Chapter 3
Affected Environment

3.1 DESCRIPTION OF ENVIRONMENTAL RESOURCES

The affected environment descriptions presented in this chapter provide the context for understanding the environmental consequences described in Chapter 4. As such, they serve as a baseline from which any environmental changes that may be brought about by implementation of the proposed action and alternatives can be identified and evaluated. The DOE sites evaluated include Hanford, NTS, INEL, Pantex, ORR, SRS, RFETS, and LANL. All eight DOE sites were evaluated under the No Action Alternative, and the first six were evaluated for long-term storage and disposition alternatives. Six of the DOE sites were evaluated for various disposition alternatives (for example, evolutionary LWR). The generic sites evaluated include a borehole site, a commercial MOX fuel fabrication facility, an existing LWR, and a partially completed LWR. The natural and human resources, as well as the facility-related resources that may be affected by the proposed action, are grouped into the following interest areas for analysis in this PEIS:

- Land resources
- Site infrastructure
- Air quality and noise
- Water resources
- Geology and soils
- Biological resources
- Cultural and paleontological resources
- Socioeconomics
- Public and occupational health and safety
- Waste management

In addition, the existing conditions and potential environmental impacts of intersite transportation of materials and environmental justice associated with the proposed action are described in Sections 4.4 and 4.5, respectively.

The alternatives defined in Chapter 2 are associated with the long-term storage of weapons-usable fissile materials and disposition of surplus Pu. In addition to these proposed actions, the No Action Alternative has also been assessed.

3.1.1 LAND RESOURCES

Definition of Resources

Land resources comprise all of the terrestrial areas available for economic production, residential or recreational use, governmental activities (for example, energy research facilities), or for natural resource protection. Primary concerns would be caused by changes in land use; conflicts with the objectives of applicable land-use plans, policies, and controls; and the degree of contrast between proposed development and the existing visual landscape. Potential effects to special status lands (for example, prime farmland, wilderness study area, or Wild and Scenic River), if any, are highlighted. The use or development of land resources is subject to regulation and must conform to governmental plans, policies, and controls at Federal, State, and local (regional, county, and municipal) levels.

Land Use. Land may be characterized by its potential for the location of human activities (land use). Natural resource attributes and other environmental characteristics could make a site more suitable for some land uses than for others. Changes in land use may have both beneficial and adverse effects on other resources (biological, geological, cultural, water, and air).

Visual Resources. Visual resources are natural and human-created features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape; however, they exert varying degrees of influence. The stronger the influence exerted by these elements in a landscape, the more interesting the landscape. The more visual variety that exists with harmony, the more aesthetically pleasing the landscape.

Approach to Defining Environmental Setting

Land Use. The environmental setting for land resources was defined by first delineating the region of influence (ROI) and then gathering information on land-use patterns and densities pertaining to that area. The land-use ROI for alternatives to be constructed at current DOE installations includes lands within 3.22 km (2 mi) of the DOE sites. Land use associated with alternatives for which site-specific locations have not been identified are described generically, based on existing information about typical locations. Land-use data were obtained from data input reports; reviews of related environmental documents; information supplied by appropriate Federal, State, or local governmental agencies; maps; and photographs.

Visual Resources. Visual resource assessments were based on the Bureau of Land Management (BLM) VRM methodology. Management classes describe the different degrees of modification allowed to the basic elements of the landscape and are used to assess the visual effect of proposed development. Class designations are derived from an inventory of scenic quality, sensitivity levels, and distance zones of a particular area. The elements of scenic quality are landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modification. Scenic value is determined by variety and harmonious composition of the elements of scenic quality. Sensitivity levels are determined by user volumes and user attention. Distance zones concern the relative visibility from travel routes or observation points. Distance zones include the following categories: foreground, 0.0 to 0.8 km (0 to 0.5 mi); middleground, 0.8 to 4.8 km (0.5 to 3 mi); background, 4.8 to 8 km (3 to 5 mi); and seldom seen, 8 km (5 mi) to infinity and areas blocked or screened from view. To determine how the visual resources of the site could be affected, the contrast of proposed development to the existing visual landscape (that is, visual resource inventory) and the sensitivity of viewpoints is analyzed.

The existing landscape at each analyzed site is assigned a VRM classification ranging from 1 to 5. Class 1 would apply to pristine areas, including designated wilderness areas and Wild and Scenic Rivers. Class 2 would apply to areas with very limited land development activity, resulting in contrasts that are seen but do not attract attention. Class 3 would apply to areas where contrasts caused by development activity are evident, but the natural landscape still dominates. Class 4 would apply to areas where contrasts caused by human activities

attract attention and are dominant features of the landscape in terms of scale, but repeat the form, line, color, and texture of the characteristic landscape. Class 5 would apply to areas where contrasts caused by human activities are the dominant feature of the landscape to the point that the natural landscape character no longer exists. For alternatives involving new facilities at non-DOE sites, a generic environmental baseline was developed based on existing resource data from representative sites.

3.1.2 SITE INFRASTRUCTURE

Definition of Resources

Site infrastructure includes those utilities and other resources required to support construction and continued operation of mission-related facilities identified under the various alternative actions. The resources described and analyzed in this PEIS include electrical power and electrical load capacity requirements; natural gas, coal, and oil fuel requirements; and transportation networks, including roads and rail access.

Approach to Defining Environmental Setting

For existing DOE sites that may be selected or analyzed for actions under the proposed alternatives, projections of electricity availability, site development plans, and other DOE mid- and long-range planning documents were utilized to describe existing site infrastructure conditions. The ROI for existing DOE sites has been limited to the boundaries of those sites.

Under some of the PEIS alternatives, specific candidate sites are not identified. As a result, no planning documents are available to provide descriptions of the site infrastructure or to establish a detailed baseline from which environmental consequences can be estimated. For these cases, generic environmental baselines based on existing information about typical locations were developed in order to define conditions. For alternatives involving new facilities at non-DOE sites, the ROI is large enough to encompass the non-DOE site and the infrastructure construction to support the new facilities.

3.1.3 AIR QUALITY AND NOISE

Definition of Resources

Air Quality. Air pollution refers to any substance in the air that could harm human or animal populations, vegetation, or structures, or that unreasonably interferes with the comfortable enjoyment of life and property. For the purpose of this document, only outdoor air pollutants are addressed. Pollutants may include almost any natural or artificial compound capable of being airborne. They may be in the form of solid particles, liquid droplets, gases, or in combinations of these forms. Generally, they can be categorized as primary pollutants (those emitted directly from identifiable sources) and secondary pollutants (those produced in the air by interaction between two or more primary pollutants, or by reaction with normal atmospheric constituents, with or without photoactivation). Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions. Air quality is affected by air pollutant emission characteristics, meteorology, and topography.

Ambient air quality in a given location has been described as the concentration of various pollutants in the atmosphere compared to the corresponding standards. Ambient air quality standards have been established by Federal and State agencies, allowing an adequate margin of safety for protection of public health and welfare from adverse effects associated with pollutants in the ambient air. Pollutant concentrations higher than the corresponding standards are considered unhealthy. Concentrations below the corresponding standards are considered acceptable.

The pollutants of concern are primarily those for which Federal and State ambient air quality standards have been established, including criteria pollutants, hazardous air pollutants, and other toxic air compounds. The criteria pollutants are those defined in 40 Code of Federal Regulations (CFR) 50, *National Primary and Secondary Ambient Air Quality Standards.* The hazardous air pollutants and other toxic compounds are listed in Title III of the 1990 *Clean Air Act* (CAA) as amended through May 1992, those regulated by the National Emissions Standards for Hazardous Air Pollutants (NESHAP), and those that have been proposed or adopted in regulations or are listed in guidelines by the respective States.

Noise. Sound results from the compression and expansion of air or some other medium when an impulse is transmitted through it. Sound requires a source of energy and a medium for transmitting the sound wave. The propagation of sound is affected by various factors, including meteorology, topography, and barriers. Noise is unwanted sound that interferes or interacts negatively with the human or natural environment. Noise may disrupt normal activities or diminish the quality of the environment.

Sound level measurements recorded to determine effects on humans are compensated by an A-weighted scale that accounts for the hearing response characteristics of the human ear. Sound levels are expressed in decibels (dB), or in the case of A-weighted measurement, decibels A-weighted (dBA). EPA has developed guidelines for noise levels for different land-use classifications. Some States and localities have established noise control regulations or zoning ordinances that specify acceptable noise levels by land-use category. These regulations are discussed in Appendix F for each site.

Approach to Defining Environmental Setting

Air Quality. The ROI for air quality would encompass the area surrounding the candidate site that is potentially affected by air emissions caused by the storage and disposition alternatives. Generally, the air quality impact area would cover a few kilometers downwind from the source. The area of the ROI depends on emission source characteristics, pollutant types, emission rates, and meteorological and topographical conditions. For the purpose of identifying the maximum air quality impacts from the proposed alternatives, an area within 10 km (6 mi) of the emission source has been selected as the impact area to be used in the air quality modeling analysis.

Meteorological and climatological data for each candidate site are obtained from the most recent site-specific environmental reports or *Local Climatological Data, Annual Summaries* produced by the National Oceanic and Atmospheric Administration (NOAA). One year of sequential hourly representative National Weather Service data from National Climatic Data Center or onsite meteorological data from the candidate site were obtained for air modeling analyses.

Areas with air quality better than the National Ambient Air Quality Standards (NAAQS) are designated as being in attainment; areas with air quality worse than the NAAQS are classified as nonattainment areas. Areas may be designated as unclassified when there is a lack of data to form a basis for an attainment status designation. The United States is divided into attainment, nonattainment, and unclassified areas by county, metropolitan statistical area, consolidated metropolitan statistical area, or portions thereof. Air Quality Control Regions (AQCR) designated by EPA are listed in 40 CFR 81, *Designation of Areas for Air Quality Planning Purposes.*

For locations that are in an attainment area, Prevention of Significant Deterioration (PSD) regulations limit pollutant emissions from new sources and establish allowable increments of pollutant levels. Three PSD classifications are designated based on criteria established in the CAA amendments. Class I areas include national wilderness areas, memorial parks larger than 20.2 square kilometers (km^2) (7.8 square miles [mi^2]), and national parks larger than 24.3 km^2 (9.4 mi^2). Class II areas include all areas not designated as Class I. Class III areas, which would allow greater deterioration than Class II areas, have not been designated.

Designation as a nonattainment area triggers control requirements designed to achieve attainment status by specified dates. In addition, facilities that constitute major new emission sources cannot be constructed in a nonattainment area without permits that impose stringent pollution control requirements to ensure progress toward compliance.

Baseline air quality of the affected environment is based on model predicted pollutant concentrations for existing sources at each site using concentrations presented in existing source documents or by modeling recent emissions data. Emissions data for existing sources are based on permit applications, the most recent site-specific environmental reports, or emission inventories.

For the generic environments used to establish a context for comparison of relative impacts from Pu disposition technologies, the assessment of potential air impacts resulting from the implementation of these technology options is not directed to specific locations, but instead to a generic site in the continental United States. For a generic site, no site-specific air pollutant emissions data can be determined. Generic site information pertaining to air quality is described with respect to air quality within the continental United States. Site-specific air quality analyses of applicable disposition alternatives would be addressed in tiered NEPA documentation, as appropriate.

