioning, and closure activities for tank closure, FFTF decommissioning, and waste management activities. Alternative Combination 1 would disturb about 2 hectares (5 acres) of Borrow Area C. Cultural deposits have a zero-to-low potential of being present in Borrow Area C. Prehistoric resources located in the 200-East and 200-West Areas would not be disturbed under this alternative combination.

Alternative Combination 2 would require 207 hectares (512 acres), and Alternative Combination 3 would require 753 hectares (1,860 acres) of previously undisturbed land. Although a larger area of land would be disturbed compared with Alternative Combination 1, cultural deposits have a zero-to-low potential of being present in the areas that would be impacted under these alternative combinations. Known prehistoric resources located in the 200-East and 200-West Areas would not be disturbed.

4.4.7.2 Historic Resources

The acreage of undeveloped land required under Alternative Combination 1 would have no impact on historic resources located within the 200-East and 200-West Areas, including buildings associated with the Manhattan Project and Cold War era.

Alternative Combinations 2 and 3, which would disturb more land than Alternative Combination 1, also would not affect historic resources in the 200-East Area. Historic resources located in the 200-West Area would not be affected by construction or excavation.

4.4.7.3 American Indian Interests

The impacts of the Tank Closure, FFTF Decommissioning, and Waste Management alternatives analyzed in this EIS on American Indian areas of interest are evaluated in Sections 4.1.8, 4.2.8, and 4.3.8.

Construction of new facilities and disturbance of previously undeveloped land would have the greatest impacts. The size of the area to be disturbed and the location of new facilities need to be considered in evaluating the impacts. The view from State Route 240 and Rattlesnake Mountain, an area of noted cultural and religious significance to the American Indians, would be impacted. Under Alternative Combination 1, the industrial appearance of the 200-East and 200-West Areas would remain largely unchanged. Alternative Combination 2 would entail expansion of IDF-East and construction of the RPPDF. Disposal facility expansion/construction, along with mining activities in Borrow Area C, would require over 20 hectares (50 acres) of land. Expansion of IDF-East and construction of the RPPDF would be minimally visible. The disturbance to Borrow Area C would be readily visible from Rattlesnake Mountain. Alternative Combination 3 would require construction of the ILAW Interim Storage Facilities and HLW Debris Storage Facilities in addition to other facilities related to Alternative Combination 2. The land requirement within Borrow Area C, which would increase to 401 hectares (992 acres), nearly triple the land requirement under Alternative Combination 2 (140 hectares [345 acres]), would have the greatest visual impact on Rattlesnake Mountain.

4.4.7.4 Paleontological Resources

The impacts of the Tank Closure, FFTF Decommissioning, and Waste Management alternatives analyzed in this EIS on paleontological resources are evaluated in Sections 4.1.8, 4.2.8, and 4.3.8. As no paleontological resources have been discovered within any of the areas that would potentially be disturbed by the alternatives proposed under any of the alternative combinations, there would be no impacts on these resources under any of the alternative combinations.

4.4.8 Socioeconomics

The socioeconomic impacts of implementing the various Tank Closure, FFTF Decommissioning, and Waste Management alternatives are presented in Sections 4.1.9, 4.2.9, and 4.3.9. This section summarizes the overall socioeconomic effects of the three alternative combinations. Table 4–162 provides the projected peak workforce, commuter traffic, and truck activity under the three alternative combinations.

Under each alternative combination, the peaks for each component could potentially occur during different time spans. To determine the potential impact of each alternative combination, the peak amounts of each component were totaled. The resulting conservative total estimates represent the upper limit of workforce requirements. As shown in Table 4–162, the projected total workforce under all three alternative combinations would be dominated by the requirements of the Tank Closure alternatives. Total workforce requirements would range from 1,840 to 12,500 FTEs over the entire duration of activities. The lower end of the range would represent approximately 1.5 percent of the projected labor force (123,000) in 2008 in the ROI. The higher workforce requirement would range from approximately 8.4 percent of the projected labor force in the ROI (150,000) in 2021 to 4 percent of that labor force (314,000) in 2101. For comparison, in 2006, the employment of approximately 10,000 people at Hanford made up about 10 percent of the labor force employed in the ROI.

The number of daily commuter vehicles would correlate with the number of employees. Assuming that employees would commute to work at a rate averaging 1.25 people per vehicle (Malley 2007), up to 10,000 vehicles per day could impact commuter traffic under Alternative Combination 3. In addition to commuter traffic, Alternative Combination 3 would require a larger number of trucks moving equipment and resources off site (around 102 trips per day) and moving material on site (approximately 1,760 trips per day). Based on this predicted truck and commuter traffic, the LOS on offsite roads in the Hanford area is expected to be impacted.

