CHAPTER 3
AFFECTED ENVIRONMENT

3.0 AFFECTED ENVIRONMENT

In Chapter 3, affected environment descriptions for the Savannah River Site (SRS), Los Alamos National Laboratory (LANL), and the Tennessee Valley Authority's (TVA's) Browns Ferry Nuclear Plant and Sequoyah Nuclear Plant are presented. The affected environments for SRS and LANL are described for the following resources areas: land resources; geology and soils; water resources; meteorology, air quality, and noise; ecological resources; human health; cultural and paleontological resources; socioeconomics; infrastructure; waste management; and environmental justice. Because of the limited range of potential environmental impacts at the TVA nuclear plants, a reduced set of resource areas are described: air quality and noise; radiation exposure and risk; waste management; and environmental justice.

In accordance with the Council on Environmental Quality's (CEQ) National Environmental Policy Act regulations (40 *Code of Federal Regulations* [CFR] Parts 1500 through 1508), this *Final Surplus Plutonium Disposition Supplemental Environmental Impact Statement (SPD Supplemental EIS)* succinctly describes the areas that could be affected by the alternatives under consideration. The affected environment descriptions provide the context for understanding the environmental consequences described in Chapter 4 of this supplemental environmental impact statement (SEIS), and serve as baselines from which any potential environmental impacts can be evaluated.

For this *SPD Supplemental EIS*, each resource area that may be affected by the Proposed Action and alternatives is described. The level of detail varies depending on the potential for impacts for each resource area. A number of site-specific and recent project-specific documents that are important sources of information for describing the existing environment are summarized and/or incorporated by reference in this chapter.

An important component in analyzing impacts is identifying or defining the region of influence (ROI) for each resource area. The ROIs are specific to the type of effect evaluated and encompass geographic areas within which potential impacts could be expected to occur. **Table 3–1** briefly describes the ROIs by site for each resource area evaluated in this SEIS. Note that transportation is included in Table 3–1 because this resource area is evaluated and the impacts presented in Chapter 4. However, it is not included among the resource areas described in Chapter 3.

This chapter begins with descriptions of the affected environment for the Savannah River Site (SRS) in Section 3.1, followed by Los Alamos National Laboratory (LANL) in Section 3.2, then the Tennessee Valley Authority's (TVA's) Browns Ferry Nuclear Plant and Sequoyah Nuclear Plant in Section 3.3.

Table 3–1 General Regions of Influence for Resource Areas

Resource Area	***Site***	***Region of Influence***
Land use and visual resources	SRS and LANL	Land use and visual resources within SRS and LANL, and nearby offsite areas
	BFN and SQN	Not applicable [a]
Geology and soils	SRS and LANL	Geologic and soil resources within SRS, LANL, and nearby offsite areas
	BFN and SQN	Not applicable [a]
Water resources	SRS and LANL	Surface-water bodies and groundwater within SRS and LANL, and nearby offsite areas
	BFN and SQN	Not applicable [a]
Air quality and noise	SRS, LANL, BFN and SQN	SRS, LANL, BFN and SQN and nearby offsite areas within local air quality control regions and the transportation corridors for the sites
Ecological resources	SRS and LANL	SRS, LANL, and adjacent offsite areas where aquatic and terrestrial ecological communities exist, including non-sensitive and sensitive habitats and species
	BFN and SQN	Not applicable [a]
Human health risk	SRS, LANL, BFN and SQN	SRS, LANL, BFN and SQN, and offsite areas (within 50 miles [80 kilometers] of the sites) where worker and general population radiation, radionuclide, and hazardous chemical exposures may occur
Cultural and paleontological resources	SRS and LANL	SRS, LANL, and adjacent offsite areas where cultural and paleontological resources exist
	BFN and SQN	Not applicable [a]
Socioeconomics	SRS	The four counties surrounding SRS: Aiken and Barnwell in South Carolina, and Columbia and Richmond in Georgia
	LANL	The four counties surrounding LANL: Los Alamos, Santa Fe, Sandoval, and Rio Arriba
	BFN and SQN	Not applicable [a]
Infrastructure	SRS and LANL	Power, fuel supply, water supply, and road systems within SRS and LANL
	BFN and SQN	Not applicable [a]
Waste management	SRS, LANL, BFN and SQN	Waste treatment, storage, and disposal facilities within SRS, LANL, BFN and SQN
Transportation	SRS and LANL	The population living within 0.5 miles (0.80 kilometers) of either side of an offsite route for incident-free impacts, and a population within 50 miles (80 kilometers) of an accident
	BFN and SQN	Not applicable [a]
Environmental justice	SRS, LANL, BFN and SQN	The minority and low-income populations within 50 miles (80 kilometers) of SRS, LANL, BFN and SQN

BFN = Browns Ferry Nuclear Plant; LANL = Los Alamos National Laboratory; SQN = Sequoyah Nuclear Plant; SRS = Savannah River Site.

[a] Consistent with the *Surplus Plutonium Disposition Final Environmental Impact Statement* (*SPD EIS*), four resource areas were considered for the two potential TVA reactor sites, Browns Ferry and Sequoyah Nuclear Plants: air quality and noise, radiation exposure and risk, waste management, and environmental justice.

3.1 Savannah River Site

This section describes the SRS environment in general and the facility areas (E-, F-, H-, K-, and S-Areas) in which activities described in Chapter 2 have been proposed. The descriptions in this section update information provided in Chapter 3, Section 3.5, of the *Surplus Plutonium Disposition Final Environmental Impact Statement* (*SPD EIS*) (DOE 1999b) for SRS, and provide additional information on the specific facility areas, as appropriate.

3.1.1 Land Resources

Land resources include both land use and visual resources.

3.1.1.1 Land Use

Land use is defined as the way land is developed and used in terms of the kinds of human activities that occur (e.g., agriculture, residential areas, and industrial areas) (EPA 2006).

General Site Description

Located in southwestern South Carolina, SRS occupies an area of 198,344 acres (80,268 hectares) in a generally rural area about 25 miles (40 kilometers) southeast of Augusta, Georgia, and 12 miles (19 kilometers) south of Aiken, South Carolina, the nearest population centers. It is bordered by the Savannah River to the southwest and includes portions of three South Carolina counties: Aiken, Allendale, and Barnwell. SRS is a controlled area, public access being limited to through traffic on State Highway 125 (SRS Road A), U.S. Highway 278 (SRS Road 1), and the CSX railway line (DOE 1999b:3-163; SRNS 2009b:1-1).

Predominant regional land uses in the vicinity of SRS include urban, residential, industrial, agricultural, and recreational. SRS is bordered mostly by forest and agricultural land, with limited urban and residential development. The nearest residences are located to the west, north, and northeast, some within 200 feet (61 meters) of the SRS boundary (NRC 2005a:3-36). Farming is diversified throughout Aiken, Allendale, and Barnwell Counties and includes such crops as corn, hay, peanuts, cotton, and winter wheat (USDA 2008). Industrial areas are also present within 25 miles (40 kilometers) of the site; industrial facilities include textile mills, polystyrene foam and paper plants, chemical processing plants, the Barnwell low-level radioactive waste (LLW) facility, and a commercial nuclear power plant. Open water and nonforested wetlands occur along the Savannah River Valley. Recreational areas within 50 miles (80 kilometers) of SRS include Sumter National Forest, Santee National Wildlife Refuge, and Clark’s Hill/Strom Thurmond Reservoir. State, county, and local parks include Redcliffe Plantation, Rivers Bridge, Barnwell State Park, and the Aiken State Natural Area in South Carolina, and Mistletoe State Park in Georgia. The Crackerneck Wildlife Management Area occupies a portion of SRS along the Savannah River and is open to the public for hunting and fishing at certain times of the year (NRC 2005a:3-36).

The State of South Carolina Councils of Governments were formed in 1967, when the state was divided into 10 planning districts. Six counties are included in the Lower Savannah River Planning District, including Aiken, Allendale, and Barnwell Counties, the three counties within which SRS is located (SCARC 2010). Private lands bordering SRS are subject to the planning regulations of these three counties (DOE 1999b:3-163).

Land use at SRS can be classified into three major categories: forest/undeveloped, water/wetlands, and developed facilities. Open fields and pine and hardwood forests make up 73 percent of the site, while 22 percent is wetlands, streams, and two lakes. Production and support areas, roads, and utility corridors account for the remaining 5 percent of the land area (DOE 2005c:3-8). The U.S. Forest Service, under an interagency agreement with the U.S. Department of Energy (DOE), manages timber production on about 149,000 acres (60,300 hectares) (USFS-Savannah River 2004:12). Public hunts for white-tailed deer (*Odocoileus virginianus*), feral hogs (*Sus scrofa*), wild turkeys (*Meleagris gallopavo*), and coyote (*Canis latrans*) are allowed on site. In 2008, 432 deer and 110 hogs were harvested from SRS (SRNS 2009b:5-8). Soil map units that meet the requirements for prime farmland soils exist on the site. However, the Natural Resources Conservation Service of the U.S. Department of Agriculture does not identify these as prime farmlands because the land is not available for agricultural production (DOE 1999b:3-163–165).

Decisions on future land uses at SRS are made by DOE through site development, land use, and future planning processes. SRS has established a Land Use Technical Committee comprising representatives from DOE, the management and operating contractor, and other SRS organizations (DOE 1999b:3-165). DOE has prepared a number of documents addressing the future of SRS, including the *Savannah River Site End State Vision* report (DOE 2005c) and the *Savannah River Site Comprehensive Plan/Ten Year Plan, FY 2011-2020* (SRNS 2010c). As noted in these documents, the Environmental Management Cleanup Project and mission will be complete by 2031 and ongoing National Nuclear Security Administration (NNSA) nuclear industrial missions will continue. SRS is a site with an enduring mission and is not a closure site; thus, SRS land will be federally owned, controlled, and maintained in perpetuity (DOE 2005c:4, SRNS 2010c:E-5).

As depicted in **Figure 3–1**, the site has been divided into six management areas based on existing biological and physical conditions, operations capability, and suitability for mission objectives. The 38,444-acre (15,558-hectare) Industrial Core Management Area contains the major SRS facilities. The primary objective of this area is to support facilities and site missions. Other important objectives are to promote conservation and restoration, provide research and educational opportunities, and generate revenue from the sale of forest products. Protection of the red-cockaded woodpecker (*Picoides borealis*) dominates natural resource decisions in the 87,200-acre (35,289-hectare) Red-cockaded Woodpecker Management Area and the 47,100-acre (19,061-hectare) Supplemental Red-cockaded Woodpecker Management Area (DOE 2005b:4-6). The Crackerneck Wildlife Management Area and Ecological Reserve is 10,400 acres (4,209 hectares) in size, and is managed by the South Carolina Department of Natural Resources (SCDNR 2010a). The primary objective of this management area is to enhance wildlife habitat through forestry and wildlife management practices. The management objective of the 10,000-acre (4,047-hectare) Savannah River Swamp and 4,400-acre (1,780-hectare) Lower Three Runs Corridor Management Area is to improve the physical and biological quality of the wetland environment (DOE 2005b:4-6).

In 1972, all of SRS was designated as a National Environmental Research Park. The purpose of the National Environmental Research Park is to conduct research and education activities to assess and document environmental effects associated with energy and weapons material production, explore methods for eliminating or minimizing adverse effects of energy development and nuclear materials on the environment, train people in ecological and environmental sciences, and educate the public (SREL 2010a). DOE has also established a set-aside program to provide reference areas for understanding human impacts on the environment. The SRS set-aside program currently contains 30 research reserves totaling 14,006 acres (5,668 hectares). These reserves were chosen as representatives of the eight major vegetation communities on the site (SREL 2010b).

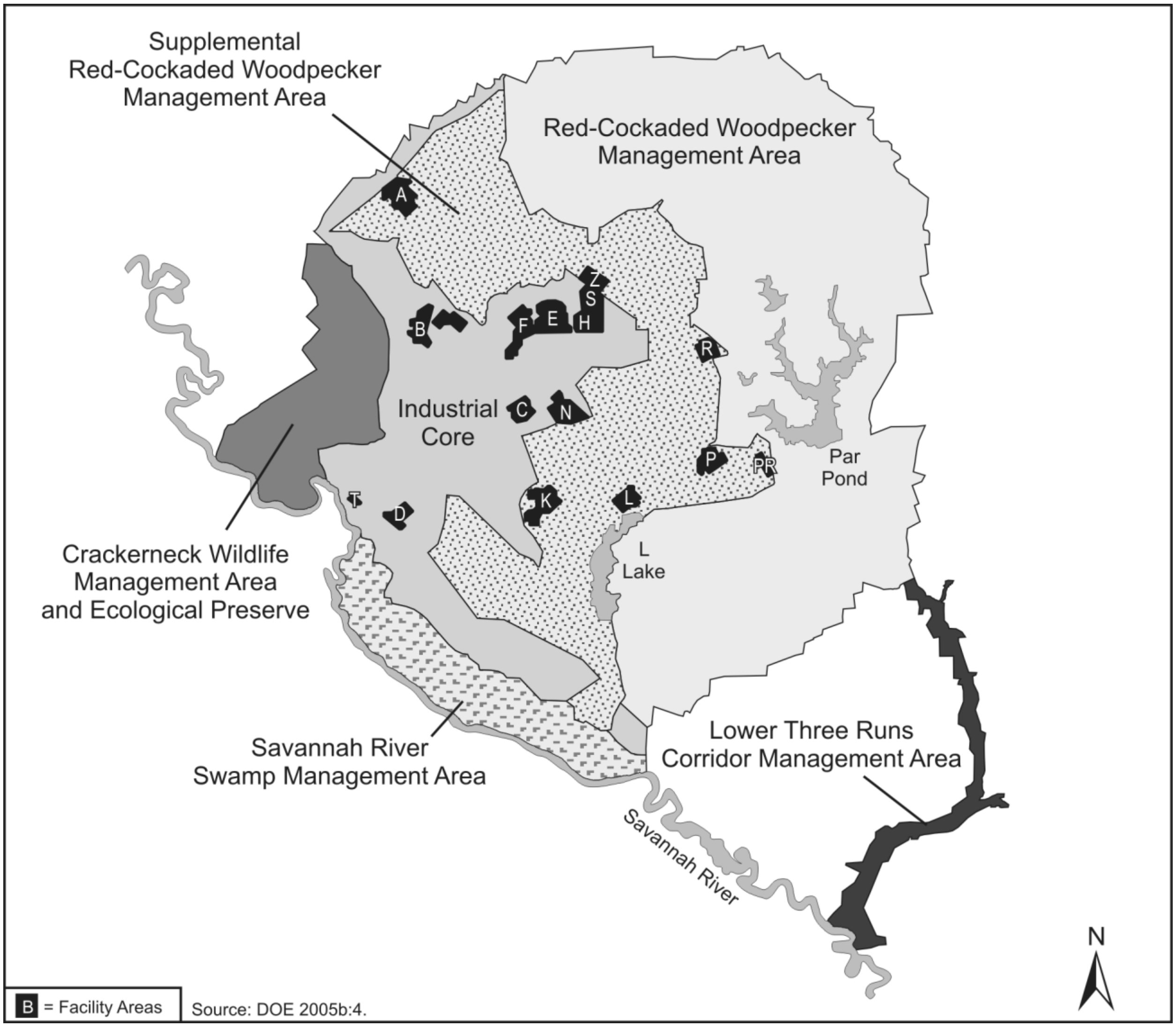

Figure 3–1 Savannah River Site Management Areas

No onsite areas are subject to American Indian treaty rights. However, five American Indian groups, the Yuchi Tribal Organization, the National Council of Muskogee Creek, the Indian Peoples Muskogee Tribal Town Confederacy, the Pee Dee Indian Association, and the Ma Chis Lower Alabama Creek Indian Tribe, have expressed concern over sites and items of religious significance on SRS. DOE routinely notifies these organizations about major planned actions at SRS and asks them to comment on SRS documents prepared in accordance with the National Environmental Policy Act (DOE 1999b:3-165).

Proposed Facility Locations

The locations of the areas described in this section are depicted in Figure 3–1.

E-Area is located in the Industrial Core Management Area between the F- and H-Areas. E-Area comprises approximately 330 acres (134 hectares) and includes the Old Burial Ground, Mixed Waste Management Facility, transuranic (TRU) waste pads, and E-Area Vaults. E-Area receives solid LLW, TRU waste, and mixed waste from across SRS. E-Area facilities are maintained to manage previously received waste and to prepare for the receipt of waste from new site operations. The current land use designation for E-Area is industrial (DOE 2005c:53). Existing facilities in E-Area would be used for storage, staging, and shipping of TRU waste, LLW, and mixed low-level radioactive waste (MLLW) that would be generated by surplus plutonium disposition activities. In addition, most of the LLW that would be generated by surplus plutonium disposition activities would be disposed of in vaults and trenches in E-Area.

F-Area is a highly developed area covering approximately 364 acres (147 hectares) near the center of SRS (DOE 2002:3-32). It is located 5.8 miles (9.3 kilometers) from the site boundary and is within the Industrial Core Management Area (DOE 1999b:3-163). The area includes nuclear, industrial, warehouse, laboratory, and administrative facilities. F-Area is the location for the Mixed Oxide Fuel Fabrication Facility (MFFF) and Waste Solidification Building (WSB), both of which are currently under construction.

H-Area covers 395 acres (160 hectares) and is located near the center of SRS, 6.8 miles (11 kilometers) from the site boundary (DOE 2002:3-32). Like F-Area, H-Area is located within the Industrial Core Management Area. The area includes nuclear, industrial, warehouse, and administrative facilities. H-Area is the last operational nuclear chemical separation area at SRS; H-Canyon/HB-Line is located in this area (SRNS 2010c:3-67).

K-Area is a 3,558-acre (1,440-hectare) area situated near the center of SRS and located just outside of the Industrial Core Management Area within the Supplemental Red-Cockaded Woodpecker Management Area. The area is 5.5 miles (8.9 kilometers) from the site boundary. K-Area is one of five SRS reactor areas with the original mission of producing material for the U.S. nuclear weapons program; however, the K-Area production reactor is in a shutdown condition with no restart capability. The K-Area Material Storage Area is located in the K-Area Complex (SRNS 2010c:3-85).

S-Area is situated in the Industrial Core Management Area and is located just north of H-Area, approximately 6.2 miles (10 kilometers) from the site boundary. This area is approximately 272 acres (110 hectares) in size. Facilities located in S-Area are related to liquid radioactive waste immobilization and interim storage (DOE 1999b:3-165; WSRC 2007b:2-15). The Defense Waste Processing Facility (DWPF) and the two Glass Waste Storage Buildings are located in S-Area.

3.1.1.2 Visual Resources

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; however, they exert varying degrees of influence. The more visual variety that exists with harmony, the more aesthetically pleasing the landscape (DOE 1999b:3-166).

General Site Description

The dominant viewshed in the vicinity of SRS consists mainly of agricultural land and forest, with some limited residential and industrial areas. The SRS landscape is characterized by wetlands and upland hills. Vegetation comprises bottomland hardwood forests, scrub oak and pine forests, and forested wetlands. Facilities are scattered throughout SRS and are brightly lit at night. These facilities are generally not visible off site, as views are limited by rolling terrain, normally hazy atmospheric conditions, and heavy vegetation. The only areas visually impacted by the DOE facilities are those within the view corridors of State Highway 125 and U.S. Highway 278 (DOE 1999b:3-166).

The developed areas and utility corridors (transmission lines and aboveground pipelines) of SRS are consistent with a Visual Resource Management Class IV designation. The remainder of SRS is consistent with a Visual Resource Management Class II or Class III designation. Management activities within Class II and Class III areas may be seen, but do not dominate the view; management activities in Class IV areas dominate the view and are the focus of viewer attention (DOI 1986:6, 7).

Proposed Facility Locations

Industrial facilities within E-, F-, H-, K-, and S-Areas consist of large concrete structures, smaller administrative and support buildings, trailers, and parking lots. The structures range in height from 10 to 100 feet (3 to 30 meters), with a few stacks and towers that reach up to 200 feet (61 meters). The facilities in these areas are brightly lit at night and visible when approached via SRS access roads (DOE 1999b:3-164). Visual resource conditions in each of the proposed facility locations are consistent with a Visual Resource Management Class IV designation. E-, F-, H-, and S-Areas are about 4.3 to 6.8 miles (6.9 to 11 kilometers) from State Highway 125 and 5.3 to 6.8 miles (8.5 to 11 kilometers) from U.S. Highway 278. K-Area is about 1.2 miles (1.9 kilometers) from State Highway 125 and 10 miles (16 kilometers) from U.S. Highway 278. Public views of the facilities within each of the proposed locations are restricted by heavily wooded areas and the nature of the terrain bordering segments of State Highway 125 and U.S. Highway 278. Moreover, facilities are not visible from the Savannah River, which is no closer than 5.5 miles (8.9 kilometers) from any of the locations in which proposed activities would occur (DOE 1999b:3-166).

3.1.2 Geology and Soils

Geologic resources are consolidated or unconsolidated earth materials, including ore and aggregate materials, fossil fuels, and significant landforms. A detailed description of the geology at SRS is included in the MFFF license application (DCS 2006:1-375–549).

Soil resources are the loose surface materials of the Earth in which plants grow, usually consisting of disintegrated rock, organic matter, and soluble salts. A detailed description of the soil conditions at SRS is included in the *SRS Ecology Environmental Information Document* (WSRC 2006b:1-1–14).

3.1.2.1 Geology

General Site Description

SRS is primarily located on the Aiken Plateau, within the southern portion of the South Carolina Upper Atlantic Coastal Plain. The Aiken Plateau, on which the central and northeastern portions of SRS are located, is highly dissected and characterized by broad flat areas cut by narrow, steep-sided valleys. The southwestern portions of SRS are located on erosional terraces. The terraces are the result of successive marine recessions during the glacial periods about 10,000 to 1 million years ago (WSRC 2006b:1-1).

The loosely consolidated Atlantic Coastal Plain sediments are located above bedrock that consists of Paleozoic-age metamorphic and igneous rock (e.g., granite) and Triassic-age sedimentary rock (e.g., siltstone) of the Dunbarton Basin (NRC 2005a:3-3). The Atlantic Coastal Plain sediments consist of layers of sandy clays and clayey sands, along with occasional beds of clays, silts, sands, gravels, and carbonate that dip gently and thicken to the southeast from near zero at the fall line to about 4,000 feet (1,219 meters) at the South Carolina coast (NRC 2005a:3-3; WSRC 2006b:1-1, 2006g:54). The Atlantic Coastal Plain sediments at SRS are approximately 600 to 1,400 feet (183 to 427 meters) thick (DOE 2002:3-1).

The Atlantic Coastal Plain sedimentary sequence near the center of SRS consists of about 700 feet (213 meters) of late Cretaceous quartz sand, pebbly sand, and kaolinitic clay, overlain by about 60 feet (18 meters) of Paleocene clayey and silty quartz sand, glauconitic sand, and silt. The Paleocene beds are overlain by about 350 feet (107 meters) of Eocene quartz sand, glauconitic quartz sand, clay, and limestone grading into calcareous sand, silt, and clay. In places, especially at higher elevations, the sequence is capped by deposits of pebbly and clayey sand, conglomerate, and clay from the Miocene or Oligocene era (DCS 2006:1-380).

The overlying Tinker/Santee Formation consists of 60 feet (18 meters) of Paleocene-age clayey and silty quartz sand, and silt with occasional beds of clean sand, gravel, clay, or carbonate. This layer is noteworthy because it contains small, discontinuous, thin calcareous sand zones (i.e., sand containing calcium carbonate) that are subject to dissolution by water. These "soft-zone" areas could subside, potentially causing settling of the ground surface (NRC 2005a:3-3). Soft zones occur throughout SRS, but are more prevalent moving across the site to the southeast. The soft zones consist of soil rather than open water-filled cavities (WSRC 1999:16, 74). These zones were encountered in exploratory borings in F-, H-, K- and S-Areas at depths between 100 and 150 feet (30 and 46 meters) (NRC 2005a:3-3; WSRC 2008a:1).

Dissolution of the carbonate materials in the soft zones is so slow (if it is occurring at all) that it is not expected to affect any present or future SRS facility. Because of the depth of the soft zones, there are no static stability issues. It is conservatively assumed that the arches supporting the soft zones would lose strength during a seismic event, resulting in a small amount of surface subsidence (WSRC 1999:vi, 75).

Geophysical studies of SRS have identified seven subsurface faults: Pen Branch, Steel Creek, Advanced Tactical Training Area, Crackerneck, Ellenton, Upper Three Runs, and an unnamed fault that passes approximately 0.5 miles (0.8 kilometers) south of F-Area, between F-Area and Fourmile Branch (DOE 2002:3-5). The actual faults do not reach the surface, stopping several hundred feet below grade (CSRACT 2007:34). The only known faults capable of producing an earthquake within a 200-mile (320-kilometer) radius of SRS are within the Charleston seismic zone (located approximately 70 miles [110 kilometers] southeast of SRS) (NRC 2005a:3-4).

The Charleston, South Carolina, earthquake of 1886 (estimated Richter scale magnitude of 6.8) is the most damaging earthquake known to have occurred in the southeastern United States and one of the largest historic shocks in eastern North America. At SRS, this earthquake had an estimated Richter scale magnitude ranging from 6.5 to 7.5. The SRS area experienced an estimated peak ground acceleration[1] of 0.10 *g* (one-tenth the acceleration of gravity) during this event (NRC 2005a:3-4).

Earthquake-produced ground motion is expressed in units of percent *g* (force of acceleration relative to that of Earth's gravity). The latest probabilistic peak (horizontal) ground acceleration (PGA) data from the U.S. Geological Survey were used to indicate seismic hazard. The PGA values cited are based on a 2 percent probability of exceedance in 50 years. This corresponds to an annual occurrence probability of about 1 in 2,500. At the center of SRS, the calculated PGA is approximately 0.17 *g* (USGS 2010b). Most of the PGA is related to the proximity of SRS to the Charleston seismic zone and not from locally generated earthquakes.

Richter Scale

The magnitude of an earthquake is a measure of the energy released during the event. It is often measured on the Richter scale, which runs from 0.0 upwards. The Richter scale is logarithmic; a quake of magnitude 5 releases over 10 times more energy than a quake of magnitude 4. Earthquakes greater than magnitude 6.0 can be regarded as significant, with a high likelihood of damage and loss of life (NRC 2005a:3-4). The largest recorded earthquake in the United States occurred at Prince William Sound, Alaska in 1964 and had a magnitude of 9.2.

Since 1973, 17 minor earthquakes (ranging in magnitude from 2.1 to 3.7) have been recorded within a 62-mile (100-kilometer) radius of SRS. Three of these earthquakes occurred within or near the SRS boundary. In 1985, an earthquake occurred with a local magnitude of 2.7. In 2001 and 2009, earthquakes occurred with local magnitudes of 2.6 (USGS 2010a). Earthquakes capable of producing structural damage are not likely to originate in the vicinity of SRS (DOE 1999b:3-149).

[1] Peak ground acceleration is the maximum acceleration amplitude (change in velocity with respect to time) measured by a seismic recording of an earthquake (called a strong motion accelerogram) (NRC 2005a:34).

No evidence of liquefaction[2] has been discovered at SRS. Nonetheless, due to the critical importance of SRS facilities, site-specific liquefaction assessments are completed for new facilities (WSRC 2008a:1).

There are no volcanic hazards at SRS. The area has not experienced volcanic activity within the last 230 million years. Future volcanism is not expected because SRS is located along the passive continental margin of North America (DOE 1999b:3-151).

The mixed sands, gravels, and clays commonly found beneath SRS are widespread and therefore are of limited commercial value. A possible exception might be well-sorted quartz sand, which is valuable as a filtration medium, an abrasive, and engineering backfill (WSRC 2008a:1).

Proposed Facility Locations

Geology and soil conditions in K-Area are consistent with subsurface conditions found throughout SRS. Soft zones underlying K-Area primarily occur in three intervals of the Santee Formation, at 120 to 130 feet (37 to 40 meters), 135 to 150 feet (41 to 46 meters), and 155 to 170 feet (47 to 52 meters) below the ground surface. The 135- to 150-foot (41- to 46-meter) depth is the primary interval in which the soft zones are encountered (WSRC 1999:19). Soft zones are limited in size and areal extent, and are poorly interconnected. The most well-developed soft zone measures approximately 50 feet (15 meters) wide by 200 feet (61 meters) long. The most well-developed soft zones are approximately 15 feet (4.6 meters) thick. There are no documented occurrences of surface depressions developed as a result of soft zone collapse at K-Area (WSRC 1999:19). Total ground surface settlements from design-basis earthquake loading of the soft zones were estimated to be between 1.4 and 1.75 inches (3.6 and 4.5 centimeters) (WSRC 1999:18).

Site-specific investigations of the subsurface conditions at MFFF in F-Area and DWPF in S-Area indicate that the geology and soils present in these areas are consistent with subsurface conditions found throughout SRS (DCS 2006:1-485; DOE 1994:3-2). Subsurface conditions in E- and H-Areas are expected to be predominantly the same as those in F- and S-Areas.

Several subsurface investigations conducted at SRS waste management areas (E-, S-, and Z-Areas), DWPF, and MFFF encountered soft sediments classified as calcareous sands within the Santee Formation. The calcareous sands were encountered in borings in F-Area between 108 and 115 feet (33 and 35 meters) below ground surface, and at DWPF between 110 and 150 feet (34 and 46 meters) below the ground surface. Preliminary information indicates that these calcareous zones are not continuous over large areas, nor are they very thick. No settling as a result of dissolution of these zones has been identified (DCS 2006:1-538; DOE 1994:3-2, 1999b:3-151; NRC 2005a:3-3). The soft zones at SRS are stable under static conditions. The geologic record shows that the soft zones have withstood earthquakes that have occurred since their formation. Therefore, no subsidence under static or dynamic conditions due to the presence of the soft zones is expected (DCS 2006:1-539). Total potential ground surface settlements at MFFF from numerical modeling of the soft zones were estimated to be between 3.2 and 4 inches (8.1 and 10.2 centimeters) (NRC 2005d:11-11).

Analyses indicate that surface soils within the vicinity of MFFF would experience no liquefaction as a result of the design-basis earthquake (DCS 2006:1-538). In addition, no appreciable differential settlement[3] is expected to occur at the MFFF foundation level due to liquefaction of soft strata that occur below the water table at a depth of 60 feet (18 meters) or greater (NRC 2005d:11-12).

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[2] Liquefaction – A process by which water-saturated sediment temporarily loses strength and acts as a fluid. This effect can be caused by earthquake shaking.
[3] Differential settlement – The vertical displacement due to settlement of one point of a foundation with respect to another point of the foundation.

No sizable economically valuable deposits of quartz sand are evident at the surface or in the shallow subsurface in K-Area (WSRC 2008a:1). Except for some small gravel deposits, no economically viable geologic resources occur in the vicinity of F-Area (NRC 2005a). This is also expected to be true for E-, H-, and S-Areas.

3.1.2.2 Soils

General Site Description

The Natural Resources Conservation Service identifies 28 soil series occurring on SRS. These soil series are grouped into seven broad soil-association groups (WSRC 2006b:1-4, 1-8). Generally, sandy soils occupy the uplands and ridges, and loamy-clayey soils occupy the stream terraces and floodplains (CSRACT 2007:33).

The Fuquay–Blanton–Dothan Association consists of nearly level to sloping, well-drained soils on the broad upland ridges, including most undisturbed soils near E-, F-, H-, K-, and S-Areas. This association covers approximately 47 percent of SRS and is composed of about 20 percent Fuquay soils, 20 percent Blanton soils, 12 percent Dothan soils, and 48 percent other soils (WSRC 2006b:1-10).

Fuquay and Dothan soils are well drained, and Blanton soils are somewhat excessively drained. These soils have moderately thick to thick sandy surface and subsurface layers and loamy subsoil. Most of these soils are suited for cultivated crops, timber production, sanitary facilities, and building sites (WSRC 2006b:1-10). The soils at SRS are considered acceptable for standard construction techniques (DOE 1999b:3-151).

Proposed Facility Locations

Most soils within the fence lines of E-, F-, H-, K-, and S-Areas have been disturbed to accommodate buildings, parking lots, and roadways. Disturbed soils within these areas are considered to be urban land where covered by structures or udorthents (NRCS 2010a, 2010b). Udorthents are well-drained, heterogeneous soil materials that are the spoil or refuse from excavations and major construction activities and are often heavily compacted. Some udorthents have slight limitations for site development due to their shrink-swell potential when the soils are dried out or wetted, respectively (DOE 2007b:129).

Undisturbed soils near F- and K-Areas are classified as the Fuquay–Blanton–Dothan Association. These soils are nearly level to sloping and are well drained. Soils along the Pen Branch floodplain are classified as the Vaucluse–Ailey Association. These soils are sloping and strongly sloping soils of low permeability (WSRC 2006b:1-8, 1-10).

Soils along the Upper Three Runs floodplain are classified as the Troup–Pickney–Lucy Association (NRC 2005a:3-5). These soils range from moderately steep to steep sloping on uplands, and are nearly level on the floodplains. Troup and Lucy soils are well drained, while Pickney soils are poorly drained (WSRC 2006b:1-11). Erosion-induced slope instability has not been a significant regional issue (NRC 2005a:3-5).

Soil conditions in E-, H-, and S-Areas are predominantly the same as those in F- and K-Areas (WSRC 2006b:1-8). Undisturbed soils near DWPF consist primarily of sandy surface layers above subsoil containing a mixture of sand, silt, and clay. These soils are well drained to somewhat excessively drained, with slopes ranging from 0 to 10 percent. The permeability of these soils is generally high, with a slight erosion hazard (DOE 1994:3-1).

3.1.3 Water Resources

Water resources encompass the sources of water that are useful or potentially useful to plants, animals, and humans in a particular area. Changes in the environment can potentially affect a hydrologic system's equilibrium, water quality, and the availability of usable water.

3.1.3.1 Surface Water

General Site Description

The Savannah River is the principal surface-water feature in the region, forming the southwestern border of SRS for approximately 35 miles (56 kilometers) (WSRC 2006g:1). The Savannah River reach along the SRS boundary has a wide channel, numerous tributaries, and extensive floodplain swamps (WSRC 2006b:4-250). Five major watershed[4] tributaries of the Savannah River Basin within SRS discharge into the Savannah River: Upper Three Runs, Beaver Dam Creek, Fourmile Branch, Steel Creek, and Lower Three Runs. Pen Branch is also a major stream at SRS, but does not flow directly into the Savannah River (DOE 2002:3-7). No streams or tributaries at SRS are federally designated Wild and Scenic Rivers or state designated Scenic Rivers (NRC 2005a:3-6; USFWS 2009:1-22; SCDNR 2006:1).

There are two manmade lakes at SRS, L-Lake, which discharges to Steel Creek, and Par Pond, which discharges to Lower Three Runs (see Figure 3–1). Additionally, there are approximately 50 other small manmade ponds and 300 natural Carolina bays (closed depressions capable of containing water) at SRS. No direct effluent discharges are released into the Carolina bays; however, they do receive stormwater runoff (NRC 2005a:3-6).

The Savannah River, except for sections of the river near the coast, is classified as a freshwater source (Class FW) that is suitable for primary- and secondary-contact recreation, including drinking water supply (after appropriate treatment), fishing, and industrial and agricultural uses (NRC 2005a:3-9; SCDNR 2009:4-1; 7-37–39). The nearest downstream water intake is the Beaufort–Jasper Water and Sewer Authority's (BJWSA) Purrysburg Water Treatment Plant, which is approximately 90 river miles (140 river kilometers), 78.5 hours of river travel time, from the easternmost extent of the SRS boundary. The BJWSA is permitted to withdraw 100 million gallons (379 million liters) of water per day. The treatment plant produces approximately 15 million gallons (57 million liters) of water per day for Beaufort and Jasper Counties, South Carolina. The BJWSA plans to have its plant at the full treatment design capacity of 45 million gallons (170 million liters) per day within the next 20 years. Over the next two decades, the average water demand is estimated to increase to 56 million gallons (212 million liters) per day with a maximum water demand of 96 million gallons (363 million liters) per day (City of Hardeeville 2009:6-3).

The South Carolina Department of Health and Environmental Control (SCDHEC) is the regulatory authority for the physical properties and concentrations of chemicals and metals in SRS effluents under the National Pollutant Discharge Elimination System (NPDES) program. In 2011, SRS discharged water into onsite streams and the Savannah River under five NPDES permits: two for industrial wastewater (SC0047431, D-Area Powerhouse; SC0000175, remainder of site), two general permits for stormwater runoff (SCR000000, industrial discharge; SC100000, construction discharge) and one general utility water permit (SC250273). Applications of dewatered sludge and related sanitary wastewater treatment facility sampling are covered by a no-discharge land applications permit (ND0072125) (SRNS 2012b:3-12). The stormwater runoff permits require the implementation

[4] A watershed is a hydrologically defined drainage area with a single drainage discharge point. It represents the land area within which surface runoff and groundwater seepage collects and drains into a central feature — usually a wetland, lake, river, or stream.

and maintenance of approved best management practices to assure that SRS stormwater discharges do not impair the water quality of receiving water resources (DOE 2007b:1).

Industrial wastewater monitoring results are reported to SCDHEC through monthly discharge monitoring reports. SRS had no permit limit exceptions during 2011 (SRNS 2012b:3-11–12).

Proposed Facility Locations

The proposed alternatives would take advantage of existing developed areas and infrastructure at E-, F-, H-, K-, and S-Areas. E-, F-, and H-Areas are centrally located inside the SRS boundary, just south of the confluence of Tinker Creek and McQueen Branch with Upper Three Runs. Surface elevations range from approximately 270 to 320 feet (82 to 98 meters) above mean sea level for E-, F-, and H-Areas (DOE 2002:3-7). E-, F-, and H-Areas are located on a drainage divide that separates the drainage into Upper Three Runs and Fourmile Branch. Approximately half of the area drains into each stream (DOE 2002:3-7). E-, F-, and H-Areas are drained by Upper Three Runs to the north and west and by Fourmile Branch to the south (DOE 2002:3-7–3-9). Data collected at Fourmile Branch in the vicinity of E-Area indicated an average annual flow of 0.40 cubic meters per second (14 cubic feet per second) (WSRC 2004:22).

K-Area is located toward the south of SRS, where it drains into Pen Branch and its major tributary, Indian Grave Branch (WSRC 2006b:4-103). Land surrounding S-Area drains into Upper Three Runs and Fourmile Branch tributaries (DOE 1999b:3-154). Stormwater runoff from most of the area near DWPF is collected and discharged into a retention basin north of S-Area. Stormwater and wastewater discharges from E-, F-, K-, and S-Areas do not affect L-Lake or Par Pond (see Chapter 1, Figure 1–2). A summary of E-, F-, H-, K-, and S-Area outfalls is presented in **Table 3–2**.

No SRS facilities are located within the 100-year floodplain (DOE 1999b:3-152). Reports have indicated that SRS streams are unlikely to flood existing facilities. DOE Order 420.1B outlines the requirements for natural phenomena hazard (including flood events) mitigation for new and existing DOE facilities. In 2000, SRS was required to determine flood elevations as a function of return period for up to 100,000 years, and to determine the flood recurrence intervals for SRS facilities. The facility-specific probabilistic flood hazard curve defines the annual probability of occurrence (or the return period in years) as a function of water elevation. In 2000, the calculated results of the probabilistic flood hazard curve illustrated that the probabilities of flooding in E-, F-, H-, K-, and S-Areas are significantly less than 0.00001 per year (WSRC 2000:9).

3.1.3.2 Groundwater

General Site Description

Topography and lithology are major factors controlling the direction and relative rate of groundwater flow. Groundwater can flow in aquifers both horizontally and vertically to points of discharge such as streams, swamps, underlying aquifers, and sometimes to overlying aquifers, depending on the surrounding lithology and topography. SRS is underlain by sediment of the Atlantic Coastal Plain, which consists of a southeast-dipping wedge of unconsolidated sediment that extends from its contact with the Piedmont Province at the fall line to the edge of the continental shelf. The sediment, comprising layers of sand, muddy sand, and clay with subordinate calcareous sediments, rests on crystalline and sedimentary basement rock. Water flows easily through the sand layers, but is slowed by less-permeable clay beds, creating a complex system of aquifers (WSRC 2007f:7-87).

Table 3–2 Summary of E-, F-, H-, K-, and S-Area Outfalls

Facility Location	*Outfall*	*Receiving Stream*	*Drainage (acres)*	*Sources*
E-Area	E-01	Unnamed tributary to Fourmile Branch	113	Stormwater
	E-02	Unnamed tributary to Upper Three Runs	128	
	E-03	Crouch Branch to Upper Three Runs	42.5	
	E-04		50.4	
	E-05	Unnamed tributary to Fourmile Branch	27	
	E-06	Crouch Branch to Upper Three Runs	14.6	
F-Area	F-02	Upper Three Runs	23.7	Stormwater
	F-08	Fourmile Branch	178	Non-process facility cooling water; cooling tower blowdown, overflow, and drain; Effluent Treatment Project radiological control basins; well flush water; and stormwater
	F-3B [a]	Unnamed tributary to Upper Three Runs	46.5	Stormwater
H-Area	H-02	Crouch Branch to Upper Three Runs	58.8	Non-process cooling water, steam condensate, and stormwater runoff after treatment in a constructed wetland wastewater treatment plant
	H-04B		203	Stormwater
	H-05	Upper Three Runs	6.11	Stormwater
	H-06		9.35	
	H-07	McQueen Branch	17.6	Cooling tower blowdown, condensate, well flush water, stormwater
	H-7A	McQueen Branch to Upper Three Runs	17.2	Stormwater
	H-7B		3.05	
	H-7C		20.8	
	H-08	Fourmile Branch	20.2	Well flush water, stormwater
	H-12		162	Process and non-process cooling water, cooling tower and air compressor blowdown, steam condensate, radiological control basins, well flush water, and stormwater
	H-16 (TH-1; TH-2)	Upper Three Runs	None	F/H Area process wastewater batch release from the Effluent Treatment Project
K-Area	K-01	Pen Branch	1.50	Stormwater
	K-02		2.55	
	K-04		6.12	
	K-New [b]		1.24	
	K-06	Indian Grave Branch	0.02	Stormwater
	K-12		None	Sanitary wastewater
	K-18		5.1	Cooling water basin, water treatment plant, reactor building processes, sanitary treatment plant wastewater, and stormwater
S-Area	S-04	McQueen Branch	None	Currently, no influents or discharges; outfall previously received Defense Waste Processing Facility chemical and industrial wastewater, stream condensate, cooling tower blowdown, and miscellaneous flushing and rinsing
	S-10	McQueen Branch	9.15	Stormwater

[a] To implement the proposed action for the environmental assessment (DOE 2007b:3-4), this outfall and permit requirement would be eliminated. The South Carolina Department of Health and Environmental Control approved the request by SRS to eliminate the outfall permit requirement.

[b] To implement the proposed action for the environmental assessment (DOE 2007b:3-4), this portion of K-Area would be subdivided into four drainage areas, resulting in the addition of a new outfall (K-New).

Note: To convert acres to hectares, multiply by 0.40469

Source: DOE 2007b:3-4; SCDHEC 2003b; SRNS 2012a.

Groundwater recharge is a result of infiltration of precipitation at the land surface. The precipitation moves downward through the unsaturated zone to the water table. The depth to the water table varies throughout SRS. Upon entering the saturated zone at the water table, water moves predominantly in a horizontal direction toward local discharge zones along the headwaters and midsections of streams, while some water moves into successively deeper aquifers. Groundwater velocities at SRS range from several inches to several feet per year in aquitards and from tens to hundreds of feet per year in aquifers (WSRC 2007f:7-90).

Although many different systems have been used to describe groundwater systems at SRS, for this *SPD Supplemental EIS*, the same system used in the *SPD EIS* and in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996c) has been adopted. The uppermost aquifer is referred to as the "water table aquifer." It is supported by the leaky "Green Clay" aquitard, which confines the Congaree Aquifer. Below the Congaree Aquifer is the leaky Ellenton Aquitard, which confines the Cretaceous Aquifer, also known as the Tuscaloosa Aquifer. In general, groundwater in the water table aquifer flows downward to the Congaree Aquifer or discharges to nearby streams. Flow in the Congaree Aquifer is downward to the Cretaceous Aquifer or horizontal to stream discharge or the Savannah River, depending on the location within SRS (DOE 1999b:3-154). Other groundwater hydrostratigraphic unit classification systems applicable to SRS are presented in the *Savannah River Site Environmental Report for 2010* (SRNS 2011:7-1–4).

SRS hydrogeology is complex due to heterogeneities in the vadose zone[5] and in the multilayer aquifer system (SRNS 2009b). The SRS groundwater flow system is characterized by four major aquifers separated by confining units. All aquifers are defined by the *South Carolina Pollution Control Act* (SC Code § 48-1-10 et seq.) as potential sources of drinking water (WSRC 2008c:A-6). None of these aquifers, however, is designated as a sole-source aquifer. A sole-source aquifer is defined as an aquifer that supplies at least 50 percent of the drinking water to the area above the aquifer (EPA 2011a:1). These areas can have no other water supply capable of physically, legally, or economically providing drinking water to local populations (NRC 2005a:3-10).

The Cretaceous Aquifer is an important water resource for the SRS region. Groundwater withdrawn in and around SRS is used extensively for domestic, industrial, and municipal purposes. Groundwater is regularly withdrawn from the Cretaceous and water table aquifers (DOE 1999b:3-155).

Domestic and process water for SRS is supplied by water supply systems that use groundwater sources. The SRS domestic and process water systems are supplied from a network of approximately 40 production wells in widely scattered locations across the site, 8 of which supply the primary drinking water system. Domestic water systems are located in A- and D-Areas, while process water systems are located in A-, F-, H-, K-, L- and S-Areas. The A- and D-Area domestic water systems are actively regulated by SCDHEC, while the remaining smaller water systems have a reduced level of regulatory oversight. Samples are collected and analyzed by SRS and SCDHEC to ensure that water systems meet SCDHEC and U.S. Environmental Protection Agency (EPA) bacteriological and chemical drinking water quality standards. All samples collected in 2011 met these standards (SRNS 2012b:7-4–5). De-ionized water (water treated to remove anions and cations) is primarily used in H-Canyon. It is procured by an offsite vendor and brought into H-Area by a portable trucking system (WSRC 2008a).

No relevant South Carolina state case law regarding common-law ownership of groundwater resources has been reported (Myszewski et al. 2005:28; SCDNR 2009:2-7). However, the State has enacted statutes to restrict water use. The South Carolina Groundwater Use and Reporting Act of 2000 (S.C.C.A. § 49-5-10 to § 49-5-150) and Surface Water Withdrawal, Permitting Use, and Report Act

[5] *The vadose zone is the region of unsaturated sediments between the surface and the saturated water table, which isolates near surface water from underlying groundwater (Burns et al. 2000:1-2).*

of 2010 (S.C.C.A. § 49-4-10 to § 49-4-180) mandate that any person[6] withdrawing groundwater or surface water for any purpose in excess of 3 million gallons (11 million liters) during any one month from a single or multiple wells or intakes under common ownership and within 1 mile (1.6 kilometers) of an existing or proposed well or intake must register with, annually report to, and be permitted by SCDHEC (SCDHEC 2005:1-2).

Groundwater and surface-water consumption for fiscal year 2010 are summarized in **Table 3–3**. For the 12-month reporting period from 2009 to 2010, approximately 316 million gallons (1.2 billion liters) of domestic water were used at SRS. SRS has a sitewide total water supply capacity of 2.95 billion gallons (11.2 billion liters) and an available capacity of 2.64 billion gallons (10 billion liters). As shown in **Table 3–4**, for the five areas reporting fiscal year 2010 domestic water use, H-Area recorded approximately 60 percent of the total water consumption, or 143 million gallons (541 million liters).

Table 3–3 Fiscal Year 2010 Water Consumption (thousand gallons)

	Groundwater					
2009–2010	*Domestic Water* [a]	*Process Water* [b]	*Service Water* [b]	*Monthly Total*	*River Water* [c]	*Grand Total* [d]
October	28,585	14,602	20,734	*63,921*	88,560	*152,481*
November	30,455	15,089	21,424	*66,968*	91,512	*158,480*
December	26,289	14,602	20,734	*61,625*	88,560	*150,185*
January	22,327	15,089	21,424	*58,840*	91,512	*150,352*
February	25,999	15,089	21,424	*62,512*	91,512	*154,024*
March	23,126	13,628	19,352	*56,106*	80,192	*136,298*
April	26,814	15,089	21,424	*63,327*	91,512	*154,839*
May	21,896	14,602	20,734	*57,232*	85,920	*143,152*
June	26,941	15,089	21,424	*63,454*	91,512	*154,966*
July	29,963	14,602	20,734	*65,299*	86,831	*152,130*
August	26,589	15,089	21,424	*63,102*	93,796	*156,898*
September	26,962	15,089	21,424	*63,475*	92,795	*156,270*
Total	**315,946**	**177,659**	**252,256**	**745,861**	**1,074,214**	**1,820,075**

[a] Domestic Water: Potable water provided to each area on site from dedicated domestic water wells. The Central Domestic Water Plant serves A-, B-, C-, F-, G-, H-, K-, L-, and N-Areas. The Central Domestic Water Plant is located in A-Area and is serviced from Wells 905-112G and 905-67B.

[b] Process/Service Water: Used to provide water for once-through cooling, boilers and other applications, fire water storage tanks, and flushing and washdown, as well as supply of makeup water for cooling tower water systems. Service water is water that is pumped from the ground, minimally treated for pH adjustment, and then introduced into the piping system for consumption. Service water becomes process water when it reaches a cooling tower. Process/Service water is provided from dedicated wells in each of the operating areas.

[c] River Water: Water pumped directly from the Savannah River. Pump 681-3G currently provides makeup water to L-Lake and for L-Area fire protection needs and steam production (Ameresco Plant). Pump 681-3G currently provides boiler feed water for the 484-D Powerhouse.

[d] Sum of groundwater and river water monthly total use.

Note: To convert gallons to liters, multiply by 3.7854.

Source: SRNS 2012a.

Table 3–4 Fiscal Year 2010 Domestic Water Consumption by Area (thousand gallons)

E-Area	*F-Area*	*H-Area*	*K-Area*	*S-Area*	*Total*
19,865	60,655	142,530	3,595	12,141	238,786

Note: To convert gallons to liters, multiply by 3.7854.

Source: SRNS 2012a.

[6] *A person is defined as an individual, firm, partnership, trust, estate, association, public or private institution, municipality, or political subdivision, governmental agency, public water system, private or public corporation, or other legal entity organized under the laws of the State or any other state or county (S.C.C.A. §§ 49-5-30 and 49-4-20).*

There has been a major decline in withdrawals since annual reporting of SRS groundwater usage began in 1983. Groundwater withdrawals were reduced by more than two-thirds, from 10.8 million gallons (40.9 million liters) per day from 1983 to 1986 to 3.4 million gallons (12.9 million liters) per day in 2010. Total annual water use was reduced by approximately 22 percent between 2008 and 2010 (from 2.3 billion gallons [8.7 billion liters] to 1.8 billion gallons [6.8 billion liters]). Facility shutdowns, site population reductions, and water supply system upgrades and consolidation have measurably reduced SRS water use demands (SRNS 2011:7-5). Potable water consumption was reduced by approximately 10.2 percent through fiscal year 2011 as compared with the base year of 2000, and nearly 5 percent between fiscal year 2010 and fiscal year 2011 (SRNS 2012b:2-9).

SRS occupies portions of Aiken, Allendale, and Barnwell Counties within the Savannah River Basin (hydrologic unit code 030601). As summarized in **Table 3–5**, primary tri-county water use categories for 2010 include irrigation, golf course, industrial, water supply, mining, and thermoelectric (SCDHEC 2011:31-32). For the tri-county area, surface water uses accounted for approximately 89 percent of total water withdrawals. Industrial (fabrication, processing, washing, in-plant conveyance and cooling) and thermoelectric (electricity generation from fossil fuel, biomass, solid waste, geothermal, or nuclear energy) sources accounted for about 23 and 73 percent of total surface water withdrawal, respectively. Water supply accounted for approximately 53 percent of total groundwater withdrawals. SRS primary water use categories relating to the 2010 tri-county data would include industrial and water supply. For comparison, SRS total water withdrawals (Table 3–3) were about 2 percent of the total reported water withdrawals for the tri-county area.

Table 3–5 South Carolina Region 2010 Surface-Water and Groundwater Withdrawal Summary (millions of gallons)

County	*Irrigation*	*Golf Course*	*Industrial*	*Water Supply*	*Mining*	*Thermoelectric*	*Total*
Surface-Water Withdrawals							
Aiken	430	280	20,000	2,200	—	64,000	87,000
Allendale	670	—	—	—	—	—	670
Barnwell	110	75	—	—	—	—	180
Total	*1,200*	*360*	*20,000*	*2,200*	—	*64,000*	*88,000*
Groundwater Withdrawals							
Aiken	320	52	1,000	5,200	33	—	6,600
Allendale	2,700	—	730	460	—	—	3,900
Barnwell	130	—	160	770	—	—	1,100
Total	*3,100*	*52*	*1,900*	*6,400*	*33*	—	*12,000*
Grand Total	**4,300**	**410**	**22,000**	**8,600**	**33**	**64,000**	**99,000**

— No water withdrawals reported.
Note: Values and totals are rounded to two significant figures. To convert from gallons to liters, multiply by 3.7854.
Source: SCDHEC 2011:31-32.

To meet state and Federal laws and regulations, extensive groundwater monitoring is conducted around SRS waste sites and operating facilities, using approximately 3,000 monitoring wells. Major contaminants include volatile organic compounds, metals, and radionuclides. Monitoring methods are generally based on the source constituent inventory, mobility, and toxicity data; correlations between contamination and groundwater resources; and the relative contribution of the contamination from the unit. Groundwater monitoring objectives, strategies, schedules, and implementation plans are presented in the *Savannah River Site Groundwater Management Strategy and Implementation Plan* (WSRC 2008b).

