CHAPTER 4: AFFECTED ENVIRONMENT

The affected environment includes the physical and natural environment around each of the four potential sites for the proposed Spallation Neutron Source (SNS) and the relationship of people with that environment. Descriptions of the affected environment provide a basis for understanding the potential direct, indirect, and cumulative impacts of construction and operation of the proposed SNS at each of the potential sites. In this chapter, the existing situation for environmental resources that the construction and operation of the proposed SNS could affect is described. The detail presented for each resource varies depending on the relevance of the resource to the construction and operation of the SNS.

4.1 OAK RIDGE NATIONAL LABORATORY

The Chestnut Ridge site is the preferred site for the proposed SNS and is located approximately 1.75 miles (2.8 km) northeast from the center of the Oak Ridge National Laboratory (ORNL). Site access is via Chestnut Ridge Road, across from the 7000 Area at ORNL (Figure 4.1-1). The Chestnut Ridge site extends on a long, wide, and gently sloping ridge top with a broad saddle area at its eastern end. This area planned for the target station would require a minimum of excavation. The linac, transport line, and ring tunnels would be notched into the south side of the ridge using cut-and-fill techniques, providing economical construction and effective shielding strategies. The entire site is currently undeveloped.

4.1.1 GEOLOGY AND SOILS

A detailed discussion of the geology of the Oak Ridge Reservation (ORR) is provided by Hatcher et. al. (1992). Elements of that report pertinent to the SNS site at Chestnut Ridge are presented below.

The ORR is located in the southwestern portion of the Valley and Ridge Physiographic Province that extends more than 500 miles (800 km) from Alabama northeastward into Virginia. The southwestern portion of the Valley and Ridge Province is about 25 to 50 miles (40 to 80 km) wide. The trend of the valleys and ridges which characterize this province reflects the regional orientation of underlying, deformed bedrock that was intensely folded and faulted by compressional forces from the southeast during the late Paleozoic Appalachian Orogeny. Features that distinguish this province are: (1) parallel ridges and valleys typically oriented from northeast to southwest, (2) topography influenced by alternating weak and strong strata exposed to erosion through a relatively great amount of folding and faulting, (3) a few major transverse streams with subsequent streams forming a trellis-like drainage pattern, (4) many ridges with similar summit levels suggesting former erosion surfaces, and (5) many water and wind gaps through ridges. The scarp (northwest-facing) slopes of these ridges are relatively short, steep, and smooth. The dip slopes (southeast facing) are longer, shallower, and dissected by drainages. Elevation ranges from 738 to 1,345 ft (225 to 410 m) above sea level. Drainage patterns have a dendritic-shape in headwater areas and a trellis shape farther downstream.

Several major ridges, formed from resistant strata, dominate the topography of ORR. Moving from southeast to northwest, prominent ridges are named Copper Ridge, Haw Ridge

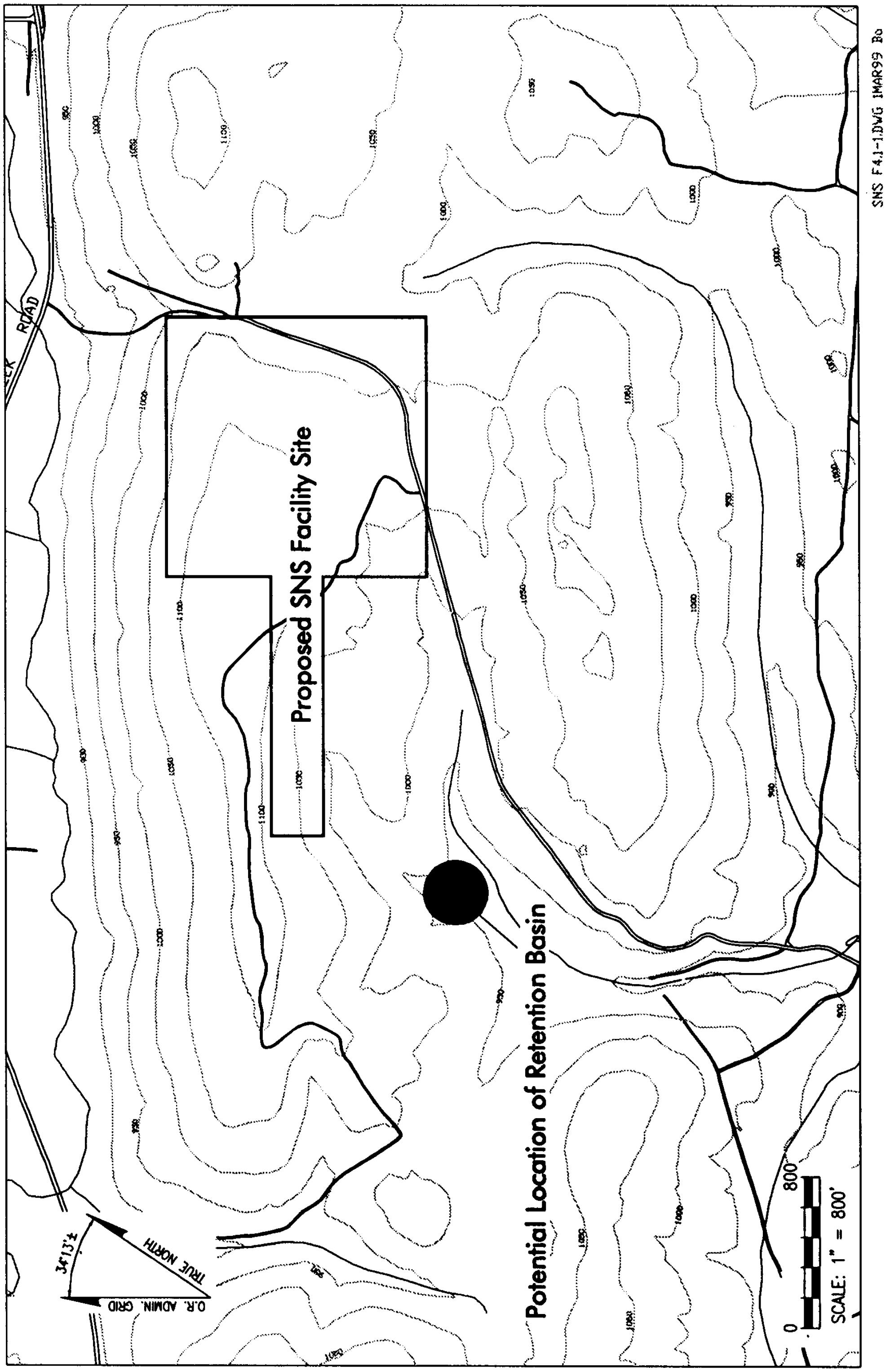

Figure 4.1-1. Proposed SNS site at ORNL.

(south of the ORNL main plant), Chestnut Ridge (separating the ORNL and Y-12 Plant sites), and Pine Ridge (between the Y-12 Plant and the City of Oak Ridge).

4.1.1.1 Stratigraphy

Rock units of the stratigraphic section in the ORR range in age from Early Cambrian to Silurian (Figure 4.1.1.1-1) [Hatcher 1992]. The stratigraphic units compose a complex assemblage of lithologies. The total thickness of the stratigraphic section in the ORR is about 1.6 miles (2.5 km), and each major stratigraphic unit possesses unique mechanical characteristics that respond differently to the strain imparted on these rocks through time.

In general, the Cambro-Ordovician age Knox Group and part of the overlying Chickamauga Group form the competent units within the major thrust sheets in the Oak Ridge area. The Knox Group underlies and forms both Chestnut Ridge (preferred site of the proposed SNS facility) and Copper Ridge and dips southward underneath Bethel Valley (Figure 4.1.1.1-2) [Hatcher 1992]. The Knox Group is composed of a series of medium to thickly bedded, massive, grey, green, and pink dolomite. On the ORR the Knox Group is divided into five separate units: the Copper Ridge Dolomite, the Chepultepec Dolomite, the Longview Dolomite, the Kingsport Formation, and the Mascot Dolomite. Total thickness of the Knox Group ranges between 1,970 and 2,950 ft (600 and 900 m) with the Copper Ridge Dolomite making up roughly one-third of the total. The Chestnut Ridge area encompasses all formation of the Knox Group, but the proposed SNS site boundary overlies the stratigraphic contact between the Copper Ridge and Chepultepec formations at the crest of Chestnut Ridge (Figure 4.1.1.1-3).

The Upper Cambrian Copper Ridge Dolomite is composed of a massively bedded cherty dolomite. It is characterized by medium to coarsely crystalline saccharoidal dolomite and is a common ridge formation in the Valley and Ridge. Sandstone beds in the upper part of the formation are common, and the contact with the Chepultepec Dolomite is mapped at the base of a prominent sandy zone. This formation forms the principal strong unit to support the folding and low-angle thrust faulting that occurs throughout the Valley and Ridge Province in East Tennessee.

Most of the Lower Ordovician Chepultepec consists of light-gray, fine-grained, medium-bedded dolomite. Chert in this formation is less abundant than in the Copper Ridge Dolomite and is characterized by the presence of white oolitic chert beds, dolomitic chert, and a prominent zone of quartz- and dolomite-cemented sandstone at the base.

4.1.1.2 Structure

Strata at the proposed SNS site are oriented (strikes along a northeast-southwest direction with dips 40 to 50° to the southeast) by the compressional tectonics that created the Valley and Ridge Province. These tectonic forces are responsible for two major northeast/southwest trending thrust faults, which dip to the southeast and define the thrust sheets: White Oak Mountain and Copper Creek Fault. Chestnut Ridge and Bethel Valley are underlain by the White Oak Mountain thrust sheet, which is soled by the White Oak Mountain fault (refer to Figure 4.1.1.1-2). Haw Ridge, Melton Valley, and Copper Ridge are underlain by the Copper

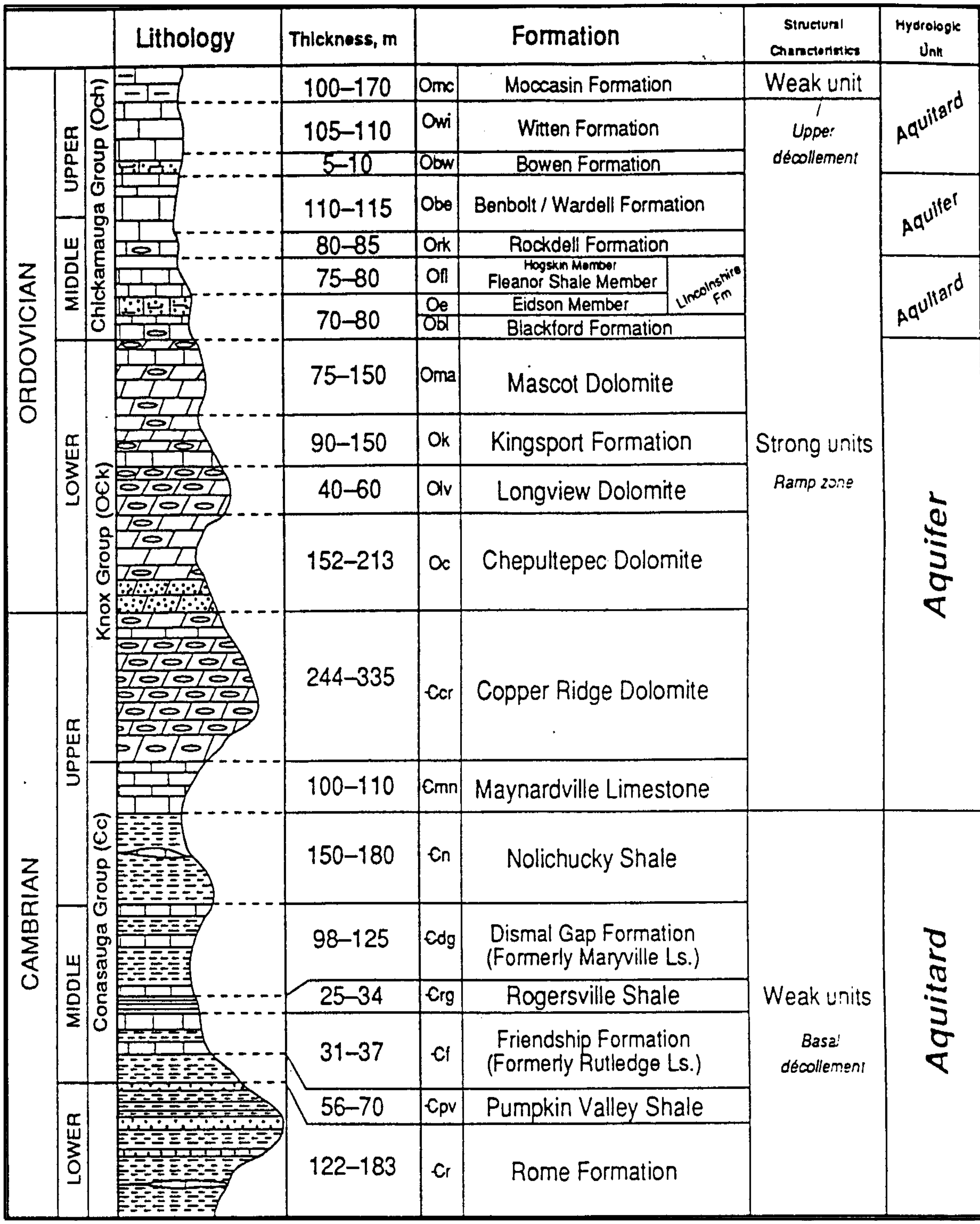

Figure 4.1.1.1-1. ORR Stratigraphy section.

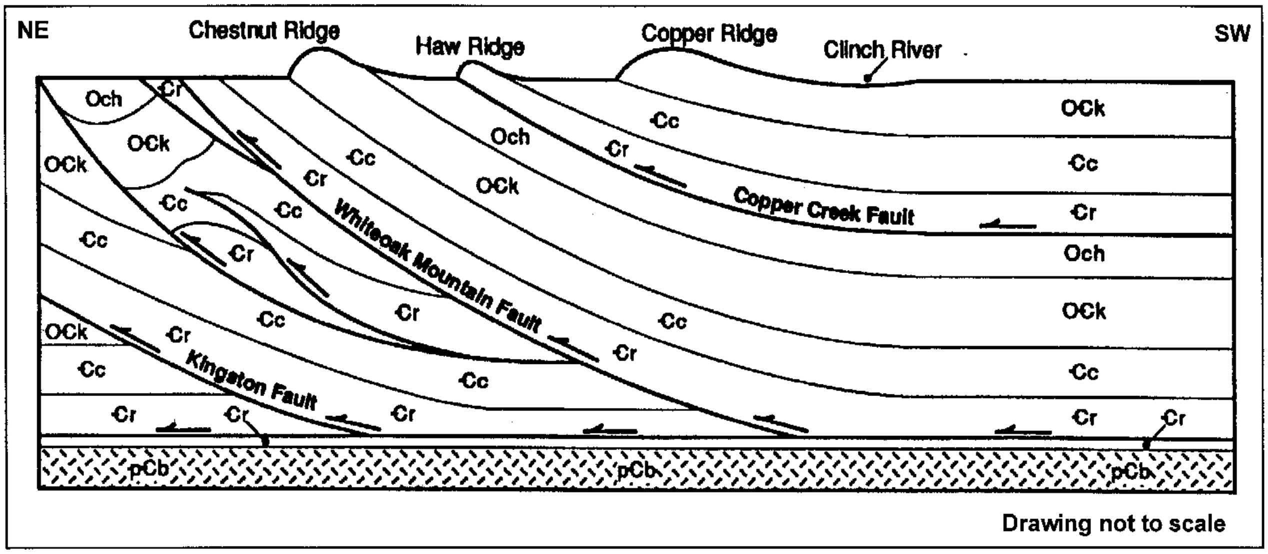

Figure 4.1.1.1-2. Geologic cross section.

Creek thrust sheet, which is soled by the Copper Creek thrust fault. Both thrusts are regional thrust faults that demonstrate at least several kilometers of translation. The faults formed during the Permian-Pennsylvanian Age Alleghenian Orogeny and have not been historically active.

Because of the large-scale faulting, all stratigraphic units in the ORR are fractured to varying degrees. Fractures are abundant on rock outcrops, in saprolite, and at shallow depths in fresh bedrock (Moore 1989). Fewer open fractures occur at deeper levels, and many are filled or partly filled with secondary minerals. Average fracture densities of 200 per meter have been measured in the saprolite of the Maynardville Limestone and Nolichucky Shale compared with five fractures per meter in fresh rock at depth. Most fractures are from a few centimeters to a meter in length. The areal extent of fractures may be only a few square meters for thin to very thin beds, but the areal extent of bedding-plane fractures may be greater by several orders of magnitude.

4.1.1.3 Soils

The following is a general discussion of the soils underlying the proposed SNS site at ORNL. More detailed information about soils across the ORR can be found in the *Status Report on the Geology of the Oak Ridge Reservation* (Hatcher et al. 1992). Five formations of the Knox Group are commonly identified by their location with respect to formations above and below and by the type of chert they contain. Soil series are designated by the first three digits of a five-digit number: the first number identifies the underlying geologic formation; the second number represents residuum, colluvium, or alluvium; and the third number indicates soil classification. Soil of the Copper Ridge Dolomite and the Chepultepec Dolomite are present under the proposed SNS facility.

Series 400 occurs on convex landforms facing south and west in the residuum of the Copper Ridge Dolomite and contains a high silt content with variable amounts of chert. Series 401 is

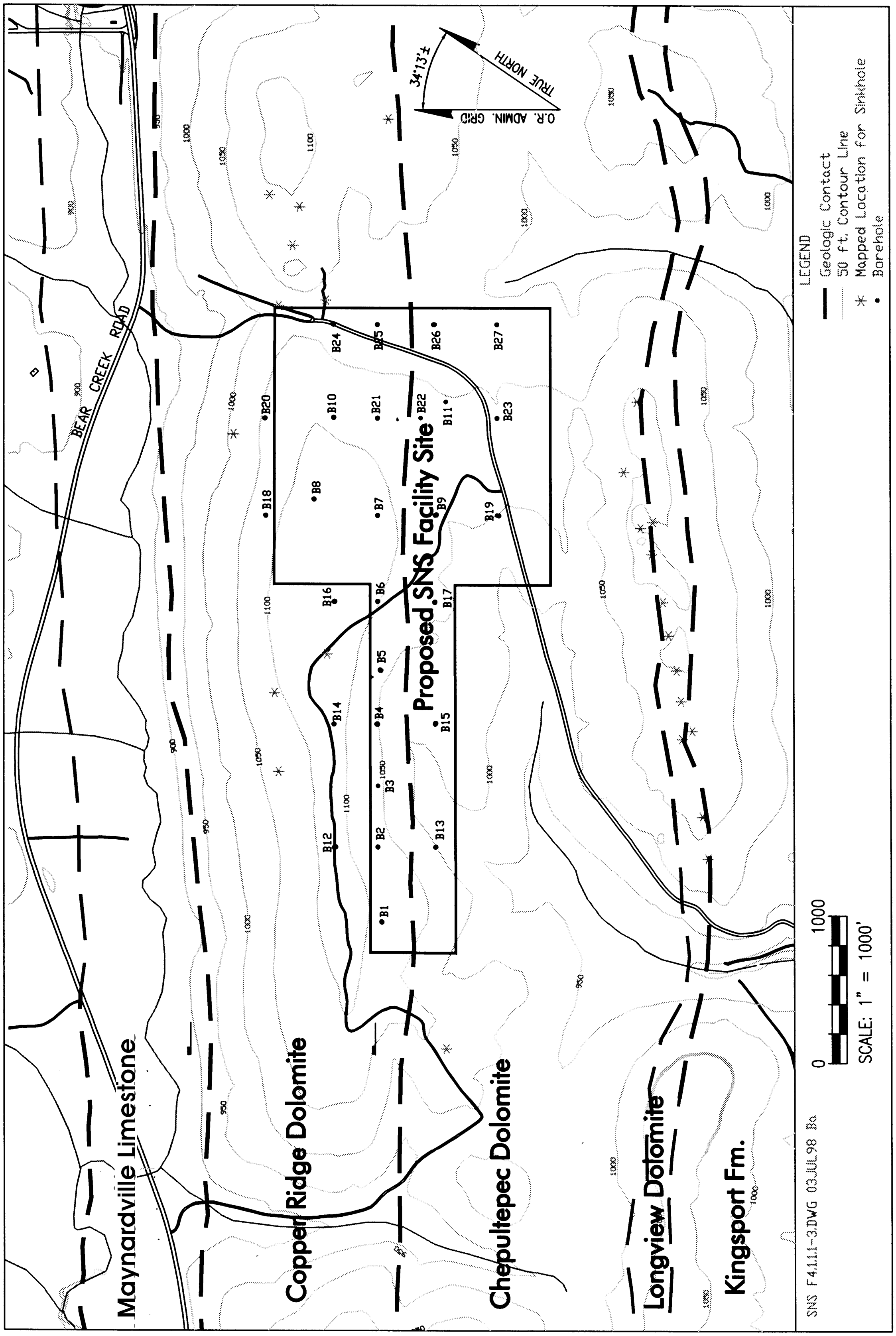

Figure 4.1.1.1-3 Geologic contacts at the SNS site at ORNL.

found in protected, shaded, and cool north slope areas. They have a thicker A horizon and a less distinct E horizon. Series 409 forms at the boundary of the Copper Ridge Dolomite and the Maynardville Limestone. They are found on the lower slope of the western side of Chestnut Ridge. Rock outcrops are common, and depth to bedrock is usually between 3.3 and 4.9 ft (1.0 and 1.5 m).

Series 402 forms in thick saprolite on upland summits and convex side slopes. The A and E horizons have higher chert content. Series 408 was observed only in Walker Branch watershed.

Prime farmland may be considered the best physical and environmental conditions for the production of food crops, livestock, feed, or forage. Prime farmland designation within the City of Oak Ridge boundary and ORR is waived, and other uses are permitted. None of the area affected by the proposed SNS could be valued as prime or unique farmlands, although prior to 1942 the area was used for subsistence farming. The proposed SNS site lies on an irregular sloping ridge line covered in secondary forest.

4.1.1.4 Site Stability

In April and May of 1997, Law Engineering (LAW 1997) installed several soil borings and a single rotary drill hole at the proposed SNS site on Chestnut Ridge to test subsurface conditions. Testing consisted of four borings (Boreholes B-1, B-5, B-8, and B-11); [refer to Figure 4.1.1.1-3] that obtained undisturbed samples at various horizons and continuous measurement of the penetration rate (as an indicator of soil strength, density, consolidation, etc.). The borings were taken to depths of approximately 100 ft (33 m) but possibly encountered bedrock at one location. A rotary drill hole was subsequently installed to determine actual depth to solid bedrock; details are forthcoming in a final report. Initial conclusions are that a highly irregular and weathered bedrock surface exists at the site and that large slabs and fragments of chert may occur within the soil mass. Additional borings and geophysical surveys would be conducted in the future to provide a more complete understanding of the subsurface.

Selected soil samples were analyzed for standard engineering characteristics such as grain size, specific gravity, moisture content, and Atterberg limits. The soils tested ranged from clayey sandy silt with gravel-sized chert (Unified Soil Classification System-"GC") (USACOE 1967) to highly plastic clayey silt ("MH"). Two soil samples yielded unconfined compressive strengths of 3.61 and 2.13 kg/ft^2 (8 and 4.7 lb/ft^2). These soils are typical of the ORR and are not susceptible to liquefaction or mass movement.

Seismicity of the southeastern United States was reviewed for the Advanced Neutron Source (ANS) site assessment that was sited approximately 1.9 miles (3 km) south of the proposed SNS site (Blasing et al. 1992). The following summarizes those findings. Historical seismicity in the southeastern United States has been traditionally correlated with surficial or shallow geologic features as expressed by physiographic and tectonic provinces. Some large earthquakes in the southeastern United States are apparently associated with basement structures, and others have not been correlated with any specific geologic structures. Little is known about the precise relationships between earthquakes and basement structure because the historical record of seismicity is too short and the location and nature of basement structures is not well know. Figure 4.1.1.4-1 displays the location of major earthquakes in relation to known or suspected basement structures.

Five tectonic provinces have experienced significant historical strong-motion earthquakes relevant to the ORR. These provinces are the Appalachian Basin, Piedmont Plateau, Interior Low Plateau, the Mississippi Embayment, and the Atlantic Coastal Plain. The strongest earthquake(s) (#1, 2, 3, 4, 5; year-1812) in the south occurred along the New Madrid Fault in the Reelfoot Rift zone. This fault zone offsets Holocene sediments of the Mississippi Embayment as well as basement rocks. The strongest earthquake within the Atlantic Coastal Plain had its epicenter at Charleston, South Carolina (#5; year-1886), near the rifted continental margin. Rift structures associated with the early opening (Triassic) of the Atlantic Ocean Basin are buried beneath the Atlantic Coastal Plain in Georgia and South Carolina, exposed at the surface in the Piedmont of North Carolina and Virginia, and exposed in the Appalachian Basin from Maryland to Connecticut. It has been suggested that South Carolina earthquakes may occur along reactivated Triassic Basin faults. The nearest Triassic Basin is about 200 miles (320 km) from the ORR. The epicenter of the Giles County, Virginia, earthquake (#7; year-1897) was located on the late Precambrian/early Cambrian basement rift zone beneath Paleozoic Appalachian Basin structures. The Anna Ohio earthquake represents the strongest earthquake in the Interior Low Plateaus Province and had its epicenter (#10; year-1937) near the junction of two Precambrian rift zones. The strongest earthquake of the Piedmont Province (#9; year-1913) was located near Spartanburg, South

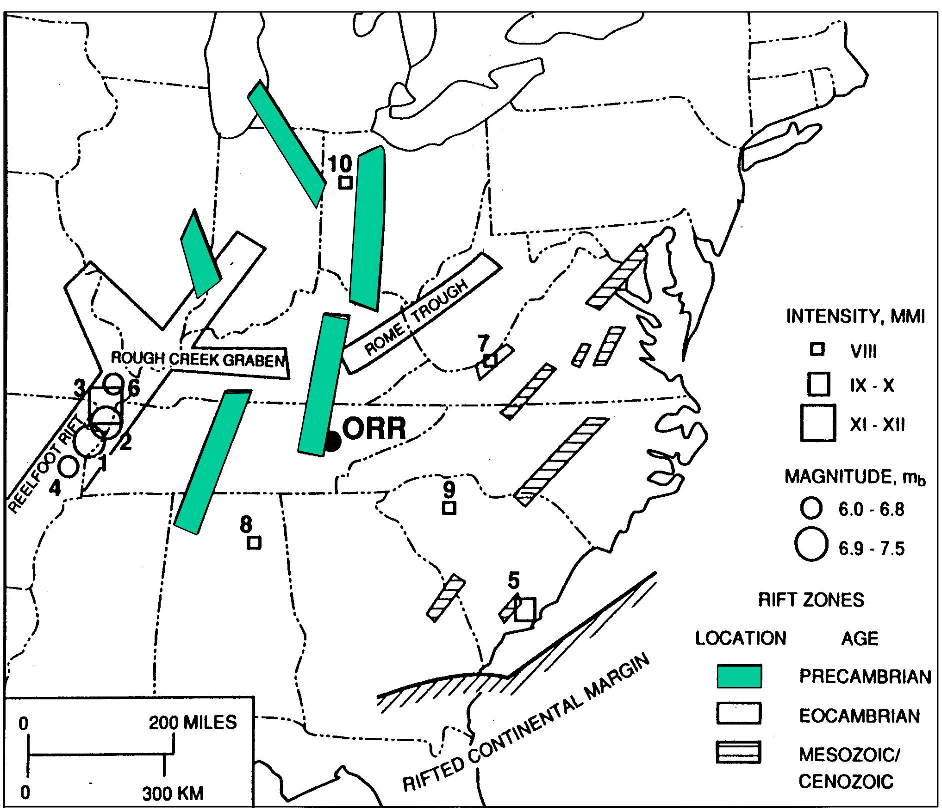

Figure 4.1.1.4-1. Southeast region basement structures and major earthquakes.

Carolina, and the strongest earthquake within 60 miles (100 km) of the ORR had an epicenter near Maryville-Alcoa, Tennessee.

The nearest capable faults (with the capacity of seismic movement) are in the New Madrid Fault zone, approximately 480 km (300 mi) northwest of ORR. An exhaustive literature search in the preparation of the Tennessee Valley Authority (TVA) Safety Analysis Review (Blasing et al. 1992) revealed no evidence of capable faults in the Appalachian Basin where the ORR is located. The U.S. Nuclear Regulatory Commission (NRC) (Blasing et al. 1992) affirmed TVA assessment for the Clinch River Breeder Reactor site with the ORR. Furthermore, the depth of earthquakes within the Appalachian Basin is generally greater than 10 km (6.2 mi) for instrumentally recorded earthquakes. Neither earthquake nor outcrop data support the hypothesis that Paleozoic faults exposed at the surface have been reactivated during modern time (Holocene). However, earthquake energies could be transmitted from adjacent physiographic provinces where recent motion events have been observed. Based on historical observations modified for the dampening effect of distance, Table 4.1.1.4-1 presents expected earthquake intensities for the ORR.

MODIFIED MERCALLI INTENSITY SCALE OF EARTHQUAKE MOTION

I. Not felt except by a few under exceptionally favorable circumstances.
II. Felt by a few persons at rest, especially on upper floors of buildings.
III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Vibration like passing of truck.
IV. Felt indoors by many; outdoors by few during the day. Dishes, windows, door disturbed; walls make creaking sound. Sensation like heavy truck striking building.
V. Felt by nearly everyone, many awakened. Some objects broken; cracked plaster in a few places. Disturbances of trees, poles, and other tall objects sometimes noticed.
VI. Felt by all, many scared and run outside. Some heavy furniture moved. Damages slight.
VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate damage in well built ordinary structures; considerable in poorly built or badly designed structures.
VIII. Damage slight in specially designed structures; considerable in ordinary substantial building with partial collapse; great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, and walls. Sand and mud ejected in small amounts. Changes in well water levels.
IX. Damage considerable in specially designed structures; well designed frame structures thrown out of plumb; great in substantial buildings. Buildings shifted off foundations. Underground pipes broken.
X. Some well-built structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Landslides considerable from river banks and steep slopes.
XI. Few, if any, structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines out of service. Earth slumps and land slips in soft ground.
XII. Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown into the air.

4.1.2 WATER RESOURCES

The following section discusses the water resources at ORNL.

Table 4.1.1.4-1. Maximum expected earthquakes and their peak ground accelerations at ORR.

Province	Maximum Historical Earthquake MMI[a]	Distance to ORR mi (km)	Maximum MMI[b] at ORR
Appalachian Basin	VIII	on-site	VIII
Atlantic Coastal Plain	X	200 (320)	VII
Interior Low Plateaus	VIII	30 (50)	VII
Reelfoot Rift	XI-XII	250 (400)	VII
Piedmont	VII-VIII	125 (200)	V-VI

[a] Blasing et al. 1992.
[b] Modified Mercalli Intensity (MMI) scale.

4.1.2.1 Surface Water

Surface water at the proposed Chestnut Ridge SNS site consists of a small perennial stream (first order) that acts as headwater to White Oak Creek. This unnamed tributary flows southeast from below the proposed footprint on Chestnut Ridge into the ORNL main plant area. (Figure 4.1.2.1-1). In the lower reaches, the stream has created a floodplain 16 to 33 ft (5 to 10 m) wide with a stream channel up to 6.5 ft (2 m) wide, with overall water depths of about 6 in. (15 cm). Up slope, the tributary forms a deep "V" slope with a channel 3.3 to 6.5 ft (1 to 2 m) wide and with water depths of 2 to 4 in. (5 to 10 cm) during wet-weather base flow. Figure 4.1.2.1-2 displays the combined flow of this stream and two other small tributaries at the weir located well below the proposed SNS site at the foot of Chestnut Ridge (Feb. 97 through Jan. 98). These flows (Salmons 1998b) represent a snapshot of the flow in White Oak Creek from a single recorded measurement for each month shown.

Flow diminishes to zero at the elevation of the proposed SNS site. Two additional drainages northeast and southwest of the site dissect the scarp face of Chestnut Ridge and flow northwesterly into Bear Creek. While these drainages may receive runoff from the footprint area, the site boundary does not overlay the actual stream channels.

No known users exist for water from these headwater tributaries. Also, the proposed site is not within a floodplain, nor is widespread flooding likely for a site location several hundred feet above the valley floor.

Water quality of the watershed below the proposed SNS site is frequently monitored and used as a reference site for comparison with the ORNL main plant area. Six sampling events (Salmons 1998a) took place in 1996-1997 at the White Oak Creek Headwater Station (WCK 6.8). For those six sampling events, volatile organic compounds (VOCs) and heavy metal contaminants were not detected. Background concentrations of dissolved metals were observed (i.e., Al, Ba, Ca, Fe, Mg, Mn, P, Na, and Zn).

Six sampling events for radiological monitoring (Salmons 1998a) took place in 1996-1997 at the White Oak Creek Headwater Station (WCK 6.8). Radionuclide levels reflect atmospheric contributions and are far below any level of concern (Table 4.1.2.1-1). Water quality of this stream reflects the nonimpacted character of the watershed.

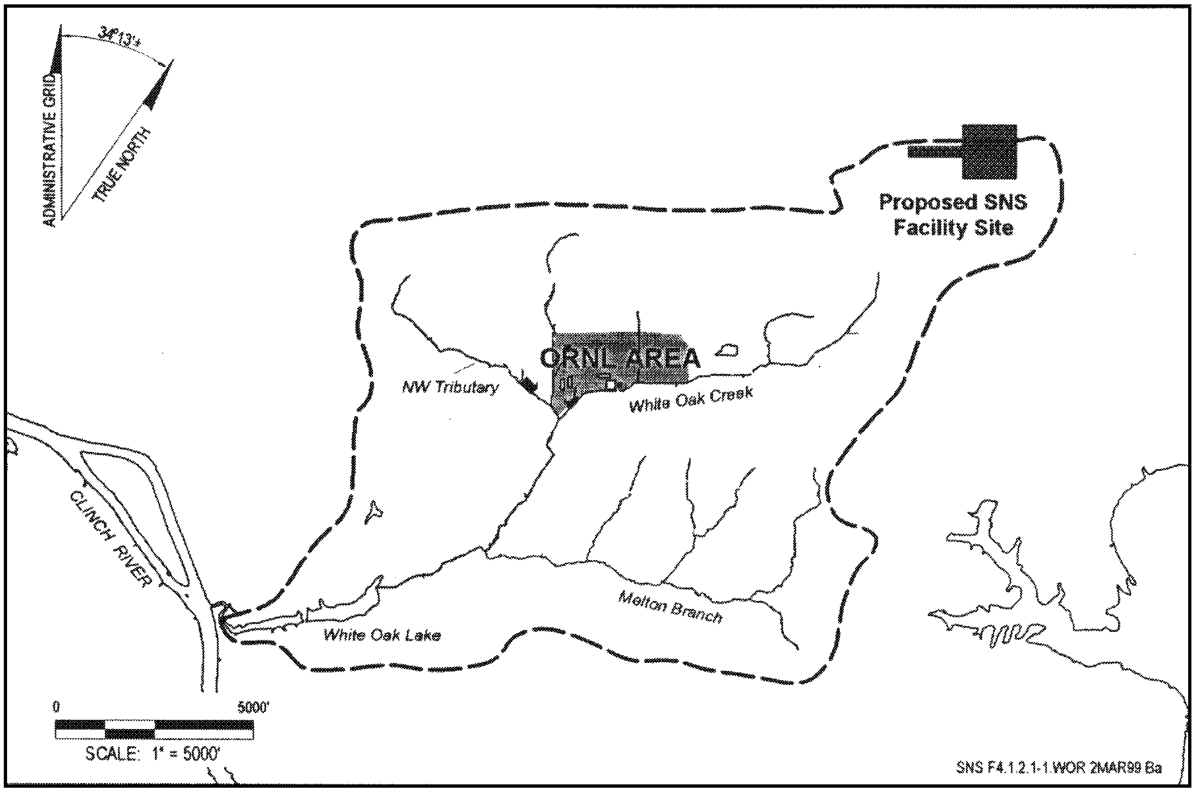

Figure 4.1.2.1-1. White Oak Creek drainage at ORR.

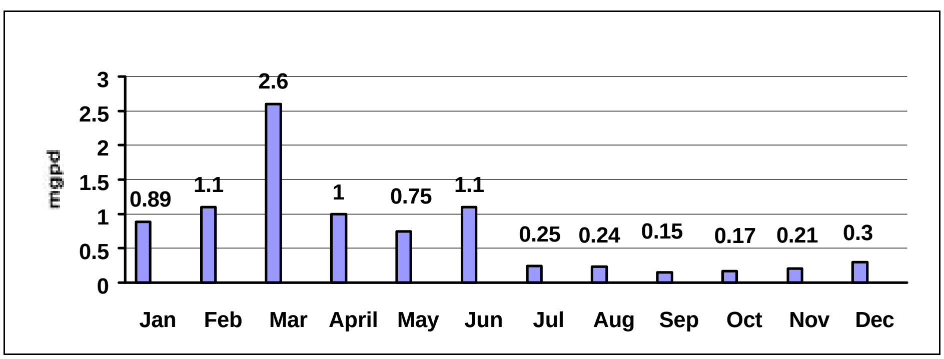

Figure 4.1.2.1-2. White Oak Creek headwater flow at ORR.

Table 4.1.2.1-1. Radionuclide activities (Bq/L) at the White Oak Creek Headwaters Monitoring Station.

Radionuclide	Frequency of Detection	Maximum Activity	Average Activity	Minimum Activity
Gross Alpha	2/9	0.044	0.0019	-0.036
Gross Beta	6/9	0.094	0.057	0.016
Be-7	0/1	0.22	0.22	0.22
Co-60	0/9	0.070	0.034	-0.050
Cs-137	0/9	0.050	0.0035	-0.053
H-3	2/9	300.0	41.0	0.0010
TC-99	1/6	0.20	0.055	-0.030
Sr-89,90	1/10	0.099	-0.0039	-0.082
Total Uranium	1/6	0.028	0.013	-0.0020

4.1.2.2 Groundwater

Groundwater at the proposed Chestnut Ridge site is observed at a depth of greater than 60 ft (18 m). Temporary water levels were recorded in open borings by Law Engineering at the site at 67 and 94 ft (20 and 29 m) (B-8 and B-1, respectively). Also, two groundwater monitoring wells (GW-165 and GW-166) located about 3,000 ft (914 m) east of the proposed site (Oak Ridge Administrative Coordinates N27800, E44500) have water levels at depths of greater than 75 ft (23 m). It should be noted that groundwater levels vary significantly depending upon height above the valley floor and seasonal and climatic conditions. No specific groundwater monitoring at the proposed SNS site is available.

Limited site-specific data about the subsurface of the SNS site are currently available. If the Chestnut Ridge alternative is selected, a geophysical, geotechnical, and hydrogeological characterization of subsurface and groundwater conditions will be completed. The following discussion is intended to supply an understanding of the proposed site as deduced from the conceptual regional model.

Two broad hydrologic units are identified in the ORR, each having fundamentally different hydrologic characteristics. The Knox Group and the Maynardville Limestone of the Conasauga Group constitute the Knox aquifer, in which flow is dominated by solution conduits formed along fractures and bedding planes. The remaining geologic units constitute the ORR aquitards, in which flow is dominated by fractures. Subsurface flow in both types of aquifers is recharged mainly on ridges and is discharged into lakes, streams, springs, and seeps.

The hydrology of the ORR has been described by Moore (1989). The subsurface flow system can be divided into the storm flow zone, the vadose zone, and the groundwater zone. Water budget models indicate that 90 percent of the active subsurface flow occurs through the top 3.3 to 6.5 ft (1 to 2 m) of the stormflow zone. Infiltration tests indicate that this zone is as much as 1,000 times more permeable than the underlying vadose zone. During rain events, the stormflow zone partially or completely saturates and transmits water laterally to the surface-water system. A vadose zone exists throughout the ORR except where the water table is at land surface. The thickness of the zone is greatest beneath ridges and thins towards valley floors. Beneath ridges underlain by the Knox aquifer (for example, Chestnut Ridge), the vadose zone is often as much as 164 ft (50 m) thick. Most recharge through the vadose zone is episodic and occurs along discrete permeable features that may become saturated during rain events.

The groundwater zone occurs typically near the transition from regolith to bedrock. This zone can be divided into three intervals: the water table interval, the intermediate interval, and the deep interval. The water table surface lies near the contact between the regolith and weathered bedrock. A large flux has formed regolith at a shallower level by dissolution of the rock cement. Fresh bedrock at deeper levels indicates a smaller water flux. Seasonal declines in water table elevation can nearly drain this interval.

Groundwater movement within the bedrock is dominated by flow through fractures that can be separated into two categories: the larger, well-connected, water-producing intervals and the smaller intervals that make up the matrix. Distinctly different transmissivity values represent two populations of aquifer properties [for example, flowing fractures (mean $T=0.23\ m^2/d$) and matrix contributions (mean $T=0.0011\ m^2/d$)]. The deeper groundwater zone occurs below any water-producing interval and generally has the same characteristics as matrix intervals within the shallow groundwater zone (SAIC 1994).

The Knox aquifer is a carbonate unit with karst features in which the majority of groundwater flow is controlled by a few cavity systems. In the Knox aquifer, and to a lessor extent in other carbonate rocks of ORR, fractures are enlarged by solution to create well-developed and extensive cavity systems. A survey of the proposed SNS site has mapped the surface expression of locations for possible sinkholes related to karst development (Figure 4.1.1.1-3). Many of these sinkholes occur within the Longview Dolomite southeast of the proposed site, but others are scattered within the general area of the SNS footprint.

In bedrock throughout the ORR, groundwater flow occurs through networks of open, connected fractures and conduits. To understand the significance of karst development within the Knox aquifer, a study of 802 wells in various formations showed that only 97 wells (12 percent) intercepted a cavity. From the population of wells that intercepted cavities, 53 out of 97 (55 percent) encountered only one cavity, while the Knox wells encountered two or more cavities 76 percent of the time. There is also a correlation between formations and the cavity size. The average cavity height at ORNL in the 97 occurrences is 1.8 ft (0.59 m). The largest cavities are generally found in the Knox Group with a mean height of 3.3 ft (1.0 m). In addition, cavities occur at deeper depths in the Knox Group than in other units. Mean depth below ground surface of the cavities in the Knox Group [112 ft (34 m)] is significantly greater than in the Rome Formation [39.3 ft (12 m)], Conasauga Group [27.2 ft (8.3 m)], or the Chickamauga Group [32.2 ft (9.8 m)].

Two wells on the southeast side of Bear Creek Valley are reported to produce greater than 950 gpm (3,596 lpm) of water, and about a dozen large springs discharge water near the base of ridges underlain by the aquifer. A tracer test in the Knox aquifer showed a fluid velocity of 650 to 950 ft/d (200 to 300 m/d) between a swallow hole and a resurgent spring farther downstream. Most wells in the Knox aquifer, however, yield small quantities of water and are not capable of similar flows from those permeable zones.

No groundwater monitoring wells are located in the vicinity of the proposed SNS site to characterize the water quality parameters.

4.1.3 CLIMATE AND AIR QUALITY

The ORR is part of the southeast climatological region of the United States and may be broadly classified as humid continental. The region is characterized by a moderate continental forest climate with mild, cool winters and warm, humid summers. The Blue Ridge Mountains to the east and the Cumberland Plateau to the west have a protective and moderating influence on the area's climate. These features divert severe storms and tornadoes; consequently, high-velocity windstorms are rare. Similarly, the mountains divert hot, southerly winds that develop along the south Atlantic Coast. Slow-moving high-pressure cells that may remain stationary for days suppress rain in the fall and provide mild weather.

Precipitation in this portion of the Tennessee Valley is seasonally distributed (Figure 4.1.3-1). Winter storms are generally of low intensity and long duration. Brief, heavy rains associated with thunderstorms are common in the summer. Peaks in precipitation usually occur in winter and early spring and in mid-late summer. The 40-year mean annual precipitation is 53.9 in. (137 cm), and the mean annual snowfall is 10.4 in. (26 cm). Year-round mean temperatures are about 58 F (14.4 °C) with a January mean of about 38 °F (3.5 °C) and a July mean of about 77 °F (25 °C). Extreme temperatures can dip as low as -24 °F (-31 °C) and peak as high as 100°F (37.8 °C).

The prevailing winds in this area follow the general topography of the surrounding ridges: up-valley winds come from the southwest during the daytime, and down-valley winds come from the northeast during the nighttime (Figure 4.1.3-2). The average wind speed recorded for 1996 was 3.13 mph (5 km/h), with a maximum recorded gust of 50.3 mph (81 km/h) and a predominant wind direction to the southwest (NCDC 1996).

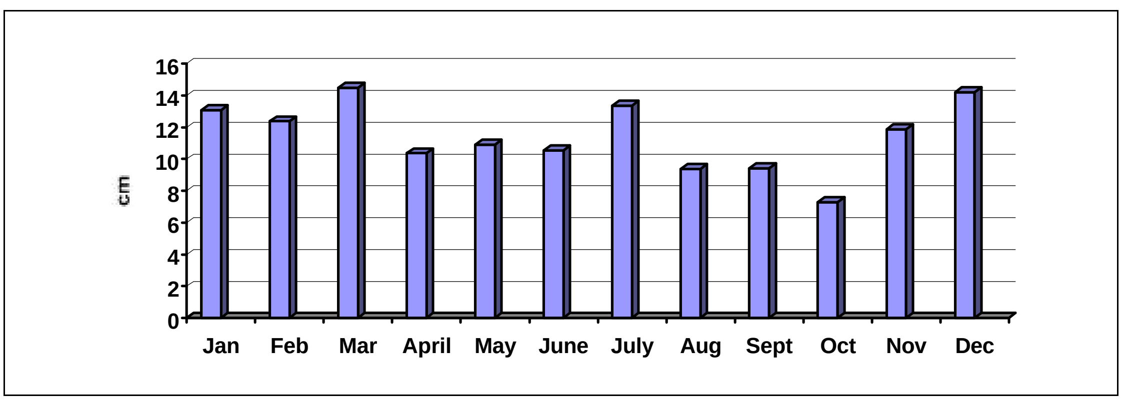

Figure 4.1.3-1. Average monthly precipitation at ORR.

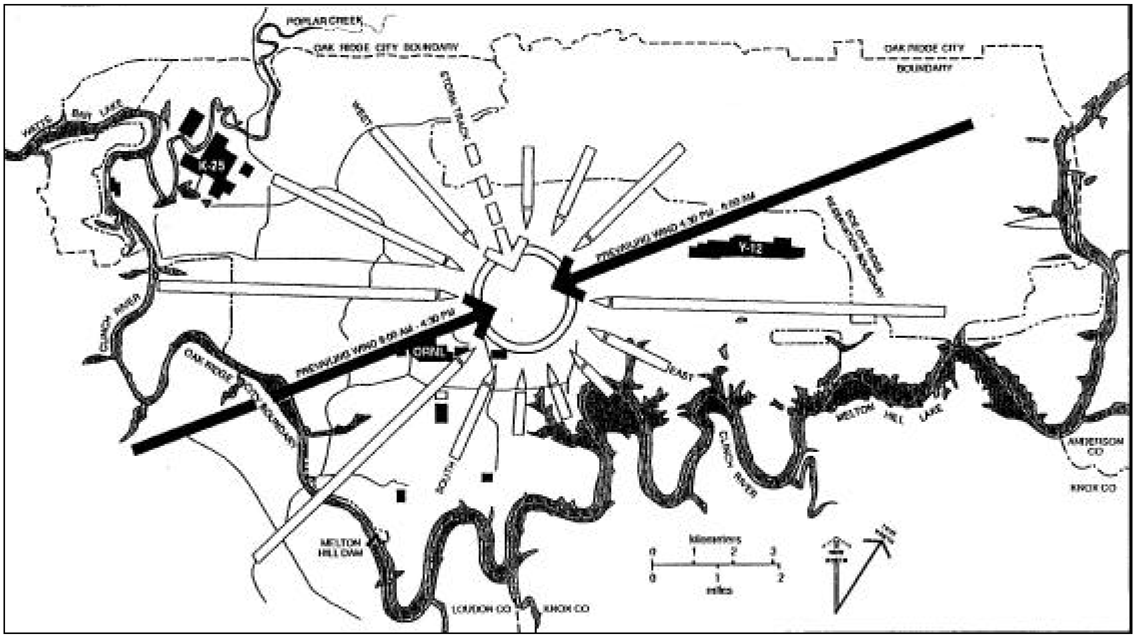

Figure 4.1.3-2. Day and nighttime wind patterns at ORR.

4.1.3.1 Severe Weather

Severe weather in the Oak Ridge area is primarily related to convective thunderstorms with associated hail and lightening. On the average, this area experiences 51.3 thunderstorm events per year. The maximum sustained wind velocity observed at the National Oceanic and Atmospheric Administration (NOAA) meteorological station was recorded January 1959 at 59 mph (95 km/h). An average of 33.6 days is observed with heavy fog restricting visibility to less than 0.25 miles (0.4 km). Historically, snowfalls greater than 1 in. (2.5 cm) have been recorded on only 3.6 days.

East of the Rocky Mountains, East Tennessee has one of the lowest incidences for severe weather involving a tornado (Figure 4.1.3.1-1). Nonetheless, occurrences of such storms are a possibility, as demonstrated by the storm of February 21, 1993. Climatic conditions of this storm spawned a tornado with winds estimated to be in excess of 100 mph (161 km/h). The storm path cut through ORR near the Y-12 Plant. It caused relatively light damage, much in part due to its course and relatively small size. Effects of a tornado on certain key facilities on the ORR have been examined from an emergency-planning standpoint. Numerous approaches to calculating tornado frequencies and recurrent intervals exist. A common approach was initially proposed by H.D.S. Thom in 1963. Based upon historical tornado sightings over a large square (one degree), a point probability can be calculated. The chance of a point, like the proposed SNS location, being struck by a tornado of *any* magnitude in a one-year period is approximately 0.0004. Conversely, the recurrence interval for a tornado striking that point is 1/0.0004 or about once every 2,500 years (Knazovich et al. 1993).

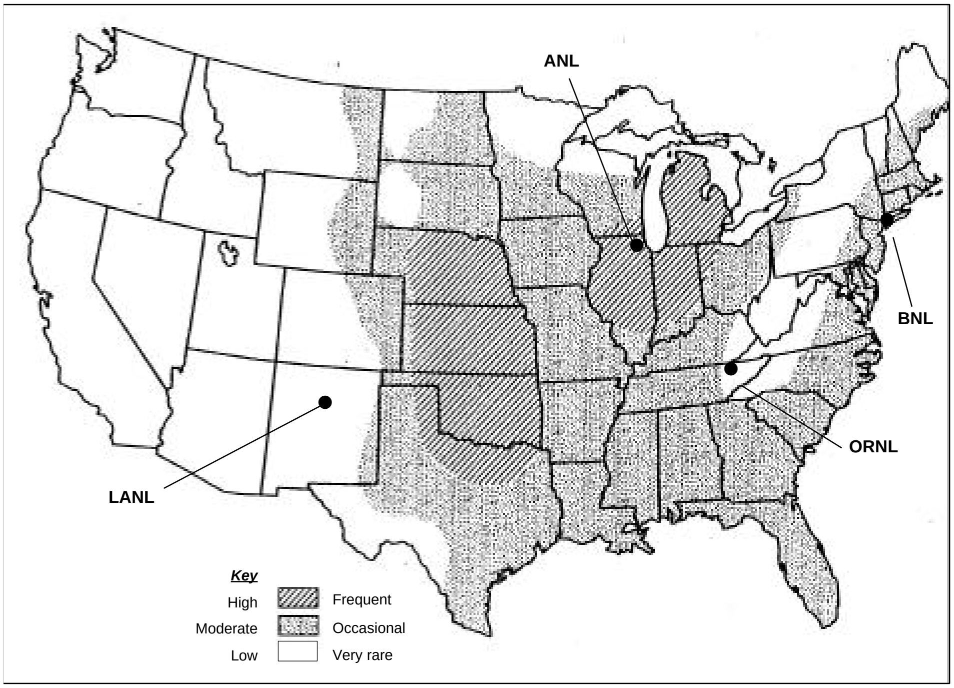

Figure 4.1.3.1-1. Tornado frequency in the United States.

Other studies by Fujita (1979, 1980), McDonald (1979), and Beavers et al. (1985) (all cited in Knazovich et al. 1993) were performed for the ORR. Based on these studies, the probability of a tornado with wind speeds in excess of 100 mph (161 km/h) occurring at Oak Ridge is approximately 5 x 10^{-5}, or a recurrence interval of about once every 20,000 years. The estimate of a tornado with higher wind speeds striking Oak Ridge is even lower. The probability of a significant tornado (F2 or higher) striking the Oak Ridge area is on the order of 3 x 10^{-5} to 1 x 10^{-7}.

4.1.3.2 Atmospheric Dispersion

Seven meteorological towers provide data on meteorological conditions and on the transport and diffusion qualities of the atmosphere on the ORR. The system consists of two towers at the Y-12 Plant [328 and 216 ft (100 and 66 m) high], three towers at the ORNL main plant area [one 328 ft (100 m) and two 108 ft (33 m) high)], and two towers at the East Tennessee Technology Park (ETTP) site [216 and 108 ft (66 and 33 m) high]. Data are collected at different levels to determine the vertical structure of the atmosphere and the possible effects of vertical variations on releases from facilities. At all towers, data are collected at 33 ft (10 m) and at the top levels. At the 328-ft (100-m) towers, data are also collected from an intermediate 108-ft (33-m) level. At each level, temperature, humidity, wind speed, and direction are measured. Select stations measure barometric pressure, precipitation, and solar radiation.

THE FUJITA SCALE

F-Scale Number	Intensity Phrase/ Wind Speed	Type of Damage Done
F0	Gale tornado: 40-72 mph	Some damage done to chimneys; breaks branches off trees.
F1	Moderate tornado: 73-112 mph	Peel surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off roads; attached garages may be destroyed.
F2	Significant tornado: 113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; large trees snapped.
F3	Severe tornado: 158-206 mph	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
F4	Debasing tornado: 207-260 mph	Well-constructed houses leveled; structures with weak foundations blown off; cars thrown.
F5	Incredible tornado: 261-318 mph	Strong frame houses lifted off foundations and carried considerable distances; automobile-sized missiles fly through the air; trees debarked; concrete structures badly damaged.

As mentioned previously, prevailing winds are channeled from the southwest or northeast by the ridges flanking the proposed site, providing limited cross-ridge flow. These conditions dominate over the entire reservation with the exception of the ETTP site, which is located in a relatively open area that has a more varied flow. On ORR, low-speed winds predominate at the surface level. Data from tower levels indicate an increase in wind speed at progressively higher elevations. The atmosphere over the reservation is dominated by stable conditions on most nights and in the early morning hours. These conditions, coupled with low wind speeds and channeling effects of the valleys, result in poor dilution of material emitted from facilities. Air stagnation is relatively common in eastern Tennessee. An average of about two air stagnation episodes for periods greater than 24 hours occurs annually, covering an average of eight days per year. August, September, and October are the most likely months for air stagnation episodes.

4.1.3.3 Air Quality

The State of Tennessee has adopted the National Ambient Air Quality Standards (NAAQS), and the Tennessee Department of Environment and Conservation (TDEC) has also adopted regulations to guide the evaluation of hazardous air pollutants and toxics to specify permissible short- and long-term concentrations. Oak Ridge is in an Air Quality Control Region, classified as an “attainment” area for the six NAAQS criteria pollutants.

Existing ambient air quality in the vicinity of ORR is best quantified in terms of recent ambient monitoring data collected by the TDEC at nearby locations. Table 4.1.3.3-1 summarizes these data and is taken from *AIRS Quick Look Report* (TDEC 1998) for 1997. The ORR is located in a Class II prevention-of-significant-deterioration (PSD) area. The nearest Class I PSD area is the Great Smoky Mountains National Park, approximately 35 miles (56 km)

Table 4.1.3.3-1. Summary of 1997 monitoring data in the vicinity of the ORR.

Pollutant Averaging Time	Nearest Monitor Location	Maximum 1st	2nd	3rd	4th	NAAQS TAAQS	Number of Exceedances
PM-10	Knox Co.						
24-hour		69.0	67.0	61.0	60.0	150.0 μg/m^3	0
Annual		33.0				50.0 μg/m^3	0
TSP	Knox Co.						
24-hour		107.0	87.0	77.0	77.0	150.0 Sec. 260.0 Pri. μg/m^3	0
Ozone	Anderson Co.						
1-hour		0.109	0.107	0.106	0.105	0.12 ppm	0
NO_x	Loudon Co.						
Annual		0.015	—	—	—	0.05 ppm	0
SO_2	Anderson Co.						
3-hour		0.152	0.125	—	—	0.5 ppm	0
24-hour		0.032	0.025	—	—	0.14 ppm	0
Annual		0.005	—	—	—	0.03 ppm	0
CO	Knox Co.						
1-hour		10.3	9.6	—	—	35.0 ppm	0
8-hour		4.9	4.8	—	—	9.0 ppm	0
Lead	Roane Co.						
Quarterly		0.13	0.11	0.07	—	1.5 μg/m^3	0

Source: TDEC 1998. TAAQS - Tennessee Ambient Air Quality Standards.

southeast of the ORR. Class I PSDs include certain national parks and wilderness areas and permit the least amount of air quality deterioration for baseline concentrations of particulate matter, sulfur dioxide, and nitrogen dioxide. All areas not designated as Class I PSDs are supplied with a Class II determination.

4.1.4 NOISE

The SNS site is proposed for a wooded section of the ORR that is roughly 0.75 miles (1.2 km) from the nearest public-use highway (Bethel Valley Road) and about 1 mile (0.6 km) from the nearest concentration of on-site workers (ORNL). A site-specific survey has not been conducted, but ambient noise levels in a rural setting such as this are typically in the 35-45 dB range. Because of its remote location, the proposed site would be protected by distance from sources of noise and removed from any sensitive populations. The proposed SNS site would be situated about 3 miles (4.8 km) from residential population centers within the City of Oak Ridge and dispersed populations within Knox County.

4.1.5 ECOLOGICAL RESOURCES

This section provides a general description of the ecological resources for the proposed SNS site and the surrounding area. The discussions are based on information readily available from other sources. Site-specific surveys were done for protected species and wetlands. All other information was obtained from existing publications. For the most part, the impacts from construction and operation of the proposed SNS would be minor. Therefore, much of the information presented here is summary in nature. Greater detail can be obtained from the references compiled for this section.

4.1.5.1 Terrestrial Resources

ORR is an area of primarily natural vegetation surrounded by dramatically different land uses.

Since 1942, when the land was purchased for the Manhattan Project, the 34,516-acre (13,980 ha) reservation has been undisturbed except for project development of the U.S. Department of Energy (DOE) and its predecessors and for forest management. The original forests on the ORR were extensively cleared, and the land was cultivated or partially cleared and used for rough pasture during settlement. Except for the very steep slopes, most of the forest had been cut for timber, though not necessarily cleared and put into cultivation. Cultivation on the ORR ended in 1942, and cultivated fields have developed into forest, either through natural selection or planting of pines. Many of these old abandoned fields support mixed hardwood forests. Between 1948 and 1954, many of the abandoned fields that were not developing into forest were planted with loblolly, shortleaf, and white pine trees. Most of these plantations have been maintained with little or no invasion of hardwoods. Most pine stands that currently exist are on lower slopes; relatively level, wide ridge tops; and well-drained bottomlands (LMES 1994; LMES 1995; LMES 1996).

Based on information from the Forest Compartment Maps for the ORR, over half of the proposed site is covered with a mixed hardwood forest, composed of red oak, white oak, chestnut oak, poplar, and hickory. Approximately 20 percent of this area is covered with loblolly pines, the majority of which were planted in the 1940s and 1950s. Approximately 20 percent of the proposed site is labeled as "Beetle Kill cut over" (clear cutting for control of the pine bark beetle). The remaining 10 percent of the vegetative cover is old field scrub.

Only general information on wildlife in the vicinity of the proposed SNS site is available. Wildlife in this area is typical for forests in East Tennessee. Numerous small mammals occupy the hardwood/mixed-hardwood habitat, including flying squirrels, southeastern shrews, eastern moles, white-footed mice, and eastern chipmunks. Birds commonly found in forest areas include the yellow-shafted flicker, red-bellied woodpecker, hairy woodpecker, downy woodpecker, blue jay, Kentucky warbler, pine warbler, yellow-breasted chat, ovenbird, Carolina chickadee, tufted titmouse, and scarlet tanager. Hawks, including red-shouldered, red-tailed, and broad-winged, are commonly found on the ORR, as are wild turkeys. Amphibians and reptiles found in the forest habitat include the dusky salamander, American toad, eastern box turtle, ground skink, worm snake, black racer, rat snake, black king snake, milk snake, and copperhead (LMES 1994; LMES 1995; LMES 1996).

Pine plantations are essentially barren of both small and large mammals due primarily to the dense canopy that shade out most undergrowth. The pine warbler and white-throated sparrow are birds commonly found, but in general few bird species prefer this type of habitat. Reptiles and amphibians make little use of this habitat.

Right-of-ways for power line, gas pipeline, and water pipeline run through or adjacent to the proposed site. In addition, there are several dirt roads running through the site.

4.1.5.2 Wetlands

A report from a field survey conducted in September 1997, describes the wetlands on and adjacent to the proposed SNS site (Rosensteel et al. 1997). Eight wetland areas were identified. Seven of the wetlands (WOM14, WOM15, WOM16, WOM17, WOM18, WONT1-1, WONT2-1) are in the White Oak Creek watershed, and one (BCST2-1) is in the riparian zone of a first-order stream in the Bear Creek watershed. The wetlands are classified as palustrine forested, broad-leaved deciduous (PFO1), palustrine scrub-shrub, broad-leaved deciduous (PSS1), and palustrine emergent, persistent (PEM1). It is most likely that the hydrologic regimes of these wetlands are saturated and temporarily flooded. One of the wetlands that is spring-fed may be semi-permanently or permanently flooded. Wetland locations are shown in Figure 4.1.5.2-1.

The boundaries of all of the wetlands, except for WOM17, WOM18, and BCST2-1, were delineated and located by a civil survey. Therefore, the area sizes given for the delineated wetlands are accurate, while those for WOM17, WOM18, and BCST2-1 are estimated. The total area of wetlands in the survey area is 3.62 acres (1.46 ha), the majority of which [3.27 acres (1.32 ha)] are in the White Oak Creek watershed.

A 0.03-acres (0.01-ha) emergent wetland (WONT2-1) was identified along a tributary of White Oak Creek. An infrequently used, grass-covered roadbed crosses the tributary near its confluence with White Oak Creek. The emergent wetland includes a low spot in the road where it crosses the stream and a small alluvial area at the mouth of the stream. Surface runoff and seasonal stream flow collect in and flow through the wetland area. Species in the wetland include smartweed (*Polygonum* sp.), false nettle (*Boehmeria cylindrica*), microstegium (*Microstegium vimineum*, an invasive exotic grass species), and sedges (*Carex* spp.).

A 0.05-acres (0.02-ha) emergent wetland swale (WOM15) is immediately adjacent and parallel to Chestnut Ridge Road. Discharge from two springs flows through the swale and empties into White Oak Creek just downstream of the Chestnut Ridge Road culvert. Shrubs, including alder (*Alnus serrulata*) and elderberry (*Sambucus canadensis*), grow along one side of the swale. The swale is vegetated with numerous wetland species including watercress (*Nasturtium officiniale*), great lobelia (*Lobelia siphilitica*), cardinal flower (*Lobelia cardinalis*), turtle head (*Chelone glabra*), smartweed (*Polygonum* sp., and sedges (*Carex* spp.).

A 0.015-acres (0.006-ha) emergent wetland (WOM14) was identified in a manmade, isolated depression in an open area. This depression is near the wetland swale (WOM15), but separated from it by a vegetated berm. The depression does not have a surface outlet to the swale or to White Oak Creek. There was no water in the depression on the day of the wetland survey or on followup visits in the summer of 1998, but it is possible that it holds precipitation and surface runoff for an undetermined period of time during the winter and spring. The soil has hydric characteristics. Species in this man-induced emergent wetland include fescue (*Festuca arundinaceae*), false nettle (*Boehmeria cylindrica*), smartweed, Frank's sedge (*Carex frankii*), and other sedges.

A 2.36-acres (0.96-ha) forested wetland (WOM16) is located in a seep and spring area in

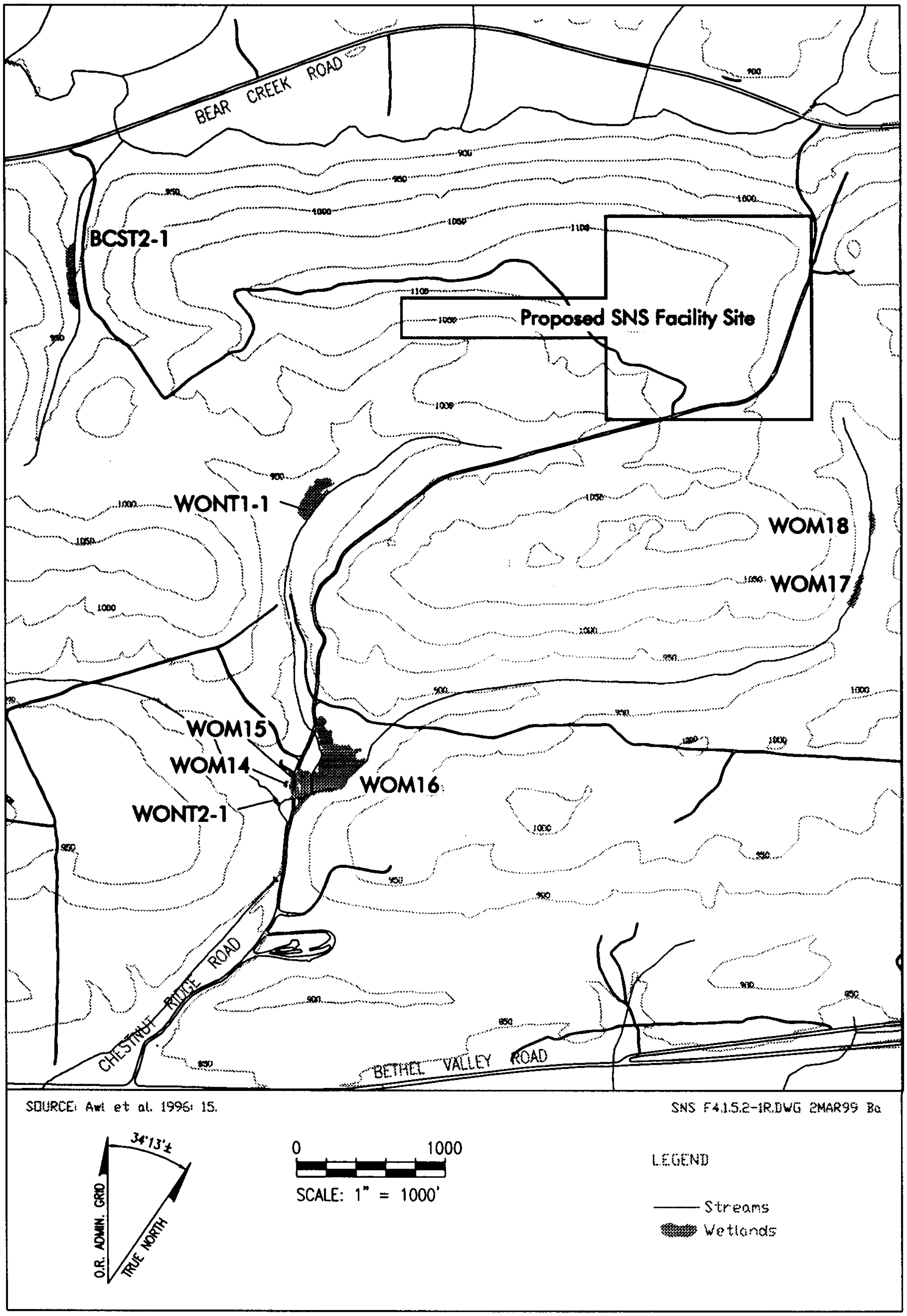

Figure 4.1.5.2-1. Wetland areas within and adjacent to the proposed SNS site at ORNL.

the floodplain of White Oak Creek, immediately adjacent to the east side of Chestnut Ridge Road. This wetland includes forested areas on both sides of White Oak Creek, a portion of a transmission line right-of-way, and a swale adjacent to Chestnut Ridge Road. Except at its upper end, this swale is separated from the rest of the wetland area by a 2 to 3 ft high upland berm. The wetland includes floodplain area on both sides of White Oak Creek. Dominant or common plant species in this wetland include sycamore (*Platanus occidentalis*), red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), spicebush (*Lindera benzoin*), sedges (*Carex* spp), watercress, microstegium, false nettle, cardinal flower, bugleweed (*Lycopus virginicus*), smartweed, and hog peanut (*Amphicarpa bracteata*). The primary hydrologic source is localized (seeps and springs) and diffuse groundwater discharge. Although this wetland is primarily an undisturbed forested wetland, the section in the transmission line right-of-way is more appropriately classified as a scrub-shrub/emergent wetland that is periodically disturbed by mowing. *Carex leptalea* and *Bartonia paniculatum*, two species that are uncommon in East Tennessee, occur in the forested part of wetland WOM16. This wetland area had initially been designated an Environmental Research Park Reference Area but is now within Environmental Research Park Natural Area 55 (Awl et al. 1996).

A small area of forested wetland (WOM17); [0.15 acres (0.06 ha)] and a small, emergent wetland (WOM18) [<0.03 acres (<0.012 ha)] were identified in the upper reach of White Oak Creek. WOM17 is a 0.15-acres (0.06-ha) wetland in a seep area that appears to contribute a significant portion of the summer and early fall base flow of a section of upper White Oak Creek. The stream channel immediately upstream and downstream of this wetland area

Wetland Classification

Wetlands identified within the vicinity of the proposed SNS site at ORNL were classified with a hierarchical system developed in 1979 by Cowardin et al. (as cited in Rosensteel et al. 1997). Wetlands are described by system, class, and subclass. Additional modifiers are used for water regime, chemistry, soils and disturbances.

The systems are marine, estuarine, riverine, lacustrine, and palustrine. The marine and estuarine systems are oceanic and coastal and do not occur on the ORR. The lacustrine and riverine systems encompass freshwater lakes and streams. The palustrine system includes nontidal wetlands dominated by trees, shrubs, or emergent vegetation. These wetlands are traditionally called marshes, swamps, or ponds.

The palustrine system includes five classes that are vegetated and that are considered as wetlands under the U.S. Army Corps of Engineers (1987) definition: (1) aquatic bed, (2) moss-lichen, (3) emergent (dominated by herbaceous plants), (4) scrub-shrub (dominated by shrubs and sapling trees), and (5) forested. Subclasses of the vegetation classes indicate differences in vegetative form. Water regime modifiers include: (A) temporarily flooded, (B) saturated, (C) seasonally flooded (F), semipermanently flooded, and (H) permanently flooded. (As cited in Rosensteel et al. 1997.)

was dry on the day of the survey. The soil was saturated, and there was flowing water in shallow surface channels on the day of the survey. The dominant vegetation species in wetland WOM17 include sweetgum, red maple, ironwood, smartweed (*Polygonum punctatum*), cardinal flower, microstegium, false nettle, and poison ivy (*Toxicodendron radicans*). WOM18 is a narrow fringe (0.6 to 0.9 m wide) of emergent wetlands on the edge of the stream channel. This section of stream contained flowing water. Dominant species in WOM18 include microstegium, cardinal flower, smartweed, bugleweed, and sensitive fem (*Onoclea sensibilis*).

A 0.63-acres (0.26-ha) forested wetland (WONT1-1) is located in the riparian zone of White Oak Creek north tributary 1. This tributary is located in a forested drainage on the west side of Chestnut Ridge Road north of the transmission line right-of-way and is in Environmental Research Park Natural Area 55. Further downstream the tributary crosses the power line, flows through a culvert under Chestnut Ridge Road, and empties into White Oak Creek in the WOM16 wetland. The wetland is located along the middle reach of the stream. The primary water source for this wetland is groundwater in the form of perennial seeps and a seasonal high water table. Overbank flooding may be an occasional, but not a sustaining, source of water. Dominant species include sycamore, red maple, sweetgum (*Liquidambar styraciflua*), green ash, bugleweed, cardinal flower, and cinnamon fem (*Osmunda cinnamomea*). At a perennial seep, which spreads out over a wide area, the dominant species include smartweed, watercress, bugleweed, cutgrass (*Leersia oryzoides*), leathery rush (*Juncus coriaceous*), avens (*Geum* sp), and tickseed sunflower (*Bidens* sp).

In the riparian zone of Bear Creek south tributary 2 (BCST2), there are three small areas of forested wetlands and emergent wetlands at streamside seeps. These three areas are close

Wetlands as defined by the U.S. Army Corps of Engineers (USACOE): Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. The USACOE uses three characteristics of wetlands when making wetland determinations:

Vegetation indicators – The vegetation community must be hydrophytic. At least 50 percent of the dominant plant species in each stratum must be classified as obligate wetland (OBL), facultative wetland (FACW, FACW-, FACW+), or facultative (FAC, FAC-, FAC+) [Reed 1988].

Soil indicator - Existence of soils that are hydric, having characteristics that indicate occurrence of anaerobic conditions resulting from depleted soil oxygen due to prolonged saturation, flooding, or ponding.

Hydrology indicators - Wetland hydrology exists when the presence of water at or above the soil surface for a sufficient period of the year significantly influences the plant types and soils that occur in the area.

Unless an area has been altered or is in a rare natural situation, wetland indicators of all three characteristics must be present for an area to be characterized as a wetland by the USACOE.

together along the stream and were combined into one wetland area (BCST2-1) for purposes of mapping and description. The approximate size of the wetland area is 0.35 acres (0.14 ha). It is downslope of, but not within, the site boundary. Dominant species include green ash, red maple, spicebush, microstegium, poison ivy, woodreed (*Cinna arundinacea*), and Virginia knotweed (*Tovara virginiana*).

4.1.5.3 Aquatic Resources

The proposed site lies within the White Oak Creek watershed (refer to Figure 4.1.5.2-1). White Oak Creek is a second-order stream with a watershed area of approximately 0.85 mi^2 (2.2 km^2), bordered by a young-to-mature forest and disturbance vegetation. The stream contains substantial aquatic vegetation, primarily watercress and peppermint. A rich and diverse assemblage of benthic invertebrates and a stable fish community occur in this area. At White Oak Creek kilometer 6.8, upstream of discharges from ORNL but downstream of the proposed SNS site, small numbers of the central stoneroller (*Campostoma anomalum*), blacknose dace (*Rhinichthys atratulus*), creek chub (*Semotilus atromaculatus*), and banded sculpin (*Cottus carolinae*) have been collected. Historically, operations at ORNL have had an adverse ecological effect on White Oak Creek and it tributaries, First Creek and Fifth Creek. The mean number of different kinds of taxa per sample (species richness) of benthic macroinvertebrates (bottom-dwelling invertebrates capable of being seen with the naked eye) is less downstream of ORNL than upstream. The number of pollution-intolerant benthic macroinvertebrate taxa is also less downstream of ORNL than upstream (LMER 1996/1997; ORNL, OR Y-12 Plant, and ETTP 1997).

4.1.5.4 Threatened and Endangered Species

DOE is in the process of consulting with the U.S. Fish and Wildlife Service (USFWS) and TDEC regarding whether or not construction and operation of the proposed SNS at ORNL would jeopardize the habitat of any threatened or endangered species and regarding appropriate mitigation measures. The USFWS responded with a list of federally listed or proposed endangered or threatened species that they believe may occur on the proposed SNS site. The TDEC has yet to respond. Appendix D presents the letters of consultation.

Surveys of the proposed SNS site for the presence or evidence of state and federally listed plant and animal species were conducted in 1997 (Rosensteel et al. 1997). No suitable habitat was identified for listed species of fish that have been previously documented on the ORR or for other listed fish known to occur in the region.

Threatened and Endangered Species: Animals, birds, fish, plants, or other living organisms in jeopardy of extinction by human-produced or natural changes in their environment are considered threatened or endangered. Requirements for declaring species threatened or endangered are contained in the *Endangered Species Act of 1973*.