Table 4–162. Combined Socioeconomic Impact Measures

Alternative Combination and Components	Alternative	Peak Annual Workforce[a] (Peak Year)	Peak Daily Commuter Traffic	Peak Daily Truck Loads (Peak Year)	
				Off Site	On Site
Alternative Combination 1					
Tank Closure	No Action	1,730 (2008)		4 (2008)	23 (2006–2008)
FFTF Decommissioning	No Action	1 (2008–2107)		Less than 1 (2008–2107)	0
Waste Management	No Action	109 (2009)		Less than 1 (2009)	6 (2009)
Total		**1,840**	**1,470**	**4**	**29**
Alternative Combination 2					
Tank Closure	2B	6,860 (2040)		48 (2040)	217 (2039–2043)
FFTF Decommissioning	2, Idaho Option, Hanford Reuse Option	151 (2017)		3 (2017)	52 (2021)
Waste Management	2, DG 1	1,180 (2051–2052)		28 (2051)	428 (2051–2052)
Total		**8,190**	**6,550**	**79**	**697**
Alternative Combination 3					
Tank Closure	6B, Base Case	7,860 (2021–2022)		66 (2040)	188 (2100)
FFTF Decommissioning	3, Idaho Option, Hanford Reuse Option	139 (2017)		2 (2013–2014)	63 (2021)
Waste Management	2, DG 2	4,540 (2101–2102)		34 (2101–2102)	1,500 (2101–2102)
Total		**12,500**	**10,000**	**102**	**1,760**

[a] The workforce is rounded into full-time-equivalent quantities.

Note: Values presented in the table have been rounded to no more than three significant digits, where appropriate. Totals may not equal the sum of the contributions due to rounding.

Key: DG=Disposal Group; FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory.

Source: Compiled from Sections 4.1.9.1–4.1.9.11, 4.2.9.1–4.2.9.3, and 4.3.9.1–4.3.9.3.

4.4.9 Public and Occupational Health and Safety—Normal Operations

The public and worker health impacts of implementing the various Tank Closure, FFTF Decommissioning, and Waste Management alternatives are presented in Sections 4.1.10, 4.2.10, and 4.3.10. This section summarizes the health impacts of selected alternative combinations on the public and workers. Table 4–163 presents the projected peak annual and total impacts on the general population and an MEI under each alternative combination. Combined impacts on the general population were estimated by adding the impacts on the population living within 80 kilometers (50 miles) of the site (Hanford or INL) under each alternative combination. Under each alternative combination, the peaks for each alternative could potentially occur during different time periods without overlap. To determine the potential maximum impact of each alternative combination, the peaks of each alternative were totaled, even when the peak impacts were projected to occur in different timeframes. Similarly, impacts on an MEI were added, even though the MEI may be in different locations along the perimeter of Hanford or INL. This approach provided a conservative estimate of the potential impacts.

Table 4–163. Combined Public Health Impacts—Normal Operations

Alternative Combination and Components	Alternative	Time Period	General Population		Maximally Exposed Individual	
			Dose (person-rem)	Risk (LCFs)[a]	Dose (millirem)	Risk (LCFs)[b]
Alternative Combination 1						
Tank Closure	No Action	Peak annual	0.78	0 (5×10^{-4})	0.041	2×10^{-8}
		Project total	74	0 (4×10^{-2})	3.6	2×10^{-6}
FFTF Decommissioning	No Action	Peak annual	0.00027	0 (2×10^{-7})	0.000017	1×10^{-11}
		Project total	0.027	0 (2×10^{-5})	0.0012	7×10^{-10}
Waste Management	No Action	Peak annual	0	0	0	0
		Project total	0	0	0	0
Combined Impacts		**Peak annual**	**0.78**	**0 (5×10^{-4})**	**0.041**	**2×10^{-8}**
		Project total	**74**	**0 (4×10^{-2})**	**3.6**	**2×10^{-6}**
Alternative Combination 2						
Tank Closure	2B	Peak annual	330	0 (2×10^{-1})	10	6×10^{-6}
		Project total	1,600	1 (1)	43	3×10^{-5}
FFTF Decommissioning	2, Idaho Option, Hanford Reuse Option	Peak annual	0.010	0 (6×10^{-6})	0.00047	3×10^{-10}
		Project total	0.022	0 (1×10^{-5})	0.0010	6×10^{-10}
Waste Management	2, DG 1	Peak annual	0.0000020	0 (1×10^{-9})	0.00000015	9×10^{-14}
		Project total	0.000077	0 (5×10^{-8})	0.0000056	3×10^{-12}
Combined Impacts		**Peak annual**	**330**	**0 (2×10^{-1})**	**10**	**6×10^{-6}**
		Project total	**1,600**	**1 (1)**	**43**	**3×10^{-5}**