Groundwater quality varies across the site. The Cretaceous Aquifer is generally unaffected except for an area near A-Area, where trichloroethylene has been reported. Trichloroethylene has also been reported in A- and M-Areas in the Congaree Aquifer. Hydrogen-3 (tritium) has been reported in the Congaree Aquifer in the General Separations Area, which includes F- and H-Areas. The water table aquifer is contaminated with solvents, metals, and low levels of radionuclides at several SRS sites and facilities. Groundwater eventually discharges into onsite streams or the Savannah River, but groundwater contamination has not been detected beyond SRS boundaries (DOE 1999b:3-155). All drinking water samples collected and analyzed by SRS and SCDHEC in 2011 met the SCDHEC and EPA bacteriological and chemical drinking-water quality standards (SRNS 2012b:7-5).

Proposed Facility Locations

The depth to the water table and the direction of groundwater flow varies by site location. The water table at K-Area is encountered at approximately 70 feet (21 meters), and flows in the southwest direction toward Indian Grave Branch at about 75 feet (23 meters) per year (WSRC 2008a). Groundwater flow in the General Separations Area (F- and H-Areas) is toward Upper Three Runs and its tributaries to the north and Fourmile Branch to the south; this is primarily due to the topography in the vicinity of E-, F-, and H-Areas (DOE 2002: 3-9–3-12). The depth to the water table underlying E-Area generally ranges from 60 to 80 feet (18 to 24 meters) (SRNS 2012a), while for F-Area, the depth to the water table is about 100 feet (30 meters) (WSRC 2008a). E-Area is located on a groundwater divide that causes groundwater on one side of the divide to flow north toward Upper Three Runs, while groundwater on the other side of the divide flows south toward Fourmile Branch (SRNS 2012a). Groundwater underlying F-Area generally flows north toward Upper Three Runs. For both locations, groundwater typically flows at about 130 feet (40 meters) per year. At H-Area, the water table is encountered at approximately 40 feet (12 meters). Here, groundwater flows either north toward Upper Three Runs or west toward McQueen's Branch at about 80 feet (24 meters) per year, depending on the starting point. At S-Area, the water table is encountered at about 40 feet (12 meters), and groundwater flows west toward McQueen's Branch at about 80 feet (24 meters) per year (WSRC 2008a).

For the proposed facility locations, the thickness of the vadose zone ranges from approximately 40 feet (12 meters) to approximately 100 feet (30 meters). Surface water and potential waterborne contaminants must pass through the vadose zone to reach groundwater systems. E-Area is a principal facility for disposing of LLW. Historically, these wastes were disposed of in shallow (within 26 feet [8 meters] of the surface), sometimes unlined, trenches. A Vadose Zone Monitoring System was developed and implemented to monitor water and contaminant migration from the trenches through undisturbed portions of the vadose zone. Monitoring results demonstrate that the E-Area disposal trenches are in compliance with the requirements of DOE Order 435.1 (Burns et al. 2000:2).

Historically, the chemical and radioactive waste byproducts of SRS nuclear material production have been treated, stored, and disposed of at various locations across SRS, resulting in contamination of soil and water resources. Waste sites typically included seepage basins, tanks, ponds, trenches, pits (burial and burning), and/or landfills that ranged in size from several square feet to tens of acres. Approximately 5 to 10 percent of SRS groundwater resources have been contaminated with radionuclides (e.g., tritium, gross alpha, and nonvolatile beta emitters), industrial solvents (e.g., trichloroethylene and tetrachloroethylene), metals, and other chemicals. Constituents of primary concern include radionuclides and industrial solvents (ATSDR 2007:28-31; SRNS 2009b:7-8).

Groundwater contamination sites are primarily located in proximity to the reactor facilities (C-, K-, L-, P-, and R-Areas), the General Separations Area, and the waste management areas (E-, S-, and Z-Areas). For the reactor facilities, tritium and trichloroethylene are the primary contaminants identified in groundwater plumes; concentrations of other radionuclides and organics and metals are also present. The General Separations Area and waste management areas include smaller, frequently overlapping groundwater plumes that include trichloroethylene and tetrachloroethylene, radionuclides, metals, and other constituents. A 2007 evaluation by the U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry (ATSDR) determined that, based on existing conditions and operations, SRS posed no apparent public health hazard to surrounding communities from groundwater or surface-water exposure (ATSDR 2007:28-29). SRS groundwater monitoring results for 2009 are presented in **Table 3–6**.

Table 3–6 Savannah River Site Areas 2009 Groundwater Contamination Summary

SRS Location	*Groundwater Monitoring Results*
F-Area and H-Area Hazardous Waste Management Facilities	Groundwater flow direction and velocity remained relatively unchanged in each area from the previous year with the exception of changes related to the installation of corrective action groundwater barrier walls.[a]
	Compliance monitoring data showed that organic, inorganic, and radionuclide constituents in both areas exceeded groundwater protection standards.[a]
	During detection monitoring, no new constituents were detected in either area above the estimated quantitative limit.[a]
	Corrective actions include groundwater barriers and base injection systems in F-Area and groundwater barriers in H-Area; treatments are having positive effects on the aquifer.[b]
Mixed Waste Management Facility	No changes in groundwater flow direction or velocity from the previous year were identified.[a]
	Compliance monitoring data indicated that 26 constituents exceeded groundwater protection standards.[a]
	Detection monitoring identified 5 constituents not on the current groundwater protection standards list in several point-of-compliance wells.[a]
	A DHEC approved phytoremediation system corrective action is being used to reduce tritium levels.[b]
K-Area Burning/Rubble Pit Operable Unit	Groundwater sampling was conducted in accordance with Industrial Solid Waste Permit number 025800-1601.[c]
	Compliance monitoring identified upper aquifer concentrations of tetrachloroethylene and trichloroethylene at levels exceeding maximum contaminant levels that remained relatively unchanged from previous year values; monitoring of natural attenuation continues.[b, c]
288-F Ash Basin	Groundwater samples were collected from the Upper and Lower Aquifer Zones.[d]
	No downgradient constituent monitoring results exceeded background levels.[d]

[a] SRNS 2010b.
[b] WSRC 2008b.
[c] Hennessey 2010.
[d] SRNS 2010a.

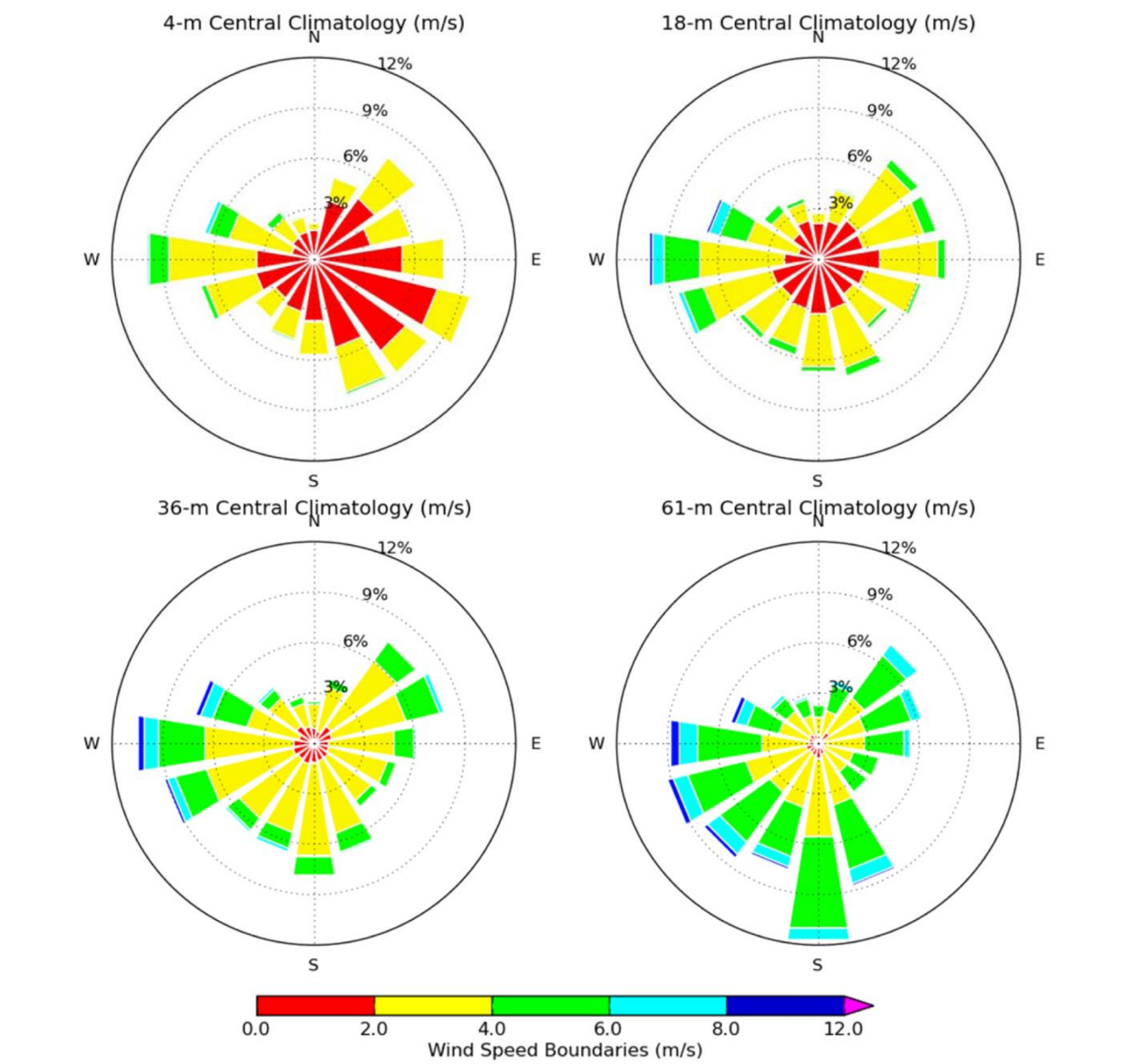
3.1.4 Meteorology, Air Quality, and Noise

3.1.4.1 Meteorology

The climate and meteorology of the SRS region are described in the *SPD EIS* (DOE 1999b) and the *Savannah River Site High-Level Waste Tank Closure Final Environmental Impact Statement* (DOE 2002). Recent data are presented in the *Savannah River Site Annual Meteorology Report for 2011* (SRNL 2012). The historical average temperature has increased to 64.3 degrees Fahrenheit (°F) (17.9 degrees Celsius [°C]) from 63.2 °F (17.3 °C) in the *SPD EIS* and the historical average annual precipitation has increased to 47.7 inches (121 centimeters) (SRNL 2012) from 45 inches (114 centimeters) in the *SPD EIS*.

SRS has a temperate climate with short, mild winters and long, humid summers. The climate is frequently affected by warm, moist maritime air masses. Temperatures vary at the Augusta National Weather Service Station, about 12 miles (19 kilometers) west of SRS, from an average daily minimum of 33.1°F (0.6°C) in January to an average daily maximum of 92 °F (33.3 °C) in July. The average annual precipitation at Augusta, Georgia, is about 48.2 inches (122 centimeters). Precipitation is distributed fairly evenly throughout the year, with the highest in summer and the lowest in autumn. The average annual windspeed at Augusta is 5.7 miles per hour (2.5 meters per second) (DOE 1999b:3-128; NOAA 2009a; SRNL 2012). The maximum windspeed in Augusta (highest 1-minute average) is 52 miles per hour (23 meters per second) (NOAA 2009b:65). Annual wind roses for the Central Climatology Tower at SRS for 2011 are provided in **Figure 3–2**. Typical wind direction patterns for the

200-foot (61-meter) elevation consist of higher frequencies of wind from the northeast section and the south to west sections. Typical variation of winds with elevation show higher frequencies of east to southeast winds and lower frequencies of south to southwest winds nearer the ground (SRNL 2012).



Notes: Windrose plot depicts the frequency of occurrence of wind direction sector (direction from which the wind blows) by wind speed category. The Central Climatology Tower is near N-Area

Source: SRNL 2012.

Figure 3–2 Annual Wind Rose Plots for 2011, Central Climatology, All Levels

Wind roses for the Vogtle Electricity Generating Plant for 1998–2002 are provided in **Figure 3–3**.

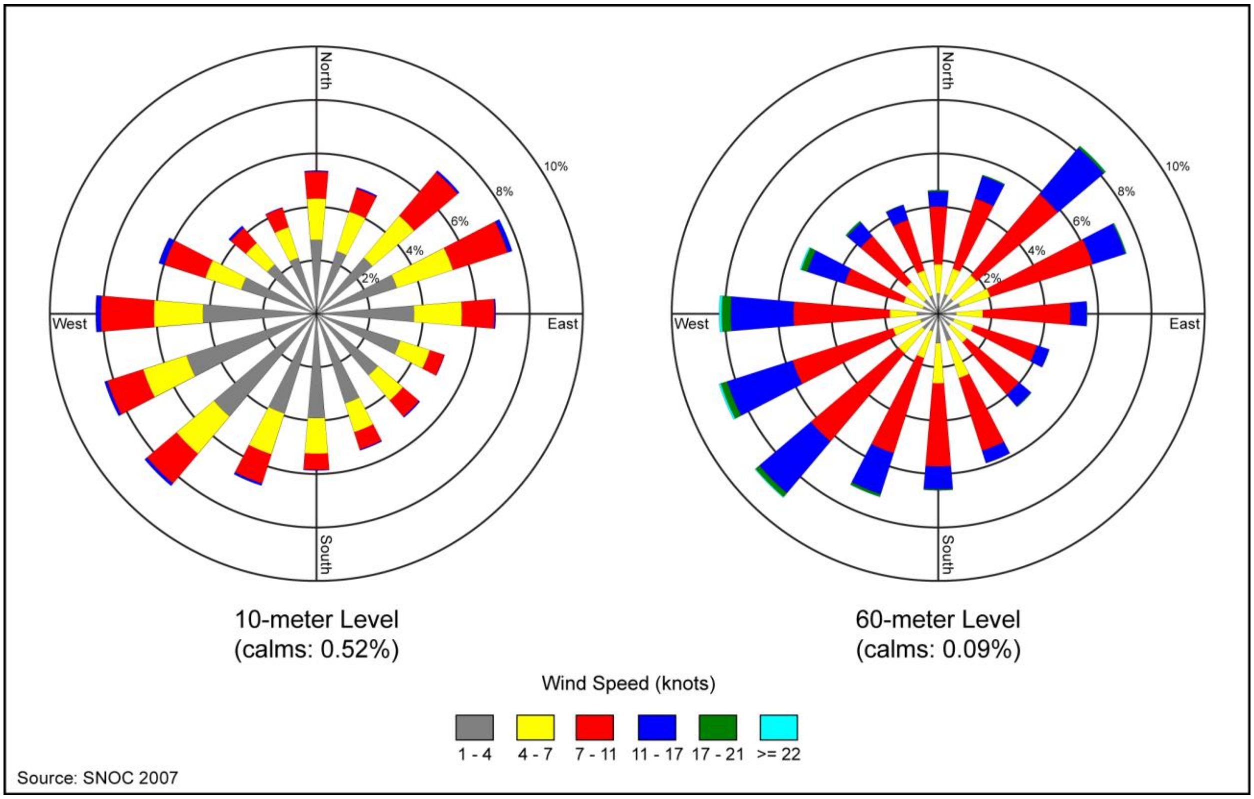


Figure 3–3 Average Annual Wind Rose Plots for 1998–2002, Vogtle Electric Generating Plant, 10- and 60-Meter Levels

Damaging hailstorms rarely occur in Aiken County (NCDC 2010). The average annual snowfall is 1.4 inches (3.6 centimeters) (NOAA 2009a).

Thirty-three tornadoes were reported in Aiken County between January 1950 and August 2010. There are typically several occurrences of high winds every year, mostly associated with thunderstorms (NCDC 2010). Hurricanes struck South Carolina 36 times during the period from 1700 to 1992, which equates to an average recurrence frequency of one hurricane every 8 years. A hurricane-force wind of 75 miles per hour (34 meters per second) has been observed at SRS only once, during Hurricane Gracie in 1959 (DOE 2002:3-20, 3-22).

3.1.4.2 Air Quality

Air pollutants are any substances in the air that could harm humans, animals, vegetation, or structures, or that could unreasonably interfere with the comfortable enjoyment of life and property. Air quality is affected by air pollutant emission characteristics, meteorology, and topography.

General Site Description

SRS is near the center of the Augusta-Aiken Interstate Air Quality Control Region #53. None of the areas within SRS or its surrounding counties are designated as nonattainment areas with respect to the National Ambient Air Quality Standards (NAAQS) for criteria air pollutants (EPA 2009a, 2009b). Although the Augusta-Aiken area is part of an early action compact to control ozone concentrations (GDNR 2002), under the more stringent ozone 8-hour standard, soon to be implemented, the area could eventually be designated a nonattainment area for ozone.

The primary sources of air pollutants at SRS are the biomass boilers in K- and L-Areas, diesel-powered equipment throughout SRS, DWPF, soil vapor extractors, groundwater air strippers, the Biomass Cogeneration Facility and back-up oil-fired boiler on Burma Road, and various other processing facilities. Other emissions and sources include fugitive particulates from vehicles and controlled burning of forestry areas, as well as temporary emissions from various construction-related activities (DOE 1999b:3-130; NRC 2005a:3-18; SRNS 2011, 2012b:3-9).

There are no Prevention of Significant Deterioration Class I areas within 62 miles (100 kilometers) of SRS. Class I areas are areas in which very little increase in air pollution is allowed due to the pristine nature of the area. A Prevention of Significant Deterioration permit for the new Biomass Cogeneration Facility and biomass boilers in K- and L-Areas has been issued by SCDHEC to Ameresco Federal Solutions (see Chapter 4, Section 4.5.2.1.1). These facilities are subject to the Prevention of Significant Deterioration permit process as a result of carbon monoxide emissions (Bulgarino 2008; SCDHEC 2008). Wood chips are the primary fuel source for the cogeneration plant and the two biomass-fired steam generating units; fuel oil is used as the back-up fuel supply. These plants began operating in late 2010 (SRNS 2011:4-6). SRS has a sitewide Title V Operating Permit (SRNS 2011:3-8).

Table 3–7 presents the applicable ambient standards and ambient air pollutant concentrations attributable to sources at SRS. These concentrations are based on potential emissions (SRNS 2010e). Only those hazardous pollutants that would be emitted under any of the surplus plutonium disposition alternatives are presented. Other toxic air pollutants are discussed in the modeling report (SRNS 2010e). Concentrations shown in Table 3–7 attributable to SRS are in compliance with applicable guidelines and regulations. Recent data from nearby ambient air monitors in Aiken, Barnwell, Edgefield, and Richland Counties in South Carolina are presented in **Table 3–8**. The data indicate that the NAAQS for particulate matter, lead, ozone, sulfur dioxide, and nitrogen dioxide are not exceeded in the area around SRS (EPA 2007b, 2010; SCDHEC 2010a, SRNS 2010e).

The "natural greenhouse effect" is the process by which part of the terrestrial radiation is absorbed by gases in the atmosphere, thereby warming the Earth's surface and atmosphere. This greenhouse effect and the Earth's radiative balance are affected largely by water vapor, carbon dioxide, and trace gases, all of which are absorbers of infrared radiation and commonly referred to as "greenhouse gases." Other trace gases include nitrous oxide, chlorofluorocarbons, methane, and sulfur hexafluoride. Additional discussion of climate change is provided in Section 4.5.4.2, Global Climate Change.

Based on the number of employee vehicle trips estimated from employment at SRS (see Section 3.1.8) and fuel and electricity use (see Section 3.1.9), emissions of carbon dioxide attributable to SRS activities were estimated to be 0.502 million metric tons per year, which is less than 0.008 percent of the total U.S. emissions of 6.8 billion metric tons of carbon dioxide equivalent per year (EPA 2012:ES-4-ES-6). Emissions of 42,000 metric tons of carbon dioxide equivalents of other greenhouse gases have been estimated from wastewater treatment, business travel, and refrigerant use/recovery from activities at SRS (SRNS 2012a). Carbon dioxide emissions from shipment of materials have not been estimated.

Reduction in greenhouse gas emissions is expected to be realized with the conversion of steam and energy production at SRS to biomass. Impacts from conversion to biomass energy production are discussed in the *Environmental Assessment for Biomass Cogeneration and Heating Facilities at the Savannah River Site* (DOE 2008e).

Table 3–7 Comparison of Ambient Air Concentrations from Existing Savannah River Site Sources with Applicable Standards or Guidelines

Pollutant	*Averaging Period*	*More Stringent Standard or Guideline (micrograms per cubic meter)* [a]	*Concentration (micrograms per cubic meter)*
Criteria Pollutants			
Carbon monoxide	8 hours	10,000 [b]	292
	1 hour	40,000 [b]	1,118.2
Nitrogen dioxide	Annual	100 [b]	42.1
Ozone	8 hours	147 [c]	(e)
PM_{10} [f]	24 hours	150 [b]	50.7
$PM_{2.5}$	Annual	15 [b]	(g)
	24 hours (98th percentile over 3 years)	35 [b]	(g)
Sulfur dioxide	Annual	80 [b]	10.2
	24 hours	365 [b]	155.1
	3 hours	1,300 [b]	723
Lead	Rolling 3-month average	0.15 [b]	0.11
Other Regulated Pollutants			
Gaseous fluoride	30 days	0.8 [d]	0.03
	7 days	1.6 [d]	0.21
	24 hours	2.9 [d]	0.23
	12 hours	3.7 [d]	0.35
Hazardous and Other Toxic Compounds			
Benzene	24 hours	150 [d]	0.082

PM_n = particulate matter less than or equal to *n* microns in aerodynamic diameter.

[a] The more stringent of the Federal and state standards is presented if both exist for the averaging period. Methods of determining whether standards are attained depend on pollutant and averaging time. NAAQS (EPA 2009c), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The 8-hour ozone standard is attained when the 3-year average of the annual fourth-highest daily maximum 8-hour average concentration is less than or equal to the standard. 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 24-hour $PM_{2.5}$ standard is attained when the 3-year average of the 98th percentile 24-hour averages is less than or equal to the standard. The annual $PM_{2.5}$ standard is attained when the 3-year average of the annual means is less than or equal to the standard.

[b] Federal and state standard.

[c] Federal standard.

[d] State standard.

[e] No concentration reported.

[f] EPA revoked the annual PM_{10} standard in 2006.

[g] $PM_{2.5}$ values are not yet available from the modeling for the Title V permit application because the modeling methodology for $PM_{2.5}$ is still under discussion with SCDHEC. Currently, the SCDHEC policy is to use demonstration of PM_{10} compliance as a surrogate for $PM_{2.5}$ compliance (SRNS 2010e).

Note: Emissions of other air pollutants not listed here have been identified at SRS, but are not associated with any of the alternatives evaluated. These other air pollutants are quantified in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996c). Values may differ from those of the source document due to rounding. Concentrations were based on the permit-allowable emissions and meteorological data for 2002 through 2006 as discussed in the air dispersion modeling report (SRNS 2010e). EPA recently promulgated 1-hour ambient standards for nitrogen dioxide and sulfur dioxide. The 1-hour standard for nitrogen dioxide is 188 micrograms per cubic meter and the 1-hour standard for sulfur dioxide is 197 micrograms per cubic meter. EPA recently promulgated a lead standard of 0.15 micrograms per cubic meter based on a 3-month rolling average. No modeling results were available for comparison to these standards (EPA 2009c).

Source: EPA 2009c; SCDHEC 2012; SRNS 2010e.

Table 3–8 Ambient Air Quality Standards and Monitored Levels in the Vicinity of the Savannah River Site

Pollutant	*Averaging Time*	*Ambient Standard (micrograms per cubic meter)*	*Concentration (micrograms per cubic meter)*	*Location*
Carbon monoxide	8 hours	10,000	2,863 [a]	Richland County, South Carolina
	1 hour	40,000	3,550 [a]	Richland County, South Carolina
Nitrogen dioxide	Annual	100	6.6 [a]	Aiken County, South Carolina
Ozone	8 hours	147	133 [b]	Aiken, South Carolina
PM_{10}	24 hours	150	61 [a]	Aiken, South Carolina
$PM_{2.5}$	Annual	15	14.5 [c]	Aiken, South Carolina
	24 hours (98th percentile over 3 years)	35	29 [c]	Aiken, South Carolina
Sulfur dioxide	Annual	80	3.9 [a]	Barnwell, South Carolina
	24 hours	365	18.3 [a]	Barnwell, South Carolina
	3 hours	1,300	39.3 [a]	Barnwell, South Carolina
Lead	Calendar quarter	1.5	0.002 [a]	Richland County, South Carolina

PM_n = particulate matter less than or equal to n microns in aerodynamic diameter.
[a] 2007 data.
[b] 2009 3-year average.
[c] 2006 data.
Note: EPA recently promulgated 1-hour standards for nitrogen dioxide and sulfur dioxide and a rolling 3-month average standard for lead for which monitoring data are not yet available. The nearby monitor in Barnwell County has been discontinued.
Source: EPA 2007b, 2009c; SCDHEC 2010a, 2012; SRNS 2010e.

Proposed Facility Locations

The meteorological conditions described for SRS in Section 3.1.4.1 are considered to be representative of E-, F-, H-, K-, and S-Areas. Information on air pollutant emissions from these areas is included in the overall site emissions described earlier in this section.

The air pollutant sources of importance for permitting include the boiler in the K-Area Complex, process emissions and diesel generators in F- and H-Areas, and the vitrification process and diesel generators in S-Area (SCDHEC 2003a; SRNS 2009b; WSRC 2007f). There are no nonradioactive air pollutant sources in E-Area that require permits (SCDHEC 2003a).

3.1.4.3 Noise

Noise is unwanted sound that interferes or interacts negatively with the human or natural environment. Noise may disrupt normal activities, diminish the quality of the environment, or if loud enough, cause discomfort and even hearing loss.

General Site Description

Major noise sources at SRS occur primarily in developed or active areas and include various industrial facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, public address systems, construction and materials-handling equipment, and vehicles). Major noise emission sources outside of these active areas consist primarily of vehicles and rail operations. Existing SRS-related noise sources of importance to the public are those related to transportation of people and materials to and from the site, including trucks, private vehicles, helicopters, and trains (DOE 1996c:3-233–235). Another important contributor to noise levels is traffic to and from SRS along access highways through the nearby towns of New Ellenton, Jackson, and Aiken, South Carolina.

Most industrial facilities at SRS are far enough from the site boundary that noise levels at the boundary from these sources would not be measurable or would be barely distinguishable from background levels. The noise environment at SRS is generally the same as that described in the *SPD EIS*.

Proposed Facility Locations

No distinguishing noise characteristics have been identified in E-, F-, H-, K-, or S-Areas. Observations of sound sources during a summer-sound-level survey near the fence line of S-Area indicate that typical sources include vehicles, turbines, locomotives, public address systems, and fans (NUS 1990:App. B). Facilities in these areas are far enough from the site boundary that noise levels from sources in these areas would not be measurable or would be barely distinguishable from background levels.

3.1.5 Ecological Resources

Ecological resources are defined as terrestrial (predominantly land) and aquatic (predominantly water) ecosystems characterized by the presence of native and naturalized plants and animals. For the purpose of this *SPD Supplemental EIS*, ecological resources are differentiated by habitat type (aquatic and wetland versus terrestrial) and sensitivity (threatened, endangered, and other special-status species).

3.1.5.1 Terrestrial Resources

General Site Description

Terrestrial cover types can be classified as both forested and nonforested. Forested cover types at SRS include bottomland hardwood, pine forest, mixed forest, and forested wetland. Nonforested cover types include scrub shrub, emergent wetland, industrial, grassland, clearcut, bare soil/borrow pit, and open water. Approximately 90 percent of the land cover at SRS is bottomland hardwood forests, pine forests, and mixed forests (DOE 1999b:3-156; WSRC 2006b:2-7). **Table 3–9** identifies the amount of land of each SRS cover/land use type.

Table 3–9 Cover/Use Types and Approximate Area on the Savannah River Site

Vegetation Type	*Acres*
Bottomland Hardwood Forests	44,138
Pine Forest	64,676
Mixed Forest	32,839
Forested Wetland	31,596
Scrub Shrub	9,036
Emergent Wetland	1,212
Industrial	2,244
Grassland	1,852
Clearcut	7,556
Bare Soil/Borrow Pit	194
Open Water	3,914
Total	199,257

Note: To convert acres to hectares, multiply by 0.40469.
Source: WSRC 2006b:2-6, Figure 2-2.

The biodiversity within SRS is extensive due to the variety of plant communities and the mild climate. Animal species known to inhabit SRS include 44 species of amphibians, 59 species of reptiles, 255 species of birds, and 54 species of mammals. Common species include the eastern box turtle (*Terrapene carolina*), Carolina chickadee (*Poecile carolinensis*), common crow (*Corvus brachyrhynchos*), eastern cottontail (*Sylvilagus floridanus*), and gray fox (*Urocyon cinereoargenteus*).

Game animals include a number of species, two of which, the white-tailed deer (*Odocoileus virginianus*), and feral hogs (*Sus scrofa*), are hunted on the site. Raptors, such as the Cooper's hawk (*Accipiter cooperii*) and the black vulture (*Coragyps atratus*), and carnivores, such as the gray fox, are ecologically important groups at SRS (DOE 1999b:3-157).

Proposed Facility Locations

The majority of the land within the E-, F-, H-, K-, and S-Areas has been developed for industrial use. As a result, the majority of natural land cover is no longer present. Outside of these developed areas, a variety of habitat types are present as indicated in the General Site Description and in Table 3–9. E-, F-, H-, and S areas fall within the Industrial Core habitat management area while K-Area falls within the Supplemental red-cockaded woodpecker management area.

In addition, within F-Area, a total of 152 acres (61.5 hectares) were disturbed during construction of MFFF and WSB, and in anticipation of construction of the Pit Disassembly and Conversion Facility (PDCF). Disturbance of land required for construction of MFFF, WSB, and PDCF has been analyzed in previous NEPA documentation (NRC 2005a). Habitat types included within the disturbed area included mainly bottomland hardwood, pine forest, and disturbed land.

3.1.5.2 Aquatic Resources

General Site Description

Aquatic habitat includes manmade ponds, Carolina bays, reservoirs, and the Savannah River and its tributaries. There are more than 50 manmade impoundments throughout the site that support populations of bass and sunfish. Carolina bays, a type of wetland unique to the southeastern United States, are natural shallow depressions that occur in interstream areas. These bays can range from lakes to shallow marshes, herbaceous bogs, shrub bogs, or bottomland hardwood forests. Among the 300 Carolina bays found throughout SRS, fewer than 20 have permanent fish populations. Redfin pickerel (*Esox americanus americanus*), mud sunfish (*Acantharchus pomotis*), lake chubsucker (*Erimyzon sucetta*), and mosquito fish (*Gambusia affinis*) are present in these bays. Although sport and commercial fishing is not permitted within SRS, the Savannah River is used extensively for both. Important commercial species are the American shad (*Alosa sapidissima*), hickory shad (*Alosa mediocris*), and striped bass (*Morone saxatilis*), all of which are anadromous (fish that live in the sea and breed in freshwater). The most important warm-water game fish are bass, pickerel, crappie, bream, and catfish (DOE 1999b:3-157).

Proposed Facility Locations

Most of the land within E-, F-, H-, K-, and S-Areas has been developed for industrial use. As a result, no wetlands currently exist within these locations, although manmade impoundments occur throughout the developed portions of these areas, including a large impoundment adjacent to the main processing building at the K-Area Complex. There are, however, aquatic resources, including small streams, wetlands, and manmade impoundments located downstream from MFFF, WSB, and the proposed PDCF in F-Area.

3.1.5.3 Wetlands

General Site Description

SRS wetlands, most of which are associated with floodplains, streams, and impoundments, include bottomland hardwood, cypress–tupelo, scrub–shrub, emergent vegetation, Carolina bays, and open water. Bottomland hardwood forest is the most extensive wetlands vegetation type along the Savannah River (DOE 1999b:3-159).

Proposed Facility Locations

As indicated in Section 3.1.5.2, the majority of the land within the E-, F-, H-, K-, and S-Areas has been developed for industrial use. As a result, no wetlands currently exist within these locations. There are, however, wetlands located downstream from MFFF, WSB, and the proposed PDCF in F-Area.

3.1.5.4 Threatened and Endangered Species

General Site Description

Sixty-one threatened, endangered, and other special-status species listed by the Federal Government or the State of South Carolina may be found in the vicinity of SRS. No critical habitat for threatened or endangered species exists on SRS (DOE 1999b:3-159, WSRC 2006b:3-43). **Table 3–10** presents the threatened and endangered species that are known to occur on SRS.

Proposed Facility Locations

No threatened or endangered species are known to occur within the developed portion of the E-, F-, H-, K-, and S-Areas.

Table 3–10 Federal or South Carolina Endangered or Threatened Plants and Animals Known to Occur on the Savannah River Site

Species	*Status and Occurrence*	
	Federal	*State*
Plants		
Smooth purple coneflower *(Echinacea laevigata)*	Endangered Three colonies on SRS	Endangered
Pondberry *(Lindera melissifolia)*	Endangered At least one colony known on SRS	Endangered
Animals		
Bald eagle *(Haliaeetus leucocephalus)*	Not listed	Endangered [a]
Red-cockaded woodpecker *(Picoides borealis)*	Endangered Numerous colonies on SRS	Endangered
Wood stork *(Mycteria americana)*	Endangered Feed in SRS swamps and reservoirs	Endangered
Shortnose sturgeon *(Acipenser brevirostrum)*	Endangered Eggs and larvae collected from Savannah River adjacent to SRS	Endangered
American swallow-tailed kite *(Elanoides forficatus)*	Not listed	Endangered One sighting reported
Gopher tortoise *(Gopherus polyphemus)*	Not listed	Endangered One reported; habitat on site
Southeastern big-eared bat *(Corynorhinus rafinesquii)*	Not listed	Endangered [a]

SRS = Savannah River Site.
[a] Occurrence data not available.
Source: SCDNR 2010b, WSRC 2006b:3-45.

3.1.6 Human Health

Public and occupational health and safety issues include the determination of potentially adverse effects on human health that result from acute and chronic exposure to ionizing radiation and hazardous chemicals.

3.1.6.1 Radiation Exposure and Risk

General Site Description

Major sources and levels of background radiation exposure to individuals in the vicinity of SRS are assumed to be the same as those to an average individual in the U.S. population. These are shown in **Table 3–11**. Background radiation doses are unrelated to SRS operations. Annual background radiation doses to individuals are expected to remain constant over time.

Table 3–11 Radiation Exposure of Individuals in the Savannah River Site Vicinity Unrelated to Savannah River Site Operations [a]

Source	*Effective Dose (millirem per year)*
Natural background radiation	
Cosmic and external terrestrial radiation	54
Internal terrestrial radiation	29
Radon-220 and -222 in homes (inhaled)	228
Other background radiation	
Diagnostic x-rays and nuclear medicine	300
Occupational	0.5
Industrial, security, medical, educational, and research	0.3
Consumer products	13
Total (rounded)	**620**

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

Releases of radionuclides to the environment from SRS operations provide another source of radiation exposure to individuals in the vicinity of SRS. Types and quantities of radionuclides released from SRS operations are listed in the annual SRS environmental reports. The annual doses to the public from recent releases of radioactive materials (2007 through 2011) and the average annual doses over this 5-year period are presented in **Table 3–12**. These doses fall within radiological limits established per DOE Order 458.1 and are much lower than background radiation.

Using a risk estimator of 600 latent cancer fatalities (LCFs) per 1 million person-rem (or 0.0006 LCFs per rem) (DOE 2003a), the annual average LCF risk to the maximally exposed member of the public due to radiological releases from SRS operations from 2007 through 2011 is estimated to be 7×10^{-8}. That is, the estimated probability of this person developing a fatal cancer at some point in the future from radiation exposure associated with 1 year of SRS operations is 1 in 14 million. (Note: It takes a number of years from the time of radiation exposure until a cancer manifests.)

Table 3–12 Annual Radiation Doses to the Public from Savannah River Site Operations for 2007–2011 (total effective dose)

Members of the Public	*Year*	*Atmospheric Releases* [a]	*Liquid Releases* [b]	*Total* [c]
Maximally exposed individual (millirem)	2007	0.04	0.05	**0.10**
	2008	0.04	0.08	**0.12**
	2009	0.04	0.08	**0.12**
	2010	0.05	0.06	**0.11**
	2011 [d]	0.03	0.08	**0.12**
	2007–2011 Average	0.04	0.07	**0.11**
Population within 50 miles (person-rem) [e]	2007	1.8	2.1	**3.9**
	2008	1.8	3.8	**5.6**
	2009	2.0	2.2	**4.2**
	2010	1.9	1.9	**3.8**
	2011 [d]	1.2	1.8	**3.0**
	2007–2011 Average	1.7	2.4	**4.1**
Average individual within 50 miles (millirem) [f]	2007	0.0025	0.0024	**0.0049**
	2008	0.0025	0.0043	**0.0069**
	2009	0.0028	0.0025	**0.0053**
	2010	0.0024	0.0020	**0.0044**
	2011	0.0015	0.0019	**0.0034**
	2007–2011 Average	0.0023	0.0026	**0.0050**

[a] DOE Order 458.1 and Clean Air Act regulations in 40 CFR Part 61, Subpart H, establish a compliance limit of 10 millirem per year to a maximally exposed individual.
[b] Includes all water pathways, not just the drinking water pathway. Though not directly applicable to radionuclide concentrations 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 a dose equivalent of 4 millirem per year (40 CFR 141.166).
[c] DOE Order 458.1 establishes an all-pathways dose limit of 100 millirem per year to individual members of the public.
[d] Beginning with the *Savannah River Site Environmental Report for 2011* (SRNS 2012b), DOE includes the potential dose from use of Savannah River water for irrigation as part of the liquid pathway dose (not included in the doses in this table). In 2011, the irrigation pathway resulted in a potential incremental collective population dose of 1.3 person-rem and maximally exposed individual (MEI) dose of 0.092 millirem. Including the dose from the irrigation pathway, the total MEI dose in 2011 was 0.21 millirem.
[e] About 713,500 for 2007–2009, based on 2000 census data, and about 781,060 for 2010–2011, based on 2010 census data. For liquid releases occurring from 2007 through 2011, an additional 161,300 water users in Port Wentworth, Georgia, and Beaufort, South Carolina (about 98 river miles downstream), are included in the assessment.
[f] Obtained by dividing the population dose by the number of people living within 50 miles of SRS for atmospheric releases; for liquid releases, the number of people includes water users who live more than 50 miles downstream of SRS.

Note: Sums and quotients presented in the table may differ from those calculated from table entries due to rounding. To convert miles to kilometers, multiply by 1.609.

Source: SRNS 2009b:Ch.6, 2010f:Ch.6, 2011:Ch.6, 2012b:Ch.6; WSRC 2008c:Ch.6.

According to the same risk estimator, no excess fatal cancers are projected in the population living within 50 miles (80 kilometers) of SRS from 1 year of normal operations during the 2007–2011 time period. To put this number in perspective, it may be compared with the number of fatal cancers expected in the same population from all causes. The average annual mortality rate associated with cancer for the entire U.S. population from 2005 through 2009 (the last 5 years for which final data are available) was 187 per 100,000 (HHS 2008:Table B, 2009:Table B, 2010:Table B, 2011a:Table B, 2011b:Table B).[7] Based on this national mortality rate, the number of fatal cancers that were expected to occur in 2011 in the population living within 50 miles (80 kilometers) of SRS is 1,460.

[7] *Preliminary data for 2010 and 2011 indicate that mortality rates were lower by less than 2 percent from the 2005–2009 average rate (HHS 2012a:Table B, 2012b:Table B).*

SRS workers receive the same dose as the general public from background radiation, but also receive an additional dose from working in facilities with nuclear materials. **Table 3–13** presents the annual average individual and collective worker doses from SRS operations from 2006 through 2010. These doses fall within the regulatory limits of DOE's "Occupational Radiation Protection" (10 CFR Part 835). Using the risk estimator of 600 LCFs per 1 million person-rem, the calculated average annual LCF risk of 0.08 in the workforce indicates a low probability of a single cancer fatality in the worker population.

Table 3–13 Radiation Doses to Savannah River Site Workers from Operations During 2006–2010 (total effective dose equivalent)

Occupational Personnel	*From Onsite Releases and Direct Radiation by Year*					
	2006	*2007*	*2008*	*2009*	*2010*	*Average*
Average radiation worker (millirem) [a]	45	53	59	50	70	55
Total worker dose (person-rem)	107	112	127	109	180	127
Number of workers receiving a measurable dose	2,387	2,135	2,151	2,183	2,587	2,289

[a] No standard is specified for an "average radiation worker;" however, the maximum dose to a worker is limited as follows: the radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, DOE's goal is to maintain radiological exposure as low as 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 (DOE 2009a).

Source: DOE 2007a:3-10, 2008b:3-10, 2009c:3-10, 2010b:3-10, 2011b:3-10.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the annual SRS environmental reports. The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (on site and off site) are also presented in that report.

Proposed Facility Locations

External radiation doses and concentrations in air of gross alpha, various plutonium isotopes, neptunium-237, and americium-241 have been measured near the center of SRS. From 2005 through 2009, the average annual external dose near the site center was 121 millirem. This is higher than the average annual dose of 84 millirem measured at the offsite control location situated near U.S. Highway 301. During the 2006–2010 time period, the average concentration of gross alpha near the center of SRS was about 0.001 picocuries per cubic meter compared with the approximately 0.0011 picocuries per cubic meter measured at the offsite control location. These values are virtually the same. During the same time period, the average concentration of plutonium-239 in the air was less than 0.00001 picocuries per cubic meter near the site center and at the offsite control location (SRNS 2012a).

3.1.6.2 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, or food through ingestion). Hazardous chemicals can cause cancer and noncancerous health effects. The baseline data for assessing potential health impacts from the chemical environment are addressed in Sections 3.1.3, "Water Resources," and 3.1.4, "Meteorology, Air Quality and Noise."

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (e.g., from the National Emission Standards for Hazardous Air Pollutants (NESHAPs) and NPDES permits) contribute to minimizing health impacts on the public. The effectiveness of these controls is verified through the use of environmental monitoring information and inspection of mitigation measures. Health impacts on the public may occur through inhalation of air containing hazardous chemicals released to the atmosphere during normal SRS operations. Risks to public health from other pathways, such as ingestion of contaminated drinking water or direct exposure, are lower than those from inhalation.

Baseline air emission concentrations and applicable standards for hazardous chemicals are addressed in Section 3.1.4. The baseline 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 in compliance with applicable guidelines and regulations.

During normal operations, SRS workers may be exposed to hazardous materials by inhaling contaminants in the workplace atmosphere or by direct contact. The potential for health impacts varies among facilities and workers. Workers are protected from workplace hazards through appropriate training, protective equipment, monitoring, materials substitution, and engineering and management controls. They are also protected by adherence to the Occupational Safety and Health Administration Process Safety Management and workplace limits, and EPA standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that reflects the frequency and quantity of chemicals used in the operational processes ensure that these standards are not exceeded. DOE also requires that conditions in the workplace be as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm.

3.1.6.3 Health Effects Studies

In 2002, ATSDR evaluated the public health impacts of releases of tritium from SRS into the environment and concluded that the levels of tritium contamination in the environment around SRS are low, and the radiation doses to members of the public from tritium in drinking water and food are correspondingly low. Individual annual doses are approximately 0.1 millirem, even taking into account possible contributions from organically bound tritium in foodstuffs (ATSDR 2002:1, 10).

ATSDR found the nominal lifetime risk of cancer from the annual intake of tritium around SRS to be 2.7×10^{-8} (ATSDR 2002:11). This nominal risk is less than 1 in 10 million, a value that is defined by ATSDR to represent “no increased risk.” ATSDR concluded that any impact on health would be very small and certainly not detectable compared with any potential impact from the natural background radiation.

In 2007, ATSDR also issued an assessment of groundwater migration to offsite areas and surface-water contamination at SRS (ATSDR 2007:Summary). That assessment focused on the period from the end of the Centers for Disease Control and Prevention dose reconstruction evaluation timeframe (1992) to the time of the report (2007). ATSDR reached the following conclusions:

- According to the information evaluated by ATSDR, under existing conditions and normal operations, SRS currently poses no apparent public health hazard to the surrounding community from exposure to groundwater or surface water.

- There is no evidence of historical (pre-1993) migration of site-related radiological or chemical contaminants to offsite groundwater, and the monitoring data evaluated since 1993 indicate that the groundwater plumes have not migrated beyond the site boundaries. However, A- and M-Areas, which are close to the northwest SRS boundary, could potentially impact offsite groundwater resources in the future. NOTE: Separate from the ATSDR conclusions, no further offsite groundwater exposure is anticipated. This expectation is based on a consideration of the natural groundwater flow paths, the ongoing capture of the primary groundwater plume in A- and M-Areas, and the continued removal of dense nonaqueous phase liquid sources by technologies such as dynamic underground stripping.

- Unless onsite processes change and begin releasing additional chemical or radioactive substances, offsite surface-water exposures should remain the same or decrease as onsite remediation projects are completed.

The Centers for Disease Control and Prevention has a long-term program to evaluate the historical releases of radioactive and chemical materials to the environment from SRS, as well as other DOE sites (CDC 2001, 2005). This multi-year program, called the Dose Reconstruction Project, independently evaluated the historical releases from SRS to the environment and estimated the impacts on the surrounding population in terms of radiological dose. Phase I identified and collected the data on historical releases from SRS over a 39-year period, from the inception of SRS in 1954 to the end of 1992, when the main production activities ceased. Phase II reported the quantities of radionuclides and chemicals that were released from SRS during that period (CDC 2001). The report from Phase III presents screening estimates of the radiation dose and associated cancer risks for hypothetical persons living near SRS and performing representative activities (CDC 2005).

The results from the Phase III screening calculations indicate that calculated doses and risks to the hypothetical receptors summed over the 39-year period studied appear to be small. The largest point estimate dose was 0.94 rem for the "Outdoor Family Child" born in 1955; the corresponding risk of cancer incidence is 0.10 percent and the corresponding risk of cancer fatality is 0.024 percent (CDC 2005:Ex. Summary page viii). The "Outdoor Family Child" was defined as a hypothetical child who lived in Jackson, South Carolina, adjacent to the northwestern SRS boundary; ate food that was grown in Jackson; boated on the Savannah River; swam and spent time along the shoreline at the Jackson Boat Ramp on the Savannah River; and ate fish caught in the river below its confluence with Lower Three Runs Creek. For all exposure scenarios, most of the hypothetical dose from air releases came from iodine-131, argon-41, and tritium. Plutonium releases represented a small fraction of the estimated doses (CDC 2005). The SRS Dose Reconstruction Project was completed in September 2006.

The National Cancer Institute publishes national, state, and county incidence rates of various types of cancer (NCI 2013). However, the published information does not provide an association of these rates with their causes, e.g., specific facility operations and human lifestyles. **Table 3–14** presents incidence rates for the United States, South Carolina, Georgia, and the four counties adjacent to SRS. Additional information about cancer profiles in the vicinity of SRS is available in *State Cancer Profiles, Incidence Rates Report* (NCI 2013).

The National Institute for Occupational Safety and Health provided funding to researchers from the University of North Carolina to determine if working with hazardous agents may have led to more deaths at SRS than would be expected in the general population. In a report addressing leukemia mortality among workers at that site hired between 1950 and 1986 and followed through 2002 (Richardson and Wing 2007), evidence is presented that, for 15 years after exposure to radiation, SRS workers have a higher chance of dying from leukemia than if they were not exposed. Although not stated in the report, it should be noted that radiation doses to SRS workers are generally lower today, and have been lower for a number of years, than during the years of operation covered by the study.

Table 3–14 Cancer Incidence Rates [a] for the United States, South Carolina, Georgia, and Counties Adjacent to the Savannah River Site, 2005–2009

	All Cancers	*Thyroid*	*Breast*	*Lung and Bronchus*	*Leukemia*	*Prostate*	*Colon and Rectum*
United States	465	11.8	122	67.2	12.4	151.4	46.2
South Carolina	460.1	8.8	121.4	72	11.5	159	44.7
Aiken County [b]	398	10.8	110.8	64.3	9.9	120	38
Barnwell County [b]	403.4	(c)	107.9	52.7	16.4	124.9	36.6
Allendale County	401.8	(c)	115.5	67	(c)	196	47.8
Georgia	461.1	9.6	119.7	71.6	11.5	167.8	45
Burke County	484.4	(c)	102.4	90.6	16.5	129.7	59.4

a Age-adjusted incidence rates; cases per 100,000 persons per year.
b SRS is located in Aiken and Barnwell Counties.
c Data have 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 2013.

In early 2012, the Radiation and Public Health Project prepared the report *Assessing Changes in Environmental Radioactivity and Health Near the Savannah River Site – A Prototype to be Used at DOE Facilities* (RPHP 2012) and submitted it to DOE as an independent assessment of the radiation environment surrounding SRS. In the report the Radiation and Public Health Project asserts that releases of radioactive contaminants and incident rates of radiosensitive diseases are increasing around SRS and that there is a shortage of published articles regarding the health of SRS workers and those living near SRS. However, following a review of the report, DOE responded by letter to the author of the report, noting that (1) the conclusions in the report regarding excess health risk among persons living near SRS does not conform to typical methodology because it uses the United States population as a comparison group rather than a more appropriate local or regional population; (2) the report's conclusion is contrary to the results from a study conducted by Medical University of South Carolina researchers that shows cancer rates in the population living near the SRS were "lower than expected;" and (3) contrary to the assertion that "there is a relative paucity of articles on the health of SRS workers…or those living in proximity to SRS…," there are in fact at least two dozen publications that include data related to SRS directly or include SRS in multi-site studies. Included in those publications are studies from the Centers for Disease Control and the Agency for Toxic Substances and Disease Registry (DOE 2012f).

3.1.6.4 Accident History

SRS annual environmental reports were reviewed to determine if there were any unplanned releases of radioactivity to the environment around the site during the most recent 5 years for which data are available (2007-2011). These are the same years for which annual radiation doses to the public from SRS operations are given in Section 3.1.6.1. For each of these years, there were no unplanned radiological (or nonradiological) releases that required sampling or analysis (SRNS 2009b:3-16, 2010f:3-16, 2011:3-19, 2012b:3-21; WSRC 2008c:3-14).

Unplanned radioactivity releases to the environment occurred during earlier site operations. A discussion of unplanned releases is presented in the *SPD EIS* (DOE 1999b: 3-145, 3-146).

3.1.6.5 Emergency Preparedness

Every site in the DOE complex has an established emergency management program that is activated in the event of an accident. These programs have been developed and maintained to ensure adequate response to most accident conditions and to provide response efforts for accidents not specifically considered. Emergency management programs address emergency planning, training, preparedness, and response for both onsite and offsite personnel.

These programs involve providing specialized training and equipment for local fire departments and hospitals, state public safety organizations, and other government entities that may participate in response actions, as well as specialized assistance teams (DOE Order 151.1C, *Comprehensive Emergency Management System*). These programs also provide for notification of local governments whose constituencies could be threatened in the event of an accident. Broad ranges of exercises are run to ensure the systems are working properly, from facility-specific exercises to regional responses. 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 the Hanford Site in Richland, Washington, in May 1997.

The emergency management system at SRS includes emergency response facilities and equipment, trained staff, and effective interface and integration with offsite emergency response authorities and organizations. SRS personnel maintain the necessary apparatus, equipment, and a state-of-the-art Emergency Operations Center to respond effectively to virtually any type of emergency, not only at SRS, but throughout the local community.

The elements of the SRS emergency management program are implemented by a number of site and facility organizations. To facilitate development and ensure consistency of implementation, the site contractor has established standards that govern many elements of the program. Document revisions are reviewed against these standards by the site contractor's emergency preparedness group to ensure consistency among SRS facilities and with the sitewide program.

For operational emergencies that do not involve safeguards and security, the site contractor is the primary responding element. For emergencies involving safeguards and security, the DOE Emergency Manager is responsible for the overall direction of emergency response activities. The response capability of each SRS facility is exercised annually. Exercises are realistic simulations of emergencies to include command, control, and communication functions and event-scene activities. Training and drills are performed periodically to develop and maintain specific emergency response capabilities. Drills provide supervised, hands-on training for members of emergency response organizations. Exercises are used to validate the elements of the emergency management program. An annual comprehensive site-level exercise is conducted to test and demonstrate the site's integrated emergency response capability. Federal, state, local, and private organizations that support the site/facility's response capability or may be affected by a facility emergency are invited to participate in exercises at least once every 3 years.

3.1.7 Cultural and Paleontological Resources

Cultural resources are human imprints on the landscape and are defined and protected by a series of Federal and state laws, regulations, and guidelines. DOE views cultural resources as archeological materials (artifacts) and sites from prehistoric, historic, or ethnohistoric periods that are located on or beneath the ground surface; standing structures that are over 50 years old or represent a major historical theme or era; cultural and natural places, certain natural resources, and sacred objects that are important to American Indians and other ethnic groups; and American folklife traditions and arts (DOE 2010c).

As a result of these Federal and state laws and regulations, in 1973 the Savannah River Archaeological Research Program of the South Carolina Institute of Archaeology and Anthropology at the University of South Carolina began a phased approach to archeological compliance involving reconnaissance surveys, general intensive watershed surveys, specific intensive surveys, data recovery, and coordination with major land users on and around SRS (SRARP 2010a). These field studies and surveys continue today under separate agreements. Originally, cultural resources at SRS were managed under the terms of a Programmatic Memorandum of Agreement among the DOE Savannah River Operations Office, South Carolina State Historic Preservation Office (SHPO), and Advisory Council on Historic Preservation (SRARP 1989:App. C). DOE uses this agreement to identify cultural resources, assess their eligibility for listing on the National Register of Historic Places (NRHP), and to consult with the South Carolina SHPO to develop mitigation plans for affected resources (DOE 2005d:14). Guidance on the management of cultural resources at SRS is included in the *Archeological Resource Management Plan of the Savannah River Archeological Research Program* (SRARP 1989). Given SRS's ongoing missions, it was recognized that site operations may affect NRHP-eligible Cold War properties, so DOE developed a Programmatic Agreement in consultation with the South Carolina SHPO, the Advisory Council on Historic Preservation, the SRS Citizen Advisory Board, Citizens for Nuclear Technology Awareness, and the Cities of Aiken, Augusta, and New Ellenton for the preservation, management, and treatment of such properties within the SRS Cold War Historic District (DOE 2004a). As a result, the *Savannah River Site's Cold War Built Environment Cultural Resources Management Plan* was developed and contains the decision process for managing NRHP-eligible Cold War historic properties (DOE 2005a:1, 2).