This Act protects animal and plant species currently in danger of extinction (endangered) and those that may become endangered in the foreseeable future (threatened). The Act provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend, both through Federal action and by encouraging the establishment of state programs. Section 7 of this Act requires federal agencies to ensure that all federally associated activities within the United States do not harm the continued existence of threatened or endangered species or designated areas (critical habitats) important in conserving those species.

No suitable habitat was identified on or adjacent to the proposed site for any federally listed wildlife species. Suitable habitat was found for species listed as threatened, in need of management by the State of Tennessee, or as federal species of concern.

Previous studies have provided an indication of protected species that may occur on this site (Mitchell et al. 1996). Table 4.1.5.4-1 provides a list of species potentially occurring on the proposed site, their preferred habitat, and their status. Suitable habitat was located for nine species listed by the State of Tennessee as in need of management, one species listed as state threatened, and one federally listed species of concern. Figure 4.1.5.4-1 illustrates the locations of potential habitat for each of these species. Appendix E contains additional details of each of these listed species.

The proposed SNS site contains the following vegetation types and landscape elements associated with the occurrence of protected plants on the ORR: deciduous forests, mixed deciduous and pine forests, overmature/ successional pine plantations, wetlands and stream bottoms, limestone outcrops, and springs and seeps. The proposed site encroaches on a National Environmental Research Park (NERP)-designated Natural Area, NA52 (Awl et al. 1996).

The locations of designated natural areas and other environmentally sensitive areas on and near the proposed SNS site are shown in Figure 4.1.5.4-2. Several areas on and near the site have been ranked by the Nature Conservancy according to their significance in terms of biodiversity. These areas are shown in Volume II, Appendix B, page B-43.

NERP Natural Areas have been established on the ORR to protect federally or state-listed species that occur on the reservation. Each natural area consists of a core area, the actual location of the protected plant, and a buffer area for habitat protection. Aquatic Natural Areas are used for study and reference areas as part of the Biological Monitoring and Abatement Program (BMAP), required by the National Pollutant Discharge Elimination System (NPDES) permit for ORNL, or environmental remediation efforts. Many of the Aquatic Natural Areas represent nonimpacted streams or reaches of streams that are comparable in terms of size and potential fauna to streams or reaches that are monitored for impacts.

Ten protected plant species were recognized as potentially occurring within the proposed SNS site (Table 4.1.5.4-2). Pink lady's slipper and American ginseng were found at three locations (Figure 4.1.5.4-3) during the 1996 site surveys. An additional species verified to be located on the proposed site during previous surveys, Howe's Sedge (*Carex howei*), was removed from protection status by the State of Tennessee in 1997. Of the remaining species potentially occurring on this site, two are classified as having high potential for occurrence, while the remaining six are classified as having low potential for occurrence.

4.1.6 SOCIOECONOMIC AND DEMOGRAPHIC ENVIRONMENT

The region of influence (ROI) for the SNS at the proposed ORR site includes Anderson, Knox, Loudon, and Roane Counties, as shown in Figure 4.1.6-1. Approximately 90 percent of ORR employees reside in this region. The region includes the cities of Clinton, Oak Ridge,

Table 4.1.5.4-1. List of species potentially occurring on the ORNL site.

Species	Habitat on the proposed SNS and Status	Preferred Habitat
Sharp-shinned hawk (*Accipter striatus*)	Power line corridors In need of management	Mixture of woods and open country
Cooper's hawk (*Accipiter cooperii*)	Powerline corridors In need of management	Mixed woods with openings
Cerulean Warbler (*Dendroica cerulea*)	Mature hardwood forest on ridgetop Federal Species of Concern	Mature hardwood forests
Grasshopper Sparrow (*Ammodramus savannarum*)	Powerline corridors In need of management	Grassy fields and farmlands
Yellow-bellied sapsucker (*Sphyrapicus varius*)	Possible in most areas except pine stands In need of management	Open deciduous woods
Rafinesque's big-eared bat (*Plecotus rafinesquii*)	Abandoned building along C-17 Road In need of management	Unoccupied man-made structures and caves
Southeastern shrew (*Sorex longirostris*)	Pine plantations and tributaries In need of management	Pine woods and stream banks
Northern Pine Snake (*Pituophis m. melanoleucus*)	Ridgetops and powerline corridors State Threatened	Pine woods, dry ridges, and old fields
Eastern Slender Glass Lizard (*Ophisaurus attenuatus longicaudus*)	Ridgetops and powerline corridors In need of management	Dry upland areas, brushy cut-over woodlands
Mole salamander (*Ambystoma talpoideum*)	Depression with temporary pools In need of management	Moist low-lying woodland areas with ponds
Four-toed salamander (*Hemidactylium scutatum*)	Tributaries of White Oak Creek In need of management	Hardwood forest wetlands

Knoxville, Loudon, Lenoir City, Harriman, and Kingston.

This section provides a description of the following socioeconomic and demographic characteristics:

- Demographics
- Housing
- Infrastructure
- Local economy
- Environmental justice

4.1.6.1 Demographic Characteristics

Population trends and projections for each of the counties in the ROI are presented in Table 4.1.6.1-1. Of the four counties, Knox has the largest population, with 70 percent of the 1995 regional population of 517,604. Anderson County accounted for 14 percent of the regional population, Roane County for 9 percent, and Loudon County accounted for the remaining 7 percent. The region represents approximately 10 percent of the state's population. The Tennessee Department of Economic and Community Development has indicated that the population in the region will likely decline to 512,399 by year 2000 and then increase slightly by year 2005. Roane County is the exception to this trend, as it is projected to grow 28 percent.

Population data for the cities in the region are presented in Table 4.1.6.1-2. Between 1980 and 1995, the populations of the four-county region and the state both grew at about one percent per year. Projections in Table 4.1.6.1-1 show that regional and state populations are expected to grow by less than half of one percent annually through the year 2005.

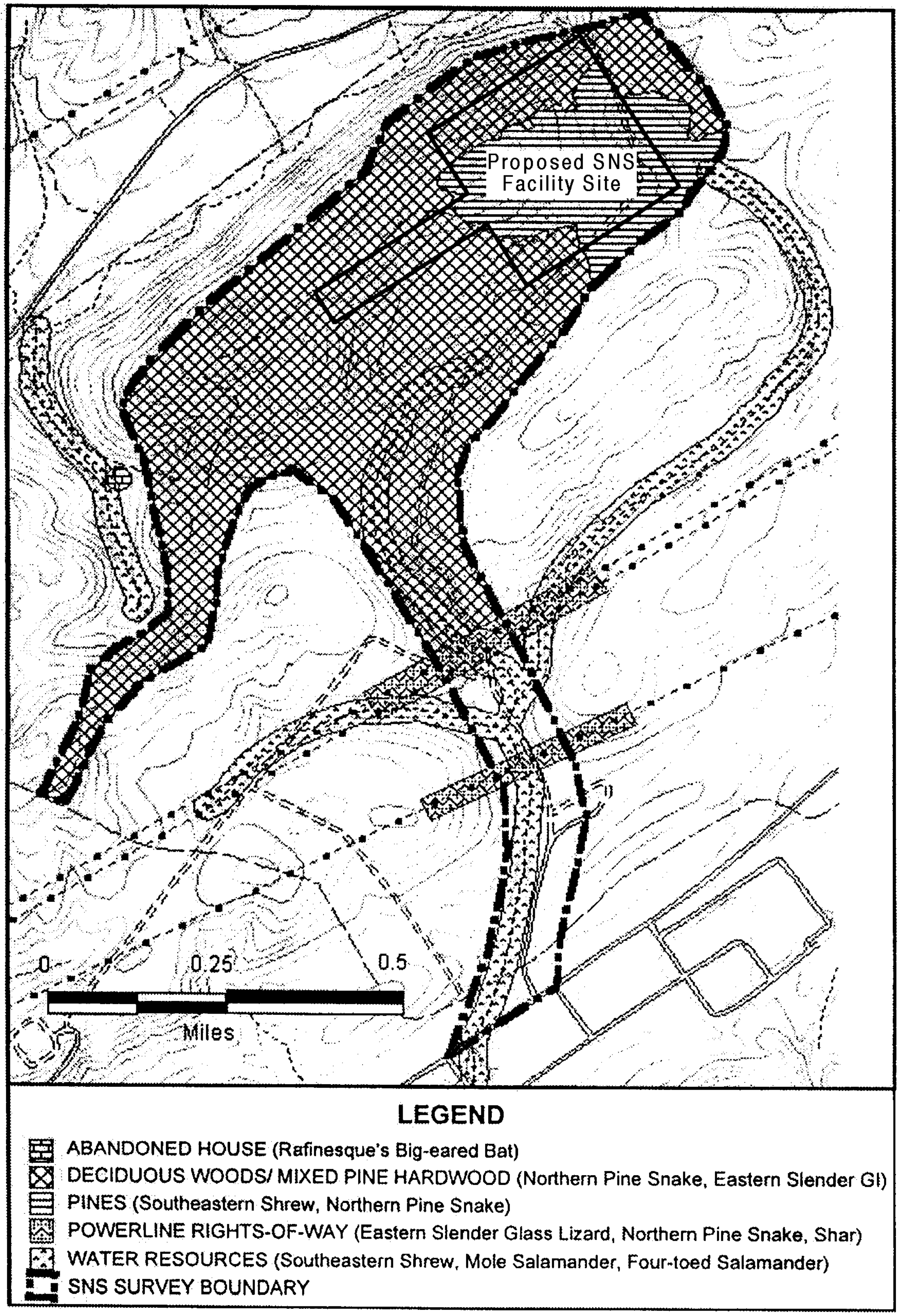

Figure 4.1.5.4-1. Potential habitat areas for threatened and endangered animal species within the ORNL site.

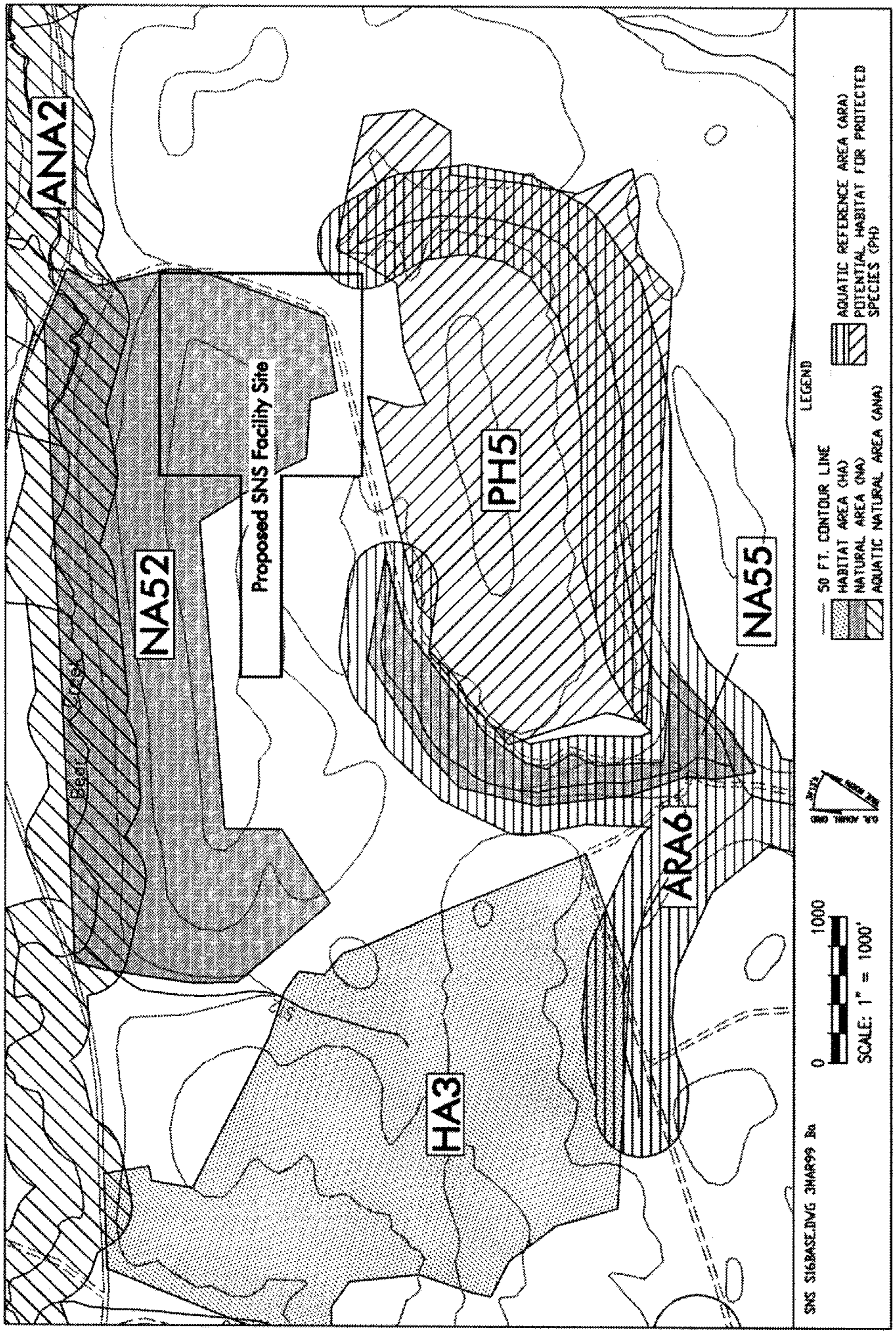

Figure 4.1.5.4-2. Natural and other environmentally sensitive areas in the vicinity of the proposed SNS site on the ORR.

Table 4.1.5.4-2. Threatened and endangered plant species potentially occurring within the proposed SNS site at ORNL.

Species	Common name	Habitat on ORR	Status[a]	Verification Time Frame	Potential for Occurrence within the Proposed SNS Site
Cypripedium acaule	Pink lady's slipper	Dry to rich woods	E-CE	Apr.-July	Verified on-site
Delphinum exaltatum	Tall larkspur	Barrens and woods	(C2), E	Aug.-Sept.	High
Fothergilla major	Mountain witch-alder	Woods	T	Apr.-May	Low
Hydrastis canadensis	Golden seal	Rich woods	S-CE	April-July	Low
Juglans cinerea	Butternut	Slope near stream	(C2), T	no time frame	Low
Lilium canadense	Canada lily	Moist woods	T	June-July	High
Liparis loeselii	Fen orchis	Forested wetland	E	May-July	Low
Panax quinquifolius	Ginseng	Rich woods	S-CE	May-Oct.	Verified on-site
Platanthera flava var. herbiola	Tuberculed rein-orchid	Forested wetland	T	May-Aug.	Low
Platanthera peramoena	Purple fringeless orchid	Wet meadow	T	July-Aug.	Low

[a] Status based on 1997 TN State List:

(C2) Special Concern, was listed under the formerly used C2 candidate designation. More information needed to determine status.
E Endangered in Tennessee.
T Threatened in Tennessee.
S Special Concern in Tennessee.
CE Status due to commercial exploitation.

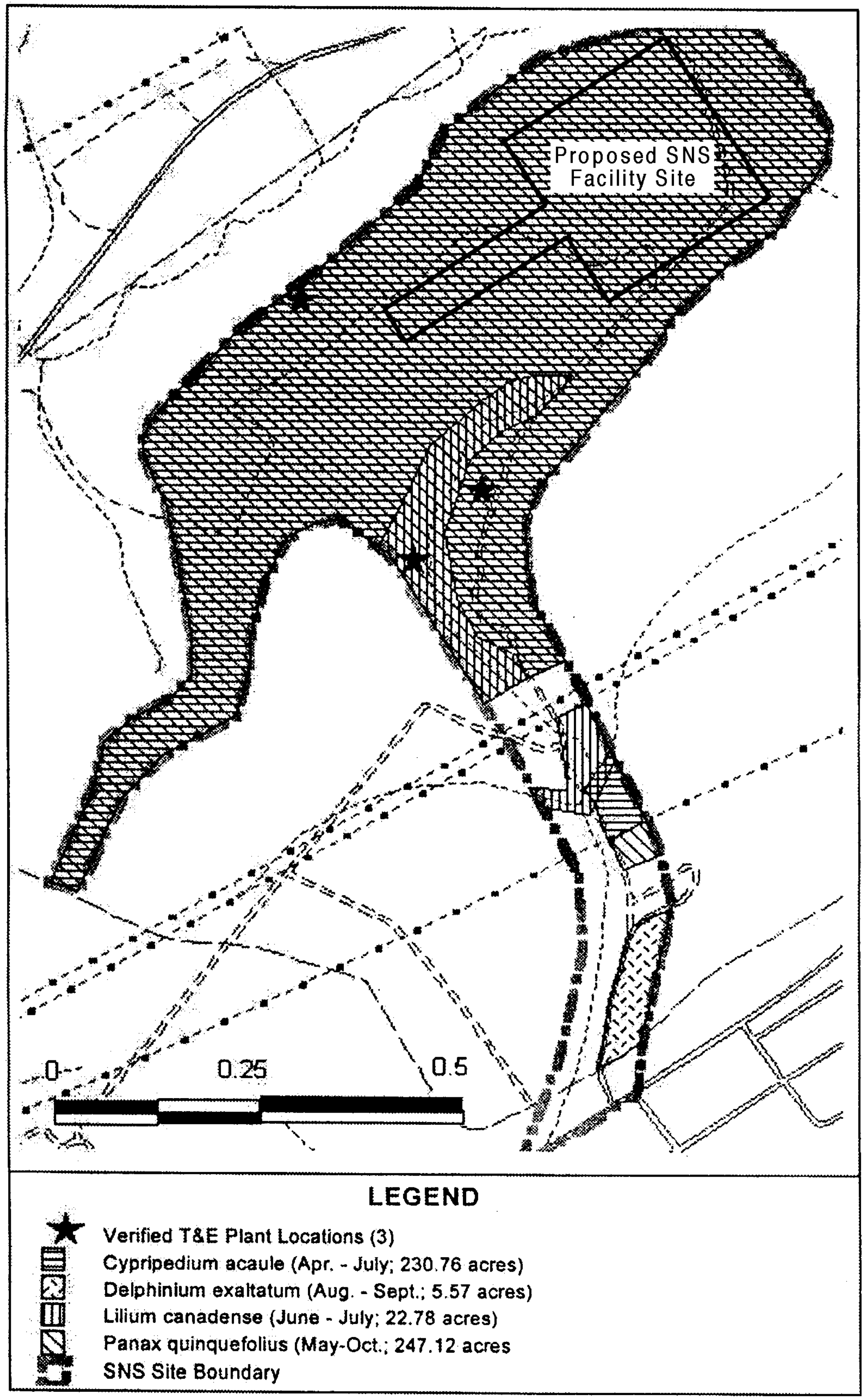

Figure 4.1.5.4-3. Threatened and endangered plant locations and potential habitat areas within the ORNL SNS site.

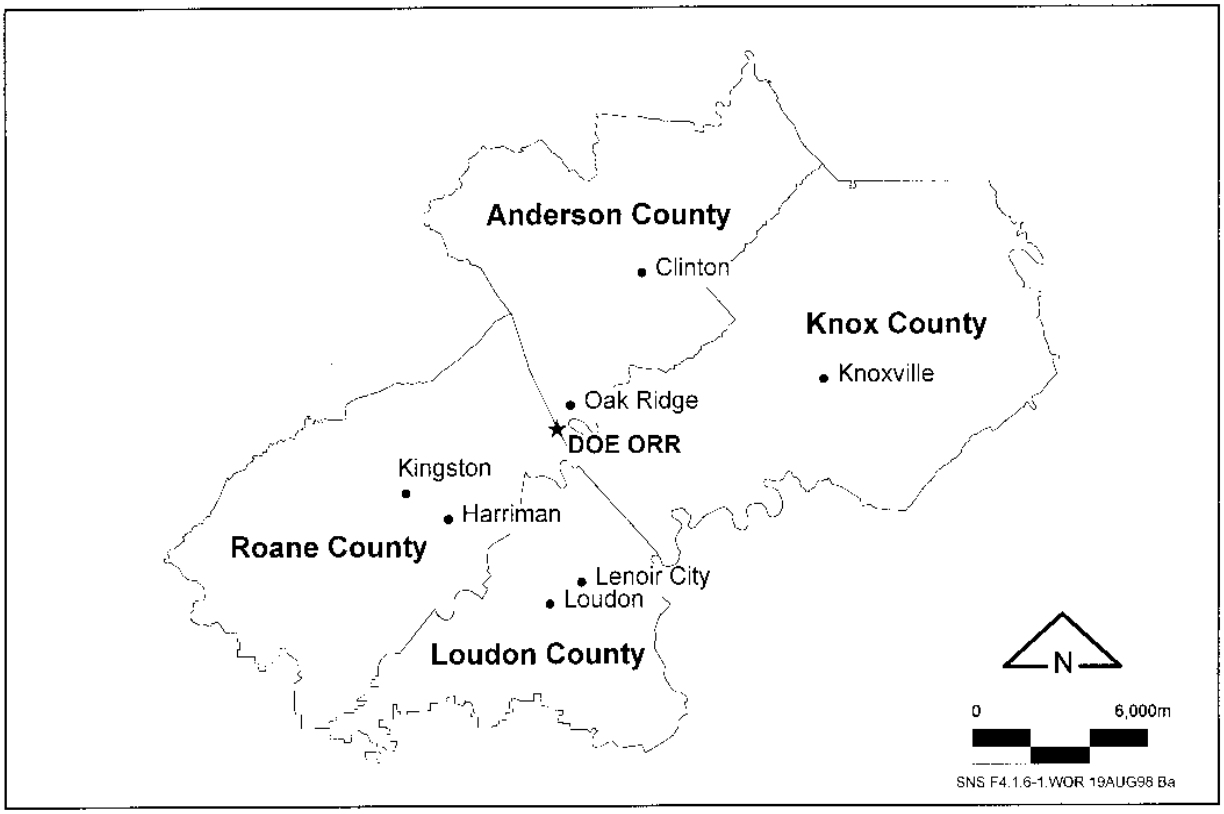

Figure 4.1.6-1. Map showing the socioeconomic ROI at ORR.

Table 4.1.6.1-1. Regional population trends and projections at ORNL.

County	1980	1990	1995	2000	2005
Anderson	67,346	68,250	71,663	68,181	66,347
Knox	319,694	335,749	361,407	353,721	360,833
Loudon	28,553	31,255	35,927	34,149	36,458
Roane	48,425	47,277	48,607	56,348	61,984
Region	464,018	482,531	517,604	512,399	525,622
State	4,591,023	4,877,185	5,235,358	5,178,587	5,305,137

Sources: U.S. Bureau of Census 1990; U.S. Bureau of Census 1996; TEDC 1994-1997.

Table 4.1.6.1-2. Population for incorporated areas within the ORR region.

Communities	1990	1996	Percent growth
Clinton	8,972	9,320	3.9
Oak Ridge	27,310	27,742	1.6
Knoxville	169,761	167,535	-1.3
Loudon	4,288	4,544	6.0
Lenoir City	6,147	8,890	44.6
Harriman	7,119	7,006	-1.6
Kingston	4,552	4,935	8.4

Source: U.S. Bureau of Census 1990; Tennessee Department of Economic and Community Development 1998.

Population by race and ethnicity for the region is presented in Table 4.1.6.1-3. The 1990 census data reflect racial and ethnic compositions in the four counties. There is little variation among the four counties, and Caucasians make up more than 90 percent of the combined population. African-Americans compose seven percent of the population.

4.1.6.2 Housing

Regional housing characteristics are presented in Table 4.1.6.2-1. In 1990, vacancy rates in the region ranged between a low of six percent in Loudon County to a high of nine percent in Roane County. Among all occupied housing units in the region, approximately two-thirds were owner occupied.

Housing vacancy rates for selected regional cities and towns are similar to county rates. In 1990, the county vacancy rate for all units was seven percent, while the combined vacancy rate for the seven selected communities (refer to Table 4.1.6.2-1) was eight percent. There were a total of 14,600 vacant units throughout the four-county region.

Median home value was similar in Roane, Loudon, and Anderson Counties, ranging between $48,700 to $55,100. Knox County median home values were higher at $69,900. Rents ranged from $280 to $351 across the ROI.

4.1.6.3 Infrastructure

The Infrastructure section characterizes the region's community services with indicators such as education, health care, and public safety.

4.1.6.3.1 Education

Tennessee is divided into 140 school districts, eight of which are within the four-county ROI. Information regarding school districts within the region is presented in Table 4.1.6.3.1-1.

The school districts in the region receive funding from local, state, and federal sources, but the percentage received from each source varies. Local funding varies from a low of 32.4 percent in Loudon County to a high of 55 percent in Knox County. State funding varies between 37.4 percent in Knox County to 60.1 percent in Loudon County, and federal funding ranges between a low of 6.7 percent in Oak Ridge and a high of 13.1 percent in Anderson County.

Table 4.1.6.1-3. 1990 population by race and ethnicity for the ORR region.

All Persons, Race/ Ethnicity	Anderson		Knox		Loudon		Roane		Total	
	Number	%[a]	Number	%[a]	Number	%[a]	Number	%[a]	Number	%[a]
All Persons	68,250	100	335,749	100	31,255	100	47,277	100	482,531	100
Caucasian	64,745	95	301,788	90	30,762	98	45,422	96	442,717	92
African-American	2,681	4	29,299	9	362	1	1,534	3	33,876	7
American Indian[b]	195	<1	996	<1	46	<1	87	<1	1,324	<1
Asian/ Pacific Islander	540	<1	3,136	<1	55	<1	177	<1	3,908	1
Hispanic of any race[c]	582	1	1,935	1	107	<1	273	1	2,897	1
Other races	89	<1	530	<1	30	<1	57	<1	706	<1

[a] Percentages may not total to 100 due to rounding.
[b] Numbers for Aleuts and Eskimos were placed in the "other" category, given their small number.
[c] In the 1990 Census, Hispanics classified themselves as White, Black, Asian/Pacific Islander, American Indian, Eskimo, or Aleut. To avoid double counting, the number of Hispanics was subtracted from each of the race categories.
Sources: U.S. Bureau of Census 1990; U.S. Bureau of Census 1996.

Table 4.1.6.2-1. Housing summary for the ORR region, 1990, by county.

	Anderson County		Knox County		Loudon County		Roane County	
	Number	%[a]	Number	%[a]	Number	%[a]	Number	%[a]
Total Housing Units	29,323	100	143,582	100	12,995	100	20,334	100
Occupied	27,384	93	133,639	93	12,155	93	18,453	91
Vacant	1,939	7	9,943	7	840	6	1,881	9
Median Home Value	$55,100	NA	$63,900	NA	$51,000	NA	$48,700	NA
Gross Rent	$342	NA	$351	NA	$280	NA	$287	NA

NA - Not applicable.
[a] May not total 100 due to rounding
Sources: U.S. Bureau of Census 1990; U.S. Bureau of Census 1996.

Table 4.1.6.3.1-1. Public school statistics in the ORR region, 1997-1998 school year.

School System	Number of Schools	Student Enrollment	Teachers	Teacher/ Student Ratio	Per-Student Expenditures
Anderson County	16	6,935	475	1:14.6	$4,508
Clinton	3	1.006	69	1:14.6	$5,269
Oak Ridge	8	4,752	342	1:13.9	$6,517
Knox County	86	51,982	3,293	1:15.8	$4,799
Loudon County	10	4,584	250	1:18.3	$4,012
Lenoir City	3	1,850	109	1:17.0	$4,530
Roane County	14	5,918	366	1:16.2	$4,387
Harriman	5	1,527	100	1:15.3	$4,951

Source: Tennessee Department of Education 1998.

4.1.6.3.2 Health Care

There are eight hospitals currently serving the region. Table 4.1.6.3.2-1 presents data on hospital capacity and usage. Average statistics for the hospitals indicate that there are approximately 2,400 acute-care hospital beds in the region, about 45 percent of which are available on any given day. This capacity is considered adequate to serve the health needs of the local population.

4.1.6.3.3 Police and Fire Protection

Table 4.1.6.3.3-1 gives the number of full time law enforcement officers for the incorporated areas within the ORNL region. The Knoxville Police Department has 383 officers with an approved fiscal year (FY) 1998 budget of $26.4 million. In addition, the Oak Ridge Police Department has 49 officers and an approved FY 1996 budget of $2.3 million. The Knoxville Fire Department has 13 fire stations, staffed by 118 Fire Department personnel. Fire protection for ORNL is provided on site by the ORNL Fire Department. The ORNL Fire Department has 30 firefighters and operates one rescue vehicle, two pumper engines, and 2 ambulances. The ORNL Fire Department has mutual agreements with the Y-12 Fire Department, the East Tennessee Technology Park Fire Department and the Oak Ridge Fire Department (Rosenbalm, 1999).

4.1.6.4 Local Economy

This subsection provides information on the economy of the region, including employment, education, income, and fiscal characteristics.

4.1.6.4.1 Employment

Regional employment data for 1997 are summarized in Table 4.1.6.4.1-1. Since 1991, unemployment has decreased in the four counties within the region, and the largest reductions in unemployment occurred in Knox County (from 4.6 percent in 1991 to 2.6 percent in 1997) and Loudon County (from 7.2 percent in 1991 to 4.2 percent in 1997). The 1997 unemployment rate for the ROI was 4.3 percent.

Table 4.1.6.4.1-2 presents employment by industry for the region. Government, manufacturing, retail trade, and services are the principal economic sectors in the region.

Table 4.1.6.3.2-1. Hospital capacity and usage in the ORR region.

Hospital	Number of Hospitals	Number of Beds[a]	Annual Bed-Days Used[b] (%)
Anderson	1	281	62
Knox	5	1,948	53
Loudon	1	62	28
Roane	1	85	53

[a] The number of acute-care beds.
[b] Based on the number of people discharged and the average length of stay divided by total beds available annually.
Sources: The American Hospital Directory, Inc. 1998; Tennessee Department of Health 1996.

Table 4.1.6.3.3-1 Full-time law enforcement officers for incorporated areas within the ORNL region (1996).

Community	Officers
Anderson County	124
Knox County	321
Loudon County	42
Roane County	49
Clinton	16
Oak Ridge	49
Knoxville	383
Lenoir City	14
Harriman	13
Kingston	8

Source: U.S. Department of Justice, 1997.

Table 4.1.6.4.1-1. ORR regional employment data, 1997.

County	Civilian Labor Force	Employed	Unemployed	Unemployment Rate
Anderson	36,800	35,270	1,530	4.2
Knox	197,420	192,280	5,140	2.6
Loudon	19,330	18,510	820	4.2
Roane	26,640	25,050	1,590	6.0
Region	280,190	271,110	9,080	3.2

Source: Tennessee Department of Employment Security 1998.

Table 4.1.6.4.1-2. Employment by industry for the Oak Ridge region of influence, by county and for the State of Tennessee (1995).

Economic Character	Anderson County	Knox County	Loudon County	Roane County	Region of Influence	State of Tennessee
Employment by Industry (1995)						
Farm	616	1,534	1,309	635	4,094	98,298
Agriculture Services	256	2,050	255	149	2,710	27,225
Mining	132	528	18	20	698	7,228
Construction	5,351	15,187	878	937	22,353	176,116
Manufacturing	11,307	25,207	3,173	5,774	45,461	553,865
Transportation and Public Utility	1,843	11,080	777	640	14,340	160,068
Wholesale Trade	596	15,924	280	433	17,233	151,126
Retail Trade	(D)	46,304	2,148	(D)	48,452	535,549
Finance, Insurance, and Real Estate	1,777	14,245	632	513	17,167	180,867
Services	(D)	75,131	3,621	(D)	78,752	848,610
Government	5,364	37,063	1,690	3,970	48,087	401,059

(D) - Data withheld to avoid disclosure when there are less than four businesses in an industry classification.
Source: U.S. Bureau of Census 1990.

Services employment is the largest employment sector in Anderson, Knox, and Roane counties. In Loudon County, the largest employment sector is manufacturing. While retail trade employs the second highest number in Knox, Loudon, and Roane Counties, retail trade employment in Anderson County is relatively low, and manufacturing and construction are the second and third highest employment sectors.

4.1.6.4.2 Income

In 1995, total regional income was approximately $11.5 billion, and six percent of this ($680,000,000) was paid to the ORR workforce (14,500 individuals, including contractors) residing in the region. Per capita income data for the region and the state are presented in Table 4.1.6.4.2-1. Over the period 1991-1995, per capita incomes in each ROI county grew by an approximate average of 22 percent to nearly $21,000. This rate of growth substantially exceeded the state-wide increase in income of only 18 percent. The number of persons in the region with income below the poverty level was 15 percent in 1990.

4.1.6.4.3 Fiscal Characteristics

Municipal and county general fund revenues in the ROI are presented in Table 4.1.6.4.3-1. The general fund supports the ongoing operations of local governments as well as community services such as police protection and parks and recreation.

The State of Tennessee does not have state or local personal income tax. Under Tennessee constitutional law, property taxes are assessed as follows:

- Residential Property equals 25 percent of appraised value.

Table 4.1.6.4.2-1. Measures of per capita income for the ORR region.

Area	Per Capita Income		Percent Increase
	1991 ($)	1995 ($)	
Anderson County	18,004	21,621	20
Knox County	18,911	23,107	22
Loudon County	15,671	19,606	25
Roane County	15,530	18,749	21
State of Tennessee	16,962	21,060	24

Sources: U.S. Bureau of Economic Analysis 1985-1995; TEDC 1994-1997.

Table 4.1.6.4.3-1. Municipal and county general fund revenues in the ORR region, FY 1997.

Revenue by Source	Anderson County		Knox County		Loudon County		Roane County	
	$(1000)	%[a]	$(1000)	%[a]	$(1000)	%[a]	$(1000)	%[a]
Local Taxes[a]	12,732	40	232,145	56	4,147	68	22,970	45
Licenses and Permits	34	<1	1,633	<1	178	3	102	<1
Fines and Forfeitures	56	<1	3,086	1	157	3	302	1
Charges for Service	2,640	8	21,811	5	43	1	1,167	2
Intergovernmental[b]	14,483	45	145,582	35	638	11	22,826	45
Interest	1,285	4	10,982	3	—[c]	NA	1,183	2
Miscellaneous Income	680	2	483	<1	911	14	2,474	5
Total	31,910	100	415,722	100	6,074	100	51,024	100

N/A - Not available.
Percentages may not total 100 due to rounding.
[a] Local taxes include real and personal property taxes, hotel/motel taxes, and local sales taxes.
[b] Intergovernmental includes state transfers and federal funds.
[c] Interest revenue not identified separately for Loudon County.
Source: Comprehensive Annual Financial Reports 1997a.

- Commercial/Industrial Property equals 40 percent of appraised value.
- Personal Property equals 30 percent of appraised value.

The largest revenue sources for the counties' general fund has traditionally been local taxes (which includes taxes on property, real estate, hotel/motel receipts, and sales) and inter-governmental transfers from the federal or state government. Over 80 percent of the 1997 general fund revenue came from these combined sources.

4.1.6.5 Environmental Justice

Figures 4.1.6.5-1 and 4.1.6.5-2 illustrate distributions for minority and low-income populations residing within 50 miles (80 km) of ORR. The definitions of minority and low-income populations and the methodology for assessing potential environmental justice effects are given in Section. 5.2.6.5.

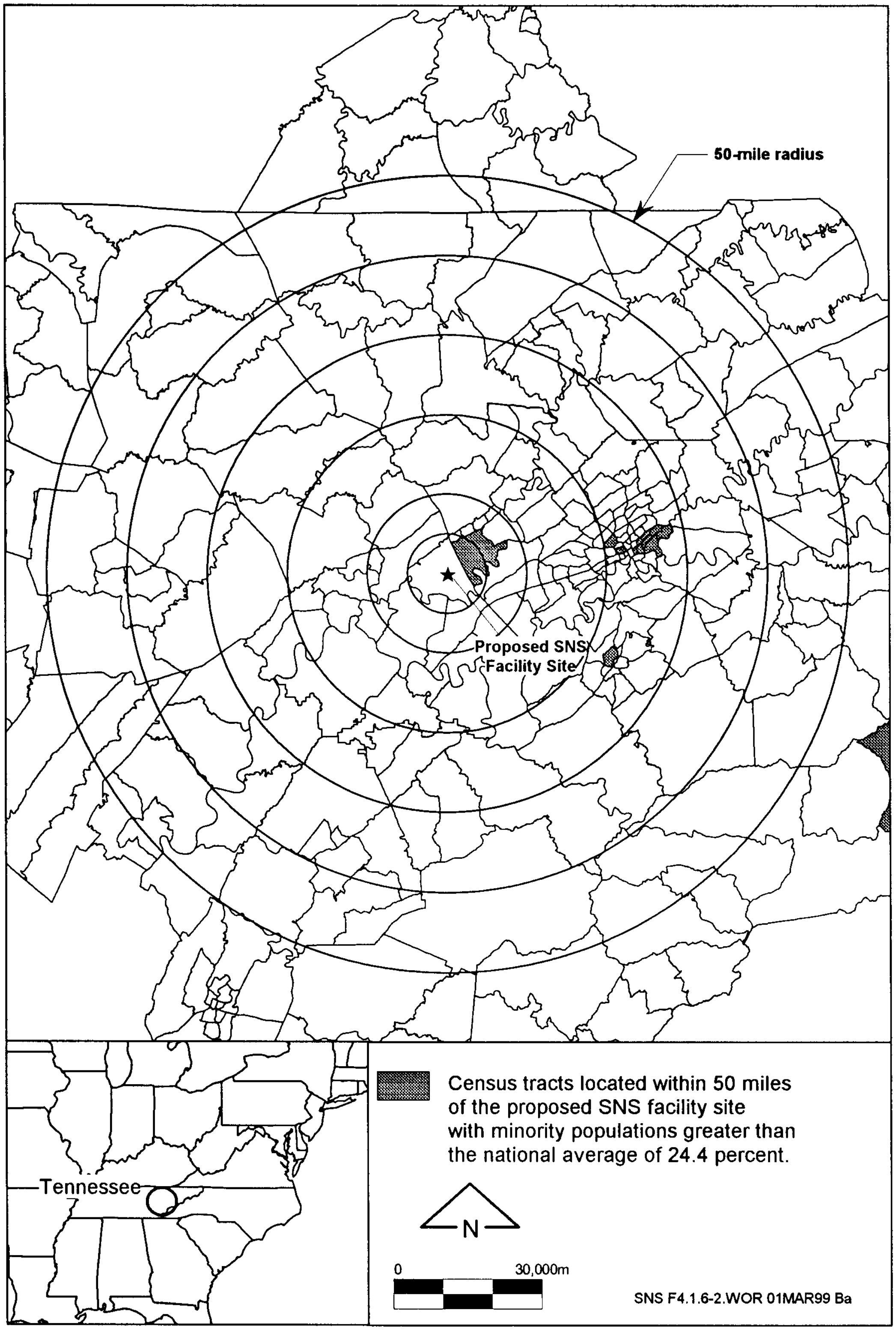

Figure 4.1.6.5-1. Distributions of minority populations at the ORR.

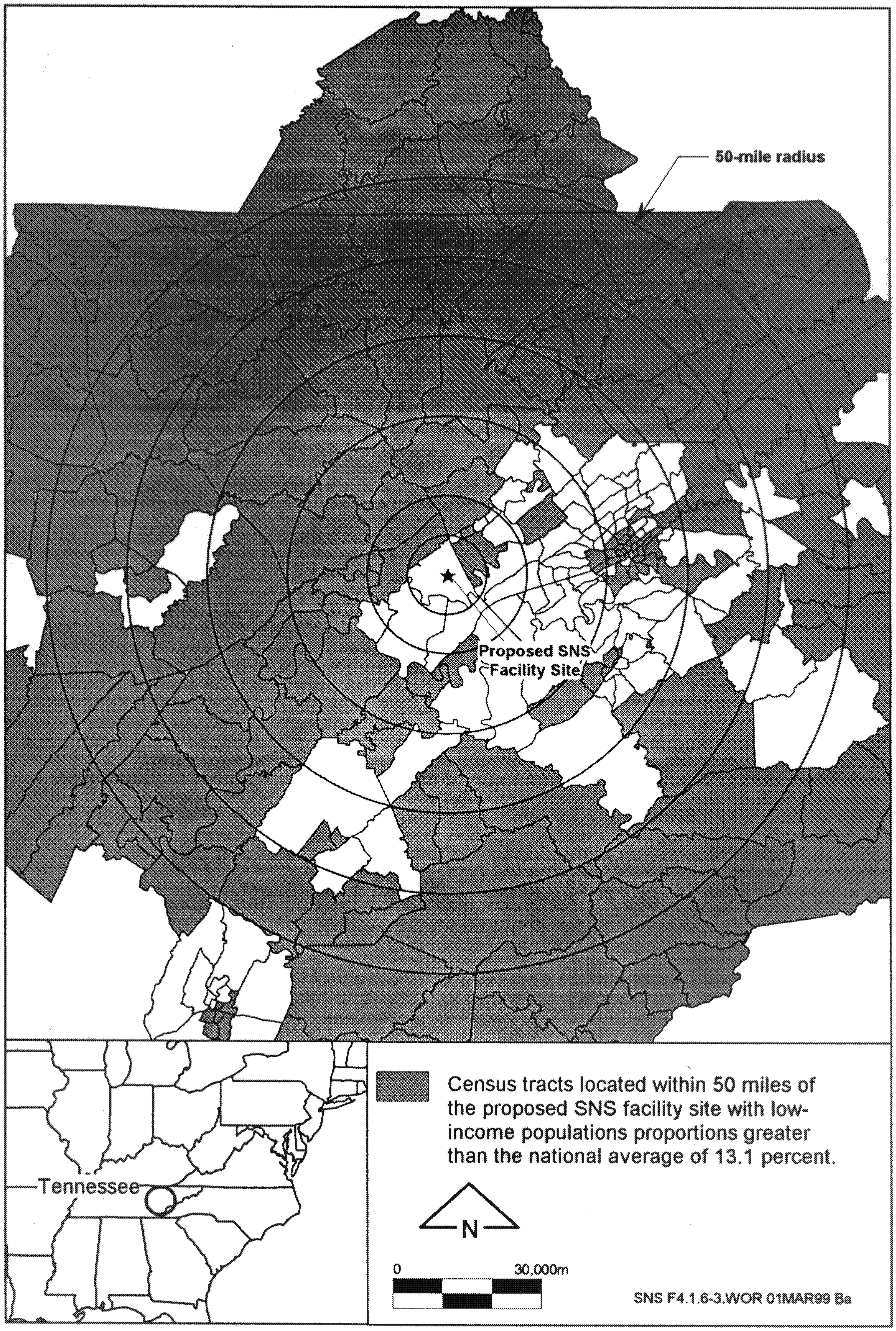

Figure 4.1.6.5-2. Distribution of low-income populations at the ORR.

Approximately 880,000 people live within a 50-mi (80-km) radius of the proposed ORR site. Minorities compose 6.1 percent of this population. In 1990, minorities composed 24.1 percent of the population nationally and 17 percent of the population in Tennessee. There are no federally recognized Native American groups within 50 miles (80 km) of the proposed site. The percentage of persons below the poverty level is 16.2 percent, which compares with the 1990 national average of 13.1 percent and a statewide figure of 30 percent (U.S. Census 1990).

4.1.7 CULTURAL RESOURCES

Cultural resources are any prehistoric or historic sites, buildings, structures, objects, or districts considered to be important to a culture, subculture, or community for scientific, traditional, or religious purposes, or for any other reason. They constitute the human legacy associated with a particular place.

The first known cultural resources study in the Lower Clinch River Basin was an archaeological survey reported by Cyrus Thomas in 1894. Since this report was published, approximately 29 archaeological and historical studies have been conducted in this area, and more than 20 studies were on the ORR (DOE 1996c: 4-29). Nearly 90 percent of the ORR has been surveyed for cultural resources at the reconnaissance level, but less than 5 percent of it has been intensively surveyed (DOE 1996c: 2-29).

Cultural resource surveys of the ORR have identified more than 45 prehistoric archaeological sites. None of these sites are actually listed on the National Register of Historic Places (NRHP), but 13 are considered to be eligible for listing. The remaining sites have not been evaluated for potential NRHP eligibility (DOE 1996c: 4-29).

More than 240 historic resources have been identified through surveys of the ORR. These resources consist of Historic Period (A.D. 1600-Present) cemeteries, structures, and archaeological remains. Thirty-one cemeteries, all established prior to 1942, are located on the reservation. Historic structures include log cabins, barns, churches, grave houses, spring houses, storage sheds, smokehouses, log cribs, privies, henhouse, and garages that predate U.S. government acquisition of the reservation from private land owners in 1942. In addition, the historic structures include many of the buildings and equipment items associated with the Manhattan Project (A.D. 1942-1945) and Cold War Period (A.D. 1946-1989) activities on the reservation. These structures include three security checking stations and the Graphite Reactor at ORNL (DOE 1996c: 4-29 to 4-30). Most of the historic archaeological remains consist of structure foundations; trash scatters and subsurface features, usually associated with foundations and standing structures; and roads. Thirty-eight of these historic resources are considered to be potentially eligible for listing on the NRHP.

Seven of the historic sites on the ORR are listed on the NRHP. These are the Oak Ridge Turnpike Checking Station, Bear Creek Road Checking Station, Bethel Valley Road Checking Station, Graphic Reactor, New Bethel Church, George Jones Memorial Church (Wheat Community), and Freels Bend Cabin. The Graphite Reactor at ORNL is a National Historic Landmark. An additional 38 historic sites on the ORR are considered to be potentially eligible for listing on the NRHP.

Surveys conducted prior to 1997 located a number of cultural resources in the vicinity of the proposed SNS site. Additional prehistoric and historic remains were identified during a cultural resources survey conducted by DuVall & Associates, Inc., from July 26 to August 5, 1997 (Pace 1997). This survey included extensive background research, a pedestrian survey of the proposed SNS site and adjacent areas, and systematic shovel testing of landforms with less than 15 percent slope.

The SNS design team has not established the areas where construction or improvement of utility corridors would be necessary to support the proposed SNS at ORNL. In addition, the complete route for one of the two access roads (southwest access road) to the proposed SNS site has not been determined. As a result, such areas could not be surveyed for cultural resources by DuVall & Associates, Inc., in 1997. Because considerable information is available on the cultural resources of the ORR, particularly the historic resources, the eventual establishment of these areas would proceed in such a manner as to avoid any known cultural resource locations. If the proposed SNS site at ORNL were chosen for construction, the established utility corridors and road improvement zones would be surveyed for cultural resources prior to the initiation of construction-related activities in these areas.

The cultural resources in the vicinity of the proposed SNS site are described in this section of the final Environmental Impact Statement (FEIS). However, the precise locations of these resources are not indicated in the descriptions. To protect these sites, DOE and Lockheed Martin Energy Research Corporation do not reveal the locations of cultural resources in documents available to the general public. Because several of the original reports cited in this section show the locations of cultural resources on the ORR, they are not included in the DOE public reading rooms established as part of the SNS EIS process.

4.1.7.1 Prehistoric Resources

No prehistoric archaeological sites were identified on the proposed SNS site at ORNL. However, three isolated occurrences of prehistoric artifacts were encountered at three other locations that may be subject to activities under the proposed action. Locus FN-1 is in the bed of a current dirt service road leading into the proposed SNS site and is very close to a proposed switchyard. Locus FN-1A is very close to the extreme southwest corner of the proposed SNS site and is near the proposed location of a retention basin. Locus FN-7 is located a substantial distance south of the proposed SNS site in an area slated for road improvements.

An Early Archaic Period *Big Sandy* projectile point/knife (ca. 8000-7000 B.C.) was found at Locus FN-1. One chert flake of indeterminate age was found at each of the other loci. Each locus may contain a low-density scatter of chert waste from the shaping or sharpening of prehistoric stone tools. Because no artifact-bearing subsurface deposits were encountered during shovel testing, these isolated occurrences are considered insufficient to define a significant cultural resource, and their loci of occurrence are not considered to be eligible for listing on the NRHP (Pace 1997: 21).

Site 40RE488 is a multicomponent archaeological site located a substantial distance south of the proposed SNS site in an area slated for road improvements under the proposed action. As defined by shovel tests, 40RE488 measures about 230 to 262 ft (70 to 80 m) north/south by

67 ft (20 m) east/west and may extend further to the west beyond the test limits. The east edge of this site is only about 26 ft (8 m) from the bed of the existing road that would be improved. Shovel tests revealed past disturbance of the site by grading, filling, scalping of topsoil, and downslope redeposition of soils. The artifacts recovered during the shovel testing indicated at least one prehistoric component at the site (ORNL-2: 21-24).

No prehistoric artifacts were recovered on the ground surface at 40RE488. The 13 prehistoric artifacts recovered at the site came from the plow zone and disturbed (spolic) layers in 5 of 10 shovel test units. These artifacts consisted of seven chert flakes, or flake fragments, and six pieces of chert debris. The date and cultural context of this prehistoric component could not be determined from these remains (Pace 1997: 24).

The prehistoric component at 40RE488 can be characterized as a low-density lithic scatter of unknown date and cultural affiliation. Given the occurrence of all prehistoric artifacts in the plow zone or other disturbed soil zones, the presence of well-preserved archaeological context with subsurface features and midden deposits is unlikely. As a result, the surveyed portion of this component is not considered to be a significant archaeological resource with potential for listing on the NRHP (Pace 1997: 27).

4.1.7.2 Historic Resources

No Historic Period cultural resources listed on or eligible for listing on the NRHP have been identified on the proposed SNS site at ORNL. In addition to the prehistoric component, a Historic Period archaeological component has also been identified at 40RE488. As previously noted in Section 4.1.7.1, this site is located substantially south of the proposed SNS site in an area subject to road improvements under the proposed action.

Thirteen historic artifacts were recovered from the same five shovel test units that yielded the prehistoric artifacts at 40RE488. These artifacts were 3 wire nails, 2 wire brads, 3 cut nail fragments, 3 miscellaneous metal fragments, and 2 pieces of container glass. While the cut nails could indicate a 19th century occupation of the site, the other artifacts suggest an occupation dating from the turn of the century to 1942 (Pace 1997: 24).

Fielder et al. identified a farm outbuilding (standing log crib) at 40RE488, which was designated as Historic Inventory #15A in his survey (Fielder et al. 1977: 47). This structure is no longer present at the site (DuVall 1994, as cited in Pace 1997: 16). In addition, historical records indicate that another structure no longer standing but presumably associated, was located to the north of the log crib in 1935. Both structures were in a 190-acre (77-ha) tract of land purchased by the U.S. government from Luther and Edith Duncan in 1942 (Fielder et al. 1977: 47). These findings suggest that the historic component at 40RE488 is part of a late 19th to early 20th century farmstead. Given significant past soil disturbance of indeterminate origin at this site and its spatial divorcement from the larger farmstead setting, this Historic Period component is not considered potentially eligible for listing on the NRHP (Pace 1997: 24-27).

4.1.7.3 Traditional Cultural Properties

A Traditional Cultural Property (TCP) is a significant place or object associated with the historical and cultural practices or beliefs of a living community. It is rooted in the community's history and is important for maintaining the continuing cultural identity of the community. A TCP may include a prehistoric or historic archaeological site, natural resource, traditional use area, shrine, sacred place, trail, spring, river, traditional hunting area, cemetery or burial, or rock art. In addition, it may include a rural community or urban neighborhood with a unique cultural tradition and identity. The term is not limited to ethnic minority groups. All Americans have properties to which they ascribe traditional cultural value.

Portions of the Tennessee, Clinch, Hiwassee, and Little Tennessee River valleys were occupied by the Overhill Cherokee during the 18th century. Most of the Cherokee people were relocated to the Oklahoma Territory via the infamous Trail of Tears in 1838. However, some of the Cherokee remained in western North Carolina and others have returned from Oklahoma over the years (DOE 1996c: 4-30). Currently, the Eastern Band of the Cherokee occupies the Qualla Reservation in Cherokee, North Carolina, and maintains an interest in the traditional Overhill Cherokee lands in East Tennessee.

DOE Oak Ridge Operations (DOE-ORO) Office has consulted with the Eastern Band of the Cherokee concerning the presence of TCPs on the ORR. No TCPs of special sensitivity or concern to the Cherokee are known to exist on the proposed SNS site or at other locations on the ORR.

4.1.7.4 Consultation with the State Historic Preservation Officer

Section 106 of the National Historic Preservation Act (NHPA) requires a review of proposed federal actions to determine whether or not they would impact properties listed on or eligible for listing on the NRHP. DOE-ORO has consulted with the State Historic Preservation Officer (SHPO) in Tennessee concerning the occurrence of such properties within the area of potential impact of the proposed SNS at ORNL. Based on cultural resources survey information provided by DOE, the SHPO has determined that no such properties occur within this area. The consultation letter received from the SHPO at the Tennessee Historical Commission is provided in Appendix D.

4.1.8 LAND USE

Described in this section are land uses for the vicinity of the ORR; within the boundaries of the reservation, which include ORNL; and on the proposed SNS site. The descriptions cover past, current, and future uses of the land in these areas. In addition, they include descriptions of environmentally sensitive land areas that have been set aside for public use, environmental protection, or research. These areas include parks, natural areas, environmental education centers, and public recreation areas. The section concludes with a discussion of visual resources.

4.1.8.1 Past Land Use

The land surrounding the ORR was predominantly forested wilderness prior to the 18th century. During the late 18th and early 19th centuries the area was settled by emigrants, who were primarily from North Carolina and

Virginia. During this settlement period, three major uses of the land were established: forestry, agriculture, and residential. Commercial, mining, transportation, waterways, and industrial land uses gradually developed.

The land that composes the ORR was purchased from private landowners by the federal government in 1942. At that time, the predominant land uses were forestry, agriculture, and residential. However, government activities during World War II changed the overall pattern of land use on the reservation. The establishment of the X-10 Plant (ORNL), Y-12 Plant, K-25 Site (ETTP), and various support facilities added industrial land use to the reservation. With the exception of some agriculture-related research activities in later years, agricultural use of the land nearly disappeared. Because much of the reservation was allowed to revert to an increasingly natural state after its purchase by the government, the amount of land covered in forest expanded. Residential land use ended over most of the reservation. However, residential and commercial land uses increased rapidly in the north corner of the reservation. The current land use pattern on the reservation and at ORNL gradually evolved between 1942 and the present day.

The proposed SNS site remained largely undeveloped after its purchase by the federal government and was not a focus of waste disposal activities. As a result, no contaminated sites were created at this location.

The U.S. Environmental Protection Agency (EPA) placed the reservation on the National Priorities List in December 1989. This list specifies contaminated sites that are subject to regulation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and are a high priority for cleanup. In 1996, DOE initiated detailed investigations of reservation land areas that were never used for activities involving hazardous materials. This process was aimed at releasing their use from regulation under existing cleanup laws. The proposed SNS site location is within an area of land scheduled for release approval by the Federal Facilities Agreement partners (DOE, EPA Region IV, and TDEC) in FY 1998 (Kendall 1998).

4.1.8.2 Current Land Use

The current uses of land in the vicinity of the ORR are forestry, agriculture, residential, commercial, industrial, mining, transportation, waterways, and several other uses. The largest use is commercial forestry, followed in order by agriculture, other uses, residential, waterways, and transportation. The remaining uses are quite small, each accounting for less than 7,410 acres (3,000 ha) of land. The predominant land use in most urban areas is residential (MMES 1994: 1-27).

The closest urban center to the reservation is the City of Oak Ridge. In fact, with the exception of a very small area of land in the northwest corner of the reservation, the city limits include the entire reservation. The total incorporated area of the city is 57,541 acres (23,296 ha). More than 60 percent of the land in the city is designated for forestry, agricultural, industrial, and research use. This high percentage is a function of having 34,516 acres (13,970 ha) of DOE land within the city limits. Less than 10 percent of the land in Oak Ridge is used for residential purposes, and most of this land is located in the northeast section of the city. The University of Tennessee owns 2,250 acres

(911 ha) of land in Oak Ridge. This land is used for research, public education, and recreation. TVA owns 2,395 acres (969 ha) of land within the city for industrial and recreational purposes (MMES 1994: 1-27; DOE-ORO 1996: 3-1).

The reservation contains 34,516 acres (13,794 ha) of land, and approximately 64 percent of this land is undeveloped. Despite being within the City of Oak Ridge, the use of ORR land is controlled entirely by DOE. DOE classifies land use on the reservation according to five primary categories: Institutional/ Research, Industrial, Mixed Industrial, Institutional/Environmental Laboratory, and Mixed Research/Future Initiatives. The Institutional/Research category applies to land occupied by the central research facilities at ORNL. Land in the Industrial category includes the Y-12 Plant and is used for defense support, manufacturing, and storage. The Mixed/ Industrial category includes the ETTP and is used for environmental management and reindustrialization of DOE land by private sector businesses. The Oak Ridge Institute for Science and Education, operated by Oak Ridge Associated Universities, provides training and research support to DOE and uses the land within the boundaries of the Institutional/ Environmental Laboratory category. The Mixed Research/Future Initiatives category applies to land currently used or available for use in field research and land reserved for future DOE initiatives, including new research facilities. Figure 4.1.8.2-1 shows the distributions of these land use categories across the reservation and the relative amounts of land within each category (LMER and LMES 1998: 7).

A large number of reservation-wide land uses overlay the primary land use categories and are officially designated as mixed uses. The largest mixed use is biological and ecological research in the Oak Ridge NERP. This mixed use overlays most of the land in the Mixed Research/Future Initiatives category (Figure 4.1.8.2-1). The other mixed uses are environmental research and demonstration areas, safety training facilities and associated safety buffers, transportation, utilities, public use areas, ecological resource management, land application of biosolids, education, waste management, environmental monitoring, wetlands mitigation, environmental restoration, protection of cultural resources, emergency response planning zones, and conservation of unique ecological resources. The latter use includes state natural areas, the Oak Ridge Wildlife Management Area, Nature Conservancy biodiversity ranked areas, Nature Conservancy landscape complexes, NERP endangered species habitats, NERP endangered species potential habitats, wetlands, and the Oak Ridge National Environmental Research Park Biosphere Reserve (LMER and LMES 1998: 7-8).

The proposed SNS site and adjoining land would be located within a portion of the Mixed Research/Future Initiatives category that is within the NERP (refer to Figure 4.1.8.2-1), which means that the land is either being used for environmental field research or is available for such use. Currently, the proposed site is not being used for environmental research. However, long-term environmental monitoring and research efforts are under way at locations in its vicinity.

Several of these efforts are being conducted in the headwaters of White Oak Creek, which drain the proposed SNS site area. Additional environmental monitoring and research projects are ongoing in the Walker Branch Watershed to

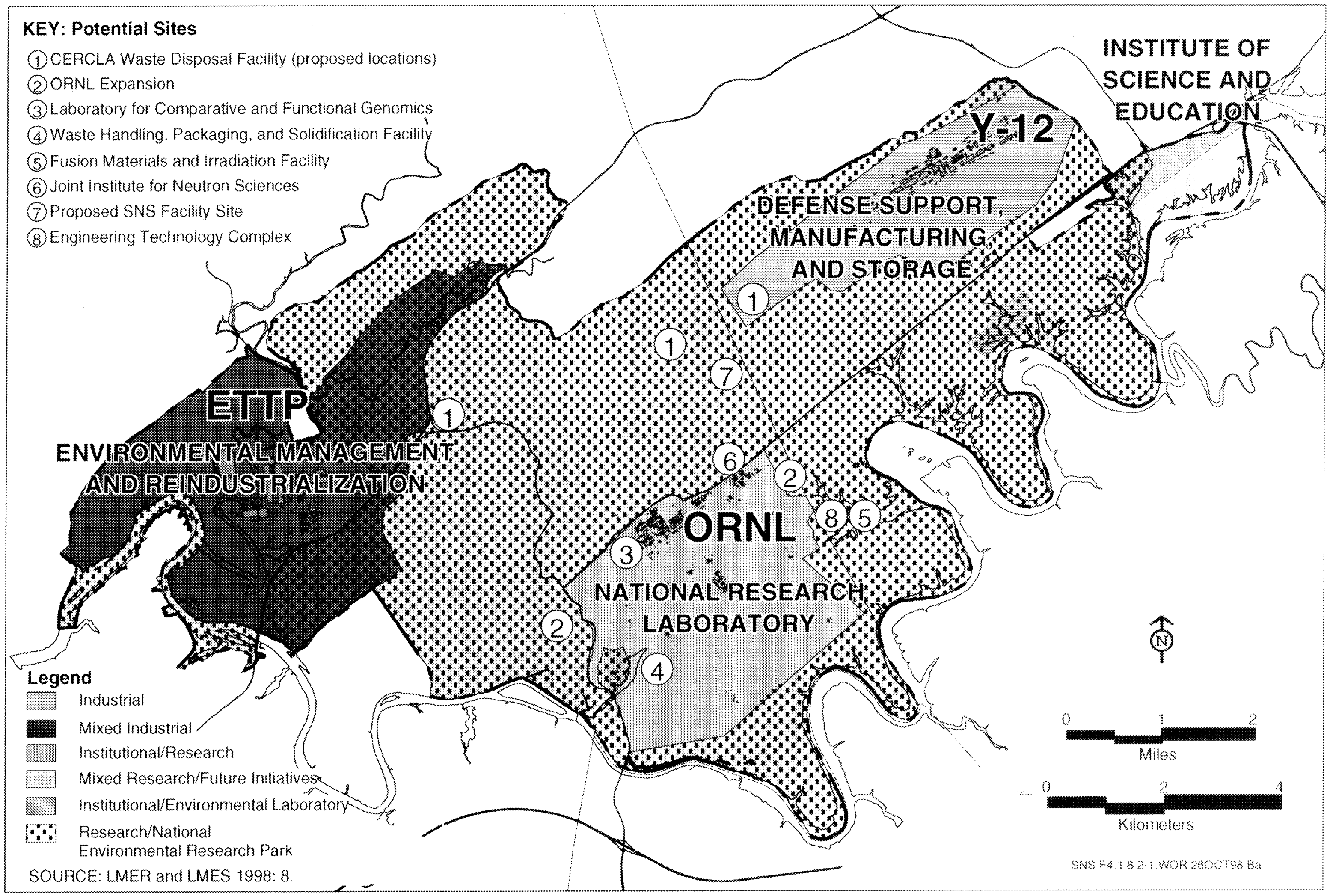

Figure 4.1.8.2-1. Map of current and potential future land uses on the ORR.

the east of the proposed SNS site. The use of these land areas and the waters that flow through them for environmental monitoring and research is described in the succeeding sections.

Headwaters of White Oak Creek

Downstream portions of the White Oak Creek Watershed receive effluent discharges from ORNL. These discharges are regulated at the federal level under the Clean Water Act and by state regulations issued by TDEC. Operating under authorization from the EPA, TDEC has issued a NPDES permit to regulate the ORNL discharges to White Oak Creek.

The NPDES permit for ORNL mandates the implementation of a Biological Monitoring and Abatement Program (BMAP) on White Oak Creek and its tributaries. The objective of the BMAP is to evaluate the effects of the discharges on the aquatic integrity of the White Oak Creek Watershed and to demonstrate that the permitted effluent limitations protect classified stream uses (ORNL, OR Y-12, and ETTP 1997: 4-48). The program involves studying the bioaccumulation of contaminants in fish and performing detailed ecological surveys of fish and benthic macroinvertebrate communities. Observed changes in the key indicators of stream integrity are compared with effluent discharge conditions and are charted through time to provide a historical perspective on stream conditions and dynamics (ORNL, OR Y-12, and ETTP 1997: 4-51 to 4-52).

The headwater tributaries of White Oak Creek near the proposed SNS site drain largely undeveloped land that has been reverting towards a natural state since its purchase by the U.S. government in 1942. No effluent discharges occur in this area. For this reason, the White Oak Creek Headwaters Monitoring Station, located approximately 3,400 ft (1,036 m) southwest of the proposed site, and several other stations immediately downstream have been used to gather baseline reference data for the ORNL BMAP, general NPDES permit compliance, and support of downstream environmental restoration efforts. The headwaters of White Oak Creek are also used as a baseline reference site for current environmental monitoring activities in McCoy Branch, which drains the south side of Chestnut Ridge approximately 3 miles (5 km) east of the proposed SNS site. This research is being conducted under the Environmental Restoration Integrated Water Quality Program (Huff 1998: 1; Peterson 1998: 1; Smith 1998: 1-2).

Use of the White Oak Creek headwaters as a reference site began in 1984, when baseline data were used to support environmental research involving Bear Creek (Smith 1998: 2). These headwaters were used to support the ORNL BMAP efforts that began in 1985, and have continued until the present day (ORNL, OR Y-12, ETTP 1997: 4-51). As a result, the headwaters of White Oak Creek have become one of the oldest and most well recorded reference sites on the reservation.

The headwaters of White Oak Creek are used to support other research projects, apart from their function as a reference site. The Environmental Sciences Division (ESD) at ORNL is currently using the headwaters as a source of algae and invertebrates for two environmental research projects funded by DOE. One of these projects is “Autotrophic Biofilms for Removing Contaminants from Industrial Wastewater.” This project is investigating the potential use of autotrophic biofilms to sorb contaminants and clean industrial wastewater. The other project, "Ecological Effects of UV-B Radiation," is studying the ecological effects of current and increasing levels of ultraviolet B (UV-B) radiation, which is caused by destruction of the earth's ozone layer (Hill 1998a: 1; Hill 1998b: 1).

Walker Branch Watershed

The Walker Branch Watershed is a major research area located approximately 0.75 miles (1.2 km) east of the proposed site. The central research area consists of approximately 247 acres (100 ha) of land covered with temperate deciduous forest and drained by two perennial streams. It is completely surrounded by a very large buffer zone, which was delineated to protect the research efforts in the area. This zone was formally established in 1990 after an evaluation process and approvals by the Reservation Management Organization (RMO) and the Oak Ridge Operations (ORO) Land Use Committee (Parr 1998b: 3-10; Parr 1998c: 1). The Walker Branch Watershed and its buffer zone are shown in Figure 4.1.8.2-2.

The Walker Branch Watershed has been the focus of ecological research by ORNL-ESD and NOAA, Atmospheric Turbulence and Diffusion Division (ATDD) since 1967. Their projects in this area have contributed to a greater understanding of how forest watersheds function, and they have provided insights into the solution of energy-related problems associated with air pollution, contaminant transport, and forest nutrient dynamics. The Walker Branch Watershed is one of the few sites

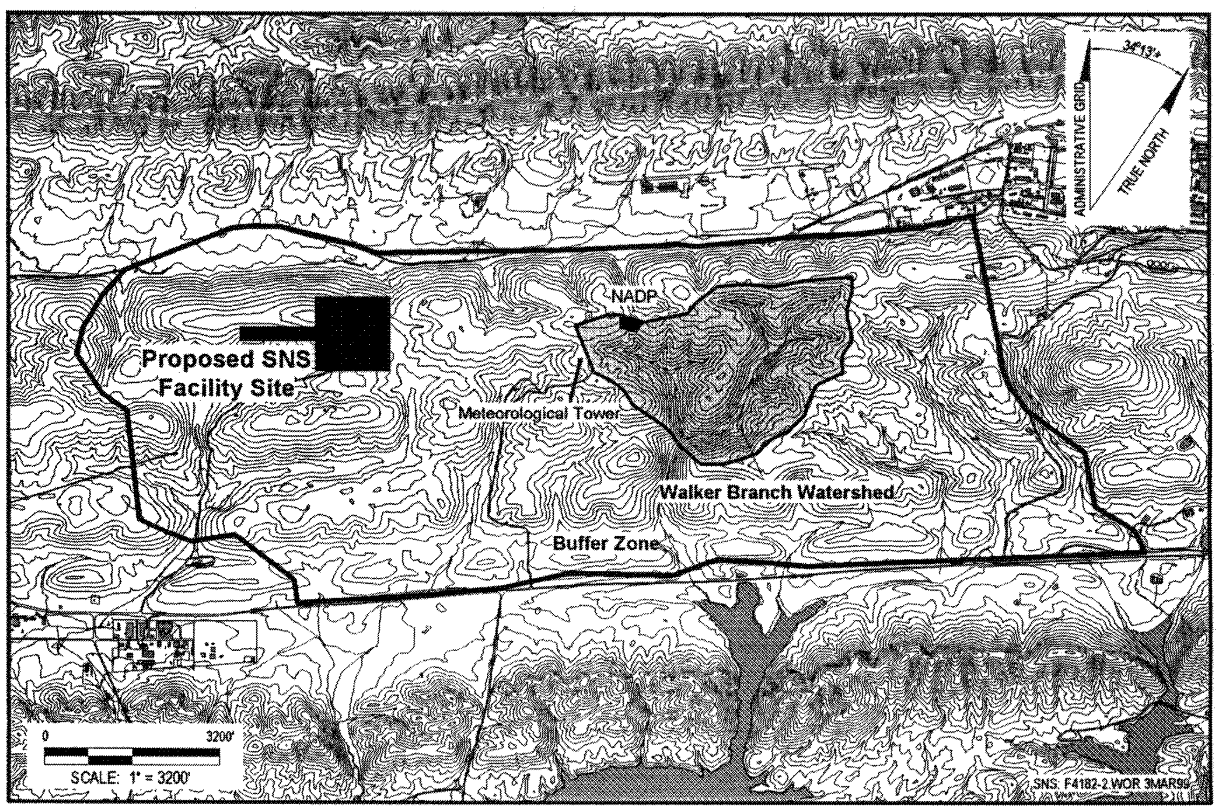

Figure 4.1.8.2-2. Walker Branch Watershed research areas and buffer zone on the ORR.

in the world characterized by long-term, intensive environmental studies (ORNL 1997d: 1 and 4).

The NOAA/ATDD is conducting the Temperate Deciduous Forest Continuous Monitoring Program (TDFCMP) in the Walker Branch Watershed. This program is measuring the continuous exchange of carbon dioxide (CO_2), water vapor, and energy between the deciduous forest in the Walker Branch Watershed and the atmosphere. The aim of the program is to continuously monitor these exchanges over a long period of time. This monitoring is needed because few direct, long-term measurements of CO_2 exchange over a whole ecosystem have been done. Their purpose is to examine the uptake, use, and loss of carbon by components of the plant community within the intact Walker Branch Watershed ecosystem. Most published reports on carbon exchange over temperate forests are derived from limited (two to three week) studies conducted during the summer growing season. When the Walker Branch Watershed study began on October 24, 1994, a research team at Harvard University had conducted the only other long-term measurements of CO_2 over forest canopies in the United States. Ultimately, the Walker Branch Watershed study is expected to result in a better understanding of local, regional, and global carbon budgets and the effects of elevated atmospheric CO_2 on temperate forests worldwide (ORNL 1997d: 2 and 8; NOAA 1998: 1).

The TDFCMP is measuring very small changes in CO_2 exchange between the atmosphere and the Walker Branch Watershed forest ecosystem. These changes are measured around a local background CO_2 level of 668 mg/m^3 (668,000 μg/m^3) of air. The measured changes are being associated with physical, chemical, and biological activity in the forest biomass and soils.

The monitoring instruments for the TDFCMP are located near the west periphery of the Walker Branch Watershed, on and near the base of a 144-ft (44-m) meteorological tower, and within the National Atmospheric Deposition Program Wet/Dry Deposition Monitoring Site (ORNL 1997d: 2 and 8). These locations are approximately 0.75 miles (1.2 km) east of the proposed SNS site. The prevailing winds blow from the direction of the proposed site to the east-northeast towards the Walker Branch Watershed during the daytime hours (refer to Section 4.1.3).

The ESD at ORNL is currently using Walker Branch Watershed land for nine major ecological research projects. Each of these projects is identified and briefly described in Table 4.1.8.2-1. A more detailed description of each project is provided in Appendix F.

4.1.8.3 Future Land Use

The current pattern of land use in the vicinity of the ORR is likely to continue into the foreseeable future. Urban development within the City of Oak Ridge will continue as the city gradually acquires control of reservation land for residential, commercial, and industrial purposes.

The missions of DOE have priority for the future use of land on the ORR. The zoning of reservation land for future use is shown in Figure 4.1.8.2-1. This zoning is the same as the current land use pattern, which reflects DOE plans to use the land in ways compatible with the current pattern of use.

Table 4.1.8.2-1. Current ORNL-ESD ecological research in the Walker Branch Watershed.

Project No.	Project	Description	Duration
C-1	Throughfall Displacement Experiment	Experimentation at the forest stand level to understand how forest ecosystems respond to changes in regional rainfall and how this relates to a warming global climate.	Long-Term (>10 years)
C-2	Long-Term Ecological Measurements of Ecosystem Response	Long-term project to monitor forest biomass and species composition, water inputs and outputs, and soil chemistry. These measurements are being made to quantify the response of the forest ecosystem to changes in climate and atmospheric deposition that are expected to occur. They support DOE's local, regional, and global research and provide baseline measurements for environmental restoration activities. The current measurement record spans 30 years.	Long-Term (>10 years)
C-3	Terrestrial Feedbacks to Regional Hydrologic Budgets	Continuous, multiyear measurement of climate variables, soil water conditions, and tree/forest evapotranspiration to enhance understanding of how closed canopy, deciduous forest stands contribute to local and regional hydrologic budgets. Project data will be used by the GEWEX Continental-Scale International Project (GCIP) to test climatic models. The Walker Branch Watershed is one of five primary project sites in the Ohio-Tennessee Watershed.	Completion by FY 2005
C-4	Nitrogen Uptake, Retention, and Cycling in Stream Ecosystems: An Intersite ^{15}N Tracer Experiment	A conservative radioisotope of nitrogen is being used as a tracer to study water use; nutrient uptake; stream metabolism; and nitrogen uptake, retention, and recycling in a stream ecosystem. Data from the Walker Branch Watershed study will be used with data from eight other sites to test hypotheses about the relationships between nitrogen uptake, cycling, and turnover and the hydrology, chemistry, and metabolism of streams.	Completion in FY 1999
C-5	Development of Gene Probes for Nitrate Reduction in Environmental Media: A Tool to Evaluate Nitrogen Retention in Watersheds	Development and field testing of molecular detection and quantification methods to evaluate nitrogen retention in watersheds.	Completion in FY 1999
C-6	Experimental and Theoretical Studies on the Seasonal, Annual, and Interannual Exchange of Water Vapor and Energy Exchange by a Temperate Forest Ecosystem in the Mississippi River Basin	Using micrometeorological, physiological, and hydrological methods to quantify the seasonal and interannual rates of water vapor and energy exchange over a temperate, broad-leaved forest and ecosystem in the Mississippi River Basin. This study illustrates the impact of periodic biotic events, ecological factors, and environmental factors on intra-and interannual variations in water vapor exchange at three scales: tree, canopy, and watershed.	Completion in FY 2000

Table 4.1.8.2-1. Current ORNL-ESD ecological research in the Walker Branch Watershed - Continued.

Project No.	Project	Description	Duration
C-7	Theoretical Studies of the Annual Exchange of CO_2 and Energy by a Temperate Forest Ecosystem	A detailed model of deciduous forest ecosystem physiology and physics is being used to simulate response of the forest in the Walker Branch Watershed to air temperature, rainfall, wind speed, solar irradiance, humidity, and atmospheric CO_2. The model will be tested against actual measurements in the Walker Branch Watershed. The aim of model development and testing is to predict land ecosystem responses to increasing atmospheric CO_2 concentrations and any associated climate change. This capability is important because land ecosystem responses to global environmental change may be significant to the global carbon cycle and climate.	Completion in FY 1999
C-8	Use of Multiscale Biophysical Models for Ecological Assessment: Applications in the Southeast	Data on primary productivity, soil carbon, and nitrogen dynamics in the Walker Branch Watershed are being used to test ecological models that evaluate variability in four fundamental factors of ecosystem condition.	Completion in FY 1999
C-9	Global Carbon Cycle Studies–Forest Carbon Dynamics: Field Experiments and Model Validation	Investigating the storage and properties of forest soil organic matter along an elevation/climate gradient in the Southern Appalachian Mountains. The Walker Branch Watershed is one of six sites where measurements relevant to this study are taken.	Long-Term (>10 years)

Source: Shriner 1998:2-6.

A number of major, mission-related projects are now planned for the ORR. These include the proposed SNS Project; expansion of ORNL; Laboratory for Comparative and Functional Genomics; Waste Handling, Packaging, and Solidification Facility; Joint Institute for Neutron Science (JINS); Engineering Technology Complex; Fusion Materials Irradiation Facility; and CERCLA Waste Disposal Facility. Future land use on the ORR would also include large-scale environmental process research, continuing reindustrialization and commercial development in the Mixed/Industrial use area, and continued environmental research activities in the NERP. Additional uses for the NERP are discussed in the *ORNL Land and Facilities Use Plan* (LMER and LMES 1998: 11).