Table 4–163. Combined Public Health Impacts—Normal Operations *(continued)*

Alternative Combination and Components	Alternative	Time Period	General Population		Maximally Exposed Individual	
			Dose (person-rem)	Risk (LCFs)[a]	Dose (millirem)	Risk (LCFs)[b]
Alternative Combination 3						
Tank Closure	6B, Base Case	Peak annual	320	0 (2×10^{-1})	9.8	6×10^{-6}
		Project total	1,700	1 (1)	49	3×10^{-5}
FFTF Decommissioning	3, Idaho Option, Hanford Reuse Option	Peak annual	0.0099	0 (6×10^{-6})	0.00047	3×10^{-10}
		Project total	0.022	0 (1×10^{-5})	0.0010	6×10^{-10}
Waste Management	2, DG 2	Peak annual	0.0000020	0 (1×10^{-9})	0.00000015	9×10^{-14}
		Project total	0.000077	0 (5×10^{-8})	0.0000056	3×10^{-12}
Combined Impacts		**Peak annual**	**320**	**0 (2×10^{-1})**	**9.8**	**6×10^{-6}**
		Project total	**1,700**	**1 (1)**	**49**	**3×10^{-5}**

[a] The reported value is the projected number of LCFs among the population and is therefore presented as a whole number. The result calculated by multiplying the collective dose to the population by the risk factor (0.0006 per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6).

[b] Probability of an LCF in the maximally exposed individual is calculated by converting the dose in millirem to rem (divide by 1,000), then multiplying the dose by the risk factor of 0.0006 LCFs per rem.

Key: DG=Disposal Group; FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; LCFs=latent cancer fatalities.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Compiled from Tables 4–19, 4–23, 4–39, 4–109, 4–111, and 4–142.

Table 4–164 presents the combined impacts of normal operations on the worker population. The total impact on the worker population was calculated as the sum of the impacts of each alternative, regardless of the duration or the time of occurrence. In some cases, the periods in which doses would occur would overlap; however, because of the varying durations of activities, there would be times when only one or two of the activities would be under way. The average annual impacts on an FTE are not additive. The average dose across all three alternatives would be lower than the highest dose of any single alternative.

Table 4–164. Combined Worker Health Impacts—Normal Operations

Alternative Combination and Components	Alternative	Project Total Impact—Worker Population		Duration of Radiation Work (years)	Average Annual Impact—Full-Time-Equivalent Worker[b]	
		Dose (person-rem)	Risk (LCFs)[a]		Dose (millirem/year)	Risk (LCFs)[a]
Alternative Combination 1						
Tank Closure	No Action	280	0 (2×10^{-1})	102	140	9×10^{-5}
FFTF Decommissioning	No Action	1	0 (6×10^{-4})	100	50	3×10^{-5}
Waste Management	No Action	37	0 (2×10^{-2})	29	200	1×10^{-4}
Combined Impacts		**320**	**0 (2×10^{-1})**		**<200**	**<1×10^{-4}**
Alternative Combination 2						
Tank Closure	2B	11,000	7	41	160	1×10^{-4}
FFTF Decommissioning	2, Idaho Option, Hanford Reuse Option	5.3	0 (3×10^{-3})	3	33	2×10^{-5}
Waste Management	2, DG 1	3,400	2	45	200	1×10^{-4}
Combined Impacts		**14,000**	**9**		**<200**	**<1×10^{-4}**
Alternative Combination 3						
Tank Closure	6B, Base Case	82,000	49	96	890	5×10^{-4}
FFTF Decommissioning	3, Idaho Option, Hanford Reuse Option	11	0 (7×10^{-3})	3	51	3×10^{-5}
Waste Management	2, DG 2	6,600	4	94	200	1×10^{-4}
Combined Impacts		**89,000**	**53**		**<890**	**<5×10^{-4}**

[a] For an individual, the lifetime risk of developing a latent cancer fatality (LCF) is based on the risk factor of 0.0006 LCFs per rem. For the worker population, the reported value is the projected number of LCFs and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses (see Appendix K, Section K.1.1.6). The LCF risk in the worker population should be viewed in light of the number of years in which the worker dose occurs (spanning multiple generations of workers) and the controls implemented by the U.S. Department of Energy and its contractors to limit individual worker dose.

[b] Average annual dose and risk are not additive. On average, the dose or risk would be lower than the highest dose or risk of any single alternative.

Key: DG=Disposal Group; FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; LCFs=latent cancer fatalities.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Source: Compiled from Tables 4–20, 4–24, 4–41, 4–108, 4–110, 4–112, 4–141, 4–143, 4–144, and 4–145.