As of fiscal year 2010, the Savannah River Archaeological Research Program has surveyed approximately 65,055 acres (26,327 hectares), or 33.7 percent of the 193,276 acres (78,217 hectares) of SRS suitable for survey (i.e., excluding SRS wetlands and developed areas). These efforts have resulted in the inventory of 1,885 sites. Through analysis, 925 of these sites have been determined to be prehistoric sites, 487 to be historic sites, and the remaining 473 to be mixed historic and prehistoric sites. During fiscal year 2010, 8 new sites were recorded and delineated; however, based on the level of survey sampling conducted, adequate information was not obtained from the sites to allow for NRHP eligibility determinations (SRARP 2010b:2, 45).

3.1.7.1 Prehistoric Resources

Prehistoric resources are physical properties that remain from human activities that predate written records (DOE 1999b:3-160).

General Site Description

In general terms, prehistoric sites on SRS consist of village sites, base camps, limited-activity sites, quarries, and workshops (NRC 2005a:3-37).

Proposed Facility Locations

The proposed capabilities would be installed in existing facilities or built in E-, F-, H-, K-, or S-Area, all of which are designated as site industrial, so there is little likelihood that prehistoric resources with research potential would be found. The majority of E-Area was disturbed when establishing the 200-acre (81-hectare) Old Burial Grounds that were in operation from 1952 to 1995, the 114,000-square-foot (10,591-square-meter) TRU waste pads that have been in operation since 1974, and E-Area vaults that became operational in 1994 and occupy 100 acres (DOE 2005c:4-53–75; Nukeworker 2010). The construction of F-, H-, and K-Areas during the 1950s likely destroyed any such resources in those areas (DOE 2005a:34–51); however, four prehistoric sites (two of which are eligible for listing on the NRHP) were identified in F-Area where MFFF and WSB are being constructed. These sites were mitigated in part through data recovery as described in a data recovery plan approved by the South Carolina SHPO. Five additional eligible sites located in the vicinity of the construction site are being monitored by Savannah River Archaeological Research Program staff members during ground-disturbing activities and in accordance with the Programmatic Memorandum of Agreement (NRC 2005a:3-38, 5-14, B-19–21). S-Area was extensively surveyed prior to construction of DWPF. No important archaeological or historic artifacts, or sites eligible for inclusion on the NRHP were found (DOE 1994:3-37).

3.1.7.2 Historic Resources

Historic resources consist of physical properties that postdate the existence of written records. In the United States, historic resources are generally considered to be those that date no earlier than 1492 (DOE 1999b:3-161).

General Site Description

Types of historic sites include farmsteads, tenant dwellings, mills, plantations and slave quarters, rice farm dikes, dams, cattle pens, ferry locations, towns, churches, schools, cemeteries, commercial building locations, and roads (DOE 1999b:3-161).

In November 2002, a resource study of SRS Cold War history and facilities was completed. In total, 732 SRS facilities were inventoried, all of which were constructed between 1950 and 1989. The study, conducted using the NRHP criteria, yielded 232 site facilities that were deemed historically eligible, including the SRS layout, classified as a NRHP-eligible Cold War Historic District because it possesses national, state, and local significance. SRS is an exceptionally important historic resource that provides information about our nation's twentieth-century Cold War history. It contains a well-preserved group of buildings and structures placed within a carefully defined site plan that are historically linked, sharing a common designer and aesthetic (DOE 2005a:1, 22; 2008a).

Proposed Facility Locations

Numerous facilities either individually or collectively in F-, H-, K-, and S-Areas were identified as NRHP-eligible, as they relate to one of two major themes: SRS's Cold War production mission and its role within the Atomic Energy Commission's program to develop peaceful uses for atomic energy. Sub-themes were defined that parallel processes and link significant buildings and building types to those themes. Facilities within E-, F-, and S-Areas that could be used under the proposed alternatives are newer and, therefore, not considered historic. However, H-Canyon is considered eligible due to its separations sub-theme as part of the historic district, and K-Reactor is individually eligible for listing, as well as many other buildings and areas based on sub-themes in association with the historic district (DOE 2005a: 24, 34, 51).

3.1.7.3 American Indian Resources

American Indian resources are sites, areas, and materials important to American Indians for religious or heritage reasons. In addition, cultural values are placed on natural resources, such as plants, that have multiple purposes within various American Indian groups. Of primary concern are concepts of sacred space that create the potential for land use conflicts (DOE 1999b:3-162).

General Site Description

American Indian tribes with traditional ties to the SRS area include the Apalachee, Cherokee, Chickasaw, Creek, Shawnee, Westo, and Yuchi. Main villages of both the Cherokee and Creek were located southwest and northwest of SRS, respectively, but both tribes may have used the area for hunting and gathering activities. American Indian resources in the region include remains of villages or townsites, ceremonial lodges, burials, cemeteries, and natural areas containing traditional plants used in religious ceremonies and for medicinal purposes (DOE 1999b:3-162).

In 1991, DOE conducted a survey of American Indian concerns about religious rights in the central Savannah River Valley. During this study, three American Indian groups, the Yuchi Tribal Organization, the National Council of Muskogee Creek, and the Indian People's Muskogee Tribal Town Confederacy, expressed continuing interest in the SRS region with regard to the practice of their traditional religious beliefs. The Yuchi Tribal Organization and the National Council of Muskogee Creek have expressed concerns that several plant species traditionally used in tribal ceremonies—for example, redroot (*Lachnanthes caroliniana*), button snakeroot (*Eryngium yuccifolium*), and American ginseng (*Panax quinquefolius*)—could exist on SRS (DOE 1999b:3-162; NRC 2005a:3-39). Redroot and button snakeroot are known to occur on SRS (Batson, Angerman, and Jones 1985:6, 21).

Proposed Facility Locations

Due to the developed nature of E-, F-, H-, K-, and S-Areas, it is highly unlikely that plants of concern to American Indians would be found. Further, no traditional cultural properties were identified during surveys conducted in association with construction of MFFF in F-Area (NRC 2005a:B-4).

3.1.7.4 Paleontological Resources

Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age (DOE 1999b:3-162).

General Site Description

Paleontological materials from the SRS area date largely from the Eocene Age (54 to 39 million years ago) and include fossilized plants, invertebrate fossils, giant oysters (*Crassostrea gigantissima*), other mollusks, and bryozoa. With the exception of the giant oysters, all other fossils are fairly widespread and common; therefore, the assemblages have low research potential or scientific value (NRC 2005a:3-39).

Proposed Facility Locations

Paleontological resources are unlikely to be found within E-, F-, H-, K-, and S-Areas due to the highly disturbed nature of these areas and, in fact, no such resources have been recorded in either F- or S-Area (DOE 1999b:3-163).

3.1.8 Socioeconomics

In this *SPD Supplemental EIS*, "socioeconomics" refers to the relationship between the economic activity associated with proposed DOE actions involving surplus plutonium disposition and the impacts that such actions may have on the ROI. Socioeconomic impacts may be defined as the environmental consequences of a proposed action in terms of potential demographic and economic changes.

Table 3–15 provides residence information for the four-county ROI. As shown in this table, approximately 86 percent of SRS employees reside in this ROI. In 2010, 8,730 persons were directly employed at SRS. Direct onsite employment accounts for approximately 4.1 percent of employment in the ROI.

Table 3–15 Distribution of Employees by Place of Residence in the Savannah River Site Region of Influence in 2010

County	*Number of Employees*	*Percent of Total Site Employment*
Aiken	4,496	52
Barnwell	580	7
Columbia	1,324	15
Richmond	1,082	12
Region of Influence Total [a]	**7,482**	**86**

[a] Totals may not add due to rounding.
Source: SRNS 2012a.

Indirect employment generated by SRS operations has been calculated using a weighted average of RIMS II [Regional Input-Output Modeling System] direct-effect employment multipliers from the U.S. Bureau of Economic Analysis for select industries that most accurately reflect the major activities at the site. The Bureau of Economic Analysis develops RIMS II multipliers using input–output tables that show the distribution of inputs purchased and outputs sold for each industry. A national input–output table, representing close to 500 different industries, is adjusted using Bureau of Economic Analysis regional economic accounts to accurately reflect the structure of a given area. The detailed industries included in the RIMS II models that were used to develop the SRS site-specific operations multiplier include Management of Companies and Enterprises; Scientific Research and Development; Investigation and Security Services; Waste Management and Remediation; Other Basic Inorganic Chemical Manufacturing; Forest Nurseries, Forest Products, and Forest Tracts; Environmental and Other Technical Consulting Services; and Construction. This method resulted in an estimated SRS direct-effect employment multiplier of 2.19. Therefore, the direct employment of 8,730 at SRS would generate indirect employment of 10,383 within the ROI, resulting in a total employment of 19,113, or 8.9 percent of the employment in the ROI.

3.1.8.1 Regional Economic Characteristics

Between 2000 and 2011, the civilian labor force of the ROI increased at an average annual rate of 0.9 percent, to 236,950. At the same time, employment in the ROI increased at an average annual rate of 0.4 percent to 215,297, resulting in a 5.3 percentage point increase in the unemployment rate. Unemployment in the ROI was 9.1 percent in 2011, up from the 2000 level of 3.8 percent. Georgia and South Carolina experienced similar trends in unemployment rates, increasing 6.3 percentage points and 6.7 percentage points over the 12-year period, respectively (BLS 2012). **Figure 3–4** illustrates the change in unemployment rates in the ROI, Georgia, and South Carolina from 2000 through 2011.

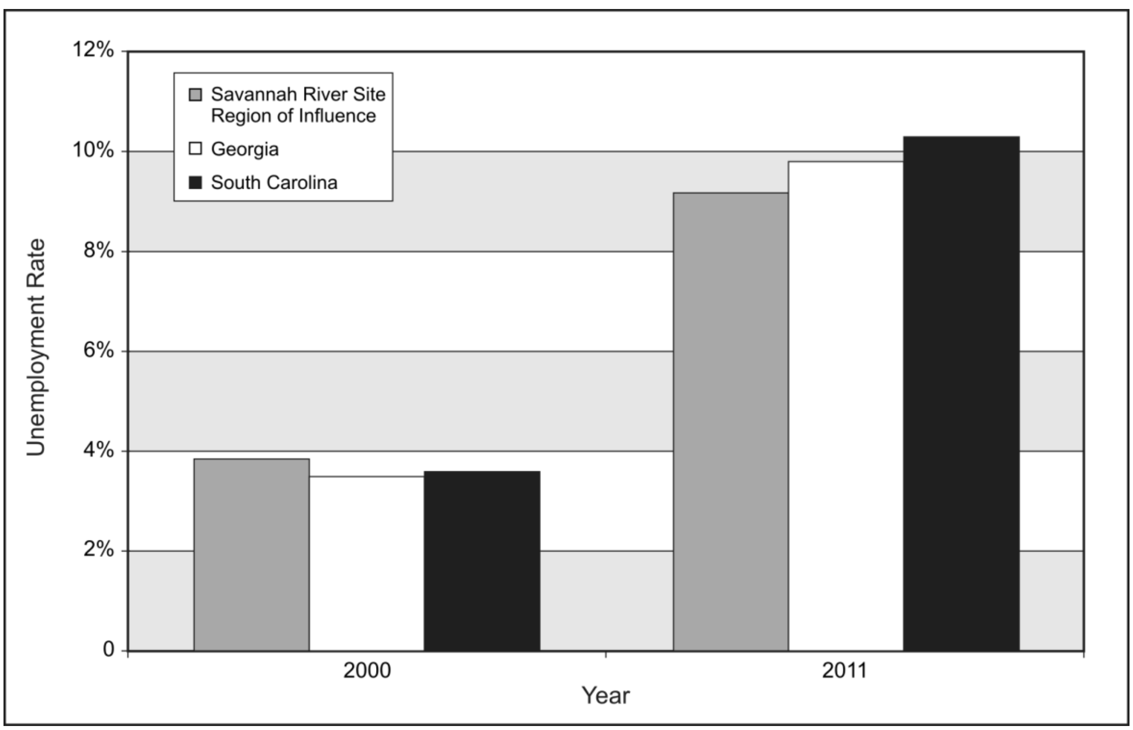


Figure 3–4 Unemployment Rates for the Savannah River Site Region of Influence, Georgia, and South Carolina from 2000 through 2011

From 2000 to 2009, the average real per capita income of the ROI increased by approximately 4 percent in 2009 dollars, to $32,678. South Carolina experienced a slightly smaller increase than in the ROI, increasing 4 percent to $32,505. The per-capita income of Georgia decreased 4 percent to $34,129 over the same time period. Over the 10-year period, real per capita income in the ROI peaked in 2009 at $32,678. Real per capita income in Georgia and South Carolina peaked in 2007 at $35,891 and $33,249, respectively (BEA 2011a). **Table 3–16** presents the per capita incomes of the ROI, Georgia, and South Carolina.

Table 3–16 Per Capita Income of the Savannah River Site Region of Influence, Georgia, and South Carolina in 2000 and 2009

	Savannah River Site Region of Influence		*Georgia*		*South Carolina*	
Year	*Nominal*	*Real* [a]	*Nominal*	*Real* [a]	*Nominal*	*Real* [a]
2000	$25,132	$31,311	$28,531	$35,546	$25,081	$31,247
2009	$32,678	$32,678	$34,129	$34,129	$32,505	$32,505

[a] Real per capita income adjusted to 2009 dollars using the Consumer Price Index for All Urban Consumers in U.S. City Average.

Source: BEA 2011a.

In 2009, the government was the largest employer in the ROI, at approximately 21 percent of total employment. Retail trade was the next leading industry at approximately 11 percent of employment, followed by healthcare and social assistance, and administrative and waste management services at approximately 10 percent each. Similar employment distributions were seen in Georgia, where the leading employment sectors were also government, retail trade and healthcare and social assistance at approximately 15 percent, 10 percent, and 9 percent, respectively. South Carolina's leading employment sectors were government, retail trade, and manufacturing at approximately 16 percent, 11 percent, and 9 percent, respectively (BEA 2011b). The major employment sectors in the ROI, Georgia, and South Carolina are presented in **Figure 3–5**.

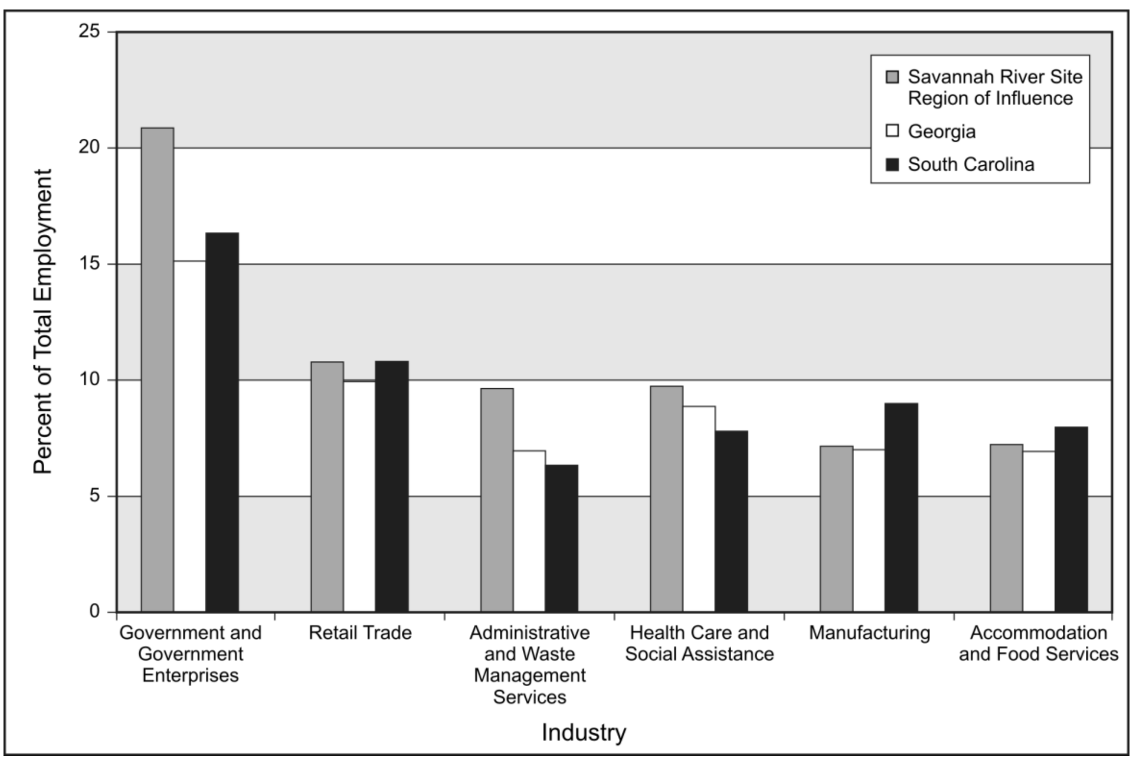


Figure 3–5 Major Employment Sector Distribution for the Savannah River Site Region of Influence, Georgia, and South Carolina in 2009

Population and Housing

In 2010, the population in the ROI was estimated to be 507, 322 (Census 2011a). From 2000 to 2010, the total population in the ROI increased at an average annual rate of approximately 1.1 percent, which was lower than the growth rate in both Georgia and South Carolina. Over the same time period, the total population of Georgia increased at an average annual rate of approximately 1.7 percent, to 9,687,653 people. South Carolina experienced an increase of approximately 1.4 percent annually, to 4,625,364 people in 2010. The populations of the ROI, Georgia, and South Carolina are shown in **Table 3–17**.

Table 3–17 Total Population of the Savannah River Site Region of Influence, Georgia, and South Carolina in 2000 and 2010

Year	*Savannah River Site Region of Influence*	*Georgia*	*South Carolina*
2000	455,096	8,186,653	4,012,023
2010	507,322	9,687,653	4,625,364

Source: Census 2011a.

From 2000 to 2010, the number of housing units in the ROI increased at an average annual rate of 1.5 percent, to 217,690 units (Census 2010a, 2011b). The number of housing units in Georgia and South Carolina increased at average annual rates of approximately 2.2 and 2 percent respectively, resulting in a total number of housing units of 4,088,801 and 2,137,683, respectively. **Table 3–18** shows the number of housing units in the ROI, Georgia, and South Carolina. The average homeowner vacancy rate for the counties that make up the ROI was 2.9 percent in 2010, slightly higher than the statewide rate for South Carolina of 2.8 percent, but lower than the homeowner vacancy rate for Georgia of 3.4 percent. The average renter vacancy rate for the ROI in 2010 was 9.2 percent, compared with the statewide renter vacancy rates of 12.4 percent for Georgia and 14.4 percent for South Carolina (Census 2011c, 2011d).

Table 3–18 Total Housing Units in the Savannah River Site Region of Influence, Georgia, and South Carolina in 2000 and 2010

Year	*Savannah River Site Region of Influence*	*Georgia*	*South Carolina*
2000	187,811	3,281,737	1,753,670
2010	217,690	4,088,801	2,137,683

Source: Census 2010a, 2011b.

3.1.8.2 Local Transportation

In addition to state transportation departments, three major planning agencies collect and maintain data on the efficiency of the transportation system in the region: the Augusta Planning Commission in Georgia, and the North Augusta Planning Commission and the Lower Savannah Council of Governments Planning Department in South Carolina. Road performance is measured using level of service (LOS) ratings. LOS ratings range from “A” to “F,” with “A” being the best travel conditions and “F” being the worst. Most planners aim for LOS C. At LOS C, roads are below, but close to, capacity and traffic generally flows at the posted speed.

In the Lower Savannah Council of Governments planning area, the roads with the highest levels of traffic operate at LOS A (LSCOG 2005). This area includes the counties immediately surrounding SRS. In the North Augusta Planning Area, roads operate at LOS C or better (NA 2005). This area includes the northwest part of Aiken County and Edgefield County. In the Augusta–Richmond County Planning Area, there are several street and highway system segments that operate below LOS C, including segments of Interstate 520 (I–520) (Bobby Jones Expressway) and I–20 (Carl Sanders Highway), as well as segments of principal arterial roads, including Deans Bridge Road, Doug Barnard Parkway, Mike Padgett Highway, Peach Orchard Road, Washington Road, and Wrightsboro Road. Most of the congested segments are located in the urbanized part of the county (ARC 2008). Roads in Columbia County operating below LOS C also include segments of I–520, I–20, Belair Road, Lewiston Road, Horizon South Parkway, Old Evans Road, and Washington Road (TEI 2004). Most SRS employees live in the Augusta area and the city of Aiken and would use roads in these planning areas to commute to SRS (DOC 2008).

3.1.9 Infrastructure

Site infrastructure includes those basic resources and services required to support planned construction and operations activities and the continued operations of existing facilities. For the purposes of this *SPD Supplemental EIS*, infrastructure is defined as transportation, electricity, fuel, water, and sewage. **Table 3–19** describes the SRS infrastructure.

Table 3–19 Savannah River Site Sitewide Infrastructure

Resource	*Estimated Use*	*Capacity*	*Available Capacity*
Transportation [a]			
Primary and secondary roads (miles)	1,230	1,230	N/A
Railroads (miles)	32	32	N/A
Electricity			
Power consumption (megawatt-hours per year)	310,000	4,400,000 [a]	4,100,000
Peak load (megawatts) [a]	60	500	440
Fuel [b]			
Oil (gallons per year)	410,000	N/A [c]	N/A
Coal (tons per year)	150,000	N/A [c]	N/A
Domestic Water (gallons per year)	320,000,000	2,950,000,000	2,630,000,000
Sewage (gallons per year)	250,000,000	383,000,000 [d]	133,000,000

N/A = not applicable or not available.
[a] WSRC 2008a.
[b] Oil use is for A-, D-, and K-Areas.
[c] Capacity is generally not limited, as delivery frequency can be increased to meet demand.
[d] Capacity includes the Central Sanitary Wastewater Treatment Facility and smaller treatment units in D-, K-, and L-Areas.
Note: To convert gallons to liters, multiply by 3.7854; miles to kilometers, multiply by 1.6093; tons (short) to metric tons, multiply by 0.90718. Totals are rounded to two significant figures from information included in SRS Infrastructure Power Quantity Cost Distribution Report D7257000, FY2010 (SRNS 2012a).

Transportation – SRS is managed as a controlled area with limited public access. In addition to the vehicular roadways, rail track is dedicated to SRS for transporting large volumes or oversized loads of materials or supplies (DOE 2005c:3.1.4-3). As shown in **Figure 3–6**, travel between facilities in E-, F-, H-, K-, and S-Areas evaluated in this *SPD Supplemental EIS* can be accomplished by both surface roads and railroads.

Vehicular access to SRS is provided from South Carolina State Highways 19, 64, 125, 781, and U.S. Highway 278. State Highway 19 runs north from the site through New Ellenton toward Aiken; State Highway 64 runs in an easterly direction from the site toward Barnwell; State Highway 125 runs through the site itself in a southeasterly direction between North Augusta and Allendale, passing through Beech Island and Jackson. U.S. Highway 278 also runs through the site, in a southeasterly direction between North Augusta and Barnwell. State Highway 781 connects U.S. Highway 278 with Williston to the northeast of the site. The northern perimeter of the site is about 10 miles (16 kilometers) from downtown Aiken. Within SRS, there are approximately 130 miles (209 kilometers) of primary and 1,100 miles (1,770 kilometers) of secondary roads (DOE 2005c:3.1.4-3). Commuter traffic between SRS and Georgia crosses the Savannah River primarily on I–20 and I–520 and primary arteries Routes 28 and 1 and Business Route 25 to the north of SRS. Another primary artery, U.S. Highway 301, crosses the Savannah River to the south of SRS.

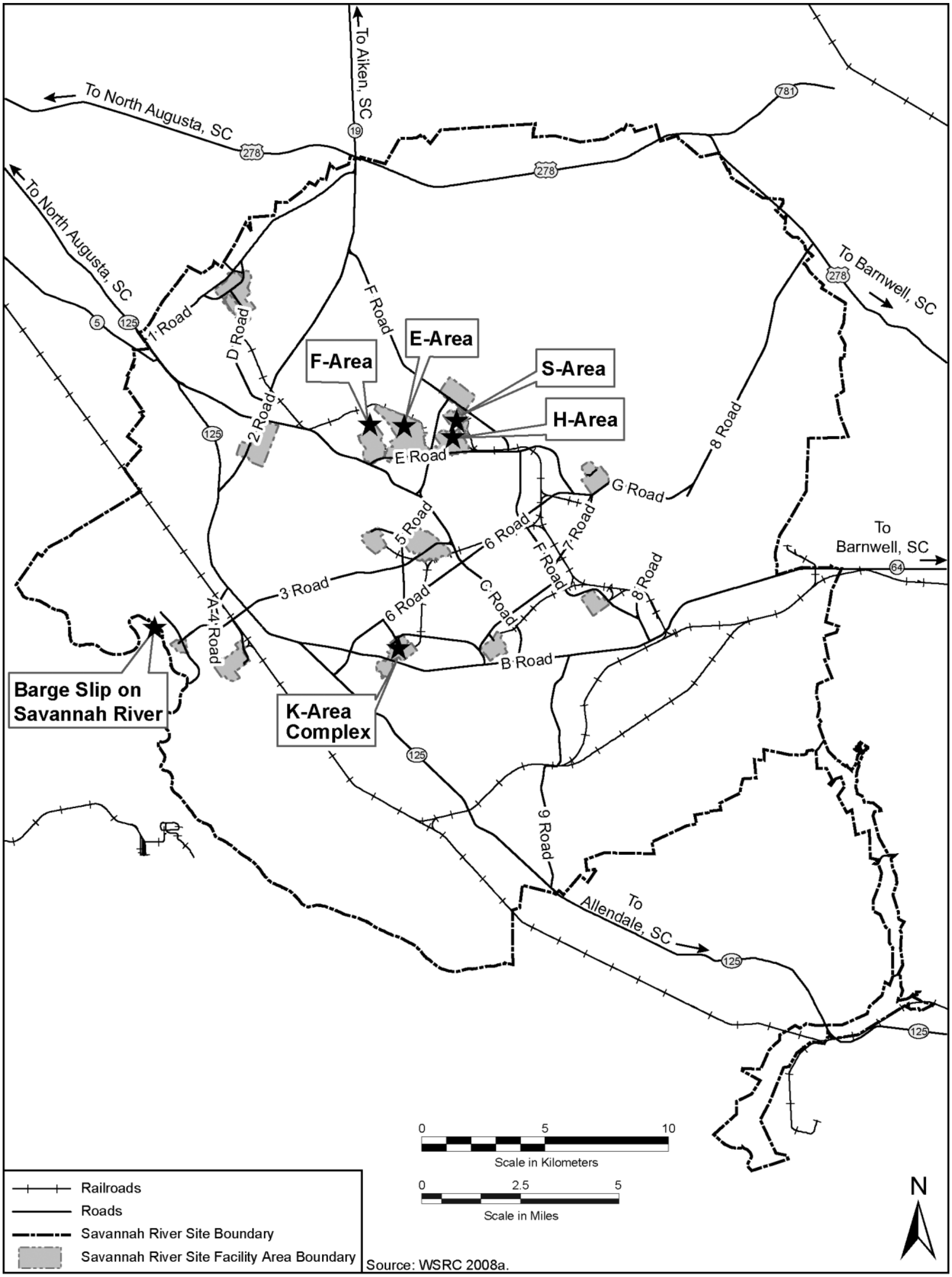


Figure 3–6 Savannah River Site Transportation Infrastructure

Several major road improvement projects in the area were recently completed. In North Augusta, Phase II of the I–520 (Palmetto Parkway) was completed in 2009. The I–520 project extended the Palmetto Parkway approximately 6.5 miles (10.5 kilometers) from Route 1 to I–20, connecting the two interstates and completing the Augusta–North Augusta loop. The project included the construction of a four-lane interstate with three interchanges and 13 bridges (SCDOT 2008). In Augusta, Georgia, major improvements to I–20 and I–520 were completed in 2009. The improvements to I–20 and I–520 in Georgia included widening 6.25 miles (10 kilometers) of I–20, the addition of collector-distributor lanes along parts of I–520 and I–20, and reconstruction of the I–20/I–520 interchange. Another major project is the planned expansion of the I–20 bridge over the Savannah River from four lanes to six lanes (City of Augusta 2010). This bridge is in the center of the main transportation route between Augusta, Georgia, and Aiken, South Carolina.

Rail service in the region is provided by the Norfolk Southern Corporation and CSX Transportation. Rail access is provided by the Robbins Station on the CSX Transportation line (DOE 1999b:3-144). Within SRS, there are approximately 32 miles (51 kilometers) of track (SRNS 2012a). The railroads support delivery of foreign and domestic research reactor fuel shipments, movement of nuclear material and equipment on site, and delivery of construction materials for new mission projects (DOE 2005c:3.1.4-3).

Barge transportation is available using the Savannah River. Currently, the Savannah River is used primarily for recreation. SRS has no commercial docking facilities, but has a boat ramp in the former T-Area that has accepted large transport barge shipments (DOE 1999b:3-144).

Columbia Metropolitan Airport in Columbia, South Carolina, and Augusta Regional Bush Field Airport in Augusta, Georgia, receive jet air passenger and cargo service from both national and local carriers. Numerous small private airports are located in the region.

Electricity – Most of the electrical power consumed by SRS is generated by offsite coal-fired and nuclear power plants, and is supplied by the South Carolina Electric and Gas Company. Approximately 310,000 megawatt-hours per year of electricity is used at SRS, with an available capacity of 4,400,000 megawatt-hours per year (SRNS 2012a). The peak load use is estimated to be 60 megawatts, with a peak load capacity of 500 megawatts.

Fuel – Coal and fuel oil are used primarily at SRS to produce steam in boiler plants. Fuel oil is also used to power emergency generators. Fuel oil is delivered by tanker truck and used in two boilers located in the K-Area Complex. Coal is delivered by rail and is stockpiled for use in D- and H-Areas. The steam plant in A-Area, which burned coal, is no longer used and was replaced with a biomass plant with fuel oil backup. The coal-powered steam boilers in H-Area are currently in standby. Natural gas is not used at SRS (DOE 2005c:3.1.4). An estimated 410,000 gallons (1.6 million liters) of fuel oil and 150,000 tons (136,000 metric tons) of coal per year are burned at SRS (SRNS 2012a). Replenishment of onsite fuel oil supplies can be delivered by truck or rail as needed. Furthermore, temporary storage tanks can be installed to supplement fuel consumption needs during construction activities. Thus, the capacity for fuel oil or coal utilization is generally not considered to be limited.

Water – Three large domestic water supply systems at SRS deliver the vast majority of the site's requirements. These water treatment facilities are located in A-, D-, and K-Areas. A smaller system located in B-Area is a backup to the A-Area facility. Raw water is drawn from subsurface aquifers through 20-inch- (51-centimeter-) diameter production wells using vertical turbine pumps. Once treated, the potable water is stored in five elevated storage tanks and distributed to the various facilities through a network of piping (DOE 2005c:3.1.4).

Approximately 320 million gallons (1.2 billion liters) of domestic water are used at SRS annually, with a capacity to supply up to 2,950 million gallons (11.2 billion liters) per year (SRNS 2012a). Process water for individual areas is supplied through separate deep groundwater wells or river intake systems (DOE 2005c).

Sewage – The Central Sanitary Wastewater Treatment Facility (CSWTF), located on Burma Road and installed in 1995, collects and treats 97 percent of sanitary wastewater generated at SRS. Also constructed in 1995, 18 miles (29 kilometers) of pressurized sewer line and 12 lift stations are used to transport sanitary waste to the CSWTF. The balance of the sanitary waste is treated at 3 smaller, and older, independent facilities located in D-, K-, and L-Areas. The original treatment facilities, lift stations, and 40 miles (64 kilometers) of gravity pipe were installed in the 1950s. Collectively, the sanitary systems include the CSWTF, 3 smaller treatment facilities, 46 lift stations, and 58 miles (93 kilometers) of sewer pipe. The CSWTF and the smaller treatment units in D-, K-, and L-Areas are estimated to collect and treat approximately 250 million gallons (950 million liters) of sewage per year with a capacity to treat up to 383 million gallons (1.5 billion liters) per year of sewage (SRNS 2012a).

Proposed Facility Locations

Proposed activities analyzed in this *SPD Supplemental EIS* would be located in E-, F-, H-, K-, and S-Areas. **Table 3–20** compares estimated current consumption of resources in these areas.

The construction and operation of MFFF in F-Area was analyzed in an EIS prepared by the U.S. Nuclear Regulatory Commission (NRC) (NRC 2005a). However, because this facility is not yet operational, the estimated use of resources presented in Table 3–20 does not include data for MFFF. Chapter 4, Section 4.1.7.7, discusses the infrastructure burden for operating MFFF and any additional modifications that may be required for implementing the alternatives analyzed in this *SPD Supplemental EIS* for F-Area.

Table 3–20 Current Use of Resources

Resource	*E-Area*	*F-Area*	*H-Area*	*K-Area*	*S-Area*
Electricity					
Power consumption (megawatt-hours per year)	2,900	46,000	99,000	9,200	45,000
Peak load (megawatts)	1 [a]	10	24.7	5.8	6
Diesel/Fuel Oil (gallons per year) [b]	N/A	N/A	N/A	170,000	N/A
Domestic Water (gallons per year)	20,000,000	61,000,000	140,000,000	3,600,000	12,000,000

N/A = not applicable.
[a] WSRC 2008a; estimated for E-Area based on requirements for other areas.
[b] Fuel oil is not used in E-, F-, H-, or S-Areas.
Note: To convert gallons to liters, multiply by 3.7854. Totals are rounded to two significant figures from information included in SRS Infrastructure Power Quantity Cost Distribution Report D7257000, FY2010 (SRNS 2012a).

Electricity – Step-down transformers are used to reduce the electrical power from the 115-kilovolt transmission loop to medium voltage levels, typically 4.16 or 13.8 kilovolts, in individual areas. There are two 30-megavolt-amp transformers for K-Area, two 44-megavolt-amp transformers for H-Area, and two 24/32-megavolt-amp transformers for each of F- and S-Areas.

The current estimated power consumption for the five areas that would be affected by the proposed activities totals approximately 202,000 megawatt-hours, which accounts for approximately 65 percent of current sitewide electrical usage and represents about 5 percent of the sitewide available capacity. The theoretical maximum peak load that could be experienced by the five areas given current estimated peak loads for each area totals approximately 48 megawatts, compared to a sitewide peak load of 60 megawatts. SRS has the capacity to deliver a peak load of up to 500 megawatts.

Fuel – In K-Area, fuel oil is used only to power two package boilers and the K-Area Interim Surveillance Backup Generator. Fuel oil is also used as the backup for the A-Area biomass steam plant. Another biomass plant is under construction to replace the D-Area powerhouse. The estimated 170,000 gallons (640,000 liters) of fuel oil used annually represents about 41 percent of the current sitewide consumption of fuel oil.

Water – The estimated current annual consumption of domestic water for all five areas of approximately 240 million gallons (910 million liters) represents 75 percent of the sitewide use and about 8 percent of sitewide capacity. Over 63 percent of the domestic water used at SRS is currently consumed in F- and H-Areas.

3.1.10 Waste Management

Waste management includes minimization, characterization, treatment, storage, and disposal of solid and liquid waste generated from ongoing DOE activities. The waste is managed according to appropriate treatment, storage, and disposal technologies and in compliance with applicable Federal and state statutes and DOE orders. Sitewide remediation activities are conducted under a 1989 Federal Facility Agreement, a tri-party agreement between EPA, SCDHEC, and DOE. The Federal Facility Agreement directs the comprehensive remediation of the site and integrates cleanup requirements under the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (WSRC 2008c:1-3). Additional information about regulatory requirements for waste treatment, storage, and disposal is provided in Chapter 5 of this *SPD Supplemental EIS*.

3.1.10.1 Waste Generation

The following waste types are managed at SRS: high-level radioactive waste (HLW), TRU waste and mixed TRU waste, solid and liquid LLW, MLLW, hazardous waste, and nonhazardous solid and liquid sanitary waste. The volume of each of these waste types currently managed by SRS would be affected by the activities proposed in this *SPD Supplemental EIS*. Solid waste generation rates from activities at SRS are provided in **Table 3–21**. Waste generation rates from activities at SRS for HLW, liquid LLW, and liquid sanitary waste are not included in Table 3–21, but are discussed in subsections that follow.

As shown in Table 3–21, sitewide 2010 generation rates for TRU waste, LLW, MLLW, and hazardous waste were considerably below the 5-year average. However, generation rates increased for solid sanitary and construction and demolition debris. These changes can be primarily attributed to fewer decontamination and decommissioning (D&D) and environmental restoration activities occurring in 2010 than in previous years. The reduction of LLW generated in K-Area can be attributed to a reduction in the area's LLW backlog, enhanced waste minimization and pollution prevention practices, and a shift in the K-Area mission to storage of special nuclear material (WSRC 2008a). It is expected that sitewide generation rates will increase over the next few years as activities funded by the *American Reinvestment and Recovery Act* are conducted.

Tables 3–22, 3–23, and **3–24** provide a summary and status of current and planned treatment, storage, and disposal facilities at SRS.

Table 3–21 Solid Waste Generation Rates at the Savannah River Site (cubic meters)

Waste Type	Savannah River Site – Total		K-Area		H-Canyon in H-Area		HB-Line in H-Area		DWPF in S-Area		E-Area and Hazardous/Mixed Waste Storage		F-Area (F-Canyon and FB-Line)	
	5-Year Average	FY2010	5-Year Average	FY2010	5-Year Average	FY2010	5-Year Average	FY2010	5-Year Average	FY2010	5-Year Average	FY2010	5-Year Average	FY2010
TRU [a]	120	67	0.5	0.6	1.5	0	27	22	0.1	0	0	0	39	27
LLW	13,000	7,700	86	64	650	830	97	130	250	190	5	5	730	950
MLLW	86	30	2.5	8.7	0.3	0	0.2	0	1.3	0.4	0	0	6.1	6.6
Hazardous	84	12	0.2	0	0	0	0	0	0	0	0	0	1.8	0
Sanitary [b]	2,400	2,600	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C&D debris [c]	83,000	130,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

C&D = construction and demolition; DWPF = Defense Waste Processing Facility; FY = fiscal year; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; N/A = not available; TRU = transuranic.

[a] Includes mixed TRU wastes.

[b] Sanitary waste is provided for all of the Savannah River Site (information by individual area is not available). Waste sent to the recycle facility and Three Rivers Landfill is measured by weight with volume estimated at 1 metric ton per cubic meter (1,690 pounds per cubic yard).

[c] C&D landfill waste volume is based on truck volumes received. Note that about 36 percent of the waste mass/estimated volume reported is sent to the recycling facility and not disposed of in the C&D landfill. Waste generation does not include waste-like materials recovered through salvage and excess property operations, or materials recovered through construction services.

Note: To convert cubic meters to cubic feet, multiply by 35.314.

Source: SRNS 2012a.

Table 3–22 Waste Treatment Capabilities at the Savannah River Site

Facility Name	Capacity	Status	Waste Type: High-Level Radioactive	Low-Level Radioactive	Mixed Low-Level Radioactive	Hazardous	Nonhazardous
Treatment Facility							
Defense Waste Processing Facility	275 canisters per year nominal [a]	Operating	X				
Tank Farm Evaporators	2H Evaporator: 810,000 liters per week; [b] 2F and 3H Evaporators: 2.1 million liters per week total	Operating		X			
Salt Waste Processing Facility	34 million liters per year, maximum rate	Planned for 2018	X [c]				
Interim processing of salt waste	15 liters per minute	Operating	X [c]				
F- and H-Areas Effluent Treatment Project	594 million liters per year	Operating		X	X		
Savannah River Technology Center Ion Exchange Treatment Probe	11,200 cubic meters per year	Operating			X		
Z-Area Saltstone Facility	28,400 cubic meters per year	Operating		X			
Central Sanitary Wastewater Treatment Facility	1.5 billion liters per year	Operating					X

[a] For sludge waste processing.
[b] Expected average annual rate of treatment of the Defense Waste Processing Facility recycle. The 2H Evaporator only treats the Defense Waste Processing Facility recycle. All evaporators are assumed to operate at 50 percent utility.
[c] The interim processing facility, which will ultimately be replaced by the Salt Waste Processing Facility, processes salt waste from the high-level radioactive waste tanks to separate the higher activity fraction of the waste (to be sent to the Defense Waste Processing Facility for vitrification) from the lower activity fraction of the waste (to be sent to Z-Area Saltstone Facility for disposal).
Note: There are no dedicated treatment facilities for transuranic/mixed transuranic waste. To convert cubic meters to cubic feet, multiply by 35.315; to convert liters to gallons, multiply by 0.26417.
Source: DOE 1999b:3-10; SRNS 2012a; SRR 2013, 2014; WSRC 2006a, 2007l, 2007m.

Table 3–23 Waste Storage Capabilities at the Savannah River Site

Facility Name	Capacity	Status	Waste Type: High-Level Radioactive	Transuranic	Mixed Transuranic	Low-Level Radioactive	Mixed Low-Level Radioactive	Hazardous
Storage Facility								
High-Level Liquid Radioactive Waste Tank Farms	8.7 million liters [a]	Operating	X					
Glass Waste Storage Buildings	4,590 canisters in two existing buildings	Operating	X					
Failed Equipment Storage Vaults (Defense Waste Processing Facility)	2 exist, space allocated for 12 more vaults	Operating	X					
Transuranic Waste Storage Pads [b]	13,200 cubic meters	Operating		X	X		X	X
Defense Waste Processing Facility Organic Waste Storage Tank	568 cubic meters	De-inventoried and decommissioned					X	
Solvent Storage Tanks at the Consolidated Incinerator Facility, S33–S36 [c]	105,000 liters per tank [d]	Operating				X	X	

[a] Operational working capacity remaining in the F- and H-Area tank farms that does not include six tanks in F-Area that have been closed or tank space in other tanks that may not be viable for storage or is maintained for safety reasons. Currently, 37 million gallons (140 million liters) of high-level radioactive waste are stored in 45 underground storage tanks.

[b] TRU Pad 26-E has been permitted to accept hazardous waste and mixed low-level radioactive waste for storage and has a maximum capacity of 296 cubic meters.

[c] These tanks were originally to be used for solvent storage; however, they were subsequently used to store other waste streams.

[d] Operating capacity.

Note: There are no dedicated low-level radioactive waste storage facilities. To convert cubic meters to cubic feet, multiply by 35.315; to convert liters to gallons, multiply by 0.26417.

Source: DOE 1999b:3-10; SRR 2013, 2014; WSRC 2007a, 2007l, 2008a.

Table 3–24 Waste Disposal Capabilities at the Savannah River Site

Facility Name	*Capacity*	*Status*	*Waste Type*	
			Low-Level Radioactive	*Nonhazardous*
Disposal Facility				
Intermediate-Level Waste Vaults	5,300 cubic meters per vault	Operating	X	
Low-Activity Waste Vaults [a]	30,500 cubic meters per vault	Limited Operations	X	
Low-level radioactive waste disposal facility slit trenches [a]	182,000 cubic meters	Operating	X	
Low-level radioactive waste disposal facility engineered trenches [a]	70,800 cubic meters	Operating	X	
Z-Area Saltstone Vaults	80,000 cubic meters per vault; up to 40 vaults planned	Operating	X	
Three Rivers Landfill [b]	4.2 million cubic meters per year (permitted)	Operating		X
Burma Road Cellulosic and Construction Waste Landfill	Not applicable	Closed		X
Construction and demolition debris landfill	2.47 million cubic yards total permitted capacity	Operating		X
288-F industrial solid waste landfill for ash from the A-Area power generating facility	105,776 cubic meters	Operating		X
488-4D industrial solid waste landfill for ash from the D-Area power generating facility	94,091 cubic meters	Operating		X

[a] As of February 2012, the estimated unused disposal capacity remaining is approximately 22,000 cubic meters for the Low-Activity Waste Vaults; 23,000 cubic meters for the slit trenches; and 14,000 cubic meters for the engineered trenches. The Low Activity Waste Vaults are generally used for waste staging; disposal of low-level radioactive waste is limited based on isotopic composition.

[b] Three Rivers Landfill is permitted to take up to 500,000 metric tons of compacted solid waste per year. Assuming a pre-compaction density of 200 pounds per cubic yard, this equates to approximately 4.2 million cubic meters per year of pre-compacted waste that can be disposed of at the landfill.

Note: Only low-level radioactive waste and nonhazardous waste are disposed of at SRS. To convert cubic meters to cubic feet, multiply by 35.315.

Source: DOE 1999b:3-10; SRNS 2012a; WSRC 2007l, 2008a.

3.1.10.2 High-Level Radioactive Waste

The F- and H-Area tank farms have received over 150 million gallons (570 million liters) of waste from SRS operations (SRR 2014:4). While DOE no longer produces nuclear materials or the used nuclear fuel (commonly referred to as "spent nuclear fuel") that generated the original waste, additional HLW is generated as part of stabilization of used nuclear fuel, plutonium, and other nuclear material. DWPF operations also generate liquids (called DWPF recycle) with low radionuclide concentrations that, after evaporation, are stored in the liquid radioactive waste tanks (DOE 2006a:2-3). Currently, approximately 37 million gallons (140 million liters) of waste containing about 287 million curies of radioactivity are stored in 45 underground tanks of the tank farms (SRR 2013, 2014:4). Approximately 2.3 million gallons (8.7 million liters) of operational working capacity remains in the F- and H-Area tank farms (SRR 2014:8). Six tanks have been grouted and operationally closed (SRR 2014:4). Chemicals such as sodium hydroxide are added to adjust the waste to an alkaline state to prevent corrosion of the carbon steel tanks. This chemical adjustment results in the precipitation of radioactive metals, including strontium and actinides, which settle to the bottom of the tanks and form a layer commonly referred to as "sludge." The supernate, or salt solution, above this sludge layer is decanted to another tank. Evaporators are used to reduce the volume of the supernate and thus concentrate it. The evaporation process creates two distinct phases, concentrated supernatant solution and solid saltcake (collectively called salt waste). Because the majority of the waste has undergone evaporation and been concentrated as much as possible, meaningful additional reduction by evaporation of the total waste volume currently stored is not possible (DOE 2006a:3-2, 3-3). DOE carefully manages the limited storage space in the tank farms because, among other considerations, DWPF operation generates recycle that is returned to the tank farm for further treatment and storage (WSRC 2007l).

DOE is using a process involving deliquification, dissolution, and adjustment to treat certain salt waste, with additional processing of salt waste using the Actinide Removal Process and Modular Caustic Side Solvent Extraction Unit (SRNS 2009a:6). After completion of the Salt Waste Processing Facility, expected to become operational in 2018 (SRR 2013), additional salt waste treatment capacity will be available. After treatment operations are completed, approximately 223 million curies of salt waste will have been removed from the F- and H-Area tank farms (71 FR 3834; WSRC 2007l).

DWPF was constructed to solidify HLW stored in the F- and H-Area tank farms into a vitrified form for eventual geologic disposal, which would then allow the HLW tanks in the tank farms to be closed.

DWPF began operating in March 1996, and is projected to complete vitrification of the HLW in the F- and H-Area tank farms by 2039 (SRR 2014:11). Operations consist of mixing a sand-like borosilicate glass (called "frit") with the waste, melting the mixture, and pouring it into stainless steel canisters to cool and harden. Each canister is 10 feet (3 meters) tall and 2 feet (0.6 meters) in diameter and has a filled weight of about 5,000 pounds (2,268 kilograms). Filled canisters are taken from DWPF to one of two adjacent Glass Waste Storage Buildings. Canisters are lowered into underground storage positions (SRNS 2012a). The estimated storage capacity for the two storage buildings is approximately 4,590 canisters (SRR 2013). Construction of additional storage is planned. The canisters will remain in safe, secure storage pending decisions on a long-term solution for management of HLW and used nuclear fuel.[8] Through December 31, 2013, 3,754 canisters of waste containing about 52 million curies had been poured at DWPF (SRR 2014:7).

[8] *DOE has terminated the program for a geologic repository for used nuclear fuel and HLW at Yucca Mountain, in Nevada. Notwithstanding the decision to terminate the Yucca Mountain program, DOE remains committed to meeting its obligations to manage and ultimately dispose of spent nuclear fuel and HLW. DOE established the Blue Ribbon Commission on America's Nuclear Future to conduct a comprehensive review and evaluate alternative approaches for meeting these obligations. The Commission issued its report in January 2012.*

3.1.10.3 Transuranic and Mixed Transuranic Waste

Packaged TRU waste materials are transported to E-Area via closed-body trucks from the generating site and are stored on covered storage pads. The transuranic waste storage pads in E-Area can store up to approximately 470,000 cubic feet (13,200 cubic meters) of transuranic and mixed transuranic waste. Periodically, the DOE Carlsbad Field Office schedules a characterization campaign at SRS. Characterization activities include nondestructive examination and nondestructive assay. The certified waste containers are subsequently loaded into Type B shipping casks and then transported to the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, for disposal (SRNS 2012a).

SRS made its first TRU waste shipment to WIPP in May 2001, and 1,299 shipments have been made through January 2012 (WIPP 2012; WSRC 2007n). Over 26,000 containers, or 193,000 cubic feet (5,460 cubic meters), of the original TRU waste inventory had been shipped as of the end of 2008 (SRNS 2009a).

The inventory of non-drummed (or large boxed) TRU waste accounts for approximately 127,000 cubic feet (3,600 cubic meters) stored in large steel boxes, concrete culverts, and other containers. This non-drummed TRU waste is currently being processed and repackaged and will be shipped to WIPP for disposal (SRNS 2012a).

3.1.10.4 Low-Level Radioactive Waste

Both liquid and solid LLW are treated at SRS. Most aqueous LLW streams are sent to the F- and H-Area Effluent Treatment Project (formerly called the Effluent Treatment Facility) and treated by pH adjustment, submicron filtration, organic removal, reverse osmosis, and ion exchange to remove chemical and radioactive contaminants other than tritium. This facility is designed to process 100,000 to 250,000 gallons (380,000 to 950,000 liters) of low-level radioactive wastewater daily. The maximum permitted facility capacity is 430,000 gallons (1.6 million liters) per day, or about 160 million gallons (590 million liters) per year. Actual processing is approximately 20 million gallons (76 million liters) of wastewater per year, or 55,000 gallons (210,000 liters) per day (WSRC 2006a, 2006f, 2007m). After treatment, the effluent is discharged to Upper Three Runs through an NPDES-permitted outfall. The treatment residuals are concentrated by evaporation and stored in the H-Area tank farm for eventual treatment in the Z-Area Saltstone Facility, where wastes are immobilized with grout for onsite disposal (DOE 1999b:3-133; WSRC 2007g).

LLW is primarily disposed of in engineered trenches and slit trenches. As of February 2012, approximately 18,000 cubic yards (14,000 cubic meters) of disposal space remains in the engineered trenches and approximately 30,000 cubic yards (23,000 cubic meters) of disposal space remains in two active slit trenches (SRNS 2012a). Together, the remaining solid LLW waste disposal capacity at SRS is estimated to be 48,000 cubic yards (37,000 cubic meters). Although some disposal capacity remains in concrete vaults located in E-Area, these are used primarily to stage LLW prior to shipment for off-site disposal and to dispose of the higher radioactive fraction of the LLW generated at SRS. Intermediate-activity waste is packaged according to waste form (DOE 1999b:3-134). While most solid LLW is disposed of on site at SRS, some LLW is shipped off site for disposal at Federal and commercial disposal facilities (SRNS 2009a).

Saltstone generated in the solidification of LLW salts separated from HLW is disposed of in the Z-Area Saltstone Vaults. Saltstone is solidified grout formed by mixing LLW salt with cement, fly ash, and furnace slag. Saltstone constitutes the highest volume of solid LLW disposed of at SRS (DOE 1999b:3-134).

3.1.10.5 Mixed Low-Level Radioactive Waste

MLLW is radioactive waste that contains material that is regulated as hazardous waste. Storage facilities for MLLW are located in several different SRS areas. These facilities are regulated under RCRA or as Clean Water Act-permitted tank systems (DOE 2002:3-43). MLLW is sent off site to RCRA-regulated treatment, storage, and disposal facilities. A section of the TRU storage pads (e.g., TRU Pad 26-E) has been permitted to store MLLW and hazardous waste and has a storage capacity of 390 cubic yards (296 cubic meters).

3.1.10.6 Hazardous Waste

Hazardous waste is nonradioactive waste that SCDHEC regulates under RCRA and corresponding state regulations. Hazardous waste is accumulated at the generating location as permitted by regulation or stored in U.S. Department of Transportation-approved containers in E-Area. A section of the transuranic storage pads (e.g., TRU Pad 26-E) has been permitted to store MLLW and hazardous waste and has a storage capacity of 390 cubic yards (296 cubic meters). Most of the waste is shipped off site to commercial RCRA-permitted treatment and disposal facilities using Department of Transportation-certified transporters (DOE 1999b:3-134–135). DOE also plans to continue to recycle, reuse, or recover certain hazardous wastes, including metals, excess chemicals, solvents, and chlorofluorocarbons (DOE 2002:3-47).