Toxic air pollutants are addressed in both the air quality and noise section and the public and occupational health section for each of the candidate sites. In the air quality section, the maximum concentration of toxic air pollutants at or beyond the site boundary is compared with a Federal, State, or local standard to determine compliance. In the Public and Occupational Health section, a health risk is calculated based upon chemical concentration and toxicity compared to the Reference Concentration (RfC) for the public and the Permissible Exposure Level (PEL) for workers for noncancer causing chemicals and slope factors for the public and workers for cancer causing chemicals. The cancer effects are a risk that is based on the slope factor (cancer potency) for chemicals that are regulated as carcinogens.

These differences in analytical methods result in the different pollutants analyzed between the air quality analysis and the public and occupational health analysis. In the air quality analysis, toxic pollutants with low emission rates in most cases will result in extremely low concentrations at the site boundary and therefore are not presented in the air quality analysis. In the public and occupational health analysis, many of the same chemical pollutants may expose an onsite worker located 100 m (328 ft) from the emission source to a health risk, and therefore are presented in this analysis. The hazardous chemical pollutants used by these two

disciplines to evaluate impacts will be different. Compliance to standards does not consider what health effects are expected nor the interaction between several chemicals that may together cause adverse health responses even if they separately are at below standard concentrations.

Noise. Noise from facility operations and traffic has the potential to affect local human and animal populations. Because most nontraffic noise associated with construction and operation of the proposed facilities is located at sufficient distance from offsite noise-sensitive receptors, the contribution to offsite noise levels is expected to be small. Impacts associated with access routes, including noise from increased traffic, are not analyzed in this document because information that would be needed for such an assessment has not been developed at this programmatic level of analysis. No acoustics-related impacts are anticipated to affect DOE's decision on the proposed facilities. The level of detail describing both the onsite and offsite acoustical environment is presented accordingly.

To provide a context for comparison of these potential acoustical impacts, the existing acoustical environment has been briefly described in terms of existing noise sources, sound level measurements that are available for the ROI, and the range of sound levels that is typical of the land uses in the ROI. The ROI for each of the alternatives includes its site and surrounding areas where related activities might increase noise levels, including transportation corridors in which noise levels could be affected by proposed activities.

In recent years, several DOE sites have compiled sound-level data representative of adjacent areas and transportation routes that serve the site. Where these data are available, they are presented. The *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (EPA-550/9-74-004, March 1974) has identified ranges of sound levels that are typical of various land uses. These ranges of sound levels have been presented for each DOE site. For generic sites, a broad range of sound levels has been identified based on typical land uses adjacent to these types of sites.

3.1.4 WATER RESOURCES

Definition of Resources

Surface Water. Surface water includes marine or freshwater bodies that occur above the ground surface, including rivers, streams, lakes, ponds, rainwater catchments, embayments, and oceans. Surface water quality is characterized by the concentration of inorganic, organic, and biological constituents in surface waters. Surface water bodies are classified based on designated uses that are to be protected (for example, drinking water supply, contact recreation, or cold water fish habitat). Federal, State, and local regulations set standards and criteria that apply to the different classifications. Potable water sources (both surface and groundwater) are regulated by the *Safe Drinking Water Act* (SDWA), while the *Clean Water Act* (CWA) protects the overall quality of the Nation's surface waters. These regulations are summarized in Appendix J.

Groundwater. Groundwater resources are defined as the aquifers underlying the site and their extensions down the hydraulic gradients to, and including, discharge points and the first major users. Groundwater quality, like that of surface water, is characterized by the concentration of its inorganic, organic, and biological constituents. Geology, soils, and the quality of surface water and other sources of aquifer recharge are the main factors affecting groundwater quality.

The quantity of groundwater an aquifer yields is directly related to its geologic properties. In general, the higher the porosity (a measure of void space) and permeability (the interconnectedness of the void space), the greater the aquifer yield. The recharge rate is the rate at which groundwater accumulates in the aquifer and represents the rate at which groundwater can be withdrawn from the aquifer without a net reduction in the quantity of groundwater in storage. Groundwater resources are specifically protected by Federal law under SDWA by the Sole Source Aquifer and Wellhead Protection programs. State and local regulations may provide additional protections, classifications, standards, or criteria.

Approach to Defining Environmental Setting

Surface Water. Surface and groundwater affected by or used in conjunction with site activities define the affected environment in terms of water resources. Surface water resource elements include surface water bodies, flow characteristics, stream classifications, and floodplains.

In support of surface water impact assessment, data obtained from documents (U.S. Geological Survey [USGS] and other Federal Government technical reports and State and local reports and databases) are used to describe major surface water features and to establish current or baseline surface water conditions at the sites. Current surface water usage includes use of surface water or offsite sources (municipal water). The existing water supply was evaluated to determine quantities of available water, capacity of the supplier, and existing water rights, agreements, or allocations. Major stream flows and stream classifications are identified when they are used as a water source or receive effluent discharge from the site. In cases where low flow data are unavailable, average flow data are used.

The water quality of potentially affected receiving waters are determined by reviewing current monitoring data primarily for radiological and nonradiological parameters. Significant known surface water contamination at the site is described. Where applicable, the site NPDES permits are briefly described and the status of compliance with permit limits and requirements is summarized.

One hundred-year floodplains and flooding history of the site, when applicable, are identified at the sites to determine whether areas of the site might be affected by high waters. When possible, the 500-year floodplain is also identified. Specific facility locations will be addressed in tiered environmental analyses, as required.

To define a reasonable generic surface water quality affected environment for alternatives that are not site-specific, a range of existing surface water quality conditions has been presented using water resources data from USGS.

Although baseline surface water quality may be defined by a multitude of parameters, for the purposes of this PEIS the baseline will be defined by those constituents expected to be released or affected by the disposition alternatives. Baseline conditions for parameters such as those regulated under SDWA will provide a basis for evaluating impacts of these alternatives.

Water usage and availability at a generic site are characterized by precipitation. In areas where rainfall is abundant and population is dense, water supply is commonly obtained from local surface water reservoirs and shallow wells. In arid climates, water supply is commonly obtained from deep wells and manmade lakes created by damming major rivers. In humid climates, water supply is generally derived from surface water taken from major waterways. Local constraints include seasonal fluctuations in precipitation, consumption by other facilities using the same water supply, and State regulations, such as the water appropriation permit requirements.

Groundwater. For site-specific analyses, the affected environment discussion includes a description of the potentially affected groundwater basins. The aquifers underlying the site, their extension down the hydraulic gradient to, and including, discharge points, and the first major users are described. The local aquifers are described in terms of the extent, thickness, character of rock formations, recharge and discharge areas, and quality of the groundwater. Aquifers are classified by Federal and State authorities according to use and quality. The Federal classifications include Class I, II, and III groundwater. Class I groundwater is either the sole source of drinking water or is ecologically vital. Class IIA and IIB are current or potential sources of drinking water (or other beneficial use), respectively. Class III is not considered a potential source of drinking water and is of limited beneficial use. Sole source aquifers are identified when located near a DOE site. When applicable, current groundwater usage at the site is identified. Any allocations, existing water rights, or agreements are briefly described.

Available data on existing groundwater quality conditions are compared to Federal and State groundwater quality standards, effluent limitations, and safe drinking water standards. When applicable, known contaminated groundwater areas at the site are described.

Generic descriptions of groundwater availability are developed based on general water supply characteristics. Overdraft of groundwater occurs when water is withdrawn from sources that cannot be renewed or is withdrawn more quickly than it can be recharged. Several areas of the country are experiencing critical groundwater overdraft more than 1,900 million l/day (500 million gal/day) of overdraft, and have low surface water availability relative to demand (VDL 1990a:725).

Many other areas of the country are experiencing moderate overdrafts of 80 to 1,900 million l/day (21.2 to 500 million gal/day) with moderate-to-low levels of surface water availability relative to demand. Other areas experience no overdraft of groundwater supplies or have an adequate supply of surface water relative to demand. The settlement of inter- and intrastate water rights issues that are ongoing or may occur could cause the potential water availability for an area to change and are discussed as applicable.

3.1.5 GEOLOGY AND SOILS

Definition of Resources

Geology resources are consolidated or unconsolidated earth materials, including mineral assets, such as ore and aggregate materials, fossil fuels, and significant landforms. Soil resources are the loose surface materials of the earth in which plants grow, usually consisting of disintegrated rock, organic matter, and soluble salts.

Approach to Defining Environmental Setting

The ROI for geology and soil resources comprises all areas subject to physical disturbance by construction and operational activities associated with an alternative. The exact location of each alternative is not known at this time. Therefore, the ROI may vary from either the area disturbed, for those sites already identified, to the entire site, for those alternatives whose location is unspecified. For alternatives not linked to specific candidate sites, a generic description encompassing a range of likely geologic and soil settings was developed.

The occurrence of geology and soil resources, as well as their status and viability at the various sites proposed, can vary greatly. The geology and soil resources were considered both with respect to the identification of those portions of the resource that could be affected by the alternative and the presence of natural conditions that may affect the alternative. Geology and soil conditions that may affect the integrity and safety of the proposed alternatives are a primary consideration. Specific geologic considerations include seismic activity (vibratory ground motion), volcanism, unique geologic resources, and karst terrain. Specific soil considerations include suitability of soil for construction, soil quality, and erosion.

The physiographic province and geologic setting have been provided for specific sites. For those alternatives that are not site-specific, a range of conditions has been provided. Earthquake potential was evaluated based on the frequency, magnitude, and intensity of past events; the location and distribution of epicenters; and the location of capable faults as defined in 10 CFR 100, Appendix A. The potential for volcanic activities was similarly evaluated. Areas of past mass movements (landslides and other forms of material transport) and conditions favorable for future mass movement were identified, including karst terrains, landslide-susceptible rock and soil materials, and excessive slopes.

Information on the geology and soil resources was derived from the most recent and applicable reports, aerial photographs, and other literature (for example, environmental assessments [EAs], EISs, and facility plans). For those alternatives where the site location has not been identified, information may have been obtained through the following additional sources: DOE; BLM; Bureau of Reclamation, Mineral Management Service; EPA; USGS; and the Soil Conservation Service.

3.1.6 BIOLOGICAL RESOURCES

Definition of Resources

Biological resources are defined as terrestrial and aquatic ecosystems characterized by the presence of native and naturalized flora and fauna. For the purposes of this PEIS, biological resources include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Although wetlands and threatened and endangered species could be considered as either terrestrial or aquatic resources, they have been identified for separate analysis in this PEIS because of their special regulatory status.

Terrestrial Resources. Terrestrial resources are defined as those plant and animal species and communities that are most closely associated with the land. For the purposes of this PEIS, terrestrial resources include the major plant communities present in a site or region and the vegetation, amphibians, reptiles, birds, and mammals found within them. Scientific names of non-special status species (both terrestrial and aquatic) listed in the text are provided in Appendix K.

Wetlands. Wetlands are defined by the U.S. Army Corps of Engineers (COE) and EPA as "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" (33 CFR 328.3). Thus, wetlands are delineated based upon the occurrence of characteristic vegetation, soils, and hydrology (USCOE 1987a:13-14).