Under each of the three alternative combinations, the selected Tank Closure alternative would dominate the impacts on the public and workers. The Tank Closure alternatives would account for an especially high proportion of the impacts on the public—up to more than 99 percent of the doses to the general population and the MEI under each alternative combination. As shown in Table 4–163, the dose to the general population over the operational life of the project under Alternative Combination 1, about 77 person-rem, would result from a comparatively low annual offsite impact occurring at a fairly constant rate for approximately 100 years. The dose to the general population over the life of the project would be of the same order of magnitude under Alternative Combinations 2 and 3 (1,600 person-rem and 1,700 person-rem, respectively); the peak annual doses under the two alternatives are also comparable (330 person-rem and 320 person-rem, respectively).

Table 4–164 shows that the cumulative worker dose would increase as the level of activity increases among the alternative combinations. Alternative Combination 1, comprising the No Action Alternatives, would result in worker doses from continued operations and maintenance activities under each alternative. Alternative Combination 2 would result in higher cumulative worker doses: the Tank Closure alternative worker dose would increase due to retrieval and processing of tank waste; the FFTF Decommissioning alternative dose would increase due to processing of sodium and RH-SCs and entombing of the buildings; and the Waste Management alternative dose would increase due to the longer period required for disposal operations and increased waste processing activities. Alternative Combination 3 would result in the largest cumulative worker doses: the Tank Closure alternative worker dose would increase due to tank and soil removal and processing; the FFTF Decommissioning alternative dose would increase due to removal of the RCB vessels, piping, and components for disposal at IDF-East; and the Waste Management alternative dose would increase due to receipt of offsite waste and the longer period required for disposal operations.

The worker risks shown in Table 4–164 should be viewed in the context of the duration of the alternatives and the DOE administrative controls employed to limit worker dose, as discussed in Section 4.1.10. Some of the alternatives would occur over multiple generations of workers (e.g., Alternative Combinations 2 and 3, Tank Closure and Waste Management alternatives), so a large number of workers would be exposed. Individual worker exposure would be controlled in accordance with DOE requirements and contractor procedures. Individual annual doses must be less than 2 rem (2,000 millirem) per year unless a higher dose is explicitly approved. An Administrative Control Level of 500 millirem per year is applied to projects to ensure the dose limit is not exceeded (DOE 2006a:2, Fluor Hanford 2006:2-1). The number of LCFs is calculated by multiplying individual FTE doses that are less than the regulatory limit by a large number of FTEs. For example, Alternative Combination 3 would require about 112,000 FTE radiation worker years; however, the actual number of workers could be greater than 112,000 to comply with the administrative control level.

Note that the FTE worker average annual dose, shown in Table 4–164, would not occur in practice. Work would be divided among a larger number of workers so that the dose received by each individual was maintained within the Administrative Control Level of 500 millirem per year.

4.4.10 Public and Occupational Health and Safety—Transportation

The risks from transportation of radioactive and nonradioactive materials resulting from implementing the various Tank Closure, FFTF Decommissioning, and Waste Management alternatives are presented in Sections 4.1.12, 4.2.12, and 4.3.12. This section summarizes the overall transportation risks of the three alternative combinations. Table 4–165 provides the impacts on transportation workers and the general population from transportation activities under the three selected alternative combinations.

Table 4–165. Combined Transportation Risks

Alternative Combination and Components	Alternative	Worker: Collective Dose (person-rem)	Worker: Risk (Latent Cancer Fatalities)	General Population: Collective Dose (person-rem)	General Population: Risk (Latent Cancer Fatalities)	Nonradiological Traffic Fatalities[a]
Alternative Combination 1						
Tank Closure	No Action	0	0	0	0	0
FFTF Decommissioning	No Action	0	0	0	0	0
Waste Management	No Action[b]	2.6	0.0	0.08	0.0	0.006
Total		**2.6**	**0 (0.0)**	**0.08**	**0 (0.0)**	**0 (0.006)**
Alternative Combination 2						
Tank Closure	2B	260	0.16	73	0.044	0.89
FFTF Decommissioning	2, Idaho Option, Hanford Reuse Option[c]	0.96	0.0	0.34	0.0	0.035
Waste Management	2, DG 1[d]	2,500	1.5	350	0.21	1.86
Total		**2,800**	**2 (1.7)**	**420**	**0 (0.25)**	**3 (2.79)**
Alternative Combination 3						
Tank Closure	6B, Base Case	560	0.34	89	0.053	1.96
FFTF Decommissioning	3, Idaho Option, Hanford Reuse Option[b]	0.99	0.0	0.34	0.0	0.035
Waste Management	2, DG 2[e]	2,500	1.5	350	0.21	2.1
Total		**3,100**	**2 (1.8)**	**440**	**0 (0.26)**	**4 (4.1)**