Polychlorinated biphenyls (PCBs) are present at SRS in various forms, including in K-Area. The majority of the PCBs in K-Area facilities are in special purpose coatings and paints. PCBs are also known to be present in fluorescent light ballasts and old capacitors, and may be present in caulking materials and non-liquid cable insulation. Wastes containing PCBs are managed in accordance with Toxic Substances Control Act regulations (40 CFR Part 761) and applicable EPA approval documents issued to SRS. Some nonradioactive and non-liquid PCBs can be disposed of in the Three Rivers Landfill. None of the PCB wastes from the K-Area reactor building can be disposed of in the onsite construction and demolition waste landfill. PCB wastes that are not eligible for disposal at SRS must be disposed of at an offsite Toxic Substances Control Act-permitted facility (SRNS 2012a).

3.1.10.7 Nonhazardous Waste

Solid sanitary waste is sent to the Three Rivers Regional Landfill, which is located within the SRS site boundary (DOE 2002:3-46) and serves as a regional municipal landfill for Aiken, Allendale, Bamberg, Calhoun, Edgefield, McCormick, Orangeburg, and Saluda Counties (LSCOG 2008). The Three Rivers Landfill has a total permitted capacity of 30 million metric tons and can receive up to 500,000 metric tons per year. As of 2008, approximately 2.4 million metric tons of solid waste had been disposed of in the landfill. Assuming a pre-compaction density of 200 pounds per cubic meter, Three Rivers Landfill is permitted to receive up to approximately 4,200,000 cubic meters of non-hazardous solid waste annually (SRNS 2012a). Construction and demolition debris is disposed of in a landfill near N-Area (WSRC 2008a).

Asbestos is commonly found throughout SRS in building materials (e.g., floor and ceiling tile, building insulation, window and door caulking, and lighting parts), packing and gaskets, wire and pipe insulation, and machine parts. To eliminate health risks to workers by unintended exposure to asbestos, SCDHEC and EPA require asbestos inspections before maintenance activities are conducted; or buildings or structures are renovated, repaired, moved, or demolished. Asbestos waste is managed as "special waste" and regulatory approval must be obtained prior to generation or disposal. While not considered a "hazardous waste" by state or Federal regulations, asbestos waste is managed by a "cradle-to-grave" process of special waste manifests and notification of waste disposal activities. Asbestos waste can only be disposed of in approved landfills (SRNS 2012a). Asbestos waste is disposed of in the Three Rivers Regional Landfill and the N-Area construction and demolition debris landfill, both of which are SCDHEC-approved asbestos waste landfills (WSRC 2008c:3-13).

Sanitary wastewater is collected and treated at the Central Sanitary Wastewater Treatment Facility prior to discharge to NPDES-permitted outfalls. The Central Sanitary Wastewater Treatment Facility has a design capacity to treat up to 383 million gallons (1.5 billion liters) per year (SRNS 2012a).

3.1.11 Environmental Justice

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionate to those on the population as a whole in the potentially affected area. The potentially affected area for SRS includes parts of 28 counties throughout Georgia and South Carolina that make up an area within a 50-mile (80-kilometer) radius of the SRS site. To be consistent with the human health analysis, the population distributions of the potentially affected area are calculated using data at the block-group level of spatial resolution from the 2010 census (Census 2010b), and have been projected to the year 2020 using data from the 1990 census, the 2000 census, and the 2010 census for each of the affected counties within a 50-mile (80-kilometer) radius of SRS (Census 1990, 2001, 2010b).

In accordance with CEQ guidance, meaningfully greater minority populations are identified where either the minority population of the affected area exceeds 50 percent, or the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis (CEQ 1997). Meaningfully greater is defined here as 20 percentage points above the population percentage in the general population. The average minority population percentage of South Carolina and Georgia for the projected 2020 population is approximately 44.6 percent and the average minority population percentage of the counties surrounding SRS is approximately 42.6 percent. Comparatively, a meaningfully greater minority population percentage relative to the general population of the state and the surrounding counties would exceed the 50 percent threshold defined by CEQ. Therefore, the lower threshold of 50 percent is used to identify areas with meaningfully greater minority populations surrounding SRS. In order to evaluate the potential impacts on populations in closer proximity to the proposed sites at SRS, additional radial distances of 5, 10, and 20 miles (8, 16, and 32 kilometers) are also analyzed. **Table 3–25** shows the composition of the ROI surrounding the proposed SRS facilities at each of these distances. No populations reside within the 5-mile (8-kilometer) radius of the facilities analyzed.

The total projected population residing in the SRS ROI in 2020 would be approximately 886,276, of which 47 percent would be considered members of a minority population. Of the 580 block groups in the potentially affected area, approximately 265 (46 percent) were identified as containing meaningfully greater minority populations.

Table 3–25 Projected Populations in the Potentially Affected Area Surrounding the Savannah River Site in 2020

Population Group	10 Miles		20 Miles		50 Miles	
	Population	Percent of Total	Population	Percent of Total	Population	Percent of Total
Nonminority	4,216	60	73,173	64	472,377	53
Black or African American [a]	2,179	31	32,262	28	332,231	37
Total Hispanic [b]	413	6	5,429	5	46,107	5
American Indian or Alaska Native [a]	29	0	641	1	3,870	0
Other Minority [a]	634	9	9,034	8	77,789	9
Total Minority [a]	2,842	40	41,937	36	413,890	47
Total Population	7,058	100	115,110	100	886,267	100
Low-Income	1,347	19	20,433	18	162,157	18

[a] Includes Hispanic persons.
[b] Includes all Hispanic persons regardless of race.
Note: To convert miles to kilometers, multiply by 1.609. Totals may not equal the sum of subcategories due to rounding. The potentially affected area comprises the area within a 50-mile (80-kilometer) radius of the site.

The overall composition of the projected populations within every radial distance is predominantly nonminority. The concentration of minority populations is greatest within the 50-mile (80-kilometer) radius. The Black or African American population is the largest minority group within every radial distance, constituting approximately 37 percent of the total population within 50 miles (80 kilometers). The Hispanic or Latino population constitutes about 5 to 6 percent of the total population at each radial distance. **Figure 3–7** displays the block groups identified as having meaningfully greater minority and low-income populations surrounding SRS.

The projected low-income population (those living below the poverty threshold) living within 50 miles (80 kilometers) of SRS in 2020 is estimated to be 162,157 people (18.3 percent). Meaningfully greater low-income populations are identified using the same methodology described above for identification of minority populations. The 2010 census does not contain any data relative to income. The U.S. Census Bureau's American Community Survey (ACS) 5-year estimates are the only data set that publishes current data relative to income at the block group level of geography. Therefore, the 2006–2010 ACS 5-year estimates were used to identify low-income populations in the potentially affected area. These populations were then scaled up to be directly comparable to the projected 2020 potentially affected population. The 2006–2010 ACS 5-year estimates show the average low-income population percentage of South Carolina and Georgia is 15.9 percent (Census 2011e). Comparatively, a meaningfully greater low-income population percentage using these statistics would be 35.9 percent. Therefore, the lower threshold of 35.9 percent is used to identify areas with meaningfully greater low-income populations surrounding SRS. Of the 580 block groups that surround SRS, 80 (14 percent) contain meaningfully greater low-income populations.

Figures 3–8 and **3–9** show cumulative total and minority and low-income populations projected to live within the potentially affected area in 2020 as a function of distance from the facilities at SRS. Values along the vertical axis show populations residing within a given distance from these facilities.

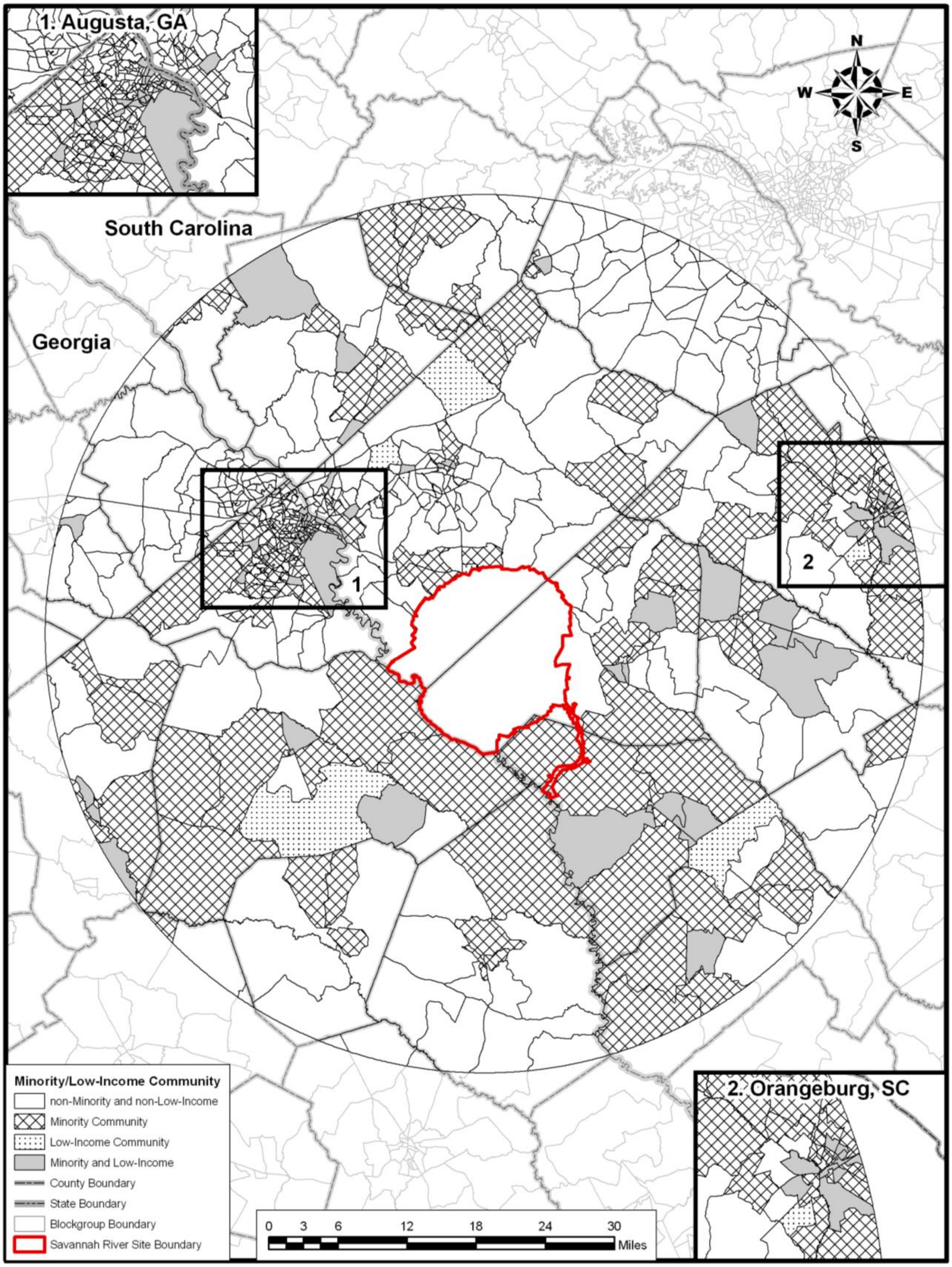


Figure 3–7 Meaningfully Greater Minority and Low-Income Populations Surrounding the Savannah River Site

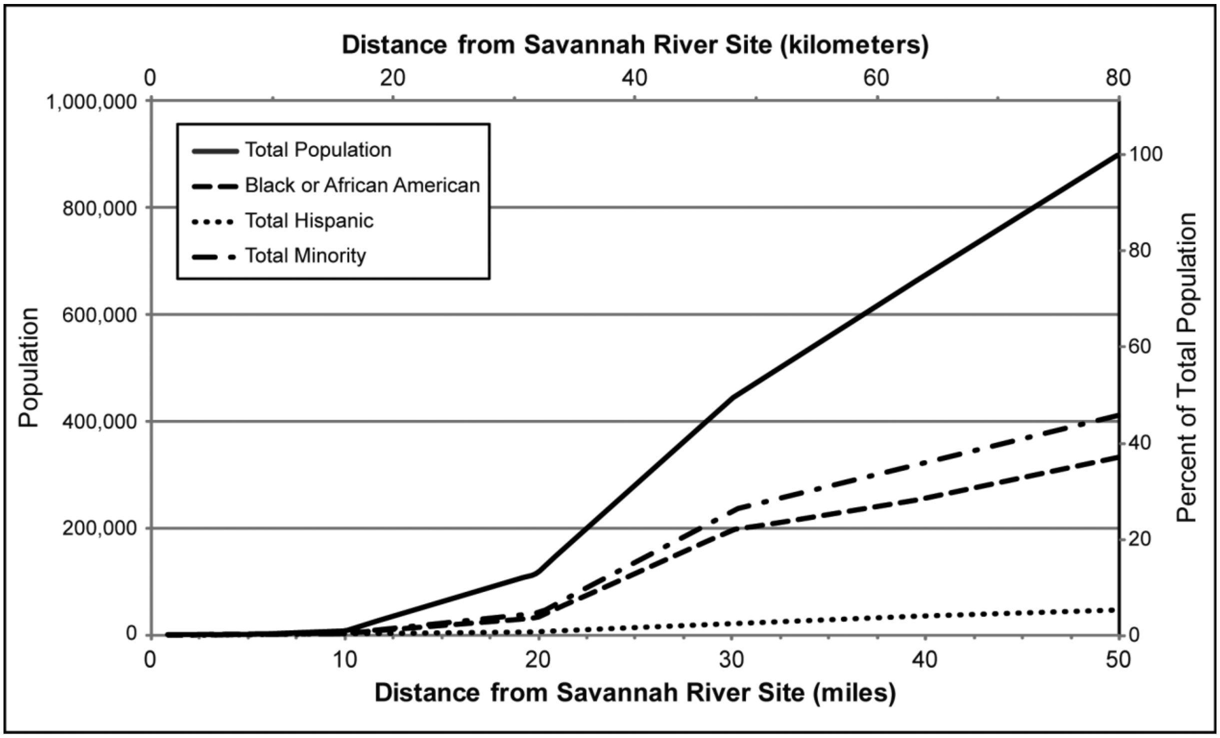


Figure 3–8 Cumulative Minority Populations as a Function of Distance from Savannah River Site

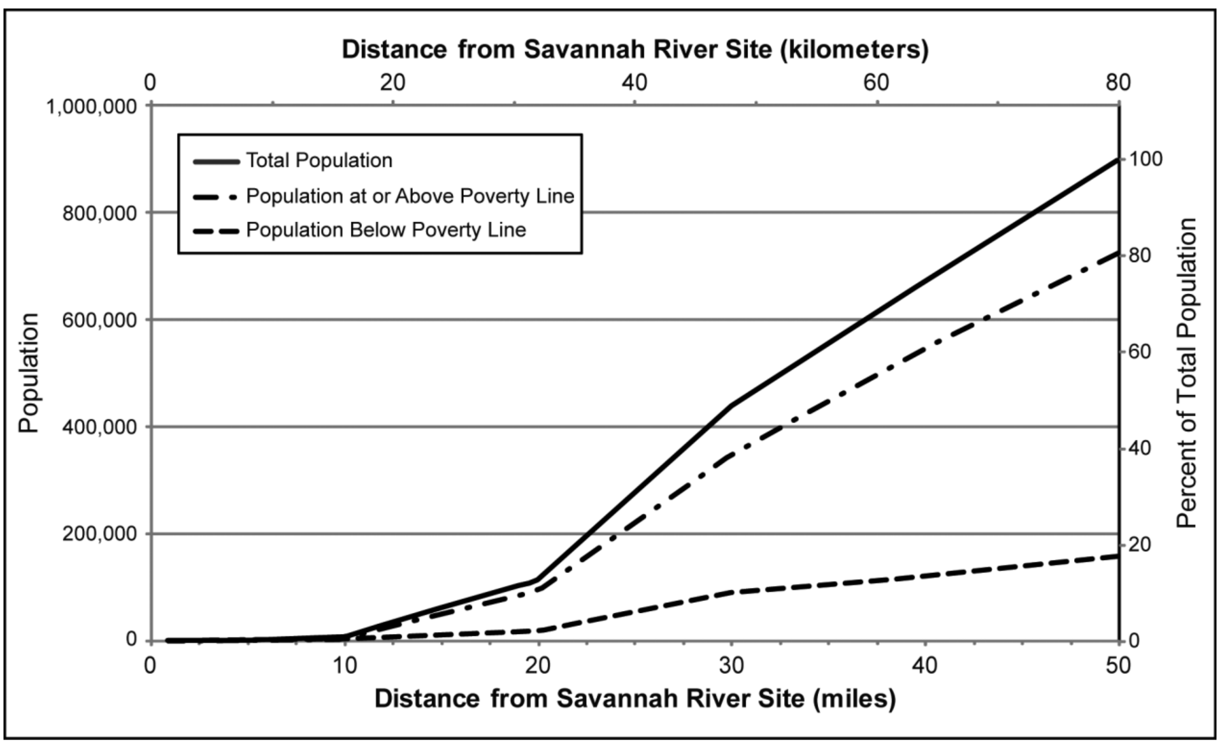


Figure 3–9 Cumulative Low-Income Populations as a Function of Distance from Savannah River Site

3.2 Los Alamos National Laboratory

This section describes the LANL environment in general and Technical Area 55 (TA-55), the technical area in which activities described in Chapter 2 have been proposed.

3.2.1 Land Resources

3.2.1.1 Land Use

LANL is located on 23,040 acres (9,324 hectares) of land in north-central New Mexico. The site is located 60 miles (97 kilometers) north-northeast of Albuquerque, 35 miles (56 kilometers) northeast of Santa Fe, and 20 miles (32 kilometers) southwest of Española. The site is owned by DOE. Portions of LANL are located in Los Alamos and Santa Fe Counties. LANL is divided into 47 contiguous technical areas with location and spacing that reflect the site's historical development patterns, regional topography, and functional relationships. Chapter 1, Figure 1–3, shows LANL's location and technical areas. In total, about 20 percent of the site is developed (DOE 2011g:3-2; LANL 2012b:2-1).

Land use in the LANL region is linked to the economy of northern New Mexico, which depends heavily on tourism, recreation, agriculture, and the state and Federal governments. Area communities are generally small, including the Los Alamos townsite and White Rock, which are home to about 11,000 and 7,000 residents, respectively, and primarily support urban uses, including residential, commercial, light industrial, and recreational. The region also includes Native American[9] communities; lands of the Pueblo de San Ildefonso share a border with LANL on its east side, while the Santa Clara and Pojoaque Pueblos are located approximately 20 miles (32 kilometers) to the northeast and east, respectively. Numerous other pueblos are also located in the Los Alamos area. Major governmental bodies that serve as land stewards and determine land uses within Los Alamos and Santa Fe Counties include county governments, DOE, the U.S. Department of Agriculture (U.S. Forest Service, Santa Fe National Forest), the U.S. Department of the Interior (National Park Service, Bureau of Indian Affairs, and the Bureau of Land Management [BLM]), the State of New Mexico, and several Native American pueblos. Bandelier National Monument and Santa Fe National Forest border LANL primarily to the southwest and northwest, respectively; however, small portions of each also border the site to the northeast (DOE 2011g:3-5).

Land use within Los Alamos and Santa Fe Counties is controlled by the counties' comprehensive plans. LANL is designated as "Federal" in the Los Alamos County Plan. The Santa Fe County Plan designates LANL as "Agricultural and Residential"; there are no agricultural activities on the site, nor are there any residential uses on LANL property. However, the privately owned Royal Crest Trailer Park, located along East Jemez Road, is entirely within the site boundaries. Although county governments have no jurisdiction over Federal lands, they seek Federal cooperation to achieve the goals set forth in their comprehensive plans (DOE 2011g:3-5).

The *Los Alamos National Laboratory Comprehensive Site Plan 2000: Los Alamos National Laboratory Project Management and Planning* (LANL 2000) identifies 10 land use categories. These categories are depicted in **Figure 3–10** and defined as follows:

- *Administration, Service, and Support*—Administrative functions, nonprogrammatic technical expertise, support, and services for LANL management and employees.
- *Experimental Science*—Applied research and development activities tied to major programs.

[9] *The term, "Native American" (rather than "American Indian") is preferred in the area surrounding LANL. The term "American Indian" is used by the U.S. Census and throughout this* SPD Supplemental EIS, *except when pertaining to LANL. "American Indian and Alaska Native" is a U.S. Census category used in applicable tables, including those for LANL.*

- *High-Explosives Research and Development*—Research and development of new explosive materials. This land is isolated for security and safety.
- *High-Explosives Testing*—Large, isolated, exclusive-use areas required to maintain safety and environmental compliance during testing of newly developed explosive materials and new uses for existing materials. This land also includes buffer areas.
- *Nuclear Materials Research and Development*—Isolated, secured areas for conducting research and development involving nuclear materials. This land use includes security and radiation hazard buffer zones. It does not include waste disposal sites.
- *Physical and Technical Support*—Includes roads, parking lots, and associated maintenance facilities; infrastructure such as communications and utilities; facility maintenance shops; and maintenance equipment storage. This land use generally is free from chemical, radiological, or explosives hazards.
- *Public and Corporate Interface*—Provides link with the general public and other outside entities conducting business at LANL, including technology transfer activities.
- *Reserve*—Areas that are not otherwise included in one of the other categories. It may include environmental core and buffer areas, vacant land, and proposed land transfer areas.
- *Theoretical and Computational Science*—Interdisciplinary activities involving mathematical and computational research and related support activities.
- *Waste Management*—Provides for activities related to the handling, treatment, and disposal of all generated waste products, including solid, liquid, and hazardous materials (chemical, radiological, and explosive).

In 1977, LANL was designated as a National Environmental Research Park for use by the national scientific community as an outdoor laboratory to study the impacts of human activities on pinyon-juniper woodland ecosystems. In 1999, the 1,000-acre (405-hectare) White Rock Canyon Reserve, located on the southeast perimeter of LANL, was dedicated to preserve its significant ecological and cultural resources. In 2000, land on and to the north and west of the site was affected by the Cerro Grande Fire. The fire burned a total of 43,150 acres (17,462 hectares), of which 7,684 acres (3,110 hectares) were within the boundaries of LANL. On June 26, 2011, the Las Conchas Fire began as a result of a wind-thrown tree striking and shorting out a power line. This fire burned 156,590 acres (63,370 hectares), including 133 acres (53.8 hectares) of LANL and DOE/NNSA property. Approximately 131 acres (53 hectares) were intentionally back-burned to help limit the spread of the wildfire, and only 1 acre (0.40 hectare) of land burned as a result of the wildfire (LANL 2012c:Appendix II, page 5). There are no agricultural activities on the LANL site, nor are there any prime or unique farmlands, as defined in the Farmland Protection Policy Act of 1981, located within the Incorporated County of Los Alamos (DOE 2011g:3-4).

As a result of the passage of Public Law 105-119, Section 632, 10 tracts on LANL were designated for possible conveyance from DOE to the Incorporated County of Los Alamos or to the Department of the Interior by 2007 to be held in trust for the Pueblo de San Ildefonso. This program was analyzed in the *Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at the Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico* (DOE 1999c). Due to changes in the program, the total acreage designated for conveyance or transfer is now estimated to be 4,309 acres (1,744 hectares) and the completion date is 2022. By mid-2011, 2,441 acres (988 hectares) had been conveyed or transferred (DOE 2011g:3-5).

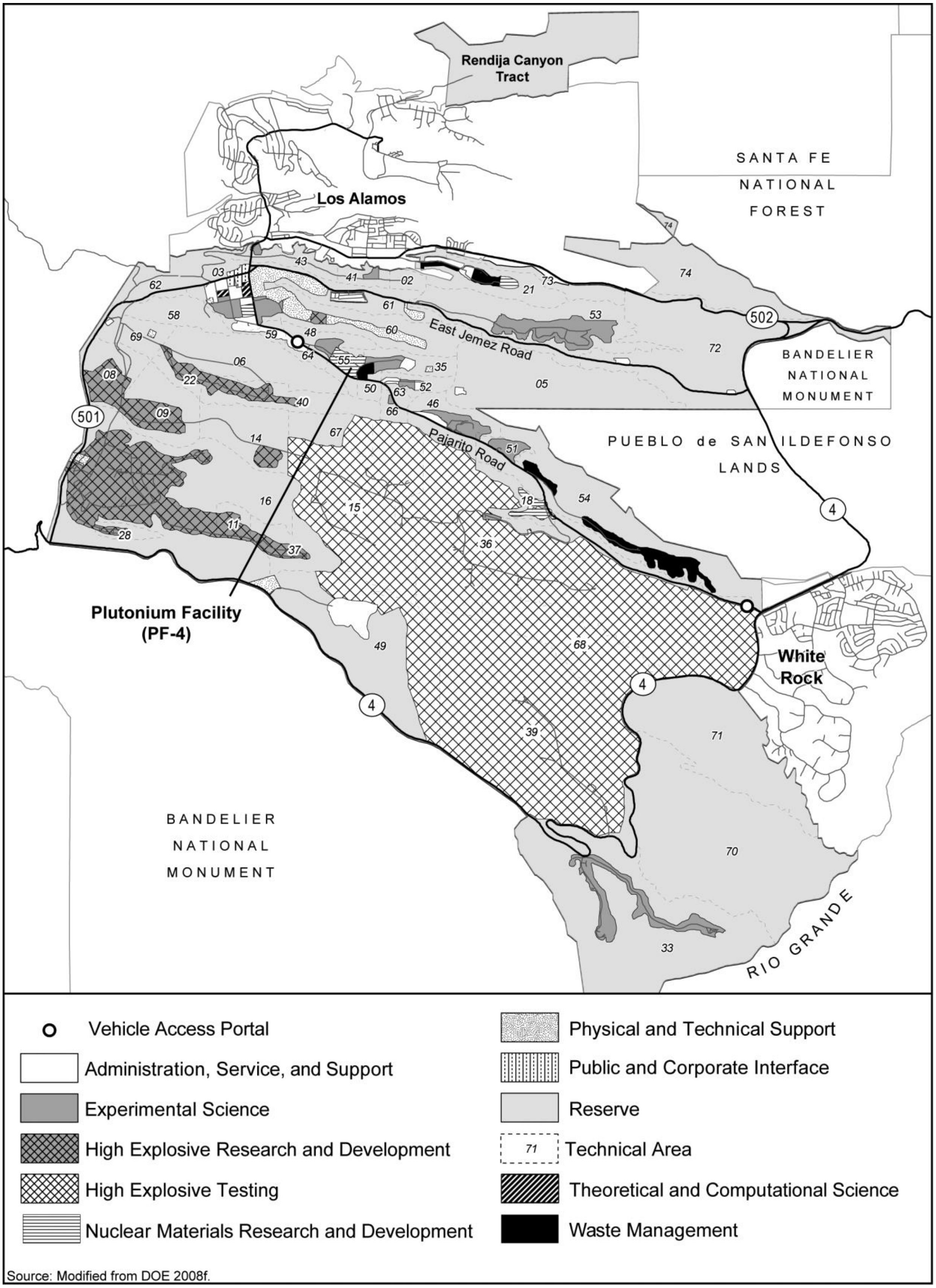


Figure 3–10 Los Alamos National Laboratory Sitewide Land Use

Proposed Facility Location

Land use within TA-55 is designated Nuclear Materials Research and Development, and Reserve. TA-55, which is 40 acres (16 hectares) in size, is largely developed, with only the south wall of an extension of Mortandad Canyon having significant vegetative cover. This area is designated Reserve while the rest of the technical area is designated Nuclear Materials Research and Development. Facilities within TA-55, including the Plutonium Facility (PF-4), support research of, and applications for, the chemical and metallurgical processes of recovering, purifying, and converting plutonium and other actinides into many compounds and forms, as well as research into material properties and fabrication of parts for research and stockpile applications (DOE 2011g:3-5).

3.2.1.2 Visual Resources

The topography of northern New Mexico is rugged, especially in the vicinity of LANL. Mesa tops are cut by deep canyons, creating sharp angles in the landform. Often, little vegetation grows on these steep slopes, exposing the geology, with contrasting horizontal planes varying from fairly bright reddish orange to almost white in color. A variety of vegetation occurs in the region, the density and height of which may change over time and can affect the visibility of an area within the LANL viewshed. Views of the site have changed over the last decade as a result of wildfires and thinning operations that were undertaken to remove wildfire fuels. While in the past motorists may have viewed more-mature woodlands, views are currently more open (DOE 2011g:3-5). Undeveloped lands within LANL have BLM Visual Resource Contrast ratings of Class II or III. Management activities within these classes may be seen, but should not dominate the view. The contrast rating system was developed by BLM as a guide for evaluating the visual impacts of a project (BLM 1986).

For security reasons, much of the development within LANL, which is generally austere and utilitarian, has occurred out of the view of the public. Passing motorists or nearby residents can see only a small portion of what is actually on the site. The most visible developments at LANL are a limited number of very tall structures; facilities at relatively high, exposed locations; or those beside well-traveled, publicly accessible roads. For example, the National Security Sciences Building in TA-3 is eight stories high and is visible from most locations throughout the Los Alamos townsite. At night, the lights of LANL, the Los Alamos townsite, and the community of White Rock are directly visible from various locations across the viewshed and as far away as the towns of Española and Santa Fe (DOE 2011g:3-7). Developed areas within LANL are consistent with a BLM Class IV Visual Resource Contrast rating, in which management activities dominate the view and are the focus of viewer attention (BLM 1986:6, 7).

Proposed Facility Location

As previously noted, most of TA-55 is developed, with only the south wall of an extension of Mortandad Canyon having significant vegetative cover. PF-4, a two story building, is the largest facility in TA-55. The newest building within TA-55 is the three-story Radiological Laboratory/Utility/Office Building (RLUOB). RLUOB is visible from a number of locations throughout LANL and is the key visible structure along Pajarito Road. However, views from Pajarito Road are limited to LANL workers, as the road is closed to the public (DOE 2011g:3-7). The visual resources along the road generally are consistent with BLM Visual Contrast Ratings of Class III and IV. Under a Class III rating, development may attract attention, but the natural landscape dominates; however, under a Class IV rating, development dominates the view and is the major focus of the landscape (BLM 1986:6, 7). When seen from higher elevations to the west, development within TA-55 blends with that within TA-35, -48, -50, and -63.

3.2.2 Geology and Soils

The majority of the information in this section was adapted from the *Final Supplemental Environmental Impact Statement for the Nuclear Facility Portion of the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico (CMRR-NF SEIS)* (DOE 2011g). A detailed description of the geology at LANL is included in the *Geology and Structure of the Chemistry and Metallurgy Research Facility Replacement Site, Los Alamos National Laboratory, New Mexico* (Gardner et al. 2008). A detailed description of soils at LANL is included in the *Soil Survey of Sandoval County Area, New Mexico, Parts of Los Alamos, Sandoval, and Rio Arriba Counties* (NRCS 2008).

3.2.2.1 Geology

General Site Description

LANL is located on the Pajarito Plateau, within the Southern Rocky Mountains Physiographic Province. The Pajarito Plateau lies between the Sierra de los Valles, located in the Jemez Mountains, to the west, and the Rio Grande River to the east. The gently sloping surface of the Pajarito Plateau is divided into multiple narrow east-southeast-trending mesas, dissected by deep parallel canyons (DOE 2003c:3-20). Rocks in the LANL region are volcanic and sedimentary (Reneau et al. 1996:8). Bedrock outcrops occur on more than 50 percent of the surface at LANL (DOE 2003c:3-21). In the LANL area, the youngest surficial geologic units consist of sediment deposited by flowing water (alluvium) and rock debris accumulated at the bases of slopes along stream channels and in canyons (colluvium). Artificial fill is also present as a result of development (DOE 2003c:3-20).

Volcanic activity began forming the Jemez Mountains approximately 16.5 million years ago (DOE 2003c:3-20) and has continued sporadically to the most recent eruptions that produced the El Cajete pumice fall, about 50,000 to 60,000 years ago (Reneau et al. 1996:20, 40). Two main types of Quaternary volcanic activity have occurred close to LANL, including explosive and effusive rhyolitic (i.e., silicic) eruptions in the Valles caldera, located approximately 6 miles (10 kilometers) west of LANL, and explosive and effusive basalt (mafic) eruptions in the Cerros del Rio volcanic field, located in the nearby Rio Grande valley (to the east) and partially underlying the eastern portions of LANL (DOE 2011g:3-29).

The Sierra de los Valles form the eastern rim of the Valles caldera, which is a cauldron-like volcanic feature, formed by the collapse of land following a volcanic eruption. The first of two major caldera-forming eruptions occurred 1.61 million years ago, forming the Toledo caldera and producing the lower, or Otowi Member, of the Bandelier Tuff (Spell et al. 1996:263). The second major caldera-forming eruption occurred 1.256 million years ago (DOE 2011g:3-19), forming the Valles caldera and depositing the upper, or Tshirege Member, of the Bandelier Tuff (Spell et al. 1996:263).

The 1.2- to 1.6-million-year-old Bandelier Tuff is a variably consolidated ash-flow unit and forms the bedrock on which nearly all LANL facilities are constructed. These rock layers dip gently southeastward and thin away from the volcanic source to the west (DOE 2003c:3-21, 2008f:4-20). As previously described, the Bandelier Tuff was formed in two eruptive pulses from the nearby Valles caldera, located approximately 10 miles (16 kilometers) west of LANL. The younger member, or Tshirege Member, of the Bandelier Tuff is widely exposed as the mesa-forming unit around LANL (DOE 2011g:3-21).

Beneath the Bandelier Tuff is approximately 18 feet (5.5 meters) of fine sand and silt, which may be a fine-grained interval of the older alluvial Puye Formation. Underlying the Puye Formation is several hundred feet of the Cerro del Rio basalt and Tschicoma Formation dacitic lava (Kleinfelder 2007:39). The complex interfingering and interlaying of strata beneath LANL results in variable properties that affect canyon wall formation, slope stability, subsurface flows, seismic stability, and the engineering properties of the rock (DOE 2003c:3-12, 2008f:4-17–20).

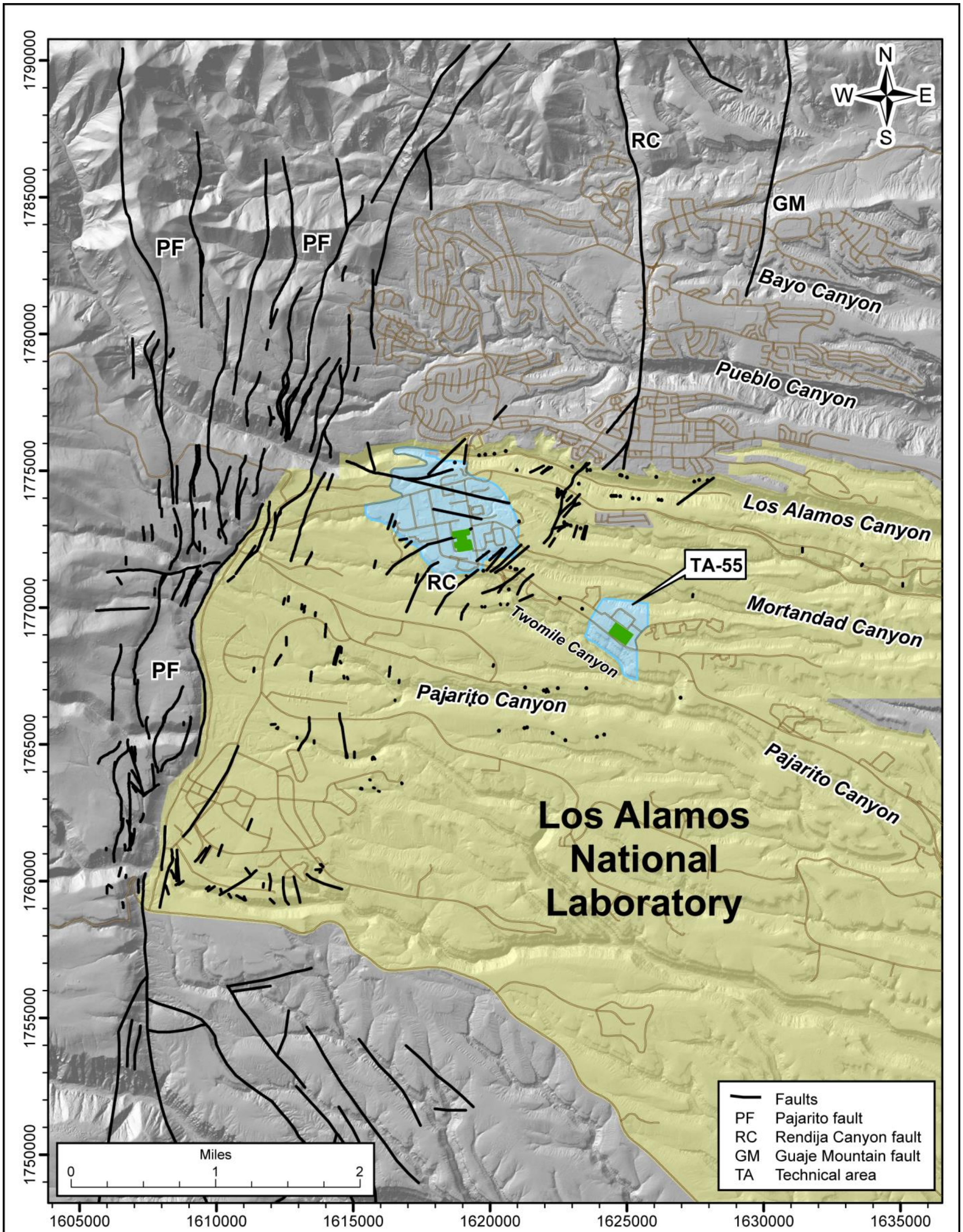
The major tectonic feature in the region is the Rio Grande rift, which begins in central Colorado, trends southward through central New Mexico, and extends into northern Mexico. This rift comprises a complex system of north-trending basins, formed from down-faulted blocks of the Earth's crust. The Jemez Mountains and associated Pajarito fault system form the western margin of the rift. In the LANL area, the rift is approximately 35 miles (56 kilometers) wide and contains the Española Basin; the Sangre de Cristo Mountains border the rift on the east (DOE 2003c:3-20).

The Pajarito fault system is a complex zone of deformation, consisting of many laterally discontinuous faults and associated folds and fractures. The Pajarito fault system extends for about 31 miles (50 kilometers) along the western margin of LANL and consists of the Pajarito, Santa Clara, Rendija Canyon, Guaje Mountain, and Sawyer Canyon faults. As shown in **Figure 3–11**, these are all roughly north–south striking, nearly parallel, and interconnected normal slip faults that were produced by extension in the Earth's crust (DOE 2011g:3-23).

The Pajarito, Santa Clara, and Sawyer Canyon are east-dipping faults, whereas the Rendija Canyon and Guaje Mountain are west-dipping faults. Of these faults, the Pajarito is the longest, has the largest Quaternary displacement (during the past 1.8 million years), and together with the Santa Clara, delineates the boundary between the Pajarito Plateau and Jemez Mountains. The Rendija Canyon, Guaje Mountain, and Sawyer Canyon faults constitute a broad zone of smaller faults within the downthrown block of the main Pajarito and Santa Clara faults (DOE 2011g:3-23). The main trace of the Rendija Canyon fault dies out near the latitude of Los Alamos Canyon, although a complex distribution of associated, smaller, discontinuous faults continue approximately 2 miles (3 kilometers) southward, curving southwest toward the Pajarito fault (DOE 2011g:3-23) (Figure 3–11).

Although large historical earthquakes have not occurred on the Pajarito fault system, geologic evidence indicates that it is seismically active and capable of producing large surface-faulting earthquakes of 6.5 to 7.3 moment magnitude (M) (LANL 2007a:ES-2; 3-9). Early Quaternary deposits have been displaced down to the east by as much as 650 feet (200 meters) along this fault zone, which also shows compelling evidence for repeated, late Quaternary faulting (LANL 2007a:5-7–8; Lewis et al. 2009:252, 254). Numerous paleoseismic trench studies (Gardner et al. 1990; Olig et al. 1996; Kelson et al. 1996; Reneau et al. 2002; Gardner et al. 2003; McCalpin 2005) have been conducted on several different traces of the fault system, revealing evidence of at least two, possibly three, large surface-faulting earthquakes that occurred during the last 11,000 years and as many as nine large earthquakes that occurred during the last 110,000 years (LANL 2007a:5-14–15, 5-38; Lewis et al. 2009:252, 268).

Previous geologic studies postulated that the southern ends of the Rendija Canyon and Guaje Mountain faults may continue as surface faults south of the Los Alamos townsite and trend through sensitive LANL sites (Dransfield and Gardner 1985; Vaniman and Wohletz 1990; Wohletz 1995, 2004). Ensuing studies used geologic field investigative techniques to recognize and map small fault displacements (Reneau et al. 1995; Gardner et al. 1998, 1999, 2008; Lavine et al. 2005). This procedure allowed the identification of fault locations in real time, with data precision better than 0.05 feet (0.02 meters) in the horizontal directions and better than 0.02 feet (0.01 meters) in the vertical direction, relative to the position of known and established benchmarks.



Source: Modified from Gardner et al. 2008.

Figure 3–11 Mapped Faults in the Los Alamos National Laboratory Area

A comprehensive update to the LANL seismic hazard analysis was completed in June 2007 (LANL 2007a). The updated study used more-recent field data, most notably from the Chemistry and Metallurgy Research Replacement (CMRR) Project site, and the application of the most current analysis methods, in order to update the seismic source model, ground motion attenuation relationships, dynamic properties of the subsurface (primarily the Bandelier Tuff) beneath LANL, as well as the probabilistic seismic hazard and design/evaluation-basis earthquake ground motions for LANL. The approach used in the 2007 analysis follows the Senior Seismic Hazard Analysis Committee's guidelines for a Level 2 analysis, as described in NRC's *Recommendations for Probabilistic Seismic Hazard Analysis – Guidance on Uncertainty and Use of Experts* (NRC 1997). Based on this analysis, the dominant contributor to seismic hazard at LANL is the Pajarito fault system, due to its proximity and rate of activity (LANL 2007a:ES-1).

In 2009, the probabilistic seismic hazard analysis was updated again to incorporate a new set of ground motion attenuation relationships and to examine potential conservatisms in the 2007 study (LANL 2009c). The results of the 2009 updated analysis were reviewed and accepted by an external review panel, DOE, and the Defense Nuclear Facilities Safety Board (DNFSB). These ground accelerations were based on the latest geologic data, including that published in Lewis et al. (2009). Expected maximum magnitudes for the various rupture scenarios of the Pajarito fault system range from M 6.5 to 7.3. The 2009 updated study refined the estimate for the dominant earthquake, determining that a range in magnitude of M 6.0 to M 7.0 was appropriate at close distances (LANL 2009c:3-8).

During earthquakes, facilities near a cliff edge or in a canyon bottom are potentially susceptible to slope instability, rock falls, and landslides. Slope stability studies have been performed at LANL facilities where a hazard has been identified. The potential for seismically induced land subsidence at LANL is considered low and, for soil liquefaction, negligible (DOE 2003c:3-25).

The unusually low amount of seismic activity in the Jemez Mountains has been interpreted to indicate that seismic signals are partially absorbed deep in the subsurface, due to elevated temperatures and high heat flow (LANL 2004:4-27). The significance of this to LANL is that it indicates that the Jemez Mountains continue to be a zone of potential volcanic activity. The U.S. Geological Survey recently rated the Valles caldera a "moderate threat" and recommended enhanced monitoring of the Jemez Mountains Volcanic Field (DOE 2011g:3-29).

Potential future silicic volcanic eruptions within the Jemez Mountains Volcanic Field would likely be similar to the most recent, 35,000-to 60,000-year-old rhyolitic eruptive cycle, which consisted of relatively small rhyolite domes and flow eruptions. Potential future silicic eruptions could consist of explosive eruptions that produce proximal and downwind tephra fallout and pyroclastic flows in topographic lows. In addition, rhyolite lava flows and domes could fill topographic low areas near the vent, up to a distance of several kilometers. Eruptive activity may continue for days to months for explosive eruptions and several years to tens of years for a single eruption cycle. The total period for a phase of eruption could last thousands of years (DOE 2011g:3-29; LANL 2010b:19).

If silicic volcanism occurred within the Valles caldera topographic rim, the Pajarito Plateau would likely be impacted by centimeter-to-meter thicknesses of tephra fallout. Tephra deposits on the slopes of the Sierra de los Valles, west of LANL, could result in the production of volcanic mudflows in the canyons as rainfall and snowmelt mobilized the loose tephra. Tephra fallout may deposit greater than 4 inches (10 centimeters) of ash within about 12 to 25 miles (20 to 40 kilometers) downwind, which would encompass LANL technical areas. Volcanic blast effects, pyroclastic flows, and lava flows would be unlikely to directly affect LANL due to distance and topographic barriers (LANL 2010b:19, 20).

In addition to silicic volcanism, basaltic (mafic) volcanism has occurred over the past 30 million years. Evidence of basaltic volcanism includes the approximately 1-million-year-old Cerros del Rio volcanic field beneath LANL and stretches tens of kilometers to the east and south. While the main activity in the Cerros del Rio volcanic field occurred more than 1 million years ago, magmatic activity has more recently occurred in the Rio Grande rift and along the Jemez Lineament, including eruptions near Carrizozo and Grants, New Mexico, located approximately 200 miles (320 kilometers) and 175 miles (280 kilometers), respectively, from LANL. These eruptions occurred 1,100 to 5,200 years ago, albeit farther from LANL than the most recent eruptions within the Jemez Mountains Volcanic Field. Therefore, the potential for new basaltic volcanism in the Española Basin cannot be ruled out (DOE 2011g:3-30, LANL 2010b:21-22).

Based on observed deposits of past eruptions, two main types of future basaltic eruption are possible, including a Strombolian eruption, which may produce a cinder cone, tephra fallout, and lava flows via fountaining and low ash column, and hydro-magmatic eruption, in which rising magma and surface water combine explosively to form maar craters, surges, ash flows, and tephra fallout. New basaltic activity is most likely within the area of existing Cerros de Rio basalts. Such explosions, surges, and magma effusion may affect areas within several hundred meters of the vent. Lava flows may affect areas within several kilometers of the vent. As described for silicic fallout hazards, tephra fall may produce significant impacts on buildings, roads, and utility infrastructure. A recurrence of volcanic activity could impact the area near the eruption for an extended period of time (months to years), until volcanic activity stopped (DOE 2011g:3-30, LANL 2010b:21-22).

Volcanism in the vicinity of LANL is very unlikely over the next 50 to 100 years, but cannot be completely ruled out. Based on consideration of available information on the volcanic history of the region surrounding LANL, the preliminary calculation of the recurrence rate for silicic eruptions is about 1×10^{-5} per year in the Valles caldera study region. Although the eruption record shows significant clustering of events, this simple calculation assumes a homogenous (Poisson) distribution of events. Similarly, the preliminary calculation of the recurrence rate for basaltic eruptions along the Rio Grande rift floor is 2×10^{-5} per year. The recurrence rate for an eruption that could produce major impacts at LANL would be less than the rates listed above for the expected recurrence of volcanic activity across the entire study area. In any event, the recurrence rate for a volcanic eruption occurring somewhere in the study region is an order of magnitude less than the performance goal of 1×10^{-4} per year (DOE-STD-1023-95) for facilities such as PF-4 at LANL (DOE 2011g:3-30, LANL 2010b:vii, 21).

Potential mineral resources at LANL consist of rock and soil for use as backfill or borrow material, or for construction of waste unit covers. Rock and mineral resources, including sand, gravel, and volcanic pumice, are mined throughout the surrounding counties. Sand and gravel are primarily used at LANL for road building; pumice for landscaping. The welded (a term that refers to depositional heat consolidation and compaction) and harder units of the Bandelier Tuff are suitable as foundation aggregate, structural and ornamental stone, and insulating material. Volcanic tuff has also been used successfully as aggregate in soil-cement sub-base for roads (DOE 2003c:3-25, 2008f:4-33).

The only borrow pit currently in use at LANL is the East Jemez Road Borrow Pit in TA-61, which is used for soil and rubble storage and retrieval. This borrow pit is cut into the upper Bandelier Tuff. There are numerous commercial offsite borrow pits and quarries in the vicinity of LANL, which primarily produce sand and gravel. Eleven pits or quarries are located within 30 miles (48 kilometers) of LANL, which is the distance considered the upper economically viable limit for hauling borrow material to LANL (DOE 2008f:4-33).

Facility Location

The Valles caldera, the source of volcanic eruptions that produced the Bandelier Tuff, is located approximately 10 miles (16 kilometers) west of TA-55. Tshirege Member bedrock subunits of the Bandelier Tuff exposed at TA-55 include Unit 2 (Qbt2), Unit 3 (Qbt3), and Unit 4 (Qbt4) (limited exposure) (Lewis et al. 2009:254). Seismic ground response, as determined by seismic characterization borings, is affected by the relatively high seismic wave velocity of the denser basement rocks, consisting of the Cerros del Rio basalt and Tschicoma Formation dacite, and the much lower seismic wave velocities of the overlying, softer Bandelier Tuff (Kleinfelder 2007:38).

Geotechnical borings were drilled at TA-55 to characterize the complete geologic column down to the basement bedrock level. Borehole DSC-1B was drilled to a depth of 741 feet (226 meters) below ground surface penetrating the Tschicoma Formation dacite, while borehole DSC-2A reached a total depth of 550 feet (168 meters) below ground surface (Kleinfelder 2007:29, 39). Based on these borings, approximately 700 feet (213 meters) of Bandelier Tuff is present beneath TA-55. The upper portion of this geologic unit comprises Units 3 (Qbt3) and 4 (Qbt4) of the Tshirege Member. The upper unit, Qbt4, is composed of soft volcanic tuff, with slight to moderate welding and substantial random fracturing. Some fractures are deeply weathered and clay-filled. The upper part of underlying Unit 3 ($Qbt3_U$) is similar to Qbt4, but less fractured and weathered (Kleinfelder 2007:38-41, 50, 51; 2010:1, 2).

The lower part of Unit 3 ($Qbt3_L$) is nonwelded to slightly welded, is weak and friable, does not sustain fractures, and exhibits more soil-like properties. This unit is, on average, approximately 56 feet (17 meters) thick across LANL, from a depth of approximately 75 feet (23 meters) to approximately 125 to 131 feet (38 to 40 meters) below ground surface, with upper and lower transition zones composed of slightly stiffer and slightly more dense material. Compared to the units above and below it, $Qbt3_L$ has lower bearing capacity, higher porosity, and less cohesion, and is more compressible. This unit also has a slight to moderate potential for hydro-collapse, due to wetting. $Qbt3_L$ displays properties more typical of slightly cemented, nonplastic, medium to dense silty sand. The apparent cementation is actually weak welding caused by vapor-phase minerals that form fragile connections between the volcanic ash particles that constitute the matrix of this unit. This weak welding is easily broken by even slight disturbance. The properties of $Qbt3_L$ that are most problematic to nuclear facility construction are those that affect the seismic response of the unit, specifically, the estimated seismic wave velocities (the speed at which seismic waves travel) associated with this rock type (DOE 2011g:3-21).

At TA-67 (south of TA-55, see Chapter 1, Figure 1–3), investigations found small, complex faults with activity older than 50,000 to 60,000 years (the age of the El Cajete pumice), but no correlation between increased fracture density and surficial faulting (DOE 2011g:3-27). At TA-3, a fault with approximately 8 feet (2.4 meters) of displacement was identified (LANL 1998:30). In contrast, around TA-55 no evidence was found for laterally continuous surface-rupturing faults (Gardner et al. 2008:1, 2).

There appear to be no active surface displacing faults at TA-55; the closest mapped surface trace of faults associated with the Pajarito fault system lies about 3,300 feet (1,000 meters) to the east (Figure 3–11). Investigations at and near TA-55 used intensive geologic field techniques to recognize and map vertical fault displacements, which may have been unmapped using standard geologic mapping techniques (Reneau et al. 1995; Gardner et al. 1998, 1999, 2008; Lavine et al. 2005). Near TA-55 the stratigraphic markers in the Bandelier Tuff are continuous and show no evidence for laterally continuous surface-rupturing faults. This is consistent with findings of subsurface excavation at the CMRR Project site in TA-55 that also used high-precision mapping techniques (Gardner et al. 2008). Although Gardner et al. (2008:1, 23) did observe some fractures and small faults confined within units of the tuff, they concluded that the exposed fractures and faults formed very shortly after emplacement of the tuff at 1.256 million years, as a result of cooling and compaction, and the identified geologic structures pose no surface rupture hazard.

Based on the 2009 study (LANL 2009c), the TA-55 horizontal and vertical peak ground acceleration values for a 2,500-year return period are 0.47 *g* and 0.51 *g*, respectively.

3.2.2.2 Soils

General Site Description

Soils in Los Alamos County have developed from decomposition of volcanic and sedimentary rocks within a semiarid climate and range in texture from clay and clay loam to gravel. Soils that formed on mesa tops of the Pajarito Plateau include the Carjo, Frijoles, Hackroy, Nyjack, Pogna, Prieta, Seaby, and Tocal soils series. All of these soils are well-drained and range from very shallow (0 to 10 inches [0 to 25 centimeters]) to moderately deep (20 to 40 inches [51 to 102 centimeters]), with the greatest depth to the underlying Bandelier Tuff being 40 inches (102 centimeters) (DOE 1999a:4-34).

Soils that develop in canyon settings can be locally much thicker. Soil erosion rates vary considerably at LANL, due to the mesa and canyon topography. The highest erosion rates occur in drainage channels and on steep slopes. Roads, structures, and paved parking lots concentrate runoff. High erosion rates are also caused by past area logging practices, livestock grazing, and loss of vegetative cover. The lowest erosion rates occur at the gently sloping central portions of the mesas, away from the drainage channels. Soils at LANL are acceptable for standard construction techniques (DOE 2003c:3-25–26). No prime farmland soils have been designated in Los Alamos County. The closest areas of prime farmland are located approximately 7.5 miles (12 kilometers) east and 10 miles (16 kilometers) south of LANL, adjacent to the Rio Grande (NRCS 2011).