As indicated in Figure 4.1.8.2-1, many of these projects would be sited in the general vicinity of ORNL and on land zoned as Institutional/Research and Mixed Research/ Future Initiatives. The land in the Institutional/Research zone is already heavily developed, and this zoning reflects plans for its continued development. The Mixed Research/Future Initiatives zone is largely undeveloped land that is zoned for a balanced mixture of future environmental field research in the NERP with new facility development (Parr 1998a: 2). The preferred site for the proposed SNS is located entirely within the Mixed Research/Future Initiatives zone.

Headwaters of White Oak Creek

The environmental compliance monitoring programs at ORNL plan to continue using the headwaters of White Oak Creek as a baseline reference site for the BMAP, NPDES permit compliance, and other research projects, as long as the physical, chemical, and ecological conditions of the stream reflect baseline conditions. These plans include continued use of the headwaters area as a unique reference site and source of organisms for research. Its use to collect data pertinent to environmental restoration programs downstream is expected to continue. Ideally, from the ORNL research perspective, the current environmental conditions that support these land uses need to persist indefinitely.

Walker Branch Watershed

The buffer zone for the Walker Branch Watershed was designed to function as a land use zoning overlay on the major land use zones in this area of the ORR. Its purpose is to exclude from its boundaries any future activities that could adversely impact environmental monitoring and experiments in the Walker Branch Watershed. The proposed location of the SNS at ORNL is entirely within this buffer zone.

Seven types of proposed activities within the buffer zone must be reviewed by the RMO and approved by the ORO Land Use Committee. They are:

- Application or disposal of any chemicals or materials that might enter groundwater streams.
- Alteration of surface topography.
- Actions that result in the generation of dust or gases that are released into the atmosphere.
- Drilling of wells.
- Application of pesticides or herbicides.
- Application of limestone, asphalt, or other materials in maintenance of infrastructure.

- Changes in the nature of activities conducted within the research area.

However, the establishment of the buffer zone and the designation of restricted activities within it are not considered to be irrevocable actions. Both actions are subject to future reconsideration by the ORO Land Use Committee, if priorities dictate a different course of action (Parr 1998b: 3-10).

The TDFCMP in the Walker Branch Watershed was established as a long-term research effort. To meet the overall objectives of the program, the established monitoring activities would need to continue for many years into the future. NOAA/ATDD plans to continue all of its monitoring activities in the Walker Branch Watershed for an indefinitely long period of time.

Eight of the nine current ORNL-ESD ecological research projects in the Walker Branch Watershed would extend into the future in some form. Three are long-term monitoring projects that are planned to continue for many years into the future. Two projects would continue into FY 2000 and 2005. Another three projects are scheduled to end in FY 1999; one project involves a subject slated for future long-term research, and the other two projects are expected to result in related follow-on work. According to the current proposed SNS project schedule, the ongoing and anticipated work on all eight projects would occur while the SNS is being constructed and operated. These projects and current plans concerning them are indicated in Table 4.1.8.3-1.

The ORNL-ESD has plans for a number of additional ecological research projects in the Walker Branch Watershed, and these projects fall into two categories. The first is research for which proposals are currently pending. These projects are identified and described in Table 4.1.8.3-2, and more detailed information on them may be found in Appendix F. The second category covers ecological research activities that are part of ORNL-ESD strategic planning goals and objectives. Proposals for this research have not been written, and no funding has been committed. Future work on all of these projects and initiatives would overlap the timeline for construction and operation of the proposed SNS.

The ORNL-ESD Strategic Plan identifies Large-Scale Environmental Process Research as a priority area in the future of the division. This priority is based in large part on the historical record of research and the understanding of the ecological processes regulating ecosystem structure and function on the NERP, which includes the Walker Branch Watershed. The NERP is the cornerstone for large field experiment campaigns in this area for decades to come. Future strategic initiatives would include:

- Large-scale manipulation of interacting factors affecting climate change, such as temperature, precipitation, CO_2, and nutrient status.
- A major initiative to gain a better understanding of the physical, biological, and chemical environment of the below-ground ecosystem.
- Terrestrial and aquatic climate warming manipulations.
- Nitrogen dynamics of a deciduous forest.
- Soil carbon management and use in forest ecosystems.

The baseline of research and monitoring activities on the Walker Branch Watershed is intended to contribute to a new national,

Table 4.1.8.3-1. Planned continuation of current ORNL-ESD ecological research projects in the Walker Branch Watershed.

Project No.	Project	Plans
C-1	Throughfall Displacement Experiment	Long-term project (>10 years)
C-2	Long-Term Ecological Measurements of Ecosystem Response	Long-term project (>10 years)
C-3	Terrestrial Feedbacks to Regional Hydrologic Budgets	Follow-on work possible beyond FY 2005 completion
C-4	Nitrogen Uptake, Retention, and Cycling in Stream Ecosystems: An Intersite ^{15}N Tracer Experiment	Nitrogen dynamics is a priority for future long-term research beyond FY 1999 completion
C-6	Experimental and Theoretical Studies on the Seasonal, Annual, and Interannual Exchange of Water Vapor and Energy Exchange by a Temperate Forest Ecosystem in the Mississippi River Basin	Continue project into FY 2000
C-7	Theoretical Studies of the Annual Exchange of CO_2 and Energy by a Temperate Forest Ecosystem	Anticipate proposal to continue project beyond FY 1999 completion
C-8	Use of Multiscale Biophysical Models for Ecological Assessment: Applications in the Southeast	Follow-on work possible beyond FY 1999 completion
C-9	Global Carbon Cycle Studies--Forest Carbon Dynamics: Field Experiments and Model Validation	Long-term project (>10 years)

Source: Shriner 1998: 2-6.

Table 4.1.8.3-2. Future ORNL-ESD research projects in the Walker Branch Watershed (proposals pending).

Project No.	Project	Description	Duration
F-1	Ecosystem Effects of Climate Change: Experimental Alteration of the Spatio-Temporal Pattern of Net Primary Productivity in a Deciduous Forest Ecosystem	This project would experimentally simulate the large-scale effects of atmospheric changes on the NPP of an eastern deciduous forest and its streams. It would focus on the ecosystem impacts of spatial and temporal variability in NPP that would result from the manipulation. The proposed experiment is a multidisciplinary collaboration with the University of Tennessee, which is submitting a separate proposal to address ecological responses.	Long-term (up to 10 years)
F-2	Ecosystem Effects of Climate Change: Responses to Experimental Alteration of the Spatio-Temporal Pattern of Net Primary Productivity in a Deciduous Forest	This study would evaluate the responses to altered NPP at several levels of the food chain in the terrestrial and aquatic portions of the ecosystem. Plant responses at the canopy, subcanopy, and herbaceous levels would be quantified using a variety of methods, including satellite imagery. Animal responses would be evaluated using forest floor, canopy, and stream invertebrates, as well as small mammal populations. This would be a companion effort to the previously described project and would be dependent upon it.	Long-term (up to 10 years)
F-3	Retention and Fate of Atmospheric Nitrogen Deposition in Forests: Tracer ^{15}N Addition Experiments in Forests of Contrasting Nitrogen Status	The retention and fate of atmospheric nitrogen deposition to forests would be studied by conducting ^{15}N addition experiments in two forests of contrasting nitrogen status. The Walker Branch Watershed forest would be used as a nitrogen deficient forest in contrast to the nitrogen-saturated Noland Divide forest in the Great Smoky Mountains National Park.	Project completion by FY 2001. A priority subject for long-term research in the Walker Branch Watershed.
F-4	The Effect of Field-Scale Climate Manipulation on the Dynamics of Dissolved Organic Matter in Soil: Implications for Soil Carbon Pools	Comparisons of paired control- and climate-manipulation regimes would be used to assess differences in the chemical nature and concentrations of DOM in soil and shallow groundwater, determine decomposition rates of DOM, measure differences in the flow of DOM from soil through stormwater, and evaluate the interactive effects of altered CO_2, precipitation, and temperature on the fate and transport of DOM in soil.	Project completion in FY 2001. A priority subject for long-term research in the Walker Branch Watershed.

DOM - Dissolved organic matter.
NPP - Net primary productivity.
Source: Shriner 1998: 6-8.

interagency program for long-term ecosystem monitoring. The Oak Ridge NERP would serve as an index site in the monitoring network.

Common Ground Process and End Uses of ORR Land

DOE-ORO has actively sought public perspectives on future ORR land use through a process called Common Ground and through the End Use Working Group. The Common Ground process has resulted in public recommendations for future use of all reservation land. The End Use Working Group has determined end use recommendations for areas of land with contaminated sites. The results of their determination have been presented to DOE in the form of final community land use guidelines and recommendations for the end use of contaminated land in specific watersheds (ORR End Use Working Group 1998).

The proposed SNS site at ORNL is located in an area DOE has zoned for a combination of environmental research and development of new facilities. As part of the Common Ground process, the Nature Conservancy was retained to assess the biological significance of land areas on the reservation. This assessment was done using ORNL data to rank the biodiversity of land areas. Most of the land on the proposed SNS site was not given a high biodiversity significance ranking (BSR). However, a BSR 3 (High Significance) was assigned to a strip of land in the middle of the “hammerhead” on the SNS footprint. A BSR 3 was also assigned to two very small areas of land within the west corner of the hammerhead (refer to the figure in Appendix B, page B-43). Furthermore, the proposed SNS site lies within a preliminarily defined landscape complex, which is a broad area encompassing several BSR areas (Figure 4.1.8.3-1). Consequently, the Common Ground process has recommended a future land use category, Conservation Area Uses, for the land on and adjacent to the proposed SNS site (Figure 4.1.8.3-2). This category includes environmental protection, research sites, forestry, agricultural research, and passive recreation (LMES 1995: 20-21 and 33).

The End Use Working Group has developed community guidelines for land use on the ORR (ORR End Use Working Group 1998). These guidelines recommend the siting of additional DOE facilities on brownfield sites instead of greenfield sites. Brownfield sites consist of previously developed land or contaminated land that has been remediated to accommodate certain uses. Greenfield sites consist of uncontaminated and previously undeveloped land. The proposed SNS site and areas adjacent to it are greenfields.

4.1.8.4 Parks, Preserves, and Recreational Resources

The University of Tennessee Arboretum is located approximately 0.25 miles (0.4 km) northeast of the ORR. This facility contains 250 acres (101 ha) of land and functions as a living botanical education center for the general public. Several trails with botanical themes run throughout the arboretum and are open to the public for hiking. The University of Tennessee operates a forest experiment station on 2,000 acres (810 ha) of land adjacent to the arboretum (LMES 1996: 2-49). This area is not open to the public.

Large portions of the ORR are devoted to nature preservation and biological research. About 21,980 acres (8,899 ha) of undeveloped and geographically fragmented areas of reservation

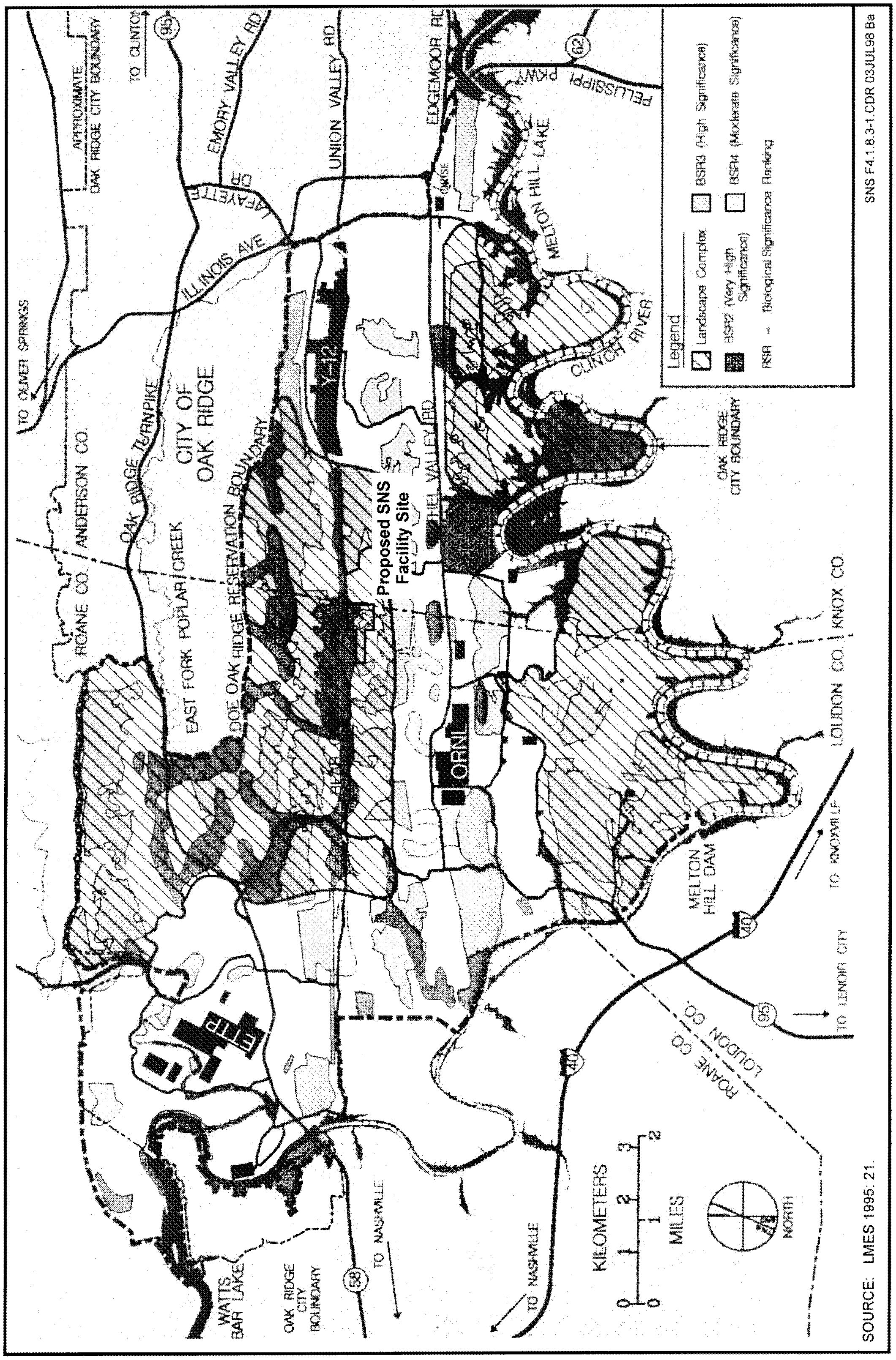

Figure 4.1.8.3-1. Map of preliminary conservation sites on the ORR.

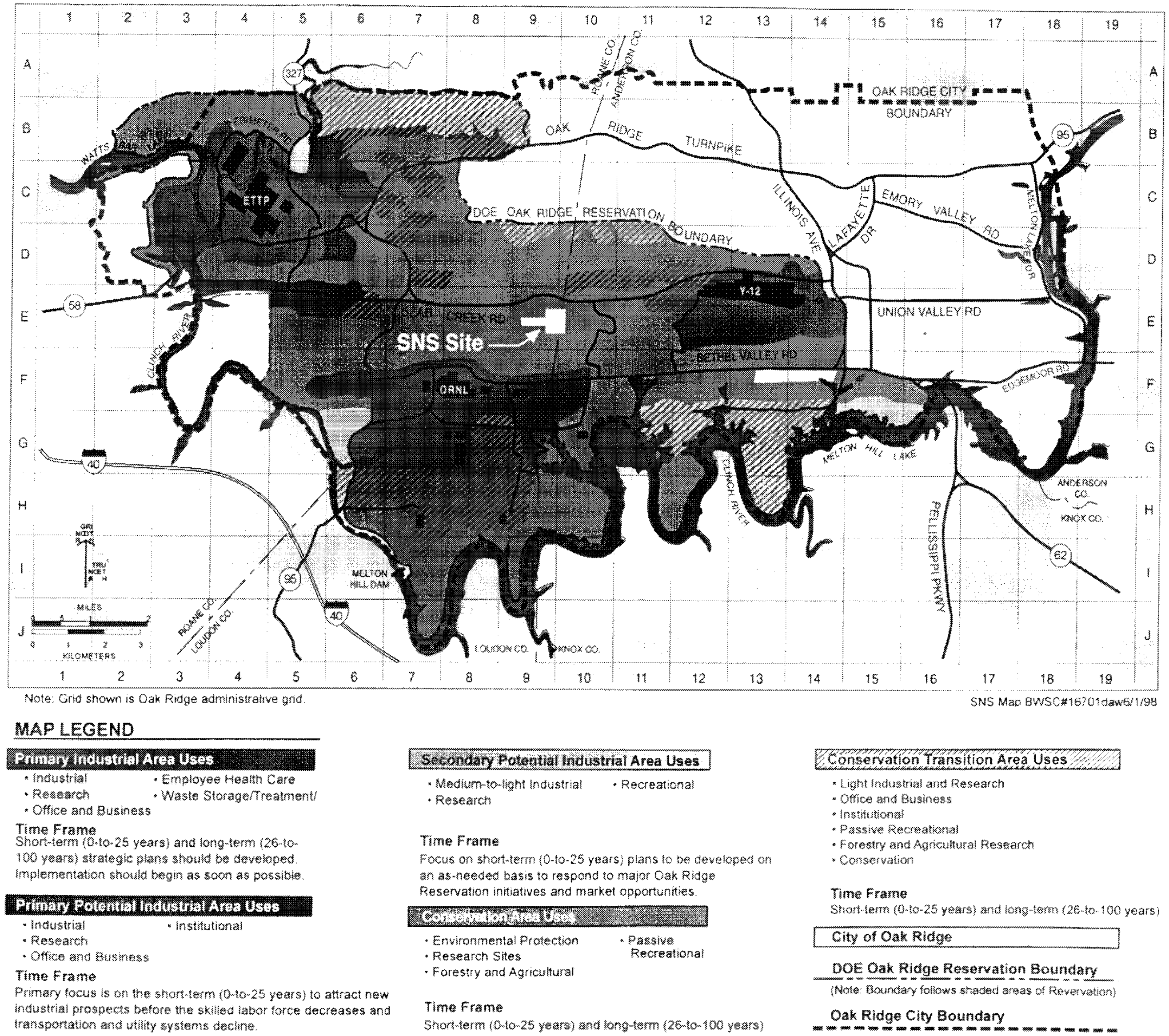

Figure 4.1.8.3-2. Map of ORR Common Ground future land use recommendations.

land comprise the Oak Ridge NERP (ORNL, OR Y-12, and ETTP 1997: 1-8). The NERP is used by the U.S. scientific community as an outdoor environmental science laboratory to study the current and future environmental consequences of the DOE mission in Oak Ridge (LMES 1995: 7). Numerous areas within the NERP are designated for the protection of rare species. A number of reference areas have been established to serve as examples of regional plant communities and unique biotic features (Pounds et al. 1993).

The Clark Center Recreational Park occupies 90 acres (36 ha) of land within the east corner of the reservation. It is open to the public for swimming, picnicking, fishing, pleasure boating, and athletic activities such as softball.

Several public recreation areas are located along Melton Hill Lake, which is outside the ORR but adjacent to a large portion of the reservation's southeast boundary. This body of water is a TVA reservoir that was formed by impounding the Clinch River with Melton Hill Dam. The body of water on the downstream side of this dam is Watts Bar Lake, which is adjacent to the southwest boundary of the reservation.

Melton Hill Dam is located approximately 2.7 miles (4.3 km) southwest of the central ORNL plant, but land used for laboratory activities extends south to the shore of the lake. A large TVA public recreation area is located at the dam on the opposite shore from ORNL land. This area is used for pleasure boating, fishing, swimming, and picnicking. Other TVA recreational areas with similar uses are located along Melton Hill Lake upstream from the dam and ORNL, including 1,051 acres (425 ha) of recreational lands within the city limits of Oak Ridge (MMES 1994: 1-27). A TVA boat ramp is located on the ORNL side of Watts Bar Lake, approximately 1.5 miles (2.4 km) downstream from Melton Hill Dam. Watts Bar Lake is used for pleasure boating, fishing, and swimming.

A portion of the reservation is operated as the Oak Ridge Wildlife Management Area through a cooperative agreement between DOE and the Tennessee Wildlife Resources Agency (DOE-ORO 1996: 3-1). In 1984, this agreement was initiated to reduce traffic accidents involving deer by opening the reservation to hunting by the public (Saylor et al. 1990: 8-2). The proposed SNS site at ORNL is located entirely within a currently designated hunting zone (MMES 1994: 2-119).

4.1.8.5 Visual Resources

The steep, linear ridges, intervening valleys, and lakes in the vicinity of ORNL create beautiful natural scenery. However, many parcels of rural land are used for agricultural and residential purposes. As a result, the visual field at many locations includes various combinations of houses, barns, roads, and utility features. In heavily developed areas of Oak Ridge, views are predominated by these features, along with numerous commercial structures, industrial plants, and public service buildings.

The ORR was primarily in agricultural use when it was purchased by the federal government in 1942. Since that time, much of it has been allowed to return to its natural state. Consequently, natural scenery abounds on the reservation. However, many views of the landscape in developed areas of the reservation, such as those in the vicinity of ORNL, are a mixture of natural features with buildings, roads, and utility features. On the reservation, there are no well-established and frequently visited visual resources, such as overlooks, that include the proposed SNS site.

The proposed SNS site would be located on top of Chestnut Ridge and approximately 1 mile (1.6 km) northeast of the central ORNL plant. Its location is visible from Bear Creek Road to the north and Chestnut Ridge Road to the east. Viewed from these locations, the proposed site appears to be completely forested. Standing at points within the interior of the proposed site, the trees shroud panoramic views of the surrounding landscape. Signs of human activity are apparent in the form of a few dirt utility roads and evidence of recent surveying and core drilling activity. From points on the east periphery of the proposed site, Chestnut Ridge Road and a utility corridor are visible.

4.1.9 RADIOLOGICAL AND CHEMICAL ENVIRONMENT

This section describes the radiological and chemical environment at ORNL.

4.1.9.1 Radiological Environment

Facilities that contribute the majority of radioactive emissions from the ORR include the Y-12 Plant; ORNL facilities, specifically the 2026 Radioactive Materials Analytical Laboratory, 3020 Development Facility, 3039 Central Off-Gas and Scrubber System, High Flux Isotope Reactor, and Radiochemical Engineering Development Center; and the Toxic Substance Control Act (TSCA) Incinerator at ETTP.

Four off-site facilities were identified as potential contributors to radiation exposure of the public around the ORR. These facilities include a waste-processing facility located on Bear Creek Road, a depleted uranium processing facility located on Illinois Avenue, a decontamination facility located on Flint Road in Oak Ridge, and a waste processing facility located on Gallaher Road in Kingston. Airborne emissions from these facilities (based on information supplied by the facilities) should not cause any individual to receive an annual effective dose equivalent (EDE) greater than 3.8 mrem. When combined with impacts caused by emissions, no individual should receive an EDE in excess of EPA or DOE limits. No information was obtained about waterborne releases, if any, from these facilities.

4.1.9.1.1 Air

DOE maintains a perimeter air monitoring network to perform surveillance of airborne radionuclides at the reservation perimeter and to collect reference data from remote locations. This network consists of eight stations spread throughout the ORR and one regional (off-site reference) station that samples levels of alpha-, beta-, and gamma-emitting radionuclides; tritium; beryllium; and total radioactive strontium. A comparison of the perimeter station data with the regional station data indicates that the ORR operations do not significantly affect local air quality (ORNL, OR Y-12, and ETTP 1997).

Station 37 in this network is centrally located within the ORR in Bear Creek Valley. It is the closest station to the proposed SNS site and monitors the overlap of the Y-12 Plant, ORNL, and the ETTP site emissions. Table 4.1.9.1.1-1 provides radiochemical results for Station 37 and the two off-site reference stations (Station 51—Norris Dam, Station 52—Ft. Loudon Dam). No significant difference can be discerned between airborne radionuclide

Table 4.1.9.1.1-1. Comparison of radionuclide levels (Ci/ml) between air monitoring stations at ORR and reference locations.[a]

Monitor Station	Be-7	Co-60	Cs-137	H-3	U-234	U-235	U-238	Gross Alpha	Gross Beta
Station 37	1.6E-13	8.3E-17	1.3E-17	9.3E-12	2.0E-17	7.2E-19	2.1E-17	2.8E-15	5.7E-15
Station 51	1.6E-13	2.4E-17	2.2E-17	9.2E-12	8.5E-18	3.8E-19	7.2E-18	2.7E-15	5.2E-15
Station 52	1.5E-13	5.0E-17	1.1E-17	6.6E-12	9.4E-18	1.4E-18	9.3E-18	1.8E-15	4.2E-15

[a] ORNL, OR Y-12, ETTP 1997.
Values: 1.6 E-13 = 1.6 X 10^{-13} Ci/ml.

activities on the reservation or off-site. (Note: Station 51 is no longer used).

Each ORR facility has a comprehensive air pollution control and monitoring program to ensure that airborne discharges meet regulatory requirements and do not adversely affect ambient air quality. During 1996, the effects of radionuclides released to the atmosphere from ORR operations were evaluated by calculating the EDE to maximally exposed off-site individuals and to the entire population residing within 50 miles (80 km) of the center of the ORR. A total of 47 emission points, each of which includes one or more individual sources, on the ORR were modeled during 1996. This total includes seven points at the Y-12 Plant, 27 points at ORNL, and 13 points at ETTP.

The EDE received by the hypothetical maximally exposed individual for the ORR was calculated to be about 0.45 mrem, which is below the National Emissions Standards for Hazardous Air Pollutants (NESHAP) standard of 10 mrem and well below the 300 mrem that the average individual receives from natural sources of radiation. The maximally exposed individual is located about 0.7 miles (1.13 km) north-northeast of the Y-12 Plant release point, about 5.8 miles (9.3 km) northeast of the 3039 stack at ORNL, and about 8.11 mile (13 km) east-northeast of the K-1435 (TSCA Incinerator) stack at ETTP. The calculated collective EDE to the entire population within 50 miles (80 km) of the ORR (about 879,546 persons) was about 9.9 person-rem, which is approximately 0.004 percent of the 264,000 person-rem that this population could have received from natural sources of radiation.

4.1.9.1.2 Water

Radionuclides discharged to surface waters from the ORR enter the Tennessee River system by way of the Clinch River and various feeder streams. Discharges from the Y-12 Plant enter Clinch River by way of Bear Creek and East Fork Poplar Creek, both of which enter Poplar Creek before it enters the Clinch River, and by direct discharge from Rogers Quarry into Melton Hill Lake. Discharges from ORNL enter the Clinch River by way of White Oak Creek and White Oak Lake. Discharges from ETTP enter the Clinch River by way of Poplar Creek.

Based on three years of data, Bear Creek downstream from the Y-12 Plant Burial Grounds has the highest levels of gross alpha activity, total uranium, and uranium isotopes. The highest levels of gross beta, total radioactive strontium, and tritium have been at Melton Branch downstream from ORNL, White Oak Creek at White Oak Dam, and White Oak Creek downstream from ORNL.

The potential radiological impacts of these discharges to persons who drink water, eat fish, swim, boat, and use the shoreline at various locations along the Clinch and Tennessee Rivers are evaluated annually. When all pathways are considered, the maximum EDE resulting from waterborne radionuclide discharges could have been about 1.5 mrem: 1.2 mrem from use of off-site waters, plus 0.3 mrem from drinking Kingston water. The collective EDE to the 50-mi (80-km) population was estimated to be about 2.0 person-rem. These are small percentages of individual and collective doses attributable to natural background radiation, 0.5 percent and 0.0008 percent, respectively.

4.1.9.1.3 Soil

Soil samples were collected from eight perimeter stations and the remote station at Norris Dam. Sampling results indicate the presence of uranium isotopes and gross alpha activity. Individual uranium isotopes were detected at less than 1 pCi/g compared to a nondetect at the Norris Dam reference locations. Gross alpha levels averaged 2.4 pCi/g at the eight locations compared to 2.3 pCi/g at Norris Dam. No readings were significantly above background levels.

4.1.9.1.4 Ambient Gamma Radiation

The ORNL continuously monitors external gamma radiation from six ambient air stations in and around the ORR. The furthest station is located at Norris Dam, 26 miles (41.9 km) northeast of the ORR. Six ambient air stations monitor external gamma radiation. The median external radiation value for the ORR in 1996 was estimated to be 67 mR/yr compared to 81mR/yr for cities across the United States.

4.1.9.2 Chemical Environment

This section describes the levels of nonradiological contaminants in air and water at ORNL. Soil is not routinely monitored for nonradiological contaminants at ORNL.

4.1.9.2.1 Air

The Y-12 Plant releases nonradiological contaminants into the atmosphere as a result of plant processes, maintenance, waste management operations, and steam production. More than 90 percent of the Y-12 Plant's emissions are attributable to the operation of the Y-12 Steam Plant. The steam plant is monitored for SO_x, NO_x, carbon monoxide, particulates, and VOCs. Other common pollutants from the Y-12 Plant include refrigerants (freon) and miscellaneous chemicals (methanol, HCl).

For ORNL, the steam plant and two small oil-fired boilers contribute the majority of nonradiological air pollutants, contributing 98 percent of allowable emissions. In 1996, no noncompliance infractions occurred.

The major sources of criteria air pollutants at ETTP consist of the three remaining steam-generating units at the K-1501 Steam Plant and the TSCA Incinerator. Signature pollutants of steam plants include sulfur dioxide, nitrogen oxides, carbon monoxide, particulates, and VOCs. The TSCA Incinerator is monitored for lead, beryllium, mercury, fluorine, chlorine, sulfur dioxide, and particulates.

4.1.9.2.2 Water

To assess the water quality of the surrounding surface water resources, surface water samples are collected from 22 locations around the ORR. Out of 79 parameters analyzed at each of the 22 sites, chromium at White Oak Dam, arsenic at the Melton Hill Reservoir at the Oak Ridge Marina, zinc at White Oak Creek upstream from ORNL, and mercury at the water supply intake for Knox County are the only parameters that exceeded a reference value in 1996.

In 1996, more than 200 surface water samples were collected from three areas bordering the Y-12 Plant. Results indicate that only mercury and zinc were detected at values exceeding criteria maxima. The source of zinc is believed to be a zinc additive in the once-through cooling water. The sample location that produced these results is located in East Fork Poplar Creek near the junction of Scarboro and Bear Creek Roads.

In 1996, over 10,000 surface water samples were collected from the ORNL property at various process discharge points, as required by the ORNL NPDES Permit. Of the samples collected, only a small number were noncompliant with NPDES permit limits. Parameters exceeding permit limits included fecal coliform, iron, and total suspended solids. ORNL has a fairly extensive mercury monitoring program. In 1996, 78 samples were collected from 13 locations. The highest value reported was 0.55 µg/L near the Outfall 207 in White Oak Creek. Average concentrations ranged from 0.13 to 0.36 µg/L.

Discharge monitoring from ETTP in 1996 indicates one excursion for total petroleum hydrocarbons and three for unpermitted discharges. Aside from those four noncompliance episodes, all discharges into receiving waters were within NPDES permit limits.

4.1.9.2.3 Soil

Soil is not routinely monitored for nonradiological contaminants at ORR.

4.1.10 SUPPORT FACILITIES AND INFRASTRUCTURE

The Support Facilities and Infrastructure section characterizes the local vehicular transportation routes around the proposed SNS site. The existing utilities that are available to provide needed services to support the operation of the proposed SNS are also described.

4.1.10.1 Transportation

The proposed SNS facility would be located between ORNL and the Y-12 Plant near the City of Oak Ridge, Tennessee. Figure 4.1.10.1-1 gives the location of the proposed SNS facility site and the transportation routes around the site.

Major transportation routes to the ORR are via two interstate highways, I-40 and I-75, and U.S. highways 11, 25W, and 70. State highways that service the area include 58, 61, 62, 95, and 162 (Pellissippi Parkway). These highways lead to Bear Creek Road and Bethel Valley Road, which border the site to the north and south, respectively. Primary access to the proposed SNS facility would be from Chestnut Ridge Road via Bethel Valley Road. Chestnut Ridge Road is constructed of gravel and laterite material and is unable to accommodate heavy vehicle loads. Traffic flow on Chestnut Ridge Road is light.

The Phase I Environmental Report for the ANS at ORNL (Blasing et al. 1992) contains a

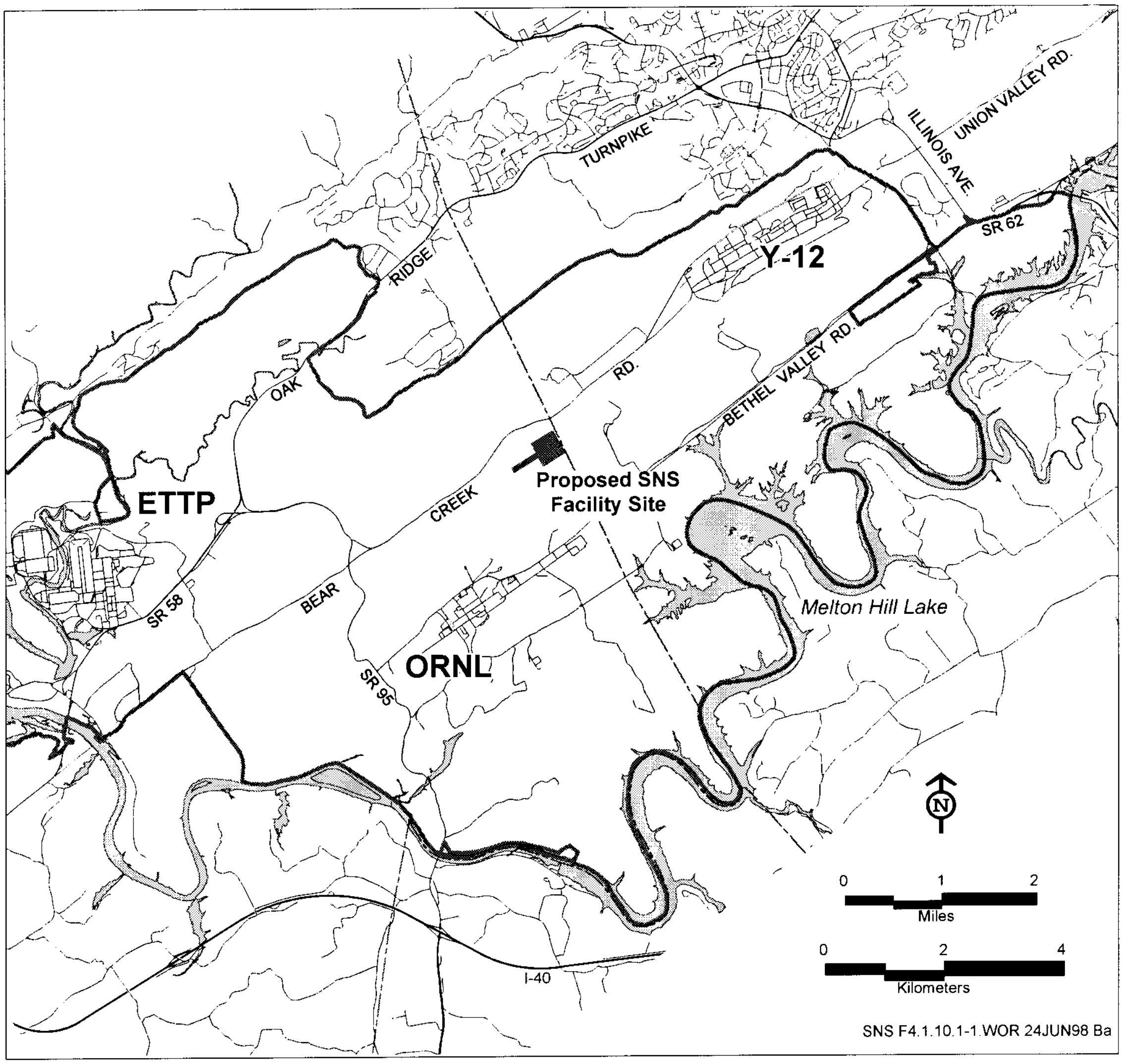

Figure 4.1.10.1-1. Transportation routes at the ORR and surrounding areas.

detailed traffic analysis of the effects of construction and operation of the ANS. This analysis is the basis for the SNS analysis at Oak Ridge because of the proximity of the respective sites considered. The major public access roads examined for the ANS traffic analysis are the same as the SNS analysis (State Road 62, State Road 95, and Bethel Valley Road) making the data and analysis directly applicable. These roadways and associated traffic flows are provided in Table 4.1.10.1-1.

4.1.10.2 Utilities

This section provides a description of the utility infrastructure at ORNL. The following is based upon existing documentation and discussions with select ORNL staff.

4.1.10.2.1 Electrical Service

ORNL purchases its electricity from TVA. Power is brought to the site via two 161-kV transmission lines, currently owned by DOE,

Table 4.1.10.1-1. Existing average daily traffic flows (vehicles/day) and LOS at ORR.

Road Segment	Average Daily Flow
Bethel Valley Road (east) (from Melton Valley Rd. eastward to SR-62)	7,400
Bethel Valley Road (west) (from Melton Valley Rd. westward to SR-95)	4,200
State Route 95 (north) (from Bethel Valley Rd. northward to SR-58)	6,600
State Route 95 (south) (from Bethel Valley Rd. southward to I-40)	6,600
State Route 62 (south) (from Bethel Valley Rd. southward to the Pellissippi Parkway toward Knoxville)	29,940

Source: Blasing et al. 1992.

which terminate into a main substation approximately 6,000 ft (1,800 m) west of the proposed site. At the substation, power is stepped down to 13.8 kV before distribution to the laboratory via overhead and underground lines. The existing 161-kV transmission lines cross Chestnut Ridge approximately 3,000 ft (914 m) west of the proposed site and have been determined to be adequate for future electrical energy demands (Schubert 1997). Currently, there are no electrical power lines or facilities on-site.

4.1.10.2.2 Steam

ORNL produces steam for its operations from the steam plant located on the far west end of the laboratory. The plant consists of five boilers, with a sixth boiler currently being installed. Four of the boilers are coal fired, each with a 50,000-lb/hr capacity. The fifth and sixth boilers are natural gas fired, each with a 100,000-lb/hr capacity. Approximately 90 percent of the steam is used for building heating systems; the other 10 percent is used for evaporators and process steam. ORNL's maximum steam consumption is approximately 70,000 lb/hr in the summer. Currently, there are no steam lines or facilities on-site.

4.1.10.2.3 Natural Gas

East Tennessee Natural Gas Company (ETNG) supplies natural gas to ORR. A 22-in. main enters ORR from Knox County, crosses the Clinch River, and proceeds to a valve station located along Bethel Valley Road. Smaller pipelines [6 to 14 in. (15.2 to 35.6 cm)] supply gas to various facilities around the laboratory. ETNG mainline pressures range from 450 to 600 psi but are reduced to 65 and 125 psig for distribution to ETTP and the Y-12 Plant, respectively, and 100 psig for distribution to ORNL. The annual natural gas demand for ORNL ranges from 110,000 to 150,000 million ft^3/yr (33,528 to 45,720 million m^3/yr). Currently, there are no natural gas lines or facilities on-site. The distribution header is located approximately 1 mile (1.6 km) from the proposed SNS site.

4.1.10.2.4 Water Service

DOE withdraws water from the Clinch River at a point south of the eastern end of the Y-12 Plant. The water is filtered and chlorinated at a water treatment plant located north of the Y-12 Plant and distributed to the City of Oak Ridge, the Y-12 Plant, and ORNL. This treatment facility provides potable water through two storage reservoirs with a combined capacity of 7 million gal (26.5 million L). Water is distributed from the treatment facility to ORNL via a 24-in. (61-cm) water main. An existing 24-in. (61-cm) line currently exists adjacent to the southern and eastern edge of the proposed SNS facility. At ORNL, two 3-million-gal (11.4-million-L) storage reservoirs hold the water before it is distributed through ORNL's water distribution system.

4.1.10.2.5 Sanitary Waste Treatment

ETTP and ORNL operate and maintain individual sanitary wastewater treatment plants (SWTPs), while the Y-12 Plant uses sewage treatment services at the City of Oak Ridge. The SWTP at ORNL is located on the western end of the laboratory. The SWTP's current capacity is 300,000 gpd (1.1 million lpd), while the average daily flow to the SWTP is less than 200,000 gpd (757,080 lpd). Within the last four years, the SWTP received upgrades including new chlorination and ozone systems and a relining of all major underground sewer lines to eliminate groundwater infiltration. The closest sewer line to the proposed SNS facility is approximately 1 mile (1.6 km) south of the site.

4.2 LOS ALAMOS NATIONAL LABORATORY

The proposed site for the SNS facility is located on the Pajarito Plateau on the east-central edge of the Jemez Mountains. The plateau is formed by an apron of volcanic sedimentary rocks and is dissected into a number of narrow mesas by southeast-trending canyons. Most of these canyons support intermittently flowing streams. The stream drainages ultimately descend into White Rock Canyon and converge with the Rio Grande near the eastern boundary of Los Alamos National Laboratory (LANL). The Rio Grande is the only permanently flowing river near the project area.

No major surface water bodies are located within 0.25 miles (0.44 km) of the proposed SNS facility. However, Ancho Canyon Spring, a smaller surface water body, is located approximately 0.5 miles (0.88 km) from the proposed site.

The proposed site is within a portion of the LANL reservation called Technical Area (TA)-70 (Figure 4.2-1), which is located on a mesa flanked by Ancho Canyon 0.27 miles (0.47 km) to the southwest and a small unnamed canyon an equal distance to the northeast. To the southeast, the Rio Grande flows through nearby White Rock Canyon, at a distance of approximately 1.2 miles (1.9 km) from the proposed facility site. The proposed site is located 0.22 miles (0.35 km) to the east of State Road 4, a two-lane paved road (Figure 4.2-1). Elevations within the area evaluated range from 6,410 ft (1,954 m) to 6,490 ft (1,978 m).

4.2.1 GEOLOGY AND SOILS

LANL is located in north central New Mexico on the Pajarito Plateau between the Jemez Mountains on the west and the Rio Grande on the east. The topography of the area is characterized by mesas and bluffs with deeply incised canyons. The major geologic feature of the area is the Rio Grande rift that extends from northern Mexico across central New Mexico and terminates in south central Colorado. The Rio Grande rift is a series of grabens or down-thrown blocks resulting from tensional tectonics some 32 million years ago. The present-day

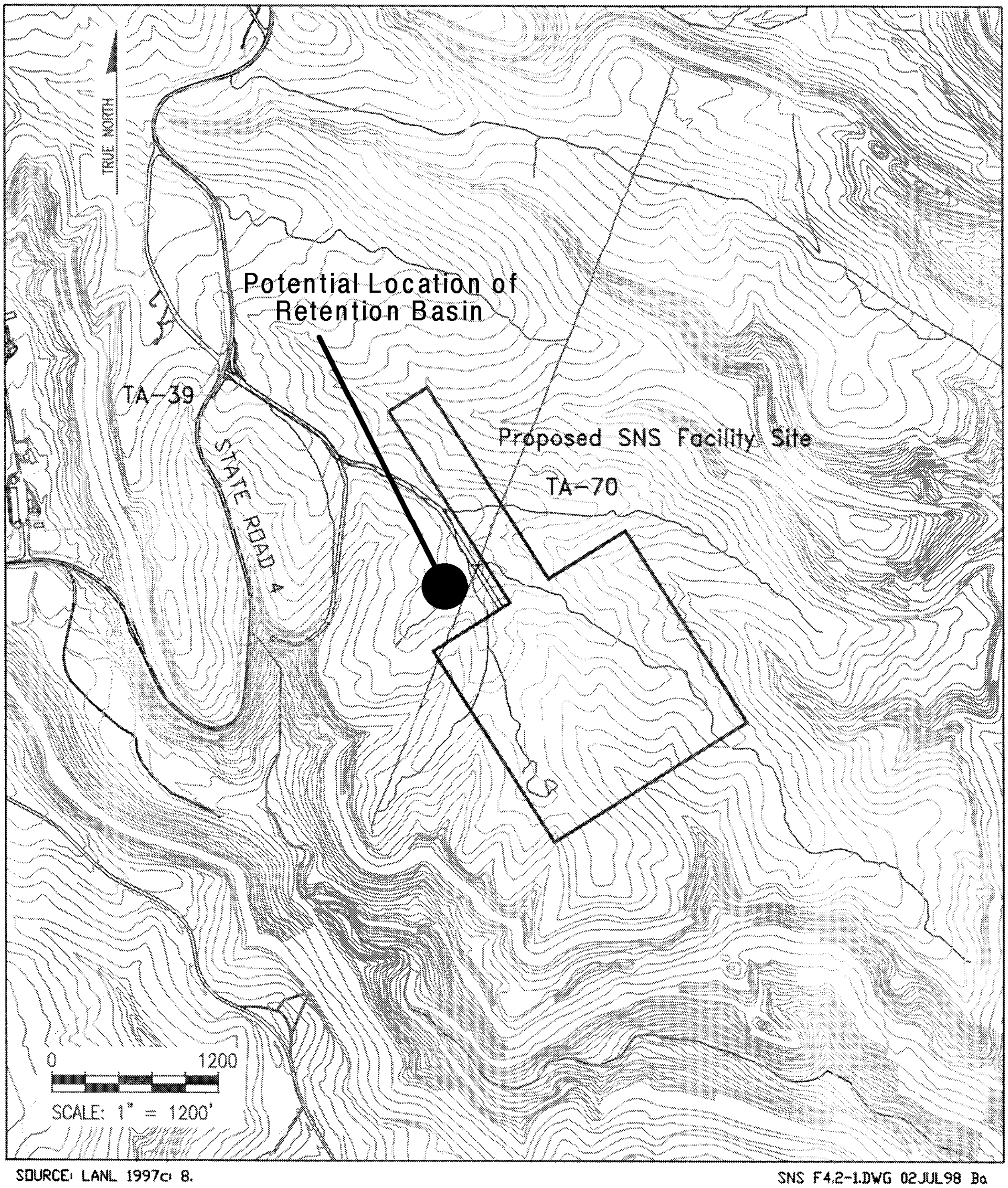

Figure 4.2-1. Proposed SNS site at LANL.

form of the rift is displayed by a series of basins filled with sediments eroded from adjacent highlands interspersed with lava flows. The rift basin in the vicinity of Los Alamos and Santa Fe is referred to as the Española Basin.

The Valles Caldera is the dominant physical feature adjoining the Los Alamos area. The caldera formed when the center of the volcanic uplift collapsed after a large volume of magma ejected along a series of ring-shaped fractures that now defines the present-day structure. Faulting associated with the rifting provided conduits for volcanic activity, such as the basaltic lavas that are interbedded with the basin-filling sediments (Figure 4.2.1-1). The deep faulting helped localize the expression of some major trends in volcanic activity. The volcanic vents in and near the Jemez Mountains lie at the intersection of a northeast trend of volcanic centers and the western edge of the Española Basin. Deposits from the Jemez Mountain vents covered the basin-filling sediments and the adjacent uplands over an area of more than 800 mi^2 (2,100 km^2). Pyroclastic eruptions occurring about 1.5 to 1.0 million years ago resulted in significant accumulations of ash fall that is called the Bandelier Tuff.

4.2.1.1 Stratigraphy

The tuffs accumulated on the Pajarito Plateau include a mixture of ash falls, ash fall pumice, and rhyolite tuff and range from welded to nonwelded tuffs. On the Pajarito Plateau the Bandelier Tuff is divided into the Otowi and Tshirege members (Figure 4.2.1.1-1). This tuff is more than 300 m (1,000 ft) thick in the western part of the plateau near the Jemez Mountains and thins to about 80 m (260 ft) at the eastern edge of the plateau above the Rio Grande.

Surface geology at the site proposed for the SNS facility is characteristic of the lower elevation mesa tops on the Pajarito Plateau. The site slopes less than 20° from the northwest to the southeast towards White Rock Canyon and the Rio Grande. The surface of the mesa top is composed of bare tuff bedrock with scattered areas of soil. Surface bedrock at this site is on the Tshirege member, but its thickness at TA-70 has not been determined.

4.2.1.2 Structure

The geologic structure of LANL is dominated by three fault zones—the Pajarito, Rendija Canyon, and Guaje Mountain faults. These faults are clearly expressed by surface offsets at some locations and are inferred from geologic evidence at others. Figure 4.2.1.2-1 shows the results of recent mapping of faults, including the young faulting that is significant to LANL in general (Wong et al. 1995). The Pajarito fault is thought to mark the currently active western boundary of the Española Basin. Prior to the Jemez Mountains volcanism, the basin boundary may have been farther west and under the present Valles Caldera. The Rendija Canyon and Guaje Mountain faults are geologically young and are capable of producing future earthquakes.

There are no known faults within a 2.8-mi (4.5-km) radius of the TA-70 site. The primary fault zones mapped within the LANL reservation occur well to the west of the TA-70 site, and no faults have been identified along the eastern boundary of LANL (although LANL is currently updating a prior study to better define the extent and paleomovements of regional faults). Using the current knowledge base, the three faults listed in Table 4.2.1.2-1 are the primary controls on the estimates of seismic

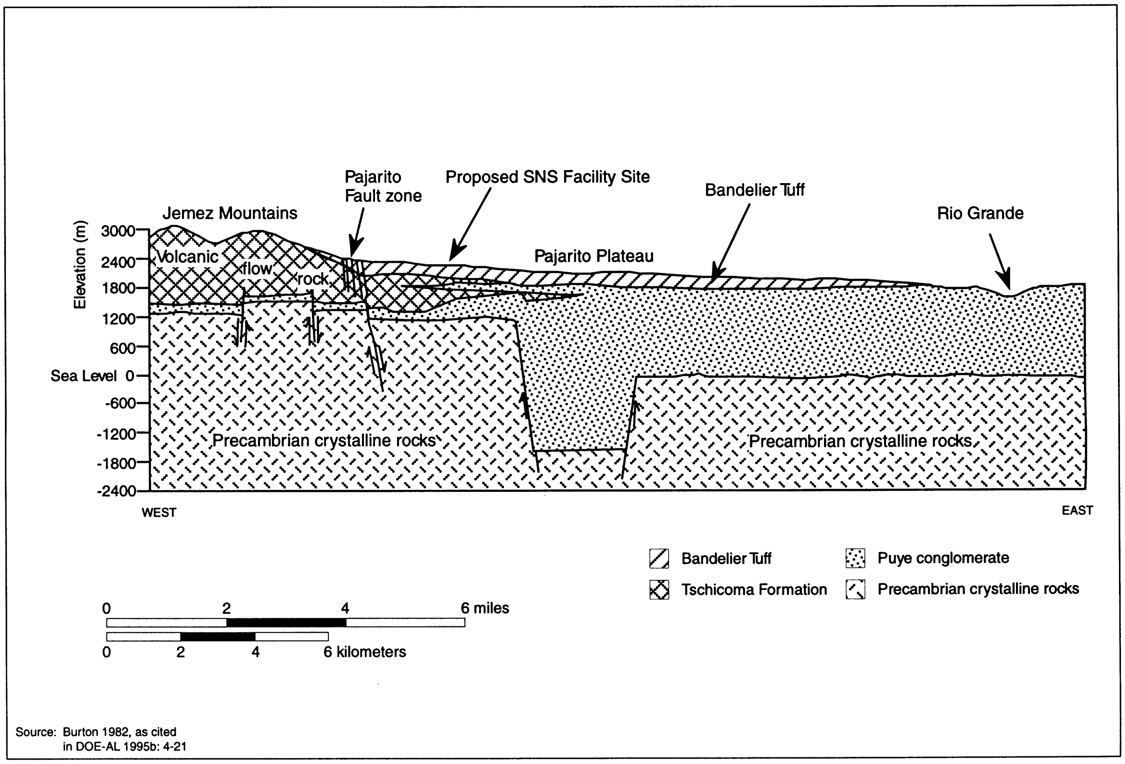

Figure 4.2.1-1. Geologic cross section of the LANL region.

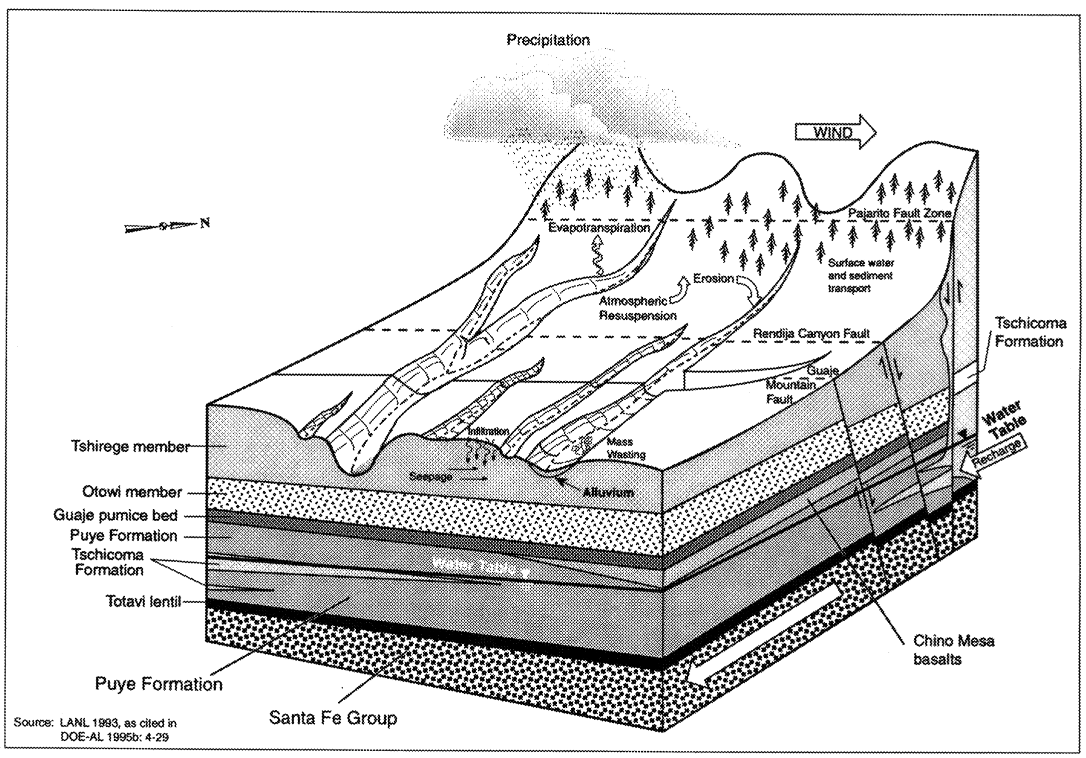

Figure 4.2.1.1-1. Conceptual model of the LANL area showing the relationships of major geologic features on the Pajarito Plateau.

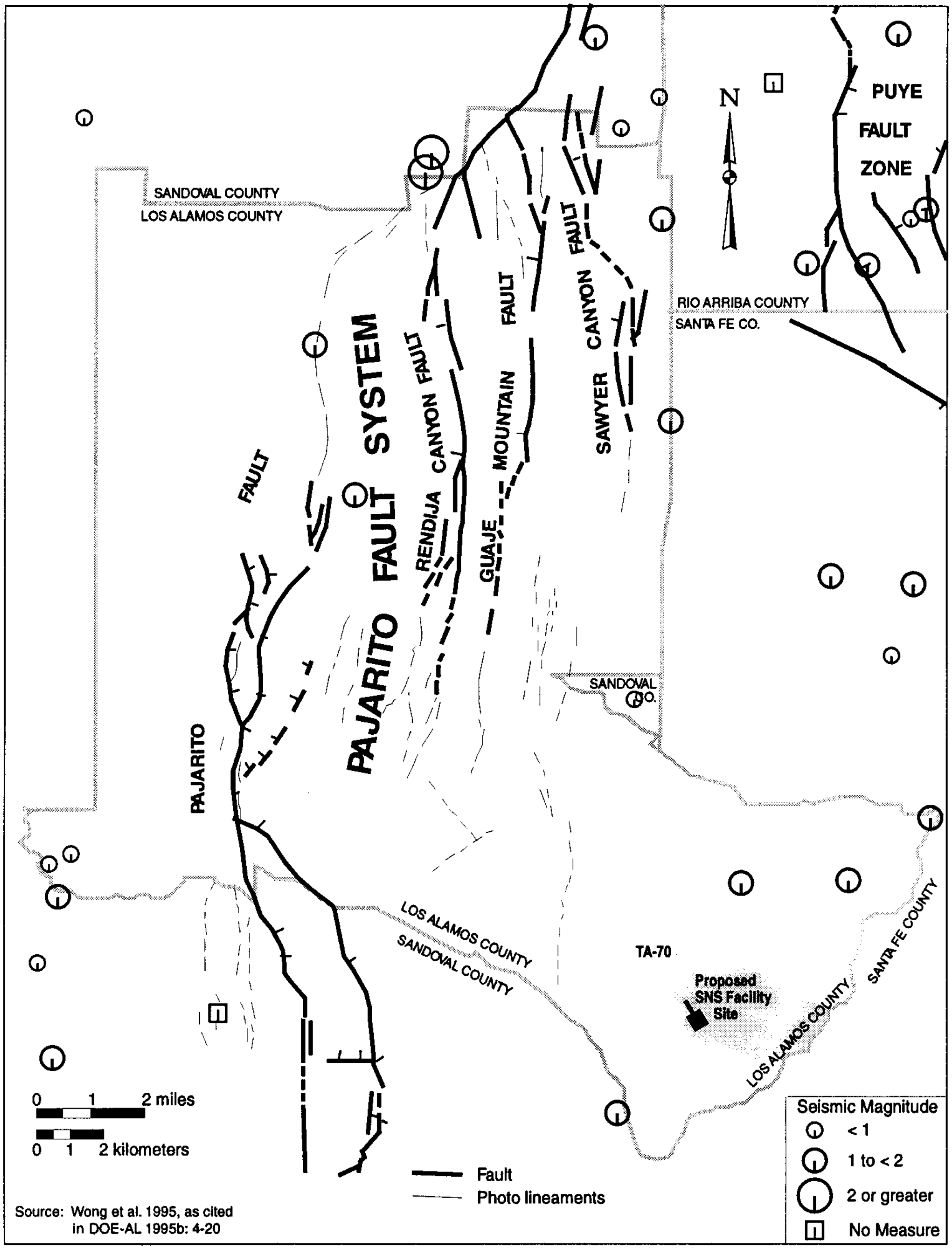

Figure 4.2.1.2-1. Recent geologic mapping of faults, lineaments, and earthquakes at LANL.

Table 4.2.1.2-1 Major faults at LANL.[a]

Name	Approximate Length [mi/(km)]	Type[b]	Most Recent Movement	Maximum Earthquake (Mw)[c]
Pajarito	29 (47.0 km)	Normal, East Side Down	multiple in past 100,000 to 200,000 years	7
Rendija Canyon	6 (9.7 km)	Normal, West Side Down	8,000 to 9,000 years ago	6.5
Guaje Mountain	8 (12.9.0 km)	Normal, West Side Down	4,000 to 6,000 years ago	6.5

[a] Source: Wong et al. 1995.
[b] Normal Fault **-** steep to moderately steep fault for which the movement is downward for the rock above the fault zone.
[c] Mw denotes the moment magnitude scale, which is physically based and calibrated to the Richter local magnitude scale at the lower values.

hazards at the proposed SNS location because of their size, proximity, and evidence of geologically young movement.

4.2.1.3 Soils

Several distinct soil types have developed on the Pajarito Plateau as the result of interaction among the bedrock, surface morphology, and local climate. Alluvium derived from the plateau, the Jemez Mountains, and windblown deposits contributes to soils in the canyons and also on some of the mesa tops. Layers of pumice from past eruptions in the Jemez Mountains and windblown sediment from beyond the Pajarito Plateau are also significant components of many soils on the plateau.

Soils on the mesas can vary widely in thickness and are typically thinnest near the edges of the mesas where bedrock is often exposed. Large areas of soil are not common at the proposed SNS site. The majority of the site consists of exposed bedrock with soils accumulated in low spots or along bedrock outcrops. Surface deposits on the mesa top include locally derived soils and in places a thin cover of fine-grained eolian sediment. The soil that does occur on the proposed site has been identified as a Hackroy sandy loam. The Hackroy is typically a light brownish, sandy loam over tuffaceous bedrock greater than 15.7 in. (40 cm) deep. The canyon slopes and bottoms adjacent to the site contain a variety of loose soils, cobble, and large boulders from mass wasting of the canyon edges. There are no agricultural activities present at LANL, nor are there any prime or unique farmlands (DOE 1996d).

Samples to assess the soil quality were collected from 12 on-site and 10 perimeter areas around the laboratory, analyzed for radiological and nonradiological constituents, and compared to regional site locations. Radionuclides in soils collected from regional background areas are due to natural and/or to worldwide fallout. In general, most radionuclide concentrations in on-site and perimeter areas were within regional statistical reference levels (i.e., the upper limit background concentration from data averaged from 1974 to 1994) and were far below LANL screening action levels. Trend analyses show that most radionuclides in soils from on-site and perimeter areas have been decreasing over time.

These trends were especially apparent for tritium and uranium in soils from on-site areas. Soils were also analyzed for trace and heavy metals, and most metals were within regional statistical reference levels and were well below LANL screening action levels.

4.2.1.4 Stability

The ground is stable at the TA-70 site, and liquefaction and mass movement are not considered to be an issue. Subsidence is unlikely due to the presence of firm rock beneath LANL. The potential for liquefaction is also minimal. Liquefaction occurs when saturated and unconsolidated sediments lose their cohesive nature and become fluid due to vibratory motions of seismic events. Conditions favorable to liquefaction do not exist at LANL. Site stability could be affected by erosional retreat of cliffs forming the mesa rims and shaking from seismic ground motions. However, geologic studies of the stability of rocks near the rim of nearby Pajarito Mesa conclude that placing a facility similar to the proposed SNS more than 200 ft (60 m) from the mesa rim would be adequate to ensure the integrity of such facilities for periods exceeding 10,000 years (DOE-AL 1995b).

The occurrence of volcanism is relatively recent on Pajarito Plateau. The youngest volcano deposit is the El Cajete Pumice derived from the El Cajete crater in the southern part of the Valles caldera. Age-dating techniques have suggested a wide range of possible ages; however, it is thought to have occurred between 45,000 and 73,000 years ago, probably around 60,000 before present (Wong et al. 1995). While this is relatively recent in geologic time, volcanism is not considered likely within the 10,000-year standard for this type of facility.

Earthquakes in the region are not always well correlated with faults that are expressed at the surface. Refer to Figure 4.2.1.2-1, which shows the epicenter for reported earthquakes near LANL from 1873 through 1992 (Wong et al. 1995). A few of these epicenters are situated near the Pajarito and Rendija Canyon faults. While the exact epicenter locations have a degree of uncertainty, geologic and seismic evidence indicates that faulting in the region is an ongoing process.

Maximum earthquake amplitudes could cause damage to structures not designed to resist such force, but it is important to note that the maximum earthquake on any fault is predicted to be a rare event. A historical catalog has been compiled of earthquakes of estimated Richter magnitude that have occurred in the LANL area from 1873 to 1991 (Wong et al. 1995). A review of the catalog indicates that only six earthquakes having an estimated magnitude of five or greater have taken place in the LANL region. The seismic hazard results indicate that the Pajarito Fault system represents the greatest potential seismic risk, and, although large uncertainties exist, an earthquake with a magnitude greater than six is estimated to occur once every 4,000 years. An earthquake with a magnitude of seven is estimated to occur once every 10,000 years.

It is possible to relate Richter magnitudes to ground acceleration values, but the relationships should be considered approximate because of numerous factors affecting the correlation (distance to epicenter, orientation in relation to fault strike, depth to solid rock, etc.). The seismic hazards study estimated ground acceleration and return period for each of eight TAs (TA-2, TA-3, TA-16, TA-18, TA-21, TA-41, TA-46, TA-55) throughout the LANL reservation. Ground acceleration values for the various TAs ranged as follows (Table 4.2.1.4-1).

4.2.2 WATER RESOURCES

The following section discusses the water resources, surface water, flood potential, and groundwater at LANL.

4.2.2.1 Surface Water

The Rio Grande is the major source of surface water in north-central New Mexico. Surface water drainage and groundwater discharge from the Pajarito Plateau usually arrives at the Rio Grande. However, various climatic conditions may prevent the perennial flow from always reaching the Rio Grande, and at certain times the stream may recharge to the ground. The Rio Grande drainage basin at Otowi has an area of 14,300 mi² (37,037 km²) in southern Colorado and northern New Mexico. The flow at Otowi has ranged from a recorded low of 60 ft³/s (1.7 m³/s) in 1902 to a high of 24,400 ft³/s (69 m³/s) in 1920. The river transports about one million tons of suspended sediments past Otowi annually (LANL 1993a, as cited in DOE-AL 1995a).

No major surface water bodies are located within 0.25 miles (0.44 km) of the proposed SNS facility. However, Ancho Canyon Spring, a smaller surface water body, is located approximately 0.5 miles (0.88 km) from the proposed site. The TA-70 site lies on a mesa bordered by Ancho Canyon to the south, an unnamed canyon to the north, and the White Rock Canyon and the Rio Grande to the east. The drainage in Ancho Canyon and the unnamed canyon are classified as intermittent riverine wetlands by the USFWS National Wetlands Inventory. Major canyons (Figure 4.2.2.1-1) that contain localized reaches of perennial streams inside LANL include Pajarito, Water, Ancho, and Chaquehui canyons. Los Alamos, Water, and Pajarito canyons/streams originate upstream of LANL facilities. Perennial streams in the lower portions of Ancho and Chaquehui Canyons usually extend to the Rio Grande without being depleted by recharge to the ground; however, various climatic conditions may prevent the perennial flow from always reaching the Rio Grande, and at certain times the perennial streams may recharge to the ground. In lower Water Canyon, the perennial stream is very short and does not extend to the Rio Grande. In Pajarito Canyon, Homestead Spring feeds a perennial stream only a few hundred yards long, followed by intermittent flows for varying distances, depending upon climatic conditions. Springs between 7,900- and 8,900-ft (2,408- and 2,713-m) elevations on the eastern slope of the Jemez Mountains supply base flow throughout the year to the upper reaches of Cañon de Valle, Los Alamos, Pajarito, and Water Canyons. These springs discharge water perched in the Bandelier Tuff at rates from 0.0045 to 0.30 ft³/s (0.0001 to 0.0085 m³/s). The volume of flow from the springs is insufficient to maintain surface flow within more than the western third of the canyons before total evaporation, transpiration, and/or infiltration into the underlying alluvium.

Table 4.2.1.4-1. Predicted peak ground acceleration (PGA) and recurrence period.

Return Period (yrs)	500	1,000	2,000	10,000
PGA	0.14 - 0.15	0.21 - 0.22	0.29 - 0.31	0.55 - 0.57

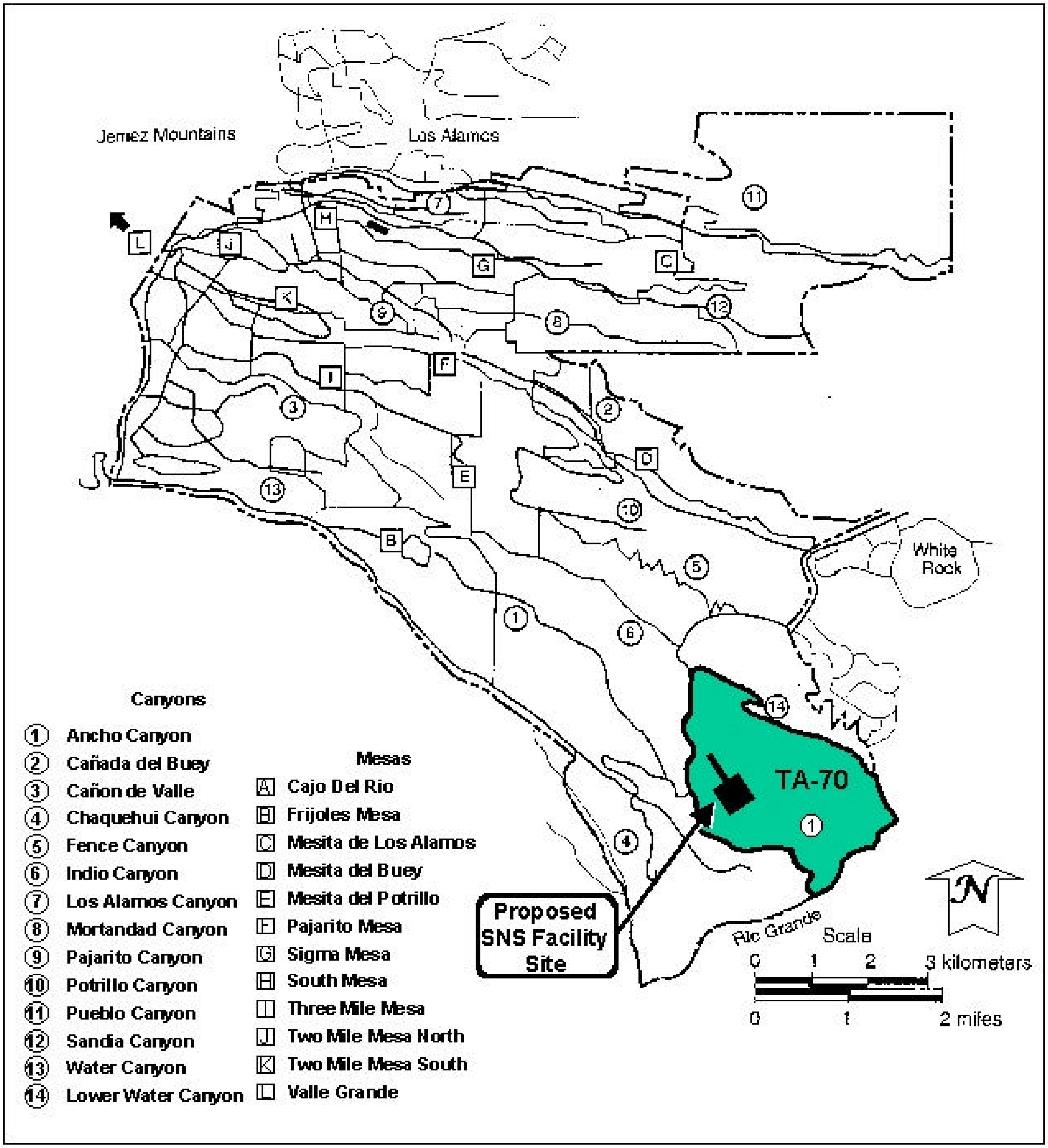

Figure 4.2.2.1-1. Major canyons and mesas at LANL.

Surface waters from regional and Pajarito Plateau stations are monitored to evaluate the environmental effects of LANL operations (no surface water is present at the proposed SNS site). The current network of annual sampling stations for surface water (both runoff and perennial flow) includes a set of regional (or background) stations and a group of stations near or within the LANL boundary. The regional stations are used to evaluate the background quantities of radionuclides derived from natural rock-forming minerals and from fallout affecting the region. The LANL stations monitor overall water quality effects of past or potential contaminant sources such as industrial or NPDES.

Concentrations of radionuclides in surface water samples may be compared to the DOE-Derived Concentration Guides (DCGs) for public dose, which are in general two orders of magnitude more conservative (lower) than similar New Mexico Water Quality Control Commission (NMWQCC) stream standards. The results of radiochemical analyses for surface water samples for 1996 are all below DCGs for public dose, and the majority are near or below the detection limits of the analytical method. Two stations sampled in 1996 were in proximity to TA-70, which allowed water quality to be characterized adjacent to or downstream from the site. Table 4.2.2.1-1 shows the results for the runoff station at Ancho Canyon near Bandelier National Monument and the surface water station Ancho Canyon at Rio Grande. None of the analyses exceeded or approached the DCG level or National Primary Drinking Water Standards (used in the absence of DCGs).

Table 4.2.2.1-1. Radiochemical analyses for runoff and surface water sampling stations within the LANL area of influence of TA-70.

Station	Tritium (pCi/L)	Sr-90 (pCi/L)	Cs-137 (pCi/L)	Total Uranium (g/L)	Pu-238 (pCi/L)
Ancho at Rio Grande	-122	1.0	-0.1	0.3	0.010
	±134	±0.4	±0.3	±0.0	±0.010
Ancho near Bandelier	-41	1.2	1.0	1.53	0.002
	±73	±0.4	±0.9	±0.15	±0.005
Water Quality Criteria	20,000[a]	8[a]	120[b]	30[b]	1.6[b]

Station	Pu-239,249 (pCi/L)	Am-241 (pCi/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Gross Gamma (pCi/L)
Ancho at Rio Grande	-0.007	-0.017	-0.4	2.9	-148
	±-0.007	±-0.017	±-0.0.1	±0.4	±50
Ancho near Bandelier	0.039	-0.014	1.4	14.7	-118
	±0.013	±0.020	±0.3	±1.8	±50
Water Quality Criteria	1.2[b]	1.2[b]	15[a]	NA	NA

±0.4 Measurement uncertainty associated with instrument quantification. If the uncertainty approaches the measurement value, then the more likely that the value is not a positive detection. Negative values represent measurements below the detection limit, which are useful for incorporation into long-term averages.

[a] Maximum Contaminant Level National Primary Drinking Water Regulations [40 CFR 141].

[b] U.S. DOE DCGs for drinking water (DOE Order 5400.5).

NA – Not available.

4.2.2.2 Flood Potential

Runoff from heavy thunderstorms and rapid snowmelt reaches the Rio Grande several times a year from some drainages that transect LANL. Water Canyon to the north of the TA-70 site has a drainage area greater than 10 mi², (26 km²), while Ancho Canyon to the south has an area of less than 5 mi² (13 km²). Theoretical maximum flood peaks range from 24 ft³/s (0.7 m³/s) for a two-year recurrence to 686 ft³/s (19 m³/s) for a 50-year recurrence. The overall flood risk to LANL and facilities at TA-70 is small because of the position of this site on a mesa top.

4.2.2.3 Groundwater

Groundwater within the LANL reservation occurs in three modes: (1) within the alluvium deposited on the canyon floors, (2) perched water within the unsaturated zone, and (3) within the main saturated regional aquifer. The main aquifer in the LANL area is the only aquifer in the area capable of serving as a municipal water supply. It is currently designated as a Class 2 aquifer but meets all the criteria for classification as a sole-source aquifer. LANL, the nearby communities of Los Alamos and White Rock, and Bandelier National Monument are entirely dependent on groundwater for their water supply, which is primarily obtained from well fields. About 4 mgpd (15.1 million lpd) are used by these communities.

The potentiometric surface of the main aquifer rises westward from its point of discharge into the Rio Grande. Here, the main aquifer surface lies within the Santa Fe Group but rises stratigraphically into the Puye Formation beneath the central and western part of the Pajarito Plateau. Figure 4.2.2.3-1 shows the elevation of the main aquifer across the LANL reservation. Depth to groundwater, 840 ft (256 m) at TA-70, is inferred by taking the difference between the surface elevation [6,445 ft (1,964 m)] of the proposed site and the groundwater contour elevation [approximately 5,605 ft (1,708 m), as referenced in the DEIS and the Site-Wide EIS] beneath the site.

Groundwater quality monitoring at LANL is divided into three principal modes cited above. Groundwater quality data are limited for the proposed SNS site at TA-70. Neither observation wells nor springs are available for monitoring of the shallow or intermediate groundwater systems in this area of the reservation. The nearest deep well to penetrate the main aquifer is located over 3.1 mile (5 km) from the site and would not be representative of the area. Ancho Spring in Ancho Canyon is sourced by the main aquifer and is adjacent to the proposed SNS site (Table 4.2.2.3-1). Concentrations of radionuclides and trace metals are shown in the Ancho Spring results. No organic compounds were detected in the samples. As compared to drinking water criteria and DOE-DCGs, groundwater in the vicinity of TA-70 is not affected by LANL.