[a] Traffic fatalities include those associated with the transport of both radioactive and nonradioactive materials.
[b] The values provided are for onsite transport of waste to a disposal site in the 200-East Area.
[c] This includes disposition of remote-handled special components at Idaho National Laboratory and disposition of bulk sodium at Hanford.
[d] The values presented are for truck transport of radioactive materials as well as construction and operational materials under Disposal Group 1. Note that Disposal Group 1 material transport needs are based on the disposal area that meets the needs of Tank Closure Alternative 4; no attempt was made to adjust the burial size under Alternative 2B. In addition, traffic fatalities using rail would be higher by a factor of 3 than the value presented here (see Section 4.3.12).
[e] The values presented are for truck transport of radioactive materials as well as construction and operational materials under Disposal Group 2. Note that Disposal Group 2 material transport needs are based on the disposal area that meets the needs of Tank Closure Alternative 6B, Option Case; no attempt was made to adjust the burial size under Alternative 6B, Base Case. In addition, traffic fatalities using rail would be higher by a factor of 3 than the value presented here (see Section 4.3.12).

Note: Totals may not equal the sum of the contributions due to rounding.

Key: DG=Disposal Group; FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory.

Source: Compiled from Tables 4–69, 4–70, 4–124, 4–125, 4–152, and 4–153.

As indicated in Table 4–165, no combination of transports is expected to result in an LCF among the exposed population. There could be two additional fatalities among the exposed workers under Alternative Combinations 2 and 3. The maximum annual dose to a transportation crew would be limited to 100 millirem per year, unless the individual is a trained radiation worker, in which case the administrative limit would be an annual dose of 2 rem (DOE Standard 1098-2008). The potential for a trained radiation worker to develop a latent fatal cancer from the maximum annual exposure of 2 rem is 0.0012 per year. Therefore, an individual transportation worker is not expected to develop a latent fatal cancer from exposures during these activities during his or her lifetime.

The expected traffic fatalities range from 0 to 4 over the entire duration of activities. Considering that the duration of activities ranges from 30 to over 100 years, and that traffic fatalities in the United States average about 40,000 per year, the expected risk of traffic fatalities is small.

4.4.11 Environmental Justice

The potential for high and adverse impacts on minority and low-income populations resulting from implementation of the Tank Closure, FFTF Decommissioning, and Waste Management alternatives is discussed in Sections 4.1.13, 4.2.13, and 4.3.13. This section presents the impacts that would result under the selected alternative combinations. Resource areas that could be impacted, and thus affect the general population, including minority and low-income populations, include public and occupational health and safety due to normal operations, accidents, and transportation, as well as air quality.

Section 4.4.9 discusses the short-term radiological impacts on the public resulting from normal operations. As shown in Table 4–163, the majority of the dose received by the public and the MEI under all alternative combinations would be dominated by the Tank Closure alternatives. As presented in Appendix J and Section 4.1.13, there is no appreciable difference between the average total dose to an individual of the minority, American Indian, Hispanic or Latino, or low-income populations and an individual of the remainder of the population in both the peak year of exposure and across the lifetime of the project under all Tank Closure alternatives. Similarly, the dose to the Yakama Reservation MEI is less than one-sixth of that to the offsite MEI for both the peak year of exposure and across the lifetime of the project under all Tank Closure alternatives. Therefore, none of the selected alternative combinations would pose disproportionately high and adverse impacts on minority or low-income populations.

The radiological and chemical impacts of facility accidents under the selected alternative combinations would be the same as those identified in Sections 4.1.11, 4.2.11, and 4.3.11. Potential impacts on minority and low-income populations due to facility accidents would be the same as those described in Sections 4.1.13, 4.2.13, and 4.3.13. As no disproportionately high and adverse impacts were identified under the individual alternatives, none of the combined alternatives would pose disproportionately high and adverse impacts on minority or low-income populations due to facility accidents.

Air quality impacts under the alternative combinations are discussed in Section 4.4.3. Air quality impacts were not analyzed separately for each minority population because the results would be similar to those for radiological impacts; as there would be no disproportionately high or adverse health or environmental impacts on minority, American Indian, Hispanic or Latino, or low-income populations due to normal operations, the same would be true for nonradioactive air emissions.

Section 4.4.10 discusses the risks to the general population of transporting radioactive and nonradioactive materials to implement the three selected alternative combinations. None of the selected alternative combinations are expected to result in an LCF to the exposed population, including minority, American Indian, Hispanic or Latino, and low-income populations. The risks associated with nonradiological transportation would also be small. Therefore, none of the alternative combinations would pose disproportionately high and adverse impacts on minority or low-income populations residing along the transportation routes.