Biological (cryptogrammic) soil crusts are surface carpets of soil bound by a mosaic of cyanobacteria, lichens, mosses, fungi, and other soil biota and their byproducts that can be up to 4 inches (10 centimeters) thick. Filaments and exudates produced by these highly specialized organisms glue loose soils together and if left undisturbed stabilize bare ground and protect soils from erosion. These communities primarily occur in semi-arid and arid regions and may constitute up to 70 percent of some plant communities (BLM 2001:1-2). In addition to protecting otherwise bare areas against erosion, soil crusts improve soil fertility by fixing atmospheric nitrogen and carbon and producing organic biomass, and influence surface runoff and water infiltration, soil moisture regimes, and soil-water-plant interactions (BLM 2001:29-40, Wilcox et al. 2003:2, 7). Crusts are adapted to severe growing conditions but are highly vulnerable to compressional disturbances. Intensive disturbances such as trampling by humans, livestock, or vehicles frequently result in the loss of living soil cover and creation of unprotected, bare soil (BLM 2001:19-22). A study by Wilcox et al. (2003:7) of hydraulic conductivity between vegetative types of Pinon-Juniper woodlands on the Mesita del Buey area of the LANL Pajarito Plateau identified areas of biological soil crusts, which were found to have limited effect on soil hydrology.

In 2000, the Cerro Grande Fire wildfire burned over 50,000 acres (20,240 hectares); approximately 7,700 acres (3,120 hectares) of LANL. The fire increased the vulnerability of the affected area to soil erosion from fire-induced habitat damage and groundcover loss. As a preventative measure to reduce on- and off-site erosion impacts, the Army Corps of Engineers installed erosion structures to control sediment generation and delivery from burned areas on LANL. In addition, soil, surface water and groundwater, and biota monitoring mitigation measures were implemented to identify any increases in area contaminant concentrations (LANL 2011d:1-5, 8-18). Also, the 2011 Las Conchas fire affected water sheds above LANL and contributed to soil erosion (LANL 2012c:36-39).

Facility Location

TA-55 is underlain by the Rock outcrop-Frijoles-Hackroy general soil map unit that includes approximately 52 percent rock outcrop, 14 percent Frijoles soils, 14 percent Hackroy soils, and 20 percent minor component soils. The bedrock outcrop component of the Rock outcrop-Hackroy Complex (60 percent rock outcrop and 25 percent Hackroy and similar soils) consists of barren to nearly barren areas on benches, ledges, and escarpment features typically located on the margins and sideslopes of mesas (NRCS 2008:27).

The Frijoles soil series consists of very fine sandy loam that occurs on 1 to 8 percent sideslope summits of narrow mesas that developed from pumice derived eolian deposits over alluvium materials. The depth to pumice generally ranges from 15 to 30 inches (38 to 76 centimeters). These soils generally are deep, well drained, and are characterized by moderately slow permeability, very low available water capacity, low shrink-swell potential, and medium runoff (NRCS 2008:27, 155-156).

The Hackroy soils of the Rock outcrop-Hackroy Complex consist of very shallow to shallow, sandy loam soils that developed from residuum weathered from tuff and primarily occur on 1 to 8 percent slopes of plateau nose slope summits. The depth to bedrock tuff typically ranges from 8 to 20 inches (20 to 51 centimeters). These well-drained soils are generally characterized by slow permeability, very low available water capacity, high shrink-swell potential, and very high runoff (NRCS 2008:27, 56-57).

3.2.3 Water Resources

Water resources encompass the surface and groundwater sources of water suitable for Native American traditional and ceremonial purposes, plants and wildlife propagation, and human endeavors and enterprise. The ROI includes on- and offsite water resource systems that could be affected by effluent discharges and releases or stormwater runoff associated with the proposed alternatives. Changes in the environment can potentially affect hydrologic equilibrium, water quality, and the availability of usable water.

3.2.3.1 Surface Water

General Site Description

LANL is located on the New Mexico Pajarito Plateau, which is bounded by the Jemez Mountains on the west and the Rio Grande on the east. The plateau consists of narrow mesas separated by deep east-west canyons (LANL 2006b:3). The LANL Pajarito Plateau drainage system is grouped into seven watersheds that primarily consist of one or more mesa drainage areas and deep, narrow canyons that collect, convey, and discharge surface runoff and groundwater seepage. The watershed drainage systems are categorized by a primary canyon (main drainage stem) and two or more mesa aggregate (tributary drainage reaches) canyons. The watersheds that encompass LANL include the Los Alamos/Pueblo, Sandia, Mortandad, Pajarito, Water Canyon/Cañon de Valle, Ancho, and Chaquehui Watersheds (LANL 2006b:13) (**Figure 3–12**). The only primary canyon wholly within LANL is the Ancho Canyon of the Ancho Watershed (DOE 2011g:3-31). LANL surface drainage and groundwater discharges flow into the Rio Grande, the largest river in New Mexico (LANL 2006b:3). The New Mexico Water Quality Control Commission (NMWQCC) has designated most surface water on the Pajarito Plateau for livestock watering, wildlife habitat, and secondary contact[10] (DOE 2011g:3-32).

Streams within LANL are generally classified as alluvial streams, which are waterways composed of sandy clays and clayey-silty sands that originate in upland areas. Primary sources of stream flow include base flow,[11] snowmelt runoff, and stormwater runoff, and permitted anthropogenic discharges. Snowmelt during the spring can last from days to weeks and produces low discharge rates and sediment loads. In contrast, periodic runoff from thunderstorms occurs over hours and produces high discharge rates and sediment loads. LANL stream flow regimes are generally classified as perennial, intermittent, and ephemeral (DOE 2011g:3-31).

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[10] *Secondary contact means any recreational or other water use in which human contact with the water may occur and in which the probability of ingesting appreciable quantities of water is minimal, such as fishing, wading, commercial and recreational boating, and any limited seasonal contact (NMWQCC 2005:4).*

[11] *Base flow is persistent but not necessarily perennial stream flow that originates from springs, effluent discharge, or streambed alluvial groundwater.*

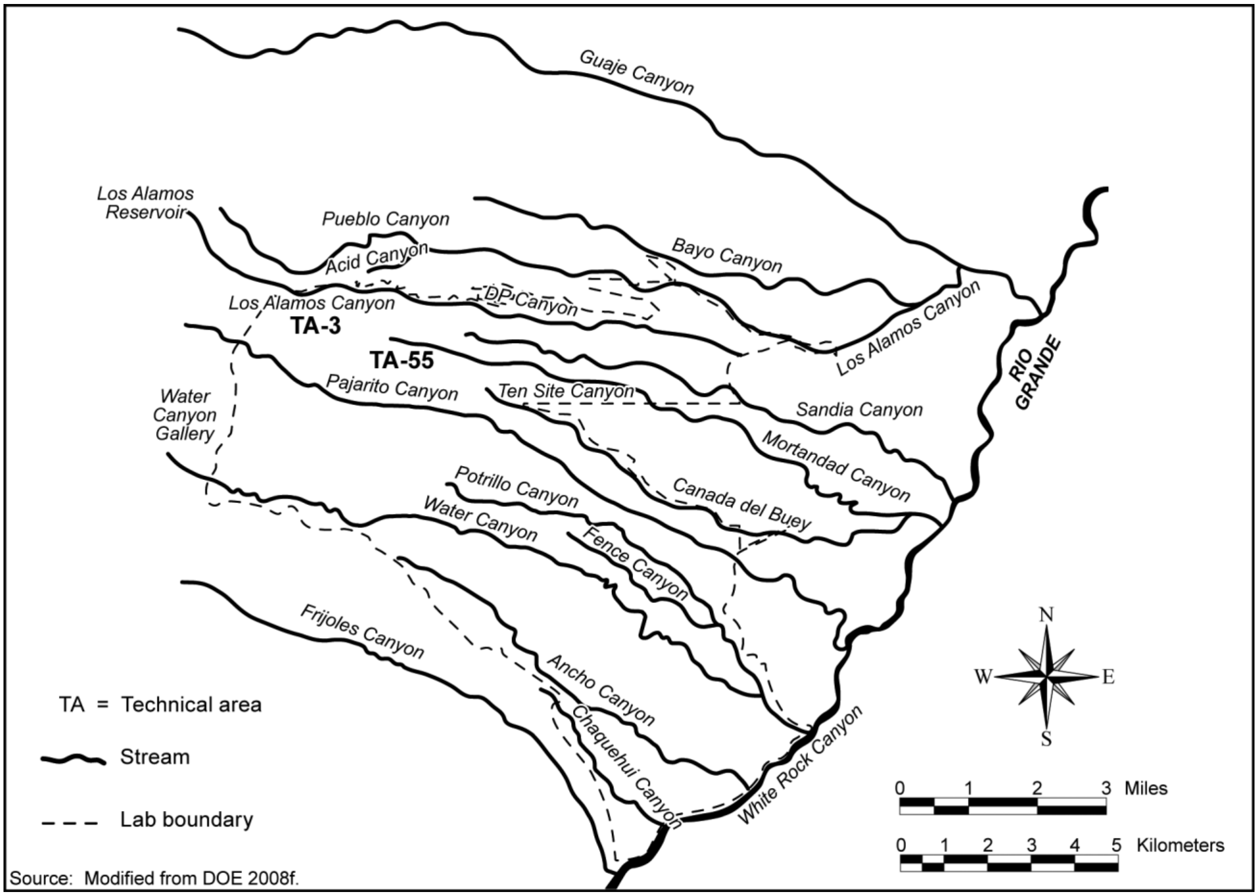


Figure 3–12 Major Watersheds in the Los Alamos National Laboratory Region

Streams in the LANL canyons are dry most of the year; perennial flows[12] do not extend the full length of any primary watershed canyon (DOE 2011g:3-31). Most canyon stream flow regimes are short-lived intermittent and/or ephemeral flows (LANL 2011d:1-2). Permitted discharges of treated LANL wastewater can be a significant source of stream flow in some canyons, such as Los Alamos Canyon. Outfall discharges can occasionally transition the naturally dry flow regimes of some small canyons to wet canyon flow regimes. Wet canyons such as Pueblo, Los Alamos, Sandia, Pajarito, Chaquehui, Cañon de Valle, Water, Mortandad, and Guaje promote conditions that result in relatively fast, unsaturated flow and transport (LANL 2005:2-77, 2-90, 4-A-3–7). In contrast, dry canyons such as Ancho, Potrillo, Canada del Buey, Fence, Rendija, Bayo, Barrancas, Twomile, and Threemile are generally characterized by smaller catchments, shallower drains, infrequent surface flows, slower infiltration, and little or no saturated alluvium in the canyon bottoms. In dry canyons, contaminants tend to remain relatively close to their original source locations (LANL 2005:2-91, 4-A-3–7).

Of the approximately 80 miles (129 kilometers) of LANL waterways, approximately 3 miles (5 kilometers) exhibit natural spring-fed perennial flow (Pajarito and Water Canyons and Cañon de Valle), 4 miles (6 kilometers) of Sandia Canyon produce perennial water flow from LANL effluent discharges from wastewater treatment plants, and the remaining 71 miles (114 kilometers) are dry most of the year, but seasonally exhibit intermittent or ephemeral flow regimes (LANL 2010a:ES-14).

[12] *Perennial flow is continuous during both wet and dry periods; baseflow is primarily generated by groundwater discharge and its upper surface is typically lower than the adjoining area water table. Intermittent flows only occur during certain times of the year resulting from springs, melting snow, or localized precipitation inputs; seasonal flows typically last longer than 30 days per year. Ephemeral flows only occur during or immediately after periods of precipitation or snowmelt; the streambed is above the adjoining area water table (NMED 2010:16).*

None of the streams within the LANL boundary average over 1 cubic foot (0.03 cubic meters) per second of flow annually and combined mean daily flow is normally less than 10 cubic feet per second (0.28 cubic meters per second) (LANL 2011d:6-4). For 2010, the largest flow of 25 cubic feet (0.7 cubic meters) per second was recorded for Los Alamos Canyon at its discharge into the Rio Grande. The average daily flow in the Rio Grande at Otowi Bridge during 2010 ranged from 407 to 4,580 cubic feet (11.5 to 129 cubic meters) per second (LANL 2011d:6-46). The flux of LANL-contaminated sediments in the Rio Grande is small (LANL 2011d:ES-16).

No federally designated Wild and Scenic Rivers occur within, are in the vicinity of, or are in the drainage region of influence of LANL. New Mexico-designated river segments in the region include the Jemez, Rio Chama, Rio Grande (segment at the New Mexico and Colorado border), and Pecos Rivers (Wild and Scenic Rivers 2009).

Canyon flash flooding during summer thunderstorms can extend beyond the LANL boundary. In particular, Pueblo Canyon storm flows occasionally flood Pueblo de San Ildefonso lands, potentially exposing area water resources to treated sanitary effluent discharged from the Los Alamos County Wastewater Treatment Plant (DOE 2011g:3-32–33). The largest recorded flood in 2009 occurred in Ancho Canyon and had an estimated peak discharge of 414 cubic feet (11.7 cubic meters) per second. No significant new sediment deposits resulted from the flood (LANL 2010a:15).

No lakes or reservoirs have been identified within the LANL boundary. The Cochiti Reservoir, approximately 10 miles (16 kilometers) south of LANL, is a Rio Grande impoundment that traps sediments, some of which are contaminated by discharges from upstream municipal centers and LANL (LANL 2006b:3). Other regional reservoirs include Los Alamos, Abiquiu, and Guaje Reservoirs (LANL 2002:2-3).

Monitoring of the Rio Grande at Otowi Bridge in 2010 showed no measurable evidence of LANL contributions to PCBs (LANL 2011d:ES-16). Nine radionuclides and gross alpha and beta alpha radiation were detected in water samples; no screening levels were exceeded. Two results were slightly above screening levels for ammonia and copper; however, average values were below chronic standards. Overall, the data indicated good river water quality (LANL 2011d:6-46).

The Clean Water Act (33 *United States Code* [U.S.C.] 1251 et seq.) was enacted to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The Clean Water Act established the NPDES permit requirements for point-source effluent discharges into the nation's waters. NPDES permits specify the chemical, physical, and biological criteria for LANL effluent discharges through permitted outfalls (LANL 2010a:62).

Within the New Mexico Environment Department (NMED), NMWQCC is the state agency that regulates surface and subsurface liquid discharges to protect all New Mexico surface-water and groundwater resources. As required, a facility must submit a discharge plan and obtain a permit from NMED (or approval from the New Mexico Oil Conservation Division for energy/mineral-extraction activities). In 2010, LANL had one discharge permit and two discharge plans pending NMED approval (LANL 2011d:ES-11).

The NPDES Industrial Stormwater Permit Program at LANL, covered under the EPA 2008 NPDES Stormwater Multi-Sector General Permit for Industrial Activities (MSGP-2008), regulates stormwater discharges from regulated industrial activities and their associated facilities (such as metal fabrication; hazardous waste treatment, storage, and disposal; landfill operations; vehicle and equipment maintenance; recycling activities; electricity generation; warehousing activities; and asphalt manufacturing). MSGP-2008 requires the development and implementation of site-specific Storm Water Pollution

Prevention Plans. To achieve compliance, LANL operated 29 stormwater monitoring stations at 19 different locations (LANL 2011b:3-6).

On February 13, 2009, an NPDES Individual Permit (NM0030759) was issued by EPA, Region 6, to Los Alamos National Security, LLC, and DOE as co-permittees authorizing stormwater discharges from LANL solid waste management units and area of concern sites associated with historical LANL 1940s-era Manhattan Project operations. The permit lists 405 sites to be managed to prevent stormwater runoff-induced offsite transport of contaminants and contaminated sediments, and requires monitoring at 250 Site Management Areas. Potential contaminants include metals, organics, high explosives, and radionuclides that have been identified as occurring in near-surface soils susceptible to erosion. The permit was issued on September 30, 2010, and became effective on November 1, 2010 (LANL 2011d:2-23, LANL 2011b:3-6).

Since 2008, LANL has operated entirely under the current NPDES permit (Permit No. NM0028355, effective date August 2007) for industrial and sanitary wastewater discharges (EPA 2007a). The NPDES point source permit establishes specific chemical, physical, and biological criteria that effluent from LANL must meet before it is discharged (LANL 2010a:49). The total number of permitted outfalls was reduced from 55 identified in 1999 to 15 that were renewed in the August 2007 permit. As a consequence, there has been a significant decrease in discharge flows (LANL 2011b:4-2). In October 2011, EPA deleted 4 outfalls from the permit, resulting in a total of 11 outfalls (LANL 2012a:2-19–20). **Table 3–26** identifies the NPDES permitted outfalls for point sources at LANL. LANL continues to meet requirements under the Clean Water Act (LANL 2012a:ES-6–8, 2-20–22).

Table 3–26 Los Alamos National Laboratory National Pollutant Discharge Elimination System Permitted Outfalls for 2011

Outfall	*TA-Building*	*Description*	*Watershed Canyon Discharge*	*Discharge (gallons)*
02A129	21-357	Steam `Plant [a]	Los Alamos	0
03A048	53-963/978	LANSCE Cooling Tower		23,000,000
051	50-1	Radioactive Liquid Waste Treatment Facility	Mortandad	0
03A021	3-21	CMR Building Air Washers [a]		0
03A022	3-2238	Sigma Cooling Tower		840,000
03A160	35-124	National High Magnetic Field Laboratory Cooling Tower		260,000
03A181	55-6	Plutonium Facility Cooling Tower		1,200,000
13S	46-347	Sanitary Wastewater Treatment Plant	Sandia	110,000,000
001	3-22	Power Plant		110,000,000
03A027	3-2327	Strategic Computing Complex Cooling Tower		14,000,000
03A113	53-293/952	LANSCE Cooling Tower		760,000
03A199	3-1837	Laboratory Data Communications Center		13,000,000
03A130	11-30	TA-11 Cooling Tower [b]	Water	0
03A185	15-312	DARHT Cooling Tower [b]		0
05A055	16-1508	High Explosives Wastewater Treatment Facility		0
			Total	**164,000,000**

CMR = Chemistry and Metallurgy Research; DARHT = Dual-Axis Radiographic Hydrodynamic Test; LANSCE = Los Alamos Neutron Science Center; TA = technical area.

[a] The discharge for the power plant includes treated effluent from Outfall 135 for the Sanitary Wastewater Treatment Plant.

[b] Outfalls deleted by EPA from LANL point-source NPDES permit on October 11, 2011.

Note: Values rounded to two significant figures. Totals may not add due to rounding. To convert from gallons to liters, multiply by 3.7854.

Source: LANL 2012a:2-20.

LANL has three principal wastewater treatment facilities located in three technical areas: the TA-46 Sanitary Wastewater Systems (SWWS) Plant, the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF), and the TA-16 High Explosives Wastewater Treatment Facility. Treated effluents from the SWWS Plant have been routed to Sandia Canyon since 1992. Released treated wastewater from NPDES-permitted outfalls at LANL rarely leaves the site (LANL 2011b:3-4). Past discharges have included accidental releases from experimental reactors and laboratories at TA-46. Historically, LANL also released wastewater into Water Canyon and Cañon de Valle from several high-explosives processing sites in TA-16 and TA-9 (DOE 2011g:3-36).

In 2011, a total of approximately 164 million gallons (621 million liters) of effluent was discharged from LANL into Los Alamos, Mortandad, Sandia, and Water Canyons. The majority of discharges came from support facilities, not facilities tied directly to operations (such as research or production). Approximately 110 million gallons (416 million liters) of treated sanitary wastewater were discharged from the Sanitary Wastewater Treatment Plant into Sandia Canyon, accounting for approximately 67 percent of the total outfall discharge for that year (LANL 2012a:2-20).

During 2011, none of the 78 samples collected from the SWWS outfall exceeded Clean Water Act effluent limits. Of the 1,335 samples collected from LANL's industrial outfalls, there were 3 copper exceedances, 4 total residual chlorine exceedances, and 1 *E. coli* exceedance of effluent limits (LANL 2012a:2-20–21). LANL surface water is not a source of municipal, industrial, or irrigation water (LANL 2010a:ES-14).

The State of New Mexico's Integrated List of Category 5 waters constitute the Clean Water Act §303(d) List of Impaired Waters. The list identifies whether a particular surface water of the state is or is not meeting its designated uses as defined by the standards for the Interstate and Intrastate Surface Waters 20 *New Mexico Administrative Code* (20.6.4 NMAC) by applying the state's assessment protocols (NMED 2008:i-v). Under the Clean Water Act §303(d) list, NMWQCC lists parts of one or more canyons within or near LANL as impaired for aluminum, arsenic, cadmium, copper, gross alpha, mercury, PCB, radium-226, radium-228, selenium, vanadium, and zinc (**Table 3–27**).

Compliance activities performed through the LANL Water Stewardship Program in 2009 to manage and protect surface water resources focused on monitoring surface-water quality and stream sediment in northern New Mexico. Samples are collected at more than 290 sites when sufficient water is present during stormwater runoff events. LANL workers analyze these samples for radionuclides, high explosives, metals, a wide range of organic compounds, and general chemistry (LANL 2010a:42-43).

The overall quality of surface water in the area of LANL is good (LANL 2011d:ES-14). In more than 100 surface water and sediment samples taken in 2009, most analytes were at concentrations far below regulatory standards and risk-based advisory levels. LANL operations have affected major watersheds in the area, resulting in sediment contamination in several canyons (mainly due to past industrial effluent discharges). However, radionuclide levels are well below applicable regulatory standards and measured sediment contamination levels are well below screening levels for recreational uses (LANL 2010a:15). Detailed information on surface-water quality monitoring, including analytical results, is presented in the *Los Alamos National Laboratory Environmental Report 2010* (LANL 2011d). LANL surface-water monitoring results are summarized in **Table 3–28**.

Table 3–27 State of New Mexico Integrated Clean Water Act §303(d)/§305(b) List of Integrated Report Category 5/5C Impaired Waters Within the Region of Influence of Los Alamos National Laboratory [a]

Impaired Waterway	*HUC* [b]	*Probable Causes of Impairment*	*Designated Uses Not Supporting* [c]
Los Alamos Canyon (within LANL)	13020101	Aluminum, Gross Alpha, Mercury, PCB in water column, Selenium	Limited aquatic life, livestock watering, wildlife habitat
Pueblo Canyon (NM 502 to headwaters)		Aluminum, Gross Alpha, Mercury, PCB in water column, Radium-226 and -228, Selenium	
Mortandad Canyon (within LANL)	13020201	Aluminum, Gross Alpha, Selenium	Aquatic life, livestock watering, wildlife habitat
Pajarito Canyon (within LANL above Starmers Gulch)		Aluminum, Gross Alpha, Radium-226 and -228, Selenium	Limited aquatic life, livestock watering, wildlife habitat
Pajarito Canyon (within LANL below Arroyo de La Delfe)			
Rio Grande (Cochiti Reservoir to Pueblo de San Ildefonso boundary)		PCB in fish tissue, Turbidity	Marginal coldwater aquatic life, primary contact
Sandia Canyon (Sigma Canyon to NPDES Outfall 001)		Aluminum, Gross Alpha, Mercury, PCB in water column	Coldwater aquatic life, livestock watering, wildlife habitat
Sandia Canyon (within LANL below Sigma Canyon)		Aluminum, Gross Alpha, Selenium	Limited aquatic life, livestock watering, wildlife habitat
Water Canyon (LANL boundary to headwaters)		Aluminum	
Water Canyon (within LANL below Area-A Canyon)		Aluminum, Arsenic, Cadmium, Copper, Gross Alpha, Selenium, Vanadium, Zinc	

HUC = Hydrologic Unit Code; LANL = Los Alamos National Laboratory; NM = New Mexico; NPDES = National Pollutant Discharge Elimination System; PCB = polychlorinated biphenyl.

[a] Integrated Report Category 5/5C: Impaired for one or more designated or existing uses; additional data will be collected before a total maximum daily load is scheduled. Total maximum daily loads must be developed for all waters that do not meet their designated uses (such as drinking water, recreation, and fish harvesting) and are thus defined as impaired. Assessment units are listed in this category if there are not enough data to determine the pollutant of concern.

[b] HUC: U.S. Geological Survey Hydrologic Unit Code used to identify watersheds.

[c] Any designated uses specified in the State of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC) that apply to the given assessment unit and/or any documented existing uses that apply to the given assessment unit.

Source: NMED 2008.

Table 3–28 Summary of Los Alamos National Laboratory 2010 Surface Water Monitoring [a]

Chemical	*Onsite*	*Offsite*	*Significance*	*Trends*
Plutonium-239/240, Strontium-90, and Cesium-137 radionuclides	No	No	No LANL-derived radionuclides exceed DOE biota concentration guides or derived concentration guidelines in 2010	Steady
Gross alpha radioactivity	Pajarito, Pueblo, Los Alamos, Sandia, Mortandad, and Water Canyons	Yes, including canyons not affected by LANL	56 percent of stormwater results from 2010 were greater than NMWQCC standards. Major source is naturally occurring radioactivity in sediments, except in Mortandad, Pueblo, and Los Alamos Canyons where there are LANL contributors.	
Chromium	Mortandad Canyon	No	Single result above standard	
Copper	Mortandad and Sandia Canyons		Elevated in 2010 at a few sites that receive runoff from developed areas, including TA-3 and the Los Alamos townsite	
Mercury	Los Alamos Canyon		Two results above standard	
Zinc	Los Alamos and Sandia Canyons		Above standards at two locations with small drainage areas receiving runoff from paved roads and other developed areas	
PCBs	Los Alamos, Mortandad, and Sandia Canyons	Yes, including canyons not affected by LANL	Above standards; PCBs have been released by historical LANL discharges from runoff from developed areas, including the Los Alamos town-site. PCBs are also found in background areas of the Santa Fe National Forest, resulting from region atmospheric fallout	

LANL = Los Alamos National Laboratory; NMWQCC = New Mexico Water Quality Control Commission; PCB = polychlorinated biphenyl; TA = technical area.

[a] Impacts resulted in values near or above regulatory standards, screening levels, or risk levels

Source: LANL 2011d:ES-15.

Proposed Facility Location

The TA-55 facility is located on the narrow Mesita del Buey Mesa within the Pajarito Watershed adjacent to Twomile Canyon Aggregate. The 12.8 square mile (33 square kilometer) Pajarito Watershed originates on the eastern boundary of the Valles Caldera National Preserve, extends across the central portion of LANL to the community of White Rock, and joins the Rio Grande at an elevation of 5,422 feet (1,653 meters) above sea level. The drainage is approximately 15.4 miles (24.8 kilometers) long from the headwaters to the confluence with the Rio Grande (LANL 2006b:50). Primary historical uses of the watershed have been for the TA-18 Los Alamos Critical Experiments Facility at the canyon bottom and surface and subsurface materials disposal operations on the mesa. TA-15 and TA-36 were also used for munitions firing (LANL 2005:3-A-34). The watershed consists of three canyons: the primary Pajarito Canyon and aggregate Twomile and Threemile Canyons (LANL 2006b:52).

Pajarito Canyon is predominantly intermittent and/or ephemeral and discontinuously perennial in its upper and lower reaches (LANL 2006b:51). Short reaches of perennial flows occur downstream of springs at Starmers Gulch between Twomile and Threemile Canyons and below springs 4A and 4C in White Rock Canyon near the Rio Grande. Discharge from these springs comes from intermediate perched groundwater and the regional aquifer (LANL 2005:3-A-31). Saturated alluvium occurs in the lower portion of Pajarito Canyon. Historically, small amounts of wastewater have been released into Pajarito Canyon tributaries (LANL 2011d:5-55). During 2010, no runoff was recorded at stream gage E250 in Pajarito Canyon above NM-4 (LANL 2011d:6-42). Twomile and Threemile Canyon surface-water flows are primarily ephemeral with possible short-reach intermittent flows (LANL 2005:3-A-31).

Sampling by The RadioActivist Campaign at spring 4A in 2003 reported the detection of cesium-137 (radioactive isotope of cesium) in water and bryophytes (aquatic moss), identifying the spring as a potential source of LANL radioactivity into the Rio Grande from groundwater discharge. Sampling by NMED in 2004 of springs 4A, 4C, and Big and Hemingway Springs identified elevated levels of tritium, chloride, nitrate, and perchlorate. Uranium isotopes 234 and 238 were detected in all bryophytes and water samples. Plutonium isotopes 239 and 240 were detected in all bryophyte samples and plutonium-238 may have been detected in spring 4A water samples. Concentrations of gamma emitters in bryophytes were near detection limits. The NMED study did not confirm detections of cesium-137 in spring 4A water and bryophytes identified by The RadioActivist Campaign study (Ford-Schmid et al. 2005:10).

Drainage from TA-55 primarily occurs as sheet flow runoff from impervious surfaces within the complex (DOE 2011g:3-32). No LANL NPDES-permitted outfalls discharge into Pajarito, Twomile, or Threemile Canyons (LANL 2006b:51-52). Metal and high explosives have been detected during surface-water sampling in the upper and middle Pajarito Canyon. Non-filtered water samples for a small Twomile Canyon tributary showed elevated levels of arsenic and mercury. Cyclotrimethylenetrinitramine (Research Department Explosive [RDX]), semivolatile organic compounds, and pesticides have been detected in Threemile Canyon water samples (LANL 2005:3-A-31**).** Portions of Pajarito Canyon are listed by the NMWQCC under the Clean Water Act §303(d) list as impaired (Table 3–27).

3.2.3.2 Groundwater

General Site Description

The LANL Pajarito Plateau groundwater hydrologic system includes alluvial groundwater, perched intermediate groundwater, and the regional aquifer (LANL 2005:1-7). Groundwater recharge occurs from snowmelt, stormwater runoff, and LANL permitted outfall discharges (LANL 2005:2-78). If not impeded by less permeable layers, infiltrating surface water eventually reaches the regional aquifer (DOE 2011g:3-35).

Alluvial groundwater occurs when water infiltrates and saturates the soil and forms shallow, perched groundwater systems. These systems are confined to the canyon bottoms generally within deposits that are layered with alluvial fans, colluvium, and rock fall deposits from adjacent slopes. In parts of some canyons, streams have filled the bottoms with alluvium up to 100 feet (25 meters) thick (LANL 2011d:5-2). Dry canyons and mesas do not have alluvial groundwater (LANL 2005:1-9, 2-77). Alluvial groundwater is not a source of municipal drinking water for the Los Alamos area (LANL 2005:2-77; DOE 2011g:3-35).

Intermediate-depth perched groundwater forms within the vadose zone by recharge from overlying alluvial groundwater. The vadose zone beneath the Pajarito Plateau ranges in thickness from 600 feet (183 meters) to over 1,200 feet (366 meters) (LANL 2005:2-85). Contributing factors to perched groundwater are local high infiltration rates and low-permeability barriers to vertical flow created by subsurface stratigraphic structures. Perched water is typically discontinuous laterally, occurring as vertical, finger-like waterbodies (LANL 2005:2-97, 2-99). Perched water depth varies from approximately 120, 450, and 500 to 750 feet (37, 137, and 152 to 229 meters) for Pueblo, Sandia, and Mortandad Canyons, respectively. Some perched water discharges at mesa edges or along canyon flanks, forming perennial and intermediate springs (LANL 2011d:5-2–3). These subsurface pathways are important to the movement of contaminated fluids from the surface to the regional aquifer (LANL 2005:1-2). Perched water is not a municipal water source in the Los Alamos area (LANL 2005:2-95; DOE 2011g:3-35).

The regional aquifer (water-bearing rock capable of yielding significant quantities of water to wells and springs) is a major source of drinking water and agricultural use in northern New Mexico and extends throughout the Española Basin (approximately 2,317 square miles [6,000 square kilometers]) (LANL 2005:2-103). The area of saturation that forms the regional groundwater aquifer serves as the only regional aquifer in the area that is capable of providing the public water supply for various customers, including LANL, Los Alamos County, Bandelier National Monument, and other consumers located in portions of Santa Fe and Rio Arriba Counties (DOE 2011g:3-35).

On the Pajarito Plateau, the aquifer is separated from alluvium and intermediate perched groundwater by approximately 350 to 600 feet (107 to 183 meters) of unsaturated tuff, basalt, and sediments with an average moisture content of less than 10 percent. The aquifer water table occurs at depths of approximately 1,200 feet (370 meters) along the western edge of the Pajarito Plateau, 600 feet (180 meters) along the eastern edge of the plateau, and 1,000 feet (300 meters) in the central portion of the plateau (DOE 2011g:3-35). Along the western portion of the plateau, the aquifer exists under unconfined (not under pressure) water table conditions; along the eastern margins of the plateau and Rio Grande confined (under pressure) artesian conditions tend to exist (LANL 2005:2-72, 2011b:1-2). Water generally flows east to southeast toward the Rio Grande. The primary recharge source is infiltration of precipitation that falls on the Jemez Mountains (LANL 2011b:1-2). Throughout much of the basin the upper source of the aquifer intersects the Rio Grande (LANL 2005:2-103). The approximate 11.5-mile (19-kilometer) reach of the Rio Grande between White Canyon and the mouth of the Rito de los Frijoles receives an estimated 4,300 to 5,500 acre-feet (5.3 million to 6.8 million cubic meters) of aquifer discharge water (LANL 2011d:1-4).

The LANL potable water supply is provided by the Los Alamos Water Supply System, owned and operated by Los Alamos County. Potable water for LANL and surrounding communities is drawn from the regional aquifer by 14 deep wells located in the Guaje, Otowi, and Pajarito well fields. The county is responsible for compliance with the Safe Drinking Water Act (42 U.S.C. 300f et seq.) and the New Mexico Drinking Water Regulations (LANL 2011d:2-24–2-25). Water consumption at LANL for 2011 was approximately 426 million gallons (1,613 billion liters) (LANL 2012a:2-5). The Los Alamos County water supply infrastructure is discussed in Section 3.2.9.

With one exception, the Los Alamos County water supply system contains no detected LANL-derived contaminants (LANL 2010a:42). During 2009, perchlorate was found in Pueblo Canyon Well Otowi-1 at concentrations up to 58 percent of the 2005 Consent Order[13] screening level of 4 micrograms per liter and 16 percent of EPA's interim health advisory for perchlorate in drinking water of 15 micrograms per liter. This well is no longer used by Los Alamos County for public water supply. Radioactive analyte concentration values in water well samples did not exceed regulatory standards (DOE 2011g:3-36; LANL 2010a:14).

Groundwater monitoring beyond LANL boundaries is conducted in locations affected by LANL operations in the past, as well as in areas unaffected by LANL for the purpose of providing baseline data. For example, in January 2013 NMED announced the results of a study in which more than 200 private and public water wells in the Santa Fe-Española area were tested for uranium, this study constituted a more detailed examination than a similar study performed in 1995. The study concluded that although the radionuclide concentrations in many of the wells exceeded the drinking water standard for uranium of 30 parts-per-billion, the detected uranium was naturally occurring and did not result from LANL activities (NMED 2013).

Groundwater monitoring and characterization is performed in compliance with the requirements of Federal and State of New Mexico laws and regulations and DOE orders (LANL 2010a:42). The NMWQCC regulates liquid discharges onto or below the ground surface to protect New Mexico's groundwater resources (LANL 2010a:68). Liquid effluent discharges since the 1940s have affected the water quality of shallow alluvial groundwater, intermediate perched groundwater, and the regional aquifer. Contaminants identified are generally associated with canyon bottom alluvial groundwater or mesa-top liquid effluent discharge outfalls such as Mortandad and upper Sandia Canyons (LANL 2011d:ES-11). The limited extent of alluvium and intermediate perched groundwater and hundreds of feet of underlying dry bedrock restricts the volumetric recharge contribution to the regional aquifer. Water movement from the surface to the aquifer water table may require several decades or longer (DOE 2011g:3-35; LANL 2011d:5-4). Based on historical monitoring data, contaminants are more likely to be detected in the shallow alluvial and intermediate perched groundwater, whereas their detection in the regional aquifer system should be less common because of its depth.

In 2010, 153,000 analyses were performed for groundwater monitoring samples (LANL 2011d:ES-11). A summary of contaminants detected in the LANL groundwater system in 2010 is shown in **Table 3–29**.

Proposed Facility Location

The TA-55 facility is located in the Pajarito Watershed. For Pajarito Canyon, surface-water infiltration creates a continuous saturated zone of alluvium that extends from the Pajarito fault zone to White Rock. Alluvial groundwater occurs in the lower portion of Threemile Canyon. Pajarito Canyon groundwater sampling identified the presence of radionuclides, metals, high explosives, volatile organic compounds, and anions (LANL 2005:3-A-32). In 2009, alluvial groundwater sampling of several wells along Pajarito Road indicated high chloride and total dissolved solids concentrations. Runoff related to winter road salting (resulting in an increase in chloride, sodium, and total dissolved solids levels) is the apparent cause (DOE 2011g:3-36). On the Pajarito Canyon mesa south of Threemile Canyon, deep perched groundwater was located at a depth of 894 feet (272 meters) with a saturated thickness of 18 feet (5.5 meters). In 2005, four rounds of water sampling characterization showed no regional aquifer impacts from LANL-related operations. Tritium was detected above background during the initial round of sampling, but was at background levels during subsequent sampling (LANL 2005:3-A-34).

[13] A Consent Order was entered into by the DOE, NMED, and LANL in March 2005 to: (1) define the nature and extent of releases of contaminants at, or from, LANL; (2) identify and evaluate, where needed, alternatives for corrective measures to clean up contaminants in the environment and prevent migration of contaminants at, or from, LANL; and (3) implement such corrective measures (DOE 2011g:3-36).

Table 3–29 Summary of Los Alamos National Laboratory 2010 Groundwater Monitoring[a]

Chemical	***Onsite***	***Offsite***	***Significance***	***Trends***
Chromium	Mortandad Canyon regional aquifer and Mortandad and Sandia Canyons intermediate groundwater	No	In aquifer above groundwater standards; not affecting drinking water supplies; source eliminated in 1972	Increasing in Mortandad Canyon intermediate groundwater; fairly steady over 5 years at one location in Mortandad and Sandia Canyons' intermediate and regional groundwater
Nitrate	Pueblo and Mortandad Canyons intermediate groundwater and Sandia and Mortandad Canyon regional groundwater	Pueblo and Los Alamos Canyons	Pueblo Canyon sources include Los Alamos Canyon's Sewage Treatment Plant or past effluent discharges.	Generally variable in Pueblo Canyon, steady in Sandia Canyon, and increasing in Mortandad Canyon
Perchlorate	Mortandad Canyon alluvial, intermediate, and regional groundwater; Los Alamos Canyon intermediate groundwater; Pueblo Canyon regional aquifer	Pueblo Canyon	Source was historical outfall discharges that were terminated	Decreasing in Mortandad Canyon alluvial groundwater and increasing in a Mortandad Canyon regional aquifer location
Dioxane[1,4-]	Pajarito, Los Alamos, and Mortandad Canyons intermediate groundwater	No	Limited in extent; not used as a source of drinking water	Over 5 years, concentrations have remained steady or decreased in Los Alamos and Mortandad Canyons; varied seasonally in Pajarito Canyon
Trichloroethane [1,1,1-]; dichloroethene[1,1-]	Intermediate groundwater near main warehouse			Seasonally variable; undergoing corrective action
RDX	Cañon de Valle alluvial and intermediate groundwater and Pajarito Canyon intermediate groundwater			Generally stable with seasonal fluctuations; Pajarito Canyon regional aquifer values are below standards but are increasing at one location
Barium	Pajarito and Mortandad Canyons and Cañon de Valle alluvial and intermediate groundwater			Generally stable in Cañon de Valle; other canyons likely due to cation exchange caused by road salt
Boron	Cañon de Valle intermediate groundwater			Generally stable with seasonal fluctuations
Tetrachloroethene, trichloroethene	Cañon de Valle alluvial and intermediate groundwater			
Strontium-90	Los Alamos and Mortandad Canyons alluvial groundwater		Not used as a source of drinking water and has not penetrated to deeper groundwater.	Mainly fixed in location; some decrease due to effluent quality improvement
Fluoride	Los Alamos and Mortandad Canyons alluvial groundwater, Pueblo and Los Alamos Canyons intermediate groundwater, and Pueblo Canyon regional aquifer	Pueblo Canyon	Source was historical effluent releases; not used as a source of drinking water	Slow decrease in concentration in alluvium due to effluent quality improvement
Chloride, total dissolved solids	Pajarito, Pueblo, Los Alamos, Sandia, and Mortandad Canyons; intermediate groundwater near Technical Area 3		Source was road salt in snowmelt	Values are generally highest in winter and spring samples
Fluoride, uranium, nitrate, total dissolved solids	No	Pine Rock Spring and Pueblo de San Ildefonso	Water quality affected by irrigation with sanitary effluent at Overlook Park	Steady over the years

RDX = Research Department Explosive.
[a] Impacts resulted in values near or above regulatory standards, screening levels, or risk levels.
Source: LANL 2011d:ES-12–ES-13.

Pajarito Canyon springs, fed by perched groundwater above alluvium, in the western portion of the canyon include Homestead, Josie, Bryan, Garvey, Perkins, Charlie's, Upper Starmer, Kieling, Bulldog, and Starmer Springs. Twomile Canyon Aggregate contains five springs (SM-30, SM-30A, Anderson, Hanlon, and TW-1.72) and the Threemile Canyon Aggregate contains two springs (Threemile Spring and TA-18). Discharge rates are typically 1 to 15 gallons (3.8 to 57 liters) per minute (LANL 2005:3-A-31, 2006a:1).

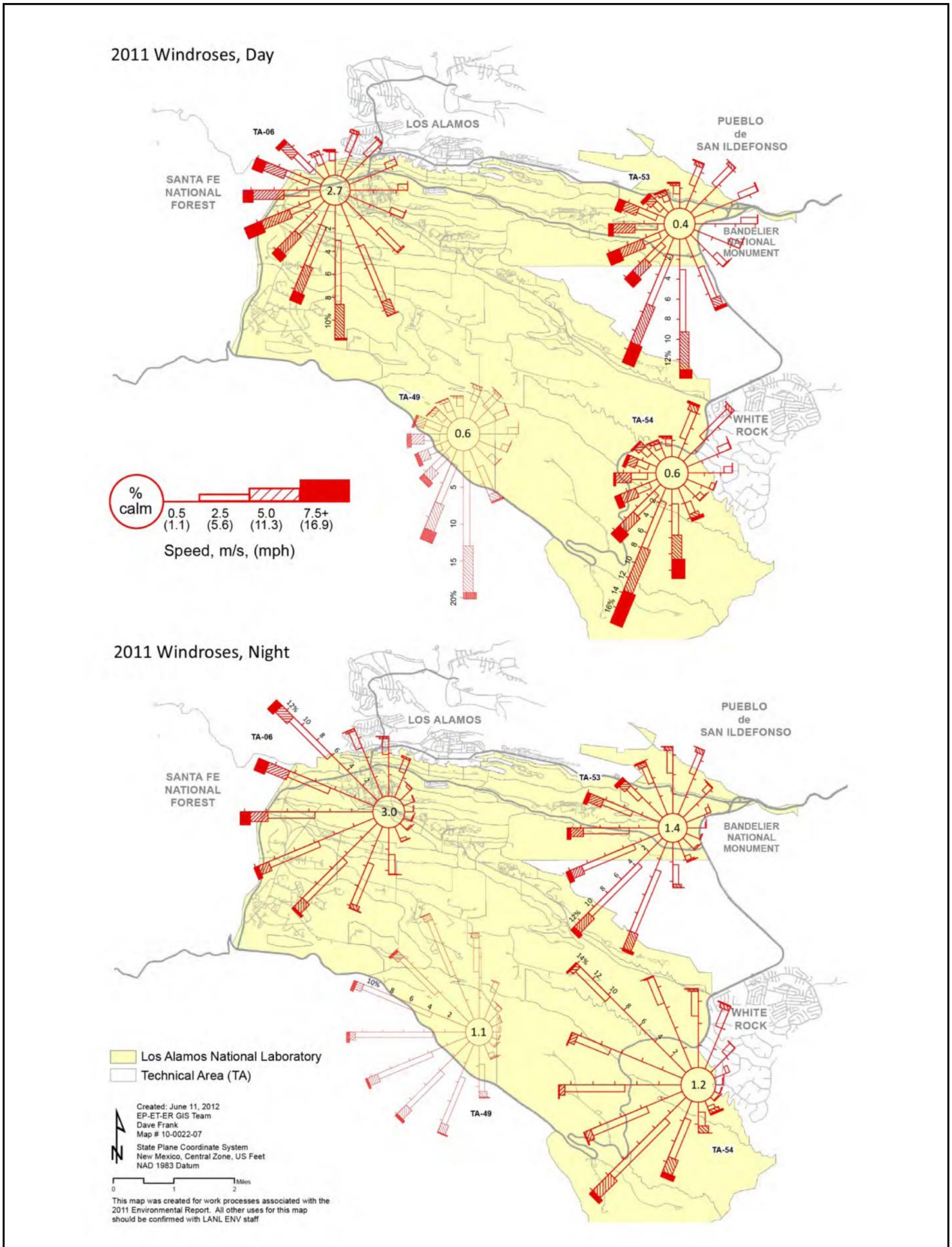
3.2.4 Meteorology, Air Quality, and Noise

3.2.4.1 Meteorology

Climate information for an area does not change drastically over time; thus, the information presented in the *Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE 2003c:3-13–14) and the *Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico (LANL SWEIS)* (DOE 2008f:4-75–82) is still applicable. Los Alamos County is a semiarid, temperate mountain climate characterized by seasonable, variable rainfall. Precipitation ranges from 10 to 20 inches (25 to 51 centimeters) per year and precipitation rates within the county decline toward the Rio Grande Valley. The town of Los Alamos is less arid (dry) than the area near the Rio Grande, which is arid continental. Mean temperatures range from 17.4 °F (-8.1 °C) in January to 80.6 °F (27 °C) in July, with an extreme low temperature of -18 °F (-28 °C) and an extreme high temperature of 95 °F (35 °C). Normal temperatures (30-year mean) in the town of White Rock range from 14.6 °F (-9.7 °C) in January to 85.6 °F (29.8 °C) in July. Temperatures in Los Alamos County vary with altitude, averaging 5 °F (3 °C) higher in and near the Rio Grande Valley, which is 6,500 feet (1,981 meters) above sea level, and 5 to 10 °F (3 to 5.5 °C) lower in the Jemez Mountains, which are 8,500 to 10,000 feet (2,590 to 3,050 meters) above sea level (DOE 2003c: 3-13–3-14).

Precipitation in Los Alamos County during July and August is 36 percent of the annual average value due to thunderstorms. Los Alamos County averages 60 thunderstorms per year, with intense and frequent lightning that has caused fires. Local lightning density is estimated at 15 strikes per square mile (5.6 strikes per square kilometer) per year, commonly observed between May and September (LANL 2012a:1-6–7). Flash flooding from heavy thunderstorms in canyons and low-lying areas does occur. Winter precipitation falls as snow, with an average annual snowfall of 59 inches (150 centimeters). Snowfall levels vary year to year, ranging from 9 inches (23 centimeters) to 153 inches (389 centimeters). Los Alamos County experienced drought conditions from 1998 through 2003, the longest and most severe drought experienced by this area during the last 80 years. Above-average precipitation in 2004 and 2005 helped to restore normal conditions. Precipitation levels were slightly below normal in 2009 (18.6 inches [47.2 centimeters]) (LANL 2010a:1-19–23, 2012a:1-6–7).

Windspeed averages 7 miles per hour (3 meters per second) in Los Alamos County. Wind speeds vary seasonally, with lowest wind speeds in December and January. The highest winds occur March through June due to intense storms and cold fronts. Due to the complex terrain surface, winds vary dramatically with time of day, location, and elevation. Generally, an upslope airflow occurs in the morning, with winds shifting from the south over the entire plateau by noon. During the night, winds come from the west-southwest to the northwest over the western portion of the plateau due to cold air drainage off the Jemez Mountains and the Pajarito Plateau (DOE 2008f:4-77–78). Wind roses for LANL for 2011 are presented in **Figure 3–13**.



Source: LANL 2012a:4-31

Figure 3–13 Daytime and Nighttime Wind Roses for 2011

3.2.4.2 Air Quality

Air pollution refers to any substance in the air that could harm humans, animals, vegetation, or structures, or that unreasonably interferes with the comfortable enjoyment of life and property. Air quality is affected by air pollutant emission characteristics, meteorology, and topography.

General Site Description

LANL is located within the Upper Rio Grande Valley Intrastate Air Quality Control Region (#157). The area encompassing LANL and Los Alamos County is classified as an attainment area for all six criteria pollutants (40 CFR 81.332).

Operations at LANL emit criteria pollutants primarily from combustion sources, such as boilers, emergency generators, and motor vehicles. Emissions at LANL are provided in **Table 3–30**.

Table 3–30 Air Pollutant Emissions at Los Alamos National Laboratory

Pollutants	***2011 Emissions (tons per year)***
Carbon Monoxide	43.1
Nitrogen Oxides	60.2
Particulate Matter	5.46
Sulfur Oxides	1.6
Volatile Organic Compounds	9.99
Hazardous air pollutants	3.62

Note: To convert tons to metric tons, multiply by 0.90718.
Source: LANL 2012a:2-18.

The Bandelier Wilderness Area is designated as a Class I Prevention of Significant Deterioration area in accordance with the Clean Air Act, as amended, and New Mexico regulations. This means that facilities located within a 62-mile (100-kilometer) radius of the area must not cause appreciable deterioration in air quality. NMED monitored levels of air pollutants of interest (sulfur dioxide, nitrogen dioxide, ozone, and particulate matter with an aerodynamic diameter less than or equal to 10 microns [PM_{10}]) at a station adjacent to Bandelier National Monument between 1990 and 1994. Operation of the station was discontinued in 1995 because the recorded values were well below applicable standards. Visibility is considered to be an important value (40 CFR Part 81; NMAC 20.2.74) and requires protection. Visibility has been officially monitored by the National Park Service at Bandelier National Monument since 1988. The visual range has not deteriorated during the period for which data are available (DOE 2003c:3-16–17).

The State of New Mexico has established ambient air quality standards for the criteria pollutants and total suspended particulates, hydrogen sulfide, and total reduced sulfur. The criteria pollutant standards and concentrations attributable to LANL are shown in **Table 3–31**. These concentrations are in compliance with the applicable ambient air quality standards.

Air quality permits have been obtained from the NMED Air Quality Bureau for various activities at LANL, including beryllium operations; open burning of high-explosives waste; and operation of an air curtain destructor, an asphalt plant, a rock crusher, the TA-3 power plant, and the TA-33 generator. Each of these operations was modified or constructed after August 31, 1972. In accordance with Title V of the Clean Air Act and NMAC 20.2.70, a sitewide operating permit application was submitted to NMED in December 1995. A modified application was submitted in 2005; a renewal application was submitted in 2008. The current approved operating permit was issued in August 2009. In 2010, LANL requested a revision to the operating permit to incorporate the CMRR-RLUOB and TA-3 power plant (LANL 2011d:2-18–19, 2012a:2-18). The LANL sitewide operating permit has voluntary facility-wide emission limits to ensure that LANL remains a minor stationary source for the purposes of the Prevention of Significant Deterioration Construction Permit Program and the Clean Air Act Title III requirements for hazardous air pollutants. Prior to construction, NMED requires air permits for new sources of emissions depending on the design and operation (DOE 2011g:3-13).

Table 3–31 Comparison of Ambient Air Concentrations from Los Alamos National Laboratory Sources with Most Stringent Applicable Ambient Air Quality Standards

Air Pollutant	*Averaging Time*	*Most Stringent Standard* [a]	*Maximum Facility-Wide Concentration*
Carbon Monoxide	8-hour 1-hour	8.7 ppm [c] 13.1 ppm [c]	0.21 ppm 1.2 ppm
Nitrogen Dioxide	Annual 24-hour	0.05 ppm [c] 0.1 ppm [c]	< 0.01 ppm 0.03
Sulfur Dioxide	Annual 24-hour 3-hour	0.02 ppm [c] 0.1 ppm [c] 0.5 ppm [b]	< 0.01 ppm 0.04 ppm 0.2 ppm
Particulate Matter (PM_{10}) [d]	24-hour	150 $\mu g/m^3$ [b]	102 $\mu g/m^3$
Particulate Matter ($PM_{2.5}$)	Annual 24-hour	15 $\mu g/m^3$ [b] 35 $\mu g/m^3$ [b]	N/R N/R
Ozone	8-hour	0.08 ppm [b]	N/R
Lead	Rolling 3-month average	0.15 $\mu g/m^3$ [b]	N/R

N/R = Not reported in the *LANL SWEIS*; PM_n = particulate matter less than or equal to *n* microns in aerodynamic diameter; ppm = parts per million; $\mu g/m^3$ = micrograms per cubic meter.

[a] The more stringent of the Federal and state standards is presented if both exist for the averaging period. Methods of determining whether standards are attained depend on pollutant and averaging time. The National Ambient Air Quality Standards (40 CFR 50), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The 8-hour ozone standard is attained when the 3-year average of the annual fourth-highest daily maximum 8-hour average concentration is less than or equal to the standard. 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 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 annual $PM_{2.5}$ standard is met when the 3-year average of the annual means is less than or equal to the standard.

[b] Federal standard.

[c] State standard.

[d] EPA revoked the annual PM_{10} standard in 2006.

Note: Emissions of other air pollutants not listed here have been identified at LANL, but are not associated with any of the alternatives evaluated. These other air pollutants are quantified in the *LANL SWEIS* (DOE 2008f:4-82–88). Values may differ from those of the source document due to rounding. EPA recently promulgated 1-hour ambient standards for nitrogen dioxide and sulfur dioxide. The 1-hour standard for nitrogen dioxide is 188 micrograms per cubic meter and the 1-hour standard for sulfur dioxide is 197 micrograms per cubic meter. EPA recently promulgated a lead standard of 0.15 micrograms per cubic meter based on a 3-month rolling average (40 CFR 50). No modeling results were available for comparison to these standards.

Source: DOE 2008f:5-49, 2011g:4-115; NMAC 20.2.3. 2006; 40 CFR 50.