The long-term trends of the water quality in the main aquifer beneath LANL have shown little impact resulting from operations (LANL 1997d). For 1996, radiochemical results for most water samples from wells or springs in the main aquifer were near or below the analytical detection limits. The few detects of radionuclides were not reproducible and were considered analytical anomalies (with the exception of dissolved uranium that is a common constituent of groundwater in the area). With just a few exceptions, values for chemical

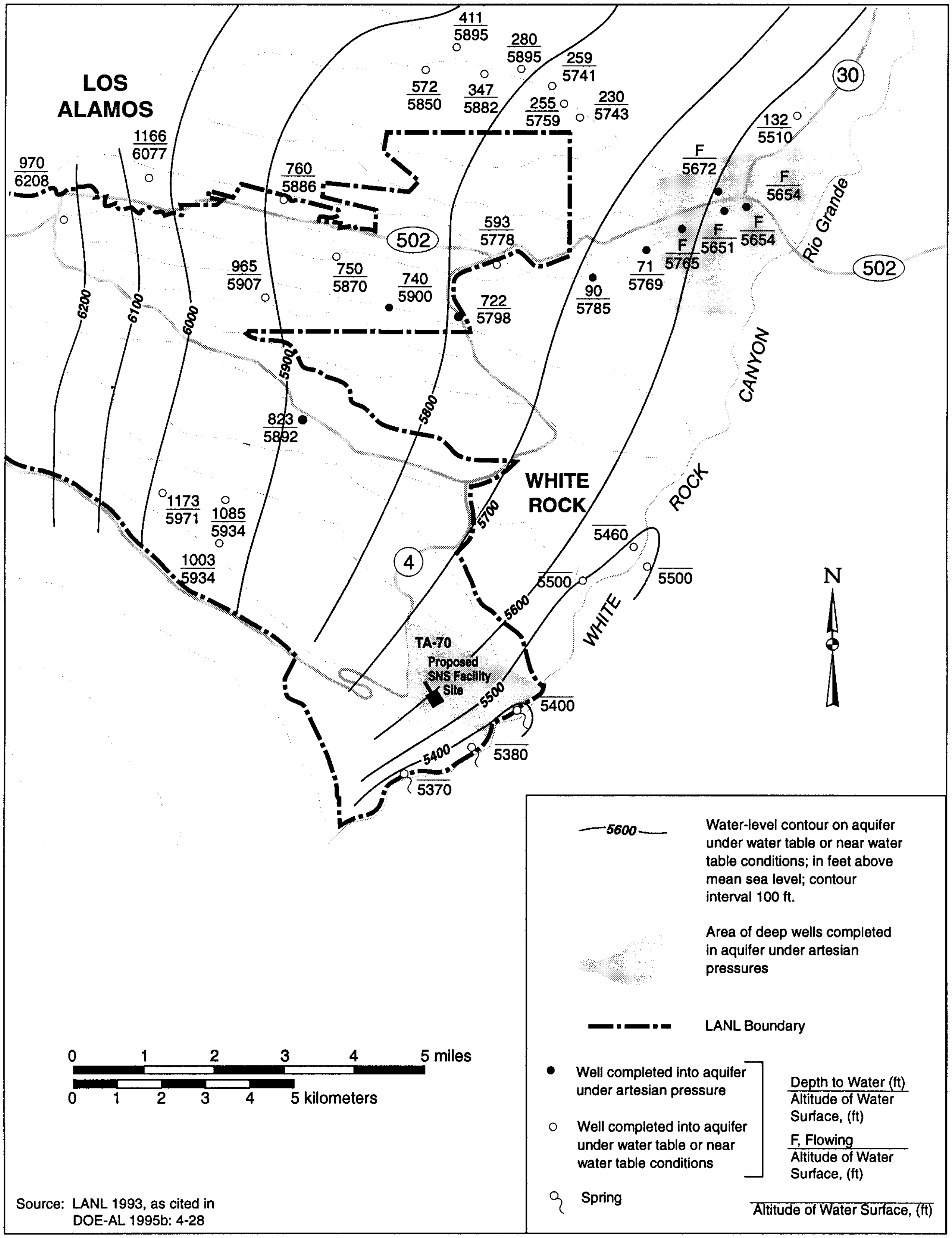

Figure 4.2.2.3-1. Groundwater surface of the main aquifer in the LANL area.

Table 4.2.2.3-1. Main aquifer water quality near the SNS site at LANL.

Radiochemical (pCi/L)	H-3	Sr-90	Cs-137	U_{total} (µg/L)	Gross Alpha	Gross Beta	Gross Gamma
Ancho Spring	-119 (134)	0.8 (0.3)	0.48 (2.5)	0.29 (0.03)	-0.34 (0.08)	2.15 (0.3)	-137 (50)
DCG-DW[a]	80,000	40	120	30	1.2	40	—
EPA-DW[b]	20,000	8	—	20	15	—	—

Chemical Quality (mg/L)	SO_4	F	NO_3-N	TDS[c]	Conductive (µS/cm)
Ancho Spring	4.4	0.35	0.43	120	133
EPA-DW	500	4	10	—	—

Recoverable Trace Metals (µg/L)	As	Ba	Be	Cd	Cr	Hg	Ni	Pb	Sb	Se	Tl
Ancho Spring	2	26	<3	<2	3	<.2	<10	<3	<3	3	<3
EPA-DW	50	2000	4	5	100	2	100	15	6	50	2

[a]DCG-DW - Derived Concentration Guide Drinking Water
[b]EPA-DW - EPA Drinking Water
[c]TDS - total dissolved solids

parameters measured in the water supply wells were within drinking water standards. The exceptions were not considered significant given the large number of samples, diversity of sample types, and varied well construction materials incorporated into the sampling program.

4.2.3 CLIMATE AND AIR QUALITY

The following is a brief description of Los Alamos climatology provided by LANL. For a more detailed discussion, Bowen (as cited in LANL 1997g) published a comprehensive climatology of the Los Alamos area based on observations at several meteorological observation stations within the LANL boundary and a summary document with more recent observations. The climate description presented here summarizes some of the Bowen analyses and discusses some recent observations of wind patterns in Los Alamos Canyon.

Los Alamos has a temperate mountain climate with four distinct seasons. Spring tends to be windy and dry. Summer begins with warm, often dry conditions in June, followed by a two-month rainy season. Summer is the rainy season (accounting for 37 percent of the annual precipitation) with afternoon convective-type thunderstorms and associated hail and lightening (Figure 4.2.3-1). In the autumn there is a return to drier, cooler, and calmer weather. Winters are generally mild, but occasional winter storms dump large snows and cause frigid temperatures.

The climate of Los Alamos is strongly influenced by the range of elevations, which creates large temperature and precipitation differences (Figure 4.2.3-2). In July, the warmest month of the year, the temperature ranges from an average daily high of 81 °F (27.2 °C) to an average daily low of 55 °F

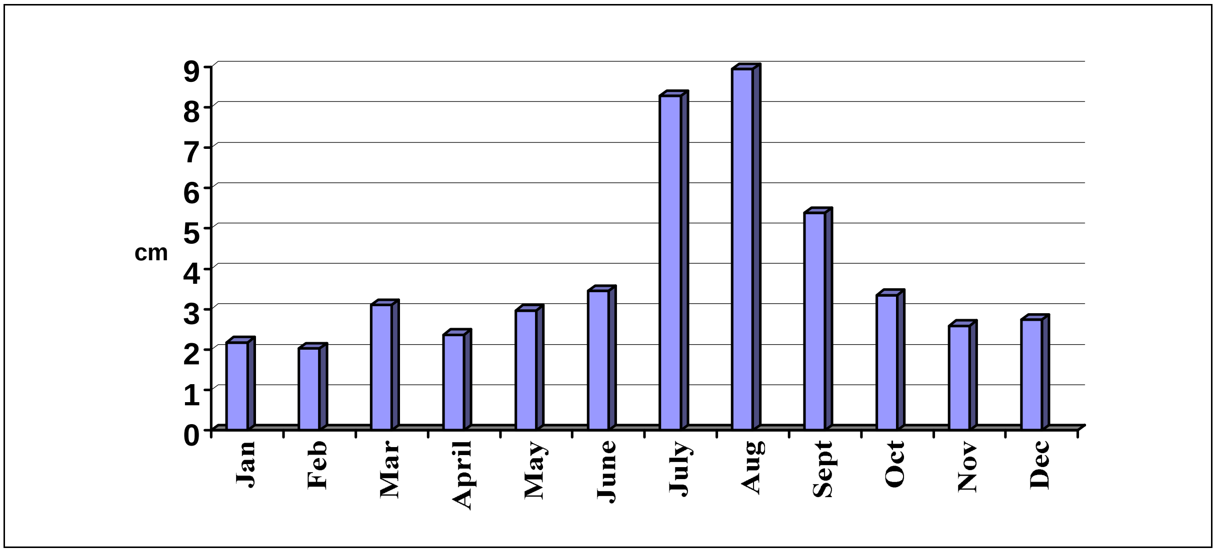

Figure 4.2.3-1. Average monthly precipitation at LANL.

(12.8 °C). The extreme daily high temperature in the record is 95 °F (35 °C). In January, the coldest month, the temperature ranges from an average daily high of 40 °F (4.2 °C) to a low of 17 °F (-8.3 °C). The extreme daily low temperature in the record is -18 °F (-27.8 °C). The large daily range in temperature is exaggerated by the site's relatively dry, clear atmosphere, which allows strong solar heating during the daytime and rapid radiant cooling at night.

The average annual precipitation (rainfall plus the water-equivalent of frozen precipitation) is 18.7 in. (47.6 cm). However, the annual total fluctuates considerably from year to year; the standard deviation of these fluctuations is 4.9 in. (12.2 cm). The lowest recorded annual precipitation is 6.8 in. (17.3 cm), and the highest is 30.3 in. (77.1 cm). The maximum precipitation recorded for a 24-hr period is 3.5 in. (8.8 cm). The maximum 15-min precipitation in the record is 0.9 in. (2.3 cm). Over the entire year, it appears that evapotranspiration totals approximately 90 percent of the annual precipitation.

Because of the eastward slope of the terrain, there is a large east-to-west gradient in precipitation across the plateau. White Rock often receives 5.1 in. (13 cm) less annual precipitation than the official observing station, and the eastern flanks of the Jemez often receive 5.1 in. (13 cm) more.

This summertime precipitation is often referred to as the "monsoon" season, but "rainy season" is probably a more accurate characterization of the July-August period. Winter precipitation occurs mostly as snow; freezing rain is rare. The snow is generally dry. On average, 20 units of snow is equivalent to one unit of water. Annual snowfall averages 59 in. (150 cm) but is quite variable. The standard deviation of fluctuations in the annual value is 28 in. (71 cm). The highest recorded snowfall for one season (1986-87) is 153 in. (389 cm), and the highest recorded snowfall for a 24-hour period (January 15, 1987) is 22 in. (56 cm). In a typical winter season, snowfalls equal to or exceeding 1 in. (2.5 cm) occur on 14 days, while snowfalls equal to or exceeding 4 in. (10.2 cm) occur on four days. The extreme single-storm snowfall in the record is 4 ft (122 cm).

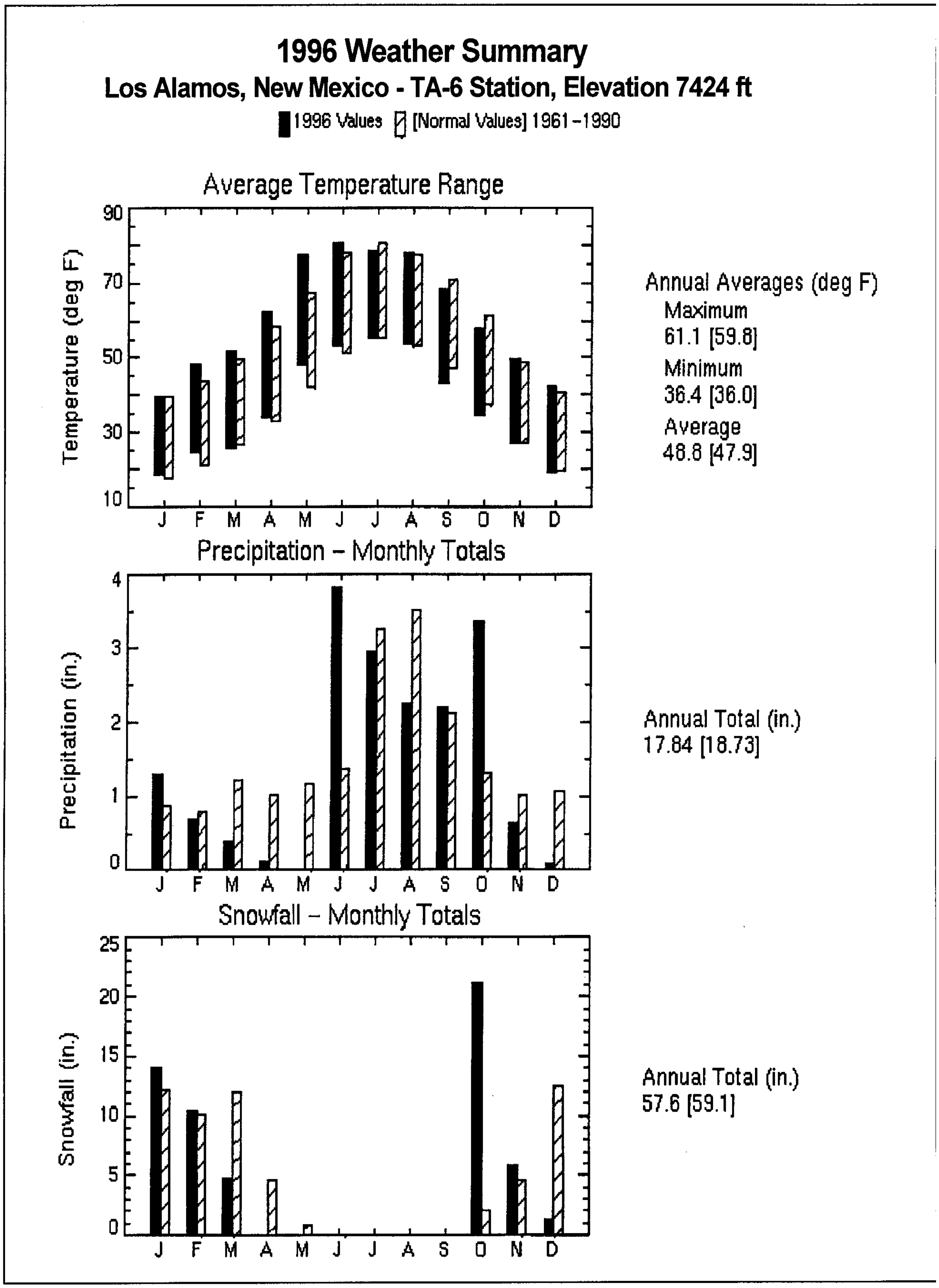

Figure 4.2.3-2. LANL 1996 weather summary chart.

4.2.3.1 Severe Weather

About 36 percent of the annual precipitation falls from convective storms during July and August. Most of these convective storms are of the single-cell type; local conditions do not support the development of supercells and the severe weather associated with them. Consequently, tornadoes are a very rare occurrence in New Mexico (refer to Figure 4.1.3.1-1), and no tornadoes are known to have touched ground in the Los Alamos area. However, funnel clouds have been observed in Los Alamos and Santa Fe counties. High winds are associated with frontal passages, thunderstorms, and mid-latitude storm systems. The highest wind gust on record is 77 mph (124 km/h).

Large-scale flooding is not common in New Mexico. However, flash floods in areas such as arroyos, canyons, and low spots do occur. Severe widespread flooding has never been observed in Los Alamos, but heavy downpour combined with saturated soil conditions caused flash flooding in Los Alamos on August 4, 1991.

Lightening is very frequent in Los Alamos. In an average year, Los Alamos experiences 61 thunderstorm days, about twice the national average. Only in the southeastern part of the United States is this frequency exceeded. In addition to lightning, hail often accompanies these summertime convective storms. Hailstones of 0.25 in. (0.6 cm) are common, but stones of 1 in. (2.54 cm) have been reported. Hail has caused significant damage to property and vegetation, and localized accumulations of 3 in. (7.6 cm) have been observed.

Fog in the Los Alamos area is a very rare occurrence. On average it occurs less than five times a year.

4.2.3.2 Atmospheric Dispersion

Los Alamos winds are generally light, having an annual average (at the TA-6 station) of 5.5 mph (9 km/h). However, the period from mid-March to early June is apt to be windy. During this windy period, sustained wind speeds exceeding 8.8 mph (14 km/h) occur 20 percent of the time during the daytime, and the daily maximum wind gust exceeds 31 mph (50 km/h) about 20 percent of the time.

Winds over the plateau show considerable spatial structure and temporal variability. The relatively dry climate promotes strong solar heating during the daytime and radiant cooling by night. Because the topography is very complex, the heating and cooling rates are uneven over the area. When the large-scale pressure gradient is weak, thermally generated local flows develop and respond to the heating/cooling cycle. During sunny, light-wind days, an up-slope flow often develops over the plateau in the morning hours. This flow is more pronounced along the western edge of the plateau, where it is 650 to 1,650 ft (200 to 500 m) deep. By noon, southerly flow usually prevails over the entire plateau. Daytime wind roses are presented in Figure 4.2.3.2-1.

The prevailing nighttime flow over the western portion of the site is west-southwesterly to northwesterly. These nighttime westerlies result from cold air drainage off the Jemez Mountains and the Pajarito Plateau; the drainage layer is typically 165 ft (50 m) deep in the vicinity of TA-6. At stations farther from the mountains, the nighttime direction is more variable but

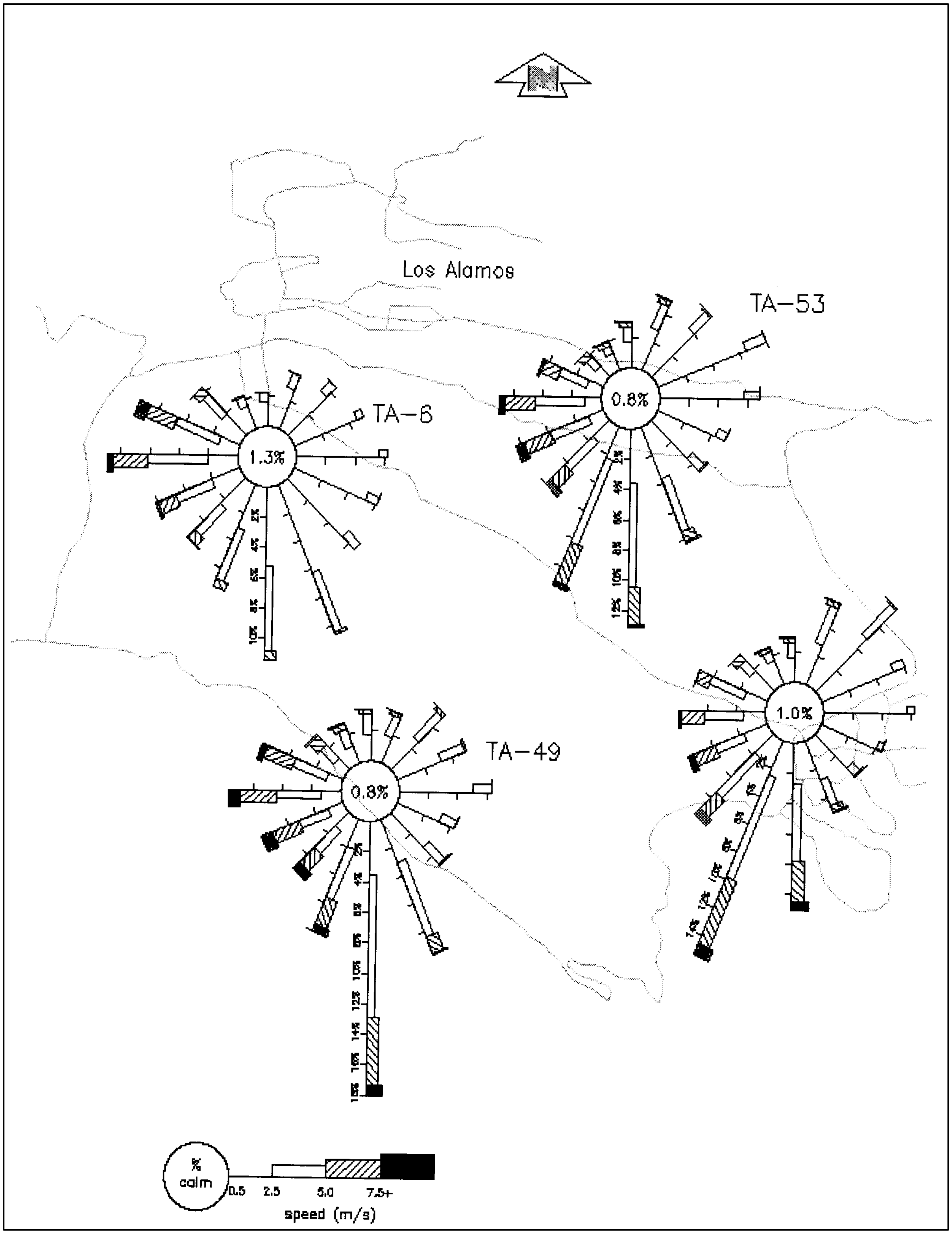

Figure 4.2.3.2-1. Daytime wind direction and speed at LANL.

usually has a relatively strong westerly component. Just above the drainage layer, the prevailing nighttime flow is southwesterly. A nighttime wind rose is presented in Figure 4.2.3.2-2.

Observations made at TA-41 in Los Alamos canyon show that atmospheric flow in canyons is quite different from flow over the plateau. During the nighttime, cold air drainage flow is observed about 75 percent of the time. This gravity flow is steady and continues for an hour or two after sunrise when it abruptly ceases and is followed by an unsteady up-canyon flow for a couple of hours. The up-canyon flow usually gives way to the development of what appears to be a rotor that fills the canyon when the wind over the plateau has a strong cross-canyon component. When the rotor occurs, southwesterly (or southeasterly) flow over the plateau results in northwesterly (or northeasterly) flow at the canyon bottom. Down-canyon flow begins again around sunset, but the onset time appears to be more variable than cessation time in the morning. Rotors have been observed at night, but they are very rare.

Although the dry atmosphere promotes rapid nighttime cooling near the ground, this cooling is somewhat counterbalanced by the flux of heat from above, generated by turbulence in the drainage flow. Therefore, the strong surface-based temperature inversions often observed in valleys are not observed on the Pajarito Plateau. Inversions of 5.4 °F (3 °C) over 328 ft (100 m) are typical, and these are generally destroyed in less than two hours after sunrise.

Turbulence intensity, when expressed as the standard deviation of fluctuations in the horizontal wind direction, has a median value of 22° during the day. Other conditions being equal, this value is larger than would be observed over flatter, smoother sites. At night, when the atmosphere is stable, the median value of the standard deviation of wind direction fluctuations drops to 15°.

Atmospheric dispersion potential is often related to a stability parameter that ranges from A to F (good to poor mixing potential). When this parameter is based on sigma phi measured at the TA-6 station, the frequency of occurrence of different stability parameter values is A: 10.6 percent, B: 8.0 percent, C: 15.9 percent, D: 38.6 percent, E: 13.9, and F: 13.1 percent. Statistics vary from station to station.

4.2.3.3 Air Quality

LANL is subject to a number of federal and state air quality programs: NESHAP, NAAQS, New Source Performance Standards, Stratospheric Ozone Protection, and Operating Permit Program. While no nonattainment areas under the Federal Clean Air Act are designated near LANL, the Bandelier National Monument and associated wilderness areas are categorized as Class I PSD areas.

Existing ambient air quality in the vicinity of LANL is best quantified in terms of recent ambient monitoring data collected by the New Mexico Environment Department Air Quality Bureau (NMEDAQB) at nearby locations. Table 4.2.3.3-1 summarizes these data and is taken from *New Mexico Air Quality 1994-1996* (NMEDAQB 1997).

Criteria pollutants released from LANL operations are primarily from combustion sources such as boilers, emergency generators,

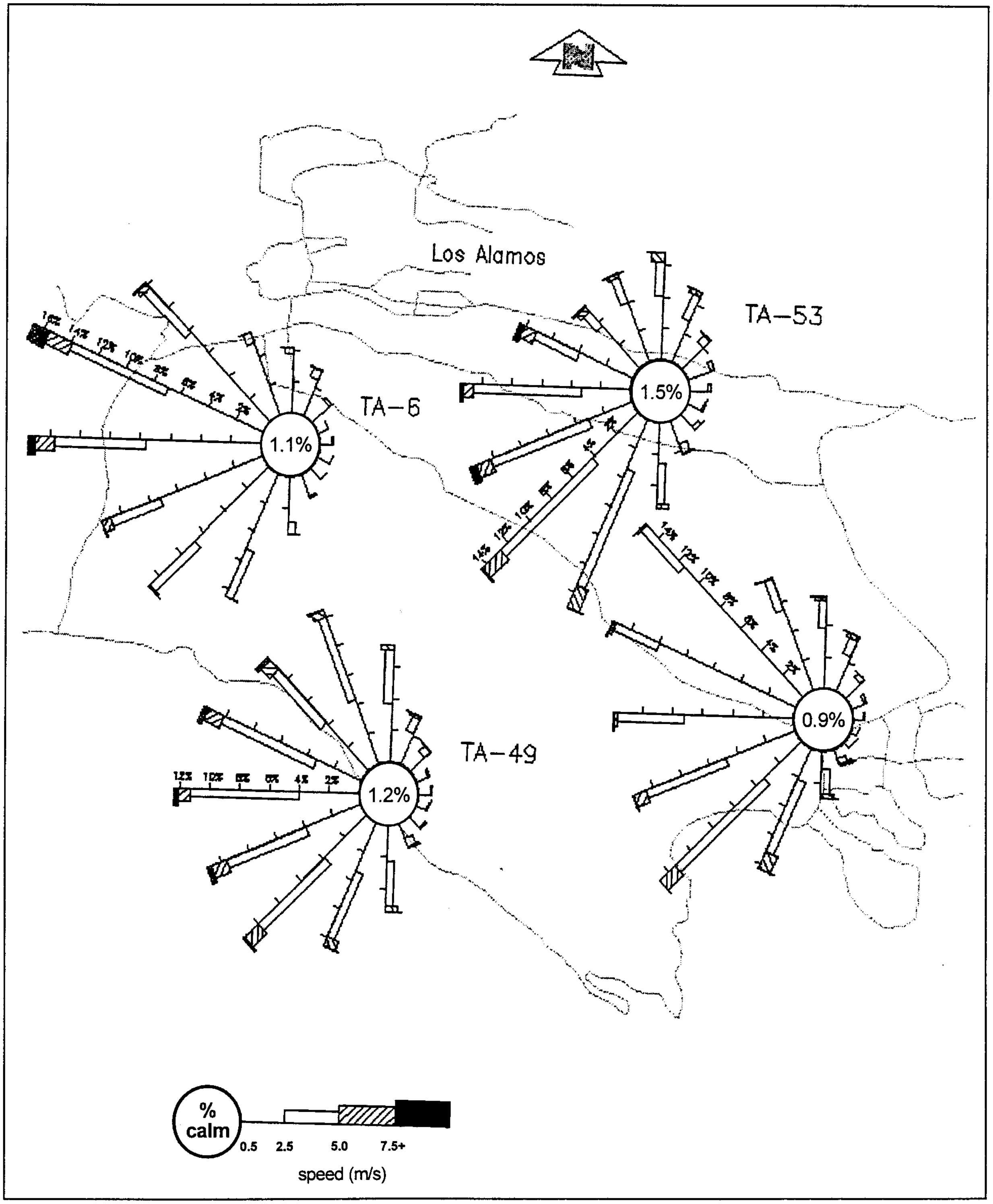

Figure 4.2.3.2-2. Nighttime wind direction and speed at LANL.

Table 4.2.3.3-1. Summary of 1996 monitoring data in the vicinity of LANL.

Pollutant Averaging Time	Nearest Monitor Location	Maximum 1st	Maximum 2nd	NAAQS NMAAQS	Number of Exceedances
PM-10	Bandelier (1994)				
24-hour		29.0	19.0	150.0 μg/m^3	0
Annual		9.0		50.0 μg/m^3	0
Ozone	Bandelier (1994)				
1-hour		0.090	0.074	0.12 ppm	0
NO_x	Bandelier (1994)				
Annual		0.003		0.05 ppm	0
24-hour		0.006	0.004	0.10 ppm	0
SO_2	Bloomfield				
3-hour		0.041	0.027	0.5 ppm	0
24-hour		0.010	0.010	0.10 ppm	0
Annual		0.0028	-	0.02 ppm	0
CO	Santa Fe				
1-hour		7.2	6.1	13.1 ppm	0
8-hour		2.3	2.2	8.7 ppm	0

Source: NMEDAQB 1997. NMAAQ – New Mexico Air Quality Standards.

and motor vehicles. Toxic air pollutants from LANL are released primarily from laboratory, maintenance, and waste management operations. Emissions from industrial sources are calculated annually because these sources are responsible for over 90 percent of all the nonradiological air pollutant emissions at the laboratory. Unlike a production facility with well-defined processes and schedules, LANL is a research and development facility with great fluctuations in both types of chemicals emitted and their emission rates. Because past reviews demonstrate that LANL's toxic air pollutant emissions are below the state's permitting threshold limits, LANL is not required to monitor toxic air pollutant emissions. As such, these emissions are not calculated annually; instead, each new or modified research source is addressed in the new source review process. Ambient monitoring for nonradioactive air pollutants was limited to particulate matter sampling as discussed herein.

The 1996 estimated emissions are shown in Table 4.2.3.3-2. These are typical industrial-type sources. LANL nonradiological emissions from research operations are small when compared with the listed sources. The three power plants, the largest sources of nonradioactive emissions, are used to supply steam for heating. The steam plant at TA-3 also produces electricity when sufficient power from outside sources is not available; approximately one-third of the emissions from this steam plant results from electricity production. The plants are primarily operated on natural gas but can use fuel oil as a backup.

PM_{10} samples (particles less than 10 μm in aerodynamic diameter) were collected for two events during 1996: the Dome Fire from April 26 through May 2 and a controlled burn on laboratory property in November. The Dome Fire samples were collected at the TA-49 air monitoring compound near the entrance to

Table 4.2.3.3-2. Emissions by source, 1996 (tons).

Source	PM	CO	NOx	SOx	VOC
TA-3 Power Plant	1.5	11.7	47.5	0.17	0.40
TA-16 Power Plant	1.9	5.5	22.6	0.08	0.19
TA-21 Power Plant	0.47	1.2	4.7	0.02	0.10
Asphalt Plant	0.14	0.07	0.05	0.001	0.03
Total	3.01	18.47	74.85	0.271	0.73

Bandelier National Monument. The controlled burn samples were collected downwind from the fire in the northwest part of Pajarito Acres. During the Dome Fire, the PM_{10} concentrations averaged 17 μg/m³, with the highest one-day concentration of 32 μg/m³, both of which are well below the federal standard of 150 μg/m³. These concentrations are typical values for the dry windy conditions present during the Dome Fire.

The laboratory conducts explosive testing by detonating explosives at firing sites operated by the Dynamic Testing Division. The laboratory maintains monthly shot records that include the type of explosives used as well as other material expended at each mound. The explosives detonations conducted at the laboratory during 1996 released quantities of beryllium, aluminum, tantalum, copper, and molybdenum. The laboratory also burns scrap and waste explosives because of treatment requirements and safety concerns. In 1996, the laboratory burned 3,482 lb of high explosives.

4.2.4 NOISE

The SNS site is proposed for an isolated area of the LANL reservation 0.6 to 1.2 miles (1 to 2 km) from the nearest public-use highway (State Road 4) and roughly 3 miles (5 km) from the nearest community of White Rock. A site-specific survey has not been conducted, but ambient noise levels in a rural setting such as this are typically in the 35- to 45-dB range. Because of its remote location, the proposed site would be protected from distant sources of noise and would be removed from any sensitive populations. The proposed site is situated about 10 miles (16 km) from the primary residential population of the City of Los Alamos.

4.2.5 ECOLOGICAL RESOURCES

This section provides a general description of the ecological resources for the proposed SNS site and the surrounding area. The discussions are based on information readily available from other sources. Site-specific surveys were done for protected species and wetlands. All other information was obtained from existing publications. For the most part, the impacts from construction and operation of the proposed SNS would be minor. Therefore, much of the information presented here is summary in nature. Greater detail can be obtained from the references compiled.

4.2.5.1 Terrestrial Resources

Three major vegetative community types have been identified within the boundaries of LANL: juniper savannas at the lowest elevations in White Rock Canyon, piñon-juniper woodlands at intermediate elevations on the mesas, and ponderosa pine forests at higher elevations on the mesas.

The juniper savanna community is found along the Rio Grande on the eastern border of the Pajarito plateau and extends upward on the south-facing sides of the canyons at 5,600 to 6,200 ft (1,700 to 1,900 m). Principal species in this community include one-seeded juniper (*Juniperus monosperma*), skunk bush sumac (*Rhus trilobata*), and sagebrush (*Artemisia spp*). The piñon-juniper community, generally found in the 6,200- to 6,900-ft (1,900- to 2,100-m) elevation range, includes large portions of the mesa tops and north-facing slopes at the lower elevations. This woodland consists of stands of piñon pine (*Pinus edulis*) and one-seeded juniper, both dominant, and includes grasses such as blue grama (*Bouteloua gracilis*) and galleta (*Hilaria jamesii*) (Travis 1992, as cited in DOE-AL 1995b).

The ponderosa pine community is found in the western portion of the plateau and on mesa tops in the 6,900- to 7,500-ft (2,100- to 2,300-m) elevation range. This community is characterized by ponderosa pine (*Pinus Ponderosa*) as the primary overstory vegetation. It also contains Douglas fir (*Pseudotsuga menziesii*), Gambel oak (*Quercus gambelii*), mountain muhly (*Muhlenbergia montana*), and little bluestem grass (*Andropogon scoparius*) (Travis 1992, as cited in DOE-AL 1995b).

Mixed-conifer forests also occur on the north-facing slopes of some canyons. Riparian zones occur in many of the drainages and along the Rio Grande.

The vegetation in the proposed SNS facility area is dominated by piñon-juniper woodlands with scattered juniper savannas. Additionally, much of the land in and bordering the adjacent canyons is bare rock. Overstory plant species include piñon and one-seed juniper. Scattered grasses, primarily blue grama, shrubs, and forbs are found in the understories. In areas where bedrock is near the soil surface, the most common shrubs include wavy-leaf oak (*Quercus undulata*), hedgehog prickly pear (*Opuntia erinacea*), and sticky rabbitbrush (*Chrysothamnus viscidiflorus*). In areas with deeper soils, big sagebrush (*Artemisia tridentata*) is common. Forbs on both deep and shallow soils include greenthread (*Thelesperma trifidum*), golden aster (*Chrysopsis villosa*), thelypody (*Thelypodium wrightii*), and trailing fleabane (*Erigeron flagellaris*).

Complete lists of species found to be occurring in the proposed SNS facility area are located in Foxx 1996. Rocky Mountain elk (*Cervus elaphus nelsoni*) use piñon-juniper woodlands for wintering habitat and some year-round use. Mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), grey fox (*Urocyon cinereoargenteus*), rock squirrel (*Spermophilus variegatus*), and desert cottontail (*Sylvilagus auduboni*) are common mammals. Common bird species include common raven (*Corvus corax*), scrub jay (*Aphelocoma coerulescens*), piñon jay (*Gymnorhinus cyanocephalus*), plain titmouse (*Parus inornatus*), and ash-throated flycatcher (*Myiarchus cinerascens*).

4.2.5.2 Wetlands

A 1996 field survey by LANL personnel identified an estimated 50 acres (20 ha) of wetlands, based on the presence of wetland vegetation (hydrophytes), within the LANL boundaries. More than 95 percent of the wetlands are located in the Sandia, Mortandad, Pajarito, and Water Canyon watersheds.
There are no wetlands in TA-70. In the vicinity of the proposed SNS site, the drainages in Ancho Canyon, 0.27 miles (0.47 km) to the

southwest, and in an unnamed canyon, 0.27 miles (0.47 km) to the northeast, are classified as intermittent riverine wetlands by the USFWS National Wetlands Inventory. These are dry and sandy drainages (arroyos) that occasionally contain water after snow melt or heavy rainstorm events. Riparian vegetation is supported in some portions of these arroyos (Foxx 1996).

4.2.5.3 Aquatic Resources

Aquatic habitats in LANL are limited to the Rio Grande and several springs and intermittent streams in the canyons. The streams and springs at LANL do not support fish; however, many other aquatic species thrive in these waters (Foxx 1996).

4.2.5.4 Threatened and Endangered Species

DOE is in the process of consulting with the USFWS regarding whether or not construction and operation of the proposed SNS at LANL would jeopardize the habitat of any threatened and endangered species and regarding appropriate mitigation measures. USFWS responded with a list of federally endangered, threatened, and candidate species and species of concern potentially occurring in Los Alamos County, New Mexico. Appendix D presents the letters of consultation.

DOE has not begun consultation with the New Mexico Department of Game and Fish. DOE recently completed the Site Draft EIS for continued operation of LANL (DOE-AL 1998). Included in Appendix D is a listing from the site-wide draft EIS of federal- and state-protected species occurring in the region of LANL.

Potential threatened or endangered species at LANL are listed in Table 4.2.5.4-1. The habitat within the proposed SNS facility site is not suitable for Mexican spotted owl (*Strix occidentalis lucida*), black-footed ferret (*Mustela nigripes*), and southwestern willow flycatcher (*Empidonax traillii extimus*). Therefore, these species were dismissed from consideration. The proposed SNS facility site area includes foraging habitat for American peregrine falcon (*Falco peregrinus anatum*) and foraging and roosting habitat for bald eagle (*Haliaeetus leucocephalus*). The American peregrine falcon is a summer resident and migrant on the Pajarito Plateau. Peregrines do not nest with LANL boundaries but do nest on surrounding land in the Jemez Mountains. Both adult and immature birds have been observed foraging on LANL. The preferred prey of peregrine falcons includes doves, pigeons, and waterfowl, all captured in flight (DOE-AL 1998). The nearest identified peregrine falcon nesting habitat is in White Rock Canyon, approximately 1.2 miles (1.9 km) from the site. Wintering bald eagles forage and roost within White Rock Canyon and connecting canyons, including Ancho Canyon. Additionally, bald eagles, whooping cranes (*Grus americana*), American peregrine falcon (*Falco peregrinus anatum*), and Arctic peregrine falcon (*Falco peregrinus tundrius*) may use White Rock Canyon as a migration route. Additional information on protected species at LANL is located in Appendix E.

Table 4.2.5.4-1. Threatened or endangered species potentially occurring on LANL.

Species	Scientific Name	Habitat Associations
American peregrine falcon (federally endangered)	*Falco peregrinus anatum*	Nests on cliff faces. Forages in all habitat types within LANL.
Whooping crane (federally endangered)	*Grus americana*	Migrates along Rio Grande in White Rock Canyon.
Southwestern willow flycatcher (federally endangered)	*Empidonax traillii extimus*	Inhabits riparian areas with established willow stands.
Black-footed ferret (federally endangered)	*Mustela nigripes*	Inhabits established prairie dog towns.
Arctic peregrine falcon (federally endangered)	*Falco peregrinus tundrius*	Potentially migrates along the Rio Grande in White Rock Canyon.
Bald eagle (federally threatened)	*Haliaeetus leucocephalus*	Inhabits riparian areas along permanent water ways such as lakes and rivers.
Mexican spotted owl (federally threatened)	*Strix occidentalis lucida*	Inhabits multistoried mixed conifer and ponderosa pine forests.

4.2.6 SOCIOECONOMIC AND DEMOGRAPHIC ENVIRONMENT

The ROI for the SNS at the proposed LANL site includes Los Alamos, Rio Arriba, and Santa Fe Counties, as shown in Figure 4.2.6-1. Approximately 90 percent of LANL employees reside in this region. The region includes the cities of Santa Fe and Española, the incorporated communities of Los Alamos and White Rock, and several small villages and unincorporated communities. The Native American Pueblos of San Ildefonso, Santa Clara, San Juan, Nambe, Pojoaque, Tesuque, and part of the Jicarilla Apache Indian Reservation are included in this tri-county region.

This section provides a description of the following socioeconomic and demographic characteristics:

- Demographics
- Housing
- Infrastructure
- Local economy
- Environmental justice

4.2.6.1 Demographic Characteristics

Population trends and projections for each of the counties in the ROI are presented in Table 4.2.6.1-1. Of the three counties, Santa Fe has the largest population, with 68 percent of the 1995 regional population of 171,977. Rio Arriba County accounted for 21 percent of the regional population, and Los Alamos County accounted for the remaining 11 percent. Population projections prepared by the New Mexico Bureau of Business and Economic Research anticipate that the combined population of the three counties will increase by 47,000 between 1995 and 2010 (about two percent per year).

Population data for the cities, communities, and pueblos in the tri-county region are presented in Table 4.2.6.1-2. Population trends in the region reflect the development of LANL as well as the growth of the tourist economy in the Santa Fe area.

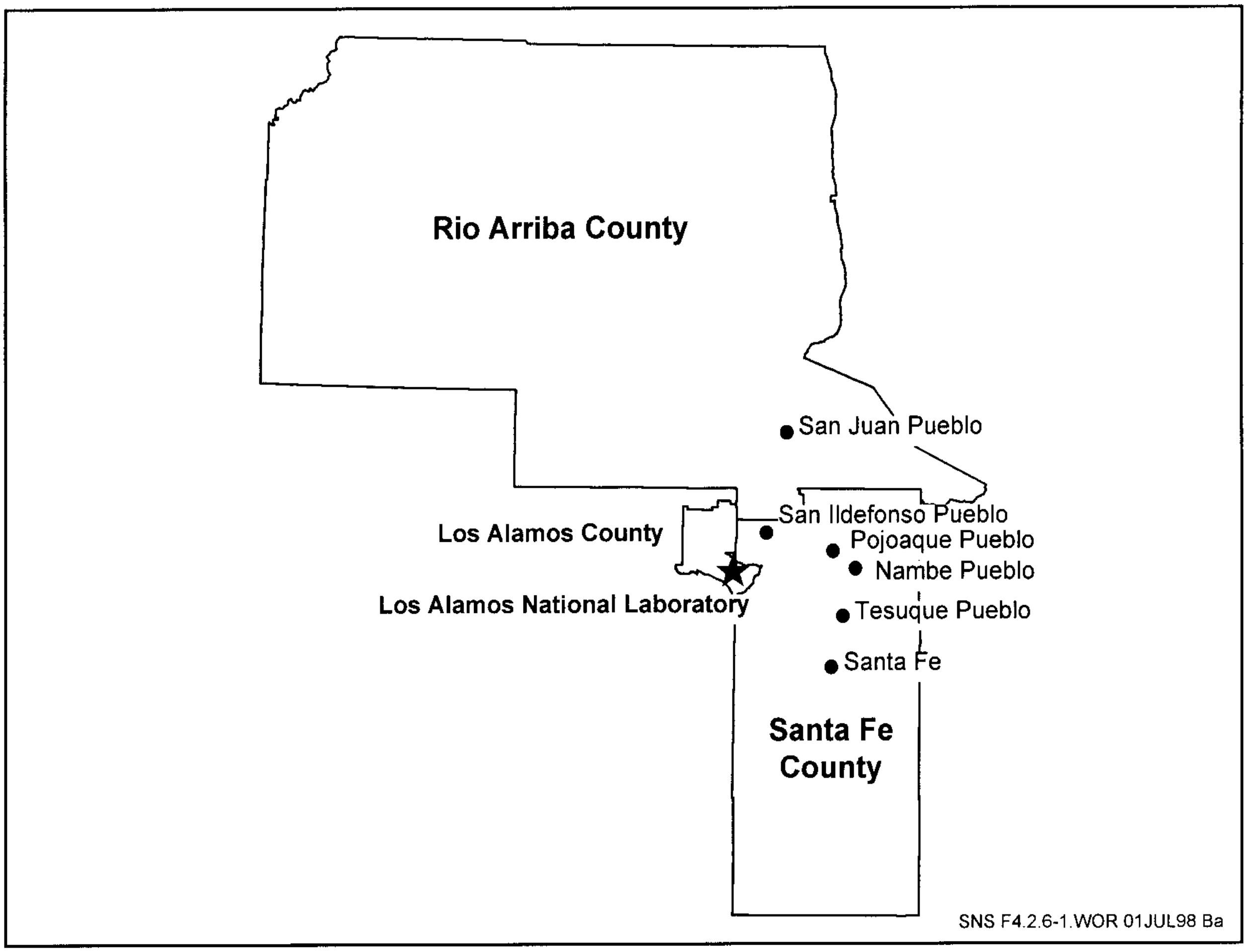

Figure 4.2.6-1. Map of socioeconomic region-of-influence for LANL.

Table 4.2.6.1-1. Regional population trends and projections.

County	1980	1990	1995	2000	2005	2010
Los Alamos	17,599	18,115	18,604	19,317	19,729	20,123
Rio Arriba	29,282	34,365	36,959	38,531	39,765	41,201
Santa Fe	75,519	98,928	116,414	128,985	142,792	157,925
Region	122,400	151,408	171,977	186,833	202,486	219,249
State	1,302,894	1,515,069	1,686,299	1,821,078	1,956,725	2,090,678

Sources: DOE-AL 1998; U.S. Bureau of the Census 1990; New Mexico BBER 1997.

Table 4.2.6.1-2. Population for incorporated and unincorporated areas within the LANL tri-county region.

Communities	1990	Most Recent
Santa Fe	56,537	66,522 (1996)
Española	8,389	9,008 (1996)
Los Alamos[a]	11,420	18,365 (1994)
Pueblos		
San Ildefonso[b]	424	580 (1998)
San Juan[b]	1,200	1,500 (1998)
Nambe[b]	NA	623 (1998)
Pojaque[b]	1,037	NA
Tesuque[b]	500	450 (1998)

[a] Includes the community of White Rock.
[b] Personal communication with tribal spokesperson, April 9, 1998.
NA - Not available.
Source: U.S. Bureau of Census 1990; U.S. Bureau of Census 1996.

Population by race and ethnicity for the tri-county region is presented in Table 4.2.6.1-3. Census data from 1990 reflect different racial and ethnic compositions in three counties. Los Alamos County is predominantly Caucasian (85 percent); Rio Arriba County is predominantly Hispanic of any race (73 percent); and Santa Fe County is predominantly Hispanic of any race (50 percent). Native Americans compose 14 percent of the population in Rio Arriba County, 2 percent in Santa Fe County, and 0.6 percent in Los Alamos County.

4.2.6.2 Housing

Regional housing characteristics are presented in Table 4.2.6.2-1. In 1990, vacancy rates in the region ranged between a low of five percent in Los Alamos County to a high of 20 percent in Rio Arriba County. Approximately 70 percent of all occupied units were “owner occupied,” and 30 percent were rented.

4.2.6.3 Infrastructure

The Infrastructure section characterizes the region’s community services with indicators such as education, healthcare, and public safety.

4.2.6.3.1 Education

New Mexico is divided into 89 school districts, four of which are predominantly within the tri-county ROI. Information regarding school districts within the tri-county region is presented in Table 4.2.6.3.1-1.

The Los Alamos School District receives 36 percent of its funding from the federal government, over 56 percent from the state, and 6.5 percent from local sources such as the property tax levy and surplus school space rental. The total school budget for FY 1997 is projected to be $24.5 million. Capacities differ at each school now in use, but as a whole,

Table 4.2.6.1-3. 1990 LANL population by race and ethnicity for the region.[a]

All Persons, Race/ Ethnicity	Los Alamos County		Rio Arriba County		Santa Fe County		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
All Persons	18,115	100.0	34,365	100.0	98,928	100.0	151,408	100.0
Caucasian	15,467	85.0	4,375	13.0	46,450	47.0	66,292	44.0
African-American	88	0.5	117	0.3	505	0.5	710	0.5
American Indian[b]	112	0.6	4,830	14.0	2,284	2.0	7,226	5.0
Asian/ Pacific Islander	421	2.0	40	0.1	439	0.4	900	0.6
Hispanic of any race[c]	2,008	11.0	24,955	73.0	48,939	50.0	75,902	50.0
Other races	19	0.1	48	0.1	311	0.3	378	0.3

[a] Percentages may not total to 100 due to rounding.

[b] Numbers for Aleuts and Eskimos were placed in the "other" category, given their small number.

[c] In the 1990 Census, Hispanics classified themselves as White, Black, Asian/Pacific Islander, American Indian, Eskimo, or Aleut. To avoid double counting, the number of Hispanics was subtracted from each of the race categories.

Sources: DOE-AL 1998; U.S. Bureau of Census 1990; U.S. Bureau of Census 1996.

Table 4.2.6.2-1. Housing summary for the LANL region, 1990.[a]

	Los Alamos County		Rio Arriba County		Santa Fe County	
	Number	Percent	Number	Percent	Number	Percent
Total Housing Units	7,565	100	14,357	100	41,464	100
Occupied	7,213	95	11,461	80	37,840	91
Vacant	352	5	2,896	20	3,624	9
Median Home Value	$125,100	N/A	$57,900	N/A	$103,300	N/A
Median Contract Rent	$403	N/A	$189	N/A	$422	N/A

N/A - Not applicable.

[a] May not total 100 due to rounding.

Sources: DOE-AL 1998; U.S. Bureau of Census 1990.

Table 4.2.6.3.1-1. Public school statistics in the LANL region, 1996-97 school year.

District	Student Enrollment[a]	Teachers[b]	Teacher/Student Ratio	Per-Student Operational Expenditures[c]
Los Alamos	3,879	264	1:15	$6,640
Santa Fe	16,490	917	1:18	$3,665
Española	6,445	369	1:17	$3,986
Pojoaque	2,140	116	1:18	$4,011
State Average	330,522	21,066	1:17	$4,009

[a] Includes public, nonpublic, and home-school students.
[b] Full-time equivalent figures.
[c] 1995-1996 data.
Sources: DOE-AL 1998; New Mexico Department of Education 1997.

schools currently in use could accommodate approximately 1,560 more students in the coming years.

4.2.6.3.2 Health Care

The three hospitals serving the tri-county region are Los Alamos Medical Center, Española Hospital, and St. Vincent Hospital in Santa Fe. St. Vincent Hospital is the second-busiest in the state and houses the only trauma center in the area. Table 4.2.6.3.2-1 presents data on hospital capacity and usage. The percentage of annual bed-days used indicates sufficient capacity to accommodate additional patients.

4.2.6.3.3 Police and Fire Protection

Table 4.2.6.3.3-1 gives the number of full-time law enforcement officers for the incorporated communities in the LANL region. The Los Alamos County Police Department has 42 full-time police officers and an approved FY 1997 budget of $3.7 million. The police department responds to approximately 1,700 service calls monthly and is involved in various community programs. The ratio of commissioned police officers in Los Alamos County was 2.33 officers per 1,000 of population in January 1997. This ratio is a higher level of police manpower than in Santa Fe. In addition to serving Los Alamos and White Rock, the police department investigates criminal activity at LANL.

The Los Alamos County Fire Department is owned by DOE and is operated through contract by Los Alamos County (fire department personnel are county employees). The Fire Department provides fire suppression, medical/rescue, wildland fire suppression, and fire prevention services to both LANL and the Los Alamos County community.

4.2.6.4 Local Economy

This subsection provides information on the economy of the region, including employment, education, income, and fiscal characteristics.

4.2.6.4.1 Employment

Regional employment data for 1996 are summarized in Table 4.2.6.4.1-1. Both Los Alamos and Santa Fe counties had

Table 4.2.6.3.2-1. Hospital capacity and usage in the LANL tri-county region.

Hospital	Number of Beds	Annual Bed-Days Used[a] (%)
Los Alamos Medical Center	53	26
Española Hospital	81	32
St. Vincent Hospital	268	51

[a] Based on the number of people discharged and the average length of stay divided by total beds available annually.
Source: DOE-AL 1998.

Table 4.2.6.3.3-1 Full-time law enforcement officers for incorporated areas within the LANL region (1996).

Community	Officers
Los Alamos County	42
Rio Arriba County	27
Santa Fe County	68
Española	24
Santa Fe	106

Source: Department of Justice, 1997.

Table 4.2.6.4.1-1. LANL regional employment data, 1996.

County	Civilian Labor Force	Employed	Unemployed	Unemployment Rate (%)
Los Alamos	10,544	10,229	315	3.0
Rio Arriba	18,099	15,352	2,747	15.2
Santa Fe	61,181	58,301	3,880	4.7
Tri-county region	89,824	83,882	5,942	6.6
State of New Mexico	799,807	735,363	64,444	8.1

Source*:* New Mexico BBER 1997.

unemployment rates below the state average of 8.1 percent and the 5.6 percent average for the United States. By contrast, the unemployment rate in Rio Arriba County was 15.2 percent.

Almost two-thirds of regional 1995 employment was in the "government" and "services" sectors. Employment in those two sectors totaled more than 64,000 persons. Also significant was employment in "retail trade" (19,200), which accounted for 19 percent of the total.

Table 4.2.6.4.1-2 presents employment by industry for the ROI. Government and services are the principal economic sectors in the region. There were approximately 6,000 business

Table 4.2.6.4.1-2. Employment by industry for the Los Alamos region-of-influence, by county, and for the State of New Mexico, 1995.

Economic Characteristic	Los Alamos County	Rio Arriba County	Santa Fe County	Region of Influence	State of New Mexico
Employment by Industry (1995)					
Farm	0	993	352	1,345	20,465
Agriculture Services	53	(D)	713	766	12,203
Mining	34	(D)	414	478	21,539
Construction	314	743	5,211	6,268	59,763
Manufacturing	166	547	3,009	3,722	52,058
Transportation and Public	78	456	1,443	1,977	36,269
Wholesale Trade	120	168	1,581	1,869	31,468
Retail Trade	1,449	1,904	15,852	19,205	163,452
Finance, Insurance, and Real Estate	589	438	5,718	6,745	53,915
Services	6,136	4,120	25,597	35,853	263,654
Government	9,860	2,933	15,549	28,342	188,626

(D) - Data withheld to avoid disclosure when there are less than four businesses in an industry classification.
Source: Regional Economic Information for Los Alamos, Rio Arriba, Santa Fe Counties and State of New Mexico (U.S. Bureau of Census 1990).

establishments, government agencies, and government enterprises in the tri-county region in 1994. Nearly 29 percent of these were service businesses that employed less than 33 percent of the employed workforce in the area and paid 30 percent of the earnings reported in 1993. Approximately 21 percent were farms or ranches, which employed less than two percent of the employed workforce and provided 0.3 percent of the 1993 earnings. Retail trade establishments composed another 21 percent of the business, and government operations employed slightly more that 17 percent of the employed workforce and paid 12 percent of the 1993 reported earnings. Government agencies and enterprises, including federal, state, county, city, school district, and tribal governments, composed 36 percent of these establishments, employed nearly 29 percent of the employed workforce, and paid nearly 40 percent of the total earnings reported in 1993.

4.2.6.4.2 Income

In 1995, total regional income was approximately $3.78 billion, and 13 percent of this ($473 million) was paid to the LANL workforce residing in the tri-county region. Wages and salaries in the region increased 47 percent between 1989 and 1994. Income data for the tri-county region are presented in Table 4.2.6.4.2-1. Median family incomes in the region vary considerably, from $21,144 in Rio Arriba County to $60,798 in Los Alamos County. In 1989, Los Alamos County had the highest family and per capita incomes in New Mexico and the highest median family income of all U.S. counties. The percentage of persons below the poverty level was approximately two percent in Los Alamos County, 13 percent in Santa Fe County, and 28 percent in Rio Arriba County (Santa Fe Planning Department 1998).

Table 4.2.6.4.2-1. Measures of LANL regional income.

Area	Median Family Income	Per Capita Income	
	1989 ($)	1989 ($)	1994 ($)
Los Alamos County	60,798	24,473	29,762
Rio Arriba County	21,144	8,590	11,731
Santa Fe County	34,073	16,679	22,531
State of New Mexico	27,623	11,246	16,346

Source: DOE-AL 1998; New Mexico BBER 1997.

4.2.6.4.3 Fiscal Characteristics

Municipal and county general fund revenues in the tri-county ROI are presented in Table 4.2.6.4.3-1. The general funds support the ongoing operations of local governments as well as community services such as police protection and parks and recreation. In Los Alamos County, the fire department is funded through a separate fund derived from DOE contract payments.

New Mexico communities are heavily dependent on gross receipts tax revenues, which are sensitive to changes in employment, income, procurement and construction contracting. In recent years, gross receipts tax revenues from retail and services have either declined or increased modestly in the region. Property taxes, another source of general fund revenues, are limited by New Mexico statute to a 5 percent annual increase on any single property.

4.2.6.5 Environmental Justice

Figures 4.2.6.5-1 and 4.2.6.5-2 illustrate distributions for minority and low-income populations residing within 50 miles (80 km) of LANL. The definitions of minority and low-income populations and the methodology for assessing potential environmental justice effects are given in Section 5.3.6.5.

Approximately 270,000 people live within a 50-mi (80-km) radius of the proposed LANL site. Minorities comprise 48.1 percent of this population. In 1990, minorities composed 24.4 percent of the national population and 24 percent of the population in New Mexico. There are several federally recognized Native American groups within 50 miles (80 km) of the site. The percent of persons below the poverty level is 13 percent, which compares with the 1990 national average of 13.1 percent and a statewide figure of 31 percent (U.S. Census 1990).

4.2.7 CULTURAL RESOURCES

The cultural resources in the Los Alamos area and on LANL land have been extensively studied and documented. Approximately 75 percent of LANL has been surveyed for cultural resources, although the coverage of some individual surveys has been less than 100 percent. However, about 60 percent of LANL has received 100 percent survey coverage (DOE 1993, as cited in DOE-AL 1998: 4-157). The cumulative results of these surveys and site excavations are recorded on the LANL Cultural Resources Database.

The LANL Cultural Resources Database indicates that 1,295 prehistoric sites have been identified on laboratory land. These prehistoric

Table 4.2.6.4.3-1. Municipal and county general fund revenues in the LANL tri-county region, FY 1995.[a]

Revenue by Source	Los Alamos County		Rio Arriba County		City of Española		Santa Fe County		City of Santa Fe	
	($)	Percent	($)	Percent	($)	Percent	($)	Percent	($)	Percent
Property Tax	3,001,910	14	2,504,037	22	262,707	5	9,819,861	34	964,507	2
Gross Receipts Tax	10,361,829	50	663,626	6	3,930,810	72	4,233,441	15	46,986,752	79
Lodgers Tax	921,854	4	205,451	2	671,746	13	1,325,943	4	3,244,930	5
Others	921,854	4	205,451	2	671,746	13	1,325,943	4	3,244,930	5
Fees, Fines, Charges, Forfeits, Licenses, and Permits	2,427,527	12	132,857	1	373,620	7	1,458,675	5	3,853,266	7
Oil and Gas Taxes	NA	NA	3,319,900	30	NA	NA	NA	NA	NA	NA
Miscellaneous Income	4,033,998	19	1,306,555	12	153,686	3	1,428,134	5	1,185,088	2
Restricted Funds	NA	NA	3,091,129	28	NA	NA	10,822,381	37	NA	NA
Total Revenues	20,919,195	100	11,223,555	100	5,450,354	100	29,088,435	100	59,870,838	100

NA - Not available.
[a] Percentages may not total 100 due to rounding.
Source: DOE-AL 1998.

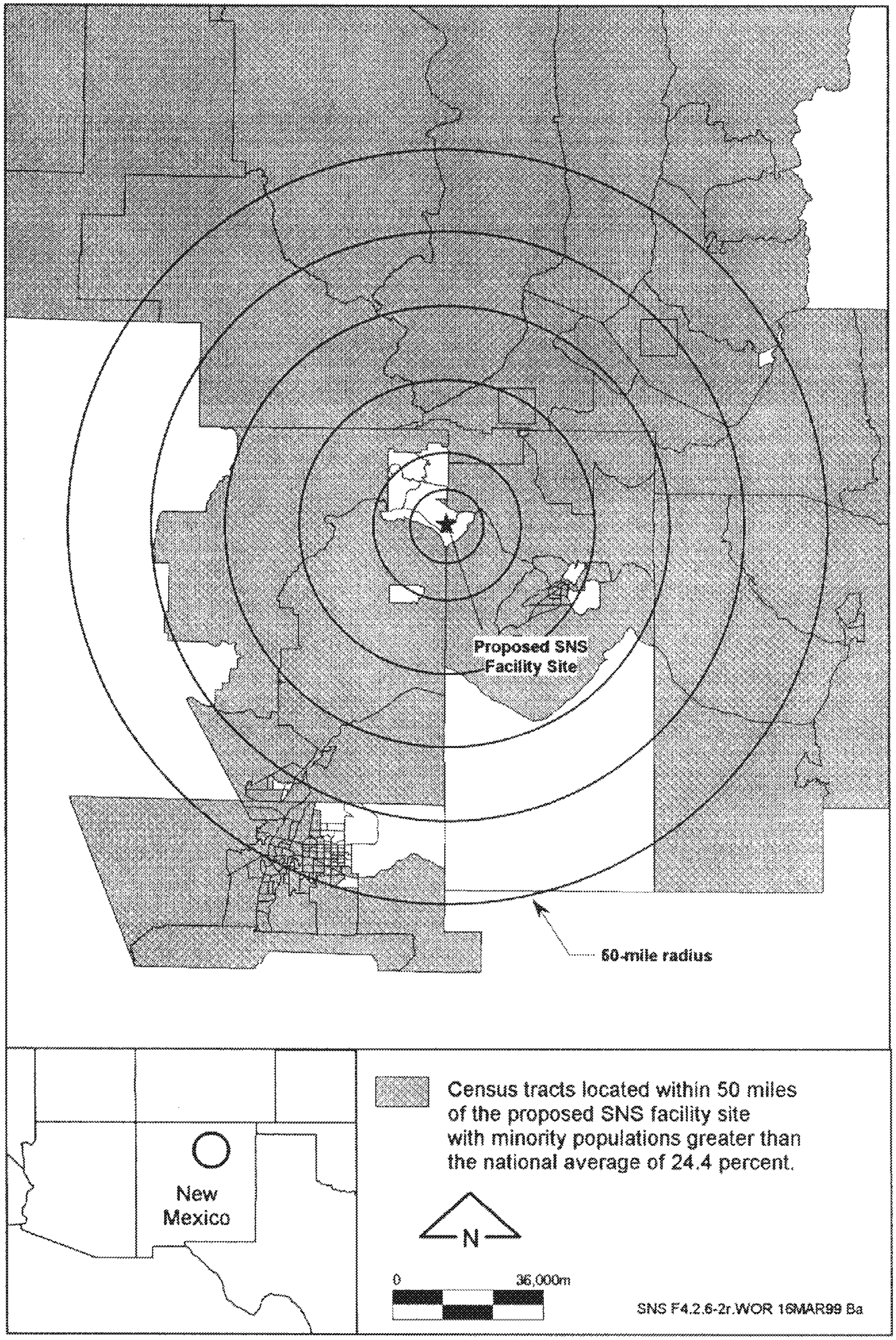

Figure 4.2.6.5-1. Distribution of minority populations at LANL.

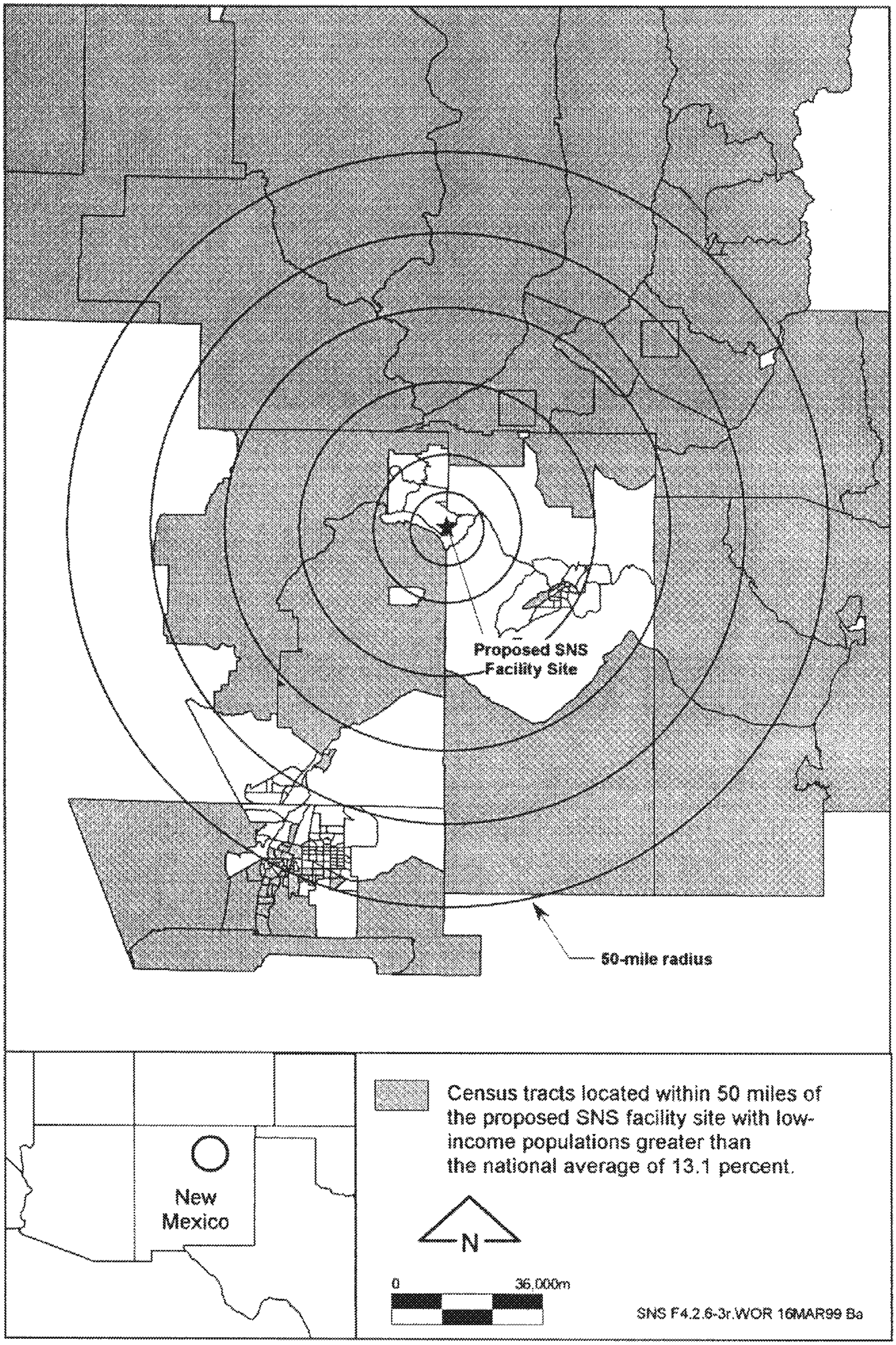

Figure 4.2.6.5-2. Distribution of low-income populations at LANL.

sites include archaeological sites such as simple pueblos, complex pueblos, small cave pueblos, highly eroded pueblos, rock shelters, artifact scatters, lithic scatters, and rock rings. Other sites in the database include trails and steps, rock art, water control features, and game traps. Of the total number of prehistoric sites in the database, 1,192 have been assessed for NRHP eligibility. Out of this number, 770 are eligible for listing on the NRHP, 322 are potentially eligible, and 100 sites are ineligible. The other 103 prehistoric sites have not been assessed for NRHP eligibility, but they are assumed to be potentially eligible until such assessments can be made (DOE-AL 1998: 4-158).

The Laboratory has not been systematically and comprehensively surveyed for historic cultural resources. However, the surveys performed to date have identified 214 historic sites. Approximately 2,105 more historic sites have been identified through a combination of archival research and field observations. Sites identified include historic archaeological sites, homesteads, commercial ranches, and guest ranches established prior to 1943. In addition, they include the original Los Alamos town site and numerous other buildings and facilities associated with the early development of nuclear weapons [World War II–Early Nuclear Weapons Development Period (A.D. 1943–1948)]. Most of the historic sites at LANL are buildings and facilities associated with Cold War Period (A.D.1946–1989) activities. Ninety-nine of the historic sites at LANL are eligible for listing on the NRHP, and two sites are listed on the State Register of Cultural Properties (DOE-AL 1998: 4-158 to 4-159).

A number of TCPs have been identified within the LANL boundaries and at nearby locations outside the laboratory boundaries. These TCPs include substance features, ceremonial and archaeological sites, natural features, plant gathering sites, and sites where artisans obtain raw materials.

A cultural resources survey of the proposed SNS site and an associated buffer zone was procured by LANL in 1997 to support preparation of this FEIS. However, only about 65 percent of this area was surveyed (LANL 1998); five prehistoric cultural resources were identified (refer to Section 4.2.7.1). Furthermore, the density of prehistoric sites per unit area of LANL land as a whole is high, and most of these sites are eligible for listing on the NRHP. Considering these factors, the chances of finding additional cultural resources within the unsurveyed 35 percent of the proposed SNS site and buffer zone would be reasonably high. If the proposed site at LANL is eventually chosen for construction of the SNS, the remaining 35 percent of the area of potential impact would be surveyed for cultural resources prior to the initiation of construction activities.

The SNS design team has not established the areas where construction or improvement of utility corridors and roads would be necessary to support the proposed SNS at LANL. In addition, the locations of ancillary structures such as a retention basin, switchyard, and sanitary waste treatment systems have not been determined. As a result, such areas could not be surveyed for cultural resources. However, the eventual establishment of these areas would proceed in such a manner as to avoid known cultural resource locations. If the proposed SNS site at LANL were chosen for construction, these areas would be surveyed for cultural resources prior to the initiation of construction-related activities within them.

The locations of archaeological sites, historic sites, and TCPs are not provided as part of the cultural resource descriptions in this section of the FEIS. These omissions are consistent with DOE and the University of California efforts to protect cultural resources from vandalism by not revealing these locations in documents available to the general public. Because several of the original reports cited in this section show the locations of cultural resources at LANL, copies of them are not available in the DOE public reading rooms established as part of the SNS EIS process.

4.2.7.1 Prehistoric Resources

Five prehistoric archaeological sites have been identified on and adjacent to the proposed SNS site at LANL. All of these sites are located within the 65 percent of the proposed SNS site and an adjacent buffer zone that have been surveyed for cultural resources. Three of these sites date to the Coalition Period, and two sites date to the Classic Period (LANL 1998).

Most of the prehistoric sites within the LANL boundaries date to the Coalition Period (A.D. 1100 to 1325). The peoples of the Coalition Period in the LANL area were maize horticulturists. Their early sites are characterized by adobe and masonry rectangular structures, and the later sites have large, masonry-enclosed plaza room blocks with over 100 rooms. Some researchers attribute the increase in numbers of sites during this period to migration of peoples into the area, while others believe that the increase was a function of *in situ* population growth.

The Classic Period (A.D. 1325 to 1600) immediately followed the Coalition Period in the LANL area. The people of this period practiced intensive maize horticulture. The settlements on the Pajarito Plateau were aggregated into three population clusters with outlying one- to two-room field houses. The central cluster consisted of four temporally overlapping sites: Navawi, Otowi, Tsankawi, and Tsirege. The Otowi and Tsirege sites are on DOE land at LANL. The ruins on these sites are ancestral to the current Tewa speakers living at the nearby Pueblo of San Ildefonso.

Descriptive data covering the prehistoric archaeological sites identified on and adjacent to the proposed SNS site are provided in Table 4.2.7.1-1. These descriptions include the official site designation, the site type defined by function, the period when the site was occupied, the time range of the period, the size of the major remains at the sites, and the NRHP eligibility of the sites.

4.2.7.2 Historic Resources

No Historic Period cultural resources have been identified within the 65 percent survey area at the proposed SNS site.

4.2.7.3 Traditional Cultural Properties

A number of TCPs are known to be present on LANL land as a result of a study conducted in support of the recent site-wide EIS covering laboratory operations. Twenty-three American Indian tribes and two Hispanic communities were contacted during the study. The Hispanic communities and 19 tribes agreed to consult with DOE on the identification of TCPs in the LANL region. All groups indicated the presence of TCPs on or near LANL land. These resources can be broadly categorized as artisan material sites, natural features, ethnobotanical sites, subsistence features, ceremonial sites, and

Table 4.2.7.1-1. Prehistoric cultural resources on the proposed SNS site at LANL.

Designation	Type	Period (Components)	Dates	Size	NRHP Eligibility[3]
LA12676-B[1]	Field house	Coalition	A.D. 1100–1325	1–2 Rooms	E
LA12676-C[1]	Pueblo	Early Coalition	A.D. 1100–1213	8–10 Rooms	E
L-154[2]	Pueblo	Classic	A.D. 1325–1600	2–4 Rooms	E
LA6786[1]	Pueblo	Early Coalition		6–8 Rooms	E
LL-155[2]	Field house	Classic	A.D. 1325–1600	1 Room	E

[1]New Mexico Laboratory of Anthropology number.
[2]LANL field numbers.
[3]E - Eligible for listing on the NRHP under Criterion D. This criterion applies to sites that are significant because of their potential to contribute to archeological and historical research.
Source: LANL 1998.

archaeological sites (DOE-AL 1998: 4-160 to 4-161). Generally, the consulted groups consider all archaeological sites, rivers and water resources, human burials, shrines, trails, plants, animals, and minerals to be TCPs (DOE-AL 1998: 5-71). Although such resources are located throughout LANL and adjacent lands, the consulting groups did not identify specific TCP features or locations (DOE-AL 1998: 4-161).

The five prehistoric archaeological sites identified within the 65 percent survey area on the SNS site would be considered to be TCPs (see Section 4.2.7.1). The specific identities and locations of any other TCPs on and adjacent to the proposed SNS site are not known and cannot be reasonably estimated.

4.2.7.4 Consultation with the State Historic Preservation Officer

Section 106 of the NHPA requires a review of proposed federal actions to determine whether or not they would impact properties listed on or eligible for listing on the NRHP. DOE-AL has consulted with the SHPO in New Mexico concerning the occurrence of such properties within the area of potential impact of the proposed SNS at LANL. The consultation letter sent to the SHPO at the New Mexico Historic Preservation Division is provided in Appendix D.

4.2.8 LAND USE

Descriptions of land use in the vicinity of LANL, within the boundaries of LANL, and on the proposed SNS site are provided in this section. The descriptions cover past, current, and future uses of the land in these areas. In addition, they include descriptions of environmentally sensitive land areas that have been set aside for public use, environmental protection, or research. These areas include parks, natural areas, environmental education centers, and public recreation areas. The section concludes with a discussion of visual resources.

4.2.8.1 Past Land Use

LANL has been surrounded by large tracts of federal, county, and Native American tribal lands for many years. Generally, the federal and tribal lands have remained in their natural state and may be largely categorized as open space. However, some areas within these lands have been devoted to residential and limited commercial/industrial use. Historically, a very small percentage of the land in the vicinity of LANL has been under local government or private ownership. This small percentage includes the urban lands in Los Alamos and White Rock. Most of the privately owned land has been developed for residential, commercial, and industrial use (DOE-AL 1995b: 4-4; LANL 1998).

The land within the boundaries of LANL was largely open space wilderness prior to its use by the Manhattan Project in 1943. Over the next 55 years, the current pattern of land use at LANL gradually evolved. This evolution involved the increasing use of laboratory land for industrial purposes related to scientific research and the development of nuclear weapons. During this period, large portions of LANL remained as open space in its natural state.

The proposed SNS site, located in TA-70 at LANL, has always been largely an open space wilderness area covered with piñon-juniper woodlands. Piñon-juniper woodlands cover 12,770 acres (5,108 ha) of land at LANL (DOE-AL 1998: 4-103). The proposed SNS site and TA-70 have not been a focus of past industrial development, and no contamination of soil from past activities is known to be present at the site. In addition to TA-70 and the proposed SNS site, TA-69 and TA-71 are also undeveloped, as is most of TA-6 (DOE-AL 1998: 2-19 to 2-22). The total area of land in TA-70 is about 1,825 acres (739 ha). The total land area in the other three TAs is approximately 1,684 acres (682 ha). On a lab-wide basis, it is estimated that approximately 16,000 acres (6,478 ha) of land have never been developed, but about 14,000 acres (5,668 ha) are unsuitable for development because they consist of canyon bottoms and land with slopes in excess of 20 percent (Anderson 1998: 1-2).

4.2.8.2 Current Land Use

The land use pattern in the vicinity of LANL stems from predominant ownership and management of the land by governmental entities and Native American tribal authorities. A general depiction of land use areas in the vicinity of LANL is provided in Figure 4.2.8.2-1.