4.4.12 Waste Management

Waste generation impacts associated with the various Tank Closure, FFTF Decommissioning, and Waste Management alternatives and options, including those associated with the construction, operations, deactivation, and closure of the waste management facilities, are presented in Sections 4.1.14, 4.2.14, and 4.3.14. The various alternatives would generate several types of waste: HLW, mixed TRU waste, LLW, MLLW, hazardous waste, and nonhazardous waste. In all cases, the waste management capacity either would be sufficient or new infrastructure would be constructed as part of the alternative. This section describes the combined impacts of managing these wastes. Projected waste generation rates for the proposed alternative were compared with Hanford's capacity to manage the waste, including the additional waste disposal capacity that is proposed to be constructed. Specifically, projected waste generation rates were compared with site processing rates and the capacities of the treatment, storage, and disposal facilities likely to be involved in managing the additional waste. The potential impacts of waste generated as a result of site environmental restoration activities that are unrelated to tank closure, FFTF decommissioning, or waste management are not within the scope of this analysis.

Table 4–166 presents projected volumes of waste that would be generated under the three alternative combinations considered. All three alternative combinations would generate onsite, non-CERCLA waste. Waste generation under Alternative Combinations 2 and 3 would also include the projected receipt of offsite-waste shipments. Under Alternative Combination 1, no offsite waste would be received. The estimated volume of the onsite, non-CERCLA waste that would be generated at Hanford would not be regulated as CERCLA waste and would be generated in facilities and during operations that are not related to tank waste. Examples of facilities and operations that are expected to generate such non-CERCLA waste include the Plutonium Finishing Plant, T Plant complex, WESF, WRAP, Waste Sampling and Characterization Facility, groundwater sampling activities, Pacific Northwest National Laboratory, Cold Vacuum Drying Facility, Canister Storage Building, and the Liquid Waste Processing Facilities, which include the LERF, ETF, SALDS, and TEDF. Estimates of these volumes were developed from the Hanford Site Solid Waste Integrated Forecast Technical (SWIFT) database (Barcot 2005) for LLW, MLLW, and TRU waste and from the SWIFT 2007.0 database (Barcot 2006) for hazardous waste. From the SWIFT source, the volume of LLW and MLLW for the period from 2006 through 2035 was estimated to be approximately 5,300 cubic meters (187,000 cubic feet). For TRU waste, the estimated volume was estimated to be 22,500 cubic meters (795,000 cubic feet). The estimated volume of hazardous waste generated was 870 cubic meters (30,700 cubic feet). However, because hazardous waste is often shipped directly off site for disposal, complete estimates are difficult to calculate. Therefore, it is expected that this is only a subset of the total hazardous waste that would be generated at Hanford. Likewise, because nonhazardous waste is also shipped directly off site for disposal, no estimates are provided other than those projected from the tank closure activities.

Table 4–166. Combined Waste Generation Volumes

Alternative Combination and Components	Alternative	Waste Type						
		HLW[a]	Mixed TRU Waste	LLW[b]	MLLW[c]	Hazardous Waste[d]	Nonradioactive/ Nonhazardous Waste[d]	Liquid LLW (liters)
Alternative Combination 1								
Tank Closure	No Action	N/A	N/A	35	21	12	307	N/A
FFTF Decommissioning	No Action	N/A	N/A	1,700	57	396	NR	623,000
Waste Management	No Action	N/A	N/A	38	N/A	38	NR	N/A
Onsite, non-CERCLA waste[e]		N/A	22,500	3,740	1,520	870	NR	N/A
Offsite waste[f]		N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total		**N/A**	**22,500**	**5,510**	**1,600**	**1,320**	**307**	**623,000**
Alternative Combination 2								
Tank Closure	2B	16,000	206	38,300	726,000	79,600	1,900	9,690
FFTF Decommissioning	2, Idaho Option, Hanford Reuse Option	N/A	N/A	85	407	N/A	458	182,000
Waste Management	2, Disposal Group 1	N/A	N/A	1,520	N/A	96	N/A	N/A
Onsite, non-CERCLA waste[e]		N/A	22,500	3,740	1,520	870	NR	N/A
Offsite waste		N/A	N/A	62,000	20,000	N/A	N/A	N/A
Total		**16,000**	**22,700**	**106,000**	**748,000**	**80,500**	**2,360**	**192,000**
Alternative Combination 3								
Tank Closure	6B, Base Case	576,000	412	104,000	2,960,000	80,900	2,480,000	9,690
FFTF Decommissioning	3, Idaho Option, Hanford Reuse Option	N/A	N/A	770	415	73	458	324,000
Waste Management	2, Disposal Group 2	N/A	N/A	1,520	N/A	96	N/A	N/A
Onsite, non-CERCLA waste[e]		N/A	22,500	3,740	1,520	870	NR	N/A
Offsite waste		N/A	N/A	62,000	20,000	N/A	N/A	N/A
Total		**576,000**	**22,900**	**172,000**	**2,980,000**	**81,900**	**2,480,000**	**334,000**

a Includes cesium and strontium canisters, HLW melters, and other HLW. Includes ILAW and LAW melters under Alternative 6B, Base Case.