Data from nearby ambient air monitors in Los Alamos for 2010 and 2011 are presented in **Table 3–32**. The data indicate that the NAAQS for particulate matter were not exceeded in the area around LANL in 2010 (LANL 2012b:3-2, 2011d:4-21). Data from nearby ambient air monitors for 2011 show higher annual averages and 24-hour maxima for particulate matter as a result of the Wallow and Las Conchas Fires of 2011 (LANL 2012a:4-23).

The "natural greenhouse effect" is the process by which part of the terrestrial radiation is absorbed by gases in the atmosphere, thereby warming the Earth's surface and atmosphere. This greenhouse effect and the Earth's radiative balance are affected largely by water vapor, carbon dioxide, and trace gases, all absorbers of infrared radiation and commonly referred to as "greenhouse gases." Trace gases include nitrous oxide, chlorofluorocarbons, methane, and sulfur hexafluoride.

Table 3–32 Ambient Air Quality Standards and Monitored Levels in the Vicinity of Los Alamos National Laboratory – 2010 and 2011

Pollutant	*Averaging Time*	*Ambient Standard (micrograms per cubic meter)*	*Concentration (micrograms per cubic meter)*		*Locations*
			2010	*2011*	
PM_{10}	24 hours	150	60 58	149 275	White Rock Fire Station Los Alamos Medical Center
$PM_{2.5}$	Annual	15	6 6	8 10	White Rock Fire Station Los Alamos Medical Center
	24 hours	35	19 12	123 262	White Rock Fire Station Los Alamos Medical Center

PM_n = particulate matter less than or equal to *n* microns in aerodynamic diameter.
Source: LANL 2011d:4-21, 2012a:4-23; 40 CFR Part 50.

LANL carbon-dioxide-equivalent emissions of carbon dioxide and methane from combustion of fossil fuels in calendar year 2011 were estimated to be 65,396 tons (59,327 metric tons) (LANL 2012a:2-17), which is less than 0.001 percent of the total U.S. emissions of 6.08 billion metric tons per year (EPA 2012:ES-4–6).

Proposed Facility Locations

The meteorological conditions described previously for LANL are considered to be representative of TA-55. Information on air pollutant emissions from this area is included in the overall site emissions discussed previously.

The air pollutant sources of significance for permitting include machining and foundry operations, boilers and heaters, and degreasers (DOE 2008f:4-84–85).

3.2.4.3 Noise

Noise is unwanted sound that interferes or interacts negatively with the human or natural environment. Noise may disrupt normal activities, diminish the quality of the environment, or if loud enough, cause discomfort and even hearing loss.

General Site Description

Existing noise related to LANL facilities that is detectable by the public comes from a variety of sources, including construction, truck and automobile movements to and from the LANL technical areas, high-explosives testing, and firearms practice by security guards. Non-LANL noise occurring within Los Alamos County is dominated by traffic movement and, to a much lesser degree, other residential-, commercial-, and industrial-related activities. Measurements of nonspecific background ambient noise in the LANL area have been taken at a couple of locations near LANL boundaries next to public roadways. Background noise levels were found to range from 31 to 35 decibels A-weighted (dBA) at the vicinity of the entrance to Bandelier National Monument and New Mexico State Route (SR) 4. In White Rock, background noise levels range from 38 to 51 dBA (1-hour equivalent sound level); the slight increase compared to Bandelier National Monument is probably due to higher levels of traffic and the presence of a residential neighborhood, as well as the different physical setting (DOE 2003c:3-17–18).

Peak noise levels from LANL operations are represented by the detonation of high explosives. The higher-frequency, audible air pressure waves that accompany detonation of explosives can be heard by both workers and the area public. The lower-frequency air pressure waves are not audible, but may cause secondary and audible noises within a testing structure that may be heard by personnel (DOE 2011g:3-18).

Noise attenuation (reduction) is affected by vegetation, topography, and meteorology. Much of LANL is forested, particularly where explosives test sites are located, and varied elevations and rock formations influence and channel noise and vibrations away from receptors. Booming noises from explosives are similar to thunder and startle receptors and LANL workers alike. The Cerro Grande Fire reduced vegetative cover, thereby decreasing the ability of the surrounding environment to absorb noise (DOE 2008f:4-93).

LANL operational noise (both audible and vibration) is regulated by worker protection standards (29 CFR 1910.95) that are consistent with the Los Alamos County Code. Los Alamos County promulgated a local noise ordinance that establishes noise level limits for residential land uses. Noise levels that affect residential receptors are limited to a maximum of 65 dBA during daytime hours (between 7 A.M. and 9 P.M.) and 53 dBA during nighttime hours (between 9 P.M. and 7 A.M.). During daytime hours, the permissible noise level can be increased to 75 dBA in residential areas, provided the noise is limited to 10 minutes in any 1 hour. Activities that do not meet the noise ordinance limits require a permit. It was determined by the Los Alamos County Community Development Department that LANL does not need a special permit under the Los Alamos County Code, as explosive test noise is not prolonged. Traffic noise is exempted from the Los Alamos County Code. Wildlife and sensitive, federally protected bird populations are vigorous in the LANL area, suggesting that noise generated at LANL is within the acceptable tolerance range for most wildlife species and sensitive nesting birds (DOE 2011g:3-19).

Proposed Facility Locations

No distinguishing noise characteristics in TA-55 have been identified. Facilities in this area are far enough from the site boundary that noise levels from sources in these areas would not be measurable or would be barely distinguishable from background levels.

3.2.5 Ecological Resources

Ecological resources are defined as terrestrial (predominantly land) and aquatic (predominantly water) ecosystems characterized by the presence of native and naturalized plants and animals. For the purpose of this *SPD Supplemental EIS*, ecological resources are differentiated by habitat type (aquatic and wetland versus terrestrial) and sensitivity (threatened, endangered, and other special-status species).

3.2.5.1 Terrestrial Resources

General Site Description

LANL is located in a region of diverse landforms, elevation, and climate. Approximately 20 percent of the land has experienced some degree of disturbance; the remaining habitat contains a high degree of biological diversity represented by approximately 900 species of vascular plants in five distinct vegetative zones. Juniper (*Juniperus monosperma*) savannas, pinyon pine (*Pinus edulis)*-juniper woodlands, grasslands, ponderosa pine (*Pinus ponderosa*) forests, and mixed conifer forests composed of Douglas fir (*Pseudotsuga menziesii)*, ponderosa pine, and white fir (*Abies concolor)* all occur within the 37-square-mile (23,680-acre [9,583-hectare]) LANL boundary. PF-4 is located within TA-55 and falls primarily within the ponderosa pine forest and mixed conifer forest vegetation type (DOE 2011g:3-32).

LANL also contains a diverse population of animals, including 57 species of mammals, 200 species of birds, 28 species of reptiles, 9 species of amphibians, and over 1,200 species of arthropods. Common species found at LANL include the western bluebird (*Sialia mexicana*), elk (*Cervus elaphus*), and raccoon (*Procyon lotor*). Raptors occurring on site include red-tailed hawk (*Buteo jamaicensis*), great-horned owl (*Bubo virginianus*) and the American peregrine falcon (*Falco peregrinus anatum*). Large carnivores include black bear (*Ursus americanus*) and bobcat (*Lynx rufus*) and the predominant game species are elk and mule deer (*Odocoileus hemionus*) (DOE 2011g:3-32).

In addition, several factors, such as the construction of new facilities, fires (including the Cerro Grande and Las Conchas fires), periods of severe drought, and bark beetle outbreaks, have all impacted the landscape at LANL. For example, in 2000, the Cerro Grande Fire burned 43,150 acres (17,460 hectares), which dramatically altered the landscape, specifically forested areas. Since 1997, forests around LANL have been mechanically thinned in an effort to reduce future wildfire potential. In addition, within 2 years of the Cerro Grande Fire, a bark beetle outbreak occurred that contributed to high mortality of pinyon, ponderosa pine, and Douglas fir trees. Bark beetle outbreaks at LANL tend to be associated with extended periods of drought, particularly periods of drought following a major wildfire (DOE 2011g:3-32).

Proposed Facility Locations

Although PF-4 is located within TA-55 and consists mainly of developed land, the area was historically part of the ponderosa pine forest and mixed conifer forest vegetation type (DOE 2011g:3-32).

3.2.5.2 Aquatic Resources

General Site Description

The Rito de Los Frijoles in Bandelier National Monument (located to the south of LANL) and the Rio Grande are the only truly perennial streams in the LANL region; however, several of the canyon floors within LANL contain reaches of perennial surface water. Some perennial streams occur in lower Pajarito and Ancho Canyons, which flow to the Rio Grande. Surface-water flow occurs in canyon bottoms seasonally or intermittently as a result of spring snowmelt and summer rain. A few short sections of riparian vegetation of cottonwood (*Populus deltoides*), willow (*Salix* spp.), and other wetland plants are present in scattered locations at LANL, as well as along the Rio Grande in White Rock Canyon. The springs and streams at LANL do not support fish populations; however, many other animal species utilize these waters. For example, terrestrial wildlife use onsite streams for drinking and associated riparian habitat for nesting and feeding.

Proposed Facility Locations

No ponds or permanent streams are identified in any of the technical areas of concern; therefore, aquatic habitat is minimal and associated with ponding within wetland areas. As explained in Section 3.2.5.3, wetlands are present within TA-55 within Mortandad Canyon (DOE 2011g:3-35).

3.2.5.3 Wetlands

General Site Description

Thirty separate wetlands occupy portions of the 14 technical areas within LANL for a total of approximately 34 acres (14 hectares). Most of wetlands at LANL are associated with canyon stream channels or are present on mountains or mesas as isolated meadows, often in association with springs, seeps, or effluent outfalls. Of these wetlands, 13 acres (5 hectares) were created or enhanced by process effluent wastewater from NPDES-permitted outfalls. This total has most likely been reduced due in part to closure or rerouting of the outfall sources. Dominant wetland plants include reed canarygrass (*Phalaris arundinacea*), narrowleaf cattail (*Typha angustifolia*), coyote willow (*Salix exigua*), Baltic rush (*Juncus balticus*), wooly sedge (*Carex pellita*), American speedwell (*Veronica americana*), common spike rush (*Eleocharis palustris*), and curly dock (*Rumex crispus*) (DOE 2011g:3-39–3-40).

Proposed Facility Locations

One wetland exists within TA-55 and is within a branch of Mortandad Canyon between TA-55 and TA-48; it covers 1.19 acres (0.48 hectares). This wetland is dominated by cattails (*Typha latifolia*) (DOE 2011g:3-40).

3.2.5.4 Threatened and Endangered Species

General Site Description

Several federally and state-listed species have been recorded at LANL and within the surrounding areas. **Table 3–33** provides a list of these species and their designation and potential to occur on site.

Table 3–33 Threatened and Endangered and Other Sensitive Species of Los Alamos National Laboratory

Common Name	*Scientific Name*	*Federal Status* [a]	*State Status* [b]	*Potential to Occur*
Mammals				
Black-footed Ferret	*Mustela nigripes*	FE	–	Low
New Mexico Meadow Jumping Mouse	*Zapus hudsonius luteus*	C	SE	Moderate
Spotted Bat	*Euderma maculatum*	–	ST	High
Birds				
American Peregrine Falcon	*Falco peregrinus anatum*	D	ST	High
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	D	ST	Moderate
Bald Eagle	*Haliaeetus leucocephalus*	D	ST	High
Broad-billed Hummingbird	*Cyanthus latirostris magicus*	–	ST	Low
Gray Vireo	*Vireo vicinior*	–	ST	Moderate
Mexican Spotted Owl	*Strix occidentalis lucida*	FT	ST	High
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	FE	SE	Moderate
Amphibians				
Jemez Mountains Salamander	*Plethodon neomexicanus*	C	SE	High
Plants				
Greater Yellow Lady's Slipper	*Cypripedium calceolus var. pubescens*	–	SE	Moderate
Wood Lily	*Lilium philadelphicum var. anadinum*	–	SE	High

Low = No known habitat exists on LANL; Moderate = Habitat exists, though the species has not been recorded recently; High = Habitat exists and the species is recorded to occur at LANL.

[a] *Federal Status*

FE = Federally Endangered; in danger of extinction throughout all or a significant portion of its range.
FT = Federally Threatened; likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
C = Candidate; substantial information exists in the U.S. Fish and Wildlife Service files on biological vulnerability to support proposals to list as endangered or threatened.
D = Federally delisted due to recovery, currently monitored.

[b] *State Status*

SE = State Endangered
Animal: any species or subspecies whose prospects of survival or recruitment in New Mexico are in jeopardy.
Plant: a taxon listed as threatened or endangered under provision of the Federal Endangered Species Act, or is considered proposed under the tenets of the act, or is a rare plant across its range within the state, and of such limited distribution and population size that unregulated taking could adversely impact it and jeopardize its survival in New Mexico.
ST = State Threatened
Animal: any species or subspecies that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range in New Mexico.
Plant: New Mexico does not list plants as threatened.

Source: DOE 2011g:3-36.

Proposed Facility Locations

TA-55 is within the core and/or buffer habitat zones of the Sandia–Mortandad Canyon and Pajarito Canyon Mexican Spotted Owl Area of Environmental Interest (DOE 2011g:3-36).

3.2.6 Human Health

Public and occupational health and safety issues include the determination of potentially adverse effects on human health that result from acute and chronic exposure to ionizing radiation and hazardous chemicals.

3.2.6.1 Radiation Exposure and Risk

General Site Description

Major sources and levels of background radiation exposure to individuals in the vicinity of LANL are shown in **Table 3–34**. Background radiation doses are unrelated to LANL operations. Annual background radiation doses to individuals are expected to remain constant over time.

Table 3–34 Radiation Exposure of Individuals in the Los Alamos National Laboratory Site Vicinity Unrelated to Los Alamos National Laboratory Site Operations

Source	*Effective Dose (millirem per year)*
Natural background radiation	
Cosmic and external terrestrial radiation	170
Internal terrestrial radiation	29
Radon-220 and -222 in homes (inhaled)	270
Other background radiation	
Diagnostic x-rays and nuclear medicine	300
Weapons test fallout	< 1
Consumer and industrial products	13
Total	**782**

Source: LANL 2012a:3-8–9.

Releases of radionuclides to the environment from LANL operations provide another source of radiation exposure to individuals in the vicinity of LANL. Types and quantities of radionuclides released from LANL operations are listed in the annual LANL environmental reports. The annual doses to the public from recent releases of radioactive materials (2007 through 2011) and the average annual doses over this 5-year period are presented in **Table 3–35**. These doses fall within radiological limits established per DOE Order 458.1 and are much lower than background radiation.

Using a risk estimator of 600 LCFs per 1 million person-rem (or 0.0006 LCFs per rem) (DOE 2003a), the annual average LCF risk to the maximally exposed member of the public due to radiological releases from LANL operations from 2007 through 2011 is estimated to be 7×10^{-7}. That is, the estimated probability of this person developing a fatal cancer at some point in the future from radiation exposure associated with 1 year of LANL operations is 1 in 1.4 million. (Note: It takes a number of years from the time of radiation exposure until a cancer manifests.)

Table 3–35 Annual Radiation Doses to the Public from Los Alamos National Laboratory Site Operations in 2007–2011 (effective dose equivalent)

Members of the Public	*Year*	*Atmospheric Releases* [a]	*Liquid Releases* [b]	*Total* [c]
Maximally exposed individual (millirem)	2007	0.52	N/A	0.52
	2008	0.55	N/A	0.55
	2009	0.55	N/A	0.55
	2010	0.33	N/A	0.33
	2011	3.53	N/A	3.53
	2007–2011 Average	1.10	N/A	1.10
Population within 50 miles (person-rem) [d]	2007	0.36	N/A	0.36
	2008	0.79	N/A	0.79
	2009	0.57	N/A	0.57
	2010	0.22	N/A	0.22
	2011	0.58	N/A	0.58
	2007–2011 Average	0.50	N/A	0.50
Average individual within 50 miles (millirem) [e]	2007	0.0013	N/A	0.0013
	2008	0.0028	N/A	0.0028
	2009	0.0020	N/A	0.0020
	2010	0.00079	N/A	0.00079
	2011	0.0017	N/A	0.0017
	2007–2011 Average	0.0017	N/A	0.0017

N/A = not applicable.
[a] DOE Order 458.1 and Clean Air Act regulations in 40 CFR Part 61, Subpart H, establish a compliance limit of 10 millirem per year to the maximally exposed individual.
[b] There are no liquid effluent pathways from normal LANL operations that result in doses to the public.
[c] DOE Order 458.1 establishes an all-pathways dose limit of 100 millirem per year to individual members of the public.
[d] Doses are to a population of about 280,000 for 2007–2010, based on 2000 census data, and about 343,000 for 2011, based on 2010 census data.
[e] Obtained by dividing the population dose by the number of people living within 50 miles of LANL.
Note: To convert miles to kilometers, multiply by 1.609.
Source: LANL 2008:Ch. 3, 2009b:Ch. 3, 2010a:Ch. 3, 2011d:Ch. 3, 2012a:Ch. 3.

According to the same risk estimator, no excess fatal cancers are projected in the population living within 50 miles (80 kilometers) of LANL from 1 year of normal operations from 2007 through 2011. This may be compared with the number of fatal cancers expected in the same population from all causes. The average annual mortality rate associated with cancer for the entire U.S. population from 2005 through 2009 (the last 5 years for which final data are available) was 187 per 100,000 (HHS 2008:Table B, 2009:Table B, 2010:Table B, 2011a:Table B, 2011b:Table B).[14] Based on this national mortality rate, the number of fatal cancers that were expected to occur in 2011 in the population living within 50 miles (80 kilometers) of LANL is 641.[15]

LANL workers receive the same dose as the general public from background radiation, but also receive an additional dose from working in facilities with nuclear materials. **Table 3–36** presents the annual average individual and collective worker doses from LANL operations from 2006 through 2010, the latest 5-year period for which data are available. These doses fall within the regulatory limits of 10 CFR Part 835. Using the risk estimator of 600 LCFs per 1 million person-rem, the calculated average

[14] *Preliminary data for 2010 and 2011 indicate mortality rates that are less than 2 percent smaller than this rate (HHS 2012a:Table B, 2012b:Table B).*
[15] *The number of fatal cancers is based on an estimated population of 343,000 people living within 50 miles (80 kilometers) of LANL in 2011 (LANL 2012a:3-4).*

annual LCF risk of 0.08 in the workforce indicates a low probability of a single cancer fatality in the worker population.

Table 3–36 Radiation Doses to Los Alamos National Laboratory Workers from Operations from 2006 through 2010 (total effective dose equivalent)

Occupational Personnel	*From Onsite Releases and Direct Radiation by Year*					
	2006	*2007*	*2008*	*2009*	*2010*	*Average*
Average radiation worker (millirem) [a]	83	107	88	83	94	90
Total worker dose (person-rem)	164	150	107	116	125	132
Number of workers receiving a measurable dose	1,985	1,392	1,219	1,392	1,335	1,465

[a] No standard is specified for an "average radiation worker"; however, the maximum dose to a worker is limited as follows: The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, DOE's goal is to maintain radiological exposure as low as 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 (DOE 2009a).

Source: DOE 2007a:3-10, 2008b:3-10, 2009c:3-10, 2010b:3-10, 2011b:3-10.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the annual LANL surveillance and environmental reports. The concentrations of radioactivity in various environmental media (including air, water, and soil) in the region (on site and off site) are also presented in those reports. Specific to measurements made in air, the average onsite concentration of plutonium-239 was 2.2×10^{-18} curies per cubic meter for the years 2007 through 2011. For the years 2006 through 2009, the average onsite concentrations in air of gross alpha and gross beta radiation were 8×10^{-16} curies per cubic meter and 1.7×10^{-14} curies per cubic meter, respectively; these measurements were discontinued in 2010. No specific measurements were reported for TA-55 (LANL 2008:101-102, 2009b:102–103, 2010a:100–104, 2011d:4-6–9, 2012a:4-8).

3.2.6.2 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 (such as 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 could occur during normal operations at LANL via inhalation of air containing hazardous chemicals released to the atmosphere by LANL operations. Other potential pathways that pose risks to public health include ingestion of contaminated drinking water or direct exposure.

Baseline air emission concentrations for air pollutants and their applicable standards are presented in Section 3.2.4. 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 LANL workers during normal operations could include inhaling the workplace atmosphere, drinking LANL potable water, and possible other contact with hazardous materials associated with work assignments. Workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. LANL workers are also protected by adherence to the Occupational Safety and Health Administration and

EPA occupational standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals used in the operation 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 LANL are substantially better than required by standards.

3.2.6.3 Health Effects Studies

Numerous epidemiological studies have been conducted in the LANL area. For example, a 1993 study found that the incidence of some cancers was greater than that observed in reference populations, while the incidence of other cancers was lower (Athas and Key 1993). The most notable increase was for thyroid cancer incidence observed in the mid-1980s, with increased incidence rates also observed for melanoma of the skin, prostate cancer, non-Hodgkin's lymphoma, ovarian cancer, and female breast cancer. The related epidemiologic investigation did not identify a specific cause for the high number of thyroid cancers observed in Los Alamos County, but indicated that it was likely the result of several causes (Athas 1996).

Using cancer incidence data for the years 1973 to 1997, a study identified a statistically significant cluster of childhood cancers in Los Alamos County and six counties to the south and west of Los Alamos County (Bernalillo, Cibola, McKinley, Sandoval, San Juan, and Valencia Counties), when all cancers were considered (Zhan 2001:5, 31-48). The same study identified a statistically significant cluster of childhood acute lymphoblastic leukemia in a nine-county area south and southwest of Los Alamos County (Bernalillo, Catron, Cibola, Dona Ana, Lincoln, Sierra, Socorro, Torrance, and Valencia Counties). Over the same years, another study identified a statistically significant cluster of female breast cancer within the four-county area of Los Alamos, Sandoval, Santa Fe, and Bernalillo Counties (Zhan 2002:25, 1-8).

In 2003, a study compared annual age-adjusted cancer incidence and mortality rates for the years 1970 to 1996 for 24 types of cancer in Los Alamos County, with rates calculated for a New Mexico state reference population (Richards 2003). Cancer incidence rates considered elevated or significantly elevated compared with the New Mexico state reference population included those for the brain, breast, colon/rectum, esophagus, Hodgkin's lymphoma, leukemia, melanoma of the skin, non-Hodgkin's lymphoma, ovary, prostate, testis, and thyroid. Cancer mortality rates considered elevated or significantly elevated compared with the New Mexico state reference population included those for breast, colon/rectum, kidney, liver, melanoma of the skin, non-Hodgkin's lymphoma, ovary, and pancreas. Incidence and/or mortality rates for other analyzed cancers were not considered elevated in Los Alamos County.

The National Cancer Institute publishes national, state**,** and county incidence rates for various types of cancer (NCI 2013). However, the published information does not provide an association of these rates with their causes, e.g., specific facility operations and human lifestyles. **Table 3–37** presents a summary of cancer incidence rates for the United States, New Mexico, and the four counties adjacent to LANL. Additional information about cancer profiles in the vicinity of LANL is presented in *State Cancer Profiles, Incidence Rates Report* (NCI 2013).

In a study entitled *Public Health Assessment, Final, Los Alamos National Laboratory*, ATSDR reported on its review of possible public exposures to radioactive materials and other toxic substances in the environment near LANL (ATSDR 2006). The study also examined the results of the Athas and Key (1993) and Athas (1996) studies and determined that there were no data to link environmental factors, other than naturally occurring ultraviolet light from the sun, with the observed incidence of any cancer in Los Alamos County. ATSDR concluded that, "[o]verall, cancer rates in the Los Alamos area are similar to cancer rates found in other communities. In some time periods, some cancers will occur more frequently and others less frequently than seen in reference populations. Often, the elevated rates are not statistically significant."

In 1999, the Centers for Disease Control and Prevention began a dose reconstruction project to estimate the possible exposures of populations from releases of radioactive and chemical materials from LANL since 1943. A final report addressing the first phase of the project – the Los Alamos Historical Document Retrieval and Assessment (LAHDRA) project – was published in 2010 (CDC 2010). Based on a review and interpretation of historical data, the LAHDRA report postulated that larger quantities of contaminants, particularly plutonium, had been emitted during the earlier years of LANL operation than had been previously reported (the vast majority of the releases occurred between the 1940s and the 1970s). The facilities that were the focus of the plutonium emissions analysis predated PF-4 and did not have the sophisticated controls and high efficiency particulate air filtration systems currently in use.

Table 3–37 Cancer Incidence Rates for the United States, New Mexico, and Los Alamos Region, 2005 through 2009 [a]

	All Cancers	*Thyroid*	*Breast*	*Lung and Bronchus*	*Leukemia*	*Prostate*	*Colon and Rectum*
United States	465	11.8	122	67.2	12.4	151.4	46.2
New Mexico	408	12.8	109.9	46.3	12.7	139.8	39.8
Los Alamos County [b]	431.8	24.9	150	24.5	14	207.2	26.2
Santa Fe County [b]	413.6	14.4	133.3	37.8	11.6	160.7	35.6
Sandoval County	440.4	15.5	127.4	44.8	17.1	139.3	44.6
Rio Arriba County	352.6	14.3	83.9	27.5	9.7	151.4	44.6

[a] Age-adjusted incidence rates per 100,000 persons per year, all races, and both sexes (as appropriate).
[b] Portions of LANL are located in Los Alamos and Santa Fe Counties.
[c] Data have been suppressed by the National Cancer Institute to ensure confidentiality and stability of rate estimates when the annual average count is three or fewer cases.
Source: NCI 2013.

3.2.6.4 Accident History

LANL annual environmental reports were reviewed to determine if there were any unplanned releases of radioactivity to the environment around the LANL site during the most recent 5 years for which data are available (2007–2011). These are the same years for which annual radiation doses to the public from LANL operations are given in Section 3.2.6.1. With the exception of an opacity exceedance that was slightly above the permit limit (25 percent versus 20 percent) and lasted less than 10 minutes in 2007, there were no unplanned radiological or nonradiological airborne, or liquid radiological releases from LANL during this time (LANL 2008:76, 2009b:74, 2010a:74-75, 2011d:2-31, 2012a:2-31–32).

LANL did experience unplanned releases of radioactivity to the environment during earlier operations. A discussion of these earlier releases and their impacts is presented in the *LANL SWEIS* (DOE 2008f:4-119–121).

3.2.6.5 Emergency Preparedness

Each site in the DOE complex has an established emergency management program that is activated in the event of an accident. These programs have been developed and maintained to ensure adequate response to most accident conditions and to provide response efforts for accidents not specifically considered. Emergency management programs address emergency planning, training, preparedness, and response for both onsite and offsite personnel.

These programs involve providing specialized training and equipment for local fire departments and hospitals, state public safety organizations, and other government entities that may participate in response actions, as well as specialized assistance teams (DOE Order 151.1C, *Comprehensive Emergency*

Management System). These programs also provide for notification of local governments whose constituencies could be threatened in the event of an accident. Broad ranges of exercises are run to ensure the systems are working properly, from facility-specific exercises to regional responses. 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 the Hanford Site in Richland, Washington, in May 1997.

Emergency response facilities and equipment, trained staff, and effective interface and integration with offsite emergency response authorities and organizations are integral components of the emergency management system at LANL. LANL personnel maintain the necessary apparatus, equipment, and a state-of-the-art Emergency Operations Center to respond effectively to virtually any type of emergency, not only at LANL, but throughout the local community as well.

The Emergency Operations Center serves as the command center for emergency responders in the event of an emergency and has space and resources to house up to 120 personnel, including representatives from neighboring pueblos, the Federal Bureau of Investigation, the Federal Emergency Management Agency (FEMA), DOE, the U.S. Forest Service, the National Park Service, the National Guard, New Mexico State Police, Los Alamos County police and firefighters, Emergency Managers, the Red Cross, and others.

The Emergency Response and Management Program at LANL effectively combines Federal and local emergency response capabilities. A coordinated effort to share emergency information with Los Alamos County is a cornerstone of the Emergency Response and Management Program. LANL emergency response and management staff and Los Alamos County police, fire, emergency medical, and 911 dispatch personnel operate out of the LANL Emergency Operations Center. It is the United States' first Emergency Operations Center that combines Federal and local operations. A computer-aided dispatch system provides a centralized dispatch capability for the Los Alamos police and fire departments. First responders from different agencies can share real-time information in the same Emergency Operations Center, resulting in a more coordinated emergency response.

3.2.7 Cultural and Paleontological Resources

Cultural resources are human imprints on the landscape and are defined and protected by a series of Federal and state laws, regulations, and guidelines. *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico*, an institutional, comprehensive plan known as the Cultural Resources Management Plan, defines the responsibilities, requirements, and methods for managing cultural resources at LANL. It provides procedures for effective compliance with Federal historic preservation laws and regulations such as the National Historic Preservation Act, Archaeological Resources Protection Act, Native American Graves Protection and Repatriation Act, and American Indian Religious Act, as well as DOE policies and directives aimed to protect cultural resources (LANL 2006c). Implementation of the Cultural Resources Management Plan is governed by a Programmatic Agreement between the DOE Los Alamos Site Office, New Mexico SHPO, and Advisory Council for Historic Preservation (DOE 2006b).

Approximately 88 percent of DOE-administered land in Los Alamos County has been surveyed for prehistoric and historic cultural resources (LANL 2012b:3-32). The great majority of these sites represent the villages, farmsteads, resource exploitation areas, rock art panels, trails, and shrines of more than 10,000 years of Native American use of the Pajarito Plateau, knowledge of which is still actively preserved in the living memory of modern Pueblo neighbors and other nearby tribes. The Ancestral Pueblo remains are themselves of such cultural richness and significance that in the early 1900s the lands now occupied by LANL were included in the then-proposed "Pajarito Park," which was eventually scaled back to the present-day Bandelier National Monument. The other archaeological sites at LANL represent the remains of homes, wagon roads, trails, trash scatters, fences, and fields of early 20th century Hispanic and Anglo homesteaders. In addition, there are hundreds of historic buildings and structures that represent locations where significant research and development activities took place, beginning with the Manhattan Project in 1943 (LANL 2006c:1).

3.2.7.1 Prehistoric Resources

Prehistoric resources are physical properties that remain from human activities that predate written records (DOE 1999b:3-160).

General Site Description

As of fiscal year 2009, 1,745 prehistoric cultural resource sites have been recorded on LANL, 1,642 of which are eligible or potentially eligible for listing on the NRHP (LANL 2011b:3-29). Nearly 73 percent of the resources are ancestral pueblo and date from the 13th, 14th, and 15th centuries. Most of the sites are found in the pinyon-juniper vegetation zone, with close to 80 percent located between 5,800 and 7,100 feet (1,800 and 2,200 meters) in elevation. Nearly 60 percent of all cultural resources are found on mesa tops (LANL 2012a:1-6).

Proposed Facility Locations

The proposed capabilities would be installed in the existing PF-4 in TA-55. A rock shelter in TA-55 has been identified as eligible or potentially eligible for listing on the NRHP (DOE 2011g:3-44).

3.2.7.2 Historic Resources

Historic resources consist of physical properties that postdate the existence of written records. In the United States, historic resources are generally considered to be those that date no earlier than 1492 (DOE 1999b:3-161).

General Site Description

LANL has identified 759 historic properties as of fiscal year 2009; 617 of these are Manhattan Project and Early Cold War period buildings. LANL has recorded 142 historic sites, some of which are experimental areas and artifacts dating from the Manhattan Project and Early Cold War periods. The majority of these sites (118) are structures or artifact scatters associated with the Early Historic Pajarito Plateau or Homestead periods; 99 are eligible for listing on the NRHP (LANL 2011b:3-29–30).

Proposed Facility Locations

The proposed capabilities would be installed in the existing PF-4 in TA-55. While PF-4 is not eligible, an historic structure in TA-55 has been identified as eligible or potentially eligible for listing on the NRHP (DOE 2011g:3-44; LANL 2001).

3.2.7.3 Native American Resources

Native American resources are sites, areas, and materials important to Native Americans for religious or heritage reasons. In addition, cultural values are placed on natural resources such as plants, which have multiple purposes within various Native American groups. Of primary concern are concepts of sacred space that create the potential for land use conflicts (DOE 1999b:3-162).

General Site Description

LANL contains ancestral villages, shrines, petroglyphs (carvings or line drawings on rocks), sacred springs, trails, and traditional use areas that could be identified by Pueblo and Hispanic communities as traditional cultural properties. In addition to physical cultural entities, concern has been expressed that "spiritual," "unseen," "undocumentable," or "beingness" aspects may be present at LANL that are an important part of Native American culture (DOE 2011g:3-45).

LANL completed its long-term monitoring program in 2006 to assess the impact of LANL mission activities on cultural resources at the ancestral pueblo of Nake'muu as part of the *Dual-Axis Radiographic Hydrodynamic Test (DARHT) Facility Mitigation Action Plan*. Nake'muu is the only pueblo at LANL with standing walls. The site was occupied from around AD 1200 to 1325 and contains 55 rooms with walls standing up to 6 feet (1.8 meters) high. The site is revisited annually; in 2008, the site experienced an unusually high percentage of newly displaced masonry blocks. LANL is in the process of evaluating possible mitigation efforts (LANL 2011b:3-31).

During fiscal year 2009, LANL continued to assist DOE/NNSA in implementing the *Traditional Cultural Properties Comprehensive Plan*. This included informal meetings with the Pueblos of San Ildefonso and Santa Clara. A Memorandum of Agreement was completed and signed (LANL 2011b:3-31).

LANL continued the Land Conveyance and Transfer Project in 2010. DOE/NNSA is in the process of conveying and transferring approximately 2,000 acres (809 hectares) of DOE lands to Los Alamos County and to the Bureau of Indian Affairs to be held in trust for the Pueblo de San Ildefonso. Thirty-nine archaeological sites were excavated during the 2002 to 2005 field seasons, with more than 200,000 artifacts and 2,000 samples collected. During 2010, the artifacts and records from the Land Conveyance and Transfer Project were transferred for curation to the Museum of Indian Arts and Culture in Santa Fe, New Mexico. Data collected from these sites provide new insights into past activities on the Pajarito Plateau from 5000 BC to AD 1943 (LANL 2011d:2-31). This work was conducted under a Programmatic Agreement among DOE/NNSA, the Advisory Council on Historic Preservation, the New Mexico SHPO, and the Incorporated County of Los Alamos concerning the conveyance of certain parcels of land to the county for economic development (LANL 2011b:3-31).

During 2010, LANL continued to monitor 18 archeological and 2 traditional cultural property fences in support of the *Mitigation Action Plan for the Special Environmental Analysis for the Cerro Grande Rehabilitation Project* (LANL 2011b:3-31).

Proposed Facility Locations

There are no identified Native American resources in TA-55 (DOE 2011g:3-44).

3.2.7.4 Paleontological Resources

Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age (DOE 1999b:3-162).

General Site Description

A single paleontological artifact was discovered at a site formerly within LANL boundaries that has since been conveyed to Los Alamos County; however, in general, the near-surface stratigraphy is not conducive to preserving plant and animal remains. The near-surface materials at LANL are volcanic ash and pumice that were extremely hot when deposited; most carbon-based materials (such as bones or plant remains) would likely have been vaporized or burned if present (DOE 2011g:3-45).

Proposed Facility Locations

No paleontological resources have been identified in TA-55 (DOE 2011g:3-45).

3.2.8 Socioeconomics

Statistics for the local economy, population, and housing are presented for the ROI, a four-county area in New Mexico made up of Los Alamos, Santa Fe, Sandoval, and Rio Arriba Counties. In 2010, there were 13,474 people employed at LANL. The majority of all LANL employees reside in this four-county area. It is estimated that approximately half of the LANL workforce resides in Los Alamos County (DOE 2011g:3-46). The total direct employment at LANL accounts for approximately 8.9 percent of the employment in the ROI.

Indirect employment generated from LANL operations has been calculated using a weighted average of RIMS II direct effect employment multipliers from the U.S. Bureau of Economic Analysis for select industries that most accurately reflect the major activities at the site. The detailed industries included in the RIMS II models that were used to develop the LANL site-specific multiplier include scientific research and development services; environmental and other technical consulting services; facilities support services; investigation and security services; and construction. This method resulted in an estimated LANL direct-effect operations employment multiplier of 2. Therefore, the direct employment of 13,474 would generate indirect employment of 13,649 within the ROI, resulting in a total employment of 27,123, or 17.9 percent of the employment in the ROI.

3.2.8.1 Regional Economic Characteristics

Between 2000 and 2011, the civilian labor force of the ROI increased at an average annual rate of 1.1 percent, to 162,796. At the same time, employment in the ROI increased at an average annual rate of 0.9 percent, resulting in a 3.7 percentage point increase in the unemployment rate. Unemployment in the ROI was 7.8 percent in 2011, up from the 2000 level of 4.1 percent. New Mexico experienced similar trends in unemployment rates, increasing 2.7 percentage points over the 12-year period (BLS 2012). **Figure 3–14** illustrates the change in unemployment rates in the ROI and New Mexico from 2000 through 2011.

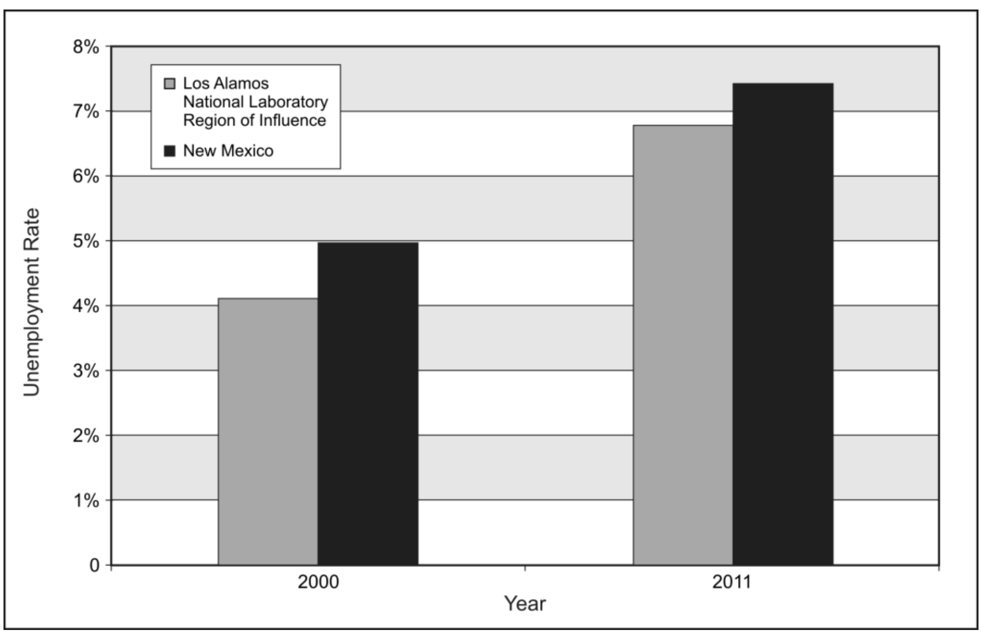


Figure 3–14 Unemployment Rates for the Los Alamos National Laboratory Region of Influence and New Mexico from 2000 through 2011

From 2000 to 2009, the average real per capita income of the ROI increased by approximately 12.7 percent in 2009 dollars, to $40,593. New Mexico experienced a larger increase than in the ROI, increasing 17.4 percent to $33,267 over the same time period. Over the 10-year period, real per capita income in the ROI peaked in 2005 at $40,831. Real per capita income in New Mexico peaked in 2008 at $33,489 (BEA 2011a). **Table 3–38** presents the per capita incomes of the ROI and New Mexico.

Table 3–38 Per Capita Income of the Los Alamos National Laboratory Region of Influence and New Mexico in 2000 and 2009

	LANL Region of Influence		*New Mexico*	
Year	***Nominal***	***Real*** [a]	***Nominal***	***Real*** [a]
2000	$28,923	$36,033	$22,751	$28,345
2009	$40,593	$40,593	$33,267	$33,267

LANL = Los Alamos National Laboratory.
[a] Real per capita income adjusted to 2009 dollars using the Consumer Price Index for All Urban Consumers U.S. City Average.
Source: BEA 2011a.

In 2009, the government was the largest employer in the ROI, at approximately 21 percent of total employment. Professional scientific and technical services was the next leading industry at approximately 13 percent of employment, followed by retail trade at approximately 10 percent and healthcare and social assistance at approximately 9 percent. Similar employment distributions were seen in New Mexico, where the leading employment sectors were also government, healthcare and social assistance and retail trade at approximately 29 percent, 11 percent, and 10 percent, respectively (BEA 2011b). The major employment sectors in the ROI and New Mexico are presented in **Figure 3–15**.

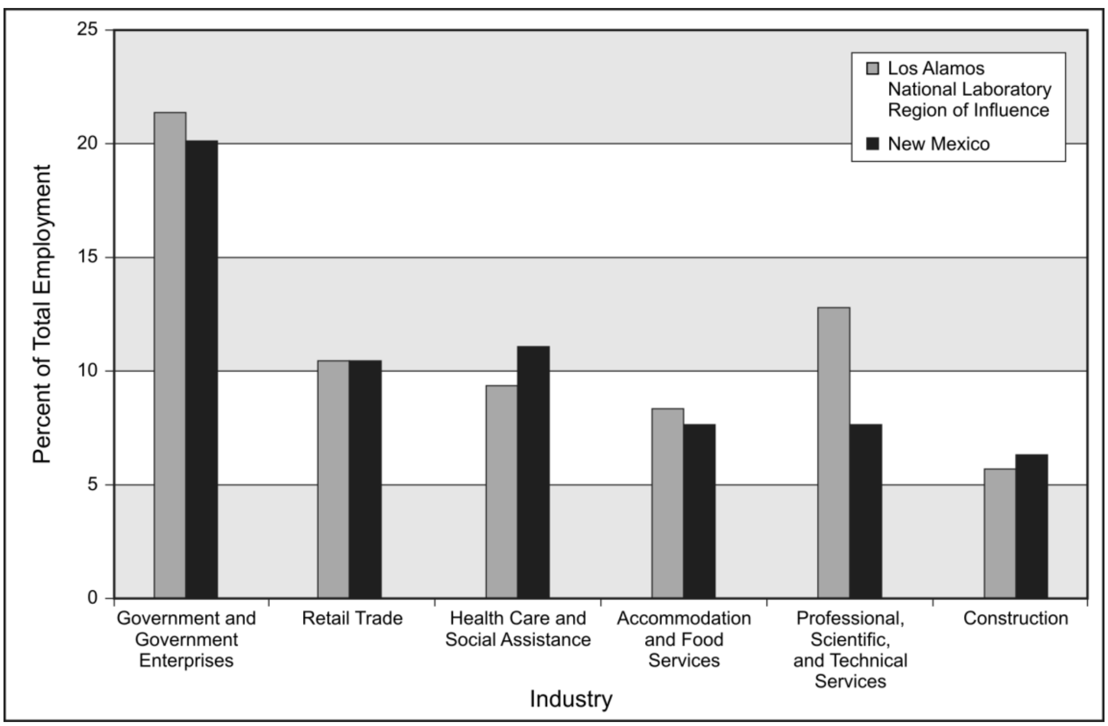


Figure 3–15 Major Employment Sector Distribution for the Los Alamos National Laboratory Region of Influence and New Mexico in 2009

3.2.8.2 Population and Housing

In 2010, the population in the ROI was estimated to be 333,927 (Census 2011a). From 2000 to 2010, the total population in the ROI increased at an average annual rate of approximately 1.8 percent, which was higher than the growth rate in New Mexico. Over the same time period, the total population of New Mexico increased at an average annual rate of approximately 1.2 percent, to 2,059,179 people. The populations of the ROI and New Mexico are shown in **Table 3–39**.

Table 3–39 Total Population of the Los Alamos National Laboratory Region of Influence and New Mexico in 2000 and 2010

Year	*LANL Region of Influence*	*New Mexico*
2000	279,368	1,819,017
2010	333,927	2,059,179

LANL = Los Alamos National Laboratory.
Source: Census 2011a.

From 2000 to 2010, the number of housing units in the ROI increased at an average annual rate of 2.5 percent, to 151,546 units (Census 2010a, 2011b). The number of housing units in New Mexico increased at average annual rate of approximately 1.4 percent, resulting in a total number of housing units of 901,388. **Table 3–40** shows the number of housing units in the ROI and New Mexico. The average homeowner vacancy rate for the counties that make up the ROI was 2.2 percent in 2010, slightly higher than the statewide rate for New Mexico of 2 percent. The average renter vacancy rate for the ROI in 2010 was 8.5 percent, compared with the statewide renter vacancy rate of 8.2 percent for New Mexico (Census 2011c, 2011d).

Table 3–40 Total Housing Units in the Los Alamos National Laboratory Region of Influence and New Mexico in 2000 and 2010

Year	*LANL Region of Influence*	*New Mexico*
2000	118,520	780,579
2010	151,546	901,388

LANL = Los Alamos National Laboratory.
Source: Census 2010a, 2011b.

3.2.8.3 Local Transportation

Motor vehicles are the primary means of transportation to LANL. Northern New Mexico is bisected by I–25 in a generally northeast–southwest direction. This interstate highway connects Santa Fe with Albuquerque. Regional transportation routes connecting LANL with Albuquerque and Santa Fe are I–25 to US 84/285 to NM 502; with Española, SR-30 to SR-502; and with Jemez Springs and western communities, SR-4.

Only two major roads, SR-502 and SR-4, access Los Alamos County. Los Alamos County traffic volume on these two segments of highway is primarily associated with LANL activities.

Most commuter traffic originates from Los Alamos County or east of Los Alamos County (Rio Grande Valley and Santa Fe) as a result of the large number of LANL employees that live in these areas. A small number of LANL employees commute to LANL from the west along SR-4.

Workers access LANL using both public transportation and privately owned vehicles. The New Mexico Park and Ride regional bus service delivers 300 riders per day to the site, and Atomic City Transit also serves LANL. Additionally, car/vanpool programs are operated by the State of New Mexico, private companies, and by individuals. The number of workers using privately owned vehicles and car/van pools is 11,750 (DOE 2011g:3-67).

The ability of roadways to function is measured in terms of LOS, which is determined based on the peak hour traffic (see Section 3.1.8). Existing average annual daily traffic and LOS classifications of the public roadways in the vicinity of LANL are provided in **Table 3–41**.

Table 3–41 Existing Annual Average Daily Traffic and Levels of Service of Roadways in the Vicinity of Los Alamos National Laboratory

Location	*Road Type and Number of Lanes*	*AADT per Year (2009)*	*Percent Trucks*	*Existing LOS*
SR-4 at Los Alamos County Line to SR-501	Minor Arterial/Two Lanes	734	9	A
SR-4 at Bandelier Park Entrance	Minor Arterial/Two Lanes	681	7	A
SR-4 at Junction of Pajarito Road – White Rock	Minor Arterial/Two Lanes	9,302	9	D
SR-4 at Jemez Road	Minor Arterial/Two Lanes	9,358	12	D
SR-501 at Junction of SR-4 and Diamond Drive	Minor Arterial/Two Lanes	11,848	11	D
SR-501 at Junction of Diamond Drive	Primary Arterial/Four Lanes	21,211	8	C
SR-501 at SR-502	Primary Arterial/Four Lanes – Divided	17,807	8	C
SR-502 at Oppenheimer Street	Primary Arterial/Four Lanes – Divided	12,817	6	C
SR-502 at Los Alamos/Santa Fe County Line	Primary Arterial/Four Lanes	12,256	9	A

AADT = annual average daily traffic; LOS = Level of Service; SR = New Mexico State Route.
Source: Valencia 2010.

3.2.9 Infrastructure

Site infrastructure characteristics are summarized in **Table 3–42**. Each infrastructure characteristic is further discussed in the following paragraphs.

Table 3–42 Los Alamos National Laboratory Sitewide Infrastructure Characteristics

Resource	*Usage* [a]	*Site Capacity*	*Available Capacity*
Transportation			
Roads (miles)	80 [b]	Not applicable	Not applicable
Railroads (miles)	0	Not applicable	Not applicable
Electricity (megawatt-hours per year)	LANL 724,000 [c] Other 150,000	1,226,000 [d]	352,000
Peak load demand (megawatts)	LANL 127 [c] Other 23	140	Exceeds available capacity
Fuel			
Natural gas (million cubic feet per year)	LANL 1,255 [c] Other 1,018	8,070 [d]	5,797
Water (million gallons per year)	LANL 428 [c]	LANL 542 [e]	LANL 114

LANL = Los Alamos National Laboratory.

[a] Usage values for electricity, fuel and water are shown for fiscal year 2010 or the projected levels of usage included in the 2008 *LANL SWEIS* (DOE 2008f) adjusted for decisions made in the associated Records of Decision, whichever is higher. Other usage is shown when capacity is shared by all Los Alamos County users, including LANL.

[b] Includes paved roads and paved parking areas only.

[c] Usage numbers conservatively include requirements for operating the Chemistry and Metallurgy Research Building Replacement Nuclear Facility at LANL as described in the *Final Supplemental Environmental Impact Statement for the Nuclear Facility Portion of the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EIS-0350-S1).

[d] Capacity values are for the entire service area, which includes LANL and other Los Alamos County users.

[e] Equivalent to DOE's leased water rights.

Note: To convert miles to kilometers, multiply by 1.6093; cubic feet to cubic meters, by 0.028317; gallons to liters, by 3.7854. A decatherm is equivalent to 1,000 cubic feet.
Values may be rounded.
Source: DOE 2011g:Tables 3-3, 4-17.

Transportation – About 80 miles (130 kilometers) of paved roads and parking surface have been developed at LANL (see Table 3–42). There is no railway service connection at the site. Local and linking regional roadway systems are discussed in Section 3.2.8.3.

Electricity – Electrical service to LANL is supplied through a cooperative arrangement with Los Alamos County, known as the Los Alamos power pool, which was established in 1985. Electric power is supplied to the pool through two existing regional 115-kilovolt electric power lines. The first line (the Norton-Los Alamos line) is owned by DOE and originates from the Norton substation east of White Rock; the second line (the Reeves Line) is owned by the Public Service Company of New Mexico and originates from the Bernalillo-Algodones Substation south of LANL. Both substations are owned by the Public Service Company of New Mexico (DOE 2008f).

Import capacity is now limited only by the physical capability (thermal rating) of the transmission lines, that is, to approximately 110 to 120 megawatts supplied from a number of hydroelectric, coal, and natural gas power generators throughout the western United States (LANL 2011b). In addition, renewable energy sources such as wind farms and solar plantations are providing a small (about 5 percent) but growing percentage of Public Service Company of New Mexico's total power portfolio (DOE 2008f). In accordance with state law, the Public Service Company of New Mexico plans to increase the percentage of electricity supplied by renewable resources to 10 percent (PNM 2012).

In April 2011, Los Alamos County completed construction of the Abiquiu Low-Flow Turbine Hydropower Project. As a result, the low-flow turbine increased energy generation at the Abiquiu facility from 13.8 megawatts to 16.8 megawatts and currently provides additional power to Los Alamos County, including LANL (DOE 2011j).

Within LANL, NNSA operates a natural gas-fired steam and electrical power generating plant at TA-3 (TA-3 Co-Generation Complex or Power Plant), which is capable of generating 27 megawatts from the combustion turbine generator, and up to 10 megawatts from two steam-driven turbine generators, for a total of 37 megawatts, all shared by the power pool. However, the two steam-driven turbine generators are currently unavailable and have not been used for several years. A third steam-driven turbine generator is also out of service due to a condenser failure (DOE 2011g).

The DOE-maintained electric distribution system at LANL consists of various low-voltage transformers at LANL facilities and approximately 34 miles (55 kilometers) of 13.8-kilovolt distribution lines. It also consists of two older power distribution substations, the Eastern Technical Area Substation and the TA-3 Substation, and a new substation built in 2002, the Western Technical Area Substation. This 115-kilovolt (13.8-kilovolt distribution) substation has a main transformer rated at 56 megavolt-amperes or about 45 megawatts. The new substation provides redundant capacity for LANL and the Los Alamos townsite in the event of an outage at either of LANL's two older substations (DOE 2008f).

Electric power availability from the existing transmission system of the power pool is conservatively estimated at 990,000 megawatt-hours, including recent upgrades to the Abiquiu Hydroelectric Facility. The additional 27 megawatts available from LANL via the combustion turbine generator at the TA-3 Co-Generation Complex give the power pool a total electric energy availability of 1,226,000 megawatt-hours (DOE 2011g). This does not include the megawatts from the unavailable steam-driven turbine generators.

In 2010, the total peak load was 69.21 megawatts for LANL and 13.3 megawatts for the rest of the power pool users. A total of 425,808 megawatt-hours of electricity were used at LANL in 2010 (LANL 2012b). Other Los Alamos County users consumed an estimated 125,000 megawatt-hours for a power pool total electric energy consumption of 550,775 megawatt-hours. An additional usage of 161,000 megawatt-hours per year have been added to LANL's historical usage for the purposes of this analysis to conservatively reflect operation of the Chemistry and Metallurgy Research Building Replacement Nuclear Facility (CMRR-NF)[16] at LANL as described in the *CMRR-NF SEIS* (DOE 2011g). Similarly, peak demand related to the operation of CMRR-NF is estimated at 26 megawatts, including requirements of RLUOB, which would exceed the site's available capacity if all operations were to experience peak demand at the same time (DOE 2011g:4-35).

The need for upgrades and the limitations of the electric transmission lines that deliver electric power to the Los Alamos power pool was documented in the 2008 *LANL SWEIS* (DOE 2008f). LANL has completed several construction projects to expand and enhance existing power capabilities. Additional upgrades are being considered, including construction of a portion of the line from the Norton substation to the Southern Technical Area substation. The existing underground ducts need upgrading to fully realize the capabilities of the Western Technical Area substation and the upgraded Eastern Technical Area substation. Redundant feeders need to be added to critical facilities, and the aging TA-3 substation needs upgrading to complete the 13.8-kilovolt distribution and 115-kilovolt transmission systems. The current CMR Building and RLUOB are served by the TA-3 substation (DOE 2011g:3-9).