A portion of the northern laboratory boundary is adjoined by the community of Los Alamos, which is characterized by a combination of residential, commercial, public/quasi public, and open space land use. The rest of the northern boundary is adjacent to the Santa Fe National Forest. The national forest is managed by the U.S. Department of Agriculture (USDA) and contains a total land area of 1,567,181 acres (634,238 ha). This area consists primarily of open space in its natural state and specific natural areas preserved for research purposes by the USDA (DOE-AL 1995b: 4-4). Land use within the national forest is further categorized according to eight discrete forest management areas. These forest management areas are delineated and described in the *Santa Fe National Forest Plan* (USFS 1987, as cited in DOE-AL 1998).

The Tsankawi area of Bandelier National Monument, lands of the Pueblo of San Ildefonso, and the community of White Rock lie along the eastern boundary of LANL. The Tsankawi area, managed by the Department of the Interior (DOI), is nonwilderness open space covering 826 acres (334 ha) and characterized by the presence of prehistoric Native American

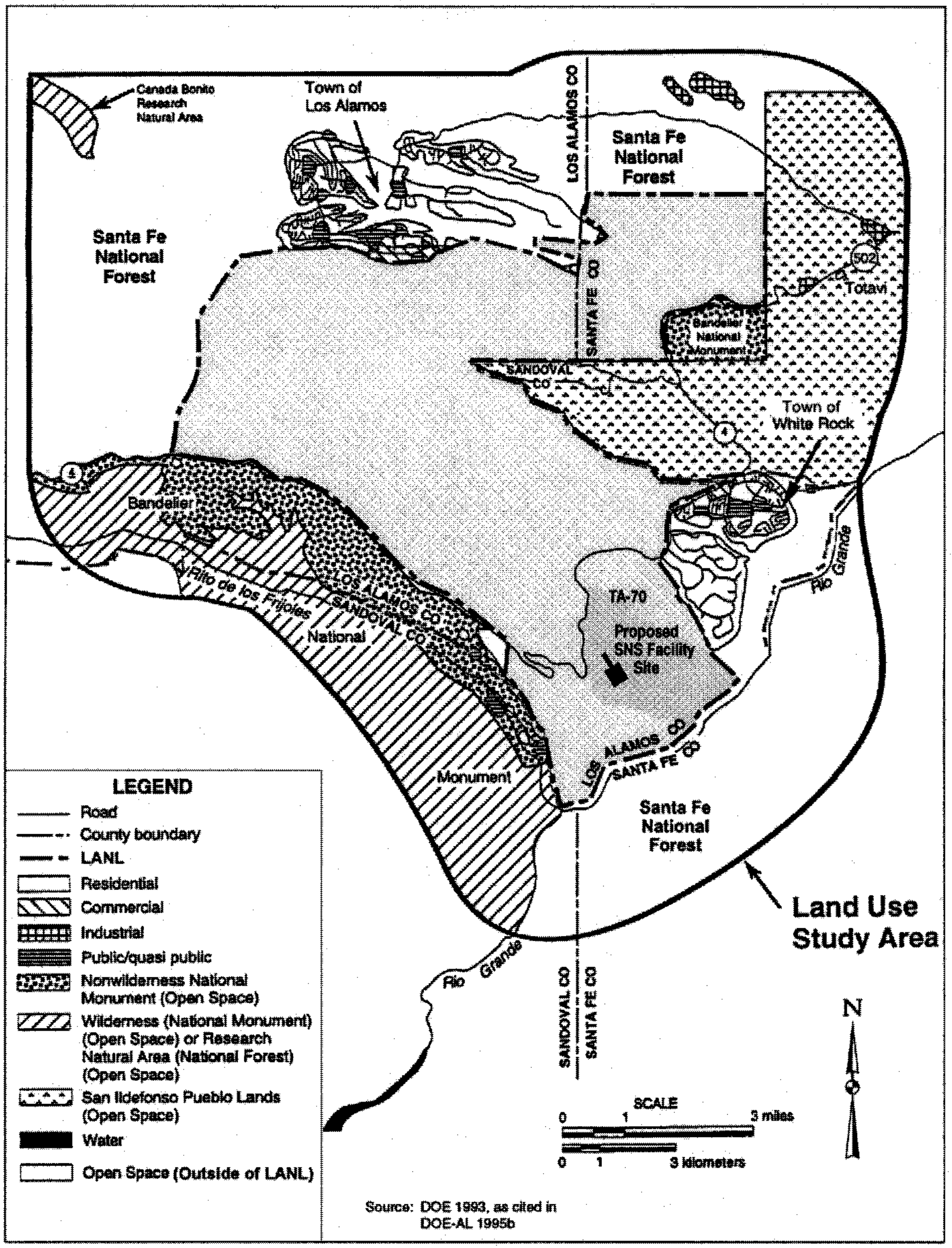

Figure 4.2.8.2-1. Map of current land use in the vicinity of LANL.

ruins. With the exception of a few small commercial, industrial, residential, and agricultural use areas, the Native American pueblo lands are largely open space. The urban land use pattern in the community of White Rock is similar to the one in Los Alamos (DOI 1995, as cited in DOE-AL 1998; DOE-AL 1995b: 4-4).

The southern and eastern boundaries of LANL are adjacent to an area of the Santa Fe National Forest and the primary area of Bandelier National Monument, respectively. The national forest tract is open space. The primary unit of the national monument is wilderness and nonwilderness open space containing prehistoric ruins (DOE-AL 1995b: 4-4). A small portion of this area is developed to meet the needs of visitors (DOI 1995, as cited in DOE-AL 1998: 4-13).

The laboratory occupies approximately 27,832 acres (11,268 ha) of land in Los Alamos and Santa Fe Counties. It is subdivided into 49 distinct technical areas, but only 30 of these are active (DOE 1996c: 4-246).

The laboratory uses a current land use characterization system consisting of 11 major categories: Environmental Research/Buffer, Physical Support and Infrastructure, Experimental Science, High Explosives Research & Development and Testing, Special Nuclear Materials Research & Development, Public and Corporate Interface, Administrative and Technical Services, Waste Management, Theoretical and Computational Science, Non-DOE Land: Potentially Physical Support and Infrastructure, and High Explosives Administrative and Technical Support Area (LANL 1995: 11). The areas of laboratory land within each category are shown in Figure 4.2.8.2-2.

The proposed SNS site is located within TA-70 at the southeast end of LANL (refer to Figure 4.2.8.2-2). All of TA-70 is in the Environmental Research/Buffer land use category (LANL 1995: 11). This area has remained largely undeveloped and could be classified as open space in more conventional land use terminology. It is surrounded on the north, east, and west by land in the same use category. The Rio Grande River and the Santa Fe National Forest are along its southern boundary.

The entire laboratory has been designated as a NERP, and all of the land on and adjacent to the proposed site is in the Environmental Research/Buffer land use category. The land on and in the vicinity of the proposed SNS site is not being used for environmental research projects that would be potentially sensitive to SNS activities. (Withers 1998: 2).

4.2.8.3 Future Land Use

Future land use in the area surrounding LANL is managed according to comprehensive land use and development plans prepared for Los Alamos County, Santa Fe National Forest, and Bandelier National Monument. A formal land use plan has not been adopted for the Pueblo of San Ildefonso.

Fifty-four percent of the land in Los Alamos County, which includes the communities of Los Alamos and White Rock, has slopes of 20 percent or greater. Land with such slopes is not conducive to building. As a result, future urban development is expected to occur in compact, contiguous areas with less slope,

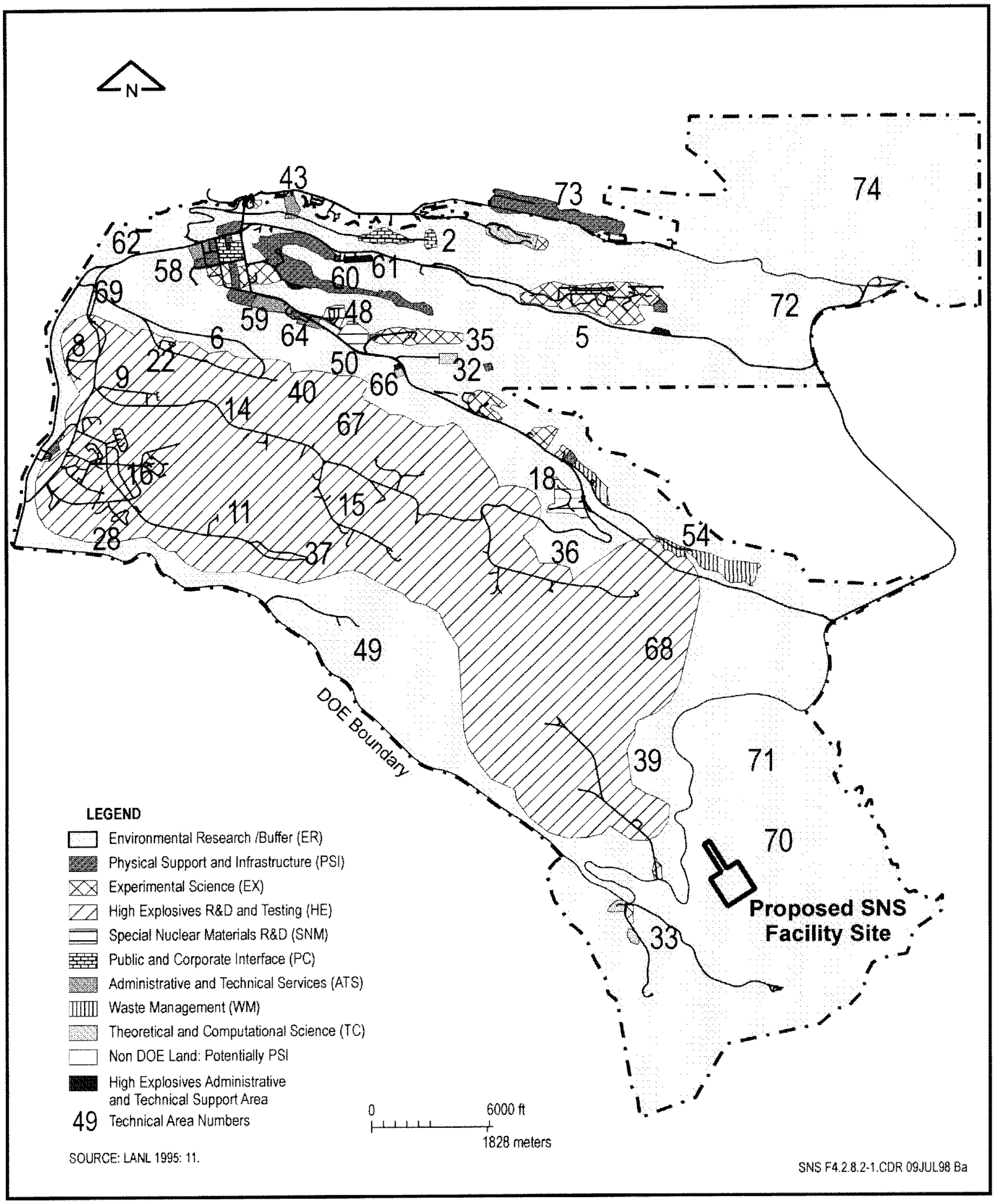

Figure 4.2.8.2-2. Map of current land use at LANL.

where public services can be most efficiently provided and where environmental impacts can be minimized. Much of this development would occur as infill or reuse of land. An outlying development is planned along the northern edge of the community of Los Alamos on land that will be transferred to the county by the U.S. General Services Administration. In cooperation with the Pueblo of San Ildefonso, another outlying development is planned on pueblo land north of the community of White Rock (Los Alamos County 1987, as cited in LANL 1997b).

Most of the land surrounding LANL is expected to remain as federal and tribal land. The use of the federal lands for a national forest and a national monument will continue for the foreseeable future, although specific land uses within each area may change with agency priorities. In the absence of a land use plan, projected land use on the Pueblo of San Ildefonso remains unknown.

The zoning of LANL land for future use involves the expansion of many current land uses into areas now used for other purposes. For example, large portions of the current Environmental Research/Buffer category are zoned for future use in Experimental Science and High Explosives Research & Development and Testing. Portions of the current Environmental Research/Buffer areas and High Explosives Research & Development and Testing areas are zoned as Waste Management in anticipation of expanding future laboratory waste management activities into these areas. The zoning of LANL land for future use is shown in Figure 4.2.8.3-1 (LANL 1995: 12).

A large portion of the current Environmental Research/Buffer land in TA-70 is zoned as Experimental Science for future use. The SNS is an experimental science facility, and the proposed SNS site is located within this zone. No environmental research that would be potentially sensitive to SNS activities is planned for the proposed site or areas in its vicinity (Withers 1998: 2). The Future Site Use Planning Integration Team was established in the mid-1990s at LANL. Its purpose was to integrate the planning of land use, facility development, environmental restoration, laboratory strategic planning, and stakeholder involvement in the current and future planning processes of the laboratory (LANL 1995: 10). However, this process has not resulted in independent stakeholder recommendations to DOE on future land use at the laboratory (Withers 1998: 1-2).

4.2.8.4 Parks, Preserves, and Recreational Resources

Several parks, natural areas, and recreation areas are located on the land surrounding LANL. Bandelier National Monument is a popular public attraction that offers natural beauty, prehistoric ruins, historic structures, abundant wildlife, picnic areas, playgrounds, campgrounds, and concession facilities. In addition, it contains 65 miles (105 km) of maintained hiking trails, ranging from easy to strenuous. In addition to timber growth and logging, the Santa Fe National Forest offers public recreation opportunities such as sightseeing, hiking, fishing, hunting, camping, and skiing. The Jemez Division of the national forest includes the Jemez Mountains and the Dome Wilderness Area, a designated habitat for federal and state protected species such as the Mexican spotted owl. Research natural areas, additional habitat for threatened and endangered species, and cultural resources are present in other areas

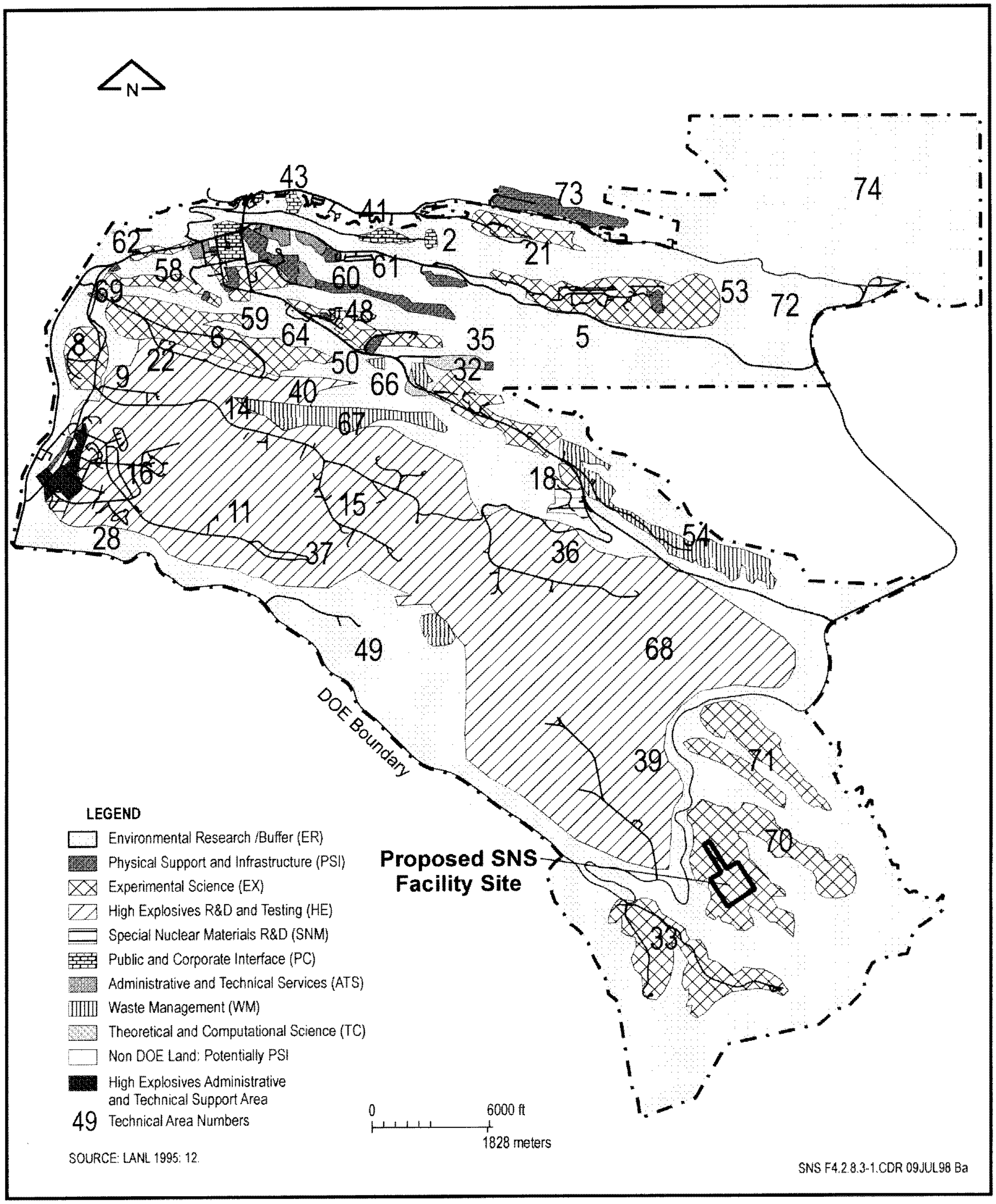

Figure 4.2.8.3-1. Land use zoning map of LANL.

of the national forest (USDA 1987, as cited in LANL 1997b; DOE-AL 1995b: 4-6).

The public is provided with limited access to certain areas of LANL for recreational purposes. An area north of Ancho Canyon between the Rio Grande River and State Road 4 is open to the public for activities such as hunting and hiking. In addition, portions of Mortandad and Pueblo Canyons are open to the public. An archaeological site (Otawi Tract) is located north of State Road 502 and is open to the public, subject to cultural resource management restrictions (DOE-AL 1995b: 4-6).

The U.S. Energy Research and Development Administration, the predecessor agency to DOE, designated all laboratory land as a NERP in 1977. This park is used by the national scientific community as an outdoor laboratory to study the effects of DOE activities on southwest woodland ecosystems (DOE 1985a: 3, 21, as cited in DOE 1996c: 4-246.)

The proposed SNS site is currently open for use by the general public. Several unpaved hiking trails are present in the site area (LANL 1998).

4.2.8.5 Visual Resources

The LANL region is well known for its spectacular views. The orientation and geographical features on the Pajarito Plateau provide dramatic views of landscapes ranging from arid grasslands to alpine and subalpine mountains (LANL 1998).

The mountains of the region are clearly visible from LANL. Looking southward from most locations at LANL, the Sandia Mountains near Albuquerque can be seen. Looking to the north and east, one can see the Upper Rio Grande Valley and the Sangre de Cristo Mountains. The Jemez Mountains are visible west of the Pajarito Plateau. The elevation of the mountains, along with the finger-like mesas and deep canyons that separate them, create a fascinating combination of landscape features at LANL (LANL 1998).

The proposed SNS site is located in a remote, undisturbed piñon-juniper woodland. Traveling from Bandelier National Monument to the community of White Rock, the site is visible from State Route 4. It is not visible from White Rock or popular use areas in Bandelier National Monument (LANL 1998).

4.2.9 Radiological and Chemical Environment

This section describes the radiological and chemical environment at LANL.

4.2.9.1 Radiological Environment

Currently LANL's largest contributors of radiation and radioactive materials to the environment are the Los Alamos Neutron Science Center (LANSCE), tritium operations, the Criticality Facility at TA-18, the Pulsed High Energy Radiation Machine Emitting X-rays Facility at TA-15, the dynamic testing facility at TA-36, and the low-level radioactive waste disposal at Material Disposal Area G.

4.2.9.1.1 Air

LANL air monitoring is designed to measure environmental levels of airborne radionuclides that may be released from laboratory operations. Radionuclide emissions from LANL point and nonpoint sources include several isotopes such as tritium, uranium, ^{90}Sr, and plutonium.

During 1996, LANL conducted ambient air sampling for airborne radioactivity at more than 50 stations (called AIRNET) including on-site, regional, pueblo, and perimeter [within 2.5 miles (4 km) from the site] locations. Collected samples were analyzed for uranium, plutonium, americium, and tritium. Natural atmospheric and fallout radioactivity levels fluctuate and affect measurements made by the laboratory's air sampling program. Regional airborne radioactivity is largely composed of fallout from past atmospheric weapons tests, natural radioactive constituents from the radioactive decay of thorium and uranium attached to dust particles, and from cosmic radiation. Regional levels of radioactivity in the atmosphere are useful for comparison against on-site measurements made at LANL (Table 4.2.9.1.1-1). Note that the measurements taken in Santa Fe (by EPA) are similar to those taken (by LANL) surrounding the LANL reservation.

More than 1,000 air samples were analyzed for gross alpha and beta contamination. Results indicate that gross alpha and beta concentrations were well below the National Council on Radiation Protection and Measurement's estimated national averages of 2 femtocuries (fCi)/m³ and 20 fCi/m³, respectively. In 1996, laboratory operations released 680 Ci of tritium. The perimeter sampling stations exhibited average tritium concentrations of 1.3 pCi/m³ that were higher than the regional and pueblo tritium concentrations. Elevated tritium concentrations were observed at a number of on-site locations. The highest maximum and annual mean concentrations were measured at TA-54 (waste disposal site), near shafts where tritium-contaminated waste is disposed.

Table 4.2.9.1.1-1. Average regional background comparison against LANL radioactivity levels.[a]

Radionuclide	Units	Santa Fe 1990–1995	LANL 1996	EPA Limits[b]
Gross Alpha	fCi/m³ (10^{-15}Ci)	NA	0.8	NA
Gross Beta	fCi/m³ (10^{-15}Ci)	10	10.2	NA
U-234	aCi/m³ (10^{-18}Ci)	14	35.6	7,700
U-235	aCi/m³ (10^{-18}Ci)	0.6	2.2	7,100
U-238	aCi/m³ (10^{-18}Ci)	13	24.7	8,300
Pu-238	aCi/m³ (10^{-18}Ci)	0.2	0.1	2,100
Pu-239-240	aCi/m³ (10^{-18}Ci)	0.3	0.7	2,000
H-3	pCi/m³ (10^{-12}Ci)	NA	0.3	1,500
Am-241	aCi/m³ (10^{-18}Ci)	NA	2.1	1,900

[a] Source: LANL 1997d.
[b] Each EPA limit equals 10 mrem/yr.
NA - Not available.

The 1996 EDE for the maximally exposed off-site individual was 1.93 mrem/yr, primarily from the LANSCE operations. The collective EDE attributable to laboratory operations to persons living within 50 miles (80 km) of the LANL was calculated to be 1.2 person-rem.

Gross alpha and gross beta analyses are used to evaluate general radiological air quality and identify potential trends. If gross activity is inconsistent with past observations, then analysis of specific radionuclides is performed. When pre-established investigation levels are exceeded, then a process is undertaken to validate the results and identify the source of the radioactivity. During 1996 further investigation was initiated by anomalous levels at TA-54, Area G; TA-16; TA-21; firing sites at TA-15; and Station #30. For a detailed discussion of those investigations, reference the annual report, *Environmental Surveillance and Compliance at Los Alamos during 1996* (LANL 1997d). None of the on-site or regional sampling and analyses suggested air quality impacts to TA-70.

4.2.9.1.2 Water

Surface waters from regional and Pajarito Plateau stations are monitored to evaluate the environmental effects of LANL operations. The current network of annual sampling stations for surface water (both runoff and perennial flow) includes a set of regional (or background) stations and a group of stations near or within the LANL boundary. None of the surface waters of the laboratory are a source of municipal, industrial, or irrigation water. In 1996, the results of radiochemical analyses indicated that all surface water concentrations were below the DOE DCGs for public dose. The majority of values were near or below the detection limits of the analytical methods except for samples from Mortandad Canyon at GS-1 (^{239}Pu, ^{240}Pu, and ^{241}Am). Most of the measurements at or above the detection limits were from locations with previously known contamination (Acid/Pueblo Canyon, Los Alamos Canyon, and Mortandad Canyon). Surface and runoff water results from Ancho Canyon (TA-70) indicate all radionuclides well below the DOE DCGs for public dose, with many reported values below analytical detection limits (Table 4.2.9.1.2-1).

Groundwater surveillance efforts at LANL are focused on the main aquifer underlying the region, the perched alluvial groundwater in the canyons, and the localized intermediate-depth perched groundwater systems. Sample results from the main aquifer indicate that most levels of ^{3}H, ^{90}Sr, uranium, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Am, and gross beta were below the DOE DCGs. Some test wells exhibited slightly elevated values from ^{3}H, ^{90}Sr, and uranium. The long-term trends of the water quality in the main aquifer have shown little impact resulting from LANL operations (LANL 1997d).

Sample results from the alluvial groundwaters indicate that except for ^{90}Sr in Mortandad and Los Alamos Canyon, none of the radionuclide activities exceed the DOE DCGs applicable to drinking water.

4.2.9.1.3 Soil

The soil sampling program at LANL evaluates radionuclide, radioactivity, and heavy metals in soils collected on-site (12 sites), around the LANL perimeter (10 sites), and regional (background) locations (six sites). In order to assess radioactive contamination from air stack emissions and fugitive dust, the on-site locations are located close to or downwind from major facilities or operations at LANL. In 1996, most

Table 4.2.9.1.2-1. Radiochemical analyses for runoff and surface water sampling stations within the LANL area of influence of TA-70.

Station	Tritium (pCi/L)	Sr-90 (pCi/L)	Cs-137 (pCi/L)	Total Uranium (µg/L)	Pu-238 (pCi/L)
Ancho at Rio Grande	-122 ± 134	1.0 ± 0.4	-0.1 ± 0.3	0.3 ± 0.0	0.010 ± 0.010
Ancho near Bandelier	-41 ± 73	1.2 ± 0.4	1.0 ± 0.9	1.53 ± 0.15	0.002 ± 0.005
Water Quality Criteria	20,000[a]	8[a]	120[b]	30[b]	1.6[b]

Station	Pu-239–249 (pCi/L)	Am-241 (pCi/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Gross Gamma (pCi/L)
Ancho at Rio Grande	-0.007 ± - 0.007	-0.017 ± - 0.017	-0.4 ± - 0.01	2.9 ± 0.4	-148 ± 50
Ancho near Bandelier	0.039 ± 0.013	-0.014 ± 0.020	1.4 ± 0.3	14.7 ± 1.8	-118 ± 50
Water Quality Criteria	1.2[b]	1.2[b]	15[a]	NA	NA

Note: ± 0.4 Measurement uncertainty associated with instrument quantification. If the uncertainty approaches the measurement value, then the more likely the value is not a positive detection. Negative values represent measurements below the detection limit which are useful for incorporation into long-term averages.

[a] Maximum Contaminant Level National Primary Drinking Water Regulations (40 CFR 141).

[b] DOE DCGs for drinking water (DOE Order 5400.5).

NA – Not available.

radionuclide concentrations in soils were within background concentrations as compared to data collected over the last 21 years. Some total uranium, ^{239}Pu, and ^{240}Pu values in some perimeter and on-site stations were higher than background but well within LANL screening levels.

4.2.9.1.4 Ambient Gamma Radiation

The laboratory's largest contributor to the ambient gamma radiation in the environment is the Criticality Facility at TA-18. Criticality experiments produce neutrons and photons; contribute to the external penetrating radiation dose. During experiments that have the potential to produce a dose in excess of 1 mrem per operation, public access is restricted by closing Pajarito Road from White Rock to TA-51. The other potentially significant contributor to penetrating radiation exposures is the LANSCE at TA-53. During experimentation at LANSCE, short-lived positron emitters are released from the stacks and diffuse from the buildings. These emitters release photon radiation as they decay, producing a potential external radiation dose.

Most of the emitters decay very quickly, and within a few hundred meters from LANSCE the dose is negligible. However, the dose at East Gate (the laboratory boundary north-northeast of LANSCE) is elevated by these laboratory emissions. The laboratory's contribution to the penetrating radiation dose at East Gate is derived by modeling and environmental measurements. The EDE as measured at the East Gate in 1996 was approximately 168 mrem, while the background measurements at TA-49 were approximately 164 mrem.

4.2.9.2 Chemical Environment

This section describes nonradiological contaminants in air, water, and soil at LANL.

4.2.9.2.1 Air

Levels of particulates with aerodynamic diameters less than 10 μm (PM_{10}) were measured during two events in 1996: the Dome Fire from April 26 through May 2 and a controlled burn on LANL property in November. PM_{10} levels at TA-49 air monitoring compound downwind of the Dome Fire averaged 17 $\mu g/m^3$, and the highest 1-day level was 32 $\mu g/m^3$. PM_{10} levels before and after the controlled burn in November were 12 $\mu g/m^3$ and 30 $\mu g/m^3$ during the burn. These levels are well below the federal 24-hour standard of 150 $\mu g/m^3$.

4.2.9.2.2 Water

Surface water samples from stations on the Rio Grande and Jemez Rivers are monitored as background locations, and samples from the Pajaroito plateau surrounding the site are monitored as indicator locations. Major chemical constituents in these samples from 1996 show some variability but are generally consistent with results from previous years. With the exception of some pH values of 8.5, monitored parameters were within applicable standards. Trace metals (lead, barium, silver, and mercury) were found in a number of surface water samples.

Groundwaters in the main aquifer, canyon alluvial aquifers, and the intermediate perched groundwater system are monitored for nonradiological contaminants. Most parameters in samples from drinking water supply wells were below applicable standards in 1996. The pH standard of 8.5 was exceeded at three locations (G-1, G-1A, and Otowi-1). At G-1, a silver concentration of 52 μg/L exceeded applicable state standards, and a thallium level of 6.0 μg/L exceeded the EPA action level. Samples from the alluvial canyon aquifers show elevated nitrate levels attributable to LANL operations. Trace metal concentrations were lower than in previous years. Levels of iron, lead, manganese, and zinc approached or exceeded the water quality standard in samples from the perched aquifer.

4.2.9.2.3 Soil

Soil samples from 1996 were analyzed for trace and heavy metals and were within background concentrations for the Los Alamos area. In fact, they were within the range of metal concentrations normally encountered in the continental United States (LANL 1997d).

4.2.10 SUPPORT FACILITIES AND INFRASTRUCTURE

The Support Facilities and Infrastructure section characterizes the local vehicular transportation routes around the proposed SNS site. The existing utilities that are available to provide needed services to support the operation of the proposed SNS are also described.

4.2.10.1 Transportation

The regional highway system and major roads in the LANL area are illustrated in Figure 4.2.10.1-1. Regional transportation routes connecting LANL with Albuquerque and Santa Fe are I-25 to US 84/285 to NM 502. Connection with Española is via NM 30 to NM 502. The route connecting LANL with western communities (including Jemez Springs) is NM 4.

Only two major roads, NM 502 and NM 4, access Los Alamos County. Traffic volume on these two highway segments is primarily associated with LANL activities. Approximately 11,000 DOE and DOE contractor personnel support LANL operations. Approximately 63 percent of commuter traffic originates from Los Alamos County, while roughly 35 percent originates from east of Los Alamos County (the Rio Grande Valley and Santa Fe). Only one percent of LANL employees commute to LANL from the west along NM 4 (DOE-AL 1998).

NM 4 is a two-lane state highway that would be the primary access road for the proposed SNS at TA-70. Access to NM 4 from both Los Alamos County and counties from the east is via NM 502. From Los Alamos County to NM 4, NM 502 is a two- to four-lane state highway, while NM 502 from NM 30 to the intersection of NM 4 is a four-lane divided state highway with an uphill truck lane.

Traffic counts in 1994 indicated that the average daily traffic on these two segments was 16,286 and 12,041, respectively. The same 1994 traffic counts indicate that the average daily traffic on NM 4 between the intersection of NM 501 and NM 4 and the entrance to Bandelier National Monument [4 miles (6.4 km)] is 758 vehicles. The average daily traffic between the entrance to Bandelier National Monument and NM 502 [9 miles (14.5 km)] is 1,029 vehicles. The latter is the section of NM 4 that would access the proposed SNS site.

4.2.10.2 Utilities

Ownership and distribution of utility services are split between the DOE and Los Alamos County. DOE owns and distributes utility services to LANL facilities, and the county provides these services to the neighboring communities of White Rock and Los Alamos. DOE also owns and maintains several main lines for electrical, natural gas, and water distribution located throughout the town's residential areas. The County's Department of Public Utilities utilizes these lines at a number of locations while maintaining the final distribution systems.

4.2.10.2.1 Electrical Service

In 1985, DOE and Los Alamos County combined their generating and transmission resources to form the Electric Resource Pool (Pool). Pool resources currently provide 72 to 94 MW from a number of hydroelectric, coal, and natural gas power generators throughout the western United States. The Pool receives power from two 115-kV electric power transmission lines originating from near Albuquerque and near White Rock. These lines distribute electricity to LANL as well as White Rock, Los Alamos, and Bandelier National Monument. On-site electrical generation comes from the TA-3 steam/power plant, which is capable of

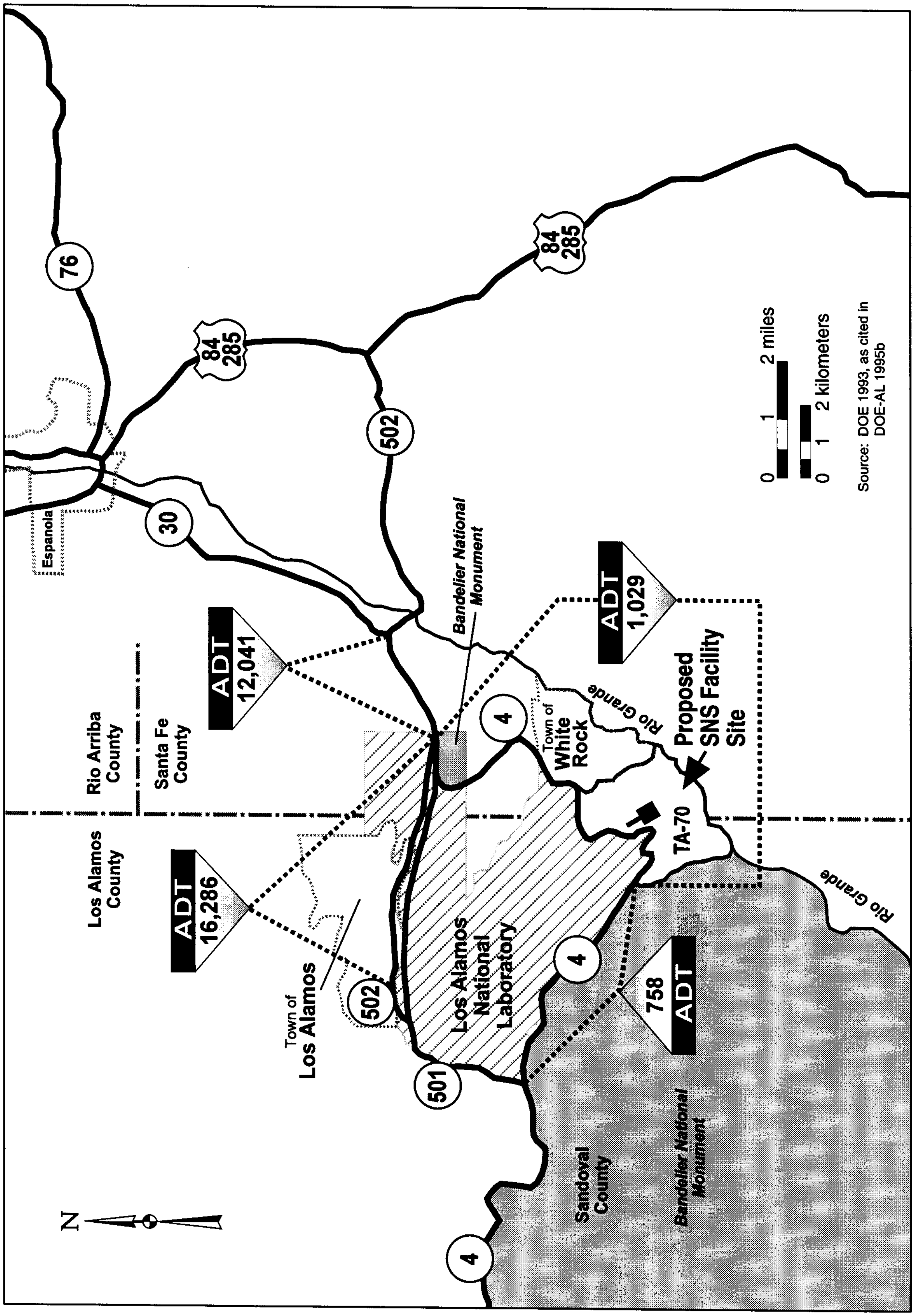

Figure 4.2.10.1-1. Transportation routes at LANL and surrounding areas

producing up to 14 MW. The TA-3 plant is used as a peaking facility when peak load demands exceed the capacity of the two 115-kV lines. The Pool peak electrical demand in 1995 was approximately 80 MW. LANL consumed roughly 66 MW (83 percent) of the total demand.

The majority of LANL's 120-mi (193-km) electrical distribution system is past or nearing the end of its useful design life. Most of LANL's 480/277-V and 208/120-V systems would fall below industry reliability standards if used to supply additional power. Roughly 19 miles (30.6 km) of 40-year-old underground cables and 13.8-kV switchgear will require replacement in the next 10 years.

4.2.10.2.2 Natural Gas

LANL purchases natural gas from the Natural Gas Clearing House through a DOE–Department of Defense Federal Defense Fuels Procurement. The majority of the on-site gas supply lines are located in the northern portion of the site. The southern portion of the site and the TA-70 area are devoid of any existing natural gas lines or distribution lines. In 1995, LANL consumed approximately 2.7 billion ft^3 of natural gas. Approximately 80 percent of the gas is used for heating (steam and hot air). The remainder is used for electrical generation. The electrical generation was used to fill the difference between peak loads and the electric distribution system capacity. Natural gas capacity is considered adequate in the region with reserves available to meet existing system needs and commitments (Withers 1998).

4.2.10.2.3 Water Service

DOE has rights to withdraw 5,541.3 acre-feet or about 1,806 million gal (6.8 billion L) of water per year from the main aquifer. In addition, DOE obtained the right to purchase 1,200 acre-feet [391 million gal (1.5 billion L)] of water per year from the San Juan–Chama Transmountain Diversion Project in 1976. Although the San Juan–Chama water rights exist, DOE has no delivery system in place and has no plans at this time to exercise this right. DOE's potable water production system consists of 14 deep wells, 153 miles (244.8 km) of main distribution lines, pump stations, storage tanks, and nine chlorination stations.

During FY 1994, of the 1,450 million gal (5.5 billion L) that DOE withdrew from the aquifer, LANL operations used approximately 487 million gal (1.8 billion L) or roughly 34 percent of the water drawn. Los Alamos County used approximately 958 million gal (3.6 billion L) [66 percent], and the National Park Service used approximately 5 million gal (19 million L).

4.2.10.2.4 Sanitary Waste Treatment

Sanitary liquid wastes are delivered by dedicated pipelines to the Sanitary Waste System Consolidation plant at TA-46, which processes sanitary waste streams from various site buildings. The plant has a design capacity of 600,000 gpd (2.3 million lpd) and in 1995 processed a maximum of about 400,000 gpd (1.5 million lpd). Some septic tank pumpings are delivered periodically to the plant for treatment.

4.3 ARGONNE NATIONAL LABORATORY

Argonne National Laboratory (ANL) occupies 1,500 acres (610 ha) of gently rolling land in the Des Plaines River Valley of DuPage County, Illinois, about 27 miles (43 km) southwest of downtown Chicago and 24 miles (39 km) west of Lake Michigan. Surrounding the ANL site is the Waterfall Glen Forest Preserve, a 2,040-acre (826-ha) greenbelt forest preserve of the DuPage County Forest Preserve District. This land was deeded to the DuPage County Forest Preserve District in 1973 for use as a public recreation area, nature preserve, and demonstration forest. Nearby highways are Interstate 55 to the north and Illinois Highway 83 to the east. The Des Plaines River is located about 0.4 mi (0.6 km) south of ANL. The Chicago Sanitary and Ship Canal is about 0.6 mi (1.0 km) south of the laboratory. The section of the Illinois and Michigan Canal that lies within the Illinois and Michigan Canal National Heritage Corridor is located about 0.8 mi (1.3 km) south of ANL. The Calumet-Sag Channel is located about the same distance to the southeast of the laboratory boundary. Figure 4.3-1 shows ANL and the proposed site for the SNS.

The terrain of ANL is gently rolling, partially wooded, former prairie and farmland. The principal stream on ANL is Sawmill Creek, running through the eastern portion of ANL, draining southward to the Des Plaines River, located approximately 1.3 miles (2.1 km) southeast of the center of the property. The forest preserve and the area between the river and ANL are undeveloped, whereas urban developments predominate other surrounding areas.

4.3.1 GEOLOGY AND SOILS

ANL sits on a slightly tilted plain that is lower to the east. Some relief exists as a result of stream erosion. Steep slopes are found only adjacent to the floodplain areas and near the southeastern edge of the reservation where the fall into the Des Plaines River Valley begins. The Des Plaines River Valley was carved by waters flowing out of the glacial Lake Michigan about 11,000 years ago.

4.3.1.1 Stratigraphy

The area surrounding ANL is located on a glacial till plateau that forms a complex arrangement of hills and depressions comprising the Valpariso Moraine (which has a northwest-southeast trend). The moraine consists of a prominent bedrock high that is covered by surficial deposits and two Pleistocene glacial units that are designated as the Wadsworth Till and the underlying Lemont Drift (Figure 4.3.1.1-1). The surficial deposits are wind-blown silts generally less than 5 feet (1.5 m) thick. The composition of the Till and Drift is highly variable both horizontally and vertically over short distances. The Till is dominated by a thick silty clay to clayey silt. Thin discontinuous granular zones, usually less than 5 to 10 ft (1.5 m to 3 m) thick, may occur within the Till. The Drift consists of sandy silt, silty sand, and clayey silt of various origins but also includes large volumes of glaciolacustrine and glaciofluvial materials. A rubble zone of dolomite fragments less than 3 feet (1 meter) to more than 10 ft (3 m) thick is present at the base of the Lemont at several locations penetrated by bedrock monitoring wells. The total thickness of deposits overlying the bedrock ranges from about 40 to 160 ft (12 to 49 m).

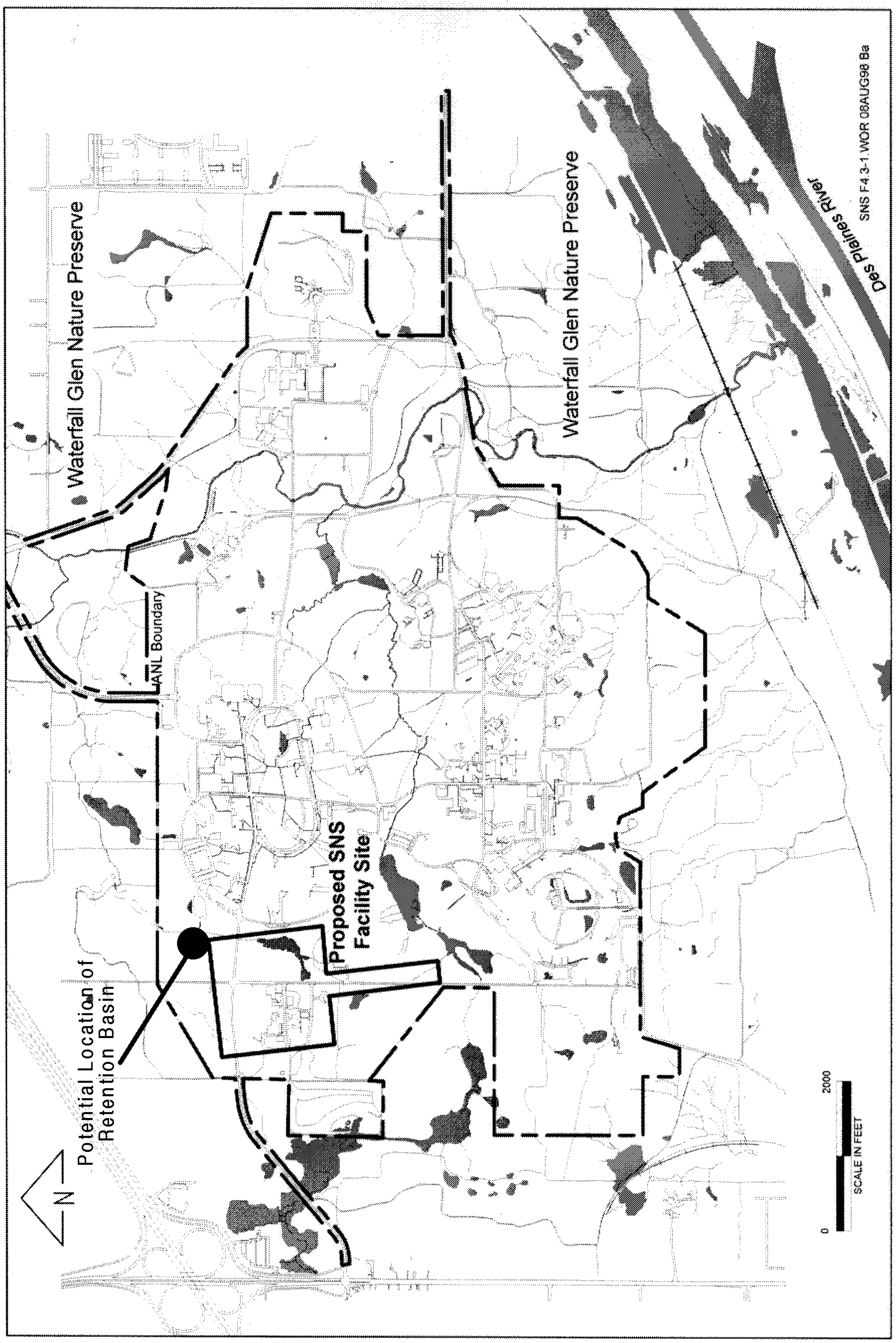

Figure 4.3-1. Proposed SNS site at ANL.

Quarternary	Pleistocene	Surficial Deposits Wadsworth Till Lemon Drift	
Silurian	Niagaran	Racine Formation (dolomite) Sugar Run Formation (dolomite and shale) Joliet Formation (dolomite and shale)	
	Alexandrian	Kankakee Formation Elwood Formation Wilhelmit Formation (dolomitic)	
Ordovician	Cincinnatian	Maquoketa Shale Group	
	Champlainian	Galena and Platteville Groups (dolomitic)	
		Ancell Group	Glennwood Sandstone St. Peter Sandstone
Cambrian	Canadian	Knox Dolomite Megagroup	
		Ironton and Galesville Sandstones	
		Eau Claire Formation (shales and siltstones)	
		Elmhurst-Mt Simon Sandstone	
Precambrian		Precambrian Basement (granites, granodiorites, rhyolites)	

Figure 4.3.1.1-1. Stratigraphy for Northeast Illinois and ANL.

The bedrock surfaces underlying ANL are the Silurian-age Niagaran and Alexandrian Series dolomites. The dolomites are thin to massive bedded, fine-to-medium grained, and calcareous with some chert, and have fractures, joints, and bedding planes that are enlarged by solutioning.

It is divided into several formations and is 200 to 225 ft (60 to 70 m) thick at the ANL site. Older units from the Ordovician and Cambrian systems underlie the Silurian dolomites. The relatively impermeable Maquoketa Shale Group consists of about 165 ft (50 m) of compact, soft shale. Below these units is a sequence containing sandstone strata that have been used as regional aquifers. The Maquoketa Shale separates the upper dolomite aquifer from the underlying sandstone and dolomite aquifers and retards the hydraulic connection between them. The underlying Precambrian basement is composed of granites or granitic rocks.

4.3.1.2 Structure

Structurally, ANL is located on the Kankakee Arch, which defines the northern limits to the Illinois Basin. Strata in the area lay nearly horizontal. No tectonic features within 62 miles (100 km) of ANL are known to be seismically active within recent geologic time, and only two major structural features occur within the region occupied by ANL. The longest of these features is the Sandwich Fault, which extends some 80 miles (128 km) along a northwest-southeast strike roughly 20 miles (32 km) southwest of ANL (William et al. 1975). This fault displays several hundred meters of displacement with the down-thrown side to the north. Smaller structural features include inactive faults of Cambrian age, insignificant faults in the Chicago area, and the Des Plaines Disturbance. The Des Plaines Disturbance is a crypto-explosion structure now believed to be an astrobleme or meteorite impact formed in the Ordovician Period. This feature is situated about 20 miles (32 km) north of ANL and is covered by younger rocks and sediments.

4.3.1.3 Soils

The soils on the ANL property have derived from glacial till over the past 12,000 years. The predominant soils are of the Morley series, which are moderately well drained upland soils with slopes ranging from 2 percent to 20 percent. The surface layer is a dark grayish-brown silt loam, the subsoil is a brown silty clay, and the underlying material is a silty clay loam glacial till. Morley soils have a relatively low organic content in the surface layer, moderately slow subsoil permeability, and a large water capacity. These soils are well suited to growing crops, if good erosion control practices are used. The remaining soils along creeks, intermittent streams, bottom lands, and a few small upland areas are of the Sawmill, Ashkum, Peotone, and Beecher Series, which are generally poorly drained. They have a black to dark gray or brown silty clay loam surface layer, high organic-matter content, and a large water capacity.

The proposed SNS site consists of support-service buildings, open space, and undeveloped ecological plots. The area was prairie and farmland before federal acquisition of the site in 1947. Land use plans designate the area as office, research, and development. This land-use commitment of the site to development precludes the land from being prime or unique farmlands under the Farmland Protection Policy Act.

4.3.1.4 Stability

A few minor earthquakes have occurred in northern Illinois, but none have been positively associated with the particular tectonic features mentioned above. Most of the recent local seismic activity is believed to be caused by isostatic adjustments of the crust in response to glacial loading and unloading rather than tectonically induced stress. In general, the area surrounding ANL is seismically quiescent (Figure 4.3.1.4-1).

There are several areas of considerable seismic activity that could influence the proposed SNS site even though they are several hundred kilometers from ANL. These areas include the New Madrid fault zone (southwestern Missouri), the St. Louis area, the Wabash Valley Fault zone along the southern Illinois–Indiana border, and the Anna region of Ohio. According to estimates, ground motions induced by near and distant seismic sources in northern Illinois are expected to be minimal. However, peak accelerations in the ANL area may exceed 10 percent of gravity once in about 600 years (-250 to +450 year error). This amplitude is on the threshold of the major damage range.

4.3.2 WATER RESOURCES

Surface water, flood potential, and groundwater resource characteristics of the area are covered in this section.

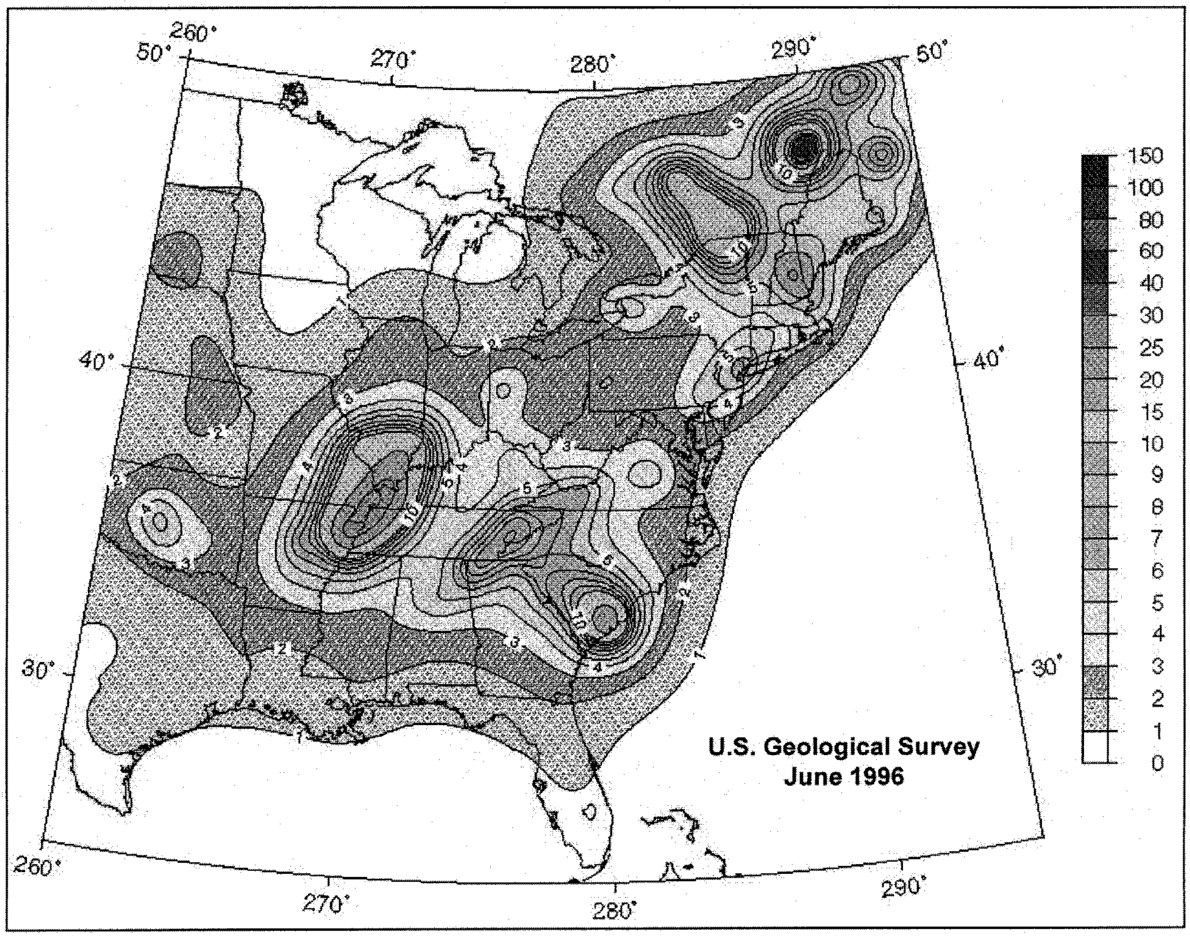

Figure 4.3.1.4-1. Peak acceleration (% gravity) with 10 percent probability of exceedance in 50 years.

4.3.2.1 Surface Water

Surface drainage at ANL is in a southerly direction toward the Des Plaines River approximately 2,000 ft (0.6 km) south. Within ANL, Sawmill Creek flows southerly through the eastern edge of the reservation and discharges into the Des Plaines River channel (Figure 4.3.2.1-1). Two intermittent branches of Freund Brook flow from west to east, draining the interior portion of the reservation and, ultimately, flow into Sawmill Creek. The larger, south branch of the creek originates in a marsh adjacent to the western boundary of the reservation. Also, an unnamed drainage flows from the northwest portion of the reservation northward into the Waterfall Glen Nature Preserve. Along the southern margin of ANL, the terrain slopes abruptly downward, forming forested bluffs. These bluffs are dissected by ravines containing intermittent streams that discharge site drainage into the Des Plaines River channel. Numerous small streams, various ponds, and cattail marshes are present throughout the reservation.

Until 10 years ago, Sawmill Creek carried effluent water from a sewage treatment plant

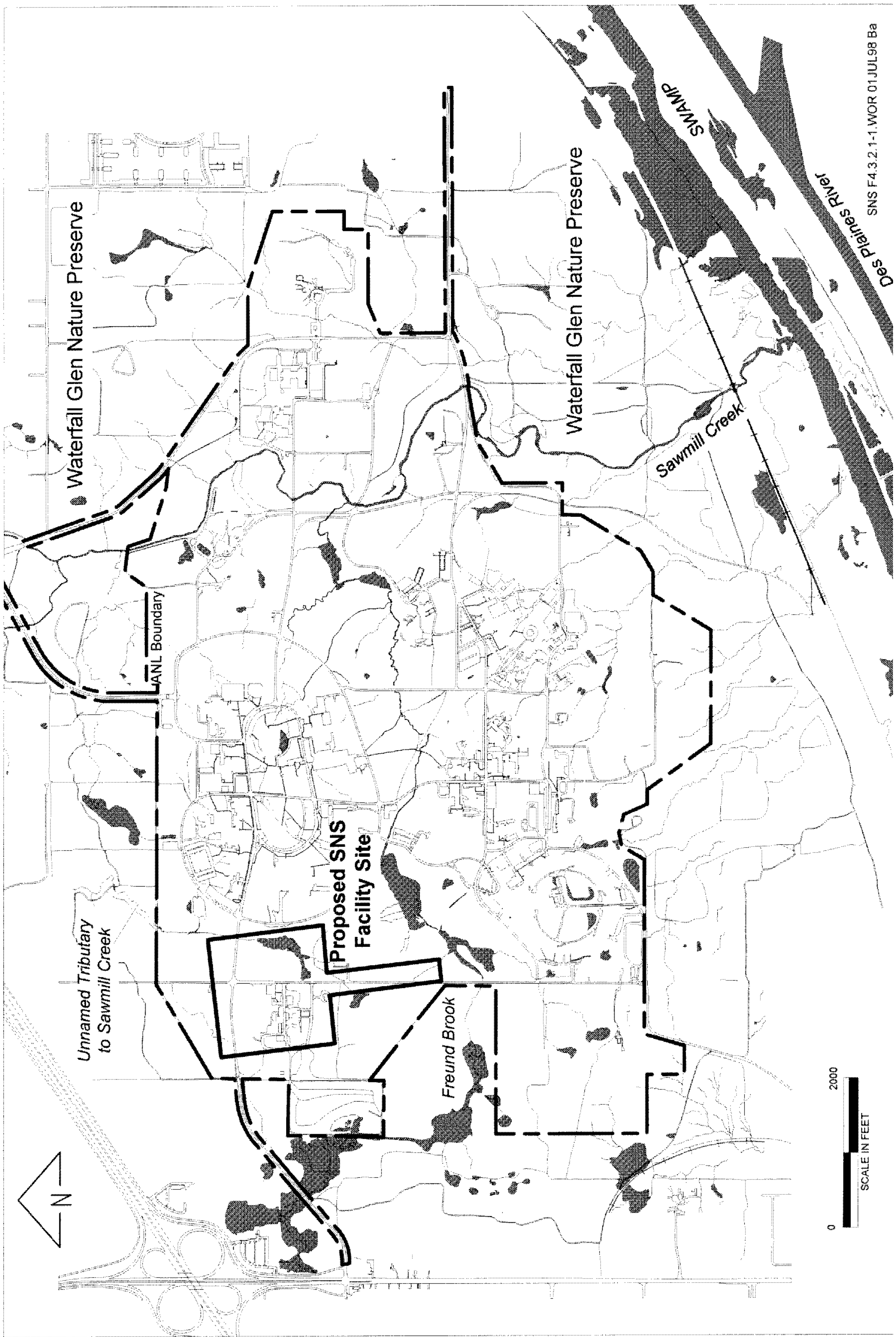

Figure 4.3.2.1- 1. Proposed SNS location and nearby drainages within ANL boundary.

(STP) located approximately 1 mile (1.6 km) north of ANL. Residential and commercial development in the area has resulted in the collection and channeling of runoff water into Sawmill Creek. Treated sanitary and laboratory wastewaters from ANL are combined and discharged into lower Sawmill Creek.

Sawmill Creek and the Des Plaines River near ANL receive very little recreational or industrial use. About 290,000 gpd (1.1 million lpd) of water from the Chicago Sanitary and Ship Canal, which runs parallel to the Des Plaines River, was previously used for cooling towers and other industrial purposes. Surface water from the area around ANL is not used as a source of drinking water with the first downstream location [about 150 miles (241 km)] of surface water being used by a community water supply system at Peoria on the Illinois River.

4.3.2.2 Flood Potential

Since the ANL reservation is situated at an elevation about 164 ft (50 m) above the Des Plaines River, it is not subject to major flooding. A number of small areas associated with the Sawmill Creek drainage and other small streams are subject to local flood conditions during heavy precipitation.

The preferred site for the proposed SNS (called the 800 Area) is situated in the northwestern portion of ANL. The footprint of the SNS would overlie two small floodplain areas. The eastern edge of the SNS footprint would overlie a portion of the 100-year floodplain and associated wetlands of an unnamed tributary of Sawmill Creek. The total area of this floodplain within the footprint would be approximately 5 acres (2 ha). This unnamed tributary originates in the 800 Area and connects to Sawmill Creek north of ANL. In addition, the southern tip of the SNS footprint would overlie a portion of the 100-year floodplain and associated wetlands of an unnamed tributary to Freund Brook. The area of floodplain within the footprint would be <1 acre (0.40 ha). This tributary originates within the footprint of the proposed SNS and flows southeast to Freund Brook. Its confluence with Freund Brook is outside the footprint of the proposed SNS. The relationship of these floodplain areas to the footprint of the proposed SNS is shown in Figure 4.3.2.2-1. Because of the many streams and marshes within the ANL boundaries, alternative sites considered for the proposed SNS would occupy similar or larger floodplains and wetlands areas.

4.3.2.3 Groundwater

Groundwater in the area surrounding ANL is segmented into three hydrogeological groups. From the surface they are (1) the glacial deposits of the Pleistocene age, (2) the shallow bedrock of the Silurian age, and (3) the deeper bedrock aquifers of the Ordovician age. The upper two groups are effectively separated from the deep bedrock system by an aquitard, and the vadose zone occurs within the Pleistocene glacial deposits.

Groundwater in the Wadsworth Till occurs mainly in the silty clay or sandy portions of the unit at a depth of 15 to 30 ft (4.6 to 9.1 m) below ground level in the 800 Area. Sands found in the Wadsworth Till formation are localized and do not represent a large scale regional formation. Thus, the major portion of the underlying geological formation at the ANL site consists of silty clay with extremely low permeability.

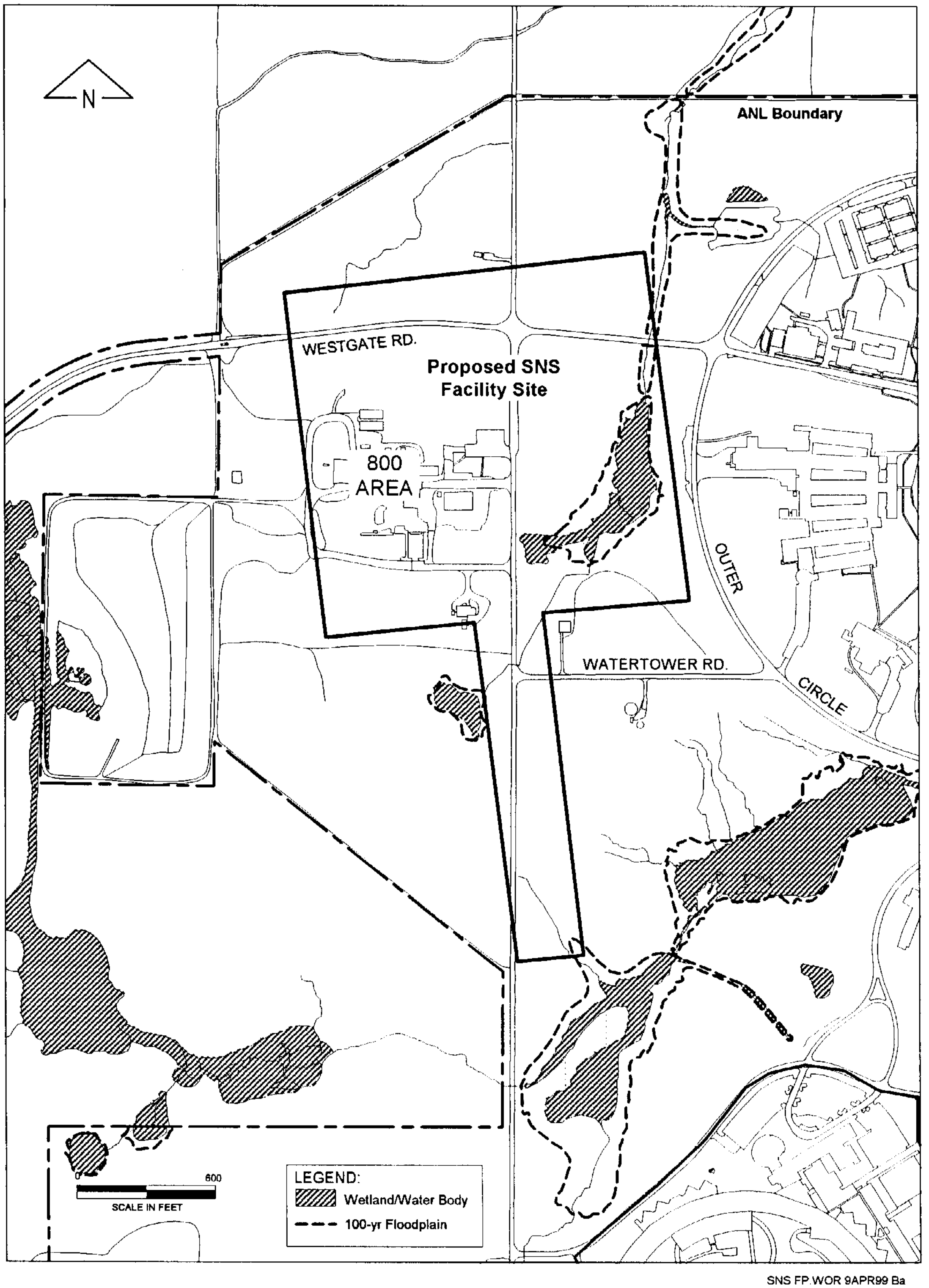

Figure 4.3.2.2-1. Floodplain areas on the proposed SNS site at ANL.

Accordingly, despite the localized, high-yield portions of sands, the overall low permeability of the silty clay should minimize the potential for offsite groundwater migration from the SNS site. Data on groundwater levels from 1988 to 1993 show seasonal fluctuations of up to several feet. The water table level and surface elevation are poorly correlated, possibly indicating the absence of significant horizontal groundwater flow. The extremely low permeability (1×10^{-7} cm/s) of the Till (SNL 1996) renders this formation unusable as a source of drinking water. The downward rate of water movement or recharge rate through the saturated zone of the Till is approximately 0.1 in./day (0.3 cm/day), or 3 ft/yr (90 cm/yr).

Little information is available on the Lemont Drift to evaluate the hydrogeological characteristics of this unit. The Drift has a clay content approximately one-half of the Wadsworth Till and is probably more permeable than the overlying unit.

The Silurian dolomite aquifer is the uppermost bedrock aquifer lying between the glacial sediments and the Maquoketa Shale. Water levels in this aquifer within the 800 Area lie at a depth of approximately 110 ft (33.5 m). Significant permeability in the dolomite occurs near the top of the unit from secondary structures such as bedding planes, joints, and fractures enhanced by solutioning. Recharge of the dolomite aquifer is primarily by precipitation that percolates downward through fractures and joints. The rate of recharge is about 4 in./yr (10 cm/yr) depending on annual precipitation. An estimated horizontal velocity in the dolomite was calculated using $K = 1.3 \times 10^{-4}$ ft/s (4×10^{-3} cm/s) with a very low gradient of 0.0005 and estimated fracture void of 10 percent. The velocity is estimated to be 20 ft/yr (1.7 cm/day).

Approximately 300 ft (90 m) below the Maquoketa Shale aquitard is a sandstone aquifer in the Ancell Group. Below the Ancell Group, older rocks contain two water-bearing sandstone units, the Galesville Sandstone and the Elmhurst-Mt. Simon Sandstone. The uppermost of the two sandstone units is the Galesville Sandstone, which is widely utilized as a source of groundwater in northern Illinois. The Elmhurst-Mt. Simon has supplied groundwater to the Chicago region in the past. The sandstone is recharged by precipitation in areas north and west of the Chicago metropolitan area where this aquifer is positioned near the surface.

Groundwater from the Silurian and Ordovician aquifers was used as ANL drinking water supplies until recently. Since 1997, water resources have been obtained from Lake Michigan (Stull 1998). Groundwater flow within the Niagaran dolomite is generally to the southeast; however, historical pumping in the eastern portion of the reservation from four ANL water supply wells has influenced the direction of flow. A large cone of depression in the dolomite potentiometric surface exists as a result of pumping an average 800,000 gpd (3 million lpd) from the supply wells since 1948. This cone extends into the western portions of ANL. Thus, movement of water within this aquifer has been generally toward the wells. The effect of the cessation in pumping will be evaluated as part of a site-wide hydrogeological assessment.

Groundwater quality representative of the 800 Area can be observed from two wells [Illinois Environmental Protection Agency (IEPA) designation G06S and G06D] about 400 ft (122 m) southwest of the proposed SNS location. G06S is screened in the shallow Till aquifer at a depth of 20 to 25 ft below ground surface and G06D is screened in the Silurian dolomite aquifer at a depth of 119 to 129 ft (36.3 to 39.3 m) below the ground surface. Each well is sampled quarterly for routine indicator parameters as well as inorganic constituents. The average concentrations from four sampling events in 1997 (ANL 1997) compared against Illinois Class I Groundwater Quality Standards (GWQS) are shown in Table 4.3.2.3-1. From the results, only manganese is elevated in respect to GWQS.

4.3.3 CLIMATE AND AIR QUALITY

The regional climate around ANL is characterized as continental with relatively cold winters and hot summers, and is slightly modified by Lake Michigan. January is the coldest month with an average of 21°F (–6°C); July is the warmest month with an average temperature of 70°F (21°C). The average annual precipitation at ANL is 31.5 in. (80 cm) and is primarily associated with thunderstorm activity in the spring and summer (Figure 4.3.3-1). Evapotranspiration in the area is estimated at 80 percent of the annual rainfall or about 25 in. (64 cm). The annual average accumulation of snow and sleet is 32.7 in. (83 cm) (DOE-CH 1997). Snow storms resulting in accumulations greater than 5.9 in. (>15 cm) occur only once or twice each year on average, and severe ice storms occur only once every 4 or 5 years (DOE-CH 1997).

4.3.3.1 Severe Weather

The area experiences about 40 thunderstorms annually (Angel 1998). Occasionally, these storms are accompanied by hail, damaging winds, or tornadoes. From 1957 to 1969 there were 371 tornadoes in the state of Illinois with more than 65 percent of tornadoes occurring during the spring months. DuPage County has been subjected to 19 tornadoes for the period from 1955 to 1995.

The theoretical probability of a 150-mph (492 km/h) tornado strike at ANL is estimated to be 3.0×10^{-5} each year, a recurrence interval of one tornado every 33,000 years (Coats and Murray 1985). ANL property has been struck by milder tornadoes, which have resulted in minor damage to power lines, roofs, and trees.

Obscured visibility in the form of fog is observed about 39 days per year in the metro Chicago area.

Table 4.3.2.3-1. Groundwater quality at ANL 800 Area.

	NH_4 (mg/L)	As (mg/L)	Cd (μg/L)	Cl^- (mg/L)	Fe (μg/L)	Pb (μg/L)	Mn (μg/L)
G06S	<0.1	5.1	<0.1	77	28	<1.0	420
G06D	0.7	4.4	<0.1	186	2,350	<1.0	95
GWQS	10.0	50.0	5.0	200	5,000	7.5	150

	Hg (mg/L)	SO_4 (mg/L)	TDS (mg/L)	Cyanide (mg/L)	Phenol (μg/L)	TOC (mg/L)	TOX (μg/L)
G06S	<0.1	210	1,044	<0.010	<5	3.2	62
G06D	<0.1	89	899	<0.011	5.0	4.7	57
GWQS	2.0	400	1,200	0.2	100.0	-	-

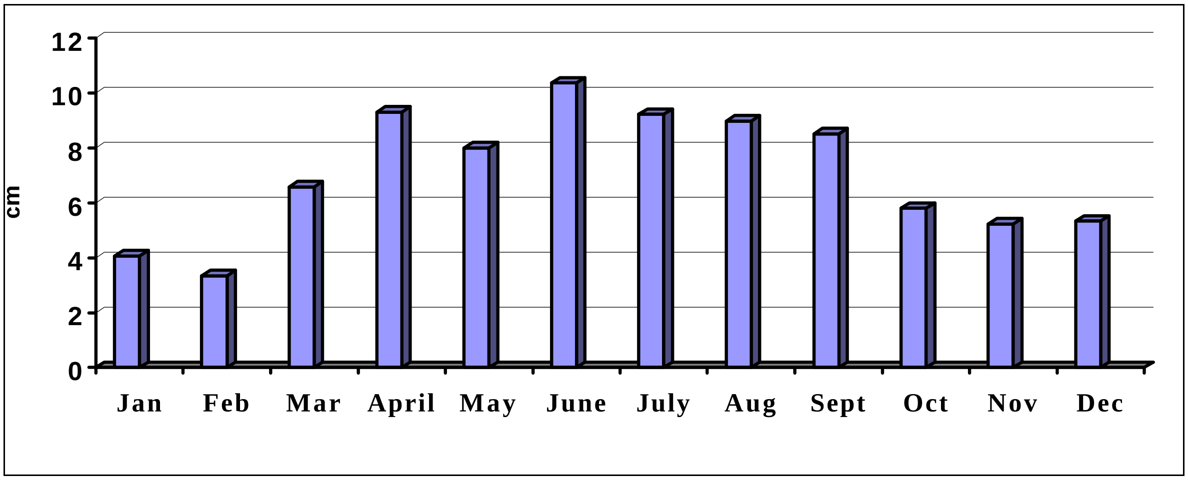

Figure 4.3.3-1. Annual monthly precipitation at ANL.

4.3.3.2 Atmospheric Dispersion

The predominant wind direction is from the south, and wind from the southwest quadrant occurs almost 50 percent of the time (Figure 4.3.3.2-1). The average wind speed at a height of 9.19 ft (2.8 m) is 7.6 mph (35 km/h); calm periods occur 3.1 percent of the time.

4.3.3.3 Air Quality

The State of Illinois has adopted the NAAQS of the Federal Clean Air Act (DOE-CH 1997) and regulates these provisions through a State Implementation Plan. DuPage County is classified as severe nonattainment for ozone and attainment for all other criteria pollutants.

The ambient air quality standard of concern for the proposed construction of the SNS applies to fugitive dust that results from soil disturbance of particulate matter of less than or equal to 10 micron in aerodynamic diameter (PM_{10}). The PM_{10} standard is 150 $\mu g/m^3$ for an averaging time of 24 hours (not more than one exceedance per year) and 50 $\mu g/m^3$ as an annual arithmetic mean. In 1995, the Naperville monitoring station reported a maximum 24-hour PM_{10} concentration of 45 $\mu g/m^3$, an annual arithmetic mean concentration of 19 $\mu g/m^3$ (DOE-CH 1997).

4.3.4 NOISE

The SNS site is proposed for the northwest portion of the ANL reservation in an area of obsolete buildings and structures scheduled for future demolition. Only ancillary storage is conducted in this area, and no estimate of ambient noise levels is available. The proposed SNS site is also located about 4,000 ft (1,220 m) north of the Advanced Photon Source (APS). The APS is a circular facility that produces high-energy photons similar to the SNS. The APS meets all Illinois State Noise Standards and DOE criteria for occupational safety and health.

Sensitive receptors would include both on-site workers and off-site residential populations. The proposed site would be located within 1,000 ft (305 m) of the 200 Area, which is the main complex of offices and research laboratories for ANL. In addition, residential populations exist outside the ANL reservation.