Aquatic Resources. Aquatic resources are defined as those plant and animal species and communities that are most closely associated with a water environment. For the purposes of this PEIS, aquatic resources include the major habitats present in a site or region and the fish species found within them.

Threatened and Endangered Species. Endangered species are defined under the *Endangered Species Act* (ESA) of 1973 (see Appendix J) as those in danger of extinction throughout all or a large portion of their range. Threatened species are defined as those species likely to become endangered within the foreseeable future. The U.S. Fish and Wildlife Service (USFWS) may designate areas of critical habitat for threatened and endangered species. Critical habitat is defined as specific areas that contain physical and biological features essential to the conservation of species and that may require special management considerations or protection. Species that are Federal proposed or candidates for listing as threatened or endangered species do not receive legal protection under ESA. However, the USFWS recommends that impacts to these species be considered in project planning since their status can be changed to threatened or endangered in the foreseeable future. The USFWS has recently changed the classification of species under review for listing as threatened or endangered (61 FR 7596). Proposed species include those plants and animals for which a proposed rule to list as threatened or endangered has been published. Candidate species include those plants and animals for which the USFWS has on file sufficient information on biological vulnerability and threat to support issuance of a proposed rule for listing as endangered or threatened. Candidate species previously included Category 1 (species appropriate for listing as protected) and Category 2 (species possibly appropriate for listing as protected). Due to the recent rule change, candidate species include only those which are appropriate for listing as protected species (i.e., species formerly listed as Category 1). The Category 2 designation has been omitted. Some of the species previously identified as Federal candidate Category 2 in the Storage and Disposition Draft PEIS also have a State status and continue to be evaluated for potential impacts. However, due to the change in candidate classification described above, many species have been eliminated from proposed site threatened and endangered species lists. At the State level, protected species are classified into a variety of categories, including endangered, threatened, sensitive, protected, in need of management, of concern, monitored, or species of special concern.

Approach to Defining Environmental Setting

Since some alternatives presented in this PEIS are site-specific and others are not, the existing environment is discussed at two levels. Where alternatives are associated with specific sites, such as for the storage alternatives, or an assumed location on a DOE site for a number of disposition facilities, the existing environment of those actual sites is addressed. However, these sites are only described when previously undisturbed areas would be affected. Biological resources addressed include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Where site locations have not been selected, a more generic discussion is presented. This discussion addresses selected biological resources, including natural habitats (both terrestrial and aquatic), wetlands, threatened and endangered species, and migratory birds. The ROI for site-specific alternatives includes the entire DOE site under consideration, while for non-site-specific alternatives it includes conditions representing various regions of the United States within which the alternative could be located. Data sources used include site-specific studies, as well as regional summaries, as appropriate. Specific data sources include DOE site studies, National Wetland Inventory (NWI) Maps, and USFWS and Natural Heritage Program records on threatened and endangered species.

3.1.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

Definition of Resources

Cultural resources are human imprints on the landscape and are defined and protected by a series of Federal laws, regulations, and guidelines. For this PEIS, cultural resources are separated into prehistoric, historic, and Native American resources. Paleontological resources, although not governed by the same laws on historic preservation, represent a similar type of surface or buried resource that may be affected in the same way as cultural resources. Paleontological resources also will be considered in this section.

Prehistoric Resources. Prehistoric resources are physical properties that remain from human activities that predate written records. These resources generally are identified as either isolated artifacts, sites, or districts. Isolated artifacts may include stone or bone tools, or remains of ceramic pottery. Sites may contain concentrations of artifacts (for example, stone tools and ceramic sherds), features (for example, remains of campfires, residences, or food storage pits), and plant and animal remains. All of these resources can be used to reconstruct life in a region or at a limited location. Depending on their age, complexity, integrity, and relationship to one another, sites may be important for, and capable of, yielding otherwise inaccessible information about past populations.

Historic Resources. Historic resources consist of physical properties that postdate the existence of written records. In the United States, historic resources are generally considered to be those that date no earlier than 1492. Historic resources include architectural structures or districts (for example, religious, commercial, or residential structures, dams, and bridges), archaeological objects, and archaeological features (for example, foundations of mills or residences, trails, and trash dumps). Ordinarily, sites less than 50 years old are not considered historic for analytical purposes, but exceptions can be made for younger properties if they are of exceptional importance, such as structures associated with Cold War themes (36 CFR 60.4).

Native American Resources. Native American resources are sites, areas, and materials important to Native Americans for religious or heritage reasons. In addition, cultural values are placed on natural resources such as plants, which have multiple purposes within various Native American groups. Of primary concern are concepts of sacred space that create the potential for land-use conflicts. Native American resources can include geological or geographic elements such as mountains or creeks; certain species of plants and animals; cemeteries, battlefields, trails, and pueblos; and archaeological sites.

Paleontological Resources. Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age. They include casts, molds, and trace fossils such as burrows or tracks. Fossil localities typically include surface outcrops, areas where subsurface deposits are exposed by ground disturbance, and environments that favor preservation, such as caves, peat bogs, and tar pits. These resources are important because they provide scientific information on paleoenvironments and the evolutionary history of plants and animals.

Approach to Defining Environmental Setting

The ROI for cultural and paleontological resources is bounded in three ways. First, there is the general natural setting. This is the location of the resource within a specific geological and geographical region, which can include significant bodies of water such as rivers or lakes; topography, such as slopes, plains, or mountains; and plants and animals that once inhabited or still inhabit the region. Because this natural region affects the location of a given prehistoric or historic resource and the life of its inhabitants, information regarding it is important for describing cultural or paleontological resources. Second, there are the modern political boundaries of the site. This PEIS includes data based on surveys of cultural and paleontological resources that may include an entire site or may include a portion of a specific site. Finally, and most specifically, there is the area directly affected or disturbed by a proposed alternative during construction or operation, including visual intrusions to the

settings or environmental context, unauthorized artifact collecting, and vandalism. In the cases of prehistoric, historic, and paleontological resources, Federal and State regulations regarding impacts are usually expressed in terms of the last ROI definition. Native American resources affected may also include viewsheds, plant communities, or resources such as mountains that are outside the potentially disturbed acreage, but may still be affected by a proposed alternative. Effects to Native American resources also include visual and audio intrusions to sacred sites and reduced access to traditional use areas. In this PEIS, each of these increasingly focused ROIs is addressed. For generic alternatives where a site is not specified, the ROI is described as a range of potentially affected resources.

Data used to assess the potentially affected cultural or paleontological resources at specific sites include information regarding the historic and prehistoric context of the proposed project area, its geology and paleontological potential, and the possible presence of sites, districts, or objects that may be eligible for listing on the National Register of Historic Places (NRHP) or may be significant to Native American groups. For non-site-specific alternatives, a general description of possible cultural or paleontological resources is presented.

Prehistoric Resources. The affected environment section for prehistoric resources includes a brief overview of the number and types of prehistoric sites in the ROI, if known, and their status on the NRHP. A summary of existing information about prehistoric resources in the ROI is provided, and the types of sites that are likely to occur are discussed.

Historic Resources. The affected environment section for historic resources includes a brief overview of the number and types of historic sites in the ROI, if known, and their status on the NRHP. The overview consists of a summary of existing information about historic resources in the ROI and a discussion of the types of sites that are likely to exist.

Native American Resources. The affected environment section for Native American resources includes a brief overview of the regional Native American groups whose resources may be affected, along with the number and types of sites, use areas, and other resources in the ROI, if known, and their status or significance. A summary of existing information about Native American resources in the ROI is provided, and the type of resources that are likely to exist is discussed.

Paleontological Resources. The affected environment section for paleontological resources includes a description of known paleontological localities and geological formations in the project areas that may be fossil-bearing.

3.1.8 SOCIOECONOMICS

Definition of Resources

Socioeconomics comprises the social, economic, and demographic characteristics of an area. The socioeconomic environment can be affected by changes in employment, income, and population, which, in turn, can affect area resources such as housing, community services, and infrastructure.

The socioeconomic analysis assesses the environmental consequences of demographic and economic changes resulting from proposed alternatives. The study focuses on the potential impacts of a change in the number of workers and their families on the economy, housing availability, community services, and infrastructure. This PEIS assesses health care, education, and public safety as representative indicators of community services. Local transportation is assessed as a representative indicator of community infrastructure. [Text deleted.]

Approach to Defining Environmental Setting

The socioeconomic environment is defined for two geographic regions: the regional economic area (REA) and the ROI. REAs are used to assess potential effects on the regional economy, and ROIs are used to assess effects that are more localized in political jurisdictions surrounding the sites.

The REA for each site encompasses a broad market that involves trade among and between regional industrial and service sectors and is characterized by strong economic linkages between the communities in the region. These linkages determine the nature and magnitude of multiplier effects of economic activity (purchases, earnings, and employment) at each site. REAs are defined by the U.S. Bureau of Economic Analysis (BEA) and consist of an economic node that serves as the center of economic activity and the surrounding counties that are economically related and include the places of work and residences of the labor force.

Potential demographic impacts were assessed for the ROI, a smaller geographic area where the housing market and local community services would be the most affected. Site-specific ROIs were identified as those counties where approximately 90 percent of the current DOE and contractor employees reside. This residential distribution reflects existing commuting patterns and attractiveness of area communities for people employed at each site and is used to estimate the future distribution of in-migrating workers. Impacts from technologies that would be located at an existing DOE site or that have sites identified as representative locations for analysis purposes were assessed using a site-specific ROI. Technology alternatives for which sites have not been identified, such as the deep borehole, were assessed using a more generic approach.

The most recent data available were used in the socioeconomic analyses. Data were obtained from sources such as the U.S. Bureau of the Census, the BEA, the Federal Bureau of Investigation, the American Medical Association, the American Hospital Association, State and local government publications, and telephone interviews with State and local government officials.

Socioeconomic issues and concerns focus primarily on how changes in the regional economy facilitated by construction and operation of a proposed alternative could affect the demographic composition and economic capacity of the host communities. Proposed alternatives could result in increased employment at potential sites, perhaps leading to population increases and associated changes in demand for community resources. The amount of change depends on the construction and operational requirements of the proposed alternatives and the socioeconomic capacity of the communities in the region where these alternatives may be sited.

New employment opportunities could be created in the regions where proposed alternatives would be located. Generally, the proposed alternatives would directly generate new income and jobs in construction, engineering, sciences, management, and support. Indirect income and job opportunities could also be created as a result of these new jobs to support new demand for goods and services generated from construction and operation

activities. These new jobs could be filled by existing available labor in the region, or workers could in-migrate from other areas to fill the jobs. The regions where proposed alternatives are located could benefit economically as a result of an increase in income, and the unemployment rate in the region could fall if new jobs are filled locally.

Increased income and employment opportunities are generally regarded as benefits to many communities. Local businesses gain additional customers, and local governments gain an increase in tax revenues. However, if the attraction of new jobs causes an influx of new workers and their families, this in-migration could overburden the housing market, community services, and infrastructure. Of concern is whether or not communities can absorb this new growth within existing systems or through expansion at a reasonable pace and cost.