Fuel – Natural gas is the primary heating fuel used at LANL and in Los Alamos County. The natural gas system includes a high-pressure main and distribution system to Los Alamos County and pressure-reducing stations at LANL buildings. LANL and Los Alamos County both have delivery points where gas is monitored and measured. In August 1999, DOE sold the 130-mile-long (210-kilometer-long) main gas supply line and associated metering stations to the Public Service Company of New Mexico. This gas pipeline traverses the area from Kutz Canyon Processing Plant south of Bloomfield, New Mexico, to Los Alamos County. Approximately 4 miles (6.4 kilometers) of the gas pipeline are within LANL boundaries. Natural gas is distributed to the point of use via some 42 miles (68 kilometers) of distribution piping (DOE 2008f).

Natural gas used by LANL is currently used for heating (both steam and hot air), with the TA-3 Co-Generation Complex being the principal user of natural gas at the site. About 200 other smaller boilers are maintained at LANL, which are primarily natural gas fired (DOE 2008f). Relatively small quantities of fuel oil are stored at LANL as a backup fuel source for emergency generators.

Fiscal year 2010 natural gas consumption for LANL and the Los Alamos service area was 1,104 million cubic feet (31 million cubic meters) and 1,018 million cubic feet (29 million cubic meters), respectively. An additional usage of 58 million cubic feet (1.6 million cubic meters) per year has been added to LANL's historical usage for the purposes of this analysis to conservatively reflect operation of CMRR-NF at LANL as described in the *CMRR-NF SEIS* (DOE 2011g).

Natural gas usage at TA-55 is limited to boilers used for heating. TA-55 is estimated to use approximately 45 million cubic feet (1.3 million cubic meters) of natural gas annually (DOE 2008f).

Water – The Los Alamos County water production system consists of 14 deep wells, 153 miles (246 kilometers) of main distribution lines, pump stations, and storage tanks. The system supplies potable water to all of Los Alamos County, LANL, and Bandelier National Monument. The deep wells are located in three well fields (Guaje, Otowi, and Pajarito). Water is pumped into production lines, and booster pump stations lift this water to reservoir tanks for distribution. Prior to distribution, the entire water supply is disinfected (DOE 2008f).

The system was originally owned and operated by DOE. On September 8, 1998, DOE transferred operation of the system to Los Alamos County under a lease agreement. Under the agreement, DOE retained responsibility for operating the distribution system within LANL boundaries, whereas Los Alamos County assumed full responsibility for ensuring compliance with Federal and state drinking

[16] *Construction of the nuclear facility portion of this project as described in the* CMRR-NF SEIS *is no longer being pursued by DOE. Thus the estimates for utility use at LANL in this* SPD Supplemental EIS *are conservative.*

water regulations. DOE retained the right to withdraw an equivalent of about 5,541 acre-feet or 1,806 million gallons (6,840 million liters) of water per year from the main aquifer and its right to purchase a water allocation of 1,200 acre-feet or 391 million gallons (1,480 million liters) per year from the San Juan-Chama Transmountain Diversion Project (DOE 2008f).

On September 5, 2001, DOE transferred ownership of the water production system to Los Alamos County, along with 70 percent (3,879 acre-feet or 1,264 million gallons [4,785 million liters] annually) of the DOE water rights. DOE leased the remaining 30 percent (1,662 acre-feet or 542 million gallons [2,050 million liters] annually) of the water rights to Los Alamos County for 10 years, with the option to renew the lease for four additional 10-year terms. LANL is now considered a Los Alamos County water customer, and DOE is billed and pays for the water LANL uses. The current 10-year agreement (water service contract) with Los Alamos County includes an escalating projection of future LANL water consumption (DOE 2008f). While the contract does not specify a supply limit to LANL, the water right owned by DOE and leased to Los Alamos County (that is, 1,662 acre-feet or 542 million gallons [2,050 million liters] per year) is a target ceiling quantity under which total water consumption at LANL should remain. The distribution system serving LANL facilities consists of a series of reservoir storage tanks, pipelines, and fire pumps. The LANL distribution system is gravity-fed with pumps for high-demand fire situations at limited locations (DOE 2008f).

Los Alamos County has signed a contract with the Bureau of Reclamation for accessing up to 391 million gallons (1,480 million liters) of water per year from the San Juan-Chama Transmountain Diversion Project. The water is currently inaccessible while the project completes engineering studies that will lead directly to the environmental clearance, enabling the county to utilize its entire annual allocation of the San Juan-Chama water supply in the most economical and beneficial way (LACBPU 2010). Use of the San Juan-Chama water, along with conservation, is integral to Los Alamos County's Long-Range Water Supply Plan (DOE 2008f).

Water use for LANL and other Los Alamos County users is shown in Table 3–42. In 2010, LANL operations consumed about 413 million gallons (1,560 million liters) of water (LANL 2012b). An additional usage of 16 million gallons (61 million liters) per year have been added to LANL's historical usage for the purposes of this analysis to conservatively reflect operation of CMRR-NF at LANL as described in the *CMRR-NF SEIS* (DOE 2011g). In recent years, total and consumptive water use for both LANL and other Los Alamos County users has increased. Water use at LANL increased by about 10 percent from 2007 to 2010, whereas from 1999 to 2005, water use at the site decreased (LANL 2010c).

NNSA continues to maintain the onsite distribution system by replacing portions of the more-than-50-year-old system as problems arise. The LANL contractor is also in the process of installing additional water meters and a Supervisory Control and Data Acquisition and Equipment Surveillance System on the water distribution system to keep track of water usage and to determine the specific water use for various applications. Data are being accumulated to establish a baseline for conserving water. NNSA has instituted a number of conservation and water-reuse projects, including improvements to the Sanitary Effluent Recycling Facility to reduce potable water usage (DOE 2008f).

3.2.10 Waste Management

A wide range of waste types are generated through activities at LANL that are related to research, production, maintenance, construction, decontamination, decommissioning, demolition, and environmental restoration. These waste types include wastewaters (sanitary liquid waste, high-explosives-contaminated liquid waste, and industrial effluent); solid waste, including routine office-type (sanitary solid) waste and construction and demolition debris; and radioactive and chemical wastes. Management of these wastes is addressed in detail in the 2008 *LANL SWEIS* (DOE 2008f).

Wastes managed at LANL are regulated in accordance with a variety of Federal and state regulations, applicable to specific waste types and their radiological and nonradiological content. Requirements for waste management activities are determined and documented by institutional requirements. These institutional requirements provide details on proper management of all process wastes and contaminated environmental media. The waste management operation tracks waste-generating processes; waste quantities; chemical and physical characteristics; regulatory status; compliance with applicable treatment and disposal standards; and final disposition (LANL 2011b:2-25–26).

Operations are conducted in accordance with the LANL waste minimization and pollution prevention program. The preferred method for minimizing waste is source reduction, including materials substitution and process improvement. Recycling and reuse practices are also implemented, along with volume reduction and treatment options. Progress in pollution prevention initiatives at LANL is measured annually against metrics approved by DOE.

In 2004, LANL began development and implementation of an environmental management system to comply with the then-current DOE Order 450.1. DOE Order 450.1 defined an environmental management system as a continuous cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental missions and goals. The environmental management system at LANL was third-party-certified to the International Organization for Standardization (ISO) 14001:2004 standard in April 2006, and recertified in April 2009, by the National Science Foundation’s International Strategic Registrations (LANL 2011b:3-9).

Research, production, maintenance, and construction activities at LANL, as well as the environmental restoration activities, generate radioactive, chemical, and other wastes. The volumes of all types of waste produced at LANL are projected to be large over the next several years because of the need for site remediation pursuant to the 2005 Consent Order and from decontamination, decommissioning, and demolition (DD&D) of facilities, in addition to routine operations. Actual waste volumes from remediation may be smaller than projected, depending on regulatory decisions and because of the employment of possible waste volume reduction and sorting techniques.

3.2.10.1 Waste Generation

Table 3–43 compares 2009 solid waste generation rates by waste type for the TA-55 Plutonium Complex and sitewide LANL. Note that solid sanitary wastes from operations are not tracked on a facility-specific basis, but only on a LANL sitewide basis. As shown in Table 3–43, sitewide 2009 generation rates for TRU waste, LLW, and MLLW were below the 5-year average. The amount of radioactive solid waste can vary significantly from year to year due to decontamination and decommissioning and environmental restoration activities. Waste minimization efforts have reduced waste generation rates for specific waste types as facility processes have been improved and nonhazardous product substitutions implemented (DOE 2008f:4-150). Waste generation rates for liquid LLW and liquid sanitary waste are not included in Table 3–43, but are discussed in the subsections that follow.

Table 3–43 Solid Waste Generation Rates at Los Alamos National Laboratory

Waste Type	*Los Alamos National Laboratory – Total*		*TA-55 Plutonium Complex*	
	5-Year Average	*2009*	*5-Year Average*	*2009*
TRU (cubic meters) [a]	206.4	112.6	109.2	96.3
LLW (cubic meters)	4,977	3,771.9	204.2	58.2
MLLW (cubic meters)	52.2	13.5	5.2	5.3
Hazardous (metric tons) [b]	1,376.2	1,722.9	5.1	9
Nonhazardous (metric tons) [c]	2,350	2,562	N/A	N/A

LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; N/A = not available; TA = technical area; TRU = transuranic.

[a] Includes mixed TRU wastes.

[b] Hazardous waste includes all chemical wastes, and not necessarily only those chemicals that are regulated by the Resource Conservation and Recovery Act.

[c] Nonhazardous (sanitary) waste is measured for LANL only (no breakdown by area). The amount of sanitary waste shown includes construction and demolition debris, but it does not include the amount associated with diverted recyclable materials not disposed in a landfill.

Note: To convert metric tons to tons, multiply by 1.1023; cubic meters to cubic feet, multiply by 35.315.

Sources: LANL 2006a:3-9, 2-12, 2007b:2-11, 3-9, 2009a:2-11, 3-9, 2010d:3-9, A-32, 2011b:3-103-13, A-32.

Table 3–44 provides a summary and status of current and planned treatment, storage, and disposal facilities at LANL.

3.2.10.2 Transuranic and Mixed Transuranic Waste

TRU and mixed TRU wastes may be generated during research, development, and stockpile manufacturing and management activities. Waste forms include contaminated scrap and residues, plastics, lead gloves, glass, and personal protective equipment. TRU and mixed TRU wastes may also be generated through environmental restoration, legacy waste retrieval, offsite source recovery, and DD&D activities. TRU and mixed TRU wastes are characterized and certified prior to shipment to WIPP (DOE 2008f:4-153). LANL made its first TRU waste shipment to WIPP in March 1999 (LANL 2011b:A-27) and has completed 923 shipments of TRU and mixed TRU waste to WIPP as of January 2012 (WIPP 2012).

TRU wastes are generated almost exclusively in PF-4, the CMR Building, the RLWTF, and the solid radioactive and chemical waste facilities in TA-50 and TA-54; and by the Environmental Programs. In 2009, mixed TRU wastes were generated only at PF-4 and the solid radioactive and chemical waste facilities. The quantities of TRU and mixed TRU waste are combined into one waste category since they are both managed for disposal at WIPP. During 2009, 112.6 cubic meters (4,000 cubic feet) of TRU and mixed TRU waste was generated at LANL, with 96.3 cubic meters (3,400 cubic feet) being generated by operations at PF-4. DOE transported 520 cubic meters (18,000 cubic feet) of TRU wastes to WIPP from LANL, and 77 cubic meters (2,700 cubic feet) of newly generated TRU wastes (nonhazardous) were added to storage. In addition, 285 cubic meters (10,000 cubic feet) of mixed TRU wastes were shipped to WIPP, and approximately 38 cubic meters (1,300 cubic feet) of mixed TRU wastes were added to storage (LANL 2011b:2-28, 3-13, A-32). LANL utilizes several locations for the storage of TRU waste. The applicable RCRA permit for storage domes at TA-54 in Area G provides for the storage of approximately 79,000 TRU drum equivalents; however, the storage capacity is constrained by safety basis analyses independent of the RCRA permit. Currently, this safety basis limits storage to approximately 17,000 TRU drum equivalents.[17] Storage pads capable of storing 2,450 55-gallon drums and a storage building capable of storing 545 55-gallon drums are also located in TA-55.

[17] DOE/NNSA has made a number of commitments to the New Mexico Environment Department (DOE/NNSA/NMED 2012) including a commitment that LANL will continue to decrease both the amounts of radioactivity and volume of TRU waste stored above-grade at Area G. Authorized storage capacity will continue to decrease at Area G as the stored waste is removed.

Table 3–44 Waste Treatment, Storage, and Disposal Capabilities at Los Alamos National Laboratory

Facility Name	Capacity	Status	Waste Type				
			Transuranic and Mixed Transuranic	*Low-Level Radioactive*	*Mixed Low-Level Radioactive*	*Hazardous*	*Nonhazardous*
Treatment Facility							
Waste Characterization, Reduction, and Repackaging Facility	Not applicable to newly generated waste [a]	Operating	X				
Radioassay and Nondestructive Test Facility	Ten shipments per week [b]	Operating	X				
Building 412 (Formerly called the Decontamination and Volume Reduction System)	Not applicable to newly generated waste [a]	Operating	X				
Transuranic waste drum preparation (TA-55 transuranic waste drum loading)	800 drums per year (55-gallon DOT Type 7A drums)	Operating	X				
Radioactive Liquid Waste Treatment Facility	TRU waste: 70,000 liters per year LLW: 4.0 million liters per year [c]	Operating	X	X	X		
Replacement Radioactive Liquid Waste Treatment Facility	TRU: 29,000 liters per year LLW: 5.0 million liters per year [d]	Design	X	X	X		
High-Explosive Waste Treatment Facility	TA-16 Open Burn: 9,070 kilograms per year; TA-36 + TA-39 Open Detonation: 6,800 kilograms per year	Operating				X	
Sanitary Wastewater System	Average actual: 400 million liters per year Design: 840 million liters per year	Operating					X
Sanitary Effluent Reclamation Facility	Current: 173 million liters per year After upgrade: 617 million liters per year	Operating					X
Los Alamos County Eco Station	Average: 940 tons per week	Operating					X
Storage Facility							
Transuranic, hazardous, chemical, mixed and tritiated waste storage domes at TA-54 [e]	17,000 55-gallon drum equivalents	Operating	X	X	X	X	
Outside drum storage pad at TA-55, 55-455 [f]	2,450 55-gallon drum equivalents	Operating	X				
Transuranic waste storage building, TA-55-0185 [f]	545 55-gallon drum equivalents	Operating	X				
Transuranic Waste Facility	Normal operations: 825 55-gallon drum equivalents with 2-high stacking Surge capacity: 1,240 drum equivalents with 3-high stacking [g]	Construction	X				

Facility Name	Capacity	Status	Waste Type				
			Transuranic and Mixed Transuranic	***Low-Level Radioactive***	***Mixed Low-Level Radioactive***	***Hazardous***	***Nonhazardous***
Disposal Facility							
Low-level radioactive waste disposal cells, shafts and trenches in Area G	3,000 cubic meters in extension to Pit 38	Operating		X			

DOT = Department of Transportation; LLW = low-level radioactive waste; TA = technical area; TRU = transuranic.

[a] The Waste Characterization, Reduction & Repackaging Facility and Building 412 are used only for legacy TRU waste repackaging. LANL waste acceptance criteria (WAC) require that newly generated TRU waste meet the WIPP WAC. Hence all newly generated TRU waste will be packaged for shipment to WIPP by the waste generator and will not require use of the Waste Characterization, Reduction & Repackaging Facility or Building 412.

[b] The number of drums of TRU waste per shipment is dependent on the weight and fissile loading.

[c] The current capacity is about 76 liters per minute (20 gallons per minute) for processing radioactive liquid waste. The facility is assumed to operate 6.5 hours per day, 135 operating days per year.

[d] The capacity would be equivalent to 27 batches per year of liquid radioactive waste, each batch containing about 1,140 liters (300 gallons).

[e] This value is based on the quantity of TRU waste currently in above-grade storage. Although the applicable RCRA storage permit provides for the equivalent of up to about 79,000 TRU drum equivalents at Area G, the storage capacity is constrained by safety basis analyses independent of the RCRA permit. Currently, this safety basis limits storage to approximately 17,000 TRU drum equivalents. DOE/NNSA has made a number of commitments to the New Mexico Environment Department (DOE/NNSA/NMED 2012) including a commitment that LANL will continue to decrease both the amounts of radioactivity and volume of TRU waste stored above-grade at Area G. Authorized storage capacity will continue to decrease at Area G as the stored waste is removed.

[f] Original capacity expressed in number of gallons but converted to 55-gallon drum equivalents since this is the primary container for storage.

[g] Surge capacity allows for temporary storage of a large quantity of transuranic waste should the need arise.

Note: Waste Management capabilities at LANL are currently being transitioned from Area G in TA-55 to new locations at LANL (see Appendix B, Section B.2.2). To convert cubic meters to cubic feet, multiply by 35.315; to convert liters to gallons, multiply by 0.26417; to convert kilograms to pounds, multiply by 2.2046.

Source: LANL 2013a.

3.2.10.3 Low-Level Radioactive Waste

LLW is generated at LANL when materials, equipment, and water are used in radiological control areas as part of work activities. When these contaminated items are no longer useable, they are removed from the area as LLW. Typical solid LLW streams include laboratory equipment, service and utility equipment, plastic bottles, disposable wipes, plastic sheeting and bags, paper, and electronic equipment (DOE 2008f:4-151). Environmental restoration and DD&D activities also generate LLW, primarily contaminated soil and debris.

LLW generated at LANL may be disposed of on site at Area G in TA-54 (a small amount of certain types of LLW) or shipped off site for disposal at Federal or commercial disposal facilities (beginning about 2008, most LLW generated by LANL operations has been disposed of off site) (DOE 2011g:3-65). Approximately 1,415 cubic meters (50,000 cubic feet) were placed into disposal cells and shafts at Area G, with the remaining 2,400 cubic meters (83,000 cubic feet) generated in 2009 disposed of off site. No new disposal cells were constructed, and disposal operations in TA-54 did not expand (LANL 2011b:2-28).

The principal facility for treating radioactive liquid waste at LANL is RLWTF, located in TA-50. RLWTF consists of the treatment facility, support buildings, and liquid and chemical storage tanks and receives liquid waste from various sites across LANL. Several upgrades to RLWTF have been implemented in recent years to upgrade the tank farm, install new ultrafiltration and reverse osmosis equipment, and install new nitrate reduction equipment. RLWTF has the capacity to treat up to 4 million liters (1.1 million gallons) per year of liquid LLW. RLWTF is slated for replacement with a new facility in accordance with the 2008 *LANL SWEIS* ROD; this new facility is being planned with an evaporation unit to eliminate liquid discharges into the environment.

3.2.10.4 Mixed Low-Level Radioactive Waste

Most operational MLLW is generated by stockpile stewardship and research and development programs. Typical waste streams include contaminated lead bricks and debris, spent chemical solutions, fluorescent light bulbs, copper solder joints, and used oil. Environmental restoration and DD&D activities also produce some MLLW. MLLW may be sent for treatment to a variety of permitted commercial facilities (located, for example, in Florida, Tennessee, Texas, Washington, and Utah) with subsequent disposal at Federal or commercial disposal facilities. In 2009, 13.5 cubic meters (480 cubic feet) of MLLW was transported on site to TA-54 for temporary storage prior to disposition off site (LANL 2011b:2-28, 3-8).

3.2.10.5 Hazardous Waste

Hazardous and toxic wastes are those wastes defined as such pursuant to RCRA and the Toxic Substances Control Act, respectively. Typical hazardous waste streams include solvents, unused chemicals, acids and bases, solids such as barium-containing explosive materials, laboratory trash, and cleanup materials such as rags. Toxic wastes principally include waste materials containing asbestos or PCBs. Special wastes are designated under the New Mexico Solid Waste Regulations and include industrial waste, infectious waste, and petroleum-contaminated soil (DOE 2008f:4-156).

Construction and demolition debris consists primarily of asbestos and construction debris from DD&D projects, and may be disposed of in permitted solid waste landfills pursuant to Subtitle D of RCRA (DOE 2008f:H-61). This waste typically consists of a mixture of materials that would be difficult to separate and sort for recycle or beneficial reuse. In 2009, 1,724 metric tons (1,900 tons) of hazardous waste were generated at LANL. Only 9 metric tons (10 tons) were generated by operations at TA-55.

3.2.10.6 Nonhazardous Waste

The SWWS Plant in TA-46 has the capacity to treat up to 840 million liters (220 million gallons) per year of liquid sanitary waste. In 2009, the plant processed about 323 million liters (85.3 million gallons) of wastewater, all of which was pumped to TA-3 to be either recycled at the TA-3 power plant (as makeup water for the cooling towers), or discharged into Sandia Canyon via permitted Outfall Number 001 (LANL 2011b:3-5).

Sanitary sludge from the SWWS Plant is dried for a minimum of 90 days to reduce pathogens and then disposed of as special waste (as determined by the State of New Mexico) at an authorized, permitted landfill. The volume of sanitary sludge generated and disposed of by DOE is reported in the annual site environmental surveillance report (DOE 2008f:4-148).

Sanitary solid waste is excess material that is not radioactive or hazardous and can be disposed of in a permitted solid waste landfill. Routine sanitary waste consists mostly of food and food-contaminated waste and cardboard, plastic, glass, Styrofoam® packing material, and similar items. Nonroutine sanitary waste is typically derived from construction and demolition projects and includes materials such as concrete, asphalt, dirt, or brush that may be separated and sorted by material for recycle or beneficial reuse. LANL sanitary solid waste was disposed of at the former Los Alamos County Landfill, which no longer receives waste for disposal. The landfill site is located within LANL boundaries. Waste volumes delivered to the landfill varied considerably over the last decade, with a peak of more than 14,000 tons (12,700 metric tons) transferred to the landfill in 2000 due to removal of Cerro Grande Fire debris. A solid waste transfer station, the Los Alamos County Eco Station, has been constructed at the former landfill site. A landfill closure plan for the Los Alamos County Landfill was submitted to NMED in September 2005 (LANL 2011b:3-103-11). Solid waste received at the Los Alamos County Eco Station is transported off site for recycle or disposal, typically to the Rio Rancho and Valencia County solid waste facilities for final disposition.

Industrial effluent is discharged through NPDES-permitted outfalls across LANL. The number of outfalls has been reduced in recent years with an eventual goal of achieving zero liquid discharge from LANL operations. As of December 31, 2009, LANL had 15 permitted wastewater outfalls (14 industrial and 1 sanitary) regulated under NPDES Permit Number NM0028355. In 2009, however, flow was recorded at only 12 outfalls. In 2009, combined discharges totaled 500 million liters (133.3 million gallons). Of this total, 4.5 million liters (1.2 million gallons) were discharged from TA-55 (LANL 2011b:4-2, A-32). Section 3.2.3.1 includes a discussion of the NPDES permit and permitted effluent discharges from LANL.

3.2.11 Environmental Justice

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionate to those on the population as a whole in the potentially affected area. The potentially affected area for LANL includes parts of eight counties throughout New Mexico that make up an area within a 50-mile (80-kilometer) radius of PF-4.

Portions or all of 16 Pueblo or tribal lands have been identified within the potentially affected area. **Figure 3–16** displays the proximity of Pueblo and tribal lands within the 50-mile (80-kilometer) potentially affected area relative to LANL.

To be consistent with the human health analysis, the population distributions of the potentially affected area are calculated using data at the block-group level of spatial resolution from the 2010 census, with the exception of Los Alamos County, where block level data from the 2010 census was used to more accurately represent populations in close proximity to the site (Census 2010b). The 2010 census data has been projected to the year 2020 using data from the 1990 census, 2000 census, and the 2010 census for each of the affected counties within a 50-mile (80-kilometer) radius of PF-4 (Census 1990, 2001, 2010b).

In accordance with CEQ guidance, meaningfully greater minority populations are identified where either the minority population of the affected area exceeds 50 percent, or the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis (CEQ 1997). Meaningfully greater is defined here as 20 percentage points above the population percentage in the general population. The average minority population percentage of New Mexico for the projected 2020 population is approximately 62.7 percent and the average minority population percentage of the counties surrounding LANL is approximately 61.6 percent. Comparatively, a meaningfully greater minority population percentage relative to the general population of the state and surrounding counties would exceed the 50 percent threshold defined by CEQ. Therefore, the lower threshold of 50 percent is used to identify areas with meaningfully greater minority populations surrounding LANL. In order to evaluate the potential impacts on populations in closer proximity to the proposed sites, additional radial distances of 5, 10, and 20 miles (8, 16, and 32 kilometers) are also analyzed. **Table 3–45** shows the composition of the ROI surrounding PF-4 at each of these radial distances.

Block versus Block Group Level Evaluation

In response to comments received on the *Draft SPD Supplemental EIS*, a more refined analysis of the area within a 50 mile (80 kilometer) radius of the Los Alamos National Laboratory (LANL) was performed using block level data from the U.S. Census Bureau as opposed to block group level data. Blocks are the smallest geographic areas for which the U.S. Census Bureau tabulates data relative to race and ethnicity. Block groups are a collection of one or more blocks. In support of this analysis, data were collected for approximately 22,000 blocks within the affected area compared to approximately 280 block groups.

The analysis performed using block level data resulted in a small decrease in the total population within the 50 mile (80 kilometer) radius compared to the population estimate developed using block group level data; a reduction of approximately 1.4 percent. However, the makeup of the estimated population in terms of the percentage of minority and non-minority individuals remained the same. For example, American Indians still represented 6 percent, persons of Hispanic descent still represented 45 percent, and minorities still represented 56 percent of the total estimated population.

The changes in the estimated population distribution that resulted from using block level data as opposed to block group level data did not change the conclusions presented in this *SPD Supplemental EIS* regarding the potential environmental impacts of the proposed surplus plutonium disposition activities at LANL on surrounding minority populations.

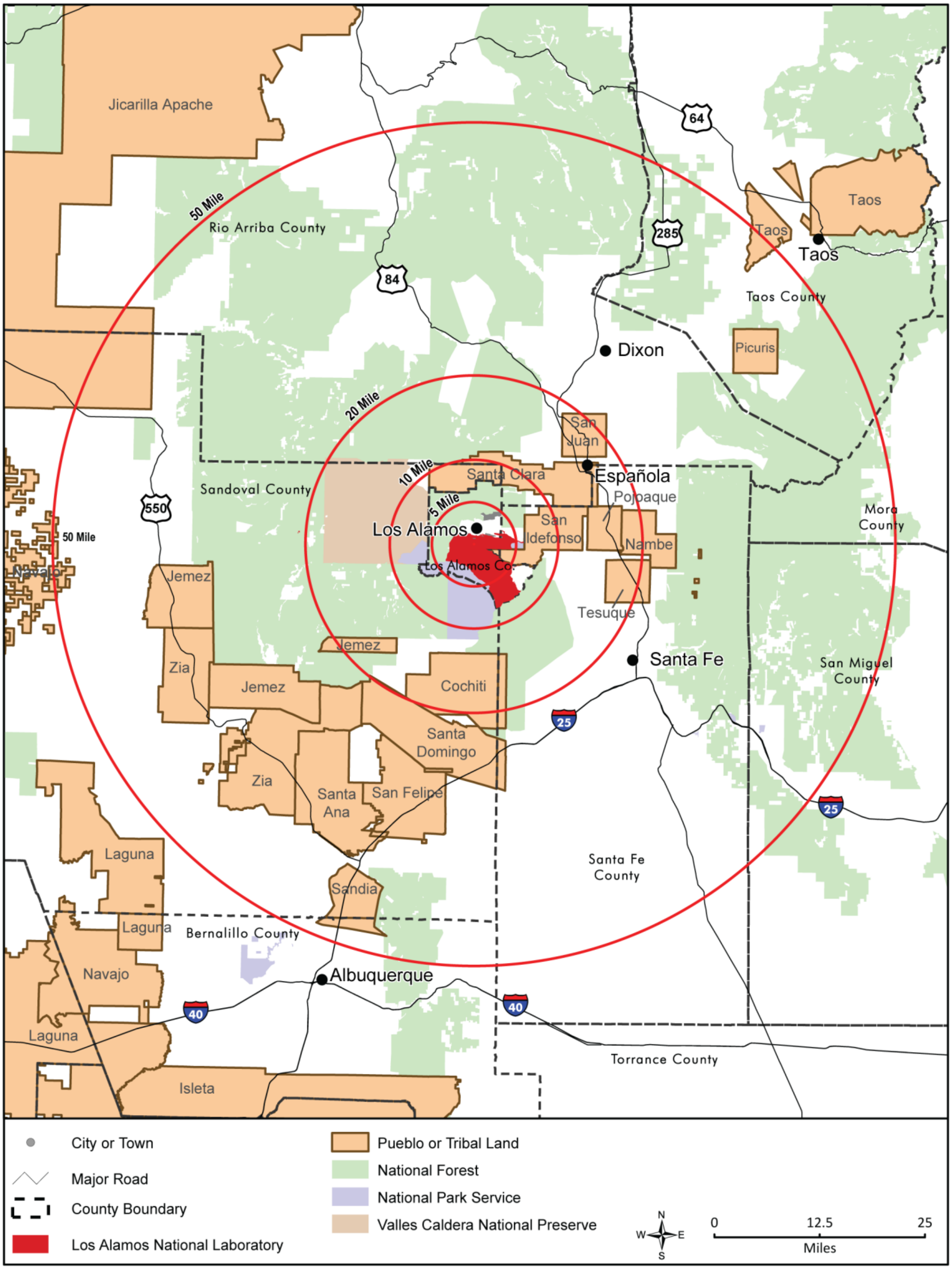


Figure 3–16 Pueblo and Tribal Lands within 50 Miles (80 kilometers) of Los Alamos National Laboratory

Table 3–45 Projected Populations in the Potentially Affected Area Surrounding Los Alamos National Laboratory in 2020

Population	5 Miles		10 Miles		20 Miles		50 Miles	
	Population	Percent of Total	Population	Percent of Total	Population	Percent of Total	Population	Percent of Total
Nonminority	8,619	69	13,493	67	21,883	36	197,224	44
Total Hispanic [b]	2,075	17	3,613	18	31,897	52	201,687	45
American Indian or Alaska Native [a]	185	1	1,043	5	5,475	9	27,801	6
Other Minority [a]	3,615	29	5,556	28	34,206	56	222,516	50
Total Minority [a]	3,800	31	6,599	33	39,681	64	250,317	56
Total Population	12,419	100	20,092	100	61,564	100	447,541	100
Low-Income	352	3	777	4	8,712	14	54,194	12

[a] Includes Hispanic persons.
[b] Includes all Hispanic persons regardless of race.
Note: To convert miles to kilometers, multiply by 1.609. Totals may not equal the sum of subcategories due to rounding. The potentially affected area comprises the area within a 50-mile (80-kilometer) radius of the site.

The total projected population residing in the LANL ROI in 2020 would be approximately 447,541; 55.9 percent of which would be considered members of a minority population. Block-level spatial resolution was used in this analysis for Los Alamos County to allow identification of populations who reside adjacent to the LANL site boundary. Of the 611 blocks in Los Alamos County, 45 (7.4 percent) were identified as containing meaningfully greater minority populations. Finer spatial resolution would not provide any benefit in identifying populations at distances further from LANL. Therefore, block group level spatial resolution was used in the remainder of the 50-mile (80-kilometer) radius. Of the 259 block groups in the remainder of the potentially affected area, approximately 147 (57 percent) were identified as containing meaningfully greater minority populations.

The areas within 5 miles (8 kilometers) of PF-4 contain the lowest concentration of minority populations. The overall composition of the ROI is predominantly nonminority within the first 10 miles (16 kilometers). The area within 20 miles (32 kilometers) contains the highest concentration of minority populations within the ROI. The percent of minority populations decreases slightly in the area within 50 miles (80 kilometers); however, the overall composition of minority populations remains high. Similar to the minority populations, the concentration of low-income populations is lowest within the first 5 miles (8 kilometers).

The Hispanic or Latino population is the largest minority population within each radial distance. **Figures 3–17** and **3–18** display the blocks and block groups identified as having meaningfully greater minority and low-income populations, respectively, surrounding PF-4.

The projected low-income population (those living below the poverty threshold) living within 50 miles (80 kilometers) of PF-4 in 2020 is estimated to be 54,194 people (12 percent). Meaningfully greater low-income populations are identified using the same methodology described for identification of minority populations. The 2010 census does not contain any data relative to income. The Census Bureau's ACS 5-year estimates are the only data set that publishes current data relative to income at the block group level of geography. Therefore, the 2006–2010 ACS 5-year estimates are used to identify low-income populations in the potentially affected area. These populations were then scaled up to be directly comparable to the projected 2020 potentially affected population. The 2006–2010 ACS 5-year estimates show the average low-income population percentage of New Mexico is 18.4 percent and the average low-income population of the counties surrounding PF-4 is 15.1 percent (Census 2011e). Comparatively, a meaningfully greater low-income population percentage using these statistics would be 35.1 percent.

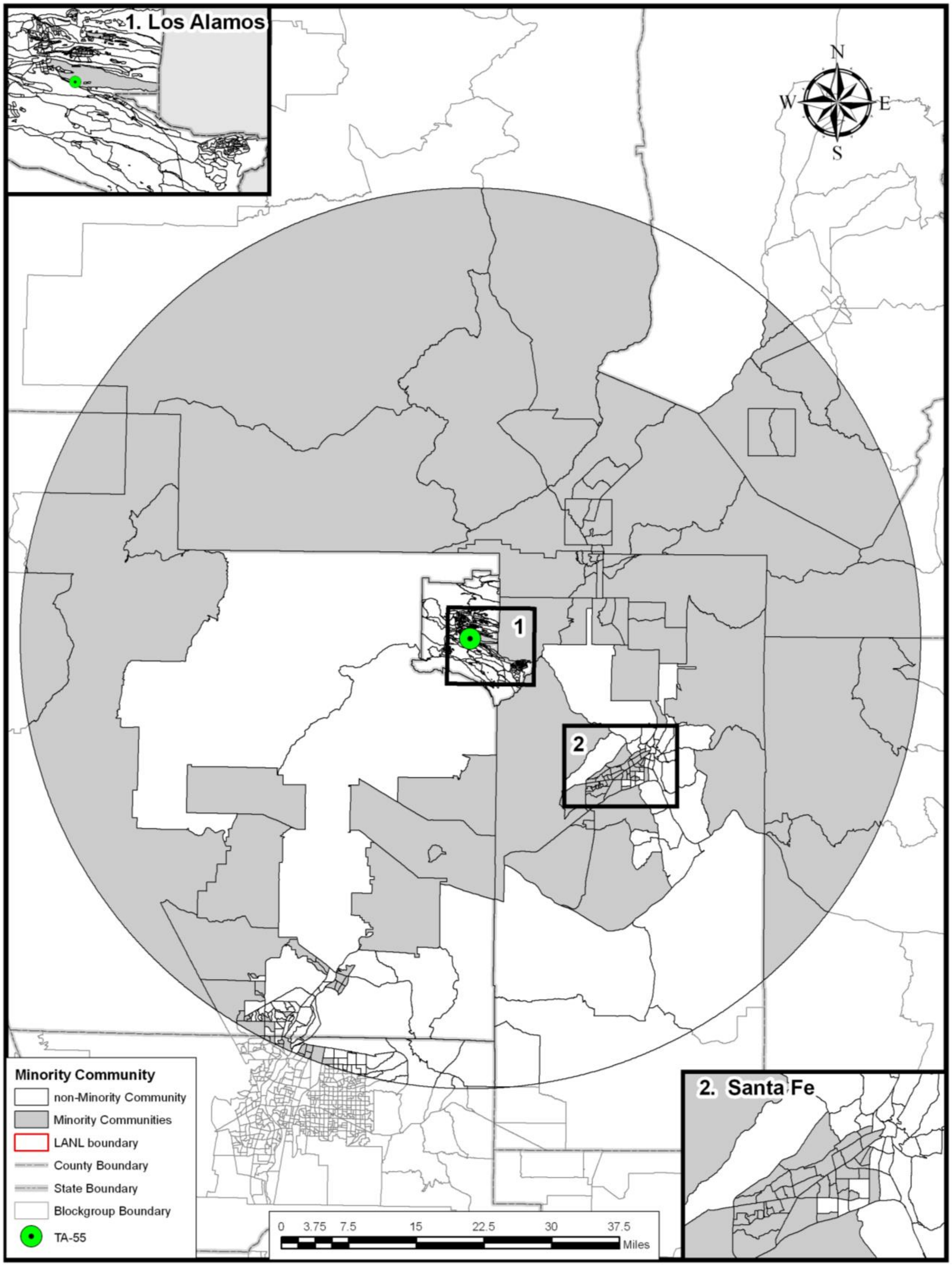


Figure 3–17 Meaningfully Greater Minority Populations Surrounding Los Alamos National Laboratory

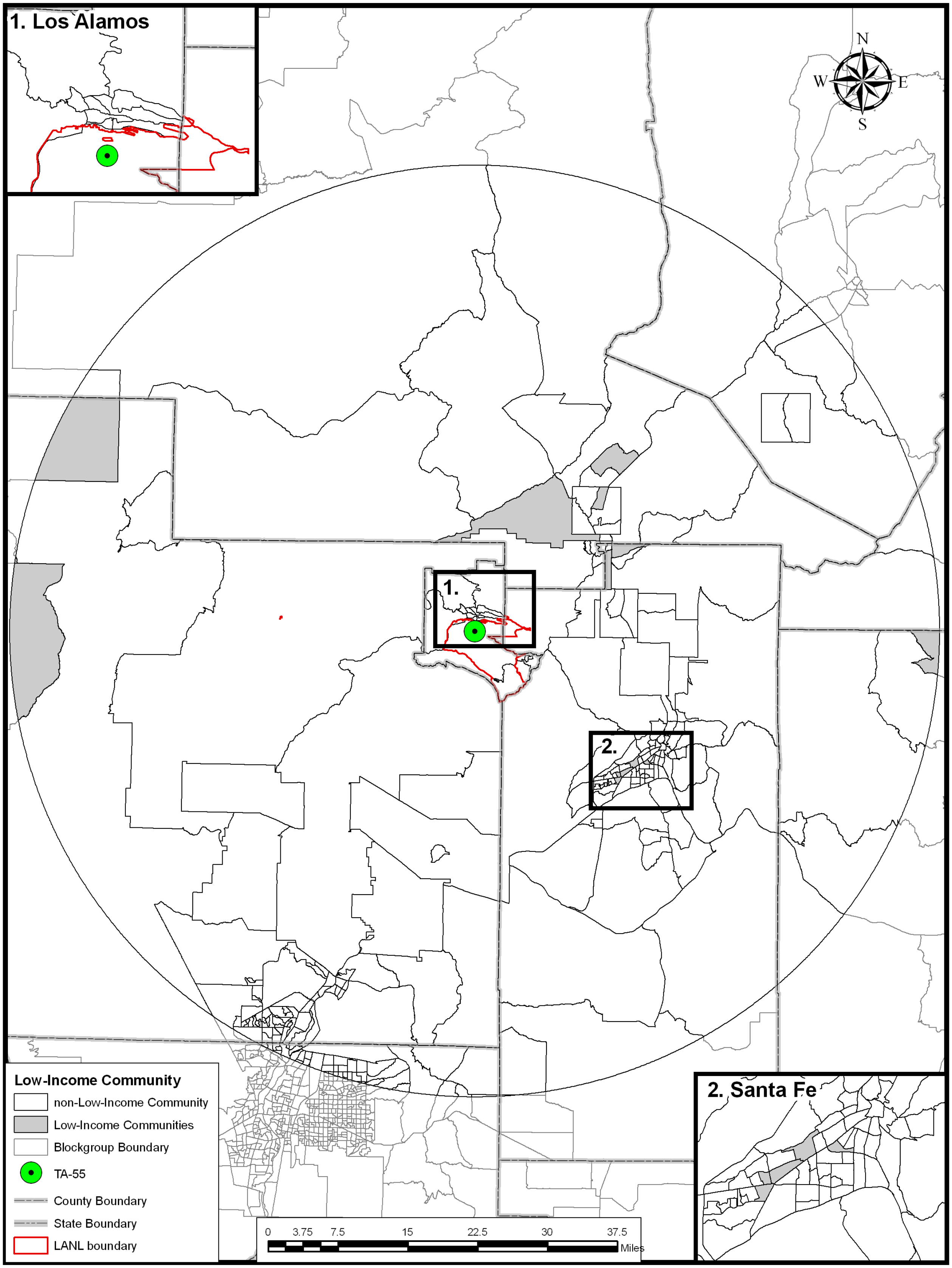


Figure 3–18 Meaningfully Greater Low-Income Populations Surrounding Los Alamos National Laboratory

Therefore, the lower threshold of 35.1 percent is used to identify areas with meaningfully greater low-income populations surrounding LANL (PF-4). Block-level spatial resolution is unavailable from the ACS 5-year estimates. Therefore, meaningfully greater low-income populations are identified using block group level spatial resolution. Of the 276 block groups that surround PF-4, 14 (5.1 percent) contain meaningfully greater low-income populations.

Figures 3–19 and **3–20** show cumulative total, minority, and low-income populations projected to live within the potentially affected area in 2020 as a function of distance from PF-4. Values along the vertical axis show populations residing within a given distance from these facilities.

3.3 Reactor Sites for Mixed Oxide Fuel Irradiation

As explained in the text box at the beginning of this chapter, this section includes only the resource areas that could be affected by the proposed action and alternatives. Consistent with the *SPD EIS*, four resource areas were considered for the two potential TVA reactor sites, Browns Ferry and Sequoyah Nuclear Plants: air quality and noise, radiation exposure and risk, waste management, and environmental justice. Other resource areas were not considered in detail because the use of mixed oxide (MOX) fuel would not impact the resource areas. For example, because the use of MOX fuel at the TVA reactor sites would not be expected to appreciably affect the number of employees working at the sites, no socioeconomic impacts would be expected as a result of a decision to use MOX fuel. Similarly, no new construction would be required at the sites if MOX fuel were used so there would be no impacts on land use, geology and soils, or cultural resources. The level of detail for the resource areas varies, depending on the potential for impacts resulting from each alternative.

3.3.1 Browns Ferry Nuclear Plant Overview

The Browns Ferry Nuclear Plant is located on approximately 840 acres (340 hectares) of federally owned land in Limestone County, Alabama, that is under the custody of TVA. It is approximately 10 miles (16 kilometers) southwest of Athens, Alabama, and about 30 miles (48 kilometers) west of Huntsville, Alabama. The plant is located on the north shore of Wheeler Reservoir. The reservoir, which is on the Tennessee River, is 74 miles (119 kilometers) long. It is formed by Wheeler Dam, a hydroelectric dam located on the river approximately 20 miles (32 kilometers) downriver from the Browns Ferry Nuclear Plant (NRC 2005c:Sections 1.3 and 2.1). The 2010 population within a 50-mile (80-kilometer) radius of the Browns Ferry Nuclear Plant is estimated to be about 819,000 (TVA 2009:Table 2.2-6).

TVA employs about 1,500 full-time equivalent employees to maintain and operate the Browns Ferry Nuclear Plant (TVA 2012:4). The Browns Ferry Nuclear Plant comprises three boiling water reactors, Units 1, 2, and 3, each with a gross maximum capacity of approximately 1,160 megawatts of electricity (1,158, 1,161, and 1161 megawatts, respectively) (TVA 2012). The reactors are operated by TVA under Operating Licenses DPR-33, DPR-52, and DPR-68 (NRC 2005c). The operating licenses were renewed in May 2006, which will allow continued operation of Units 1, 2, and 3 until 2033, 2034, and 2036, respectively (TVA 2010a). TVA plans to increase the generating capacity of each unit to approximately 1,295 megawatts with an extended power uprate (TVA 2012). The Browns Ferry Nuclear Plant units are cooled by pumping water from Wheeler Reservoir into the turbine generator condensers and discharging it back to the reservoir via three large submerged diffuser pipes (NRC 2005c:Section 2.1.3). Cooling towers may or may not be used, depending on ambient (e.g., river temperature, air temperature, dew point temperature) and operating conditions. When cooling towers are not in service, the withdrawal and return rates are about the same (2,031,528 gallons per minute [7,689,333 liters per minute]). When cooling towers are in service, 33,215 gallons per minute (125,720 liters per minute) of the withdrawn water is evaporated in the cooling towers (TVA 2012:5).

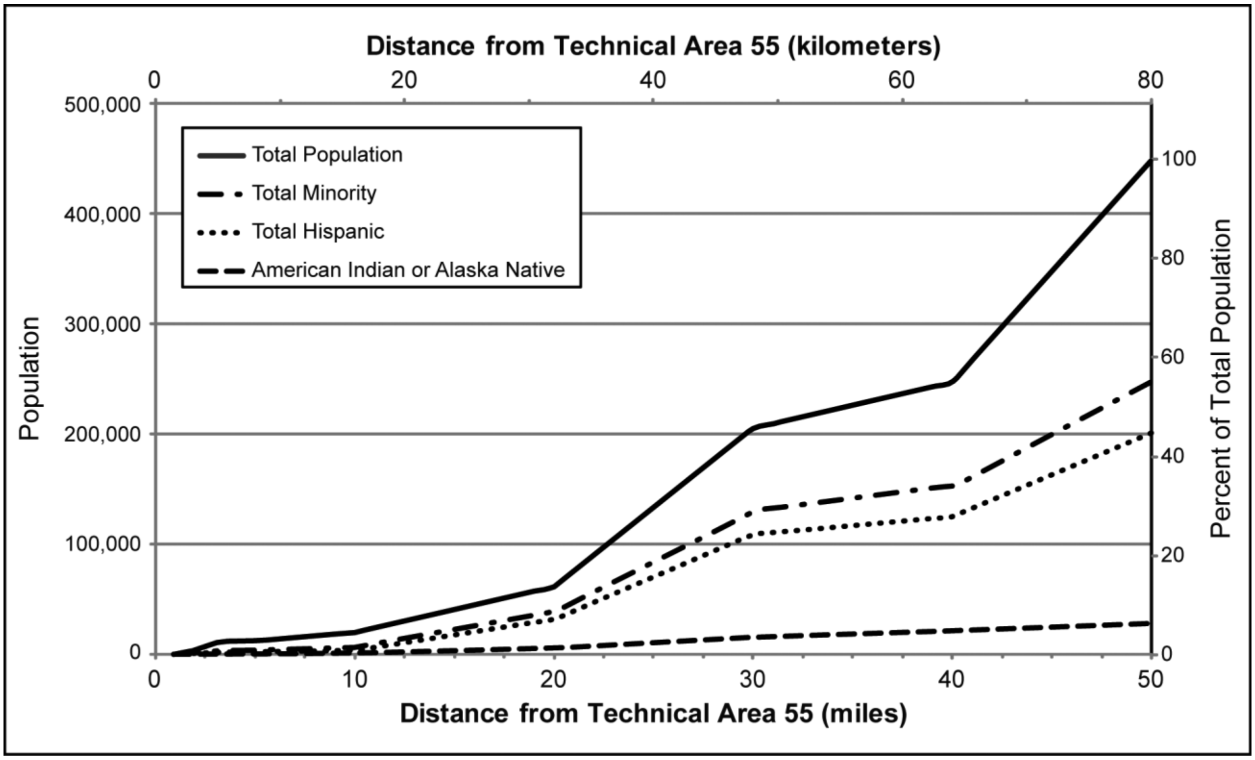


Figure 3–19 Cumulative Minority Populations as a Function of Distance from Los Alamos National Laboratory

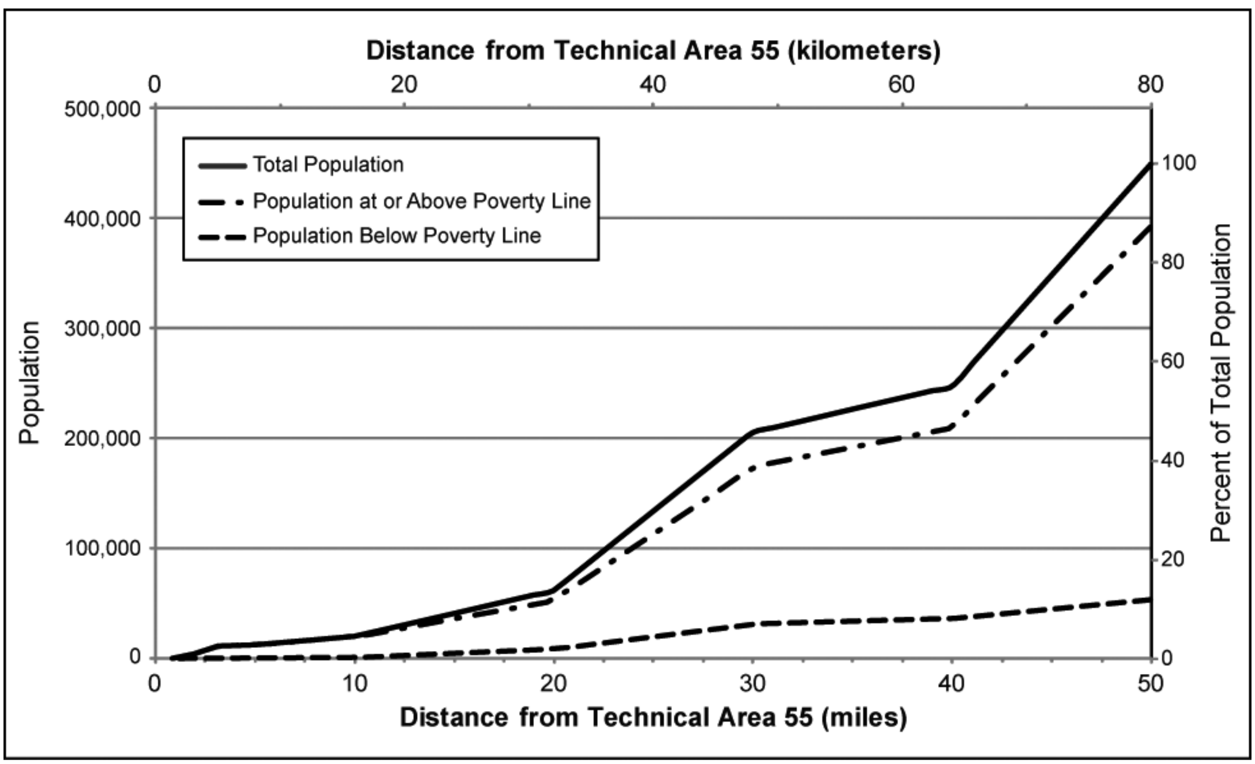


Figure 3–20 Cumulative Low-Income Populations as a Function of Distance from Los Alamos National Laboratory

New (unirradiated) fuel is transferred directly to the used fuel storage pool upon receipt. There is a dry storage vault in the Reactor Building, but it no longer is used to store new fuel. Fuel transfer during refueling is conducted underwater. Irradiated (used) fuel is stored underwater in the Reactor Building until prepared for shipment from the site or for additional interim storage at the onsite Independent Spent Fuel Storage Installation. During a typical 24-month fuel cycle (TVA 2012:5), 312 used fuel assemblies are generated. A Fuel Pool Cooling and Cleanup System is provided to remove decay heat from used fuel stored in the fuel pool and to maintain a specified water temperature, purity, clarity, and level.

Security at the site is provided in accordance with NRC regulations and includes security checkpoints, barbed wire fencing, surveillance cameras, and intruder detection.

In addition to the information presented in this section, more details about the affected environment at the Browns Ferry Nuclear Plant Units 1, 2, and 3 can be found on the NRC website: http://www.nrc.gov/ in NRC Docket Numbers 50–259, 50–260, and 50–296, respectively.

3.3.1.1 Air Quality and Noise

State monitoring data for Limestone County, nearby Huntsville, and adjoining counties include ambient monitoring data for PM_{10}, $PM_{2.5}$, and ozone. Concentrations of PM_{10} and $PM_{2.5}$ in the region in 2008 were within the NAAQS. Monitoring values in Huntsville, the nearest ozone monitor to Browns Ferry Nuclear Plant, exceeded the ozone 8-hour standard value on two occasions in 2008 (EPA 2010). Neither Limestone County nor the adjoining counties are designated as nonattainment areas with respect to the NAAQS for criteria air pollutants (EPA 2009d).

The primary sources of nonradiological air pollutants at Browns Ferry include emergency diesel generators and employee vehicles (TVA 2012).

Major noise emission sources on the site include various industrial facilities, equipment, and machines. Although traffic is the primary source of noise at the site boundary and at residences near roads, the acoustic environment along the site boundary and at nearby residences away from traffic noise is typical of rural locations.

3.3.1.2 Radiation Exposure and Risk

The radiation environment of the Browns Ferry Nuclear Plant is addressed in this section in terms of radiological health impacts on humans associated with background radiation and normal operations at the plant. Radiological health impacts on individual members of the public, on the populations living within 50 miles (80 kilometers), on individual Browns Ferry Nuclear Plant workers, and on the total workforce at the plant are presented.

General Environment

Background Radiation – Major sources and levels of background radiation exposure to individuals in the vicinity of the Browns Ferry Nuclear Plant are shown in **Table 3–46**. Background radiation doses are unrelated to plant operations. Annual background radiation doses to individuals are expected to remain constant over time.

Tennessee Valley Authority's (TVA's) Commitment to Nuclear Safety

TVA's top priority for its nuclear plants is safety. TVA operates its nuclear plants with appropriate safeguards and practices, and with oversight by a number of internal and external agencies.

TVA's nuclear power activities are carried out with public health and safety, the protection of its employees, and the environment as paramount considerations. To support this objective, it is TVA's policy to maintain a strong nuclear safety culture that serves to make nuclear safety the overriding priority for each nuclear facility and for each individual associated with it. For the complete text of TVA's Commitment to Nuclear Safety, go to: http://www.tva.gov/foia/readroom/policy/newprin/Commitment_to_Nuclear_Safety.htm.