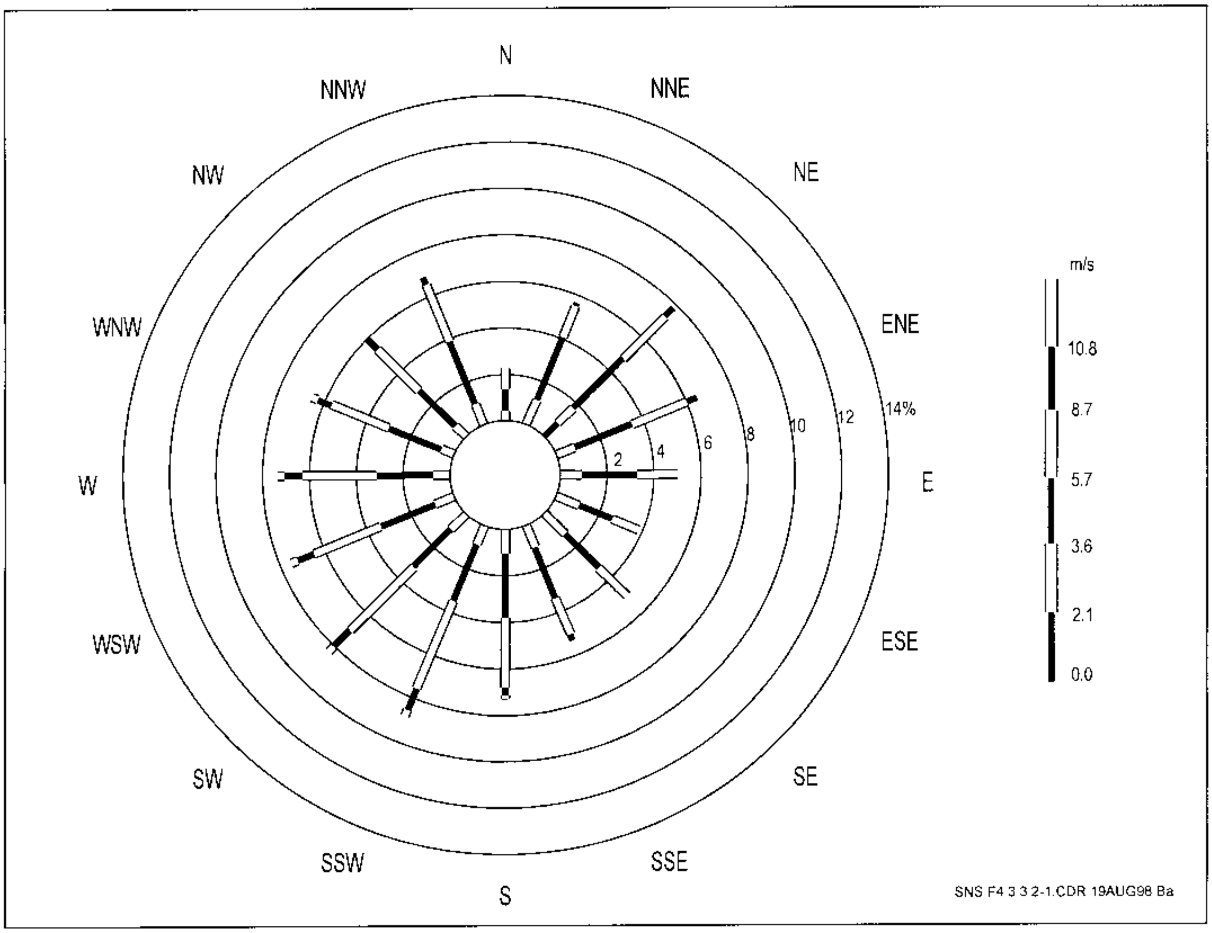

Figure 4.3.3.2-1. Windrose for ANL for the period 1992 to 1994.

Population density for the northwest quadrant adjacent to ANL is estimated at: zero for 0-1.0 miles (0-0.6 km) buffer zone, 2,990 persons for 1.0-2.0 miles (0.6-1.2 km) range, and 12,124 persons for 2.0-3.0 miles (1.2-1.8 km) range (Golchert and Kolzow 1997).

Overall ambient air quality in the vicinity of ANL is best quantified in terms of recent ambient monitoring data collected by the IEPA at nearby locations. Table 4.3.3.3-1 summarizes these data and is taken from the *Illinois Annual Air Quality Report* for 1996.

ANL contains a number of sources of conventional air pollutants, including a steam plant, oil-fired boilers, fuel-dispensing facilities, bulk chemical tanks, dust collection system, and fire training activities. The operating air pollution control permit for the steam plant requires continuous opacity and sulfur dioxide monitoring of Boiler No. 5 equipped to burn coal. No exceedances occurred during 1996. Table 4.3.3.3-2 provides the annual emissions for ANL.

Table 4.3.3.3-1. Summary of 1996 monitoring data in the vicinity of ANL.

Pollutant Averaging Time	Nearest Monitor Location	Maximum 1st	2nd	3rd	4th	NAAQS IAAQS	Number of Exceedances
PM-10	DuPage Co.						
24-hour	Naperville	47.0	42.0	35.0	34.0	150.0 µg/m^3	0
Annual		20.0				50.0 µg/m^3	0
Ozone	DuPage Co.						
1-hour	Lisle	0.102	0.087	0.087	0.085	0.12 ppm	0
NO_x	Cook Co.						
Annual	Schiller Park	0.032	—	—	—	0.05 ppm	0
SO_2	DuPage Co.						
3-hour	Lisle	0.053	0.052	—	—	0.5 ppm	0
24-hour		0.021	0.019	—	—	0.14 ppm	0
Annual		0.003	—	—	—	0.03 ppm	0
CO	Cook Co.						
1-hour	Hoffman Estates	3.1	2.9	2.6	—	35.0 ppm	0
8-hour		1.9	1.9	1.8	—	9.0 ppm	0
Lead	DuPage Co.						
Quarterly	Bensenville	0.04	0.04	0.03	0.02	1.5 µg/m^3	0

Source: IEPA 1997.

Table 4.3.3.3-2. Annual emission report for ANL.

Pollutant	CO	NO_x	PM	SO_2	VOC
Total (tons/yr)	30.9	249.2	1.46	123.3	2.6

4.3.5 ECOLOGICAL RESOURCES

This section provides a general description of the ecological resources for the proposed SNS site and the surrounding area. The discussions are based on information readily available from other sources. Site-specific surveys were done for protected species and wetlands. All other information was obtained from existing publications. For the most part, the impacts from construction and operation of the proposed SNS would be minor. Therefore, much of the information presented here is summary in nature. Greater detail can be obtained from the references compiled for this section.

4.3.5.1 Terrestrial Resources

The predominant vegetation community on the proposed SNS site is open grassland, consisting of scattered areas of old-field and intermittently mowed areas (Figure 4.3.5.1-1). The dominant graminoid species in both mowed and unmowed areas are non-native grasses commonly found on disturbed soils at ANL. Orchard grass (*Dactylis glomerata*), smooth brome (*Bromus inermis*), tall fescue (*Festuca elatior*), timothy (*Phleum pratense*), and quack grass (*Agropyron repens*) are abundant in these areas, while native species, such as big bluestem (*Andropogon gerardii*), indian grass (*Sorghastrum nutans*), and prairie

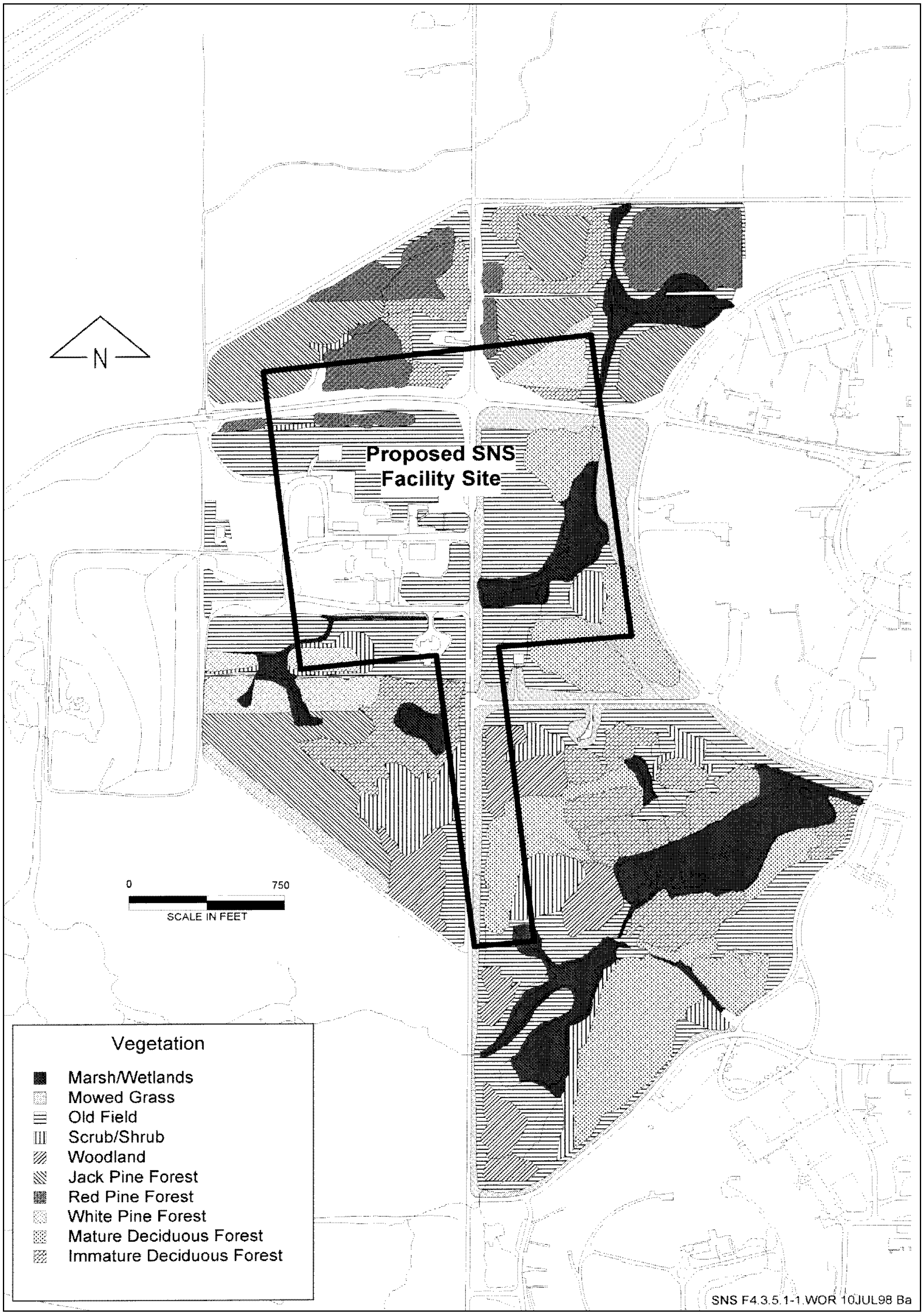

Figure 4.3.5.1-1. Vegetative cover at the proposed ANL SNS site.

cordgrass (*Spartina pectinate*) occur in small isolated patches in less disturbed areas. Other common herbaceous species in disturbed areas include crown vetch (*Coronilla varia*), wild carrot (*Daucus carota*), Canada thistle (*Cirsium arvense*), and yarrow (*Achillea millefolium*), all of which are non-natives. Old-field communities of less recent disturbance support a number of native species such as wild bergamot (*Monarda fistulosa*), Missouri ironweed (*Vernonia missurica*), and germander (*Teucrium canadense*). Undisturbed native prairie communities do not occur in the vicinity of the proposed site.

Scrub-shrub communities in early successional stages occur in the southwestern and southeastern portions of the proposed site. These communities have remained relatively undisturbed in the past decade or more and support many species found in the open grasslands. Low shrubs form scattered clumps in these areas and include gray dogwood (*Cornus racemosa*), honeysuckle (*Lonicera* spp.), and multiflora rose (*Rosa multiflora*). These communities often intergrade with forested areas, forming dense thickets of low shrubs in addition to common buckthorn (*Rhamnus cathartica*), wild black cherry (*Prunus serotina*), box elder (*Acer negundo*), and riverbank grape (*Vitis riparia*).

Woodland communities with relatively open canopies occur in the southern portion of the proposed site. Small woodlands of medium to large size box elder are scattered to the southwest. Associated species include wild black cherry, honeysuckle, and many herbaceous species such as white snakeroot (*Eupatorium rugosum*), garlic mustard (*Alliaria petiolata*), crown vetch, orchard grass, and smooth brome. A large open woodland, with less than 50 percent estimated canopy cover, lies to the southeast. Medium and large cottonwood (*Populus deltoides*) are the dominant trees, with medium size green ash (*Fraxinus pennsylvanica var subintegerrima*), and medium and small box elder. Scattered shrubs and small common buckthorn are interspersed among a predominantly graminoid herbaceous stratum of tall fescue and silky wild rye (*Elymus villosus*).

Forested communities in the vicinity of the proposed site include a wide variety of forest types. Several fairly large coniferous forests occur to the north and southwest. These areas were planted with young pines in the 1950s and consist of three types distinguished by the species planted. Jack pine (*Pinus banksiana*) forest is the most common and occurs in five distinct forest blocks to the north and southwest. Red pine (*Pinus resinosa*) forest occurs in seven areas of varying size to the north, and white pine (*Pinus strobus*) forest consists of six relatively small areas north and southwest. These pine forests are characterized by a high density of trees of uniform size. Associated deciduous species typically include scattered wild black cherry, with common buckthorn, box elder, and honeysuckle often present. Herbaceous species include garlic mustard, white snakeroot, stickseed (*Hackelia virginiana*), and white avens (*Geum canadense*).

Mature deciduous forest occurs in three blocks in the eastern portion of the site. These forests have an overstory of medium and large size red oak (*Quercus rubra*), white oak (*Quercus alba*), bur oak (*Quercus macrocarpa*), and black oak (*Quercus velutina*), in varying proportions. Understory species include various sapling oaks and wild black cherry. These forests support a high diversity of herbaceous, mostly native, species including common oak sedge (*Carex* *pensylvanica*), white snakeroot, stickseed, woodland knotweed (*Polygonum virginianum*), spring beauty (*Claytonia virginica*), enchanter's nightshade (*Circaea lutetiana var canadensis*), and the non-native garlic mustard. These oak forests contain many large oaks exceeding 2 ft (0.6 m) in diameter and have very low occurrences of invasive non-native species such as common buckthorn or honeysuckle.

Areas of immature deciduous forest occur throughout the proposed site. The dominant woody species are box elder, green ash, cottonwood, wild black cherry, and black locust (*Robinia pseudaccacia*). Associated species include common buckthorns, honeysuckle, garlic mustard, white snakeroot, and orchard grass.

A large portion of the proposed site was disturbed in 1996 and 1997 by activities associated with facility removal, resulting in limited wildlife use. However, an area of high diversity of habitats with little recent disturbance still exists in the vicinity of the proposed site, supporting a large number of wildlife species. Many species that have been observed on the ANL site are listed in Messenger et al. (1969, as cited in DOE-CH 1990) and include 9 species of amphibians and reptiles, 86 species of birds, and 26 species of mammals. Amphibians observed in wetlands on the site include leopard frog, spring peeper, and chorus frog. A variety of grassland, forest, and wetland bird species are found on or near the proposed site. Observed species include red-tailed hawk, American goldfinch, indigo bunting, downy woodpecker, red-winged blackbird, great blue heron, Canadian goose, mallard, great egret, pied-billed grebe, and black-crowned night heron. Canadian geese have been observed nesting on the proposed site. Mammals observed on the proposed site include muskrat, beaver, woodchuck, raccoon, fox squirrel, and northern gray squirrel. The proposed ANL site supports thriving populations of the native white-tailed deer and introduced fallow deer, which are frequently observed. Beavers and muskrats have intermittently occupied wetlands on and in the vicinity of the proposed site.

4.3.5.2 Wetlands

A variety of wetland types, totaling approximately 17.3 acres (7 ha), occur in and around the proposed SNS site (refer to Figure 4.3.5.1-1). Although most of these wetlands have been disturbed to some degree in the past, they continue to retain wetland value, such as wildlife habitat and flood control.

A large wetland, approximately 4 acres (1.6 ha), lies in the northeast part of the proposed site. This wetland receives surface flows from an intermittent stream to the south and storm sewer drainage to the east. Surface water is generally present throughout the year within the stream channel and storm drainage. Areas not inundated are saturated within 12 in. (30 cm) of the surface for extended periods. Common cattail (*Typha latifolia*) is the dominant species in the eastern portion of the wetland and in the southern part of the stream channel, while reed canary grass (*Phalaris arundinacea*), a non-native species, is dominant within most of the stream channel and much of the central portion. Although beavers had built a dam and lodge in this wetland in the past, they have not occupied this area since 1993.

A 2.7-acre (1.1-ha) wetland in the eastern portion of the proposed site, almost totally within the footprint of the SNS, includes a small pond at the northern end. This wetland receives surface flows from storm sewer drainages to the east and west and an excavated channel to the west. Surface water is present throughout the year within the pond. The southwestern arm is inundated early in the growing season and generally has a narrow, shallow flow during dry months of the year. Most of this wetland, other than the pond, is dominated by narrow-leaf cattail (*Typha angustifolia*). Beavers also built a dam and lodge in this wetland, yet they have not occupied this area since 1993.

A small, 0.4-acre (0.2-ha) wetland to the southeast of the proposed site receives surface water drainage from two nearby water towers. Drainage is present throughout the year and enters at the north end forming a shallow stream, which dissipates at the south end. The dominant species in this marshy wetland are common and narrow-leaf cattail.

A large wetland to the southeast of the proposed site contains surface water throughout the year that fluctuates in depth according to the level of a beaver dam at the northeast end. This wetland is 7.5 acre (3.1 ha) and receives surface flow from a small stream to the southwest (Freund Brook) and storm sewer drainages to the north. Lower water levels allow wetland plants to colonize areas that under higher levels support only submerged aquatic vegetation and non-rooted floating plants. The dominant species in this wetland are common and narrow-leaf cattail and common reed (*Phragmites australis*). Three state-listed endangered bird species have been observed at this wetland: great egret, black-crowned night heron, and pied-billed grebe.

A shallow area along Freund Brook lies immediately upstream of the previous wetland. Surface water is present throughout most of the year, although flows are sluggish during summer months. Dominant species along the muddy stream margin are large-flowered water plantain (*Alisma triviale*), rice cut-grass (*Leersia oryzoides*), lady's thumb (*Polygonum persicaria*), and marsh purslane (*Ludwigia palustris var americana*). A low marshy area along a tributary to the southeast of Freund Brook contains shallow surface water much of the year and supports rice cut grass, large-flowered water plantain, and river bulrush (*Scirpus fluviatilis*).

An 0.8-acre (0.3-ha) seasonally flooded wetland in the southern portion of the proposed site and within the SNS footprint is inundated early in the growing season, but surface water is absent by mid-summer. Dominant species are wild mint (*Mentha arvensis var villosa*), smartweed, (*Polygonum* sp.), sedge (*Carex* sp.), and white grass (*Leersia virginica*). The wetland margin is lined by mature cottonwood and black willow (*Salix nigra*) trees. Hydrologic input is primarily groundwater discharge. However, a minor surface flow in spring is received from an excavated channel to the northwest.

A 1.4-acre (0.6-ha) wetland system to the south includes a narrow channel receiving surface water from the landfill area on the west and storm sewer drainage on the north. The southern portion of the wetland is saturated early in the growing season but is seldom inundated. Surface water is present in the channel throughout the year downstream of the storm drain outlet. Common cattail is the dominant species in the channel, while dominants in the remainder include reed canary grass, swamp marigold (*Bidens aristosa*), and sedges.

A small, 4,050-ft^2 (380-m^2) seasonal wetland occurs within a drainage ditch in the western portion of the proposed site. Surface water is present early in the growing season but usually absent by late summer. Dominant species are narrow-leaved cattail, barnyard, grass (*Echinochloa crusgalli*), common beggar's ticks (*Bidens frondosa*), and great bulrush (*Scirpus validus* var *creber*).

4.3.5.3 Aquatic Resources

There is little information on aquatic biotic resources at ANL. Section 4.3.2.1 presents a physical description of the streams at ANL. Sawmill Creek flows through the eastern portion of the site and is classified by IEPA as a general use water body. This classification provides for the protection of indigenous aquatic life, primary and secondary contact recreation, and agricultural and industrial uses. The biotic community of Sawmill Creek is relatively sparse, reflecting the high silt load and steep gradient of the creek. The invertebrate fauna consists primarily of blackflies, midges, isopods, and flatworms. Clean water invertebrates, such as mayflies or stoneflies, are rare or absent. Fish populations in Sawmill Creek are scarce, represented by minnows, sunfishes, and catfish.

Freund Brook flows just south of the proposed SNS site. The gradient of this stream is relatively steep, and riffle habitat predominates. The substrate is coarse rock and gravel on a firm mud base. Aquatic macrophytes include common arrowhead, pondweed, duckweed, and bulrush. Invertebrate fauna consists primarily of dipteran larvae, crayfish, caddisfly larvae, and midge larvae. Few fish are present because of low summer flows and high temperatures.

4.3.5.4 Threatened and Endangered Species

DOE is in the process of consulting with the USFWS at the State of Illinois regarding whether or not construction and operation of the proposed SNS at ANL would jeopardize the habitat of any threatened or endangered species, and appropriate mitigation measures. USFWS responded, stating that the only federally listed species that may be affected by the proposed SNS project would be the Hine's emerald dragonfly. The State of Illinois has not yet responded. Appendix D presents the letters of consultation on protected species.

There are no federally listed threatened or endangered species known to occur in the vicinity of the proposed site or on the ANL site. The federally listed endangered Indiana bat (*Myotis sodalis*) and the federally listed endangered Hine's emerald dragonfly (*Somatochlora hineana*) are known to occur in the surrounding area (Stull 1997).

Three state-listed endangered bird species, great egret (*Casmerodius alba*), black-crowned night heron (*Nycticorax nycticorax*), and pied-billed grebe (*Podilymbus podiceps*), have been observed in the wetlands in the southeast portion of the proposed site, but are not known to breed there or elsewhere on ANL. Hairy marsh yellow cress (*Rorippa islandica* var *hispida*), state-listed as endangered, and Kirtland's snake (*Clonophis kirtlandii*), state-listed as threatened, have been observed on the ANL site, but not in the vicinity of the proposed SNS site.

Five state-listed endangered species: river otter (*Lutra canadensis*), white lady's slipper (*Cypripedium candidum*), red-shouldered hawk (*Buteo lineatus*), slender sandwort (*Arenaria patula*), and inland shadblow (*Amelanchier interior*), and two state-listed threatened species: early fen sedge (*Carex crawei*) and marsh speedwell (*Veronica scutellata*) have not been observed at the ANL site but occur in the area.

4.3.6 SOCIOECONOMIC AND DEMOGRAPHIC ENVIRONMENT

The ROI for the SNS at the proposed ANL site includes Cook, DuPage, Kane, and Will Counties, as shown in Figure 4.3.6-1. Approximately 95 percent of ANL employees reside in this region. The region includes the cities of Chicago, Chicago Heights, Oak Park, Naperville, Elmhurst, Elgin, Aurora, and Joliet.

This section provides a description of the following socioeconomic and demographic characteristics:

- Demographics
- Housing
- Infrastructure
- Local economy
- Environmental justice

4.3.6.1 Demographic Characteristics

Population trends and projections for each of the counties in the region are presented in Table 4.3.6.1-1. Of the four counties, Cook has the largest population, with 76 percent of the 1996 regional population of 6,754,029. DuPage County accounted for 13 percent of the regional population, Will County for 6 percent, and Kane County accounted for the remaining 5 percent. It is anticipated that the regional population will increase to more than 6.9 million by the year 2000 and to more than 7.2 million by the year 2010. (This is equivalent to an annual growth rate of more than 10 percent between 1990 and 2010.)

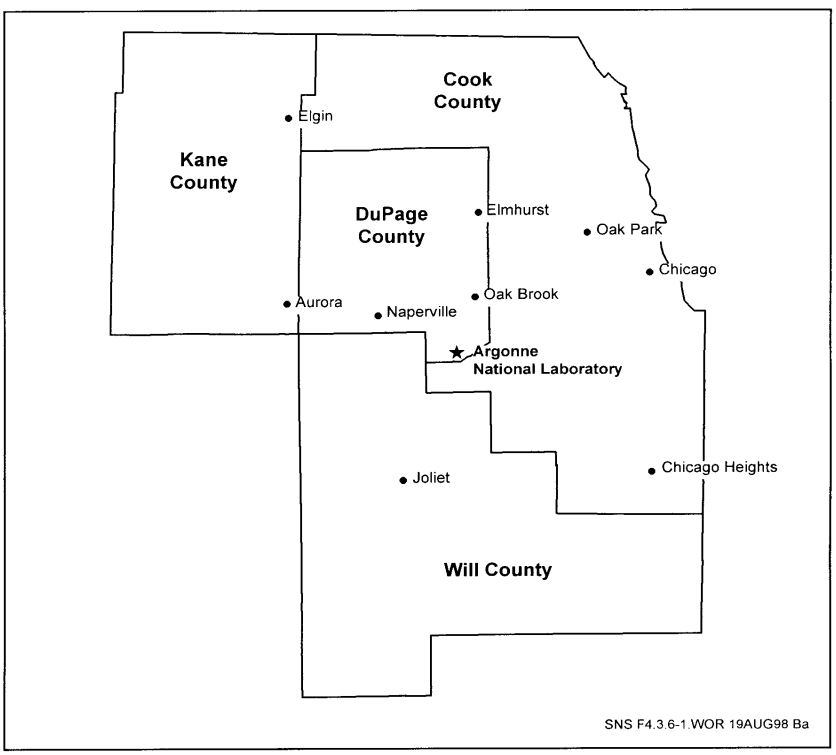

Figure 4.3.6-1. Map showing socioeconomic ROI for ANL.

Table 4.3.6.1-1. ANL regional population trends and projections.

County	1980	1990	1995	2000	2010
Cook	5,253,628	5,105,044	5,136,877	5,200,563	5,271,891
DuPage	658,858	781,689	853,458	884,949	928,133
Kane	278,405	317,471	359,950	386,997	461,453
Will	324,460	357,313	413,379	468,930	608,606
Region	6,515,351	6,561,517	6,763,664	6,941,439	7,270,083

Sources: U.S. Bureau of Census 1996; U.S. Bureau of Census 1990.

Table 4.3.6.1-2. Population for incorporated areas within the ANL region.

Communities	1990	1997
Chicago	2,783,726	2,768,483
Chicago Heights	33,072	NA
Oak Park	53,468	53,648
Naperville	85,351	121,712
Elmhurst	42,029	43,080
Oak Brook	9,178	NA
Aurora	99,581	117,500[a]
Elgin	77,010	85,068
Joliet	76,836	90,647

[a] 1996 data.
NA - Not available.
Source: U.S. Bureau of Census 1990.

Population data for the cities in the region are presented in Table 4.3.6.1-2. During the 1990s Chicago's population decreased by over 15,000 individuals, while population in the surrounding eight communities increased by 3.2 percent between 1990 and 1997. During this period, communities such as Naperville and Joliet grew at a particularly rapid pace (42 percent and 20 percent, respectively).

Population by race and ethnicity for the region is presented in Table 4.3.6.1-3. The 1990 census data reflect different racial and ethnic compositions in the four counties. All four counties are predominantly White. The African-American population comprises 26 percent in Cook County, 11 percent in Will County, and less than 10 percent in the other two counties.

4.3.6.2 Housing

Regional housing characteristics are presented in Table 4.3.6.2-1. In 1990, vacancy rates in the region ranged between a low of 4 percent in Kane County to a high of 8 percent in Cook County. Median home values varied considerably among the cities and villages in the region in 1990, from a low of $62,500 in Chicago Heights to $477,000 in Oak Brook. Similarly, median rents varied from approximately $400 to $650 per month.

Table 4.3.6.1-3. 1990 population by race and ethnicity for the ANL region.

All Persons, Race/ Ethnicity	Cook County		DuPage County		Kane County		Will County		Total	
	Number	% [a]	Number	% [a]	Number	% [a]	Number	% [a]	Number	% [a]
All Persons	5,105,087	100	781,689	100	317,471	100	357,313	100	6,561,560	100
Caucasian	3,208,115	63	714,905	91	270,301	85	303,420	85	4,496,741	69
African American	1,314,859	26	15,462	2	18,981	6	38,361	11	1,387,663	2
American Indian[b]	10,387	<1	962	<1	612	<1	692	<1	12,653	<1
Asian/ Pacific Islander	188,467	3	55,096	7	4,320	1	4,774	1	252,657	4
Hispanic of any race[c]	677,949	13	34,567	4	42,234	13	19,524	5	774,274	12
Other Races	383,259	7	10,703	1	23,257	7	10,066	3	427,285	6

[a] Percentages may not total 100 due to rounding.
[b] Numbers for Aleuts and Eskimos were placed in the "other" category given their small number.
[c] In the 1990 Census, Hispanics classified themselves as White, Black, Asian/Pacific Islander, American Indian, Eskimo, or Aleut. To avoid double counting, the number of Hispanics was subtracted from the total for all persons.
Source: U.S. Bureau of Census 1990.

Table 4.3.6.2-1. Housing summary for the ANL region, 1990.

	Cook County		DuPage County		Kane County		Will County	
	Number	Percent[a]	Number	Percent[a]	Number	Percent[a]	Number	Percent[a]
Total Housing Units	2,051,833	100	292,537	100	111,496	100	122,870	100
Occupied	1,879,488	92	279,344	95	107,176	96	116,933	95
Vacant	172,345	8	13,193	5	4,320	4	5,937	5
Median Home Value, Owner Occupied	$102,100	NA	$137,100	NA	$102,500	NA	$89,900	NA
Gross Rent	$478	NA	$625	NA	$508	NA	$453	NA

[a] May not total 100 due to rounding.
N/A - Not applicable.
Source: U.S. Bureau of Census 1990.

4.3.6.3 Infrastructure

This section characterizes the region's community services with indicators such as education, health care, and public safety.

4.3.6.3.1 Education

Information regarding school districts within the region is presented in Table 4.3.6.3.1-1.

The school districts in the region all receive funding from local, state, and federal sources, but the percentage received from each source varies. In 1994, expenditures for elementary and secondary schools ranged from a low of $3,146 per student to $10,416. By comparison, the state average was $6,158.

4.3.6.3.2 Health Care

Table 4.3.6.3.2-1 shows that there are over 70 hospitals serving the Metropolitan Chicago Region (60 of which are in Cook County) with a combined total of nearly 21,000 acute care beds. In 1996, 51 percent of these beds were available on any given day, which is considered sufficient to meet the health care needs of the local population.

4.3.6.3.3 Police and Fire Protection

Table 4.3.6.3.3-1 gives the number of full time law enforcement officers for the incorporated communities in the ANL region. Fire protection for ANL is provided by the Argonne Fire Department located onsite. The Argonne Fire Department has 23 employees who are all certified hazardous material technicians and 16 are trained as paramedics. The Fire Department has two pumper engines, two ambulances, a forest-fire rig, and a command vehicle. The Argonne Fire Department is part of the Mutual Aid Box Alarm System for Northern Illinois (Division 10) and can receive support from other member fire departments. The Argonne Fire Department routinely supports and is supported by the Lemont Fire Department, Darien-Woodridge Fire Protection District, and the Tri-State Fire Protection District (Veerman, 1999).

4.3.6.4 Local Economy

This subsection provides information on the economy of the region, including employment, education, income, and fiscal characteristics.

Table 4.3.6.3.1-1. Public school statistics in the ANL region, 1995 - 1996 school year.

District	Number of Schools	Student Enrollment[a]	Teachers[a]	Teacher/Student Ratio (1998)
Cook	663	1,324,299	63,000	1:21
DuPage	221	138,000	8,900	1:16
Kane	136	87,000	5,000	1:17
Will	117	101,606	5,300	1:19

[a] Full-time equivalent figures.
NA – Not available.
Source: Illinois Board of Education 1996.

Table 4.3.6.3.2-1. Hospital capacity and usage in the ANL region (1996).

County	Number of Hospitals	Number of Acute Beds	Annual Bed-Days Used[a] (%)
Cook	60	17,647	52
DuPage	5	1,489	52
Kane	5	1,135	44
Will	2	697	51

[a] Based on the number of people discharged and the average length of stay divided by total beds available annually.

Source: The American Hospital Directory, Inc., 1998.

Table 4.3.6.3.3-1 Full-time law enforcement officers for incorporated areas within the ANL region (1996).

Community	Officers
Cook County	528
DuPage County	142
Kane County	94
Will County	276
Chicago	13,032
Chicago Heights	86
Oak Park	115
Naperville	147
Elmhurst	68
Oak Brook	39
Aurora	242
Elgin	151
Joliet	224
Lemont	23
Darien	30
Woodridge	46

Source: Department of Justice, 1997.

4.3.6.4.1 Employment

Regional employment data for 1995 are summarized in Table 4.3.6.4.1-1. Since 1990, unemployment has decreased in the four counties within the region: the largest reduction in unemployment occurred in Cook County (from 6.7 percent in 1990 to 5.6 percent in 1995). Total 1995 employment for the region was over 3.3 million jobs. The "services" sector made up 29 percent of this total, and about one-third was associated with "retail trade" and "manufacturing."

Table 4.3.6.4.1-2 presents employment by industry for the region. Services, retail trade, and manufacturing are the principal economic sectors in the region.

4.3.6.4.2 Income

In 1995, total regional income was approximately $187 billion. Income data for the region are presented in Table 4.3.6.4.2-1. Per capita incomes in 1995 in the region varied from $22,869 in Will County to $34,840 in DuPage County. In 1989, the percentage of persons below the poverty level was approximately 14.2 percent in Cook County, 6.8 percent in Kane County, 6.0 percent in Will County, and 2.7 percent in DuPage County.

4.3.6.4.3 Fiscal Characteristics

Municipal and county general fund revenues in the ROI are presented in Table 4.3.6.4.3-1. The general funds support the ongoing operations of local governments as well as community services such as police protection and parks and recreation. Cook, Kane, and DuPage Counties rely on local taxes the most for general revenue funds. Intergovernmental transfers constitute less than 20 percent of the general fund in Kane and DuPage Counties and only 3 percent in Cook County. In contrast, Will County's general fund relies mainly on intergovernmental transfers for 40 percent of its revenue and local taxes for another 36 percent.

4.3.6.5 Environmental Justice

Figures 4.3.6.5-1 and 4.3.6.5-2 illustrate distributions for minority and low-income populations residing within 50 miles (80 km) of ANL. The definitions of minority and low-income populations and the methodology for assessing potential environmental justice effects are given in Section 5.4.6.5.

Table 4.3.6.4.1-1. ANL regional employment data, 1995.

County	Civilian Labor Force	Employed	Unemployed	Unemployment Rate (%)
Cook	2,599,063	2,454,314	144,749	5.6
DuPage	493,989	477,183	16,806	3.4
Kane	193,742	184,303	9,439	4.9
Will	213,234	202,216	11,018	5.2
Region	3,500,028	3,318,016	182,012	5.2
State of Illinois	6,054,954	5,547,300	368,837	5.1

Sources: Illinois Center for Government Studies 1990 and 1995; U.S. Bureau of Census 1990.

Table 4.3.6.4.1-2. Employment by industry for the Argonne region of influence, by county, and for the State of Illinois - 1995.

Economic Characteristic	Cook County	DuPage County	Kane County	Will County	Region of Influence	State of Illinois
Employment by Industry (1995)						
Farm	570	319	1,332	1,421	3,642	99,044
Agricultural Services	13,749	5,051	2,396	2,897	24,093	57,723
Mining	3,497	799	330	378	5,004	27,679
Construction	114,757	33,387	11,359	14,042	173,545	983,542
Manufacturing	443,455	75,669	37,998	19,607	576,629	983,542
Transportation and Public	197,075	36,744	4,967	8,168	246,954	366,356
Wholesale Trade	185,204	56,170	10,180	6,317	257,871	375,073
Retail Trade	467,383	111,156	33,619	26,667	638,825	1,115,010
Finance, Insurance, and Real Estate	336,333	54,512	14,696	9,116	414,657	589,697
Services	1,050,535	208,787	59,542	43,484	1,362,348	2,068,377
Government	370,413	44,539	18,601	20,575	457,128	858,795
Total Employment	3182971	627,033	195,020	152,672	4,157,696	6,854,787

Source: Regional Economic Information for Cook, DuPage, Kane, and Will Counties, and State of Illinois, 1990-1995 (U.S. Bureau of Census 1990).

Table 4.3.6.4.2-1. Measures of ANL regional income.

Area	Median Household Income 1989($)	Per Capita Income 1995 ($)
Cook County	32,673	27,153
DuPage County	48,876	34,840
Kane County	40,080	24,796
Will County	41,195	22,869
State of Illinois	32,252	25,293

Sources: U.S. Bureau of the Census 1990; Northern Illinois Planning Commission 1985-95.

Table 4.3.6.4.3-1. Municipal and county general fund revenues in the ANL region, FY 1996.

	Cook County		DuPage County		Kane County		Will County	
Revenue by Source	**($)**	**Percent[a]**	**($)**	**Percent[a]**	**($)**	**Percent[a]**	**($)**	**Percent[a]**
Local Taxes	587,090	71	48,774	51	21,713	57	37,726	36
Licenses and Permits	162,239	20	0[a]	N/A	1,343	4	3,335	3
Fines and Forfeitures	0[a]	N/A	23,909	25	2,186	6	943	1
Charges for Service	0[a]	N/A	0[a]	N/A	6,238	16	16,682	16
Intergovernmental	21,260	3	11,476	12	5,914	16	41,441	40
Interest	3,805	<1	6,694	7	457	1	2,901	3
Miscellaneous Income	24,018	3	4,782	5	82	<1	423	<1
Total Revenues	827,195	100	95,635	100	37,933	100	103,452	100

[a] Accounted for in other revenue sources.
N/A - Not applicable.
Percentages may not total 100 due to rounding.
Source: Comprehensive Annual Financial Reports 1997b.

Approximately 8,030,000 people live within a 50-mi (80-km) radius of the proposed ANL site. Minorities comprise 33.5 percent of this population. In 1990, minorities comprised 24.1 percent of the population nationally and 22 percent of the population in Illinois. There are no federally recognized Native American roups within 50 miles (80 km) of the proposed site. The percent of persons below the poverty level is 11.4 percent, which compares with the 1990 national average of 13.1 percent and a statewide figure of 22 percent (U.S. Census 1990).

4.3.7 CULTURAL RESOURCES

ANL is located in the Illinois and Michigan Canal National Heritage Corridor, which is an area known to have a long and complex cultural history. With the exception of the Paleo Indian Period (13,000 to 8,000 B.C.), artifacts representative of all periods in the cultural chronology of Illinois have been documented in the ANL area through professional cultural resource investigations and interviews with local artifact collectors (Golchert and Kolzow 1997: 1-18).

Archaeological surveys have been conducted throughout all of ANL (Wescott 1997: 2). As a result of these surveys, 43 prehistoric archaeological sites have been identified. These include base camps, special purpose camps, and chert quarries (Golchert and Kolzow 1997: 1-18). Three of these sites are eligible for listing on the NRHP, and 19 sites are ineligible for listing. The eligibility of the remaining 21 prehistoric sites has not been determined.

Archaeological surveys of ANL have identified six Historic Period archaeological sites. Three of these exist as historic components on sites that also contain prehistoric components. These sites are representative of farmsteads that were active prior to 1946. One site has been determined to be ineligible for listing on the NRHP. The NRHP eligibility of the other five sites has not been determined.

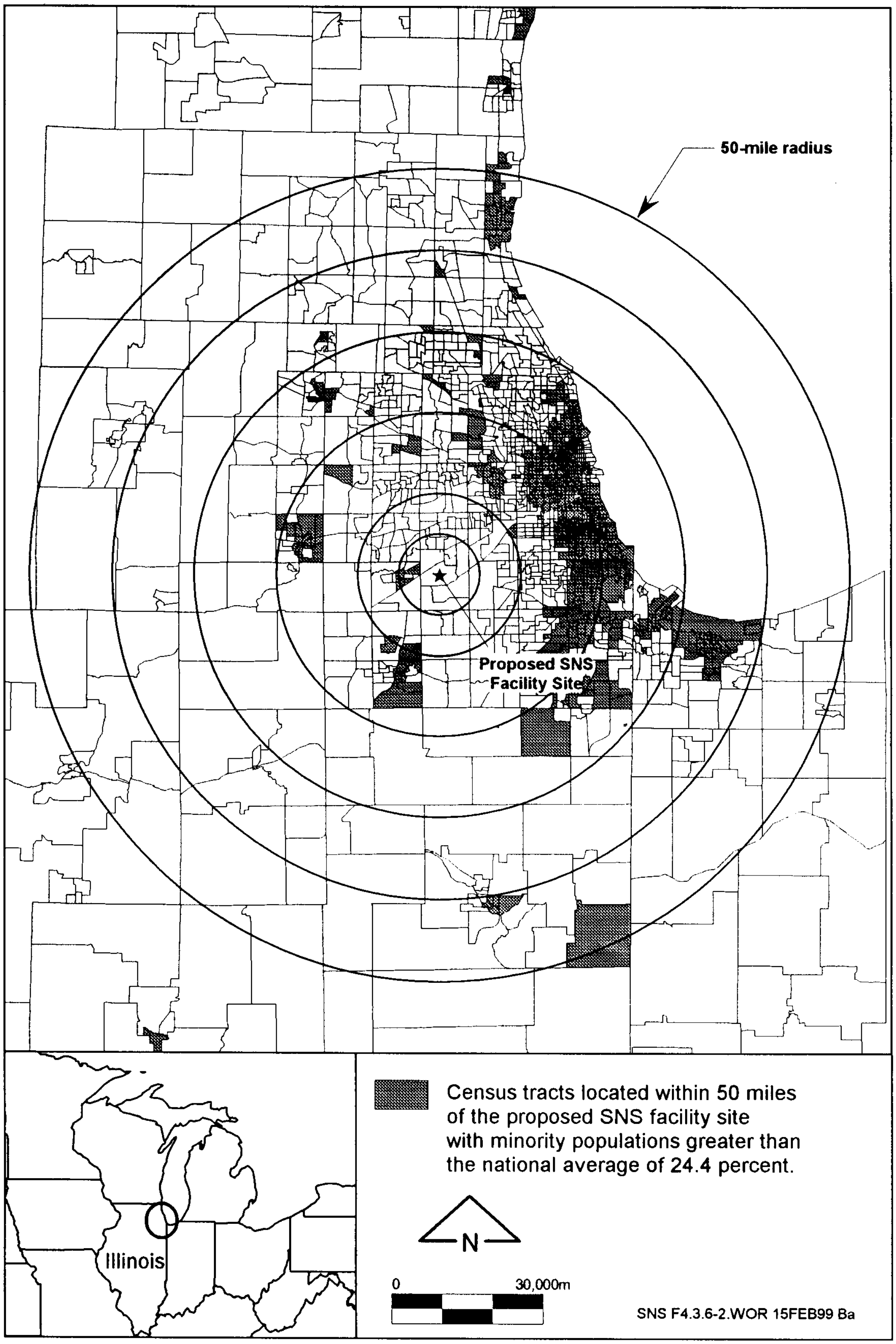

Figure 4.3.6.5-1. Distribution of minority populations at ANL.

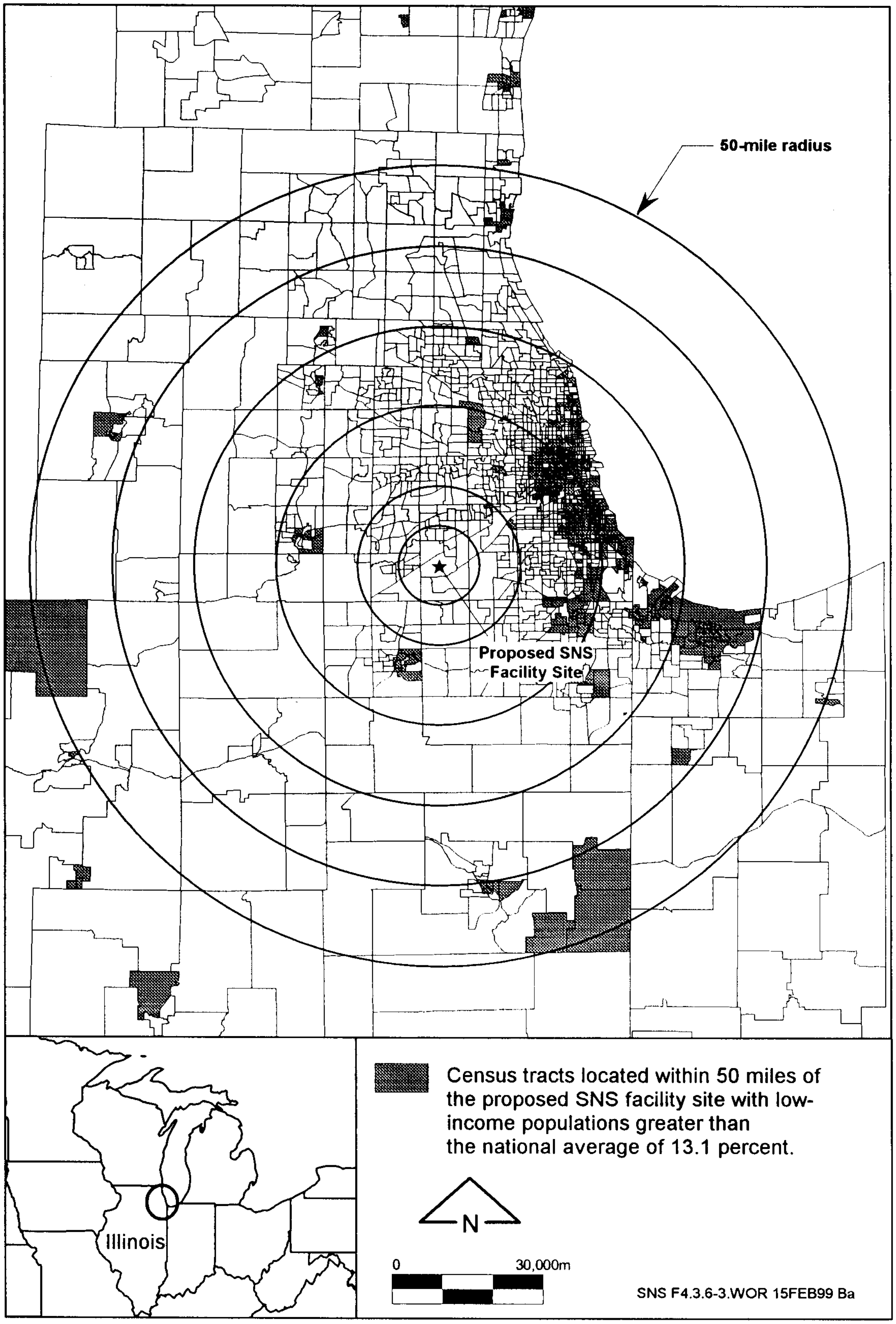

Figure 4.3.6.5-2. Distribution of low-income populations at ANL.

A formal survey of ANL for historic resources other than archaeological sites (buildings, landscape features, equipment, etc.) has not been conducted (Wescott 1997: 2). However, the former CP-5 Reactor, Experimental Boiling Water Reactor, and Argonne Thermal Source Reactor date to the Cold War Period and may be of historical significance. A formal NRHP eligibility evaluation (Porubcan 1996, as cited in DOE-CH 1997) of these facilities was submitted to the Illinois Historic Preservation Agency on August 14, 1996. However, at the request of the agency, the final eligibility of these facilities for listing on the NRHP has not been determined, pending the development of a historic context addressing the role of ANL in the development of nuclear research, experimentation, and technology in the state of Illinois and the United States (Golchert and Kolzow 1997: 2-47).

The proposed SNS site at ANL and the area surrounding it have been surveyed for prehistoric and historic archaeological sites by ANL and Midwest Archaeological Research Services, Inc. (Wescott 1997: 3). The results of these surveys have been reported in Curtis et al. (1987), Elias and Greby (1990), Bird (1992), and Demel (1993a, 1993b) (all cited in Wescott 1997). However, this area has not been surveyed formally for historic structures and features. The occurrence of cultural resources on the proposed SNS site and at locations in its vicinity is discussed in this section of the FEIS.

The SNS design team has not established the areas where construction or improvement of utility corridors and roads would be necessary to support the proposed SNS at ANL. In addition, the locations of ancillary structures such as a retention basin and a switchyard have not been determined. As a result, such areas could not be surveyed for cultural resources. However, the eventual establishment of these areas would proceed in such a manner as to avoid known cultural resource locations. If the proposed SNS site at ANL were chosen for construction, these areas would be surveyed for cultural resources prior to the initiation of construction-related activities within them.

The locations of archaeological and historical sites are not provided as part of the cultural resource descriptions in this section of the FEIS. These omissions are consistent with DOE and University of Chicago efforts to protect cultural resources from vandalism by not revealing their locations in documents available to the general public. Because several of the original reports cited in this section show the locations of cultural resources in ANL, copies of them are not available in the DOE public reading rooms established as part of the SNS EIS process.

4.3.7.1 Prehistoric Resources

No prehistoric archaeological sites have been identified on the proposed SNS site. However, site 11DU207 is located adjacent to the proposed SNS site in an area that may be subject to construction activities and heavy equipment movement under the proposed action. It is characterized by a low-density surface scatter of chert debris resulting from the manufacture and/or sharpening of stone tools. The prehistoric cultural association of these remains is unknown. ANL has not assessed this site for NRHP eligibility.

4.3.7.2 Historic Resources

No Historic Period archaeological sites have been identified on the proposed SNS site at

ANL. Furthermore, no such sites are located adjacent to the site perimeter in locations that may be subject to activities under the proposed action.

The 800 Area is located within the perimeter of the proposed SNS site. This area contained a number of buildings and associated roads constructed by the initial site development contractor. This construction began about 1950 (ANL 1994a: 2-32). During the Cold War Period, the site development contractor used these buildings for storage and shop support. They were also used for accounting activities, plant maintenance shops, electronics development, and a motor pool. Most of the buildings in the 800 Area have been demolished, and several were removed as part of environmental restoration efforts in the area. As a result, only Building 829 remains, and this building is not eligible for listing on the NRHP. The 800 Area is currently used for the storage of trailers and lumber (White, B. 1998a: 1).

4.3.7.3 Traditional Cultural Properties

DOE-CH has found no Native American tribal representatives in the ANL area. Consequently, it has not been possible for DOE-CH to consult with them about the potential occurrence of TCPs on the proposed SNS site and at locations in its immediate vicinity. In addition, no Native American TCPs have been identified in the ANL area, and no Native American groups have expressed an interest in the occurrence and preservation of TCPs in ANL. As a result, it has been concluded that no TCPs occur on the proposed site or anywhere else on laboratory land (White, B. 1998c: 1; Wescott 1998a: 1).

4.3.7.4 Consultation with the State Historic Preservation Officer

Section 106 of the NHPA requires a review of proposed federal actions to determine whether or not they would impact properties listed on or eligible for listing on the NRHP. DOE-CH has consulted with the SHPO in Illinois concerning the occurrence of such properties within the area of potential impact of the proposed SNS at ANL. The consultation letter sent to the office of the SHPO at the Illinois Historic Preservation Agency is provided in Appendix D.

4.3.8 LAND USE

Descriptions of land use in the vicinity of ANL, within the boundaries of ANL, and on the proposed SNS site are provided in this section. The descriptions cover past, current, and future uses of the land in these areas. In addition, they include descriptions of environmentally sensitive land areas that have been set aside for public use, environmental protection, or research. These areas include parks, natural areas, environmental education centers, and public recreation areas. The section concludes with a discussion of visual resources.

4.3.8.1 Past Land Use

The land surrounding ANL was wilderness during the early 19th century. As people from the eastern United States gradually immigrated to the area and established settlements, this wilderness gave way to increasing agricultural and residential land use. The establishment and rapid growth of urban Chicago and Cook County, as well as its suburbs in adjacent counties, acted to minimize wilderness and agricultural land use while maximizing land uses typical of densely populated areas. As a result of being sandwiched between the growing suburban communities of Downers Grove to the north and Lemont to the south, the land surrounding ANL has developed a largely suburban character over the years. The predominant land use in this area has been residential mixed with commercial, industrial, and other typical suburban uses.

The land occupied by ANL was acquired originally as a 3,705-acre (1,500-ha) unit by the Atomic Energy Commission in 1947. At this time, it was largely agricultural land consisting of approximately 75 percent plowed fields and 25 percent pasture, oak woodlots, and oak forests. These agricultural lands were later reforested. Most of the original buffer area [2,001 acres (810 ha)] around ANL was transferred to the DuPage County Forest District in 1973 (ANL 1994a: 2-1; Golchert and Kolzow 1997: 1-16).

The development of ANL for research operations began in 1947 and generally followed the initial architectural site development planning of the 1940s and 1950s. Over the years, the current pattern of land use in ANL gradually developed (ANL 1994a: 2-1).

The proposed SNS site fully encloses the 800 Area, which currently consists of a few substandard buildings, a number of former building locations, and associated infrastructure such as roads. The northern and southern portions of the site overlap Ecology Plot Nos. 6, 7, and 8, which were once established as potential areas for ecological research. However, they were rarely used. The northern boundary of the proposed SNS site overlaps a small area that was used as a small arms firing range from the early 1950s to the late 1970s. In addition, the proposed site contains land that was previously unused Open Space (ANL 1994b: 11).

A large portion of the proposed SNS site and the land in its immediate vicinity have been a focus of intensive past use. Many of the buildings in this area were once used in support services operations for ANL. These operations included grounds maintenance, transportation center (motor pool), vehicle maintenance, and transformer storage. They involved the use of oils, fuels, and hazardous materials. As a result, a number of contaminated areas and waste disposal areas developed within the 800 Area, in other areas of the proposed SNS site, and in nearby areas outside the proposed site. For environmental restoration management purposes, these areas have been designated as Solid Waste Management Units (SWMUs) and Areas of Concern (AOC). These areas are described in Sections 4.3.8.2 and 4.3.9.2.3.

4.3.8.2 Current Land Use

The land in the vicinity of ANL continues to be suburban in character, and most of it is devoted to various kinds of residential use. Much smaller total areas of land are officially categorized as Commercial, Office/Research/ Development, Manufacturing (industrial), Institutional (schools, hospitals, etc.), Open Space (parks, recreation, reserved residential), Transportation/Commercial/ Utilities, and Forest Preserve. The ANL boundary is surrounded on all sides by forest preserve land that functions as a buffer between the laboratory and developed areas (DuPage County 1985, as cited in ANL 1994a). This area of land is the Waterfall Glen Nature Preserve (ANL 1994a: 3-103).

ANL occupies 1,500 acres (607 ha) of land in southern DuPage County (Golchert and Kolzow 1997: 1-4). Most of the buildings, research facilities, and support facilities on this land are distributed among 10 major activity areas: East Area, 100 Area, 200 Area, 300 Area, 360 Area, 400 Area, 500 Area, 600 Area, 800 Area, and ANL Park. The activities conducted in each area and the various laboratory facilities that support them are described extensively in the *Laboratory Integrated Facilities Plan* (ANL 1994a: 2-5 to 2-53).

Current land use at ANL is classified according to 10 major categories. Three categories are associated with separate programmatic research missions: Programmatic Mission–200 Area, which contains laboratory and office facilities; Programmatic Mission–APS Project, which contains the APS and related research facilities; and Programmatic Mission–Other Areas, which encompasses other mission-related research facilities. The other categories are Support Services (heating, maintenance, supplies, etc.); Housing/Amenities; Ecology Plots; ANL Park (employee recreation area and a child care facility); and ANL Landfill (inactive). Although not given a formal designation (ANL 1994a), the tenth category is land located between the preceding nine categories. This category is Open Space where very little development has occurred, except for roads and utilities (ANL 1994b: 11). Environmentally sensitive areas, such as wetlands, are present within portions of this area. Figure 4.3.8.2-1 delineates the current land use categories and shows their distribution relative to the 10 major activity areas.

The land on and in the vicinity of the proposed SNS site is not being used for environmental research projects. The Ecology Plot land use designation refers to open, undeveloped land that would be potentially suitable for certain types of ecological research. However, the ecology plots have no official protection status relative to other areas of the laboratory, and little, if any, actual ecological research has ever been conducted in these areas. There are no currently on-going ecological research projects in Ecology Plot Nos. 6, 7, and 8 (LaGory 1998: 1).

The proposed SNS site overlaps portions of several current land use areas. These are Ecology Plot Nos. 6, 7, and 8 that support no current ecological research; Support Services (developed portions of the 800 Area); and Open Space (ANL 1994b: 11; LaGory 1998: 1). The relative proportions of land associated with these use designations on the proposed site are shown in Figure 4.3.8.2-1.

Three SWMUs and one AOC are located within the boundaries of the proposed SNS site in ANL. Another five SWMUs and two AOCs are located outside the proposed site but in relatively close proximity to it. All are formally identified, located, and described in Section 4.3.9.2.4. This description includes the current status of characterization and remediation efforts in each SWMU and AOC.

4.3.8.3 Future Land Use

Land use planning for the area surrounding ANL has been presented in the land use plan for DuPage County, Illinois. In the future, residential land use would continue to be predominant in this area. Smaller total areas of land would be used for Commercial, Office/ Research/Development, Manufacturing, Institutional, Open Space, and Transportation/ Commercial/ Utilities purposes. The large forest preserve immediately surrounding ANL would

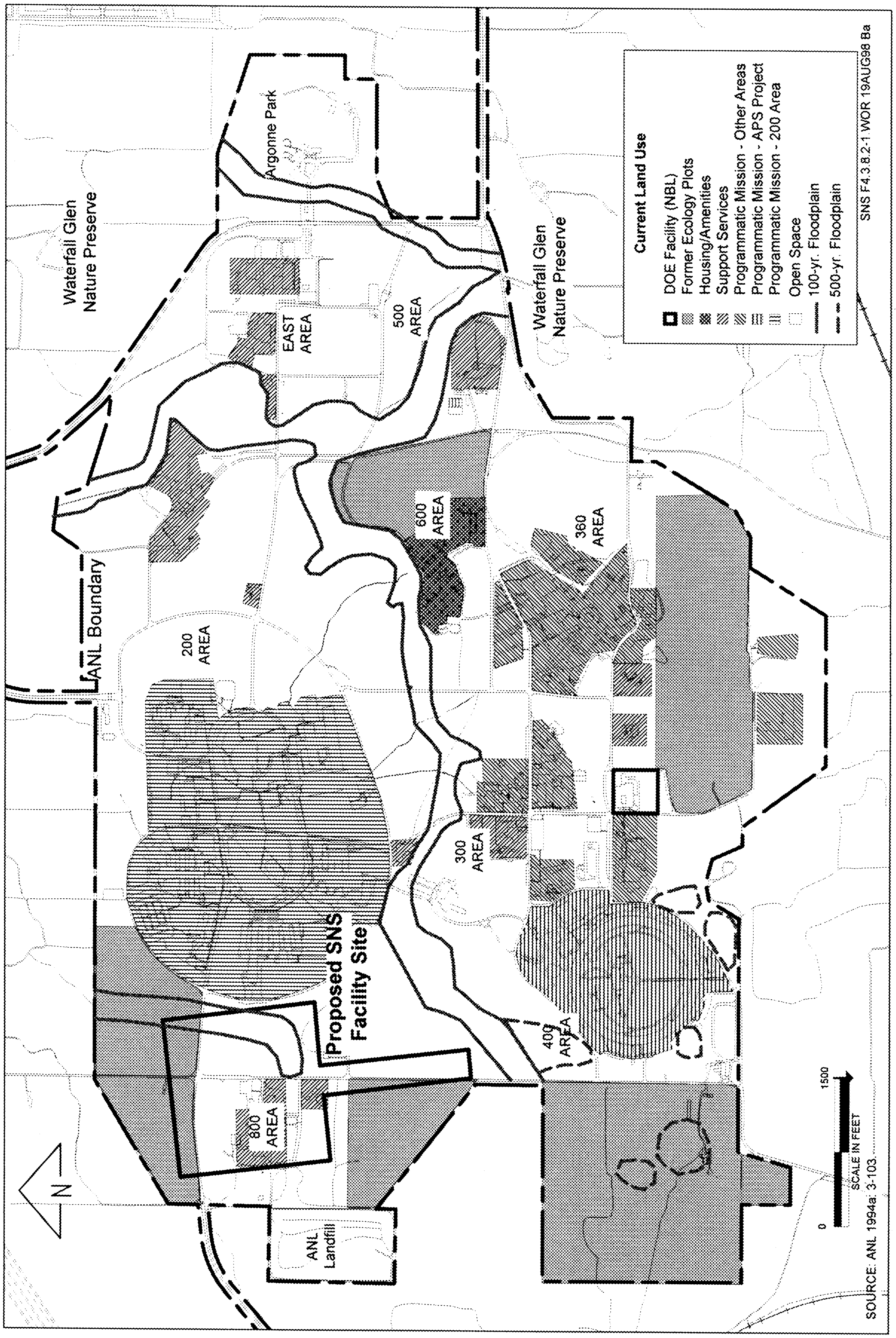

Figure 4.3.8.2-1. Map of current land use in ANL.

continue as the Waterfall Glen Nature Preserve. Moreover, its function as a buffer between ANL and nearby developed areas would continue (DuPage County 1985, as cited in ANL 1994a).

The plans for future land use in ANL reflect the pattern of past development at the laboratory and basic elements of the current land use pattern. These plans would involve continued expansion of current functional uses (programmatic research missions, housing/amenities, and support services) into dedicated expansion areas. These expansion areas would consume large portions of the existing open space at the laboratory. In addition, all of some ecology plots and portions of others would be used. However, the land use plan for ANL calls for the delineation and preservation of environmentally sensitive areas and retaining some open space and ecology plot land. These areas would function as permanent green belts or zones of transition between developed areas of the laboratory.

Future land use in ANL is zoned according to nine official categories. Three categories encompass the expansion of research facilities: Programmatic Mission–200 Area, land reserved for expansion of the current 200 Area office and laboratory facilities; Programmatic Mission–APS Project, land reserved for uses related to the APS; and Programmatic Mission–Other Areas, land reserved for special-purpose research and technology transfer facilities. The remaining categories are Support Services, Open Space, Environmentally Sensitive Areas, ANL Park, and ANL Landfill.

Figure 4.3.8.3-1 shows the future land use categories and zoning for ANL. A comparison of the future or dedicated land use zones on this map to the ecology plots and open space shown

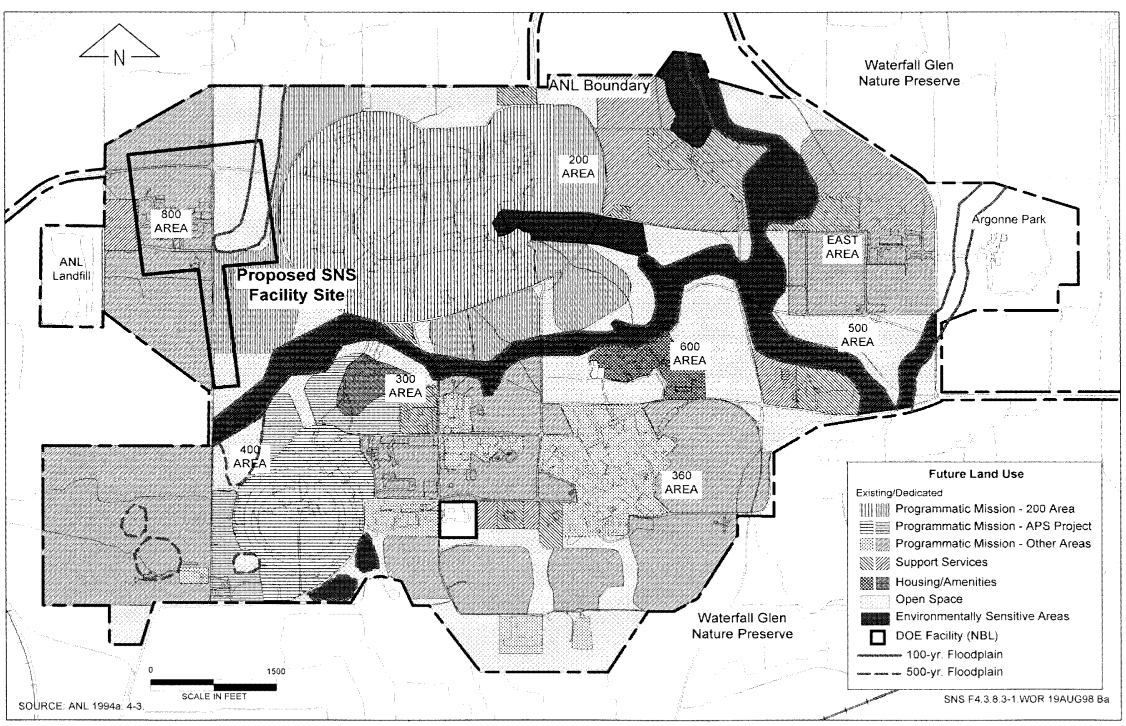

Figure 4.3.8.3-1. Land use zoning map of ANL.

in Figure 4.3.8.2-1 reveals the amounts of current ecology plot and open space land slated for future expansion of laboratory facilities and operations.

The land on the proposed SNS site is distributed among five future land use categories—Programmatic Mission–Other Areas, Programmatic Mission–200 Area, Ecology Plot No. 8, Open Space, and Support Services. The largest category within the proposed site is Programmatic Mission–Other Areas, which would include portions of current Ecology Plot Nos. 6 and 7, two current support services areas (old 800 Area developments), and Open Space. The western edge of the proposed site overlaps a portion of SWMU-744, which is also within the Programmatic Mission–Other Areas category. The amount of proposed SNS site land within each zoning category is illustrated in Figure 4.3.8.3-1. The land immediately adjacent to the proposed SNS site is zoned for future use according to these same categories.

No future uses of proposed SNS site and vicinity land for environmental research are planned. The future use of Ecology Plot Nos. 6 and 7 for ecological research is precluded by their incorporation into zoning designations for future programmatic uses. No future ecological research is planned for Ecology Plot Nos. 6, 7, and 8 (LaGory 1998: 1).

4.3.8.4 Parks, Preserves, and Recreational Resources

A number of parks, nature preserves, and recreation areas are located outside ANL but in the general vicinity of the laboratory. Several forest preserves within the Forest Preserve District of Cook County are located approximately 7 miles (11.3 km) east and southeast of ANL. They include McGinnis Slough, Saganashkee Slough, and a few smaller lakes. These areas are used by the public for picnicking, boating, fishing, and hiking (Golchert and Kolzow 1997: 1-16). Sawmill Creek and the Des Plaines River receive very little recreational use, but some duck hunting and fishing occur in areas downstream from ANL (Golchert and Kolzow 1997: 1-15; DOE-CH 1990: 32).

The principal recreation area near ANL is the Waterfall Glen Nature Preserve, which is adjacent to the laboratory on all sides. It contains 2,240 acres (907 ha) of largely forested land dedicated to ecological and forest demonstration activities, preservation of nature, and public recreation. The recreational opportunities in the preserve include hiking, skiing, and equestrian sports (DOE-CH 1990: 35; Golchert and Kolzow 1997: 1-16).

A portion of the southern ANL boundary is built around Saint Patrick’s Cemetery. An area adjacent to the southwest boundary of ANL is used by visitors to the cemetery, occasional hikers, and model airplane enthusiasts who use the area for access to a field where their models are flown (DOE-CH 1990: 35).

The ANL Park is on laboratory land at the east end of ANL. This park is used for recreational activities by ANL and DOE employees. One of the local municipalities uses the park for athletic events (Golchert and Kolzow 1997: 1-16).

4.3.8.5 Visual Resources

The land in the vicinity of ANL is topographically flat. As a result, there are no naturally elevated vantage points that provide spectacular and varied views of the area.

Because of the massive suburban development in the area, many ground level views of the landscape involve a mixture of buildings, roads, and utility features with trees and grassy open spaces. However, within natural areas, such as the Waterfall Glen Nature Preserve, pristine natural views are available. Because this densely forested nature preserve completely surrounds ANL, the laboratory is essentially hidden from the view of persons at ground level outside the preserve. However, developed areas of ANL are visible from some interior points within the preserve.

Most views within ANL are a varied mixture of research facilities, office buildings, roads, parking lots, tree stands, and cleared land with low vegetation cover. For persons inside ANL, the nature preserve creates a green visual backdrop around the laboratory perimeter.

The proposed SNS site and the land immediately surrounding it are largely clear of trees, which affords clear views of developments in the 800 Area and some other areas of the laboratory. These views are a mixture of roads, old buildings, existing buildings, open land with low vegetation cover, and a background of trees, especially in the direction of the nature preserve. Similar views are apparent to persons standing deep inside the west portion of the Waterfall Glen Nature Preserve and looking across approximately 1,700 ft (518 km) of boundary fence into the area of the proposed SNS site. The nature preserve is located approximately 400 ft (122 m) west of the proposed SNS site.

4.3.9 RADIOLOGICAL AND CHEMICAL ENVIRONMENT

This section describes the radiological and chemical environment at ANL.

4.3.9.1 Radiological Environment

The principal sources of radiation at ANL are: the APS; the Argonne Tandem Linac Accelerating System, which is a superconducting heavy ion linear accelerator; a 22-MeV pulsed electron linac; several other charged particle accelerators (principally Van de Graaff and Dynamitron types); the Intense Pulsed Neutron Source (IPNS), which is a large fast neutron source; chemical and metallurgical laboratories; and several hot cell laboratories.

4.3.9.1.1 Air

ANL operates under emission limits set for radionuclides, asbestos, and halogenated solvents by NESHAP. ANL uses continuously operating air samplers to collect samples of airborne particulate matter potentially contaminated by radionuclides. Radionuclides detected included hydrogen-3, carbon-11, nitrogen-13, oxygen-15, argon-41, krypton-85, radon-220 plus decay progeny, and a number of actinides. Of total dose from airborne pathway, 80% is due to Ra-220 and decay progeny. Air samplers are placed at 14 locations around the ANL perimeter and at 6 off-site locations to determine background concentrations. Currently nonradiological air contaminants in ambient air are not monitored.

From the air pathway, the dose to the maximally exposed off-site individual in 1996 was 0.053 mrem/yr, which is well below the EPA standard of 10 mrem/yr. The full-time resident who would receive this dose is located approximately 0.5 miles (0.8 km) north-northwest of the proposed site boundary. The cumulative population dose from gaseous radioactive effluents from ANL operations in

1996 was 2.64 person-rem to the population within a 50-mi (80-km) radius.

4.3.9.1.2 Water

Surface water quality is monitored by the collection of water samples from Sawmill Creek both above and below the point at which ANL discharges its treated waste into the creek and at several outfalls within the ANL boundary. Control samples are collected from the Des Plaines River and from remote locations during the spring and fall. The results of radiological analysis of water samples collected below ANL are compared to upstream and off-site results to determine ANL contributions. In 1996, the only surface water location where radionuclides attributable to ANL operations were detected was Sawmill Creek below the wastewater outfall. Although this water is not used for drinking water purposes, the 50-year EDE was calculated for the hypothetical individual ingesting water at the sampled location. The resulting dose was estimated to be 0.0343 mrem, which is well below the DOE standard of 100 mrem/yr.

Groundwater at ANL is monitored through the collection and analysis of samples obtained from a series of groundwater monitoring wells located near several sites that have the potential of causing groundwater impact. Samples are collected from 34 monitoring wells located near the 800 Area Landfill, the 317/319 waste management area, and the site of the inactive CP-5 reactor. The Illinois EPA-approved sanitary landfill groundwater monitoring program continues to indicate that the Ground Water Quality Standards of some routine indicator parameters are consistently being exceeded. Contamination in this area will be addressed under the RCRA Corrective Action Program under way at ANL.

4.3.9.1.3 Soils

ANL collects annual soil samples from 10 perimeter and 10 remote locations. Comparative soil sampling in 1996 indicated that average radionuclide concentrations were similar for off-site and on-site soils, supporting a conclusion that soil contaminants are the result of global fallout and not ANL operations. The average annual dose equivalent in the U.S. population from fallout is <1 mrem.

4.3.9.1.4 Ambient Gamma Radiation

Measurements of gamma radiation emanating from several sources within the ANL are collected from 14 locations at the site perimeter and on-site and at 5 off-site locations. Above-normal fence-line doses attributable to ANL operations in 1996 were found at the southern boundary near the Waste Storage Facility. The closest residents are about 1 mile (1.6 km) south of the fence line. At this distance the dose rate, extrapolated from measured fence-line doses, was calculated to be 0.004 to 0.012 mrem/yr. At the fence line, where higher doses were measured, the land is wooded and unoccupied. Occasionally visitors may conduct activities near the ANL site boundary that could result in exposure to radiation from this site. Examples of these activities could be cross-country skiing, horseback riding, or running in the fire lane next to the perimeter fence. If the individual spent 10 min per week adjacent to the 317 Area boundary, the annual dose would be 0.03 mrem at the 317 Area fence. Longer presence would result in linearly scaled higher doses (10 min per day every day of the year would result in

0.2 mrem annually). This dose is well below the DOE standard of 100 mrem/yr.

4.3.9.2 Chemical Environment

The principal nonnuclear activities at ANL that have the potential to cause environmental impacts are the use of a coal-fired boiler, studies of the closed-loop heat exchanger for heat recovery, and the use of large quantities of chlorine for water treatment. The closed-loop heat exchanger studies involved the use of moderately large quantities of toxic or flammable organic compounds, such as toluene, freon, as well as others.

4.3.9.2.1 Air Pathway

Nonradiological contaminants in air are not currently monitored at ANL.

4.3.9.2.2 Water Pathway

Surface-water samples were collected from NPDES-permitted outfalls and Sawmill Creek and compared with permit limits and IEPA effluent standards. During 1996 permit limits were exceeded only two times, once each for zinc and iron. The results of chemical analyses are compared with applicable IEPA stream quality standards to determine if the ANL is degrading the quality of the creek. Nonradiological analyses performed in the vicinity of the proposed SNS site (800 Area) were conducted for outfalls in that area. Monthly monitoring showed no exceedances for storm-water runoff (flow, pH, temperature, oil, and grease) during 1996 (Golchert and Kolzow 1997).

4.3.9.2.3 Soil

Soils are not monitored for nonradiological contaminants as part of environmental surveillance activities at ANL.

4.3.9.2.4 Solid Waste Management Units

The 800 Area at ANL, the proposed location of the SNS, has served several functions during its history, but it has been primarily the grounds and transportation center, the vehicle maintenance center, as well as the location for one (or possibly two) sanitary landfills. As such, a number of sites within the 800 Area have been identified as being potentially contaminated with chemicals or construction debris. Table 4.3.9.2.4-1 lists the sites that are under active consideration (for example, these sites have not been remediated or determined not to impact the environment).

Some of the sites within the 800 Area have mitigated or proposed mitigation measures that would eliminate contaminant exposure by capping and isolating specific areas. Some of these areas would fall within the construction footprint of the proposed SNS (Figure 4.3.9.2.4-1).

4.3.10 SUPPORT FACILITIES AND INFRASTRUCTURE

The Support Facilities and Infrastructure section characterizes the local vehicular transportation routes around the proposed SNS site. The existing utilities that are available to provide needed services to support the proposed SNS are also described.

Table 4.3.9.2.4-1. Active SWMUs in the vicinity of the SNS site[a] at ANL.

	Description	Status
SWMU 4	**800 Area Landfill** 21.78-acre landfill used for disposal of demolition debris, refuse, boiler-house ash, and other nonradioactive waste.	Because of proximity these three SWMUs have been combined—groundwater contamination of the dolomite aquifer observed—landfill was closed and capped in October 1993. An RCRA Facility Investigation was conducted and an extension to the 800 Area cap is proposed. IEPA is currently evaluating a NFA request that post closure care will identify any future releases or maintenance problems and that any remedial actions will be conducted as part of post closure care.
SWMU 20	**800 Area French Drain** From 1969-78 about 28,700 gal of liquid waste (organic and inorganic chemicals) were poured into a pipe inserted into a limestone bed located in NE corner of landfill.	
AOC-C	**800 Area Landfill Leachate Seep** Seeps escaped from the edge of the landfill and flowed into the accompanying wetlands (AOC-B) but have not been active since installation of the cap.	
SWMU 29	**Waste Oil Storage Area** Fenced area used since early 1980s for the storage of waste oil and lead-acid batteries—oil was contained in drums and a remaining UST.	Sampling has indicated a release has occurred and a Tier 1 analysis of data was started in December 1997 for both sites.
SWMU 170[b]	**Waste Oil Satellite Accumulation Area (Bldg. 815)** Waste oil accumulation for interim storage prior to transfer to Waste Oil Storage Area.	
SWMU 176[b]	**Scrap Metal Storage** From the 1950s to 1975 scrap metal and car batteries were placed in dumpsters in an area west of Bldg. 827—exact location is unknown—and nonhazardous and nonradioactive scrap was stored at this location.	Additional sampling was performed after surface and subsurface soils indicated a release had occurred—Tier 2 soil levels were exceeded for methylene chloride.
SMWU 182[b]	**Waste Oil Spread On Road** Until the 1970s waste oil was spread on one road that led to the landfill.	Request for NFA was denied by IEPA, and a Tier 1 analysis of data was started in December 1997.

Table 4.3.9.2.4-1. Active SWMUs in the vicinity of the SNS site[1] at ORNL (continued).