The duration of the proposed alternative is an important issue. If the proposed alternative is a large construction effort of short duration with little or no operational employment following, there could be a boom-and-bust effect. Initially, there could be rapid economic expansion and increased demand for housing, community services, and infrastructure. Housing prices may rise, and services and infrastructure may have to be expanded or will become congested beyond capacity. After construction is complete and workers out-migrate to find work elsewhere, unemployment may rise, additional housing vacancies may occur, and expanded community services and infrastructure may be underutilized and more expensive to maintain. Some regions with sophisticated and varied economies can absorb rapid economic expansions and contractions without experiencing significant impacts, but for other communities the boom-and-bust effect could be devastating.

Local transportation discussions characterize the transportation systems in the ROI. The affected environment section describes the locations and general features of the ROI transportation networks, which include road, rail, air, and waterway systems. In addition, current and planned improvements to the road network that will affect access to the site are discussed, as well as public transportation to the site.

General information regarding local transportation modes in the ROI was obtained from local DOT and environmental documents. Roadways to be analyzed for traffic congestion were determined using current employee commuting patterns. Current levels of service designations for these roadways were calculated using information from the DOT, other socioeconomic analyses, and a transportation model designed from the *Highway Capacity Manual #209* equations and factors. This model is used to estimate future baseline No Action projections as well as level of service impacts associated with alternatives.

3.1.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Definition of Resources

Public and occupational health and safety issues include the determination of potentially adverse effects on human health and safety that result from acute and chronic exposures to ionizing radiation and hazardous chemicals. The degree of hazard is directly related to the type and quantity of the particular radioactive or chemical material to which the person is exposed and to the duration of this exposure. For normal operations, the exposures have been converted to potential cancers and/or noncancer effects of an acute or a chronic nature. [Text deleted.]

Approach to Defining Environmental Setting

The current radiological and chemical environments at the various sites considered in this PEIS help characterize the setting and serve as a baseline against which impacts associated with the various alternative actions can be compared. Of particular importance are the radiological and hazardous chemical doses that workers and the public receive from exposures associated with both the natural background and existing site operations. These doses may result in health effects. To characterize each site's operational culture, an accident history is presented, past and ongoing health studies of people who work onsite or live in the vicinity are described, and the site's emergency management program is discussed.

Existing site environmental descriptions originate from a series of environmental and radioactive release reports issued annually by DOE sites or sites licensed by the NRC. These reports present the levels of radioactivity and hazardous chemicals in various environmental media (such as air, water, and vegetation) on the site, in the immediate vicinity of the site, and at various distances from the site boundary out to more than 100 km (62 mi). Radiological and chemical doses to individual members of the public and to population groups (including the total population within 80 km [50 mi] of the site) are also given in these reports. The main source of information used to establish existing health impacts to workers, both individual and collective, is the compilation of occupational exposures issued annually by DOE and NRC. Accident histories and the results of epidemiological studies were obtained from many literature sources, including incidence reports and medical journals.

Several methods were used to determine the environmental setting for generic sites. These included the use of regional or national average background radiological and chemical doses and concentrations, the assumption of radiological and chemical doses and concentrations that have been averaged over a number of representative sites; and the presentation of ranges of values associated with representative sites. For a generic borehole site, the current DOE sites proposed in the PEIS adequately bound normal operational radiological and chemical conditions in terms of population density and meteorological conditions; therefore, for the purposes of a generic analysis of the disposition technologies, ranges of conditions are presented. For a generic commercial reactor site, existing normal radiological impacts for representative commercial reactor sites and releases were determined, and a range of results is presented. For a generic commercial MOX fuel fabrication site, normal radiological impacts for representative commercial fuel fabrication sites and their releases were used to establish the range of conditions.

Toxic air pollutants are addressed in both the Air Quality and Noise section and the Public and Occupational Health and Safety section for each of the sites considered in this PEIS. In the air quality section, the maximum concentration of toxic air pollutants at or beyond the site boundary is compared with a Federal, State, or local standard to determine compliance. In the Public and Occupational Health and Safety section, a health risk is calculated based upon chemical concentration and toxicity compared to the RfC for the public and the PEL for workers for noncancer causing chemicals and slope factors for the public and workers for cancer causing chemicals. The cancer effects are a risk that is based on the slope factor (cancer potency) for chemicals that are regulated as carcinogens.

These differences in analytical method result in the different pollutants between the air quality analysis and the public and occupational health analysis. In the air quality analysis, toxic pollutants with low emission rates in most cases will result in extremely low concentrations at the site boundary and therefore are not presented in the air quality analysis. In the public and occupational health analysis, many of these same chemical pollutants may expose an onsite worker located 100 m (328 ft) from the emission source to a health risk and therefore are presented in this analysis. The hazardous chemical pollutants used by these two resource areas to evaluate impacts will be different. Compliance to standards in air quality does not consider what health effects are expected nor the interaction between several chemicals that may together cause health responses even if they separately are at below standard concentrations.

3.1.10 WASTE MANAGEMENT

Definition of Resources

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing DOE activities. Waste management accepts waste produced by DOE's processing, manufacturing, remediation, D&D, and research activities. The waste is managed using appropriate treatment, storage, and disposal technologies and in compliance with all applicable Federal and State statutes and DOE orders. Appendix E defines the waste categories (high-level, TRU, low-level, mixed, hazardous, and nonhazardous) managed by DOE. Although spent nuclear fuel is not categorized with nuclear waste, it is included in the waste management section of this PEIS, since it is radioactive material that must be stored, managed, and handled. Wastes are generated and categorized by their health hazard and handling requirements. Treated waste is waste that, following generation, has been altered chemically or physically to reduce its toxicity or to prepare it for storage or disposal. Waste treatment can include volume reduction activities, such as incineration or compaction, which may be performed on waste before storage, disposal, or both. Stored waste is waste that, following generation (and usually some treatment), is being retained (temporarily) in a retrievable manner and monitored pending disposal. Disposed waste is waste that has been put in final emplacement to ensure its isolation from the environment and with no intention of retrieval. Deliberate action would be required to regain access to the waste. Disposed wastes include materials placed in a geological repository and buried in landfills.

Approach to Defining Environmental Setting

In order to operate most of its facilities, DOE has entered into numerous agreements with States and EPA to address compliance issues concerning certain aspects of environmental regulatory requirements that have arisen due to either the age of DOE facilities or the uniqueness of DOE operations. For the most part, DOE facilities are in compliance with a major portion of all environmental regulatory requirements, and these compliance agreements address a few specific situations. Appendix E summarizes the applicable Federal statutes and DOE Orders relevant to waste management. In the siting and construction of new facilities, the intent is to meet current regulations; to reach the goal of maximum recycle, minimum waste generation, and no liquid discharges to the surface; and to treat and stabilize unavoidable wastes sufficiently for storage (greater than 90 days) or permanent disposal either onsite or offsite.

Both DOE and the sites maintain waste management databases and publish documents as a reporting mechanism to disclose and gauge progress in meeting environmental regulatory requirements. These databases and reports represent key sources of data that were used for analysis for the waste management resource area. Specific examples include the Waste Management Information System database; the *Integrated Database for U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics Report*; and the *Mixed Waste Inventory Report*. Other site-specific documents include Annual Waste Minimization and Generation Reports, Site Treatment Plans, Pollution Prevention and Waste Minimization Awareness Plans, Annual Environmental Reports, and Waste Management Plans.

For the generic borehole site, a pristine condition was assumed. For example, no waste generation activities or waste management facilities exist. The generic fuel fabrication facility was compiled from characteristics based on several existing commercial fuel fabricator facilities.

Site-specific data from existing representative LWRs were used to develop a generic existing LWR site. For the generic partially completed reactor, an approach similar to that used for the generic existing LWR site was taken. However, because completion of construction has been deferred, maintenance and limited engineering design work are the only activities. Therefore, only a description of waste management practices that would go into effect once the reactors are operational is provided.

3.2 HANFORD SITE

Hanford, established in 1943 as one of the three original Manhattan Project sites, is located in the State of Washington just north of Richland (see Figures 2.2.1–1 and 2.2.1–2). Hanford was a U.S. Government nuclear materials production site that included nuclear reactor operation, storage and reprocessing of spent nuclear fuel, and management of radioactive and dangerous wastes. Present Hanford programs are diversified and include management of radioactive wastes, R&D for advanced reactors, renewable energy technologies, waste disposal technologies and cleanup of contamination, and Pu stabilization and storage.

Hanford is owned and used primarily by DOE, but small portions of it are owned, leased, or administered by other government agencies. Public access is limited to travel on the Route 4 and Route 10 access roads as far as the Wye Barricade, Highways 24 and 240, and the Columbia River. By restricting access onsite, the public is buffered from the smaller areas formerly used for production of nuclear materials and currently used for waste storage and disposal. Only about 6 percent of the land area has been disturbed and is actively used, leaving mostly open vacant land with widely scattered facilities. The entire Hanford Site has been designated a National Environmental Research Park (NERP).

Hanford includes extensive production, service, research, and development areas. Onsite programmatic and general-purpose facilities total approximately 799,337 m^2 (8,600,000 ft^2) of space. Fifty-one percent (407,658 m^2 [4,390,000 ft^2]) is general-purpose space, including offices, support laboratories, shops, warehouses, and other support facilities. The remaining 391,679 m^2 (4,216,000 ft^2) of space are programmatic facilities comprising processing, evaporation, filtration, waste recovery, waste treatment, waste storage facilities, and R&D laboratories. More than half of the general-purpose and programmatic facilities are more than 30 years old. Facilities designed to perform previous missions are being evaluated for reuse in the cleanup mission (HF DOE 1993c:2). The existing facilities are grouped into the following numbered operational areas (see Figure 2.2.1–2):

- The 100 Areas, located on the southern shore of the Columbia River, are the site of eight retired Pu production reactors and the dual-purpose N Reactor, all of which have been permanently shut down since 1991. The 100 Areas cover about 1,100 ha (2,720 acres).

- The 200 West and 200 East Areas are located on a plateau and are about 8 and 11 km (5 and 7 mi), respectively, south of the Columbia River. Historically, these areas have been dedicated to fuel reprocessing; Pu processing, fabrication, and storage; and waste management and disposal activities. The 200 Areas cover about 1,600 ha (3,950 acres).

- The 300 Area, located just north of the city of Richland, is the site of nuclear and nonnuclear research and development to include the Pacific Northwest Laboratory (PNL). This area covers 150 ha (370 acres).

- The 400 Area, approximately 8 km (5 mi) northwest of the 300 Area, is the location of the recently shut down FFTF and FMEF. FFTF is an advanced liquid metal-cooled research reactor that was used in the testing of breeder reactor systems. FMEF consists of several connected buildings. The six-level Process Building (427 Building) is the main structure of the FMEF and encloses approximately 17,000 m^2 (183,000 ft^2) of operating area. This building has never been operated and is free of contamination. The exterior walls are reinforced concrete, and the cell walls are constructed of high-density concrete. The facility was designed and constructed for spent fuel examination and was subsequently partially converted for MOX fuel fabrication.