b Includes secondary LLW and closure LLW.

c Includes secondary MLLW, closure MLLW, LAW melters, and ILAW under Alternative 2B. Includes secondary MLLW, closure MLLW, and Preprocessing Facility melters and glass under Alternative 6B, Base Case.

d Hazardous and nonhazardous waste is directly shipped off site; therefore, it is generally not forecast.

e Data for LLW, MLLW, and TRU waste are from the Hanford Site Solid Waste Integrated Forecast Technical database fiscal year (FY) 2006–2035 report, while data for hazardous waste are from the FY 2007–2035 report. The FY 2007 report was used for hazardous waste because the forecast shows a 630-cubic-meter increase over the FY 2006 forecast due to changes in the site infrastructure forecast, based on historical generation rates and process knowledge regarding infrastructure support/operations.

f No offsite waste would be received under the Waste Management No Action Alternative.

Note: All values are in cubic meters except as noted. To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, by 0.26417.

Key: CERCLA=Comprehensive Environmental Response, Compensation, and Liability Act; FFTF=Fast Flux Test Facility; Hanford=Hanford Site; HLW=high-level radioactive waste; Idaho=Idaho National Laboratory; ILAW=immobilized low-activity waste; LAW=low-activity waste; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; N/A=not applicable; NR=not reported; TRU=transuranic.

Source: Compiled from Tables 4–84, 4–86, 4–94, 4–126, and 4–155.

Estimated volumes of the LLW and MLLW that would be received from other DOE sites were established in the "Record of Decision for the Solid Waste Program, Hanford Site, Richland, WA: Storage and Treatment of Low-Level Waste and Mixed Low-Level Waste; Disposal of Low-Level Waste and Mixed Low-Level Waste, and Storage, Processing, and Certification of Transuranic Waste for Shipment to the Waste Isolation Pilot Plant" (69 FR 39449). The volumes are limited to 62,000 cubic meters (81,100 cubic yards) of LLW and 20,000 cubic meters (26,200 cubic yards) of MLLW. Thus, this *TC & WM EIS* evaluated the upper limits of the volumes of offsite wastes that may be disposed of at Hanford. These upper-limit volumes were used for analysis purposes only.

Disposal and Capacity

For waste disposal, the range of actions includes onsite and offsite disposal. Waste disposed of on site would be influenced by the volume of waste produced and the ability of the waste to meet onsite disposal criteria. Use of current disposal facilities (e.g., lined trenches) and construction of new facilities (IDF and RPPDF) were analyzed under the Waste Management alternatives. All three Waste Management alternatives include continued disposal of LLW and MLLW in lined trenches, with the timeframe for disposal completion varying from 2035 to 2050. Waste Management Alternatives 2 and 3 include construction of the RPPDF for disposal of equipment and soils resulting from clean closure activities that are not highly contaminated, as well as one or two IDFs for disposal of tank waste, onsite non-CERCLA waste, FFTF decommissioning waste, waste management waste streams, and, as applicable, LLW and MLLW received from offsite locations. The difference between the action alternatives is that Waste Management Alternative 2 includes one IDF, while Waste Management Alternative 3 includes two IDFs, one in the 200-East Area (IDF-East, for tank waste only) and one in the 200-West Area (IDF-West). The Waste Management No Action Alternative discontinues the construction of IDF-East.

Both Waste Management action alternatives analyze three disposal group options. These options were developed based on the amounts and types of waste generated under the various alternatives (within each of the three sets of alternatives that this *TC & WM EIS* analyzes, i.e., tank closure, FFTF decommissioning, and waste management). Facility operational timeframes also vary between the disposal group options. Disposal details for each of the Waste Management alternatives and disposal groups are discussed in Chapter 2.

For HLW, combined generation rates would range from 16,000 cubic meters (563,000 cubic feet) under Alternative Combination 2 to 576,000 cubic meters (20.3 million cubic feet) under Alternative Combination 3 (see Table 4–166). All HLW would be treated, packaged, and stored on site. Under Tank Closure Alternative 1, the cesium and strontium capsules would be stored indefinitely in the WESF, in a manner similar to that currently used.

For mixed TRU waste, combined generation rates would range from 22,500 cubic meters (796,000 cubic feet) under Alternative Combination 1 to 22,900 cubic meters (810,000 cubic feet) under Alternative Combination 3. It is anticipated that TRU waste would be disposed of at WIPP.