Description		Status
SWMU 736[b]	**800 Area Transformer Storage Pad** Area east of Bldgs 821, 822, and 823 suspected as being a former transformer pad.	Sampling indicated that PCB concentrations were less than Tier 1 levels (25 mg/kg), but an NFA was denied. IEPA stated that a 10-in. cover was needed.
SWMU 744[b]	**Newly Identified, Suspected Solid Waste Landfill** Area northeast of the gate to the landfill suspected to contain buried waste material—dates of operation and quantities of waste are unknown.	A geophysical survey has concluded that buried metal occurs in two separate cells north and east of SWMU 29. Subsequent investigations were reported in the RFI Report
AOC-B	**800 Area Landfill Wetland Area** Located in SW corner of landfill.	Investigation indicated that contaminant levels are very low and no human receptors are at risk—preparing an NFA and ecological risk assessment.
AOC-F*	**Contaminated Soil near Bldg 827** USTs 18 and 19 near Bldg. 816.	During removal of tanks and adjacent soils for UST 18 and 19, soil contaminated from another source was discovered—work plan is in preparation to assess that source.

NFA - No further action.
PCB - Polychlorinated biphenyls.
UST - Underground storage tank.
[a]Source: Gowdy 1998.
[b]Sites located within footprint of the proposed SNS facility.

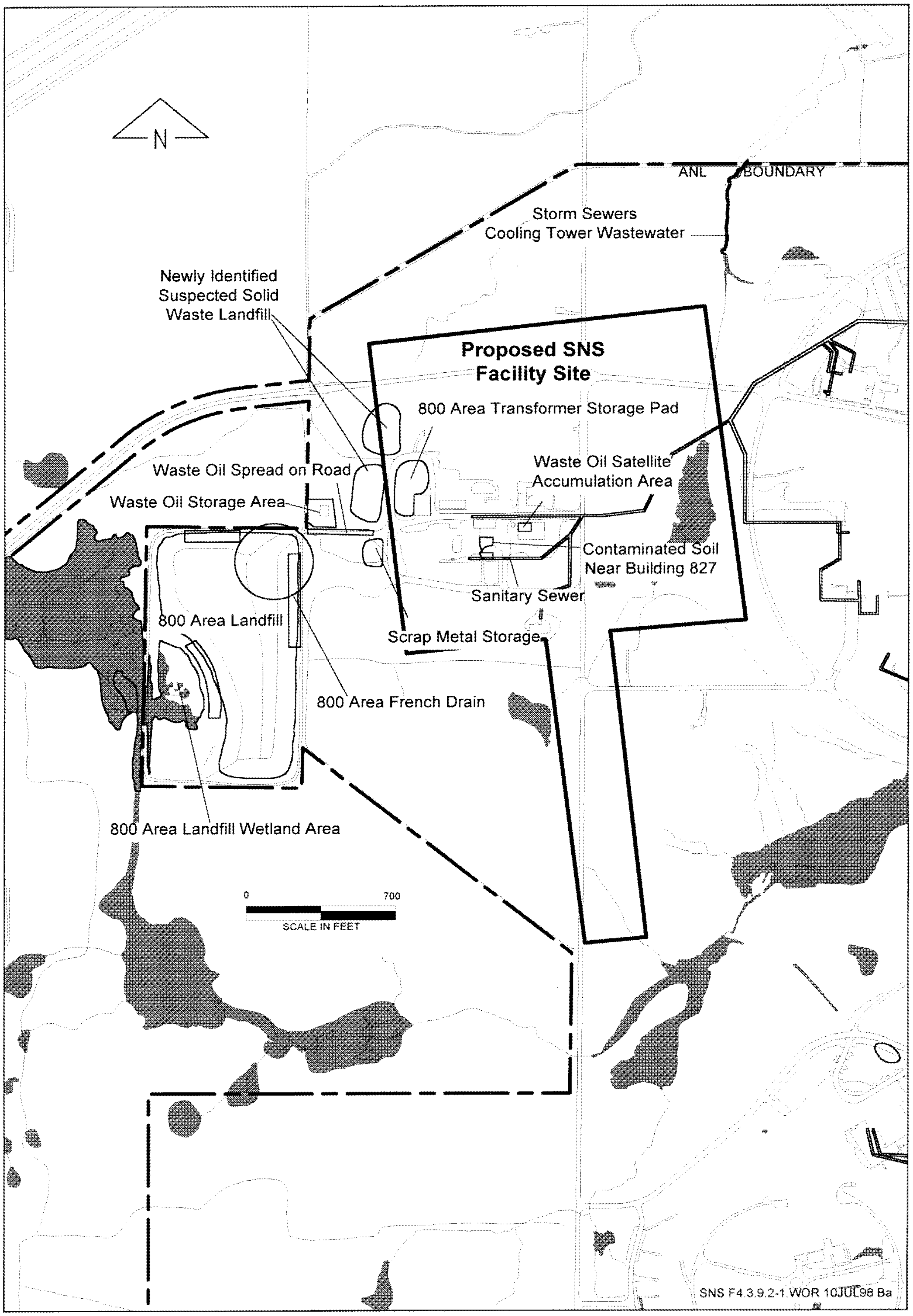

Figure 4.3.9.2.4-1. Locations of SWMUs in the 800 Area.

4.3.10.1 Transportation

ANL is located in DuPage County, Illinois, approximately 30 miles (48 km) from the city of Chicago. Figure 4.3.10.1-1 gives the location of the proposed SNS facility site and the transportation routes around the site. ANL is bordered on the north by I-55, on the east by State Highway 83, and to the south by State Highway 171, which intersects with Lemont Road. Lemont Road runs north-south on the western border of the site.

On-site travel is provided by motor vehicle. However, within each area employees walk between buildings. Vehicular circulation is controlled by the existing road configuration, but road use during most of the day differs from that between 7 a.m. and 9 a.m., or 4 p.m. and 6:30 p.m., when employees are arriving or departing the ANL. The main gate (North Gate) is open 24 hours a day, 365 days a year. The west gate is open Monday through Friday from 6:30 a.m. to 7 p.m. Many truck deliveries are made directly to the Supply Facility dock between Buildings 4 and 5 with fenced direct access from Cass Avenue. These deliveries do not contribute to on-site traffic. Other truck traffic is light so that only minor problems occur occasionally at entrance gates. At the present, no marked difficulties have been noted for on-site traffic either during peak periods of arrival and departure or during midday work hours. According to Illinois Department of Transportation standards, vehicle accumulation at intersections and gates is minor, even during rush hours.

4.3.10.2 Utilities

This section provides a description of the utility infrastructure at ANL. The following is based upon existing documentation and discussions with select ANL staff.

4.3.10.2.1 Electrical Service

ANL purchases electric power from the Commonwealth Edison Company (Edison) at 138 kV. Two Edison 138-kV lines enter ANL at Facility 543, located south of the laboratory. The majority of ANL's electricity needs are serviced by two 13.2-kV transmission lines that originate from Facility 543. The exception is the 300 Area, which uses a separate power distribution system to meet its heavy load requirements. A 138-kV overhead line connects the Edison line at Facility 543 to transformers at 549-A and -B in the 300 Area.

4.3.10.2.2 Steam

Steam is used primarily for central heating and for steam turbine-driven emergency generators. Most of the steam for ANL is produced at the Central Heating Plant (CHP) located in the 100 Area and distributed by an extensive piping network to a majority of on-site buildings. The CHP consists of five conventional (Wickes) boilers and various auxiliary systems. The CHP's maximum steam-generating capacity is 340,000 lb/hr of saturated steam at 200 psi. APS use is approximately 60,000 lb/hr (Fornek 1998a) ANL's present service distributes steam at 200 psig to all buildings on-site, where it is typically reduced to 15 psig for use in space heating and miscellaneous building services.

4.3.10.2.3 Natural Gas

Natural gas is distributed to ANL from a nearby high-pressure main. A 6-inch branch line supplies gas from the main to Building 108 at 150 psig. The gas pressure is reduced to 60 psig

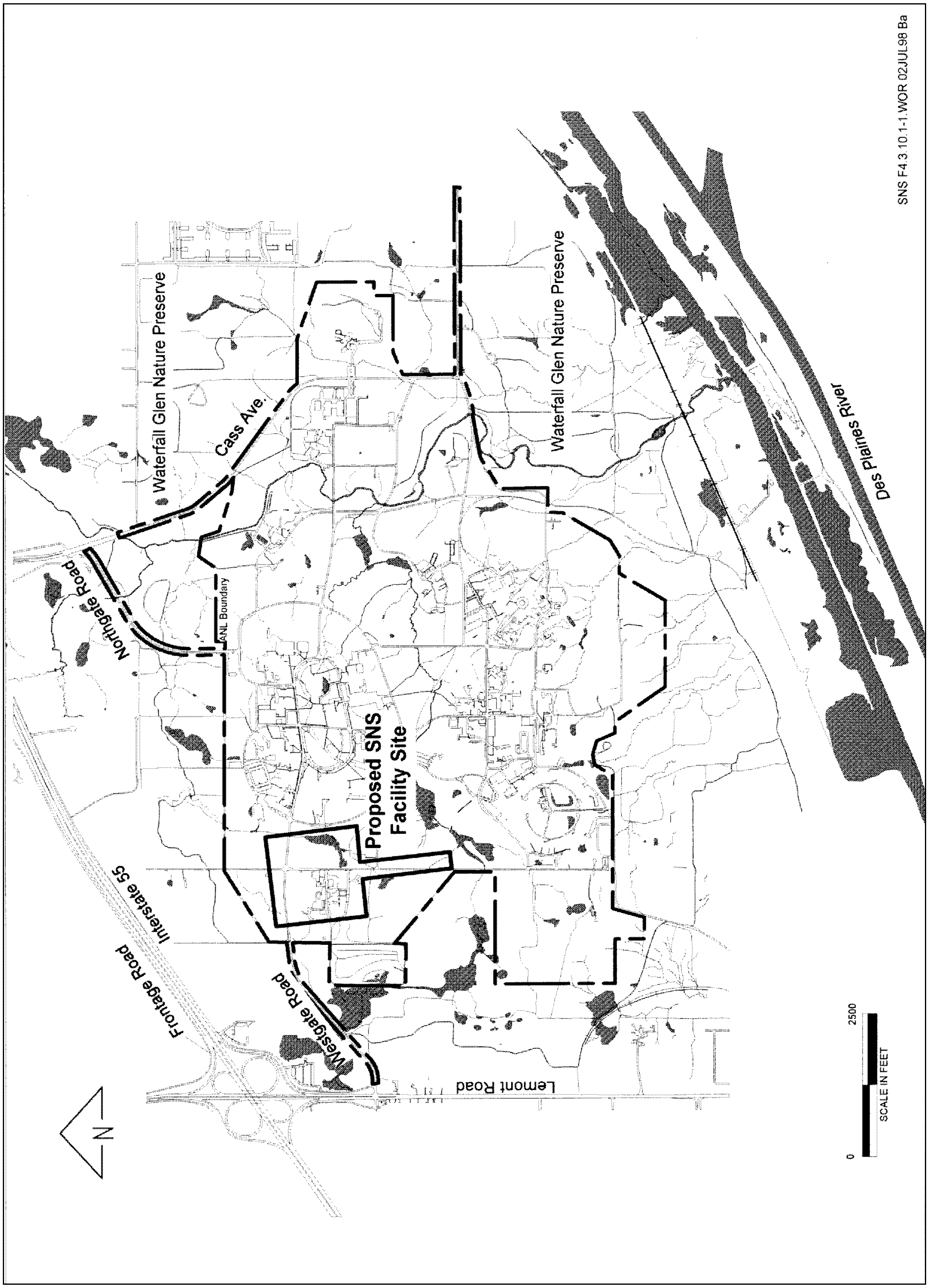

Figure 4.3.10.1-1. Transportation routes at ANL and surrounding areas.

before being piped to the CHP. A branch line extends to the north side of the CHP where the site-wide gas supply is metered and pressure regulated to 10 psig. Gas is distributed to the site for use in laboratory areas and to boilers and furnaces that are not served by the central heating system. ANL plans to upgrade its natural gas distribution system around the site in 1999.

4.3.10.2.4 Water Service

Potable water at ANL is purchased from the DuPage County Water Commission. Nonpotable water is obtained from the Chicago Sanitary and Ship Canal, located south of the laboratory. Canal water is treated on-site and piped to a 250,000-gal (946,350-L) holding tank for distribution through the canal water distribution system. Water for domestic use and fire suppression is distributed through a common network that serves most of the site. The system has three elevated storage tanks and one ground-level storage tank with capacities of 500,000, 150,000, 300,000, and 650,000 gal (1.9 million, 567,810, 1.1 million, and 2.5 million L) respectively. The water system for laboratories is segregated from the domestic and fire water systems to prevent potential contamination from backflow. Laboratory water is stored in the 800 Area in a 75,000-gal (283,905-L) elevated tank. ANL currently has a remaining capacity of approximately 2 mgpd (7.6 million lpd) of nonpotable water. The existing capacity of the process wastewater treatment system is over 1 mgpd (3.8 million lpd). ANL currently treats about 300,000 gpd (1.1 million lpd) (Fornek 1998a).

4.3.10.2.5 Sanitary Waste Treatment

Sanitary sewage from various buildings is conveyed by underground sewers to the SWTP located at Bluff Road and Railroad Drive. The treatment facility has approximately 500,000 gpd (1.9 million lpd) of remaining capacity (Fornek 1998a).

4.4 BROOKHAVEN NATIONAL LABORATORY

Brookhaven National Laboratory (BNL), a 5,000-acre (2,024-ha) site, is located close to the geographical center of Suffolk County, Long Island, about 60 miles (97 km) east of New York City. The developed area is approximately 2.6 mi² (6.7 km²). There are more than 300 structures on the laboratory property. The balance of the site is largely wooded. BNL is in a section of the Oak-Chestnut Forest Region known as the Atlantic Coastal Plain Physiographic Province. BNL was established in 1947 at the former Camp Upton, a World War I and II Army training and recovery center. BNL evaluated four potential sites for the proposed SNS facility. The preferred site is situated in the north-central part of the reservation east of the Relativistic Heavy Ion Collider (RHIC) and west of the STP (see Figure 4.4-1).

4.4.1 GEOLOGY AND SOILS

This section identifies the characteristics of the geology and soils associated with the region.

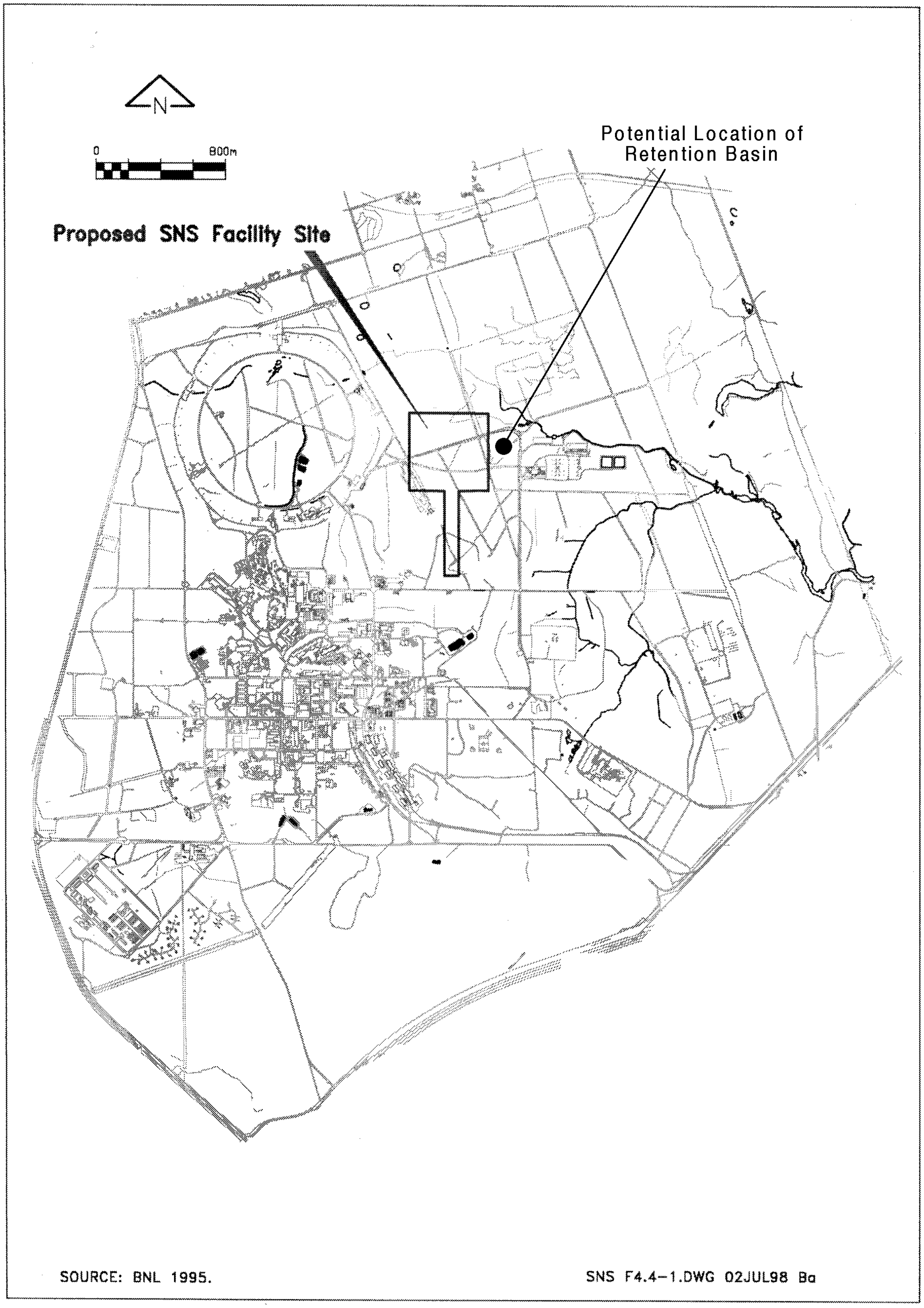

Figure 4.4-1. Proposed SNS site at BNL.

4.4.1.1 Stratigraphy

Long Island shares many of the same coastal features common to the barrier island of Massachusetts, the New Jersey Coastal Plain, and coastal regions as far south as Cape Hatteras. Surface features of eastern Long Island were shaped by the cyclical advance and retreat of glacial ice during the late Wisconsin Stage of the Pleistocene Epoch. BNL is located on the Ronkonkoma Moraine and consists of undulating morainal topography of relatively low relief with erratics present throughout. The elevation of the area is approximately 82 ft (25 m) with a total relief of 30 ft (9 m). The area of greatest relief is in the southernmost portion of the site.

Remnant glacial features include the Harbor Hill Moraine and the Ronkonkoma Moraine as prominent topographic ridges near BNL. The Harbor Hill Moraine is oriented east-west and lies to the north of BNL. The Ronkonkoma Moraine is characterized by an irregular band of hills with elevations ranging from 100 to 180 ft (30 to 55 m) above mean sea level. The laboratory lies between moraines on a relatively flat outwash plain, with elevations ranging from 40 to 120 ft (12 to 37 m), and is situated on the west rim of the shallow Peconic River watershed.

BNL is underlain by a wedge of unconsolidated sediments that thickens and dips to the southeast toward the Atlantic Ocean. These unconsolidated sediments range in age from Late Cretaceous to Recent and rest unconformably on crystalline bedrock consisting of Precambrian-age metamorphic rocks. Surficial Holocene deposits of soil and bog accumulations occur locally throughout the island, but the province is primarily covered by unconsolidated surface sediments that have been deposited and reworked by glaciation processes. Table 4.4.1.1-1 summarizes the stratigraphy in the vicinity of BNL.

Deposits of glacial origin cover the surface of the mid-island area, and range in thickness from 20 ft (6 m) to more than 600 ft (182 m) in buried valleys. Most of the glacial materials were deposited in Wisconsin time about 14,000 to 43,000 years ago and are collectively referred to as upper Pleistocene deposits. These deposits include terminal moraines, outwash deposits, ground moraine, and lake deposits. The Ronkonkoma terminal moraine marks the farthest advance of glaciation on Long Island. The moraine lies mostly above the water table and is composed of crudely stratified sand, gravel, and boulders. Outwash deposits derived from melted glacial ice lie south of the Ronkonkoma moraine. Some glacial lake deposits lie within outwash deposits but below the land surface and occur mostly between the terminal moraines. Because of the varied materials carried by the glacier, outwash deposits are stratified but consist of a heterogeneous suite of rock types. The large diversity of rock and mineral types in the Pleistocene deposits along with the presence of chemically unstable mineral suites allows differentiation from Cretaceous deposits on Long Island.

The Gardiners Clay is a marine interglacial deposit of Sangamon age. It is composed of variable amounts of massive green clay; silty and sandy green clay; and clayey silt and sand. The representative color is derived from trace amounts of glauconite and green clay minerals. The Gardiners Clay has a representative microfossil assemblage that is distinctive from the Upper Pleistocene units and the underlying

Table 4.4.1.1-1. Stratigraphy of Long Island, New York.[a]

Series	Geologic unit	Aquifer unit	Character of deposits	Water-bearing properties
Quaternary				
Holocene	Recent stream and salt marsh, alluvium and shoreline deposits	Recent deposits	Sand, gravel, clay, silt, organic mud, peat, loan, and shells.	Beach deposits are highly permeable; marsh deposits poorly permeable. Locally hydraulically connected to underlying aquifers.
Pleistocene	Upper Pleistocene deposits	Upper glacial aquifer	Till composed of clay, sand, gravel, and boulders, forms Harbor Hill and Ronkonkoma terminal moraines. Outwash deposits consist of quartzose sand, fine to very coarse, and gravel, pebble to boulder sized. Also contains lacustrine, marine, and reworked deposits.	Till is poorly permeable. Outwash deposits are moderately to highly permeable. Glacio-lacustrine and marine clay deposits are mostly poorly permeable but locally have thin, moderately permeable layers of sand and gravel. Average horizontal K=200ft/d.
	Gardiners Clay	Gardiners Clay	Clay, silt, and few layers of sand. Contains marine shells and glauconite.	Poorly permeable conditions constitute a confining layer of underlying aquifer. Sand lenses may be permeable.
Upper Cretaceous	Matawan Group-Magothy Formation; undifferentiated	Magothy aquifer	Sand, fine to medium quartzose, clayey in parts; interbedded with lenses and layers of coarse sand and sandy clay. Gravel in basal zones. Lignite, pyrite, and iron oxide common.	Most layers are poorly to moderately permeable; locally permeable. Unconfined in upper parts and confined elsewhere. Average horizontal K=50ft/d.
	Raritan Formation–unnamed clay unit	Raritan confining unit	Clay, solid and silty; few lenses and layers of sand. Lignite and pyrite are common.	Poorly to very poorly permeable; constitutes confining layer for underlying Lloyd aquifer. Average vertical K=0.001 ft/d.
	Raritan Formation–Lloyd Sand member	Lloyd aquifer	Sand, quartzose, fine to coarse, and gravel with clayey matrix; some lenses of solid and silty clay; contains thin lignite layers.	Poorly to moderately permeable. Confined aquifer conditions created by overlying Raritan clay. Average horizontal K=40/ft/d.
Precambrian	Bedrock	Bedrock	Crystalline metamorphic and igneous rocks; muscovite-biotite schist, gneiss, and granite. Soft clayey zone of weathered bedrock locally greater than 70 ft (21.3 m) thick.	Poorly permeable to impermeable; constitutes lower boundary of groundwater reservoir. Some hard freshwater in joints and fractures.

[a] IT and G&M 1997.

Magothy Formation. The northern limit of Gardiners Clay is located south of BNL; however, lobes of the clay extend to BNL. The irregular occurrence of the clay inland suggests that it was greatly affected by erosion.

The Monmouth Group is a Late Cretaceous age marine deposit consisting of a green to black clay, silt, or clayey to silty sand. It exists along the south shore of Long Island but is absent under BNL.

The undifferentiated Matawan Group/Magothy Formation comprises the Magothy aquifer of Long Island. This unit is composed of beds and lenses of fine to coarse, white to brown quartz sand with variable quantities of interstitial clay and silt. Interbedded layers of clay and silts are present, along with pyrite and lignite. The surface of this unit is highly irregular because of erosion during Tertiary and Pleistocene times. Depth to the upper surface of the Magothy aquifer range from about 100 to 500 ft (30.5 to 152.4 m).

The Late Cretaceous Raritan Formation is subdivided into the Lloyd Sand and the Raritan Clay. The Lloyd Sand overlies the bedrock and is approximately 300 ft (91 m) thick. The Lloyd Sand consists of coarse to fine quartzose sand with gravel and interbedded clay. The Raritan Clay overlies the Lloyd Sand and is approximately 200 ft (61 m) thick beneath BNL. The Raritan Clay is comprised of lignitic clay with some silt and sandy clay and lenses of sand and gravel. The Clay is present throughout Suffolk County and mimics the surface of the Lloyd Sand and underlying bedrock.

Two deep U.S. Geologic Survey exploratory wells encountered bedrock at approximately 1,600 ft (488 m) below the land surface at BNL. The bedrock consists of a banded granitic gneiss without significant primary porosity and with no indication of fracturing that would provide appreciable amounts of water. The bedrock slopes to the southeast, and represents an advanced erosional surface with little relief. It is overlain by remnant paleosoil consisting of a tough white clay.

4.4.1.2 Structure

No structures are preserved in the unconsolidated surface sediments of Long Island, and there are no known active faults in the Long Island area. Data for bedrock is limited for the BNL and elsewhere on the island by the lack of well penetrations. It is assumed to be similar to bedrock outcrops exposed on the mainland in nearby parts of New York and Connecticut. The basement rocks have a maximum relief of about 100 ft (30 m) except where modified by erosion in Pleistocene or Recent time. The low relief and localized weathering of the bedrock suggests that the surface had reached an advanced stage of peneplain. The bedrock surface slopes southeast at about 80 ft/mi (15 m/km), and its relief in the vicinity of BNL is not expected to be greater than 50 to 100 ft (15 to 30 m).

4.4.1.3 Soils

The Soil Survey of Suffolk County, New York, (IT and G&M 1997) has mapped several soil units across the BNL. The Plymouth Series is a deep, well-drained, coarse-textured sandy soil. It typically forms in a mantle of loamy sand or sand over thick layers of stratified coarse sand and gravel. These soils have very low available moisture capacity and rapid water intake. The soil type occurs on moraines and outwash plains. Slopes range from zero to 35 percent, and colors range from dark grayish brown to yellowish brown with depth.

The Carver Series consists of deep, excessively drained, coarse-textured sandy soils. This series is similar to, and often associated with, the Plymouth Series but contains more iron and humus. These soils also have slopes ranging from zero to 35 percent and are typically found on moraines and outwash plains. Color ranges from gray near the surface to brown and yellowish brown with depths greater than 8 in. (20 cm).

The Riverhead Series is a deep, well-drained, moderately coarse-textured soil that forms over stratified coarse sand and gravel. These soils occur on moraines and outwash plains and can have slopes ranging from zero to 15 percent. Riverhead soils are less sandy than Plymouth and Carver soils.

The Haven Series is a deep, well-drained, moderately coarse-textured soil that forms over stratified coarse sand and gravel. The soils most commonly occur between moraines and have slopes that range from zero to 12 percent. Haven Series soils are also less sandy than the Plymouth Series.

The southern portion of BNL is dominated by the Riverhead Series and grades into a mixture of Riverhead and Haven Soil near the center of BNL. The northern part of BNL, including the proposed site for the SNS, is covered by Plymouth loamy sands. Limited areas of Haven and Riverhead Series soils are present west of the proposed SNS location.

Approximately 69 acres (28 ha) are currently used for growing crops at BNL for biological research, but these areas are not prime or unique farmlands. No prime or unique farmlands are present on BNL land (Yadav 1999).

4.4.1.4 Stability

Construction of the proposed SNS would not be affected by site stability problems at BNL. The soil material is excellent for construction and there are no foundation or other associated problems. Soil conditions typically provide for 6,000-psi design loads (Schaeffer 1998). Neither soil liquefaction nor subsidence is a potential problem in this area. Because of the gentle rolling topography, landslides are not common to the site.

BNL is in an area of quiescent seismic activity compared to other potential sites for the proposed SNS (Figure 4.3.1.4-1). A seismic assessment suggested that a peak ground acceleration (horizontal) of 0.2 gravity be used for the Design Basis Earthquake for the High Flux Beam Reactor (HFBR) (Kelley 1998). A study for Shoreham Nuclear Power Plant indicates that 26 earthquakes have been capable of being felt at the site with an intensity of IV [Modified Mercalli (MM)] or greater. Four major earthquakes located more than 200 miles (322 km) from the site are estimated to have been felt with a maximum intensity at BNL of IV (Table 4.4.1.4-1).

Within a 200-mi (322-km) radius of the site, five earthquakes have been noted that may have influenced the site with an intensity of IV (MM) or slightly greater (Table 4.4.1.4-2).

It is indicated that 90 earthquakes are known to have occurred within 50 miles (80 km) of the site historically, but only two of these earthquakes were actually felt on-site (Table 4.4.1.4-3).

Table 4.4.1.4-1. Earthquakes greater than 200 miles (322 km) from BNL.

Date	Location	Intensity
June 11–12, 1638	Three Rivers, Quebec	IX
February 5, 1663	St. Lawrence Valley (Quebec City)	X
September 16, 1732	Montreal, Canada	IX
March 1, 1925	St. Lawrence Valley (Quebec City)	IX

Table 4.4.1.4-2. Earthquakes less than 200 miles (322 km) from BNL.

Date	Location	Intensity
November 10, 1727	Cape Ann, Mass.	VII
December 18, 1737	New York, N.Y.	VII
November 18, 1755	Cape Ann, Mass.	VIII
May 16, 1791	East Haddam, Conn.	VI–VII
August 10, 1884	New York, N.Y.	VII

Table 4.4.1.4-3. Earthquakes within 50 miles (80 km) from BNL.

Date	Intensity	Estimated BNL Intensity
May 16, 1791	VI-VII	IV-V
July 19, 1937	IV	III

4.4.2 WATER RESOURCES

The following section discusses the water resources at BNL.

4.4.2.1 Surface Water

BNL is near the western boundary of the Manorville drainage basin and contains the headwaters of the Peconic River (Figure 4.4.2.1-1). Surface drainage is poor in the Manorville basin which accounts for the marshy and swamp areas near the river. East of the Manorville drainage basin, the Peconic River valley widens and forms the Riverhead Basin. The Peconic River drains in an easterly direction and flows into Flanders Bay, an arm of the Great Peconic Bay. Like other coastal-plain streams, the Peconic River is a low-gradient, low-velocity stream with slightly acidic waters and a moderate-to-dense growth of aquatic vegetation. Stream flows are heavily influenced by groundwater levels, with discharge of groundwater to streams during periods of high rainfall and infiltration of stream flow during periods of low rainfall. The marshy area in the northern and eastern section of BNL has the potential to be a principal tributary of the Peconic River. However, this tributary has been essentially dry during the regional drought over the past 10 years. It should be noted that there has been no year-round sustained flow from BNL since 1983 (Naidu et al. 1996) even with the contribution of 242 million gal (916 million L) from the STP.

Coastal-plain ponds are naturally occurring or manmade ponds with permanent standing water.

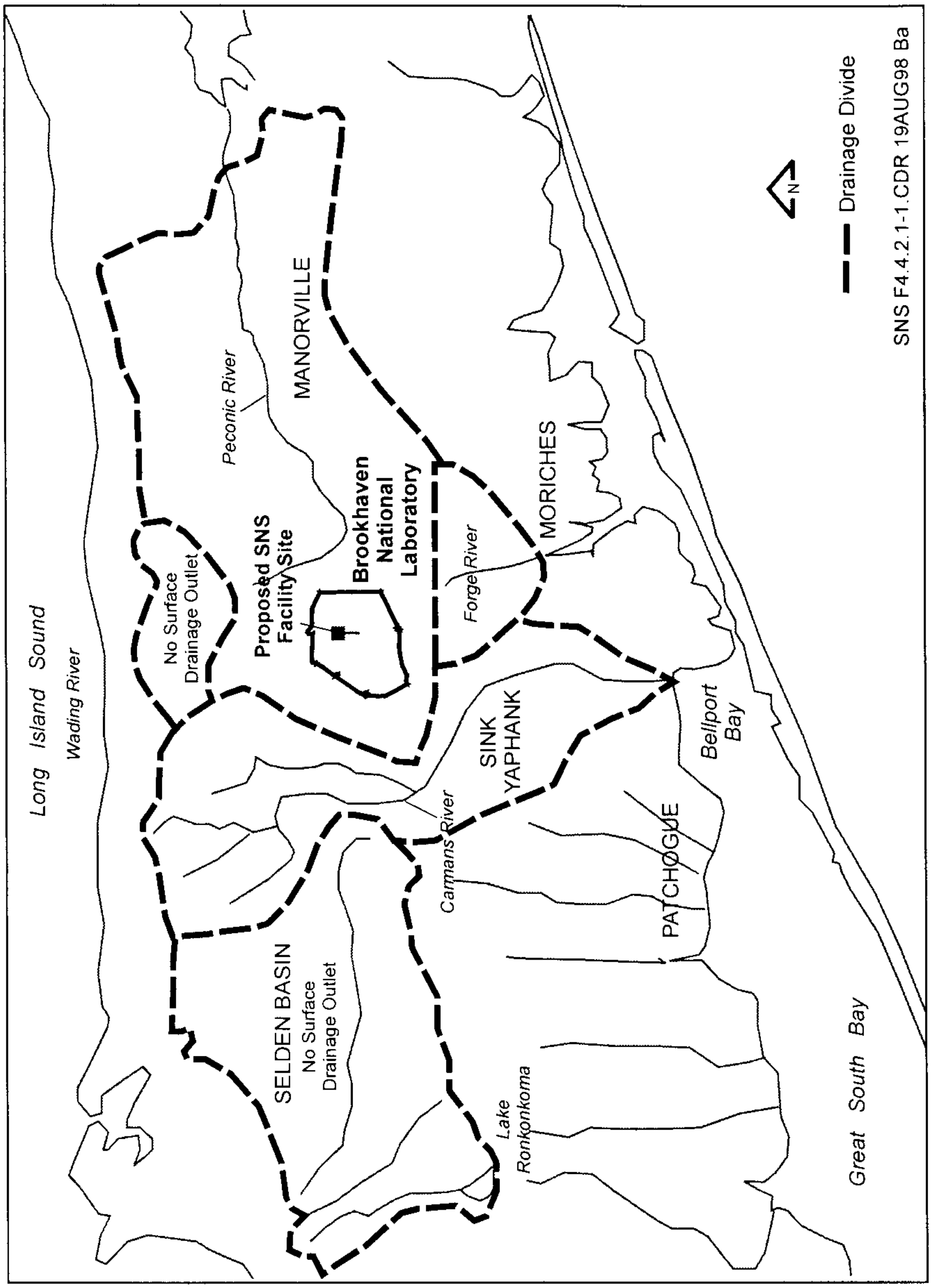

Figure 4.4.2.1-1. Drainage basin surrounding BNL.

A number of such ponds with water depths usually less than 4 ft (1.22 m) occur in the northern portion of BNL. In addition, cooling and industrial process water recharges the groundwater system via discharge into small streams or man-made recharge basins.

One-hundred-year floodplains and wetlands encompass approximately 346 acres (140 ha) of the BNL site, mostly in the areas bordering the headwaters of Peconic River. The 100-year flood maps of the Federal Emergency Management Agency's National Flood Insurance Program indicate that in the vicinity of the Relativistic Heavy Collider, immediately west of the proposed SNS location, the elevation of the 100-year floodplain is approximately 52.5 ft (16 m) above mean sea level.

Land bordering the Peconic River up to 0.5 miles (0.8 km) from the river's bank is regulated by New York State because of its designation as "Scenic" under the State's Wild, Scenic and Recreational Rivers Systems Act. Freshwater wetlands in the north and east quadrant of the BNL reservation remain in an area once part of a principal tributary to this river system. The Peconic River is not used for a drinking water supply or for irrigation.

4.4.2.2 Groundwater

The groundwater system beneath Long Island exists as a distinct well-defined system delineated by natural hydrologic boundaries. The upper boundary is defined by the water table surface [at about 45+ ft (13.7 m) mean sea level] in the Upper Glacial sediments modified by the numerous streams and surface water bodies that intersect the water table. The base of the system is bounded by the impermeable crystalline bedrock surface. The entire system is bounded laterally by salty groundwater and saltwater bodies. Along the shore, groundwater discharges from the upper glacial deposits flow directly into these saltwater bodies. Offshore, fresh groundwater flows vertically upward across the confining layers. Where the overlying groundwater is salty, the water discharges from the fresh system and mixes with salty groundwater. These areas are referred to as subsea discharge boundaries and are considered part of the lateral groundwater system boundaries. Under natural conditions, all water enters and leaves the groundwater system across these boundaries.

Precipitation on Long Island averages 45 in. (114 cm) per year, of which 23 in. (58 cm) recharges to replenish the groundwater. Trending east-west, the main groundwater divide for Long Island lies about 1 to 2 miles (1.6 to 3.2 km) north of BNL (Figure 4.4.2.2-1). Water entering the groundwater system north of the divide generally flows north into the Long Island Sound. Water entering the system south of the divide (including BNL) flows south and/or east toward the Peconic River, the Forge River, the Carmans River, or toward the south shore of Long Island. Groundwater eventually discharges either into the rivers or directly into the Great South Bay or the Atlantic Ocean across a subsea discharge boundary. The higher water table to the west of the BNL area generally inhibits westward movement.

The hydrogeologic units (Figure 4.4.2.2-2) that comprise the groundwater system are the Upper Glacial aquifer, the Gardiners Clay (aquitard), the Magothy aquifer, the Raritan confining unit, the Lloyd aquifer, and the crystalline bedrock (confining unit). Groundwater in the Upper Glacial aquifer exists under unconfined

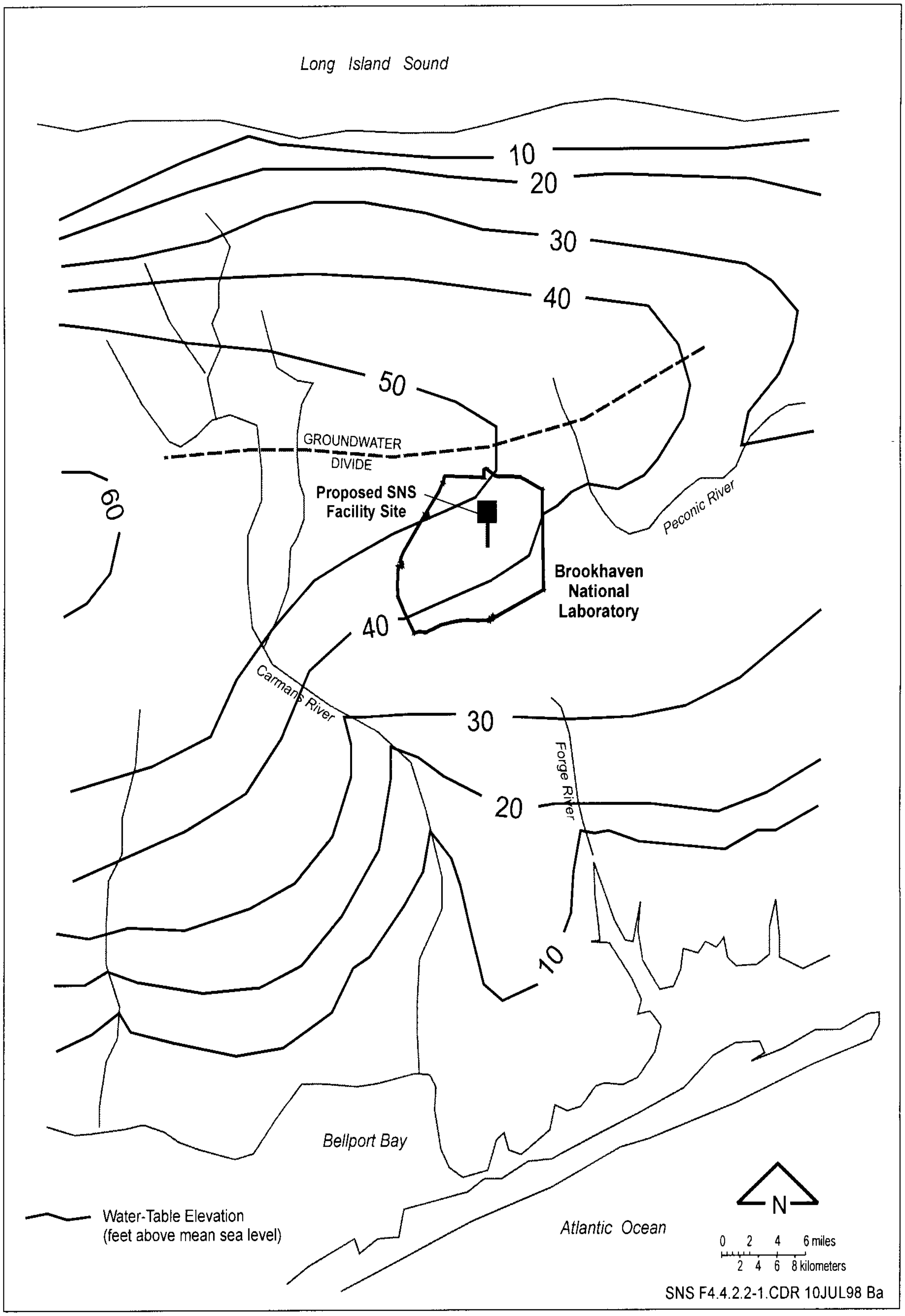

Figure 4.4.2.2-1 Groundwater divide in vicinity of BNL.

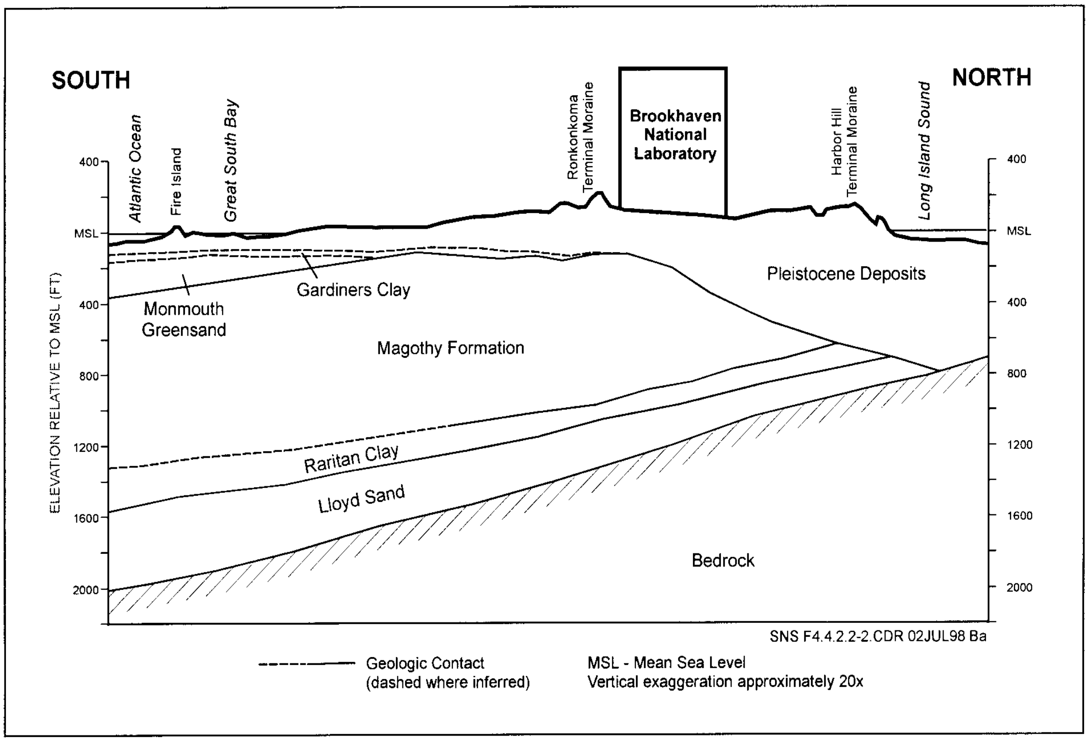

Figure 4.4.2.2-2. Stratigraphic cross section through Long Island and BNL.

conditions except where locally continuously clay lenses create semi-confined conditions. When the Magothy aquifer is overlain by the confining Gardiners Clay unit (south of BNL) groundwater exists under confined conditions. Where the Magothy is in direct hydraulic connection with the Upper Glacial aquifer, semi-confined to confined conditions are present from localized clay layers. The Lloyd aquifer is under confined conditions as a result of the continuous presence of the overlying Raritan Clay unit. Limited recharge is available to support the Lloyd aquifer, and therefore, it is very sensitive to pumpage and drawdown.

McClymonds and Franke (IT and G&M 1997) have estimated the distribution of hydraulic conductivities (K) from pump tests for the three primary aquifers underneath Long Island. The Upper Glacial aquifer has the highest and greatest range of horizontal hydraulic conductivity values (K) 20 to 300 (0.007 to 0.106 cm/s) which reflects the variations in the unconsolidated deposits. Stratification in this unit is common, yielding varied values at different locations and depths. The stratification also has a pronounced effect on the vertical K with a 10:1 ratio of horizontal to vertical hydraulic conductivity. The K of the Magothy aquifer ranges from 30 to 80 ft/d (0.011 to 0.028 cm/s) for the thicker upper zone and 45 to 120 ft/d (0.016 to 0.042 cm/s) for a coarse basal sand unit. Ratios of horizontal to vertical K approach 100:1 because of the stratified nature of the Magothy. The Lloyd aquifer is estimated to have a K in the 35 to 75 ft/d (0.012 to 0.027 cm/s) range with horizontal to vertical ratios of 100:1. Approximations of K for the confining unit are several orders of magnitude less than for the aquifers (0.01 to 0.001 ft/d).

Horizontal groundwater flow directions across BNL are generally south to southeast (see Figure 4.4.2.2-3). The overall groundwater table gradient from the northwest corner to the southern boundary of BNL averages 0.001. Using 160 ft/d (0.056 cm/s) as the mean value of the range of K estimates [20 to 300 ft/d (0.007 to 0.106 cm/s)] for the Upper Glacial aquifer and a porosity of 0.33 (Warren et al. 1963), a horizontal groundwater velocity is calculated to be 0.48 ft/d. This calculation is in close agreement with the results (0.53 ft/d) of a tracer test reported by Warren (Warren et al. 1963), where the velocity of an injected solution of ammonium chloride was recorded between two shallow wells. Data for the Magothy aquifer suggests a velocity range of 0.1 to 0.2 ft/d for horizontal groundwater flow, but the confidence of measurements is not as reliable as in the upper aquifer. Based on a 24-hr pump test, the velocity of the Lloyd aquifer is estimated to be 0.025 ft/d, substantially less than in either of the principal overlying aquifers (Warren et al. 1963).

Six wells (BNL-4, 6, 7, 10, 11, and 12) were used to supply potable water at BNL during 1995 (Naidu et al. 1996). Monitoring requirements included quarterly analyses for principal organic compounds; monthly bacteriological analyses; annual analysis for asbestos, micro-extractables, synthetic organic compounds, and pesticides; and semiannual inorganic analyses. Review of the data shows the BNL potable water supply to meet all New York State Drinking Water Standards (NYSDWS) in 1995.

In addition, BNL's Safety and Environmental Protection Division maintains a comprehensive sampling and analysis program for the potable water supply system. Specific analyses include: pH, conductivity, chlorides, sulfates and nitrates for water quality; Ag, Cd, Cr, Cu, Fe, Hg, Mn, Na, Pb, and Zn for metal analysis; and chloroform, dichloroethylene, 1,1,1 trichloro-thane, and trichloroethylene for volatile organic analysis. Their monitoring showed that water quality parameters met NYSDWS. Values for pH range from 5.8 to 6.6 which are typical for Long Island, but water from three wells is adjusted to reduce the corrosivity of the groundwater. The majority of metals were not detected in the potable water supply wells. Common constituents, such as Mn, Cu, Pb, and Zn, were observed at levels below their respective NYSDWS. Sampling of the water supply wells at the well-head showed that of 10 organic compounds, only chloroform and TCA were detected in the potable wells. However, only TCA exceeded the NYSDWS, and Well No. 11 is fitted with a carbon-adsorption treatment system that reduces the concentration to acceptable levels.

During 1995, 1,715 groundwater samples were taken from over 200 surveillance wells and over 100 temporary vertical profile wells at various waste sites at BNL. These samples were analyzed for constituents similar to the potable and process wells. Results indicate that except for pH, water quality parameters are below the New York State Ambient Water Quality Standards (AWQS) even in areas of potential contamination. Metal and volatile organic compounds (VOCs) exceed AWQS in a number of areas across the site. The VOCs are usually traceable to known spills or chemical-waste storage or former disposal areas. In several areas of BNL, iron is above AWQS reflecting natural background concentration. However, in areas such as the Current Landfill (closed in 1990), elevated iron and sodium concentrations are related to releases from the landfill.

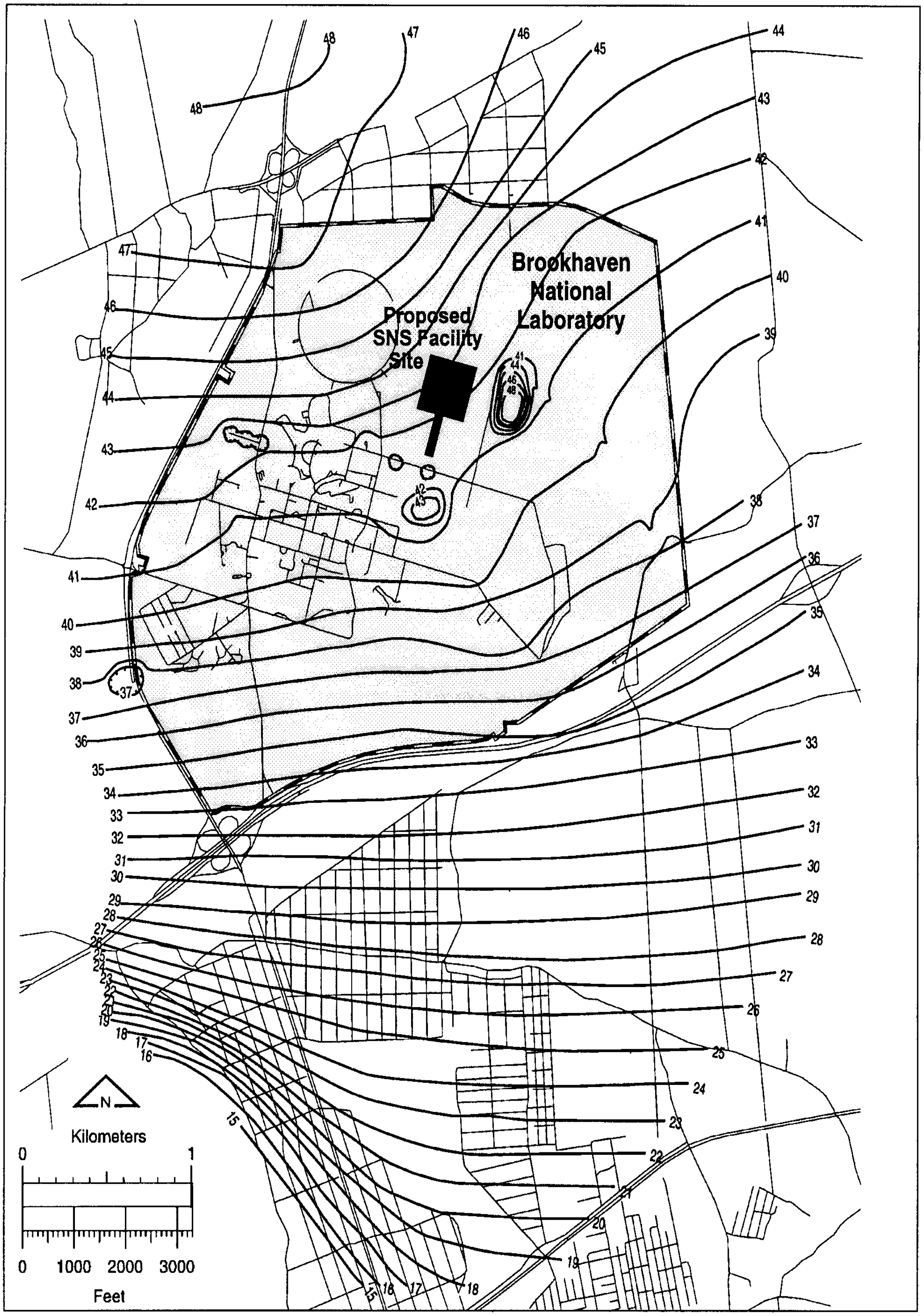

Figure 4.4.2.2-3. Water table contour map for the BNL site.

Groundwater wells in the immediate vicinity of BNL's preferred site for the proposed SNS indicate slightly elevated levels of iron and sodium.

Long Island's drinking water supply comes from groundwater. Long Island's Upper Glacial Aquifer has been designated as a sole source aquifer by the EPA.

Human consumption utilizes 4 percent of the total pumpage. Approximately 70 percent of the total pumpage is returned to the aquifer through on-site recharge basins, and about 15 percent is discharged into the Peconic River. The area occupied by BNL was identified by the Long Island Regional Planning Board and Suffolk County as being over a deep-flow recharge zone for Long Island. It is estimated that 50 percent of the precipitation recharges the lower aquifer systems (Magothy and Lloyd aquifers) lying beneath the Upper Glacial Aquifer.

4.4.3 CLIMATE AND AIR QUALITY

BNL has a climate typical to most eastern seaboard areas. Temperatures average 49.7 °F (7 °C) on an annual basis, but have ranged from a low of −23 °F (−30 °C) in 1961 to a high of 100.5 °F (38 °C) in 1991. By comparison, the average temperature in 1995 was 51 °F (10.6 °C) and the range was 44 °F (6.9 °C) to 84 °F (29.1 °C). Precipitation averages 48.13 in. (122 cm) per year with a maximum of 68.66 in. (174 cm) and a minimum of 34.55 in. (87 cm) since 1949 (Figure 4.4.3-1). Snowfall averages about 30.2 in. (76 cm) per year with a maximum annual accumulation recorded at 90.8 in. (230 cm) in the 1995-96 season. The months of December through March account for the majority of accumulations.

4.4.3.1 Severe Weather

The most severe weather for Long Island is related to hurricane occurrences with associated winds and precipitation. The peak wind speed at BNL was recorded during Hurricane Carol at 125 mph (201 km/hr) in 1954. Similarly, the maximum hourly [2.1 in. (5.3 cm)] and daily [9.02 in. (22.9 cm)] precipitation were recorded during Hurricane Edna in 1954. In addition, Suffolk County has experienced 10 tornadoes

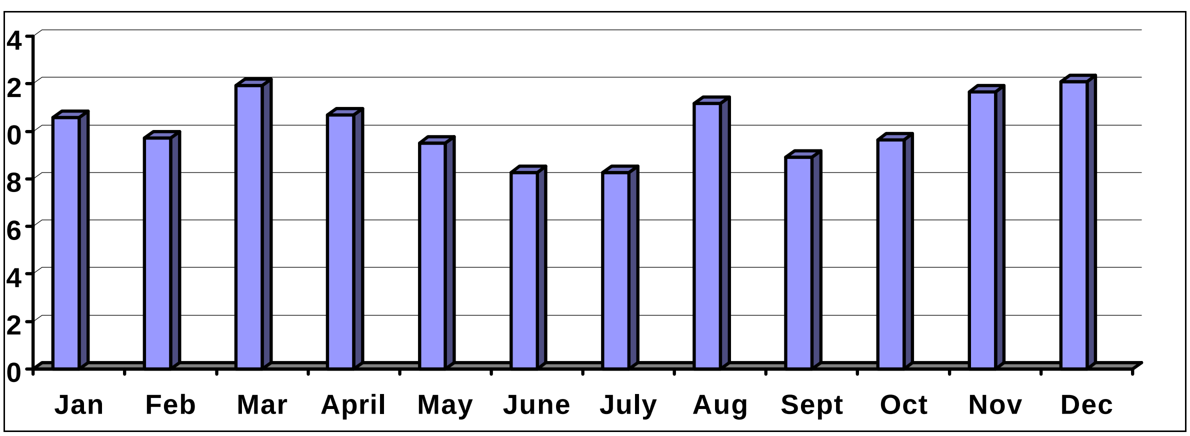

Figure 4.4.3-1 Average monthly precipitation at BNL.

during the 1950 to 1995 period (refer to Figure 4.1.3.1-1). However, the severity of these tornadoes has been relatively minor (F0-3, F1-6, F2-1) as measured on the F-scale.

4.4.3.2 Atmospheric Dispersion

BNL can be characterized as a well-ventilated area. The prevailing ground level winds are from the southwest during the summer, from the northwest during the winter, and about equally from these two directions during the spring and fall. Figure 4.4.3.2-1 displays an annual wind rose diagram for BNL (Naidu et al. 1996).

4.4.3.3 Air Quality

Suffolk County is listed as severe nonattainment for ozone and attainment for all other criteria pollutants by the New York State Department of Environmental Conservation (NYSDEC).

Existing ambient air quality in the vicinity of BNL is best quantified in terms of recent ambient monitoring data collected by NYSDEC at nearby locations. Table 4.4.3.3-1 summarizes these data and is taken from *New York State Air Quality Report: Ambient Air Monitoring System* (1997) for 1996.

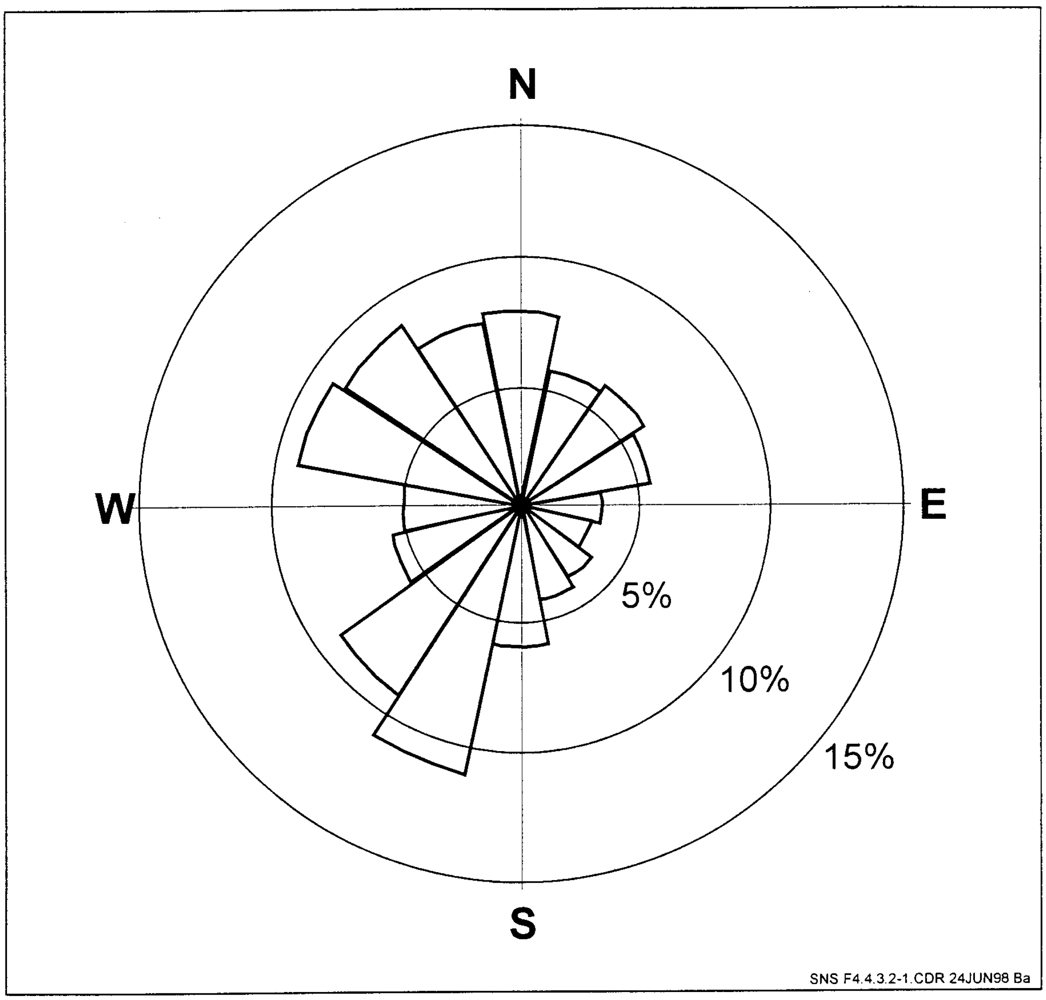

Figure 4.4.3.2-1. Annual wind rose for BNL during 1995.

Table 4.4.3.3-1. Summary of 1996 monitoring data in the vicinity of BNL.

Pollutant Averaging Time	Nearest Monitor Location	Maximum 1st	2nd	3rd	4th	NAAQS NYAAQS	Number of Exceedances
PM-10 24-hour	Babylon 41 km SW	57.0	40.0	34.0	—	150.0 μg/m^3	0
TSP 24-hour	Oster Bay 55 km NW	61.0	60.0	50.0	—	150.0 Sec. 260.0 Pri. μg/m^3	0
Ozone 1-hour	River Head 19 km NE	0.121	0.116	0.102	0.101	0.12 ppm	0
NO_x Annual	Eisenhower Park 68 km SW	0.026	—	—	—	0.05 ppm	0
SO_2 3-hour	Babylon 41 km SW	0.085	0.050	0.043	—	0.5 ppm	0
24-hour		0.029	0.025	0.024	—	0.14 ppm	0
CO 1-hour	Eisenhower Park 68 km SW	6.9	6.6	6.6	—	35.0 ppm	0
8-hour		5.8	4.9	4.3	—	9.0 ppm	0

Source: NYSDEC 1997. NYAAQS – New York Ambient Air Quality Standards.

4.4.4 NOISE

The SNS site is proposed for the north-central portion of the BNL reservation, which is situated between the STP and the RHIC. The proposed site is removed from the main area of offices, laboratories, and on-site workers. Ambient noise levels are not available for the proposed SNS site (Note: The RHIC will not be operational until 1999). Sensitive populations would include on-site workers and off-site residential populations. Approximately 8,000 residents live within 0.3 miles (0.5 km) of BNL's boundary, and the proposed SNS would be positioned roughly 1 mile (1.6 km) from the northern border and 2 miles (3.2 km) from the southern border. Natural buffering of sound levels is provided by the undeveloped forested buffer zone between the laboratory property and residential development.

4.4.5 ECOLOGICAL RESOURCES

This section provides a general description of the ecological resources for the proposed SNS site and the surrounding area. The discussions are based on information readily available from other sources. Site-specific surveys were done for protected species and wetlands. All other information was obtained from existing publications. For the most part, the impacts from construction and operation of the proposed SNS would be minor. Therefore, much of the information presented here is summary in nature. Greater detail can be obtained from the references compiled for this section.

4.4.5.1 Terrestrial Resources

The proposed SNS site at BNL lies within the Long Island Pine Barrens (see Section 4.4.8.4).

The southern portion of the proposed site consists of a stand of white pine (*Pinus strobus*) apparently planted during the 1930s, most likely as a Civilian Conservation Corps project. Communities composed of planted white pine are common in Suffolk County. Self-sown pitch pine (*Pinus rigida*) is scattered within this area. The understory consists of huckleberry (*Gaylussacia* sp.) with lesser amounts of blueberry (*Vaccinium* sp.) but is sparse because of shade and pine needle litter. Occasional oaks (*Quercus* sp.) are found along the edges of the firebreaks and lanes in this area. A native oak-pine woodland is present just north of the white pines.

There is evidence of extensive disturbance associated with operations at Camp Upton during World War I. These disturbed areas include an extensive system of trenches, as well as a complex of deep pits and banks that are found within a narrow area of the site and the adjacent buffer zone. Mounded areas formed in the course of trenching operations are vegetated by large white pines. Confirmation that these areas were disturbed during World War I comes from the presence of the white pines planted in the 1930s. These pines are presently overgrowing the trenches and pits.

In the extreme southern portion of the proposed SNS site, there is an assemblage of species not found elsewhere on the proposed site. These species include introduced ornamental shrubs, such as Japanese barberry (*Berberis thunbergii*) and jetbead (*Rhodotypos scandens*), as well as black locust (*Robinia pseudoaccacia*). The native red maple (*Acer rubrum*), wild black cherry (*Prunus serotina*), and grape (*Vitis* sp.) are also present. The presence of these species may be the result of the somewhat moister conditions within the deep pits.

In the more open areas along the firebreaks and lanes throughout this area the vegetation primarily consists of broomsedge (*Schizachyrium* sp.), sedges (*Carex* spp.), including the Pennsylvania sedge (*C. pensylvanica*) and lichens (*Cladina* sp.).

The remainder of the proposed site is composed of pine-oak or oak-pine communities. In the pine-oak community, pitch pine may make up as much as 90 percent of the total population. The only obvious recruitment of new individuals is along the edges of the firebreaks and lanes where pitch pine saplings are common.

The oaks inhabiting the entire site are predominantly scarlet oak (*Q. coccinea*) and white oak (*Q. alba*), with the scarlet oak being the most common. The understory is huckleberry and blueberry with occasional individuals of scrub oak (*Q. ilicifolia*) and, rarely, highbush blueberry (*V. corymbosum*).

The northeast corner of the proposed site approaches the wetlands associated with the headwaters of the Peconic River. The community structure in this section shifts abruptly from the upland vegetation of pitch pine, white and scarlet oak to a wetland vegetation of red maple, tupelo (*Nyssa sylvatica*), swamp azalea (*Rhododendron viscosum*), and sweet pepperbush (*Clethra alnifolia*). Widely dispersed, large individual pitch pine also occur in this area.

In severely disturbed portions of the proposed SNS site, where the subsoils are exposed, monospecific stands of young pitch pines are found. In addition, a 2.5-acre (1.0-ha) abandoned borrow pit located on the east side of the site is exclusively occupied by a mature stand of pitch pines.

An inventory of mammals at BNL was done in 1994 and 1995. This survey did not include the proposed SNS site. However, the survey did include areas with the same type of habitat as found on the proposed site. White-tailed deer, the most common mammal reported in this study, were found throughout both natural and developed areas. Within forests and wetlands, deer browse on saplings, grasses, and greenbrier. White-tailed deer are less common in the pine plantation areas than in the pitch pine/oak forest and wetland areas, probably because of a smaller food supply.

Other species commonly observed at BNL, but in low numbers, were raccoon, muskrat, cottontail rabbits, gray squirrel, eastern chipmunk, and red fox. White-footed mouse and indications (such as droppings or tracks) of other small mammals were found throughout the BNL site. Meadow voles, or indications of their presence, were found in fields and emergent wetland areas. Other species observed included woodchuck, pine vole, and meadow jumping mouse.

4.4.5.2 Wetlands

Information about the wetlands in the vicinity of the proposed site for the SNS is summarized from *Final Phase II — Sitewide Biological Inventory Report* (CDM 1995). There are three jurisdictional wetlands in the vicinity of the proposed site for the SNS at BNL **(**Figure 4.4.5.2-1**)**. These wetlands are associated with the upper reaches of the Peconic River.

The NYSDEC has prepared a wetland delineation manual that uses the same three parameters (soils, vegetation, and hydrology) as the 1987 USACOE manual to define and map wetlands. The delineation of the wetlands at BNL meet the regulatory criteria of both USACOE and NYSDEC. One important difference between the two sets of regulations is that NYSDEC places a 100-ft (30.5-m) wide buffer upland of wetland area boundaries whereas the USACOE does not. Hence, work performed outside a wetland regulated jointly by NYSDEC and USACOE but within the NYSDEC buffer zone requires a permit from NYSDEC under ECL Part 663.4.

Wetland WL-1 is a palustrine forested wetland with broad-leaved deciduous vegetation and is considered by NYSDEC as a Class I wetland. This wetland is split by the Peconic River. The parcel to the north is drier and characterized by a dense red maple canopy. The parcel south of the river is frequently inundated. Tree growth is

NYSDEC Class I Wetland: A wetland is classified as a Class I wetland in New York State if it has any of the following seven enumerated characteristics:

It is a classic kettlehole bog;
It is a resident habitat of an endangered or threatened animal species;
It contains an endangered or threatened plant species;
It supports an animal species in abundance or diversity unusual for the State or for the major region of the State in which it is found;
It is tributary to a body of water which could subject a substantially developed area to significant damage from flooding or from additional flooding should the wetland be modified, filled or drained;
It is adjacent or contiguous to a reservoir or other body of water that is used primarily for public water supply, or it is hydraulically connected to an aquifer which is used for public water supply; or
It contains four or more of the enumerated Class II characteristics.

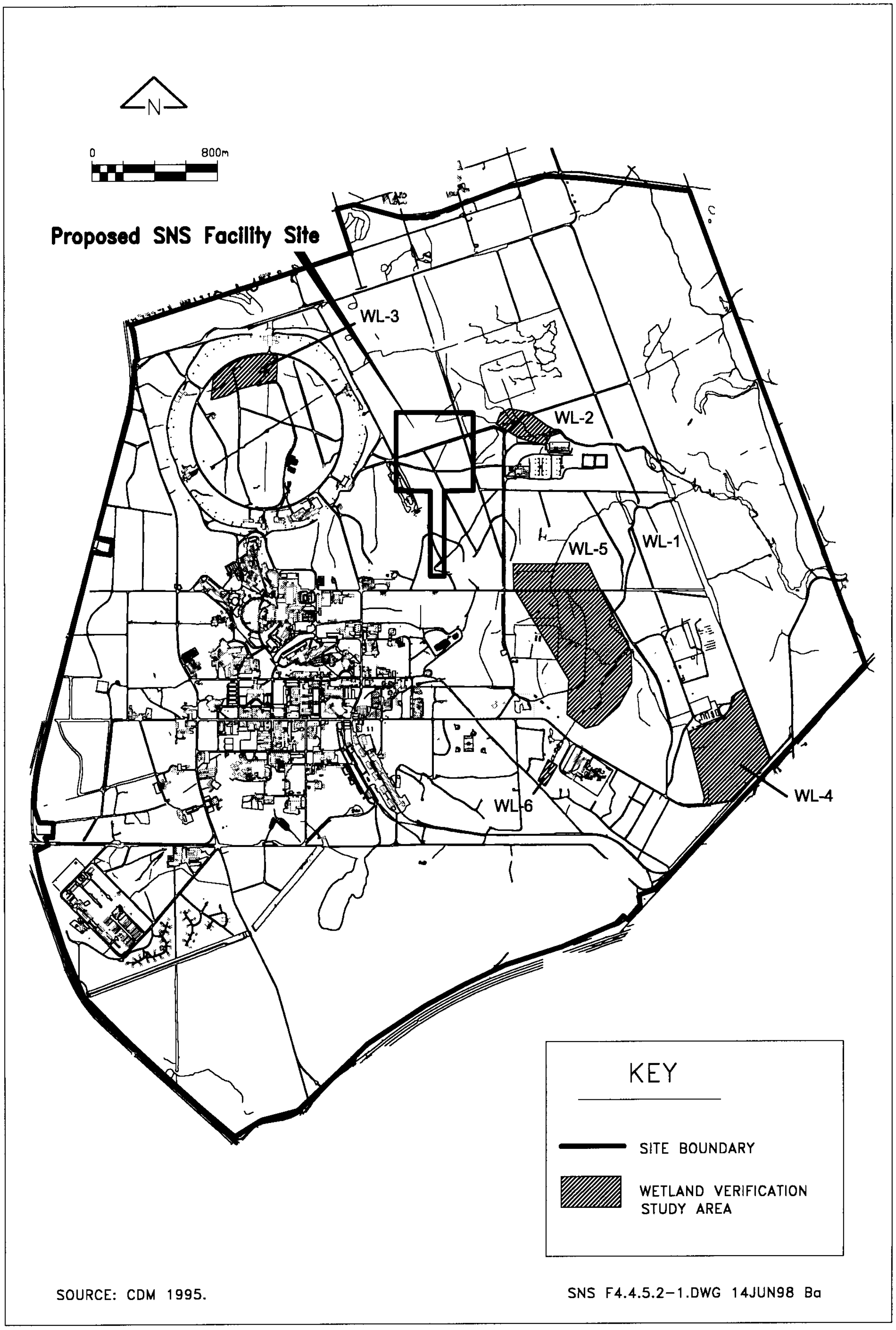

Figure 4.4.5.2-1. BNL wetlands.

sparse and there is a dense growth of annual grasses and wetland indicative plants, such as spiked bur-reed, marsh pepper smartweed, and tussock sage. Soils in the wetland are listed as Wareham loamy sand, which is a hydric soil. The discharge from the BNL STP, located just west of this wetland, is sufficient to support aquatic plant, invertebrate, and vertebrate species. As part of the delineation of this wetland, one south-to-north transect was described. The transect began in an upland oak-pine forest, crossed the flooded forested wetland and the Peconic River channel, crossed an upland peninsula of grassed-over fill, reentered the forested wetland, and ended in the oak-pine forest north of the wetland.

Wetland WL-2 also borders the Peconic River. NYSDEC considers this a Class I wetland. This wetland is described as a palustrine forested wetland with broad-leaved deciduous vegetation, seasonally saturated, and as a palustrine shrub/sapling wetland with broad-leaved deciduous vegetation, and emergent narrow-leaved persistent vegetation, seasonally saturated. This wetland is dominated by a red maple canopy forest with a weak tree canopy in the center and a tussock sedge ground cover.

Soils in the wetland are listed as Wareham loamy sand, which is a hydric soil. Three ponded areas within the wetland probably serve as a refuge for fish, amphibians, and reptiles during periods of low water. Based on field observations, the Peconic River upstream of the STP flows only from late winter to late spring. Most of the wetland appears to be inundated during spring. Therefore, the wetland probably functions as a control of flood and stormwater and potentially absorbs nutrients and sediments from upstream portions of the Peconic River. As part of the delineation of this wetland, one southwest-to-northeast transect was described. The transect began in an upland oak-pine forest, crossed a dense red maple dominated wetland, crossed the dry Peconic River channel, reentered the dense forested wetland, and ended in an oak forest.

Wetland WL-5 is a forested wetland north and south of Fifth Avenue and east of First Avenue. NYSDEC considers this a Class I wetland. This is a palustrine forested wetland with broad-leaved deciduous vegetation, seasonally saturated. Soils in this wetland are listed as Atsio sand, Berryland mucky sand, Muck, and Walpole sandy loam, all of which are hydric soils. There is evidence that the wetland was extensively ditched in the past. A series of east-west-oriented ditches merge to form a central north-south ditch that eventually enters the Peconic River. The ditches probably reduce the inundation of the wetland, encouraging growth of a red-maple-dominated palustrine forest over a shrub/sapling or herbaceous wetland community. A 2-acre (0.81-ha) area of recently killed red maples south of Fifth Avenue is indicative of poor drainage and/or an increase in the period of inundation or saturation of the soils. This wetland functions principally in the control of stormwater and flood water and as habitat for wildlife. Wildlife observed in this wetland include white-tailed deer, cottontail rabbit, gray squirrel, red-bellied woodpeckers, and several species of warblers. Many of the larger red maples are either hollow or contain holes, providing nesting sites for birds, such as flickers and wood ducks. As part of the delineation of this wetland, two west-to-east transects were described. The transect north of Fifth Avenue began in an upland pitch pine forest, crossed the red-maple-dominated palustrine forest, and ended in an upland pitch pine forest. The south transect began in an upland oak forest, crossed through a red-maple-, black-gum-, and greenbrier-dominated palustrine forest, and ended in an upland forest.

4.4.5.3 Aquatic Resources

The Peconic River flows through the northern portion of BNL. The northeast corner of the proposed SNS site is approximately 300 ft (91 m) from the river. The headwaters of the Peconic River are located approximately 0.75 miles (1.2 km) to the west of BNL and exit the site to the east. Currently the BNL STP accounts for 90 percent of the water flow in the Peconic River in the spring and early summer and almost 100 percent during late summer and fall.

The Peconic River is protected under the Freshwater Wetlands Program as it is a Class I wetland. Two reaches of the Peconic River downstream of BNL were designated as a scenic river in 1986 under the New York State Wild, Scenic, and Recreational River Act. The two reaches represent the last significant undeveloped river corridor within the Long Island Pine Barrens area. The reaches extend 10.5 miles (16.8 km) from the western boundary of the red maple swamp to the Long Island Railroad bridge between Connecticut and Edwards Avenues 3 miles (4.8 km) from Middle Country Road to its confluence with the main channel of the Peconic River.