- The 600 Area comprises the remainder of Hanford, which includes most of the undisturbed land and has the following key attributes:

- Fitzner-Eberhardt Arid Lands Ecology Reserve (ALE), set aside for ecological studies
- Living sand dunes
- Cultural/historical facilities and sites
- Hanford Reach free-flowing Columbia River
- Old growth sagebrush/habitat areas
- A patrol training facility
- A low-level radioactive waste disposal site, which is leased by the State of Washington and subleased to a commercial enterprise (U.S. Ecology)
- Washington Public Power Supply System (WPPSS) nuclear power plants
- Waste Sampling and Characterization Facility
- Support facilities and infrastructure (for example, roads, railroads, telecommunications, water treatment and distribution, electrical transmission lines/substations, fire/ambulance, and access control facilities, borrow pits, and a landfill)
- DOE waste disposal sites
- A 260-ha (640-acre) parcel of land transferred to the State of Washington as a potential site for a hazardous waste disposal facility
- Meteorological towers and facilities
- A wildlife refuge under revocable use permit to the USFWS
- A recreational game management area under revocable use permit to the State of Washington Department of Fish and Wildlife
- A gravitational-wave observatory, presently under construction

• The 700 Area is the administrative center in downtown Richland and consists of government-owned buildings (for example, the Federal Building).

• The 1100 and 3000 Areas are support areas located in north Richland. The 1100 Area includes support services such as general stores and transportation maintenance. The 3000 Area is being vacated but still contains some administrative and support facilities.

In addition, there are DOE-leased facilities and DOE contractor privately owned facilities, which support Hanford operations, located on private land south of the 300 Area and outside of the 1100 and 3000 Areas (HF PNL 1994b:5).

Department of Energy Activities. The Hanford mission is to clean up the site, provide scientific and technological excellence to meet global needs, and to partner the economic diversification of the region (HF DOE 1994a:3-6). The current DOE activities that support Hanford's mission are shown in Table 3.2–1. In

the area of waste management, Hanford has embarked on a long-range cleanup program in compliance with the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) and applicable Federal, State, and local laws. DOE has set a goal of cleaning up Hanford's waste sites and bringing its facilities into compliance with Federal, State, and local environmental laws by the year 2028 (HF PNL 1994b:3). In addition, as part of the cleanup mission, DOE has the responsibility to safely store, handle, and stabilize Pu materials and spent fuel.

Table 3.2–1. Current Missions at Hanford Site

Mission	Description	Sponsor
Waste management	Store defense wastes and handle, store, and dispose of radioactive, hazardous, mixed, or sanitary wastes from current operations	Assistant Secretary for Environmental Management
Environmental restoration	Restore approximately 1,100 inactive radioactive, hazardous, and mixed waste sites and about 100 surplus facilities	Assistant Secretary for Environmental Management
Research and development	Conduct research in the fields of energy, health, safety, environmental sciences, molecular sciences, environmental restoration and waste management research and development, and national security activities	Various DOE Program Managers
Technology development	Develop new technologies for environmental restoration and waste management, including site characterization and assessment methods, and waste minimization	Various DOE Program Managers
Economic transition	Use the cleanup and science and technology mission elements to help the community establish a diversified and stable economic base over the long term	Assistant Secretary for Environmental Management

Source: HF DOE 1994a; HF PNL 1994b.

Non-Department of Energy Activities. In addition to the DOE mission-related activities listed in Table 3.2–1, Hanford has some unique and diverse assets and non-DOE missions, such as the following:

- The Fitzner-Eberhardt ALE Reserve, 31,100 ha (76,800 acres), established in 1967, is managed by Battelle Pacific Northwest Laboratory for DOE with assistance from the Nature Conservancy as a habitat and wildlife reserve and nature research center
- The area north of the Columbia River that is managed in part by the Washington State Department of Wildlife as the Wahluke Slope Wildlife Recreation Area and in part by USFWS as Saddle Mountain National Wildlife Refuge
- The Washington Nuclear Plant–2 (WNP–2) 1,100 MWe reactor operated by WPPSS and also the partially completed WNP–1 reactor
- The Laser Interferometer Gravitational-Wave Observatory, operated by the National Science Foundation as one of two widely separated installations (within the United States) that are operated in unison as a single gravitational-wave observatory
- Hanford Meteorological Station and towers
- An observatory and radio telescope facilities located on Rattlesnake Mountain
- The U.S. Ecology commercial low-level radioactive waste disposal site on State-leased lands near the center of Hanford

3.2.1 LAND RESOURCES

Land Use. The discussion of land resources at Hanford includes land use at Hanford and surrounding area. Hanford encompasses approximately 145,000 ha (358,000 acres) of mostly vacant land in the south-central area of the State of Washington. The land area is relatively flat and dominated by grasses and sagebrush. The Columbia River, which flows through the site, is the area's most important geographical feature. [Text deleted.]

Existing Land Use. Existing generalized land uses at Hanford and its vicinity are shown in Figure 3.2.1–1. All land within Hanford is owned by the Federal Government and is administered and controlled by DOE. Land use in the area southeast of Hanford includes residential, commercial, and industrial development in the Tri-Cities area. This area, encompassing the cities of Richland, Kennewick, and Pasco, is the closest population center and has about 107,000 residents. Agriculture is a major land use in the remaining area surrounding Hanford.

Hanford contains a variety of widely dispersed facilities, including old reactors, R&D facilities, the WPPSS nuclear power facility, consisting of the incomplete WNP-1 reactor and the complete WNP-2 reactor, and various production and processing plants within the specialized operational areas described in Section 3.2. As shown in Figure 3.2.1–1, sensitive open space areas include the Fitzner-Eberhardt ALE Reserve, approximately 31,100 ha (76,800 acres) near Rattlesnake Mountain; and two areas north of the Columbia River: the Saddle Mountain National Wildlife Refuge (12,220 ha [30,200 acres]), which is administered by USFWS, and the Wahluke Unit Columbia Basin Wildlife Area (22,260 ha [55,000 acres]), which is managed by the Washington State Department of Fish and Wildlife (HF NPS 1994a:314,315).

Public access to ALE Reserve and Saddle Mountain National Wildlife Refuge is prohibited (HF DOE 1992b:24,34). Other special status lands within the vicinity include McNary National Wildlife Refuge, administered by USFWS, and Columbia River Islands Area of Critical Environmental Concern (ACEC) and McCoy Canyon, both administered by BLM (Figure 2.2.1–2). McNary National Wildlife Refuge and Columbia River Islands ACEC consist of several islands within the Columbia River that are closed to public access for approximately 6 months of the year (HF NPS 1994a:315,316). The U.S. Department of Agriculture, National Resources Conservation Service does not identify prime farmland on Hanford. However, some soil mapping units have the potential to be prime farmland soils if irrigated (WA USDA 1996a:1).

In 1975, DOE designated the entire Hanford Site area as a NERP, an outdoor laboratory for ecological research to study the environmental effects of energy developments. The Hanford NERP is a sagebrush-steppe habitat that contains a wide range of arid land ecosystems and offers the opportunity to examine linkages between terrestrial, subsurface, and aquatic environments on a systems basis (DOE 1985a:1,3). The closest residence is approximately 30 m (98 ft) from the north Hanford boundary. There is also a mobile home park approximately 60 m (197 ft) from the south boundary.

Land-Use Planning. The DOE Richland Operations Office (RL) has undertaken comprehensive land-use planning to define how best to utilize land at Hanford for the next 30 to 40 years. The December 1994 Secretary of Energy Policy requires RL to manage its land and facilities as valuable national resources. The resulting Comprehensive Land-Use Plan (CLUP) will identify existing and planned future land uses with accompanying restrictions, cover a specific timeframe, and be updated as needed. The development and evaluation of the CLUP will be integrated with the upcoming *Hanford Remedial Action Environmental Impact Statement.* Together, these processes will identify land-use cleanup scenarios, create a remediation baseline for the environmental restoration program, and provide a framework for the future management and utilization of land at Hanford.

Private lands bordering Hanford are subject to the planning regulations of Benton, Franklin, and Grant Counties, and the city of Richland. The majority of Hanford, particularly the site area not reserved as a buffer, is situated within Benton County. Benton County and the city of Richland currently have a comprehensive land-use planning process under way, with statutory mandated deadlines under the State of Washington *Growth*

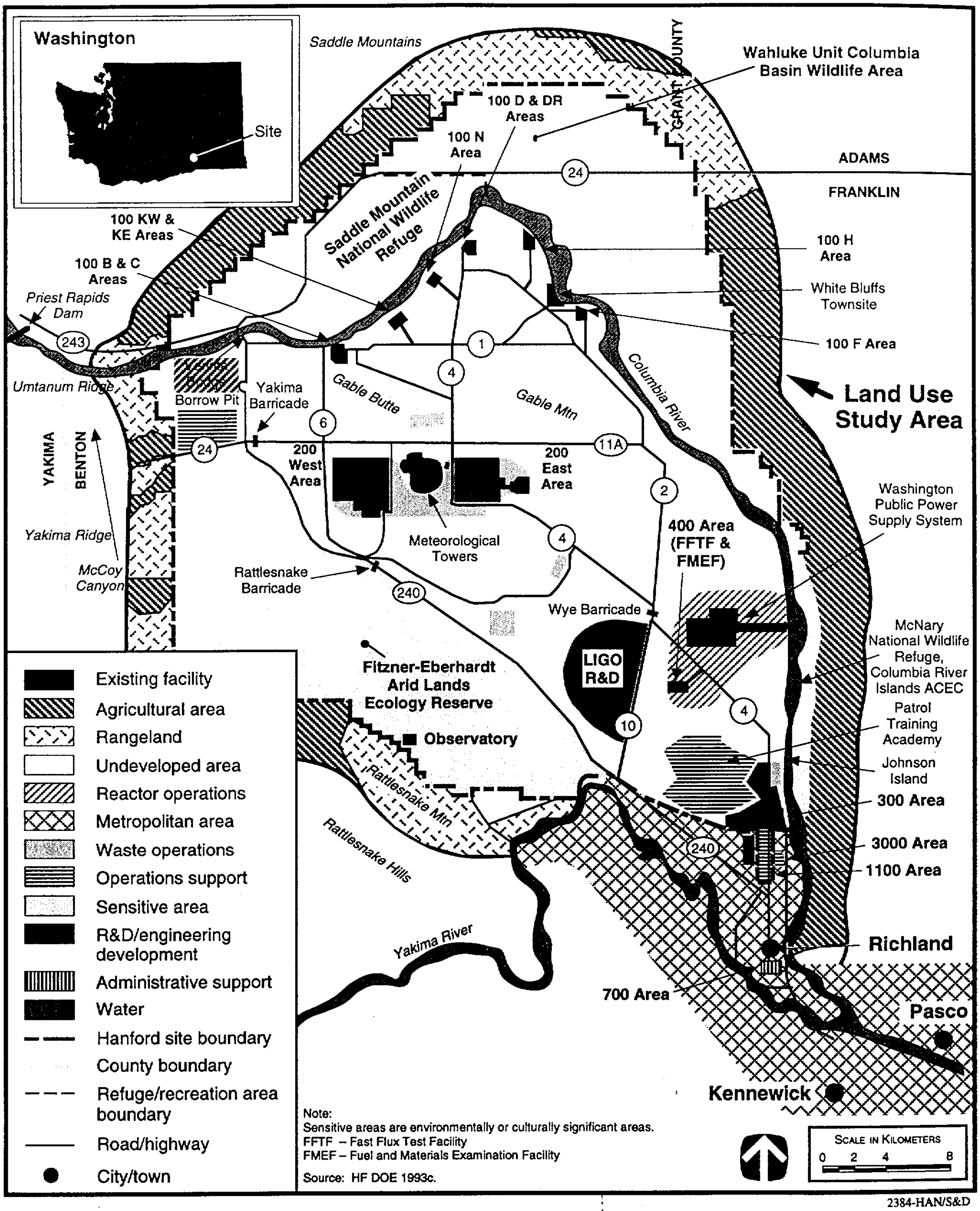

Figure 3.2.1–1. Generalized Land Use at Hanford Site and Vicinity.