For LLW, combined generation rates would range from 5,510 cubic meters (194,000 cubic feet) under Alternative Combination 1 to 172,000 cubic meters (6.07 million cubic feet) under Alternative Combination 3. All LLW would be disposed of on site.

For MLLW, combined generation rates would range from 1,600 cubic meters (56,300 cubic feet) under Alternative Combination 1 to 2.98 million cubic meters (105 million cubic feet) under Alternative Combination 3. Through a combination of on- and offsite capabilities, MLLW would be treated to meet RCRA land-disposal-restriction treatment standards and then disposed of on site.

Hazardous waste volumes are often not forecast, but for those volumes that have been forecast, combined generation rates would range from 1,320 cubic meters (46,600 cubic feet) under Alternative Combination 1 to 81,900 cubic meters (2.89 million cubic feet) under Alternative Combination 3. All hazardous waste generated at Hanford is shipped off site for disposal or recycling.

Nonhazardous waste volumes are also often not forecast, but for those volumes that have been forecast, combined generation rates would range from 307 cubic meters (10,800 cubic feet) under Alternative Combination 1 to 2.48 million cubic meters (87.6 million cubic feet) under Alternative Combination 3. All nonhazardous waste generated at Hanford is shipped off site for disposal or recycling.

As discussed above, none of the three alternative combinations would exceed the capacity of the current or planned Hanford waste management infrastructure. While Alternative Combination 3 reflects the upper end of the three alternative combinations, it does not represent the limit for waste management infrastructure demands. An alternative combination that would substitute Tank Closure Alternative 6A, Base or Option Case, for Alternative 6B, Base Case, and include FFTF Decommissioning Alternative 2 (with all facilities to be built at Hanford) and Waste Management Alternative 2 or 3 (with Disposal Group 3), would have the greatest combined impacts on the waste management infrastructure for HLW, MLLW, hazardous waste, and liquid LLW.

An alternative combination that would substitute Tank Closure Alternative 6B, Option Case, for Alternative 6B, Base Case, and include FFTF Decommissioning Alternative 2 (with all facilities to be built at Hanford) and Waste Management Alternative 2 or 3 (with Disposal Group 3), would have the greatest combined impacts on the waste management infrastructure for LLW.

An alternative combination that would substitute Tank Closure Alternative 4 for Alternative 6B, Base Case, and include FFTF Decommissioning Alternative 2 (with all facilities to be built at Hanford) and Waste Management Alternative 2 or 3 (with Disposal Group 3), would have the greatest combined impacts on the waste management infrastructure for mixed TRU waste.

However, generation of these wastes is not likely to have major impacts on the waste management infrastructure at Hanford because sufficient capacity exists or would be constructed under the corresponding Waste Management alternatives.

4.4.13 Industrial Safety

The industrial safety risks and impacts of implementing the various Tank Closure, FFTF Decommissioning, and Waste Management alternatives are presented in Sections 4.1.15, 4.2.15, and 4.3.15. This section summarizes the overall industrial safety impacts of the three alternative combinations. For each alternative combination, the number of TRCs and fatalities was projected over the duration of the alternatives under that combination (see Table 4–167). The resulting total number of TRCs and fatalities represents the potential impacts on worker safety.

As indicated in Table 4–167, the number of projected TRCs and fatalities would be greatly influenced by the requirements of the Tank Closure alternatives. The numbers of TRCs would range from 173 under Alternative Combination 1 to 6,830 under Alternative Combination 3. The greater number of TRCs would be directly related to the amount of work required and the duration of time that work was performed.

Table 4–167. Combined Industrial Safety Impacts

Alternative Combination and Components	Alternative	Number of Total Recordable Cases	Number of Fatalities
Alternative Combination 1			
Tank Closure	No Action	163	0.02
FFTF Decommissioning	No Action	0.42	0.00005
Waste Management	No Action	10.0	0.001
Total		**173**	**0.02**
Alternative Combination 2			
Tank Closure	2B	3,880	0.50
FFTF Decommissioning	2, Idaho Option, Hanford Reuse Option	14.8	0.001
Waste Management	2, DG 1, Subgroup 1-A	578	0.076
Total		**4,470**	**0.58**
Alternative Combination 3			
Tank Closure	6B, Base Case	5,150	0.67
FFTF Decommissioning	3, Idaho Option, Hanford Reuse Option	16.2	0.003
Waste Management	2, DG 2, Subgroup 2-B	1,660	0.21
Total		**6,830**	**0.88**

Note: Totals may not equal the sum of the contributions due to rounding.
Key: DG=Disposal Group; FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory.
Source: Compiled from Tables 4–98, 4–132 , and 4–156.

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