The Peconic River downstream of the potential site for the proposed SNS is described as a Coastal Plain Stream. In general, upstream of the STP, the habitat of the river consists of a narrow, often channelized stream with dense, overhanging brush. There is a weir upstream of the STP that may restrict fish movement both upstream and downstream. A man-made pond, approximately 6 ft (1.8 m) deep and 30 ft by 30 ft (9 m by 9 m) in size is located approximately 50 ft (15.2 m) upstream of the weir. Downstream of the STP, the habitat consists of a shallow [average depth is less than 1 ft (0.3 m)], wide [10 to 15 ft (3 to 4.6 m)], low-gradient stream channel with fallen logs, brush, and aquatic vegetation providing cover for fish. A dense stand of red maple trees farther to the east precludes the growth of aquatic vegetation in that portion of the stream. Another weir is located just above the east firebreak. Farther downstream the river becomes shallow, with no distinct channel or streambed in some areas. The stream and associated wetlands are heavily vegetated with a mix of emergent herbaceous plants. Several shallow, open-water areas are located approximately 0.25 miles (0.4 km) downstream of the firebreak. The flow in the Peconic River ceases about midway between the east firebreak and the east BNL property line. No standing water was found downstream of this point to the BNL property line.

NYSDEC
Surface Water "C" Classification for the Peconic River (Summary)

Best Use – Fishing. Suitable for fish survival and propagation. Suitable for primary and secondary contact recreation.

pH – Not less than 6.5 nor more than 8.5.

Dissolved Oxygen – The minimum daily average shall not be less than 5.0 mg/L and at no time less than 4.0 mg/L.

Temperature – Water temperature at the surface of the stream shall not be raised to more than 90 °F (32 °C).

Turbidity – No increase that will cause a substantial visible contrast to natural conditions.

Results of fish collections above the weir and wastewater discharge (CDM 1995) show that the fish community in this portion of the river is characterized by certain species (Table 4.4.5.3-1).

The dominant aquatic vegetation in these reaches of the Peconic River included water-starwort (*Callitriche palustris*), reported to be very common and very dense. Other common plants include manna grass (*Glyceria grandis*), arrow arum (*Peltandra virginica*), and pickerel weed (*Pontederia cordata*).

The Peconic River was designated as a Wild and Scenic River by the State of New York in 1986 because it represented the last significant undeveloped river within the Long Island Pine Barrens area. Approximately 14 miles (22.4 km) of the Peconic River are now listed as "scenic river" by the State of New York, of which 7.5 miles (12 km) are also listed as a "recreational river." Scenic rivers are rivers or sections of rivers that are "free of diversions or impoundments (except for log dams), with limited road access and are very primitive and largely undeveloped river areas; or areas that are partially or predominantly used for agriculture, forest management, and other human activities which would not substantially interfere with public use and enjoyment of the rivers and their shores" (NYSDEC 1988a, as cited in CDM 1995: 2-3). Recreational rivers are "rivers or river sections readily accessible by road or railroad, which may have undergone development, impoundment, or diversion in the past" (NYSDEC 1988a, as cited in CDM 1995: 2-3), such as those reaches downstream of BNL.

Recreational activities afforded by the Peconic River include bird-watching, fishing, hunting, and canoeing. The entire Peconic River drainage is a Class I wetland. The Peconic River headwaters area is also identified as an "S1" habitat by the Natural Heritage Program, indicating that it is one of five or fewer coastal plain stream communities in the state.

4.4.5.4 Threatened and Endangered Species

DOE is in the process of consulting with the USFWS and the New York Department of

Table 4.4.5.3-1. Fish community above the wastewater discharge point within BNL.

Common Name	Scientific Name
Chain pickerel	*Esox niger*
Goldfish	*Carassius auratus*
Golden shiner	*Notemigonus chrysoleucas*
Creek chubsucker	*Erimyzon oblongus*
Brown bullhead	*Ameiurus nebulous*
Mummichog	*Fundulus heteroclitus*
Largemouth bass	*Micropterus salmoides*
Banded sunfish	*Enneacanthus obesus*
Pumpkinseed	*Lepomis gibbosus*
Yellow perch	*Perca flavescens*

Environmental Conservation regarding whether or not construction and operation of the proposed SNS at BNL would jeopardize the habitat of any federal or state protected species and about appropriate mitigation measures. The letters of consultation are presented in Appendix D.

New York State endangered species are defined as native species in imminent danger of extirpation or extinction in the state or listed as endangered by USFWS. State threatened species are native species likely to become endangered within the foreseeable future in New York or listed as threatened by USFWS. Special-concern species are native species for which a welfare concern or risk of endangerment has been documented by NYSDEC. Table 4.4.5.4-1 lists the state and federally listed threatened, endangered, or special-concern species. The tiger salamander is known to be breeding on laboratory property (CDM 1995).

The northwest portion of the proposed SNS site approaches wetlands associated with the Peconic River. This area may be suitable habitat for the tiger salamander and the spotted salamander.

Thirteen species of plants found on BNL are protected in New York State under Environmental Conservation Law (ECL) 9-1503 and New York State Regulation 193.3, which states the “no one may knowingly pick, pluck, sever, remove or carry away (without the consent of the owner thereof) any protected plant.” (This is a designation distinct from threatened, endangered, rare, or special concern.) (Table 4.4.5.4-2). Three of these plants, the spotted wintergreen, bayberry, and swamp azalea, have been found on the proposed SNS site (Black 1998).

Table 4.4.5.4-1. State and federally listed protected species reported to occur at BNL.

Common Name	Scientific Name	NYS Status	Federal Status
Osprey	*Pandion haliaetus*	T	
Peregrine falcon	*Falco peregrinus*	E	E
Common nighthawk	*Chordeiles minor*	SC	
Eastern bluebird	*Sialia sialia*	SC	
Spotted turtle	*Clemmys guttata*	SC	
Eastern hognose snake	*Heterodon platirhinos*	SC	
Spotted salamander	*Ambystoma maculatum*	SC	
Eastern tiger salamander	*Ambystoma tigtinum*	SC	
Banded sunfish	*Enneacanthus obesus*	SC	

T – Threatened
E – Endangered
SC – Special concern.

Table 4.4.5.4-2. Plants protected by ECL 9-1503 and New York State Regulation 193.3.

Common Name	Scientific Name
Butterfly weed	*Asclepias tuberosa*
Spotted wintergreen	*Chimaphila maculata*
Lady's slipper	*Cypripedium acaule*
Bayberry	*Myrica pensylvanica*
Flowering dogwood	*Cornus florida*
Swamp azalea	*Rhododendron viscosum*
Hayscented fern	*Dennestaedtia punctilobula*
Shield fern	*Dryopteris* sp.
Sensitive fern	*Onoclea sensibilis*
Cinnamon fern	*Osmunda cinnamomea*
Clayton's fern	*Osmunda claytoniana*
Royal fern	*Osmunda regalis*
Marsh fern	*Thelypteris palustris*
Virginia chain fern	*Woodwardia virginica*

Among the protected wildlife found in the Peconic River Basin are one endangered species, the tiger salamander; two special concern species, the spotted turtle and banded sunfish; and one candidate for threatened species, the swamp darter. The Peconic River is one of only two locations in the state known to support a population of banded sunfish. The distribution of the swamp darter in New York is limited to the eastern two-thirds of Long Island.

Four species of wildlife cited as unique (locally uncommon or color variants) are reported by NYSDEC to occur in the Peconic River drainage: a polymorphic variety of the northern water snake (*Nerodia sipedon*), a population of lead-backed salamander (color variant of the red-backed salamander), the stinkpot or musk turtle, and the river otter (*Lutra canadensis*). Although the four species are not recognized as endangered, threatened, or of special concern by NYSDEC, they are considered unique because the first two are color variants of a common species and the latter two are locally uncommon but widespread in New York. These four species were previously reported as occurring well downstream of the BNL site. Recently, the lead-backed salamander and the musk turtle have been reported on BNL property (CDM 1995).

4.4.6 SOCIOECONOMIC AND DEMOGRAPHIC ENVIRONMENT

The ROI for the SNS at the proposed BNL site includes Nassau and Suffolk Counties, as shown in Figure 4.4.6-1. Approximately 90 percent of BNL employees reside in this region. The region includes the cities of Levitown and Hicksville.

This section provides a description of the following socioeconomic and demographic characteristics:

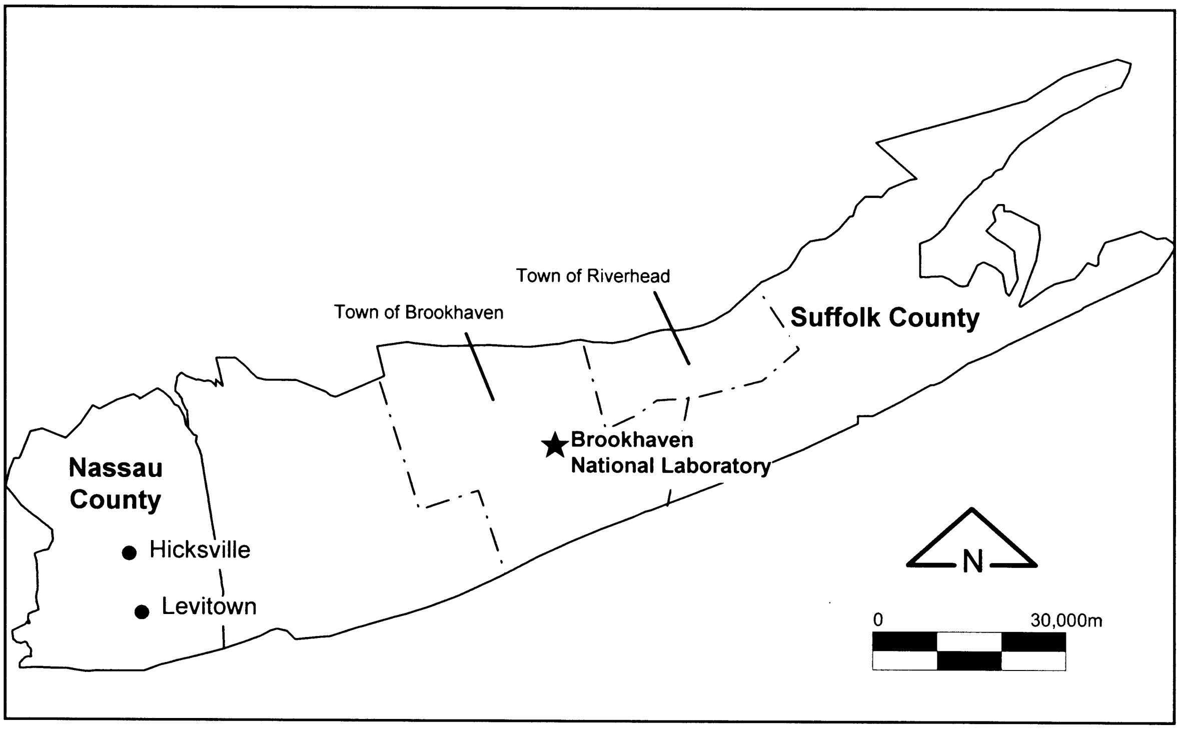

Figure 4.4.6-1. Map showing socioeconomic ROI for BNL.

- Demographics
- Housing
- Infrastructure
- Local economy
- Environmental justice

4.4.6.1 Demographic Characteristics

Population trends and projections for each of the counties in the ROI are presented in Table 4.4.6.1-1. Nassau and Suffolk Counties are of similar size, each having a population of approximately 1.3 million in 1995. Although the population of Suffolk County increased steadily since 1980, Nassau County was larger in 1980 than in 1995 (the county's population declined by 3 percent between 1980 and 1990).

Population data for selected cities in the region are presented in Table 4.4.6.1-2. Population growth has been slow throughout the region since 1980, with an increase of only 54,000 individuals (about 2 percent). Some communities, such as Levitown, have experienced population decreases between 1990 and 1997.

Population by race and ethnicity for the region is presented in Table 4.4.6.1-3. Both counties are predominantly Caucasian (87 to 90 percent). African Americans are the second largest racial group, comprising 6 to 9 percent of the two counties.

4.4.6.2 Housing

Regional housing characteristics are presented in Table 4.4.6.2-1. In 1990, vacancy rates in the region ranged between a low of 3 percent in Nassau County to a high of 12 percent in Suffolk County.

Table 4.4.6.1-1. Regional population trends and projections.

County	1980	1990	1995	2000	2010
Nassau	1,321,582	1,287,444	1,305,772	1,316,000*	1,346,000*
Suffolk	1,284,231	1,321,768	1,353,704	1,364,000*	1,418,000*
Region	2,605,813	2,609,212	2,659,476	2,680,000*	2,764,000*
State	17,558,165	17,990,778	18,136,000	18,146,000	18,916,000

* Estimated figure.
Sources: U.S. Bureau of Census 1990; U.S. Bureau of Census 1996.

Table 4.4.6.1-2. Population for incorporated areas within the region.

Communities	1990	1997
Levitown CDP	52,286	52,542
Hicksville	40,174	N/A
Brookhaven	407,779	419,745
Riverhead	23,011	24,589
Ridge CDP	11,734	11,935

N/A: Data for 1997 are not available.
Source: U.S. Bureau of Census 1990.

Table 4.4.6.1-3. 1990 population by race and ethnicity for the region.

All Persons, Race/ Ethnicity	Nassau		Suffolk	
	Number	Percent[a]	Number	Percent[a]
All Persons	1,287,444	100	1,321,768	100
Caucasian	1,116,949	87	192,236	90
African American	110,991	9	82,473	6
American Indian[b]	1,626	<1	3,233	<1
Asian/ Pacific Islander	38,914	3	22,185	2
Hispanic of any race[c]	77,386	6	87,852	7
Other Races	18,868	1	21,737	2

[a] Percentages may not total to 100 due to rounding.
[b] Numbers for Aleuts and Eskimos were placed in the “other” category given their small number.
[c] In the 1990 Census, Hispanics classified themselves as White, Black, Asian/Pacific Islander, American Indian, Eskimo, or Aleut. To avoid double counting, the number of Hispanics was subtracted from each of the race categories.
Sources: U.S. Bureau of Census 1990; U.S. Bureau of Census 1996.

Table 4.4.6.2-1. Housing summary for the region, 1990.

	Nassau County		Suffolk County	
	Number	**Percent[a]**	**Number**	**Percent[a]**
Total Housing Units	446,292	100	481,317	100
Occupied	431,515	97	424,719	88
Vacant	14,777	3	56,598	12
Median Home Value	$209,500	N/A	$165,900	N/A
Gross Rent	$749	N/A	$802	N/A

N/A = not applicable
[a] May not total 100 due to rounding
Sources: U.S. Bureau of Census 1990; U.S. Bureau of Census 1996.

In 1990, median home values were highest in Hicksville and Brookhaven (approximately $175,00 and above) and lowest in Riverhead and Ridge (approximately $135,000 and below). The median housing unit price in 1990 was $209,500 for Nassau County and $165,900 in Suffolk County.

4.4.6.3 Infrastructure

The infrastructure section characterizes the region's community services with indicators such as education, health care, and public safety.

4.4.6.3.1 Education

New York is divided into 774 school districts, 126 of which (626 schools) are located in the region. Information regarding school districts within the region is presented in Table 4.4.6.3.1-1. Teacher-student ratios of below 1:15 are regarded as exceptional. By comparison, many public school districts throughout the United States staff classrooms at a ratio of around 1:20. Student enrollment in the Nassau-Suffolk area could increase by a substantial margin and still not exceed the 1:20 ratio.

The school districts in the region all receive funding from local, state, and federal sources, but the percentage received from each source varies.

4.4.6.3.2 Health Care

There are currently 27 hospitals serving the region with 8,600 acute care beds (Table 4.4.6.3.2-1). On the average, these hospitals have a relatively high use rate, with less than 10 percent of beds available.

4.4.6.3.3 Police and Fire Protection

Table 4.4.6.3.3-1 gives the number of full-time law enforcement officers for the incorporated communities in the BNL region. Nassau County has 2,988 officers and an approved FY 1998 budget of over $469 million, and Suffolk County has 129 officers. Because of the potential severity of the consequences of a BNL emergency, the fire department has been specially trained to respond to a variety of incidents.

Table 4.4.6.3.1-1. Public school statistics in the region, 1995–1996 school year.

County	Number of Schools	Student Enrollment[a]	Teachers[a]	Teacher/ Student Ratio (1998)	Per Student Operational Expenditures
Nassau	295	317,875	24,450	1:13	$11,697
Suffolk	331	347,688	24,830	1:14	$11,168
Region	626	665,563	49,280	1:14	$11,421

[a] Full-time equivalent figures.
Source: New York State Education Department 1996.

Table 4.4.6.3.2-1. Hospital capacity and usage in the region.

Hospital	Number of Hospitals	Number of Beds[a]	Annual Bed-Days Used[a](%)
Nassau	14	4,746	93
Suffolk	13	3,902	94
Region	27	8,648	93

[a] Based on the number of people discharged and the average length of stay divided by total beds available annually.
Source: New York State Department of Health 1996.

Table 4.4.6.3.3-1 Full-time law enforcement officers for incorporated areas within the BNL region (1996).

Community	Officers
Nassau County	2,988
Suffolk County	129
Riverhead	73

Source: Department of Justice, 1997.

4.4.6.4 Local Economy

This subsection provides information on the economy of the region, including employment, education, income, and fiscal characteristics.

4.4.6.4.1 Employment

Regional employment data for 1997 are summarized in Table 4.4.6.4.1-1. Since 1994, the regional unemployment rate has decreased from 5.6 percent to only 3.4 percent. The majority of new jobs in the ROI are associated with retail trade and services.

Table 4.4.6.4.1-2 presents employment industry for the ROI. Government, services, and retail trade are the principal economic sectors in the region, making up about 65 percent of all 1995 jobs. By comparison, in 1990 these three sectors comprised around 60 percent of all jobs.

4.4.6.4.2 Income

In 1995, total regional income was approximately $85.3 billion. Income data for the ROI are presented in Table 4.4.6.4.2-1. Only 3 percent of all families in the region had 1989 incomes below the poverty level, which was considerably less than the statewide average.

4.4.6.4.3 Fiscal Characteristics

Municipal and county general fund revenues in the ROI are presented in Table 4.4.6.4.3-1. The general funds support the ongoing operations of local governments, as well as community services such as police protection and parks and recreation. The largest single component for the two ROI counties was local taxes, which includes real estate, property, hotel/motel, and sales taxes. ROI local taxes represented about 60 percent of the general fund revenues in that year, and intergovernmental were about 30 percent.

Table 4.4.6.4.1-1. Regional employment data, 1997.

County	Civilian Labor Force	Employed	Unemployed	Unemployment Rate
Nassau	695,155	674,300	20,855	3.0
Suffolk	711,007	684,700	26,307	3.7
Region	1,406,162	1,359,000	47,162	3.4

Source: New York State Department of Labor 1998.

Table 4.4.6.4.1-2. Employment by county, region, and the State of New York (1995).

Economic Character	Nassau County	Suffolk County	Region	State of New York
Employment by Industry (1995)				
Farm	107	2,547	2,654	60,966
Agriculture Services	5,795	8,998	14,793	67,572
Mining	579	422	1,001	10,748
Construction	26,481	37,237	63,718	373,361
Manufacturing	47,324	72,533	119,857	982,532
Transportation and Public Utility	31,377	28,501	59,878	476,424
Wholesale Trade	45,442	39,910	85,352	463,204
Retail Trade	127,254	106,647	233,901	1,403,944
Finance, Insurance, and Real Estate	95,237	50,570	145,827	1,049,318
Services	273,388	212,722	486,110	3,433,419
Government	80,555	100,867	181,422	1,419,305
Total Employment	733,539	660,954	1,394,513	9,740,793

Source: Regional Economic Information for Nassau and Suffolk Counties, Nassau-Suffolk, NY PMSA and NYS 1990–1995 (U.S. Bureau of Census 1990).

Table 4.4.6.4.2-1. Measures of BNL regional income.

Area	Median Household Income 1989 ($)	Per Capita Income 1996 ($)
Nassau County	54,283	23,352
Suffolk County	49,128	18,481
New York State	32,965	16,501

Source: U.S. Bureau of Census 1990.

Table 4.4.6.4.3-1. Municipal and county general fund revenues in the region, FY 1997.

Revenue by Source	($1,000)	Percent[a]	($1,000)	Percent[a]
Local Taxes[a]	779,293	63	697,076	57
Licenses and Permits	3,445	<1	0[b]	N/A
Fines and Forfeitures	8,853	<1	0[b]	N/A
Charges for Service	0[b]	NA	103,784	9
Intergovernmental[c]	407,192	33	349,357	29
Interest	47,999	4	0[b]	N/A
Miscellaneous Income	450	<1	64,588	5
Total	1,247,232	100	1,214,804	100

[a] Local taxes include real estate and personal property taxes, hotel/motel taxes, and local sales taxes.
[b] This revenue item accounted for under other revenue sources.
[c] Includes payments of state and federal funds.
N/A = not available.
Source: U.S. Bureau of Census 1990; Comprehensive Annual Financial Reports 1997c.

4.4.6.5 Environmental Justice

Figures 4.4.6.5-1 and 4.4.6.5-2 illustrate distributions for minority and low-income populations residing within 50 miles (80 km) of BNL. The definitions of minority and low-income populations and the methodology for assessing potential environmental justice effects are given in Section 5.5.6.5.

Approximately 5,260,000 people live within a 50-mi (80-km) radius of BNL. Minorities comprise 21.4 percent of this population. In 1990, minorities comprised 24.1 percent of the population nationally and 26 percent of the population in New York. There are no federally recognized Native American groups within 50 miles (80 km) of the site. The percentage of persons below the poverty level is 5.4 percent, which compares with the 1990 national average of 13.1 percent and a statewide figure of 23 percent (U.S. Census 1990).

4.4.7 Cultural Resources

BNL is located in an area of Long Island that has a long cultural history. The first inhabitants of the area were Native American groups, many

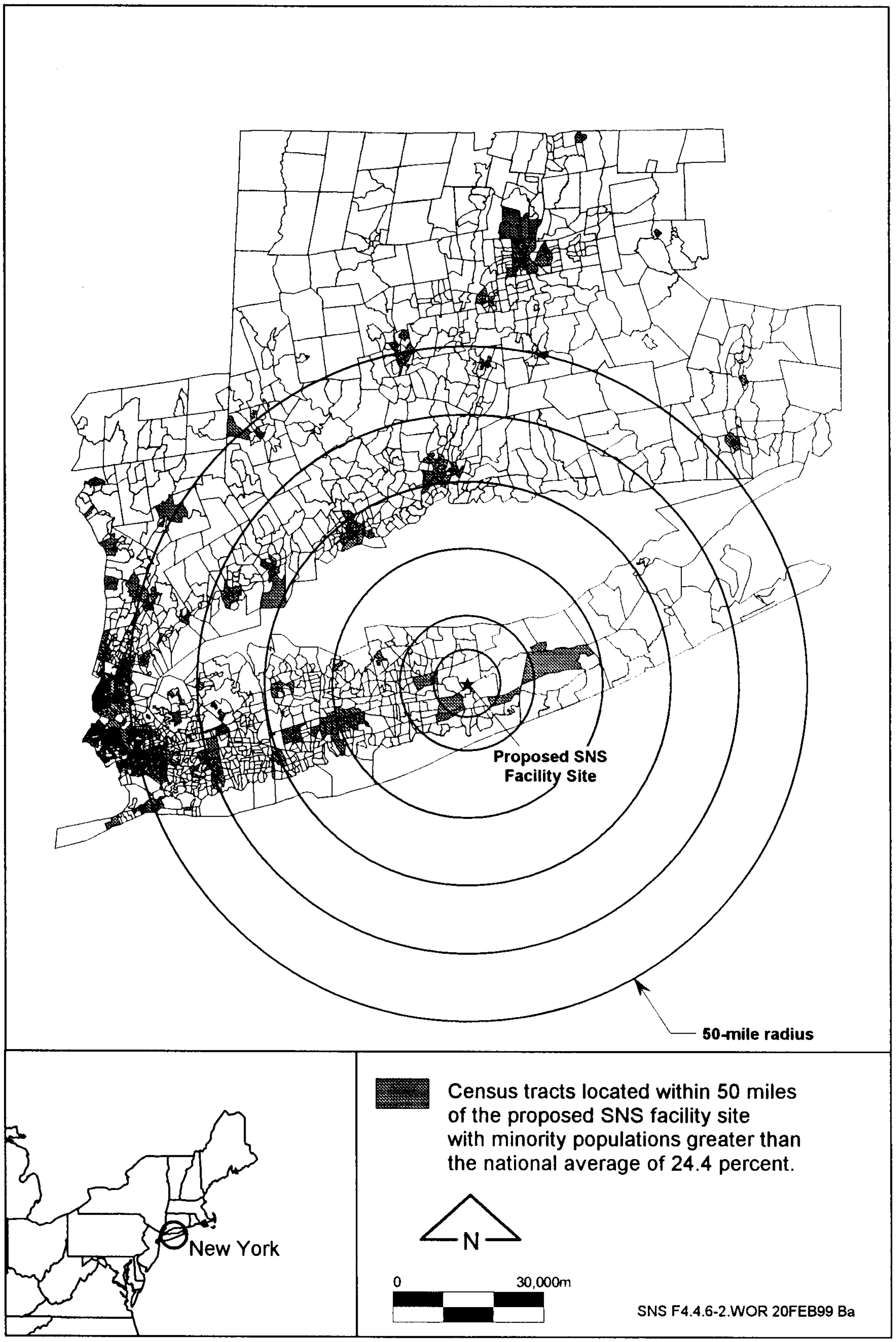

Figure 4.4.6.5-1. Distribution of minority populations at BNL.

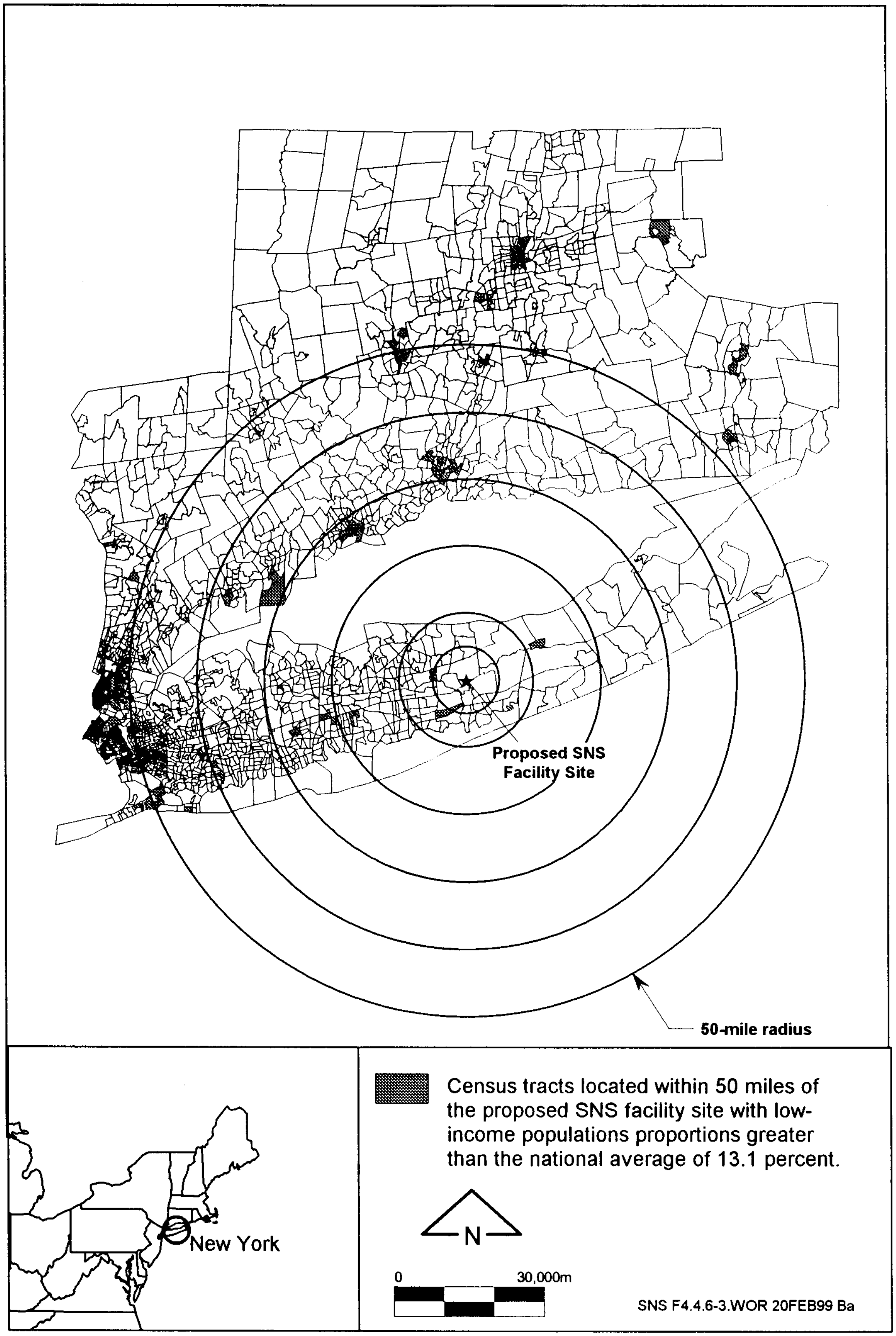

Figure 4.4.6.5-2. Distribution of low-income populations at BNL.

with cultures adapted to life in a marine coastal setting. European settlement of the area began in the 17th century. The first European settlement in Suffolk County can be traced historically to A.D. 1640, when English settlers established Southampton and Southold (BNL 1995: 4-1). Since this time, the area has been inhabited continuously, primarily by Euroamerican settlers and their descendants. Given the depth of local history, the citizens of the area are actively involved in the preservation of cultural resources such as historic sites and buildings (BNL 1995: 4-1).

The prehistory of BNL land remains largely unknown because most of it has never been surveyed for prehistoric archaeological sites (BNL 1995: 4-5). Prior to initiation of this EIS, only two archaeological studies had been conducted at BNL. One of these studies was a reconnaissance survey limited to the periphery of three ponds, a wooded area covering approximately 20 acres (8.1 ha), and areas along the Peconic River (Johannemann 1974: B-2 to B-3). The other study consisted of archaeological test excavations in the area that was to be impacted by the ISABELLE/Colliding Beam Accelerator (CBA), which was begun during the 1970s and later canceled (Johannemann and Schroeder 1977). Both studies covered small portions of the 5,261 acres (2,130 ha) of land at BNL, and no evidence of prehistoric human activity was encountered.

A brief history of land use at BNL has been prepared and published by Associated Universities, Inc. (BNL 1995), the former management and operating contractor for the laboratory. This history begins in 1917 with the establishment of Camp Upton, a large U.S. Army induction center and hospital that was occupied until about 1921. It continues with the demise of Camp Upton shortly after World War I, its reestablishment during World War II, and its final closure at the end of the war. The history concludes by tracing the general development of BNL during the period 1947 to 1997. However, this history has never been supplemented with a detailed, site-wide survey for historic archaeological sites and other types of historic cultural resources.

Fourteen historic archaeological sites dating to the Camp Upton occupation of BNL land have been identified and partially excavated within the ISABELLE project area (Johannemann and Schroeder 1977: 33-53). This area and the partially constructed accelerator facilities in it have been incorporated into construction of the RHIC.

A limited review of all BNL properties for historical resources was conducted in June 1990 by representatives from the SHPO for the state of New York. As a result of this review, three potentially significant historic resources were identified: a group of World War I trenches dating to the Camp Upton occupation, the Graphite Reactor Building (Building 701), and the Old Cyclotron Enclosure (Building 902). These resources are considered to be potentially eligible for listing on the NRHP (DOE-BNL 1994a: 19; Naidu et al. 1996: 2-44). A formal historical context for these resources has not been developed.

A cultural resources survey of the proposed SNS site and an adjacent buffer zone was conducted in January 1998. This survey focused on identifying prehistoric and historic remains in these areas. The results of the survey are summarized in Sections 4.4.7.1 and 4.4.7.2.

The SNS design team has not established the areas where construction or improvement of utility corridors and roads would be necessary to support the proposed SNS at BNL. In addition, the locations of ancillary structures such as a retention basin and a switchyard have not been determined. As a result, such areas could not be surveyed for cultural resources. However, the eventual establishment of these areas would proceed in such a manner as to avoid known cultural resource locations. If the proposed SNS site at BNL were chosen for construction, these areas would be surveyed for cultural resources prior to the initiation of construction-related activities within them.

The occurrence of cultural resources on the proposed SNS site and in its vicinity is described in this section of the FEIS. However, the locations of archaeological and historic sites are not indicated in the descriptions. To better protect these sites, DOE and Brookhaven Science Associates do not reveal the locations of cultural resources in documents available to the general public. Because several of the original reports cited in this section show the locations of cultural resources on BNL, they are not included in the DOE public reading rooms established as part of the SNS FEIS process.

4.4.7.1 Prehistoric Resources

No prehistoric cultural resources have been identified on or adjacent to the proposed SNS site (Black 1998: 5).

4.4.7.2 Historic Resources

A number of earthen berms, linear trenches, pits, and mounds have been identified at four separate locations throughout the proposed SNS site. These locations were designated as Stations 2, 4, 8, and 10. The landscape features at these stations may have been associated with World War I trench warfare training at Camp Upton. At Station 2 on the proposed SNS site, a group of berms and pits may be the remains of a command post associated with adjacent trenches. If they were associated with World War I training exercises, all of these features would date to 1917–1918. No standing Historic Period structures were identified on or adjacent to the proposed SNS site (Black 1998: 4-6).

The earthen features at Stations 2, 4, 8, and 10 are considered potentially eligible for listing on the NRHP, based on the results of the 1997 site survey and past New York SHPO concern for World War I trench warfare training features at BNL (DOE-BNL 1994a: 19; Black 1998: 6; Brown 1998b: 1). However, no surface artifacts definitively dating to World War I were found in association with these features during the survey. As a result, archaeological testing would be necessary to positively determine their historical context and to obtain additional data relevant to a formal eligibility determination. Until such assessments can be made, the indicated course of action is to manage these features as significant cultural resources that are eligible for listing on the NRHP.

4.4.7.3 Traditional Cultural Properties

No Native American tribal representatives have been identified in the BNL area, and no Native American lands are located on the BNL site. Because no Native American groups have been identified, it has not been possible for DOE to consult with such groups concerning the potential occurrence of TCPs on and near the proposed SNS site. A survey of the proposed site and limited surveys of other areas at BNL have encountered no evidence of prehistoric occupations. In addition, no Native American TCPs have been identified in the BNL area. Based upon these results, it has been concluded that no TCPs occur on the proposed SNS site or anywhere else on laboratory land (White, B. 1998b: 1).

4.4.7.4 Consultation with the State Historic Preservation Officer

Section 106 of the NHPA requires a review of proposed federal actions to determine whether or not they would impact properties listed on or eligible for listing on the NRHP. DOE-Brookhaven Group has consulted with the SHPO in New York concerning the occurrence of such properties within the area of potential impact of the proposed SNS at BNL. The consultation letter sent to the SHPO at the New York State Office of Parks, Recreation, and Historic Preservation is provided in Appendix D.

4.4.8 LAND USE

Land uses in the vicinity of BNL, within the boundaries of BNL, and on the proposed SNS site are described in this section. The descriptions cover past, current, and future uses of the land in these areas. In addition, they include descriptions of environmentally sensitive land areas that have been set aside for public use, environmental protection, or research. These areas include parks, natural areas, environmental education centers, and public recreation areas. The section concludes with a discussion of visual resources.

4.4.8.1 Past Land Use

The land occupied by BNL and the surrounding area was largely wilderness prior to 1917. Although this remote inland landscape probably supported a sparse residential population and some agricultural activities during this period, most of the residential, commercial, industrial, and recreational land use in the area were centered in nearby coastal areas and urban centers such as Brookhaven and Southampton.

The U.S. Army established and operated Camp Upton on BNL land from 1917 to 1920. Because it functioned as an induction and convalescent center during this period, much of the camp land was devoted to residential use and soldier training. Considering the wide range of activities typically conducted at large military installations, some areas of the camp may have been devoted to industrial, commercial, agricultural, and recreational uses. With closure of the camp in 1920, a major shift in land use occurred. The federal lands at Camp Upton were managed for the next 20 years as Upton National Forest. From 1940 to 1945, Camp Upton was reestablished and operated once again as an induction and convalescent center. During both military periods, portions of camp land probably remained as undeveloped open space (BNL 1995: 4-1 to 4-2 and 4-5).

BNL was established on the Camp Upton site in January 1947, and the new research center began by using many of the remaining Camp Upton facilities. During the ensuing 50 years, the current pattern of land use at BNL developed (BNL 1995: 1-4 and 4-2).

The land on the proposed SNS site has been undeveloped open space for at least the past 50 years, but the major historical centers of laboratory activity surround the site and are located within 492 to 2,297 ft (150 to 700 m) of it. The only major activity that appears to have been conducted at this location was construction of several roads that crisscross the site. As a result, none of the surficial soils on the site have been contaminated by past laboratory uses of the land (BNL 1995: 4-19). The site overlaps the boundary between environmental restoration Operable Units III and V, which indicates the possibility of groundwater contamination beneath the proposed SNS site. If such contamination is present, it has probably arrived through subsurface migration from past BNL waste disposal, accidental spill, or routine release locations outside of the proposed site (BNL 1995: 7-6 to 7-9).

4.4.8.2 Current Land Use

Most of the land surrounding BNL is developed for commercial, industrial, or residential use. With respect to residential use, the area in the vicinity of BNL is lightly settled, especially compared to the dense population on west Long Island. Combined commercial, industrial, and residential use account for 38 percent of the land in the area. Another 32 percent of the land is used for recreational (parklands), institutional (educational facilities, hospitals, etc.), and transportation (airports, roads, etc.) purposes. The remaining 30 percent of the land is undeveloped woodlands and agricultural areas (BNL 1995: 6-2 to 6-4 and 8-1).

Land clearing has been initiated for a new 150-acre (60.7-ha) shopping mall (Brookhaven Town Center) located in close proximity to BNL. The mall site is at the intersection (northwest corner) of the Long Island Expressway and William Floyd Parkway. The parkway serves as a buffer between BNL and the mall site (Yadav 1998:1).

BNL occupies 5,261 acres (2,130 ha) of land near the geographic center of Suffolk County (BNL 1995: 4-5). The current use of this land is classified according to four major categories: Industrial/Commercial, Agricultural, Residential, and Open Space. The locations of these land use areas are shown in Figure 4.4.8.2-1.

Approximately 75 percent of the land within the BNL boundaries is Open Space, and with the exception of firebreaks, environmental monitoring wells and stations, utility rights-of-way, and recreation fields, most of this land is in a natural state. The large expanse of Open Space surrounding the developed central area of BNL serves as a buffer zone for the Industrial/ Commercial land use in this area.

The land areas categorized as Industrial/ Commercial contain most of BNL's buildings and major research facilities. These areas of land include the central portion of BNL, RHIC ring, STP, Hazardous Waste Management Facility, and NEXRAD weather radar facilities.

The latter are on 7.4 acres (3.0 ha) of land leased by DOE to the U.S. Department of Commerce, NOAA. The major research facilities in the Industrial/Commercial areas are the Alternating Gradient Synchrotron, National Synchrotron Light Source, Scanning Transmission Electron Microscope, HFBR (BNL 1995: 8-4).

Two areas in the southwest corner of BNL are devoted to Residential use by laboratory visitors and temporary staff. The total area of land devoted to Residential use is 170 acres (69 ha). The largest of these areas is surrounded entirely by Open Space. The smaller area is adjacent to the Industrial/Commercial use area. Apartment buildings, dormitories, summer cottages, efficiencies, mobile homes, houses, guest rooms, and a child care facility are located within the Residential use areas (BNL 1995: 8-7).

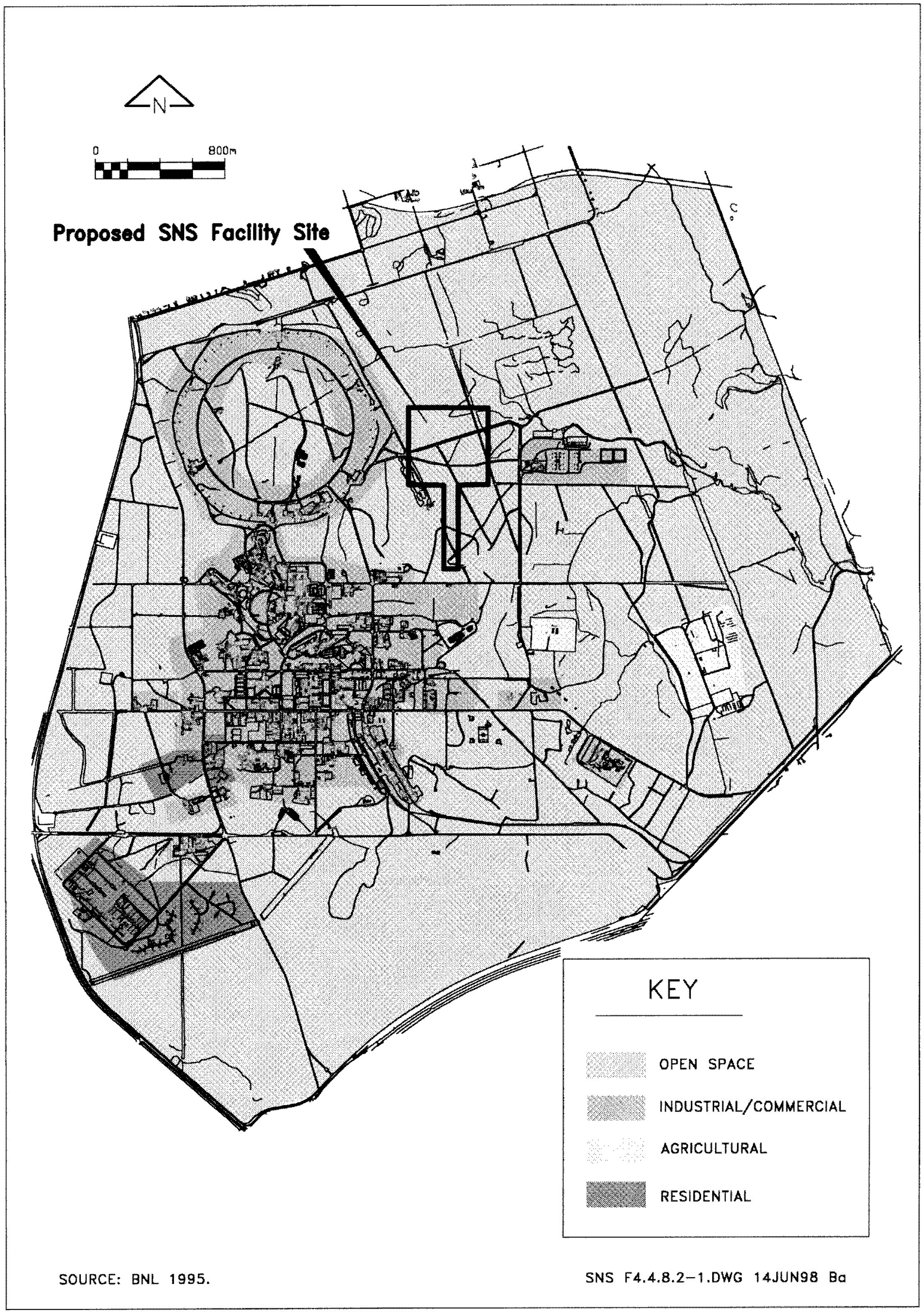

Figure 4.4.8.2-1. Map of current land use at BNL.

The proposed SNS site is located entirely within an area categorized as Open Space. Industrial/Commercial use areas surround this site in relatively close proximity. The location of the proposed site relative to current land use areas is shown in Figure 4.4.8.2-1.

Two small areas of BNL land [69.2 acres (28 ha)] are used for agricultural purposes. They are located in the eastern area of BNL, and each is completely surrounded by land categorized as Open Space. The crops grown on this land are used for biological research (BNL 1995: 8-7). None of the areas designated as Open Space are used for ecological research (BNL 1995: 9-3). Thus, the land on and in the vicinity of the proposed SNS site is not being used for environmental research projects.

4.4.8.3 Future Land Use

Future use of the land surrounding BNL has been set forth in local government master plans. These plans call for retention of residential land use on the Long Island shores. The central areas of Long Island would be developed for commerce, culture, light industry, and high technology. Adjoining areas would be devoted to high-density cluster housing and medium-density housing for single families. The local plans would preserve agricultural lands, parks, and open wooded areas (BNL 1995: 6-2).

Proposals for an industrial park and housing developments adjacent to BNL have been presented to the Town of Brookhaven. The area immediately to the north and west of BNL is wooded, privately owned, and zoned for residential development. BNL reviews local government master plans and proposed development actions such as these to assess potential impacts on its operations (BNL 1995: 6-4).

Land use at BNL has been projected for the next 20 years through a formal land use planning process. Up to 20 percent of the land that is now Open Space is zoned for future Industrial/ Commercial use. Two different versions of Industrial/Commercial zoning at BNL are available, and each version is related to a large facility acquisition that might occur within the next 20 years. One is based on possible construction of a new linear accelerator (Figure 4.4.8.3-1). The other version is based on possible construction of a muon-muon collider (Figure 4.4.8.3-2). Land in the Commercial/ Industrial zoning category could be used for other types of new research facilities, as well.

The areas of BNL land zoned as Open Space would remain as natural areas, except for the addition of groundwater monitoring wells on the site perimeter. Several stakeholders in the area have indicated that some Open Space could be used for short- and long-term ecological research. However, the laboratory has made no plans for ecological research, and no Open Space areas have been set aside for that purpose (BNL 1995: 9-3). The current pattern of agricultural land use would continue unchanged into the future. The Residential zoning anticipates a future contraction of the small housing area now in use in the southwest corner of BNL and an expansion of the larger residential area to meet gradually growing demands for housing (BNL 1995: 9-1 to 9-9).

The proposed SNS site is located on land that is zoned for Open Space and Industrial/ Commercial use. A comparison of Figures 4.4.8.3-1 and 4.4.8.3-2 indicates that slightly

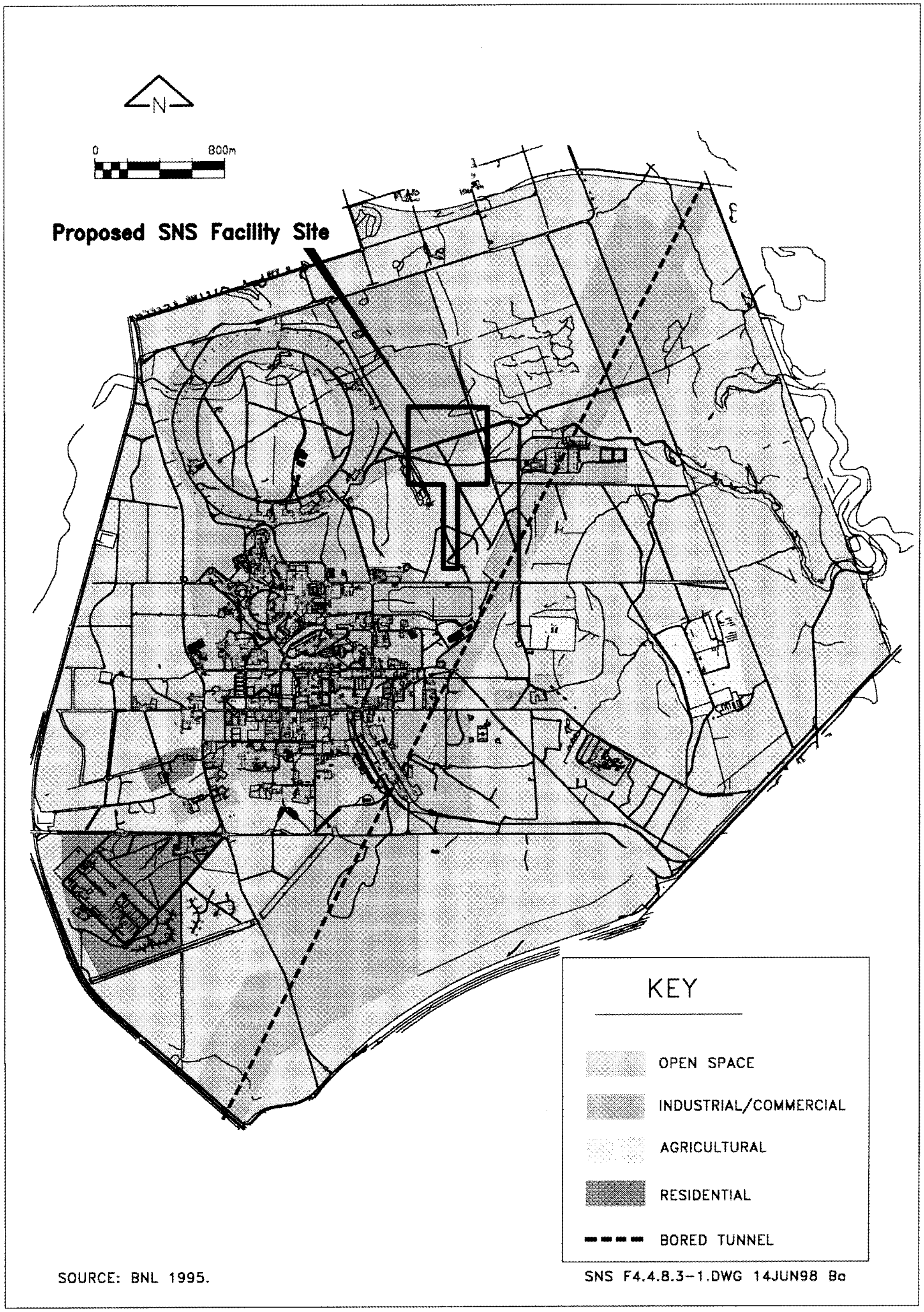

Figure 4.4.8.3-1. Map of land use zoning at BNL (Linear Accelerator Plan).

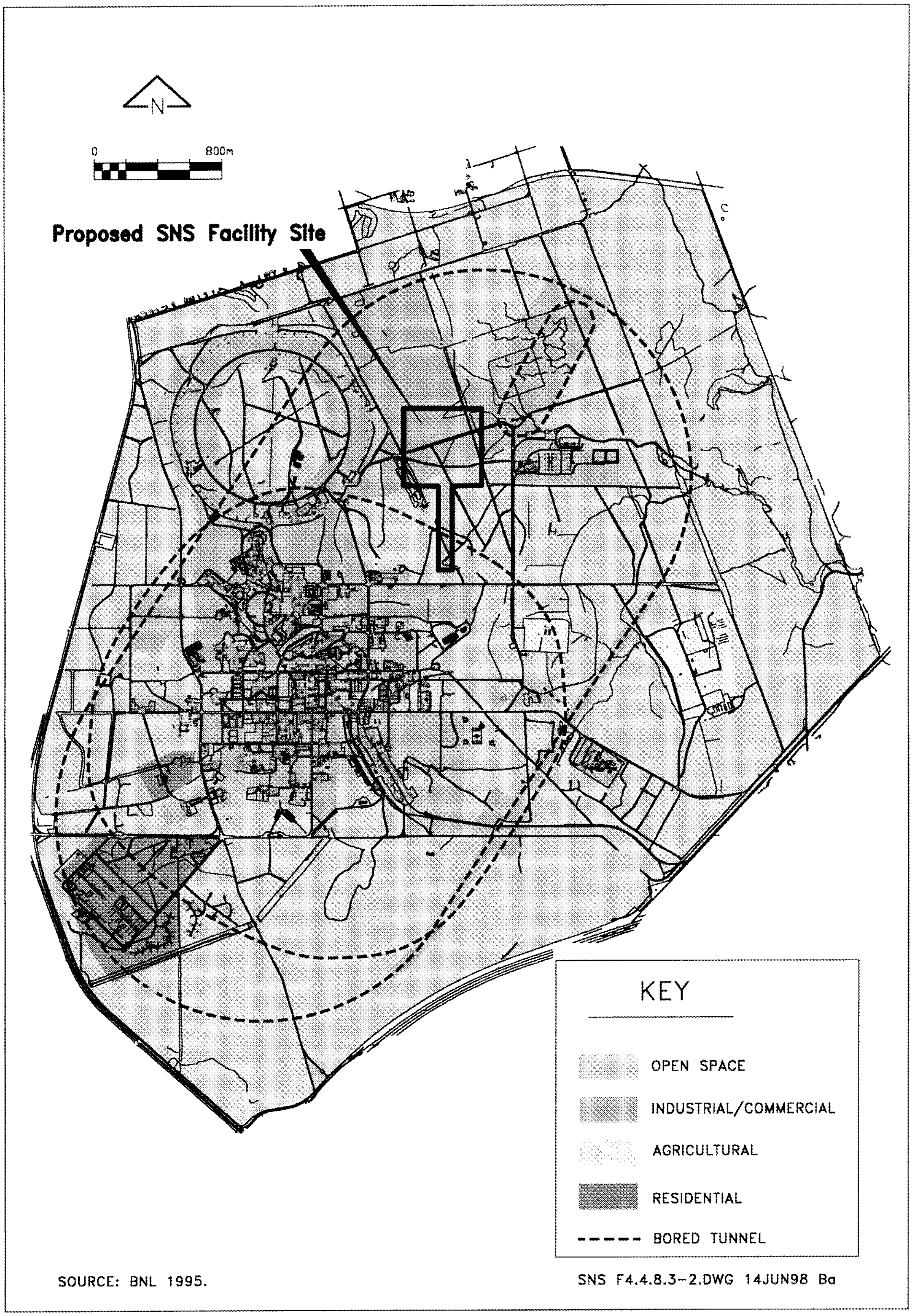

Figure 4.4.8.3-2. Map of land use zoning at BNL (Muon-Muon Collider Plan).

more Industrial/Commercial land would lie within the proposed site under the muon-muon collider version of zoning. No future uses of proposed SNS site and vicinity land for environmental research are planned.

The end uses of BNL land upon eventual closure of the laboratory have been considered in the land use planning process. The zoning for end use is shown in Figure 4.4.8.3-3. This zoning pattern reflects environmental restoration considerations and solicited input from citizen stakeholders living in the surrounding area. This zoning does not account for the possible presence of the proposed SNS, because construction of the proposed SNS at BNL was not an issue when this zoning was completed in 1995.

4.4.8.4 Parks, Preserves, and Recreational Resources

The laboratory is located in an area of Long Island where much of the land is preserved in its natural state as parkland. In 1993, the state of New York passed the Long Island Pine Barrens Protection Act, requiring the comprehensive management of environmentally sensitive pine barrens areas [100,035 acres (40,500 ha)] in the vicinity of the towns of Brookhaven, Riverhead, and Southampton, as well as two villages in Suffolk County. For protection and management purposes, the Central Pine Barrens Zone was subdivided into a Core Preservation Area and a Compatible Growth Area. The principal management goal for the Core Preservation Area is to preserve its natural state by limiting or prohibiting construction, development, and other activities. However, such activities are more possible within the Compatible Growth Area.

The Compatible Growth Area encompasses the central portion of BNL, where most of the laboratory's existing facilities are located. The Core Preservation Area encompasses 1,235 acres (500 ha) of BNL land on the north and south sides of the laboratory. The proposed SNS site and immediately adjacent land are located entirely within the Compatible Growth Area (BNL 1995: 1-2 to 1-3 and 7-2 to 7-3; Helms 1998: 4).

It is the position of DOE that the Long Island Pine Barrens Protection Act does not give the state of New York jurisdiction over the use of federal land at the laboratory. However, BNL has been providing technical support to the Pine Barrens Commission and has agreed to use the Long Island Pine Barrens Management Plan as a guide in site development and future land use planning (BNL 1995: 7-3).

A number of major parks, nature preserves, and recreational areas are located in the general vicinity of BNL. These locations are listed and described in Table 4.4.8.4-1.

4.4.8.5 Visual Resources

BNL is located on gently rolling land near the center of Long Island, New York. The area is mostly suburban in character. As a result, the broad area surrounding the laboratory is largely developed for residential and commercial purposes. In addition, large portions of laboratory land are developed. As a result, most views in the area contain a mixture of man-made and natural features. No established visual resources that include the proposed SNS site are known to exist in the vicinity of the laboratory.

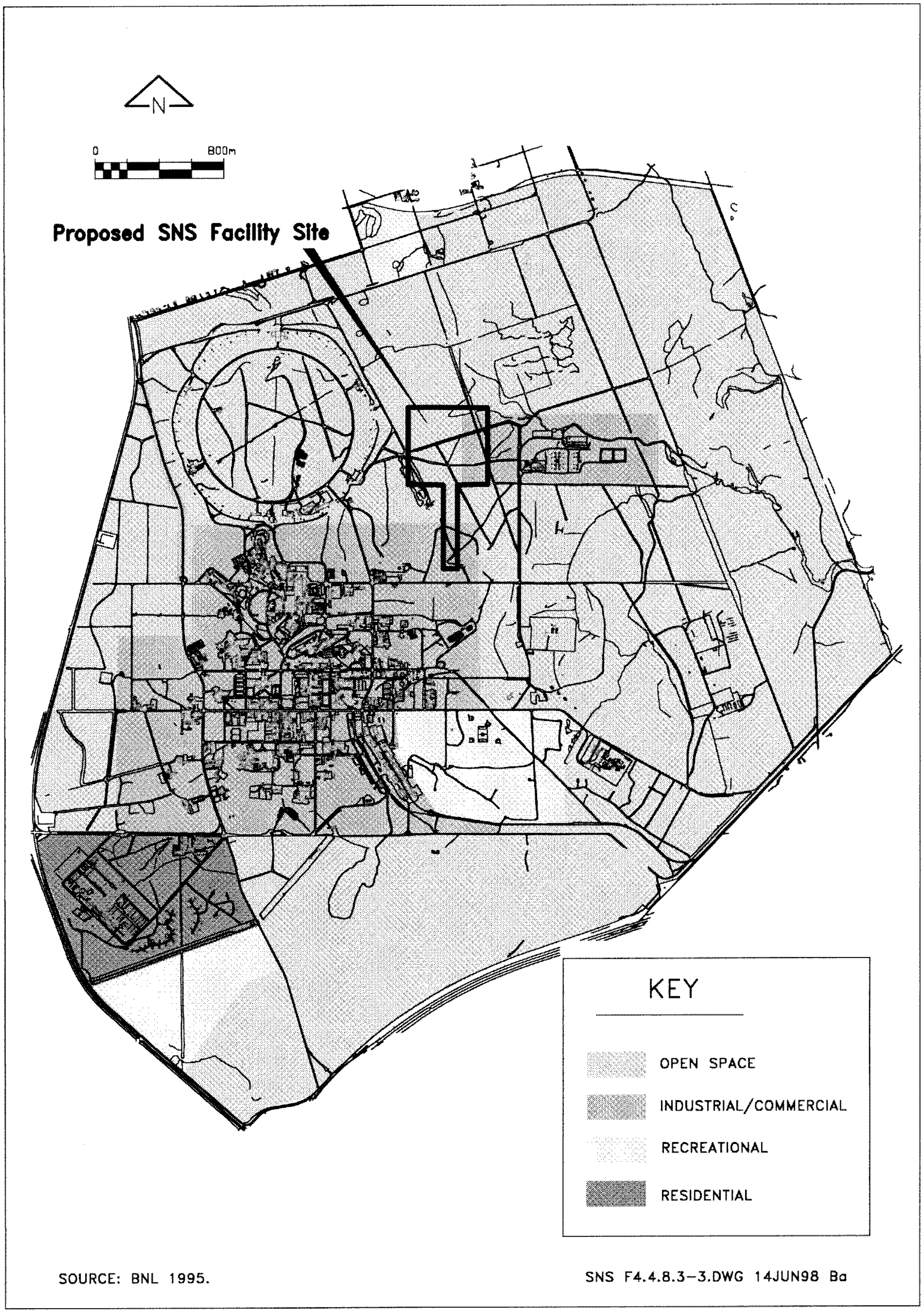

Figure 4.4.8.3-3. Map of end use zoning at BNL.

Table 4.4.8.4-1. Major parks, preserves, and recreational areas in the vicinity of BNL.

Facility	Direction from BNL[a]	Distance (mi/km)	Description and Uses
Peconic River	E	0-12.4/0-20	New York State Scenic and Recreational River. Fishing and canoeing.
Brookhaven State Park	N	0.3/0.5	Undeveloped state park. Hunting and hiking. Hiking trail along east boundary of BNL.
Rocky Point State Park	NW	1.9/3	Hunting, horseback riding, hiking, mountain biking.
Calverton Naval Weapons Plant	E-NE	0.3/0.5	Property being transferred to local government. Undeveloped portions used for hunting, hiking, fishing, horseback riding, and mountain biking.
Wildwood State Park	NE	5.6/9	State park developed for camping, swimming, and hiking.
Cathedral Pines County Park	W	1.2/2	County park used for hiking and mountain biking.
Carmens River	W	1.9/3	New York Scenic and Recreational River.
South Haven County Park (Carmens River)	W-SW	1.2/2	County park used for fishing, canoeing, hiking, picnicking, and skeet shooting.
Wertheim National Wildlife Refuge	SW	3.1/5	Protected area along the southern portion of the Carmens River to its discharge into Bellport Bay. Protection of wildlife and canoeing.
Randall Road Hunting Station	NW	0.6/1	Small state conservation area and checking station for hunters.

[a]NE- northeast, SE- southeast, SW- southwest, NW- northwest.
Source: Helms 1998.

4.4.9 RADIOLOGICAL AND CHEMICAL ENVIRONMENT

This section covers the radiological environment pathways and the chemical environment pathways associated with the site.

4.4.9.1 Radiological Environment

The principal sources of radiation at BNL include the HFBR, the Brookhaven Medical Research Reactor, and the Brookhaven Linear Accelerator Isotope Production Facility. Much smaller sources of radioactivity include Building 801 and the Alternating Gradient Synchrotron Facility.

4.4.9.1.1 Air

On a weekly basis, BNL collects air samples from six stations around the site and analyzes them for radioactive content. Results from air monitoring in 1995 indicate that the maximum tritium concentration recorded in a single event was 78 pCi/m³ at the northeast section of the laboratory. Annual gross alpha results ranged from <0.01 to 0.03 pCi/m³ while gross beta results ranged from 0.02 to 0.07 pCi/m³.

In 1995, the EDE to the maximally exposed off-site individual adjacent to the north-northeast boundary was estimated to be 0.06 mrem. Approximately 94 percent of this dose is attributed to ^{41}Ar released from the Brookhaven

Medical Research Reactor. By comparison, 0.06 mrem is well below the EPA airborne dose limit of 10 mrem per year. The collective dose to the population within a 50 miles (80 km) radius of BNL was estimated to be 3.2 person-rem.

4.4.9.1.2 Water

In early 1997 sampling in the vicinity of the HFBR identified tritium in the groundwater, with levels exceeding 600,000 pCi/L. Subsequent investigations narrowed the source of groundwater contamination to a leak in the reactor's spent fuel pool and determined that the plume extended a distance of 1200 m (4000 ft) south of the HFBR at a depth of 6–15 m (20–50 ft) below the ground surface. The contaminated plume front was located at approximately 760 m (2500 ft) from the site boundary, advancing at approximately 1 ft per day. In May 1997 BNL installed a pump-and-recharge system as an interim measure to ensure that tritium above the EPA drinking water standard (20,000 pCi/L) will not leave the BNL site boundary. A permanent remedy for the tritium plume is currently undergoing regulatory review with extensive community involvement (BNL 1998).

Monitoring of the surface water for the Peconic River watershed is performed at two stations within BNL, four stations downstream of BNL, and one station on the Carmens River for a reference location. With the following exceptions, radiological constituents in 1995 were either not detectable or at ambient levels. The ^{137}Cs levels within BNL (max 1.18 pCi/L and avg. 0.87 pCi/L at Station HM located interior to BNL) were slightly greater than ambient levels but consistent with the outfall at the STP and far below the DOE DCG of 3,000 pCi/L. The principal radionuclide detected at the STP Peconic River Outfall was tritium. The total annual release of tritium to the Peconic River in 1995 was 2.7 Ci, and the average annual tritium concentration was 2,960 pCi/L (compared to NYSDWS 20,000 pCi/L). Because the Peconic River is not used either as a drinking water supply or for irrigation, its waters do not constitute a direct pathway for the ingestion of radioactive material.

Potable and process groundwater supply wells were sampled for gross alpha and beta activity, tritium, and gamma-emitting radionuclides in 1995. Radioactivity was typical of regional water samples. Tritium was not observed above the minimum detection limit in any of the wells and gamma emitters were not detected in all the wells but one (Well No. 4 contained gamma activity levels close to the detection limit, making the results inconclusive).

BNL collects groundwater from 207 monitoring wells and performs analysis for radioactive constituents. Data from private wells adjacent to BNL were used to estimate the potential maximum EDE to an individual from water ingestion. Tritium was the only radionuclide detected in the wells. Maximum tritium concentration observed in a private well was 2,520 pCi/L, roughly eight times less than the 20,000 pCi/L limit established by the EPA. The corresponding dose to that maximally exposed individual is 0.1 mrem. Safe Drinking Water Act Standards restrict the annual dose limit to 4 mrem per year for the drinking water pathway.

Approximately five groundwater monitoring wells are within the immediate vicinity of BNL's preferred proposed SNS site. Data from these wells indicate that most of the wells are below the detection limit for all measured radionuclides. One well exhibits very slightly elevated ^{137}Cs and ^{90}Sr, which are 4.30 pCi/L and 1.49 pCi/L, respectively. To the east of the preferred site, wells at the STP exhibit slightly elevated levels of tritium, ^{137}Cs, and ^{90}Sr, primarily due to liquid effluents processed at the STP both past and present.

4.4.9.1.3 Soils

Soil samples were collected from off-site locations as part of the Soil and Vegetative Sampling Program and analyzed for radioactive content. Soil samples were collected from local farms situated adjacent to BNL. Sampling data from 1995 indicate that all radionuclides detected were of natural origin. No nuclides attributable to laboratory operations were detected.

4.4.9.1.4 Ambient Gamma Radiation

On a quarterly basis, BNL measures external gamma radiation levels at 24 on-site locations and 24 locations off-site. The average annual on-site integrated dose for 1995 was approximately 70 mrem; the off-site integrated dose was approximately 65 mrem.

4.4.9.2 Chemical Environment

This section describes the levels of nonradiological contaminants in air and water at BNL.

4.4.9.2.1 Air

Nonradioactive air emissions at BNL are typically from minor sources such as welding, degreasing, sandblasting, painting, and parts cleaning. Boilers at the Central Steam Facility (CSF) produce a majority of the nonradioactive air emissions at BNL. The CSF contains four boilers that are monitored for opacity, O_2, and CO_2. Emissions data are reported quarterly to the NYSDEC but are not included in the BNL Site Environmental Report.

4.4.9.2.2 Water Pathway

Water-quality analyses conducted on groundwater samples collected site-wide generally show compliance with New York State Ambient Water Quality Standards (NYS AWQS). However, metals and VOCs in groundwater exceed the NYS AWQS in a number of areas across the site. In some cases high iron levels reflect natural ambient levels in the subsurface aquifer, but in the vicinity of the Current Landfill, high iron and sodium levels are associated with materials disposed there. VOCs were detected above NYS AWQS at several locations on site, as well as across the southern boundary in an industrial park area (Schroeder 1998).

The off-site portion of the VOC contaminant plume is composed primarily of carbon tetrachloride, a solvent once widely used by BNL and in industry for degreasing. The solvent has been detected in on- and off-site monitoring wells at a depth of 55–90 m (180–300 ft) in concentrations as high as 5,100 parts per billion (ppb), exceeding the EPA drinking water standard of 5 ppb. A pump-and-treat system constructed in 1997 is currently cleaning up the on-site portion of the plume and preventing further off-site migration. An in-well air stripping system was funded in 1997 for treatment of the off-site plume.

Although a 1995 residential well sampling program in the area beyond the southern boundary showed no contamination from BNL above drinking water standards, DOE has offered area home and business owners free connections to the public water supply as a precautionary measure. Through 1997, approximately 800 private owners have been connected to the public water supply at DOE expense.

Surface waters were collected from the Peconic River and from the Carmens River as an off-site control location. All water quality parameters, except pH, were within State Pollution Elimination Discharge System discharge standards or New York State AWQS. Low pH may be attributed to natural conditions of groundwater recharge to the stream or stormwater runoff. All metal concentrations were consistent with historical data and the background levels at Carmens River Station were (except for iron) below the State Pollutant Discharge Elimination System effluent limits or appropriate AWQS. With the exception of a single chloroform concentration of 2.3 g/L (detection limit = 2 g/L), all surface water measurements for VOCs were not detectable.

4.4.9.2.3. Soil

Soils are not monitored for nonradiological contaminants at BNL.

4.4.10 SUPPORT FACILITIES AND INFRASTRUCTURE

The Support Facilities and Infrastructure section characterizes the local vehicular transportation routes around the proposed SNS site. The existing utilities that are available to provide needed services to support the proposed SNS are also described.

4.4.10.1 Transportation

BNL is located on Long Island, Suffolk County, in the state of New York. Figure 4.4.10.1-1 gives the location of the proposed SNS facility site and the transportation routes surrounding the site.

There are three primary roads that border BNL: (1) the Long Island Expressway (I-495), a four-lane divided highway that runs east-west and borders BNL on the south; (2) the William Floyd Parkway, a four-lane divided highway that runs north-south and borders BNL to the east; and (3) Route 25, a four-lane divided highway that runs north-south and borders BNL to the north.

In 1990, a transportation master plan was completed for BNL that evaluated traffic circulation impacts for a predicted future site population of 3,800 employees. At that time, the number of employees was approximately 3,400. The results of that report indicated that the transportation infrastructure in and around BNL could adequately service the predicted site workforce of 3,800. In 1995, a BNL traffic study indicated that approximately 2,500 vehicles per day enter and exit BNL.

4.4.10.2 Utilities

This section provides a description of the utility infrastructure at BNL. The following is based upon existing documentation and discussions with select BNL staff.

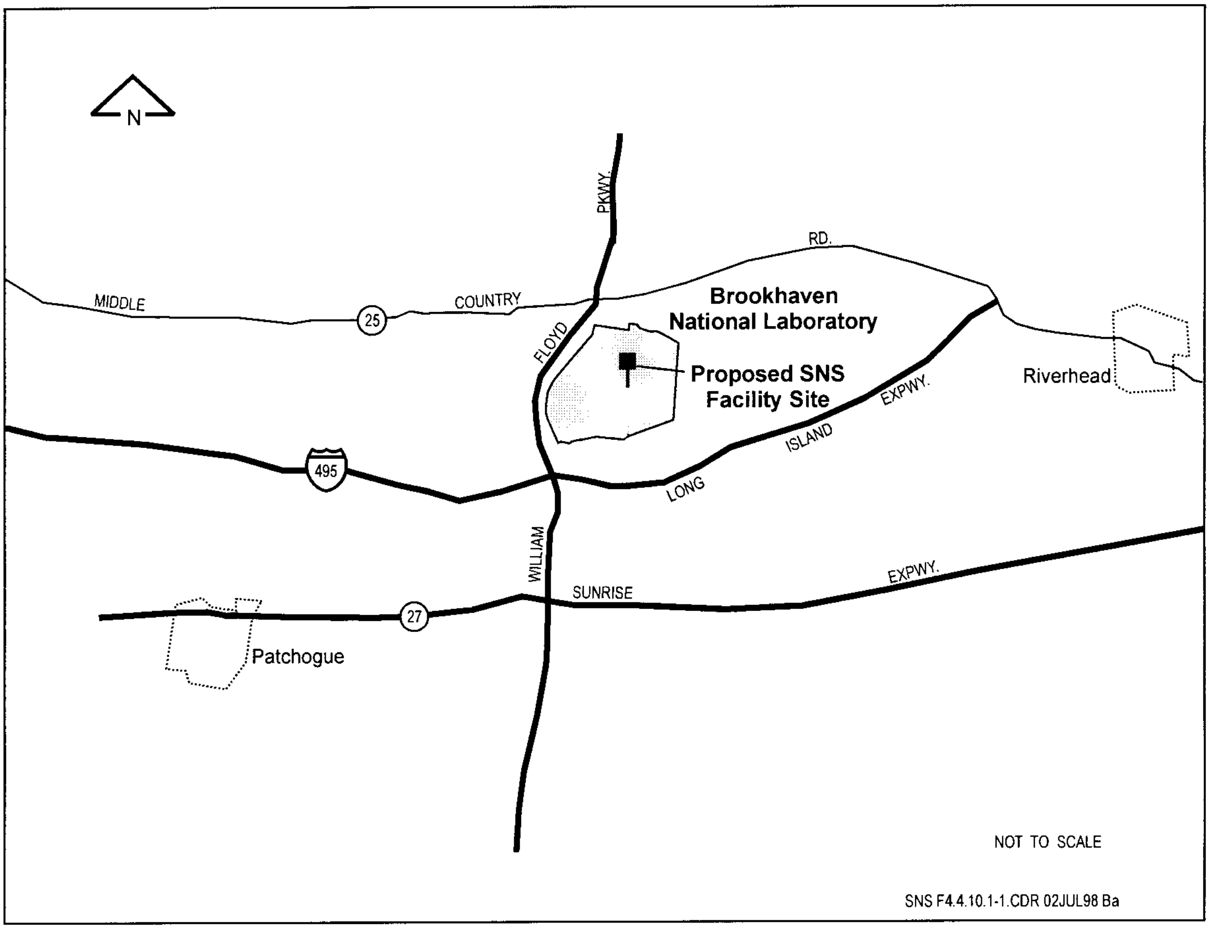

Figure 4.4.10.1-1. Transportation routes at BNL and surrounding areas.

4.4.10.2.1 Electrical Service

BNL purchases electric power from the New York Power Authority and the Long Island Lighting Company (LILCO). Power enters BNL via a 69-kV transmission line at a substation located at the southeast corner of the site. BNL has two main electrical substations that step down the power from 69 kV to 13.8 kV. The vast majority of electrical distribution at BNL is via underground lines; however, the RHIC and STP are fed via overhead distribution lines. BNL's present electrical demand is 52 MW but is expected to increase to 80 MW by the year 2000.

4.4.10.2.2 Steam

Steam originates for BNL operations on-site from the CSF. The CSF is located southwest of the BNL preferred location. The CSF consists of four boilers that have a combined capacity of 475,000 lb of steam per hour at 125 psig. The steam is distributed via 11 mile (17.6 km) of pipeline to various buildings, facilities, and laboratories and is used to power steam generators when needed. The present steam load at BNL peaks at 170,000 lb/hr.

4.4.10.2.3 Natural Gas

Natural gas is purchased from LILCO and is piped to BNL from an existing main located near the electrical substation at the southeast corner of the site. Natural gas is distributed exclusively to the CSF for steam production. The capacity of this line is 240,000 ft^3/hr (73,152 m^3/hr). BNL's present usage peaks at approximately 200,000 ft^3/hr (60,960 m^3/hr). The existing gas line is located at the CSF, approximately 4,000 ft (1,219 m) from the proposed SNS location.

4.4.10.2.4 Water Service

BNL obtains its general water supply from six on-site wells. The total pumping capacity of the wells is approximately 7,200 gpm (27,255 lpm). Currently, three of the domestic water wells are in the area of the proposed SNS location, and each is capable of producing 1,200 gpm (4,542 lpm). The average daily water usage at BNL is approximately 1 mgpd (3.8 million lpd). Water is stored on-site in three storage tanks with one million, 400,000, and 300,000 gal (14.3 million, 1.5 million, 1.1 million L) capacity, respectively. Only one of the supply wells is used for the site's water needs. BNL operates a 4.5 mgpd (17 million lpd) water treatment plant located less than 1 mile (1.6 km) west of the CSF.

4.4.10.2.5 Sanitary Waste Treatment

The BNL STP is located in the eastern portion of the site and directly east of the preferred site for the proposed SNS location. The plant receives all sanitary wastewater from the laboratory for processing before discharge to the Peconic River. The plant was renovated in 1997 to upgrade its hydraulic capacity to 3 mgpd (11.4 million lpd). Currently, the average daily volume of waste flow is less than 1 mgpd (3.8 million lpd).

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