Management Act (GMA) of 1990. The GMA requires Benton County and the city of Richland to include portions of Hanford in their plans.

The county and city planning could be carried out independently, without any integration with DOE. This would have a significant potential for overlap and duplication, which would result in public confusion as to how the plans relate to each other. To avoid this, RL's integrated CLUP/HRA-EIS process includes coordinating internal organizational and external involvement activities. Tribal Nations, local cities, counties, and State and Federal agencies are voluntarily and cooperatively participating in the preparation of the CLUP to eliminate duplication of efforts and attempt to identify and resolve conflicts early on. A single integrated Geographical Information System data management system is being used to ensure optimum consistency and compatibility among the end products each government agency is developing. The CLUP is scheduled to be implemented by RL in April 1997, after the ROD from the HRA EIS is issued.

Visual Resources. Hanford is located in the Pasco Basin of the Columbia Plateau north of the city of Richland, which is at the confluence of the Yakima and Columbia Rivers. Site topography ranges from generally flat to gently rolling. In the north-central part of the site, two small east-west ridges, Gable Butte and Gable Mountain, rise approximately 60 m (197 ft) and 180 m (591 ft), respectively, above the surrounding terrain. Rattlesnake Hills, Rattlesnake Mountain, Umtanum Ridge, and Yakima Ridge are located along the southwestern and western site boundaries, and the Saddle Mountains are located along the northern site boundary. The Columbia River flows through the northern part of the site and, turning south, forms part of the eastern site boundary. A 79.7-km (49.5-mi) segment of the Columbia River extending downstream from below Priest Rapids Dam to near Johnson Island (river mile 346.5 to 396) is currently protected and is part of a Proposed Action designating this segment of the Hanford Reach as a Wild and Scenic River (HF NPS 1994a:5,62,311). The Yakima River runs along a small portion of the southern site boundary (Figure 3.2.1–1).

The site is dominated by widely spaced low brush and grasslands, typical of the regional shrub-steppe desert. A large area of unvegetated mobile sand dunes is located along the eastern site boundary, and unvegetated blowouts are scattered throughout the site. Hanford consists mostly of undeveloped land, with widely spaced clusters of industrial buildings located along the southern and western banks of the Columbia River and at several interior locations. The WPPSS nuclear power facility is also located along the west bank of the Columbia River. The adjacent visual landscape consists mainly of rural rangeland and farms; the city of Richland, part of the Tri-Cities area, is the only adjoining urban area. Construction and operation of the DOE and WPPSS facilities have disturbed the character of the landscape within their respective areas. The DOE and WPPSS facilities are brightly lit at night and highly visible from many areas. The plume of steam that rises high into the air at the WPPSS facility is also highly visible from the surrounding area, including portions of the Tri-Cities area. The developed areas of Hanford are consistent with a VRM Class 5 designation. The remainder of the site ranges from a VRM Class 3 to Class 4 designation.

Viewpoints affected by DOE and WPPSS facilities are primarily associated with the public access roadways (including State Highways 24 and 240, Hanford Road, Horn Rapids Road, and Route 4 South/Stevens Drive), the bluffs along the east bank of the Columbia River, and the north edge of the city of Richland. Views of DOE facilities from the surface of the Columbia River are generally blocked by high river banks; however, stack plumes from the WPPSS facility are visible. Because of the semi-arid climate, views can exceed 80 km (50 mi); however, topographic relief provides significant visual screening of the Hanford facilities.

The most sensitive visual areas include the Columbia River, because of its potential designation as a Wild and Scenic River, and the northern part of the city of Richland that borders the site, because of the high-density commercial and residential land use. Route 4 South/Stevens Drive is the only affected public access roadway with high traffic volumes. However, since this route primarily serves the DOE and WPPSS facilities, user sensitivity is low. Although some facilities are visible from the east bank of the Columbia River, densities are low and, in most instances, the viewing distances are great.

3.2.2 SITE INFRASTRUCTURE

Baseline Characteristics. Activities at Hanford are concentrated at facilities in several general areas previously described in Section 3.2. To support these missions, an extensive infrastructure exists. Baseline site infrastructure characteristics are shown in Table 3.2.2–1.

Table 3.2.2–1. Hanford Site Baseline Characteristics

Characteristics	Current Usage	Site Availability
Transportation		
Roads (km)	420	420
Railroads (km)	204	204
Electrical		
Energy consumption (MWh/yr)	345,500	1,678,700
Peak load (MWe)	58	281
Fuel		
Natural gas (m^3/yr)	459,200	20,804,000
Oil and propane (l/yr)	9,334,800	14,775,000
Coal (t/yr)	41,580	91,708
Steam (kg/hr)	40,847	40,847

Source: HF DOE 1990e.

The site infrastructure provides for transportation of personnel and most material shipments by road. Bulk materials (primarily coal), large equipment, irradiated fuel, and radioactive solid and liquid wastes are transported by rail. High-level and low-level liquid radioactive wastes from past process operations are transported between waste management facilities by encased pipeline. Large barged shipments (decommissioned submarine reactor cores) are routinely offloaded at the Port of Benton dock facility (on the Columbia River in north Richland) and transported to a site disposal facility using special multiwheeled trailers.

Hanford has a network of paved roads. Only 104 km of the 420 km (65 of 261 mi) of these roads are accessible to the public. Hanford is also crossed by State Route 240, which is the main route traveled by the public. Most onsite employee travel is on Route 4, the primary highway from the Tri-Cities to most Hanford outer area work locations. A recently constructed access road between State Route 240 and the 200 West Area has alleviated peak traffic congestion on Route 4. Access to the outer areas (100 and 200 Areas) is controlled by DOE at the Yakima, Wye, and the new Rattlesnake barricades.

Onsite rail transport is provided by a short-line railroad owned by DOE, which controls all access. Hanford's railroad is a Class III Railroad System, as defined by the Federal Railroad Administration. Its common carrier tie is with the Union Pacific Railroad in Richland. A series of maintenance upgrades to the site's main trackage was completed in 1994. The Hanford railroad will continue to support site cleanup in a variety of ways, such as transporting liquid waste, contaminated soils, construction materials, spent nuclear fuel, large equipment, and closure materials.

Electricity, the only regional utility service supplied to Hanford, is provided by the Bonneville Power Administration (BPA). A site electrical transmission and distribution system is used to provide power to the majority of Hanford. The city of Richland distributes power for about 3 percent of the total site usage. Hanford is a Priority Firm customer, and the BPA is contractually obligated to provide as much power as the site requires. Being a Priority Firm customer ensures that, in the event of severe regional power shortages, Hanford (along with other Priority Firm customers) would be the last level of BPA service to be shut off. Power to the BPA grid is dominated by hydropower (more than 70 percent), which provides a typically reliable source of power.

Hydropower is normally more constrained by seasonal variation in peak demand than in meeting momentary peak demand levels. The Northwest Sub-Regional Power Pool capabilities are shown in Table 3.2.2–2.

Natural gas, provided by the Cascade Natural Gas Corporation, is currently used in a few locations on Hanford. Fuel oil and propane are also used in some areas. Coal is currently used to fuel the 200 East Area central steam plant, which also supplies steam to the 200 West Area. The steam system (production and distribution) in the 200 Areas was built in the 1940s, and upgrade and replacement are required to maintain reliability. Natural gas, in conjunction with distributed package boilers, is planned for alternative steam production and heating systems. These improvements are planned for 1996.

Table 3.2.2–2. Northwest Sub-Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel[a]	
Coal	34%
Nuclear	3%
Hydro/geothermal	46%
Oil/gas	7%
Other[b]	11%
Total Annual Production	256,404,000 MWh
Total Annual Load	250,045,000 MWh
Energy Exported Annually	6,359,000 MWh
Generating Capacity	49,596 MWe
Peak Demand	33,325 MWe
Capacity Margin[c]	13,655 MWe

[a] Percentages do not total 100 percent due to rounding.
[b] Includes power from both utility and nonutility sources.
[c] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.
Source: NERC 1993a.

The Columbia River is the primary source of raw water for Hanford. The average annual river flow through the site is approximately 203 million l/minute (min) (50 million gal/min). The Export Water System, with a capacity of 124,900 l/min (33,000 gal/min), serves the 200 Areas and most of the shutdown 100 (reactor) Areas. The 100 K East and K West Areas have an independent river source. Wells supply water to the 400 Area and a variety of low-use facilities at remote locations. The administrative and research areas in north Richland are supplied with water by the city of Richland.

Most of the weapons-usable Pu at Hanford is stored in the PFP. The PFP is a group of buildings located in an enhanced security portion of 200 West Area around the 234-5Z Building. The total area (all levels) is approximately 25,000 m^2 (270,000 ft^2), including processing and all service/support space.

The PFP complex includes the following: Pu processing systems in gloveboxes and cells, HVAC systems (some with multiple stages of HEPA filtration), analytical laboratory, developmental laboratory, maintenance shops, administrative offices; security features, and fire suppression systems. Additional services, such as fire protection, medical services, security support, steam, water, and electrical power, are provided to the PFP from site services. [Text deleted.]

The original purpose of the PFP was to convert Pu nitrate into metal ingots and weapons components. The facility is essentially self-sustaining; its process capability is supported by scrap recycle capability, Pu storage, and maintenance/repair facilities. The 234-5Z Building has no identified future missions beyond Pu stabilization

and is programmed for D&D. The newer 2736-Z Pu storage vault and two ancillary structures are located immediately south of the 234-5Z Building and provide 8,224 storage spaces for Pu. This facility will continue to be utilized for Pu storage until new facilities are constructed or the Pu is shipped offsite. Approximately 25 percent of 2736-Z has been dedicated as a vault where Pu material can be stored under IAEA surveillance.

The ROD resulting from the *Plutonium Finishing Plant Stabilization Final Environmental Impact Statement* (DOE/EIS-0244-F) decided to remove Pu material in holdup in the PFP and stabilize the holdup and other Pu-bearing material at the PFP. Following stabilization, Pu will be in a form suitable for interim storage in existing vaults at the PFP Facility. Low Pu content material could be treated to meet WIPP Waste Acceptance Criteria.

Another existing facility complex at Hanford that could be used to store or process Pu is the FMEF. The FMEF consists of several connected buildings located in the 400 Area. The six-level Process Building (427 Building), the main structure of the facility, has an attached single-level mechanical wing on the west side and an emergency power wing at the northwest corner. The Process Building encloses approximately 17,650 m^2 (190,000 ft^2) of operating area and extends from 30 m (100 ft) above grade to about 11 m (36 ft) below grade. This building has never been operated and is free of contamination. The exterior walls are made of reinforced concrete 0.3 m (1.0 ft) thick and the cell walls are constructed of high-density concrete 1.2 m (4.0 ft) thick. Some of the walls within the facility are used as both load-bearing and radiation-shielding walls. In some locations, high-density concrete is used for cell-shielding walls because of specific shielding requirements. The other building within the FMEF complex is a two-level building (4682 Building), which is connected to the south side of the Process Building. The 4682 Building is divided into two portions: (1) the administrative portion known as the entry wing and (2) the shop portion, which was designed to house the Fuel Assembly Area for fabrication of MOX fuel and test assemblies for the FFTF.