Table 3–46 Radiation Exposure of Individuals in the Browns Ferry Nuclear Plant or Sequoyah Nuclear Plant Site Vicinities Unrelated to the Plant Operations

Source	*Effective Dose Equivalent (millirem per year)*
Natural background radiation	
Cosmic and terrestrial radiation [a]	90
Radon-220 and -222 in homes (inhaled) [b]	228
Other background radiation [b]	
Diagnostic x-rays and nuclear medicine	300
Occupational	0.5
Industrial, security, medical, educational, and research	0.3
Consumer products	13
Total (rounded)	**630**

[a] TVA 2012:3.
[b] NCRP 2009:12, Represent averages for the United States.

Public – The maximally exposed individual (MEI) is a hypothetical person residing near the Browns Ferry Nuclear Plant who would receive the highest effective dose equivalent from plant operations. Typical (representative) Browns Ferry Nuclear Plant operations result in an annual dose of 0.043 millirem to the MEI from all pathways (TVA 2012:3). This dose is well below the annual permissible public exposure guideline values of 5 millirem from atmospheric releases and 3 millirem from liquid releases (10 CFR Part 50, Appendix I – Numerical Guides to meet the "as low as reasonably achievable" [ALARA] criterion) and the 25-millirem standard from all pathways combined (40 CFR Part 190). It is also below the annual limit of 100 millirem total effective dose equivalent to an individual member of the public that is given in 10 CFR 20.1301. The MEI dose is well below the 318 millirem[18] received annually by an average individual in the vicinity of the Browns Ferry Nuclear Plant from natural background radiation.

Using a risk estimator of 600 LCFs per 1 million person-rem to the public (or 0.0006 LCFs per rem) (DOE 2003a), the LCF risk to the MEI from annual Browns Ferry Nuclear Plant operations is estimated to be 3×10^{-8}. That is, the estimated annual probability of this person developing a fatal cancer sometime in the future from normal plant operations is about 1 in 33 million.

The annual dose to the population residing within 50 miles (80 kilometers) of the Browns Ferry Nuclear Plant was calculated to be 0.15 person-rem from typical plant operations (TVA 2012:2). This is well below the annual dose of 247,000 person-rem received by this same population from natural background radiation.[19] Plant operations are projected to cause no LCFs in the population within 50 miles (80 kilometers) of the Browns Ferry Nuclear Plant. Using the risk estimator of 600 LCFs per 1 million person-rem, the calculated LCF risk is 9×10^{-5} from 1 year of operations; this indicates an annual risk of 1 in 11,000 of a single excess latent fatal cancer occurring in the population as a result of normal Browns Ferry Nuclear Plant operations.

Workers – Browns Ferry Nuclear Plant workers may receive an additional dose from working in facilities with nuclear materials. In conformance with the requirements given in 10 CFR 20.1101 (b), procedures and engineering controls are employed to achieve occupational doses that are ALARA. For the 5-year period from 2005 through 2009, the average annual dose to an individual worker from plant operations was 175 millirem and the maximum annual dose to a worker was 1,398 millirem (TVA 2012:4). These values are below the NRC annual radiological dose limit of 5,000 millirem (10 CFR Part 20.1201). Over

[18] *The dose from cosmic and terrestrial radiation measured by TVA is 90 millirem per year (TVA 2012:3); the average dose to an individual in the United States from radon-220 and -222 is 228 millirem per year (NCRP 2009:12).*
[19] *This value is based on an annual natural background radiation dose of 318 millirem to an individual, including doses from radon-220 and -222. If only cosmic and terrestrial radiation is considered, the population dose would be 70,044 person-rem (TVA 2012:3).*

the same period, the average annual total worker dose to the 3,042 workers who received a measurable dose was 532 person-rem (TVA 2012:4). Using a risk estimator of 600 LCFs per 1 million person-rem, the risk of an LCF for the average worker would be 0.0001 annually. No fatal cancers are projected for the worker population from normal plant operations.

Health Effect Studies

The National Cancer Institute publishes national, state, and county incidence rates of various types of cancer (NCI 2013). However, the published information does not present an association of these rates with their causes, e.g., specific facility operations and human lifestyles. **Table 3–47** presents incidence rates for the United States, Alabama, Tennessee, Limestone County, and the four counties in Alabama and the two counties in Tennessee that are adjacent to Limestone County.

Table 3–47 Cancer Incidence Rates [a] for the United States, Alabama, Tennessee, and Counties in the Vicinity of the Browns Ferry Nuclear Plant Site, 2005–2009

	All Cancers	*Thyroid*	*Breast*	*Lung and Bronchus*	*Leukemia*	*Prostate*	*Colon and Rectum*
United States	465	11.8	122	67.2	12.4	151.4	46.2
Alabama	466.2	8	118.8	76	11.5	161	49.2
Limestone County [b]	458.2	9.2	101.4	80.7	14.2	161.8	42
Lauderdale County	476.1	11.7	106	76.7	14.3	139.6	51.7
Lawrence County	421.1	(c)	86.5	83.8	(c)	141.7	49
Madison County	448.6	9.3	127.2	66.5	13.6	138.8	45.1
Morgan County	508.8	5.1	122.5	81.5	15.2	192.2	49.9
Tennessee	470.5	11.3	119.6	80.3	11.7	145.6	47.7
Giles County	445.7	19.7	106.5	86.1	11.5	105.3	55.3
Lincoln County	442.4	14.6	109.9	75.2	10.2	102.5	65.7

[a] Age-adjusted incidence rates; cases per 100,000 persons per year.
[b] Location of the Browns Ferry Nuclear Plant.
[c] Data have been suppressed by the National Cancer Institute to ensure confidentiality and stability of rate estimates when the annual average count is three or fewer cases.
Source: NCI 2013.

Emergency Preparedness

The design and operating procedures instituted in accordance with the regulations for operating the Browns Ferry Nuclear Plant and the plant's highly trained workforce make it unlikely that an accidental release of radiation would take place. Nevertheless, emergency preparedness is an integral part of the programs at the plant to assure that the impacts on people associated with an accident are controlled to the extent possible. The Emergency Management Program for Browns Ferry is based on the following principles:

- Identification and characterization of accidental radiation releases
- Analysis of potential accidents associated with the radiation releases
- Prediction of consequences of the releases at various locations
- Planned response actions to minimize exposure of workers and the public

The Browns Ferry Nuclear Plant emergency plan specifies the actions to be taken in the case of an emergency. Designated plant personnel work closely with Federal, state, and local agencies to ensure that coordinated emergency response plans are in place to protect plant employees and the public in the event of an accident whose predicted dose may exceed Federal government protective action guidelines. As a condition for obtaining and maintaining an operating license for the Browns Ferry Nuclear Plant, TVA developed and updates both on- and offsite emergency plans. The onsite emergency plan, including updates, is approved by NRC. The offsite plan is evaluated by FEMA, then provided to NRC. NRC considers TVA's resolution of FEMA's findings as a condition of maintaining the Browns Ferry Nuclear Plant operating license.

The on- and offsite plans are closely coordinated. The onsite plan includes a series of emergency plan implementing procedures that define the responsibilities and actions to be taken by plant personnel in the event of an emergency. The offsite plan defines two "emergency planning zones." One zone covers an area within a 10-mile (16-kilometer) radius of the plant, in which people could be potentially harmed by exposure to direct radiation. Necessary sheltering and evacuation of communities are planned for within this zone. The second zone covers an area out to a 50-mile (80-kilometer) radius from the plant, where radioactive materials could contaminate water supplies, food crops, and livestock, and interdiction may be necessary. Mitigation measures implemented in this zone would depend on the contamination levels measured and their locations.

Each year, TVA; the State of Alabama; and the Counties of Lauderdale, Lawrence, Limestone, and Morgan provide emergency preparedness planning information to residents and businesses within 10 miles (16 kilometers) of the Browns Ferry Nuclear Plant. Included in this information is an evacuation map showing transportation routes, checklists of emergency and evacuation supplies, and instructions on obtaining potassium iodide tablets.[20] In the event of an emergency, sirens in this zone would sound and additional relevant information would be provided through local radio and television stations. Actions people should take if advised to take shelter or leave an area are included in the preparedness information and would be augmented by real-time information provided through local media.

As part of the reactor oversight process, NRC reviews TVA's emergency procedures and training annually. These reviews include regular drills and exercises that assist TVA in identifying areas needing improvement. TVA is required to exercise its full emergency plan for the Browns Ferry Nuclear Plant with NRC, FEMA, and offsite authorities at least once every 2 years. However, the emergency sirens are tested more frequently.

3.3.1.3 Waste Management

Solid wastes generated in conjunction with operation of the Browns Ferry Nuclear Plant can be subdivided into four general categories: LLW, MLLW, hazardous waste, and nonhazardous waste.

Solid LLW consists of spent resins, and dry active waste (contaminated protective clothing, paper, rags, glassware, and trash). This waste is temporarily stored on site and subsequently transported to a licensed disposal facility (TVA 2002:3-5). The generation of MLLW is sporadic, but when generated, MLLW is shipped to a licensed treatment, storage, and disposal facility (TVA 2012). **Table 3–48** shows the quantity of solid waste generated at the Browns Ferry Nuclear Plant.

Table 3–48 Solid Waste Generation at the Browns Ferry Nuclear Plant

Waste Type	***Annual Generation*** [a]
Low-level radioactive waste [b] – cubic meters (cubic feet)	1,986 (70,134)
Mixed low-level radioactive waste [c] – cubic meters (cubic feet)	0.1 (3.5)
Hazardous waste – kilograms (pounds)	1,351 (3,000)
Nonhazardous waste – metric tons (tons)	612 (675)

[a] Reflective of three-unit operation.
[b] Average of data from 2006 to 2009.
[c] Based on fiscal years 2008 to 2009.
Source: TVA 2012:4.

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[20] *Potassium iodide (KI) is a chemical compound that can be used to protect the thyroid gland from possible radiation injury caused by radioactive iodine (radioiodine).*

Hazardous wastes include paint-related materials, spent solvents used for cleaning and degreasing, and universal wastes such as spent batteries and fluorescent light tubes. TVA operates a hazardous waste storage facility in Muscle Shoals, Alabama that holds a RCRA Part B permit for temporary storage of hazardous wastes. The hazardous waste storage facility serves as a central collection point for TVA-generated hazardous wastes, and maintains contracts with waste treatment and disposal facilities. All hazardous waste generated at the Browns Ferry Nuclear Plant is shipped to the hazardous waste storage facility for consolidation, storage, and disposal through approved and licensed facilities. The Browns Ferry Nuclear Plant recycles paint solvents (primarily methyl ethyl ketone) using an onsite still. Universal wastes are collected and shipped to recycling firms to be recycled. While not a hazardous waste as defined in the RCRA regulations, used oil is also generated at the Browns Ferry Nuclear Plant as a result of maintenance activities. Used oil is collected, stored on site, and shipped to an approved recycling center for energy recovery (TVA 2002:3-6).

Nonhazardous waste includes sanitary waste and construction and demolition debris. Sanitary waste is collected and transported to a state-licensed regional landfill permitted to accept Subtitle D waste materials from Limestone County. The Browns Ferry Nuclear Plant has an active recycling program that segregates and recycles scrap metal, cardboard, paper, batteries, and aluminum cans at approved state and local recycling facilities. The Browns Ferry Nuclear Plant operates a state-permitted construction/demolition landfill (Permit Number 42-02) within the confines of the Browns Ferry Nuclear Plant site (TVA 2002:3-5).

Liquid waste consists of 2.3 million liters (600,000 gallons) per day of wastewater (TVA 2012:4). The wastewater contains low levels of radionuclides that are monitored prior to release to Wheeler Reservoir on the Tennessee River in accordance with NPDES permit requirements.

3.3.1.4 Environmental Justice

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionate to those on the population as a whole in the potentially affected area. The potentially affected area surrounding the Browns Ferry Nuclear Plant includes parts of 21 counties throughout Alabama and Tennessee that make up an area within a 50-mile (80-kilometer) radius of the Browns Ferry Nuclear Plant site. To be consistent with the human health analysis, the population distributions of the potentially affected area are calculated using data at the block-group level of spatial resolution from the 2010 census (Census 2010b), and have been projected to the year 2020 using data from the 1990 census, 2000 census, and the 2010 census for each of the affected counties within a 50-mile (80-kilometer) radius of the Browns Ferry Nuclear Plant (Census 1990, 2001, 2010b).

In accordance with CEQ guidance, meaningfully greater minority populations are identified where either the minority population of the affected area exceeds 50 percent, or if the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis (CEQ 1997). Meaningfully greater is defined here as 20 percentage points above the population percentage in the general population. The 2020 population projections estimate the average minority population percentage of the states surrounding the Browns Ferry Nuclear Plant as 30.2 percent and the average minority population percentage of the counties surrounding the Browns Ferry Nuclear Plant as 21.8 percent. Comparatively, a meaningfully greater minority population percentage relative to the general population of the state and surrounding counties would be 41.8 percent. Therefore, the lower threshold of 41.8 percent is used to identify areas with meaningfully greater minority populations surrounding the Browns Ferry Nuclear Plant. In order to evaluate the potential impacts on populations in closer proximity to the Browns Ferry Nuclear Plant, additional radial distances of 5, 10, and 20 miles (8, 16, and 32 kilometers) are also analyzed. **Table 3–49** shows the composition of the ROI surrounding the Browns Ferry Nuclear Plant at each of these distances.

Table 3–49 Projected Populations in the Potentially Affected Area Surrounding the Browns Ferry Nuclear Plant in 2020

	5 Miles		*10 Miles*		*20 Miles*		*50 Miles*	
Population Group	*Population*	*Percent of Total*	*Population*	*Percent of Total*	*Population*	*Percent of Total*	*Population*	*Percent of Total*
Nonminority	2,379	73	26,712	63	159,155	71	820,861	76
Black or African American [a]	591	18	10,582	25	33,231	15	155,108	14
Total Hispanic [b]	190	6	3,658	9	19,247	9	61,586	6
American Indian or Alaska Native [a]	19	1	477	1	2,860	1	9,665	1
Other Minority [a]	272	8	4,831	11	27,722	12	101,407	9
Total Minority [a]	882	27	15,890	37	63,813	29	266,180	24
Total Population	3,261	100	42,602	100	222,968	100	1,087,041	100
Low-Income	406	12	6,864	16	31,255	14	160,412	15

[a] Includes Hispanic persons.
[b] Includes all Hispanic persons regardless of race.
Note: To convert miles to kilometers, multiply by 1.609. Totals may not equal the sum of subcategories due to rounding. The potentially affected area comprises the area within a 50-mile (80-kilometer) radius of the site.

The total projected population residing within the potentially affected area in 2020 would be approximately 1,087,041, approximately 24 percent of which would be considered minority. Of the 699 block groups in the potentially affected area, approximately 119 (17 percent) were identified as containing meaningfully greater minority populations.

The overall composition of the projected populations within every radial distance is predominantly nonminority. The concentration of minority populations is the greatest in the area within 10 miles, where the minority population accounts for approximately 37 percent. The Black or African American population is the largest minority group within every radial distance of the potentially affected area, constituting approximately 25 percent of the total population within 10 miles; and 14 percent of the total population within 50 miles. The Hispanic or Latino population constitutes about 9 percent of the total population within 10 miles, and approximately 6 percent of the total population within 50 miles.

The projected low-income population (those living below the poverty threshold) in 2020 is estimated to be 160,412 people (15 percent). Meaningfully greater low-income populations are identified using the same methodology described above for identification of minority populations. The 2010 census does not contain any data relative to income. The Census Bureau's ACS 5-year estimates are the only data set that publishes current data relative to income at the block group level of geography. Therefore, the 2006–2010 ACS 5-year estimates are used to identify low-income populations in the potentially affected area. These populations were then scaled up to be directly comparable to the projected 2020 potentially affected population. The 2006–2010 ACS 5-year estimates show the average low-income population percentage of the states surrounding the Browns Ferry Nuclear Plant is 17 percent, and the low-income population percentage of the counties surrounding the Browns Ferry Nuclear Plant is 15 percent (Census 2011e). Comparatively, a meaningfully greater low-income population percentage would be 35.3 percent. Therefore, the lower threshold of 35.3 percent is used to identify low-income populations surrounding the Browns Ferry Nuclear Plant. Of the 699 block groups that surround the Browns Ferry Nuclear Plant, 62 (8.9 percent) contain meaningfully greater low-income populations.

Figure 3–21 displays the block groups identified as meaningfully greater minority and low-income populations surrounding the Browns Ferry Nuclear Plant.

Figures 3–22 and **3–23** show cumulative minority and low-income populations projected to live within the potentially affected area in 2020 as a function of distance from the Browns Ferry Nuclear Plant. Values along the vertical axis show populations residing within a given distance from the plant.

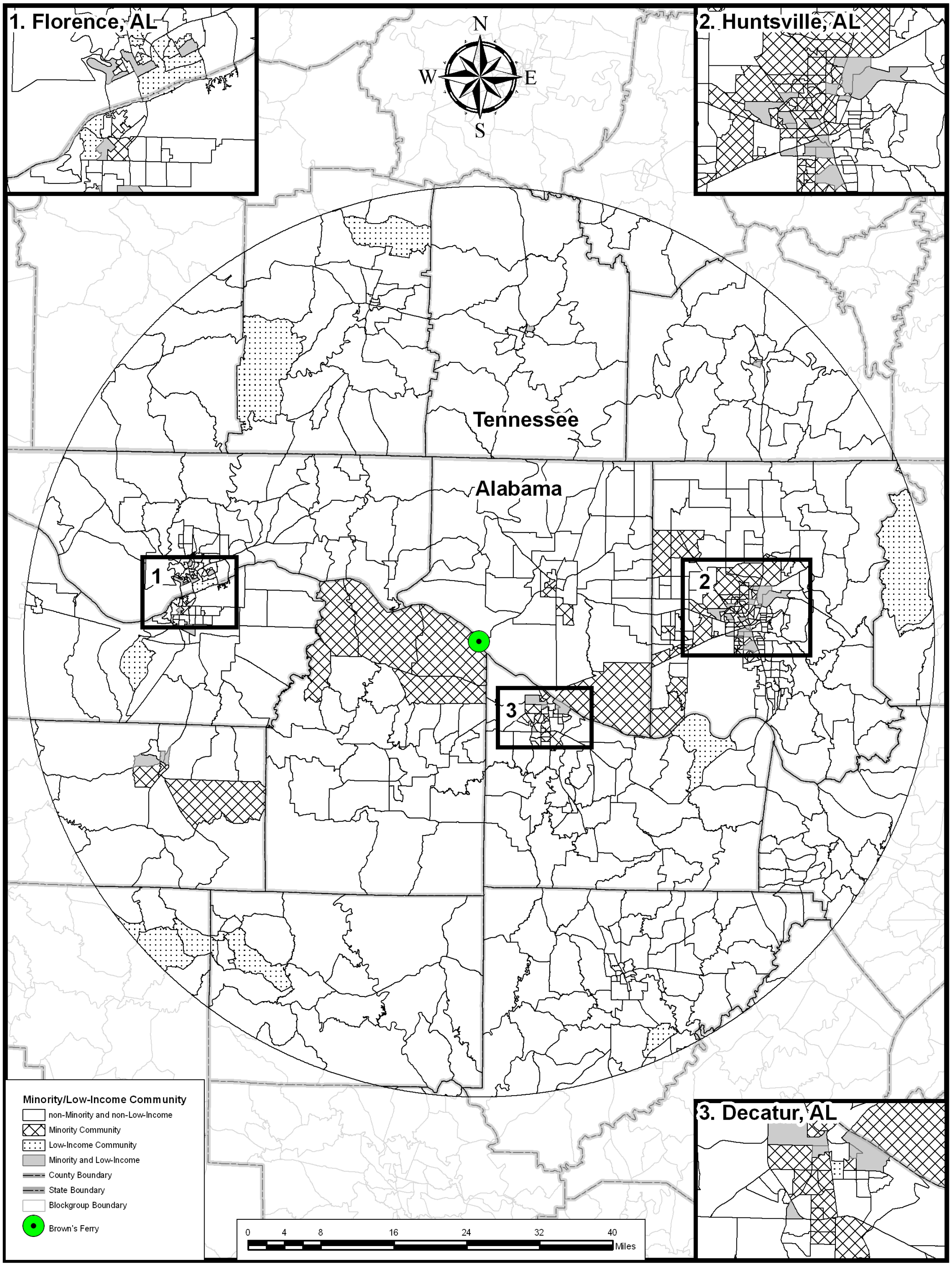

Figure 3–21 Meaningfully Greater Minority and Low-Income Populations Surrounding the Browns Ferry Nuclear Plant

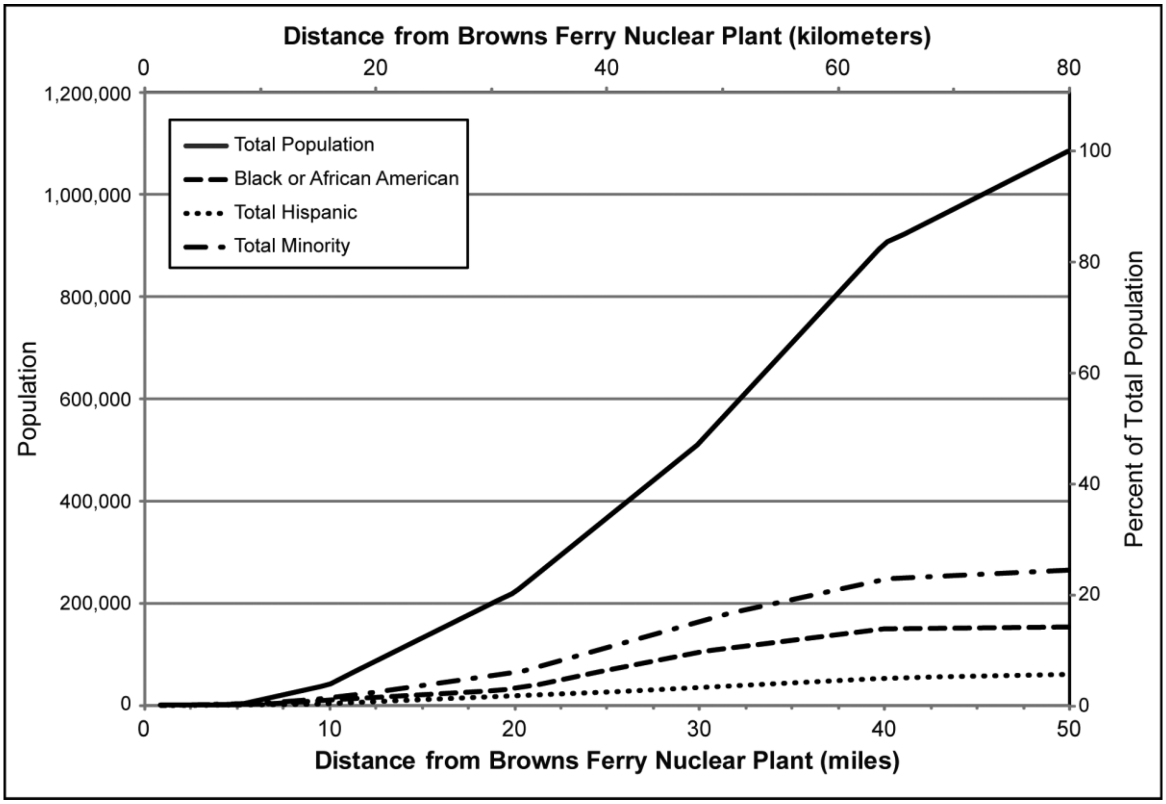

Figure 3–22 Cumulative Minority Populations as a Function of Distance from the Browns Ferry Nuclear Plant

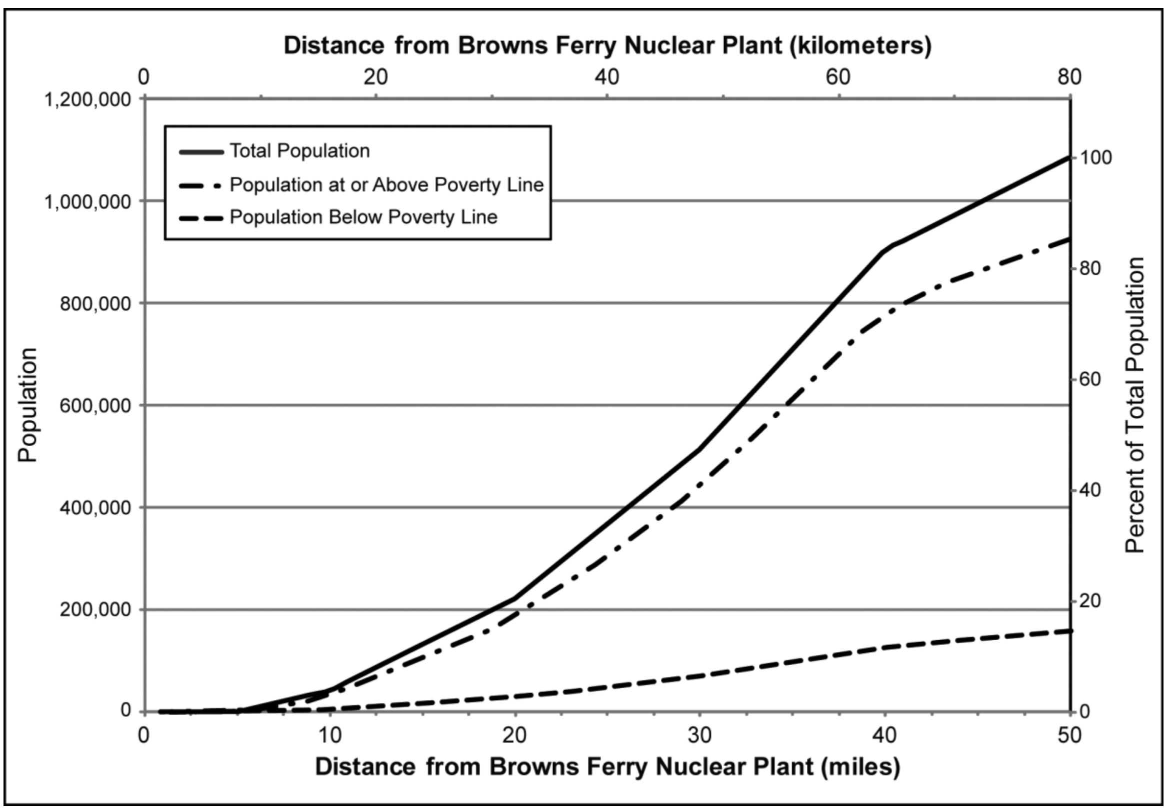

Figure 3–23 Cumulative Low-Income Populations as a Function of Distance from the Browns Ferry Nuclear Plant

3.3.2 Sequoyah Nuclear Plant Overview

The Sequoyah Nuclear Plant is located on approximately 525 acres (212 hectares) of federally owned land that is under the custody of TVA in Hamilton County, Tennessee. It is approximately 6 miles (10 kilometers) east of Soddy-Daisy, Tennessee, and 7.5 miles (12 kilometers) northeast of Chattanooga, Tennessee. The site is located on a peninsula on the western shore of Chickamauga Reservoir, which is along the Tennessee River (TVA 2010b:Section 2.1). The 2010 population within a 50-mile (80-kilometer) radius of the Sequoyah Nuclear Plant is estimated to be about 983,000 (TVA 2010b:Table 2.1.3-12).

TVA employs about 1,150 full-time equivalent employees to maintain and operate the Sequoyah Nuclear Plant (TVA 2012:4). The Sequoyah Nuclear Plant comprises two pressurized water reactors, each with a gross maximum capacity of approximately 1,205 megawatts of electricity (1,216 and 1,194 megawatts, respectively) (TVA 2012). The reactors are operated by TVA under Operating Licenses DPR–77 and DPR–79, which were granted in 1980 and 1981, respectively, with expiration dates of 2020 and 2021. TVA is currently seeking an extension of the Sequoyah Nuclear Plant for another 20 years, through 2040 for Unit 1 and 2041 for Unit 2 (75 FR 18572).

The Sequoyah Nuclear Plant units are cooled by water taken from and returned to the Chickamauga Reservoir. During operations, cooling towers may or may not be used. When cooling towers are not in use, the withdrawal rate is 1,068,958 gallons per minute (4,046,006 liters per minute) and the discharge rate is 1,068,888 gallons per minute (4,045,741 liters per minute). When cooling towers are in service, less than 32,786 gallons per minute (124,095 liters per minute) of the withdrawn water is evaporated in the cooling towers (TVA 2012:5).

New (unirradiated) fuel assemblies are removed one at a time from the shipping cask and stored dry in the fuel storage racks located in the fuel storage area or wet in the used fuel pool. Used fuel is removed from the reactor vessel by the manipulator crane and placed in the Fuel Transfer System. During a typical 18-month fuel cycle, 81 used fuel assemblies are generated. In the used fuel pool, the fuel is removed from the Fuel Transfer System and placed in the storage racks. After a suitable decay period, the fuel may be removed from storage and loaded in a shipping cask for removal from the site or the used fuel assemblies may be placed in interim storage at the Sequoyah Nuclear Plant Independent Spent Fuel Storage Installation. Used fuel is handled entirely under water from the time it leaves the reactor vessel until it is placed in a cask for shipment from the site or until the used fuel assemblies are placed in interim storage at the Sequoyah Nuclear Plant Independent Spent Fuel Storage Installation (TVA 2010b:1.2-4, 2012).

Security at the site is provided in accordance with NRC regulations and includes security checkpoints, barbed wire fencing, surveillance cameras, and intruder detection.

In addition to the information presented in this section, more details about the affected environment at the Sequoyah Nuclear Plant Units 1 and 2 can be found on the NRC website: http://www.nrc.gov/ in NRC Docket Numbers 50–327 and 50–328, respectively.

3.3.2.1 Air Quality and Noise

State monitoring data for Hamilton County and adjoining counties include ambient monitoring data for nitrogen dioxide, PM_{10}, $PM_{2.5}$, and ozone. Concentrations of nitrogen dioxide, PM_{10}, and $PM_{2.5}$ in these counties were within the NAAQS. Monitoring values for ozone at the nearest monitors to Sequoyah Nuclear Plant in Hamilton County exceeded the 8-hour standard value on several occasions in 2008 (EPA 2010). The adjoining counties are designated as in attainment with respect to the NAAQS for criteria air pollutants, except for Hamilton County, which is designated nonattainment for $PM_{2.5}$ (EPA 2009e).

The primary sources of nonradiological air pollutants at the Sequoyah Nuclear Plant include emergency diesel generators and employee vehicles (TVA 2012).

Major noise emission sources on the site include various industrial facilities, equipment, and machines. Although traffic is the primary source of noise at the site boundary and at residences near roads, the acoustic environment along the site boundary and at nearby residences away from traffic noise is typical of rural locations.

3.3.2.2 Radiation Exposure and Risk

The human radiation environment of the Sequoyah Nuclear Plant is addressed in this section in terms of radiological health impacts associated with background radiation and normal operations at the plant in the same manner as for the Browns Ferry Nuclear Plant.

General Environment

Background Radiation – The major sources and levels of background radiation exposure to individuals in the vicinity of the Sequoyah Nuclear Plant are the same as for the Browns Ferry Nuclear Plant shown in Table 3–46.

Public – Typical (representative) Sequoyah Nuclear Plant operations result in an annual dose to the MEI from all pathways of 0.15 millirem (TVA 2012:3). This dose is well below the annual permissible public exposure guideline values of 5 millirem from atmospheric releases and 3 millirem from liquid releases (10 CFR Part 50, Appendix I – Numerical Guides to meet the ALARA criterion), and the 25-millirem standard for exposure from all pathways combined (40 CFR Part 190). It is also below the annual limit of 100 millirem total effective dose equivalent to an individual member of the public that is given in 10 CFR 20.1301. The MEI dose is well below the 318 millirem[21] received annually by an average individual in the vicinity of the Sequoyah Nuclear Plant from natural background radiation.

Using a risk estimator of 600 LCFs per 1 million person-rem (or 0.0006 LCFs per rem) (DOE 2003a), the LCF risk to the MEI from annual Sequoyah Nuclear Plant operations is estimated to be 9×10^{-8}. That is, the estimated annual probability of this person developing a fatal cancer sometime in the future from normal plant operations is 1 in 11 million.

The annual dose to the population residing within 50 miles (80 kilometers) of the Sequoyah Nuclear Plant was calculated to be 2.5 person-rem from typical plant operations (TVA 2012:2). This is well below the annual dose of 337,000 person-rem received by this same population from background radiation.[22] Plant operations are projected to cause no LCFs in the population within 50 miles (80 kilometers) of the Sequoyah Nuclear Plant. Using the risk estimator of 600 LCFs per 1 million person-rem, the calculated LCF risk is 0.002 from 1 year of operations; this indicates an annual risk of 1 in 500 of a single excess latent fatal cancer occurring in the population as a result of normal Sequoyah Nuclear Plant operations.

Workers – Sequoyah Nuclear Plant workers may receive an additional dose from working in facilities with nuclear materials. In conformance with the requirement given 10 CFR 20.1101 (b), procedures and engineering controls are employed to achieve occupational doses that are ALARA. For the 5-year period from 2005 through 2009, the average dose to the individual worker from plant operations was 110 millirem and the maximum dose to a worker was 751 millirem (TVA 2012:4). These values are

[21] The dose from cosmic and terrestrial radiation measured by TVA is 90 millirem per year (TVA 2012:3); the average dose to an individual in the United States from radon-220 and -222 is 228 millirem per year (NCRP 2009:12).

[22] This value is based on an annual natural background radiation dose of 318 millirem to an individual, including doses from radon-220 and -222. If only cosmic and terrestrial radiation is considered, the population dose would be 95,400 person-rem (TVA 2012:3).

below the NRC annual radiological dose limit of 5,000 millirem (10 CFR Part 20.1201). In the same year, the total worker dose to the 1,289 workers who received a measurable dose was 142 person-rem (TVA 2012:4). Using a risk estimator of 600 LCFs per 1 million person-rem, the risk of an LCF for the average worker would be 0.00007 annually. No fatal cancers are projected for the worker population from 1 year of normal plant operation.

Health Effects Studies

The National Cancer Institute publishes national, state, and county incidence rates of various types of cancer (NCI 2013). However, the published information does not present an association of these rates with their causes, e.g., specific facility operations and human lifestyles. **Table 3–50** presents incidence rates for the United States; Tennessee; Georgia; Hamilton County, Tennessee; and for the six counties in Tennessee and four counties in Georgia that are adjacent to Hamilton County. Additional information about cancer profiles near the Sequoyah Nuclear Plant is available in the National Cancer Institute's publication (NCI 2013).

Table 3–50 Cancer Incidence Rates [a] for the United States, Tennessee, Georgia, and Counties in the Vicinity of the Sequoyah Nuclear Plant Site, 2005–2009

	All Cancers	*Thyroid*	*Breast*	*Lung and Bronchus*	*Leukemia*	*Prostate*	*Colon and Rectum*
United States	465	11.8	122	67.2	12.4	151.4	46.2
Tennessee	470.5	11.3	119.6	80.3	11.7	145.6	47.7
Hamilton County [b]	480.2	11.3	120.5	73.2	11.9	170.8	43.8
Bradley County	426.6	10.2	112.6	64.2	9.3	107.9	45.5
Bledsoe County	344	(c)	81.1	66.7	(c)	139.9	33.3
Marion County	456.4	(c)	117.8	86.7	13.2	128	46.1
Meigs County	594.1	(c)	136.3	116.2	(c)	170.7	54.5
Rhea County	616.8	14.2	190.6	118.1	12.9	133.4	59.3
Sequatchie County	418.5	(c)	94	67.4	(c)	113.8	44
Georgia	461.1	9.6	119.7	71.6	11.5	167.8	45
Catoosa County	406.7	9	101.6	76.9	13.2	97.1	36.9
Dade County	460.6	(c)	111.8	90.8	(c)	111.1	48.4
Walker County	465.7	8.7	100.4	103.5	13.9	132.1	42.5
Whitfield County	483.9	14.2	110.5	100.4	13.9	146.1	44.1

[a] Age-adjusted incidence rates; cases per 100,000 persons per year.
[b] Location of the Sequoyah Nuclear Plant.
[c] Data have been suppressed by the National Cancer Institute to ensure confidentiality and stability of rate estimates when the annual average count is three or fewer cases.
Source: NCI 2013.

Emergency Preparedness

The design and operating procedures instituted in accordance with the regulations for operating the Sequoyah Nuclear Plant and the plant's highly trained workforce make it unlikely that an accidental release of radiation would take place. Nevertheless, emergency preparedness is an integral part of the safety programs at the Sequoyah Nuclear Plant, and an approved emergency plan is required to maintain its NRC operating license. The emergency plans for the Sequoyah Nuclear Plant are structurally the same as those for the Browns Ferry Nuclear Plant discussed in Section 3.3.1.2. However, specifics such as locations of onsite facilities and the associated number of workers; population densities around the plant; and zone evacuation times, which depend on road systems and population densities, are different.

Each year, TVA, the State of Tennessee, Bradley and Hamilton Counties, and the City of Cleveland within Bradley County provide emergency preparedness planning information to residents and businesses within 10 miles (16 kilometers) of the Sequoyah Nuclear Plant. The information includes instructions on actions people should take if advised to seek shelter or leave an area. Included is an evacuation map showing transportation routes, emergency and evacuation supply checklists, and instructions on obtaining potassium iodide tablets.[23] In the event of an emergency, sirens in this zone would sound and the planning information would be augmented by real-time information provided by local television and radio stations.

Oversight and testing of the Sequoyah Nuclear Plant emergency plan and necessary training are similar to that discussed for the Browns Ferry Nuclear Plant.

3.3.2.3 Waste Management

Solid wastes generated in conjunction with operation of the Sequoyah Nuclear Plant can be subdivided into four general categories: LLW, MLLW, hazardous waste, and nonhazardous waste. In general, these different waste types are managed in a similar manner as described in Section 3.3.1.3 for the Browns Ferry Nuclear Plant. LLW and MLLW are stored on site and subsequently transported to offsite licensed disposal facilities. TVA transports hazardous waste generated at the Sequoyah Nuclear Plant to its hazardous waste storage facility in Muscle Shoals, Alabama. Nonradioactive hazardous waste is transported to local offsite disposal facilities. **Table 3–51** shows the quantity of solid waste generated at the Sequoyah Nuclear Plant.

Table 3–51 Solid Waste Generation at the Sequoyah Nuclear Plant

Waste Type	***Annual Generation*** [a]
Low-level radioactive waste [b] Cubic meters (cubic feet)	394 (13,914)
Mixed low-level radioactive waste [c] Cubic meters (cubic feet)	0.1 (3.5)
Hazardous waste [d] kilograms (pounds)	481 (1,062.6)
Nonhazardous waste [d] Metric tons (tons)	705.9 (778.1)

[a] Reflective of two-unit operation.
[b] Average of data from 2006 to 2009.
[c] Based on fiscal years 2008 to 2009.
[d] Based on data from 2009.
Source: TVA 2012:4.

Liquid waste consists of 265,000 liters (70,000 gallons) per day of wastewater (TVA 2012:4). The wastewater contains low levels of radionuclides that are monitored prior to release to the Tennessee River in accordance with NPDES permit requirements.

3.3.2.4 Environmental Justice

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionate to those on the population as a whole in the potentially affected area. The potentially affected area surrounding the Sequoyah Nuclear Plant includes parts of 32 counties throughout Alabama, Georgia, North Carolina, and Tennessee that make up an area within a 50-mile (80-kilometer) radius of the Sequoyah Nuclear Plant site. To be

[23] *Potassium iodide (KI) is a chemical compound that can be used to protect the thyroid gland from possible radiation injury caused by radioactive iodine (radioiodine).*

consistent with the human health analysis, the population distributions of the potentially affected area are calculated using data at the block-group level of spatial resolution from the 2010 census (Census 2010b), and have been projected to the year 2020 using data from the 1990 census, 2000 census, and the 2010 census for each of the affected counties within a 50-mile (80-kilometer) radius of the Sequoyah Nuclear Plant (Census 1990, 2001, 2010b).

In accordance with CEQ guidance, meaningfully greater minority populations are identified where either the minority population of the affected area exceeds 50 percent, or if the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis (CEQ 1997). Meaningfully greater is defined here as 20 percentage points above the population percentage in the general population. The 2020 population projection estimates show the average minority population percentage of the four states surrounding the Sequoyah Nuclear Plant as 38.3 percent and the average minority population percentage of the counties surrounding the Sequoyah Nuclear Plant site as 18.7 percent. Comparatively, a meaningfully greater minority population percentage relative to the general population of the state and surrounding counties would be 38.7 percent. Therefore, the lower threshold of 38.7 percent is used to identify areas with meaningfully greater minority populations surrounding the Sequoyah Nuclear Plant. In order to evaluate the potential impacts on populations in closer proximity to the Sequoyah Nuclear Plant site, additional radial distances of 5, 10, and 20 miles (8, 16, and 32 kilometers) are also analyzed. **Table 3–52** shows the composition of the ROI surrounding the Sequoyah Nuclear Plant at each of these distances and illustrates the racial and ethnic composition of the minority population in the potentially affected areas surrounding the Sequoyah Nuclear Plant.

Table 3–52 Projected Populations in the Potentially Affected Area Surrounding the Sequoyah Nuclear Plant in 2020

	5 Miles		*10 Miles*		*20 Miles*		*50 Miles*	
Population	***Population***	***Percent of Total***	***Population***	***Percent of Total***	***Population***	***Percent of Total***	***Population***	***Percent of Total***
Nonminority	26,097	94	91,473	90	389,888	75	968,905	80
Black or African American	407	1	4,454	4	78,232	15	97,556	8
Total Hispanic [b]	567	2	2,556	3	28,611	6	104,986	9
American Indian or Alaska Native [a]	95	0	325	0	2,078	0	5,474	0
Other Minority [a]	1,154	4	5,821	6	47,573	9	140,021	12
Total Minority [a]	1,656	6	10,600	10	127,883	25	243,051	20
Total Population	27,753	100	102,073	100	517,771	100	1,211,956	100
Low-Income	2,563	9	7,335	7	79,698	15	203,554	17

[a] Includes Hispanic persons.
[b] Includes all Hispanic persons regardless of race.
Note: To convert miles to kilometers, multiply by 1.609. Totals may not equal the sum of subcategories due to rounding. The potentially affected area comprises the area within a 50-mile (80-kilometer) radius of the site.

The potentially affected area around the location of the Sequoyah Nuclear Plant is defined by a circle with a 50-mile (80-kilometer) radius. The total projected population residing within that area in 2020 would be approximately 1,211,956, approximately 20 percent of which would be considered minority. Of the 781 block groups in the potentially affected area, approximately 110 (14 percent) were identified as containing meaningfully greater minority populations.

The overall composition of the populations within every radial distance is predominantly nonminority. The concentration of minority populations is the greatest in the area within 20 miles (32 kilometers), where the total minority population accounts for approximately 25 percent. The Hispanic or Latino population is the largest minority group within the potentially affected area, constituting approximately 2 percent of the total population within 5 miles (8 kilometers), and approximately 9 percent of the total population within 50 miles (80 kilometers). The Black or African American population is the largest minority population within the 20-mile (32-kilometer) radius, constituting about 15 percent of the total population.

The projected low-income population (those living below the poverty threshold) in 2020 is estimated to be 203,554 people (17 percent). Meaningfully greater low-income populations are identified using the same methodology described above for identification of minority populations. The Census Bureau's ACS 5-year estimates are the only data set that publishes current data relative to income at the block group level of geography. Therefore, the 2006–2010 ACS 5-year estimates are used to identify low-income populations in the potentially affected area. These populations were then scaled up to be directly comparable to the projected 2020 potentially affected population. The 2006–2010 ACS 5-year estimates show the average low-income population percentage of the four states surrounding the Sequoyah Nuclear Plant is 16 percent and the average low-income population percentage of the counties surrounding the Sequoyah Nuclear Plant is 16.3 percent (Census 2011e). Comparatively, a meaningfully greater low-income population percentage would be 36 percent. Therefore, the lower threshold of 36 percent is used to identify areas with meaningfully greater low-income populations surrounding the Sequoyah Nuclear Plant. Of the 781 block groups that surround the Sequoyah Nuclear Plant, 71 (9.1 percent) contain meaningfully greater low-income populations.

Figure 3–24 displays the block groups identified as meaningfully greater minority and low-income populations surrounding the Sequoyah Nuclear Plant.

Figures 3–25 and **3–26** show cumulative total, minority, and low-income populations projected to live within the potentially affected area in 2020 as a function of distance from the Sequoyah Nuclear Plant. Values along the vertical axis show populations residing within a given distance from the Sequoyah Nuclear Plant.

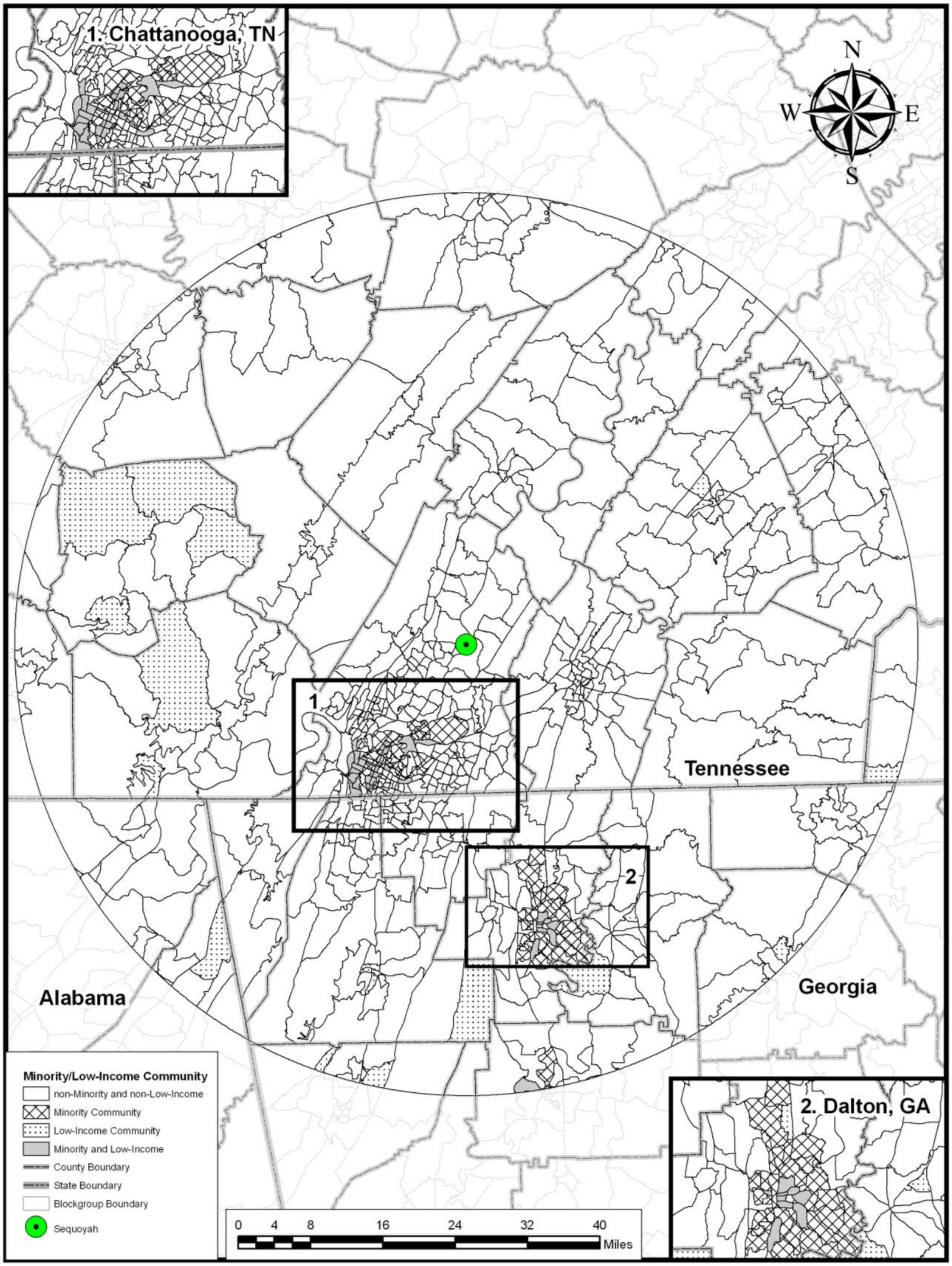

Figure 3–24 Meaningfully Greater Minority and Low-Income Populations Surrounding the Sequoyah Nuclear Plant

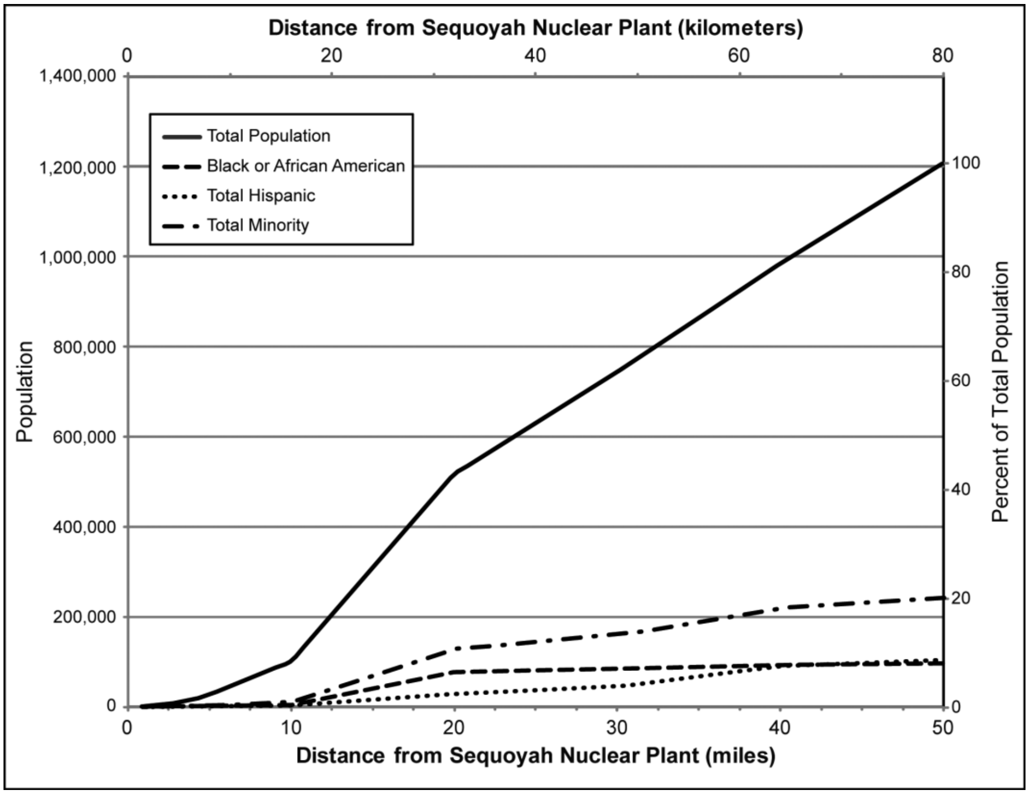

Figure 3–25 Cumulative Minority Populations as a Function of Distance from the Sequoyah Nuclear Plant

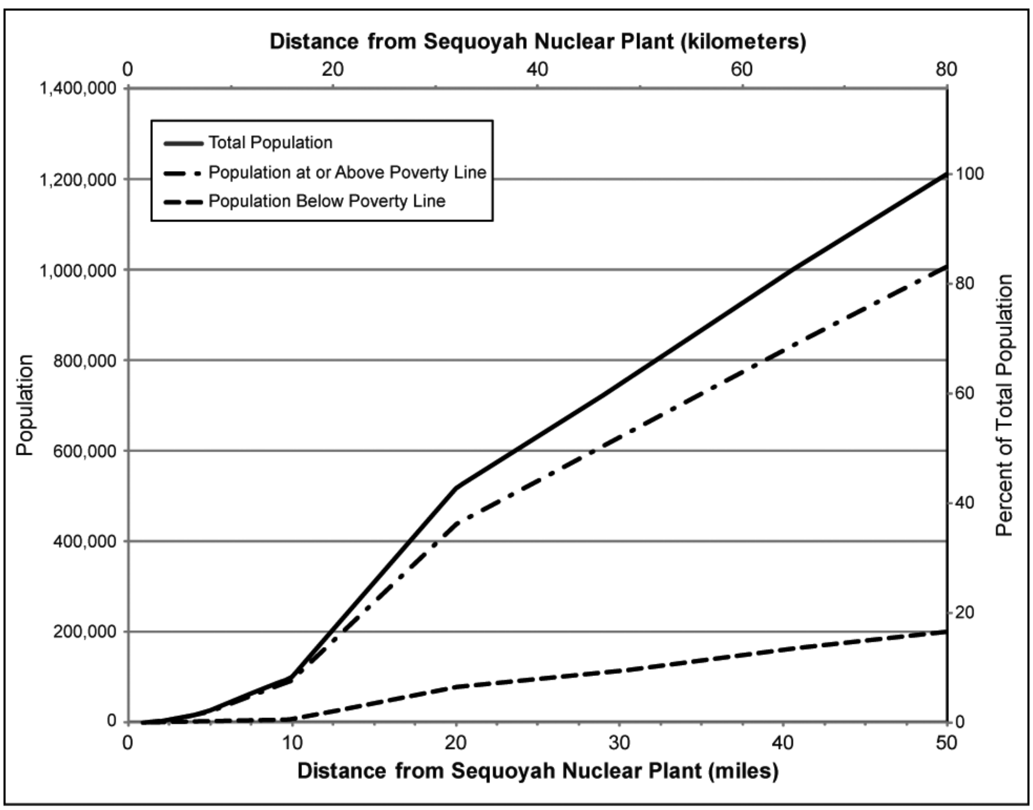

Figure 3–26 Cumulative Low-Income Populations as a Function of Distance from the Sequoyah Nuclear Plant