3.2.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The climate at Hanford and in the surrounding region is characteristically that of a semiarid steppe. The humidity is low, and winters are mild. The average annual temperature is 11.8 °C (53.3 °F); average monthly temperatures range from a minimum of -1.5 °C (29.3 °F) in January to a maximum of 24.7 °C (76.5 °F) in July. The average annual precipitation is 16.0 cm (6.3 in). The prevailing winds at Hanford are from the northwest. The average annual windspeed is 3.4 m/second (s) (7.6 miles per hour [mph]) (HF PNL 1994b:83-84). Additional information related to meteorology and climatology at Hanford is presented in Appendix F.

Ambient Air Quality. Most of Hanford is located within the South-Central Washington Intrastate Control AQCR (#230) with a small portion of the site being located in the Eastern Washington-Northern Idaho Interstate AQCR (#62). None of the areas within Hanford and its surrounding counties are designated as a nonattainment area (40 CFR 81.348) with respect to NAAQS for criteria pollutants (40 CFR 50). Applicable NAAQS and Washington Ambient Air Quality Standards are presented in Appendix F.

Four PSD (40 CFR 52.21) Class I areas have been designated in the vicinity of Hanford: Goat Rocks Wilderness Area, located 145 km (90 mi) west of the site; Mount Rainier National Park, located 160 km (99 mi) west of the site; Mount Adams Wilderness Area, located 153 km (95 mi) southwest of the site; and Alpine Lakes Wilderness Area, located 177 km (110 mi) northwest of the site.

Since the creation of the PSD program in 1977, permits were obtained for nitrogen dioxide (NO_2) emissions from Pu-uranium extraction and uranium oxide plants located in the 200 Area. The maximum increases in the annual NO_2 concentration at the Hanford boundary were estimated to be negligible (Table 3.2.3-1).

Ambient air quality within and near the Hanford boundary is currently monitored for NO_2 and particulate matter. The ambient air quality data collected during the last few years are either very small percentages of the limits set in applicable ambient standards (sulfur dioxide [SO_2] and carbon monoxide [CO]) or substantially lower than the limits set in applicable ambient standards.

At Hanford, the major sources of criteria air pollutants (pollutants for which a NAAQS has been written including PM_{10}, SO_2, NO_2, CO, ozone [O_3], and lead [Pb]) are coal-burning boilers and fugitive coal piles. Other emissions include other process emissions, vehicular emissions, and temporary emissions from various construction activities. Most of the process emissions at Hanford will have been discontinued, and space heating requirements will be met by burning natural gas by 2005 as reflected in the No Action emissions presented in Appendix F.

Table 3.2.3–1 presents the baseline ambient air concentrations for criteria pollutants and other pollutants of concern at Hanford. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

Noise. The major noise sources within Hanford include various facilities, equipment, and machines (for example, cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials handling equipment, and vehicles). Data from two noise surveys indicate that background noise levels (measured as 24-hour equivalent sound level) at Hanford range from 30 to 60.5 dBA (Appendix F). The 24-hour background sound level at undeveloped areas at Hanford ranges from 24 to 36 dBA, except when high winds elevate sound levels (HF PNL 1994a:4.145). The primary source of noise at the site and nearby residences is traffic. Most Hanford industrial facilities are at a sufficient distance from the site boundary that noise levels at the boundary from these sources are not measurable or are barely distinguishable from background noise levels.

The State of Washington has established noise standards for different source and receptor areas. Hanford belongs to source area Class C (industrial). The maximum allowable noise level for residential, commercial, and

Table 3.2.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Hanford Site, 1994

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] ($\mu g/m^3$)	Baseline Concentration ($\mu g/m^3$)
Criteria Pollutants			
Carbon monoxide	8-hour	10,000[b]	0.7
	1-hour	40,000[b]	2.6
Lead	Calendar Quarter	1.5[b]	<0.01
	24-hour	0.5[c]	<0.01
Nitrogen dioxide	Annual	100[b]	0.2
Ozone	1-hour	235[b]	[d]
Particulate matter less than or equal to 10 microns in diameter	Annual	50[b]	0.01
	24-hour	150[b]	0.1
Sulfur dioxide	Annual	52[c]	0.8
	24-hour	260[c]	6.6
	3-hour	1,300[b]	22.9
	1-hour	1,018[c]	47.9
	1-hour	655[c,e]	47.9
Mandated by the State of Washington			
Gaseous fluoride	30-day	0.8[c]	[f]
	7-day	1.7[c]	[f]
	24-hour	2.9[c]	[f]
	12-hour	3.7[c]	[f]
Total suspended particulates	Annual	60[c]	0.01
	24-hour	150[c]	0.1
Hazardous and Other Toxic Compounds			
Arsenic	Annual	0.00023[c,g]	0.00019
Cadmium	Annual	0.00056[c,g]	0.00008
Chromium	24-hour	1.7[c,g]	0.0029
Copper	24-hour	3.3[c,g]	0.0018
Formaldehyde	Annual	0.077[c,g]	0.00017
Manganese	24-hour	0.4[c,g]	0.0040
Nickel	Annual	0.0021[c,g]	0.00097
Polycyclic organic matter	24-hour	[h]	0.19
Selenium	24-hour	0.67[c,g]	0.00036
Vanadium	24-hour	0.17[c,g]	0.010

[a] The more stringent of the Federal and State standards is presented if both exist for the averaging time.
[b] Federal and State standard.
[c] State standard.
[d] Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. See Section 4.1.3 for a discussion of ozone-related issues.
[e] The standard is not to be exceeded more than twice in any seven consecutive days.
[f] No sources of the pollutant have been identified.
[g] Risk-based acceptable source impact levels.
[h] No State standard for indicated averaging time.
Source: 40 CFR 50; HF 1995a:1; WA Ecology 1994a.

industrial receptor areas is 50 to 70 dBA (Appendix F). Hanford is currently in compliance with State and Federal noise regulations.

3.2.4 WATER RESOURCES

Surface Water. Major surface water features at Hanford are the Columbia River (northern and eastern sections), the Yakima River, springs along the Columbia River and on Rattlesnake Mountain, and onsite ponds (Figure 3.2.4–1).

The flow of the Columbia River is regulated by 11 dams within the United States, 7 upstream and 4 downstream of the site (HF PNL 1994a:4.40). Located approximately 10 km (6.2 mi) upstream of Hanford, the Priest Rapids Dam is the nearest dam, while McNary is the nearest dam downstream (80 km [50 mi]). The portion of the Columbia River between these dams is referred to as the Hanford Reach. Flows through the Hanford Reach fluctuate significantly and are controlled primarily by operations at Priest Rapids Dam. The annual average flow rate in the vicinity of Priest Rapids Dam is approximately 3,360 cubic meters (m^3)/s (118,642 cubic feet [ft^3]/s) (HF PNL 1994a:4.40).

The Yakima River, bordering a short length of the southern portion of Hanford, has a low annual flow rate compared to the Columbia River (HF PNL 1994a:4.42). The average annual flow rate is about 104 m^3/s (3,673 ft^3/s). Approximately one-third of Hanford is drained by the Yakima River System.

Rattlesnake Springs and Snively Springs, located on the western part of Hanford, form small surface streams. Rattlesnake Springs flows for about 3 km (1.9 mi) before disappearing into the ground (Figure 3.2.4–1). Cold Creek and its tributary, Dry Creek, are ephemeral streams located in the southern portion of Hanford (HF PNL 1994a:4.42). These streams drain areas to the west of Hanford and cross the southwestern part of the site toward the Yakima River. Surface flow, when it occurs, infiltrates rapidly and disappears into the surface sediments in the western part of the site.

The primary uses of the Columbia River include the production of hydroelectric power, transportation, and extensive irrigation in the Mid-Columbia Basin (HF PNL 1994a:4.40). Another principle use of the river is by the fishery industry. Several communities located along the Columbia River rely on the river as their source of drinking water and for recreational purposes. Water from the Columbia River along the Hanford Reach is also used as a source of drinking water by several onsite facilities and for industrial uses.

Large Columbia River floods have occurred in the past, but the likelihood of recurrence of large-scale flooding has been reduced by the construction of several flood-control and water-storage dams upstream of the site (HF PNL 1994a:4.42). Major floods on the Columbia River are typically the result of rapid melting of the winter snowpack over a wide area augmented by above-normal precipitation. The largest flood on record occurred June 7, 1894, with a peak discharge at Hanford of 21,000 m^3/s (741,615 ft^3/s). The floodplain associated with the 1894 flood was limited to within approximately 3 km (1.9 mi) of the banks of the river. The largest recent flood took place in 1948, with an observed peak discharge of 20,000 m^3/s (706,300 ft^3/s) at Hanford. The probability of flooding at the magnitude of the 1894 and 1948 floods has been greatly reduced because of upstream regulation by dams (HF PNL 1994a:4.42).

Major flooding of the Yakima River, which has occurred several times this century, could extend into a small portion of the southern section of Hanford, but the upstream Yakima River is physically separated from Hanford by Rattlesnake Mountain, which would prevent major flooding on Hanford (HF PNL 1994a:4.43). There are no Federal Emergency Management Agency (FEMA) floodplain maps for the Hanford Reach of the Columbia River. FEMA only maps developing areas, and the Hanford Reach is specifically excluded.

Surface Water Quality. The State of Washington has classified the stretch of the Columbia River from Grand Coulee to the Washington-Oregon border, which includes the Hanford Reach, as Class A, excellent raw drinking water, recreation area, and wildlife habitat. The Columbia River is currently in compliance with applicable State and Federal drinking water standards (HF PNL 1994a:4.58).

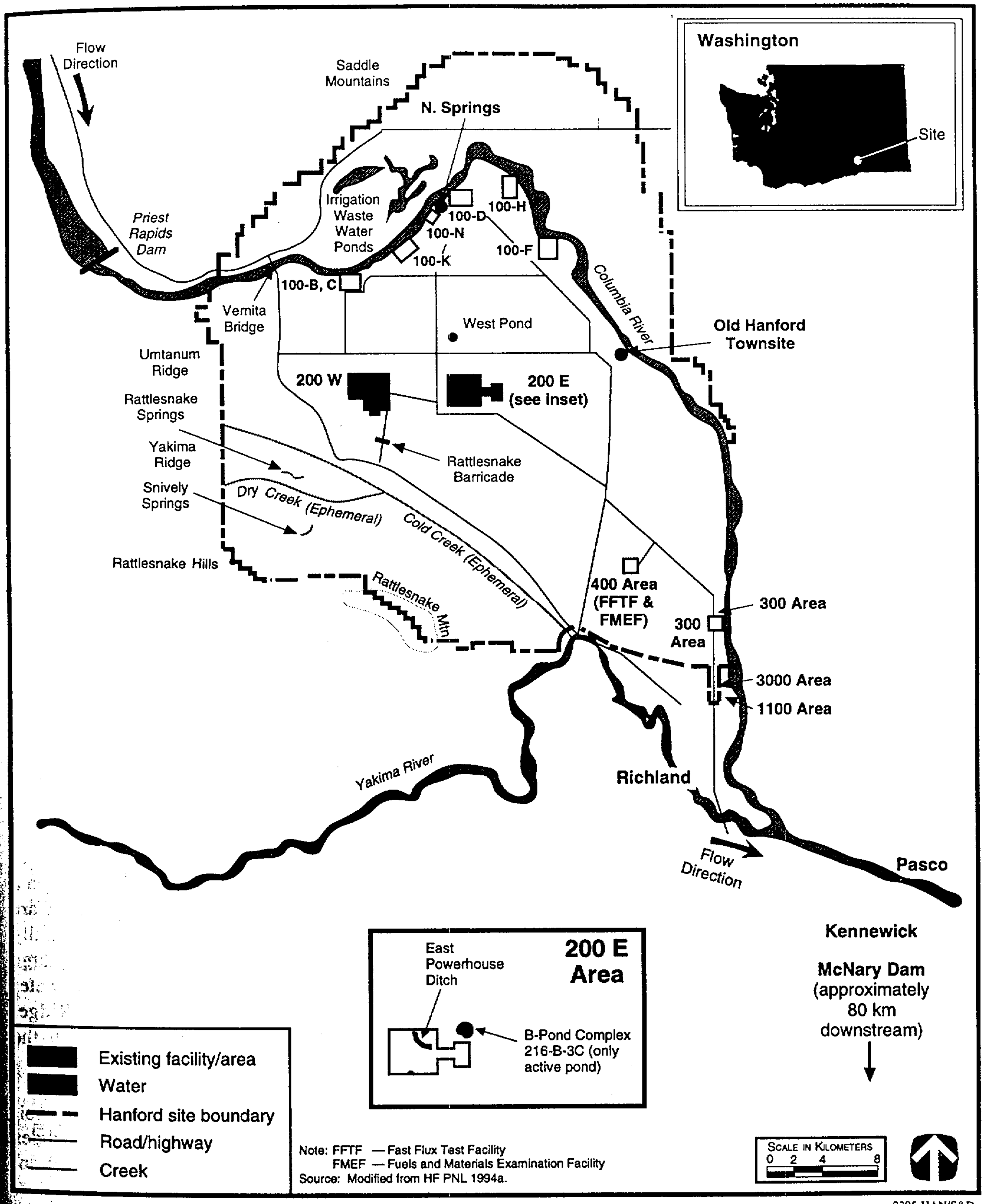

Figure 3.2.4–1. Surface Water Features at Hanford Site.

Water samples have been collected periodically from the Hanford Reach of the Columbia River. Radionuclides consistently detected in the river during 1993 were iodine-129 (I-129), strontium-90 (Sr-90), tritium, U-234, and uranium-238 (U-238). In addition, technetium-99 (Tc-99), U-238, and Pu-239/240 were detected in 50 percent or more of the samples analyzed during the year. Total alpha and beta measurements were similar to previous years and were approximately 5 percent or less of the applicable drinking water standards of 15 and 50 picocuries (pCi)/l (4 pCi/gal and 13.2 pCi/gal), respectively. These measurements are useful indicators of the general radiological quality of the river and, because results are obtained quickly, provide an early indication of changes in radioactive contamination levels. Tritium measurements at Richland were all well below State and Federal drinking water standards. All nonradiological water quality standards were met for Class A-designated water (HF PNL 1994a:4.58). Surface water quality data downstream of Hanford are presented in Table 3.2.4–1.

Surface Water Rights and Permits. The Department has asserted, and continues to assert, a federally reserved water withdrawal right to obtain water from the Columbia River. Currently, Hanford withdraws approximately 13.5 billion l/yr (3.57 billion gal/yr) of water from the Columbia River.

Groundwater. Groundwater under Hanford occurs in unconfined and confined aquifers. The unconfined aquifer lies within the boundaries of the Pasco Basin contained within glaciofluvial sands and gravels of the Hanford Formation as well as the fluvial and lacustrine sediments of the Ringold Formation. Across the site, groundwater generally flows easterly through sands and gravels of the middle member of the Ringold Formation of the unconfined aquifer. The base of the aquifer is the Columbia River Basalt or, in some areas, the clay zones of the lower member of the Ringold Formation. The aquifer thickness ranges from 15 to 61 m (49 to 200 ft), where it thins along the flanks of bordering structures. As a result of local water disposal to surface ponds, the water table has risen as much as 27 m (89 ft) in the 200 West Area (HF PNL 1994a:4.54). This has caused groundwater mounding, including radial and northward flow components, in the 200 Areas. Depth to groundwater ranges from approximately 24 to 80 m (79 to 262 ft) across Hanford. Figure 3.2.4–2 shows the water table elevations and the direction of groundwater movement.

The unconfined aquifer is recharged from rainfall and runoff from higher bordering elevations to the west, water infiltrating from small ephemeral streams, river water along influent reaches of the Yakima and Columbia Rivers, and upward leakage from the lower confined aquifers and from artificial recharge (agricultural irrigation and waste disposal operations at Hanford). In the Hanford vicinity, groundwater is discharged primarily along the Columbia River, with lesser amounts going to the Yakima River (HF PNL 1994a:4.52).

The confined aquifers at Hanford consist of sedimentary interbeds and interflow zones that occur between basalt flows in the Columbia River Basalt Group. Main water-bearing portions of the interflow zones occur within a network of interconnecting vesicles and fractures of the flow tops or flow bottoms. The confined aquifers are continuous throughout most of the Pasco Basin except where the aquifers have been eroded or stratigraphically pinched out. The thickness of these aquifers varies from several centimeters to at least 52 m (171 ft). Recharge of the confined aquifer occurs primarily where the basalt formations are at or near ground levels as water infiltrates from precipitation and stream runoff at areas including the Rattlesnake Hills, Yakima Ridge, Umtanum Ridge, and the Saddle Mountains. Groundwater from these confined aquifers is also discharged to the Columbia River (HF PNL 1994a:4.91).

Groundwater Quality. Groundwater quality at Hanford has been affected by liquid waste released to the soil column by past and ongoing site operations. [Text deleted.] Minor quantities of the longest-lived radionuclides have reached the water table via a failed groundwater monitoring well casing and through reverse well injection, a disposal practice that was discontinued at Hanford in 1947. The unconfined aquifer contains both radiological and nonradiological contaminants at concentrations exceeding water quality criteria and standards. Table 3.2.4–2 shows the unconfined groundwater quality at Hanford. Tritium and I-129 have been detected in the confined aquifer. Contamination in the confined aquifer, however, is typically limited to areas where there is exchange with the unconfined aquifer (HF PNL 1994a:4.52).

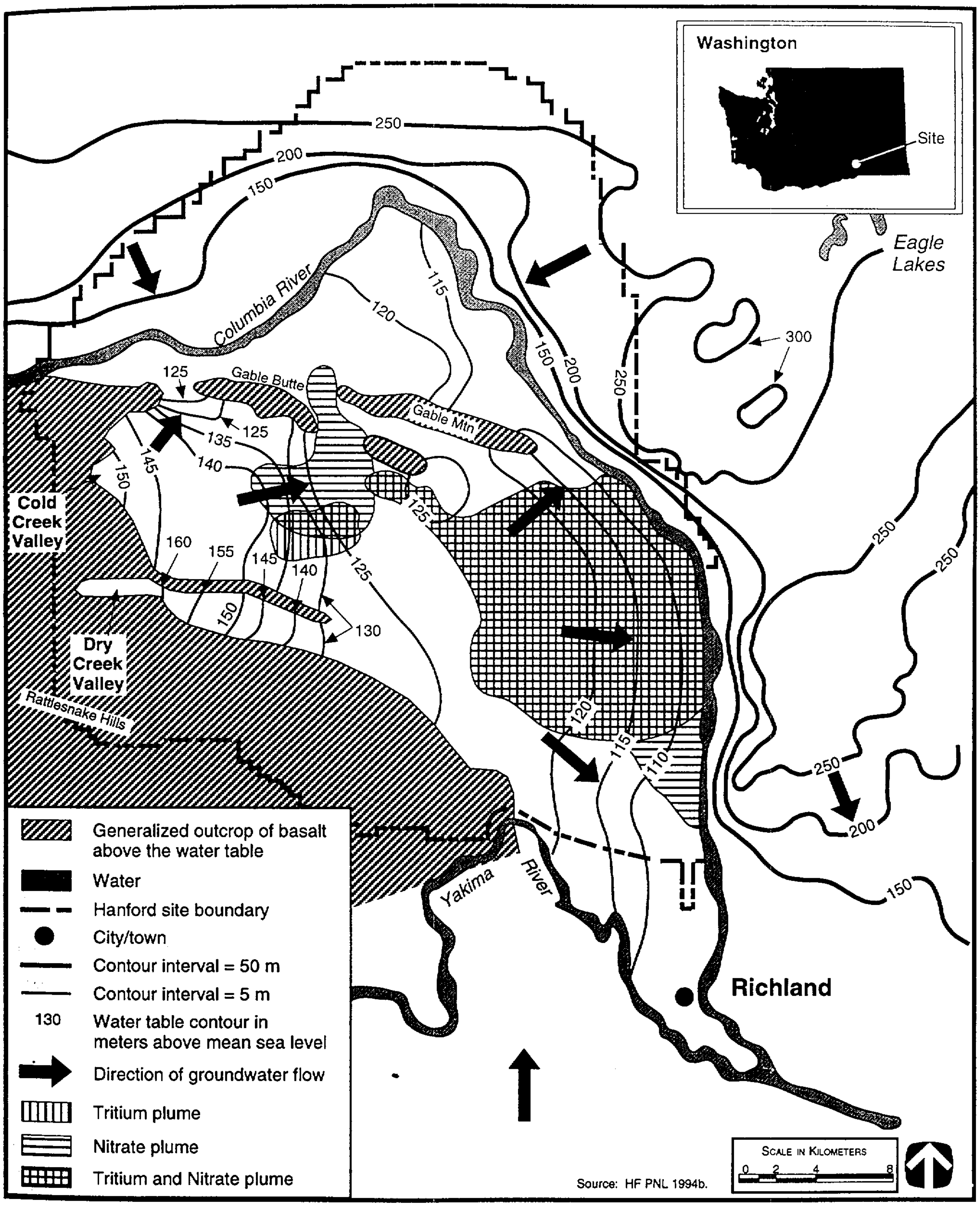

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Figure 3.2.4–2. Water Table Elevations and Major Plumes for the Unconfined Aquifer at Hanford Site, June 1993.

Table 3.2.4–1. Summary of Columbia River Surface Water Quality Monitoring at Hanford Site (Richland Pumphouse), 1993

Parameter	Unit of Measure	Water Quality Criteria and Standards[b]	Concentration[a] High	Concentration[a] Low
Alpha (gross)	pCi/l	15[c]	1.69	$<1.18\times10^{-3}$
Barium	mg/l	2[c]	0.036	0.029
Beta (gross)	pCi/l	50[d]	2.8	NR
Calcium	mg/l	NA	22.1	17.0
Chloride	mg/l	250[e]	1.2	1.01
Chromium	mg/l	0.1[c]	$<2.0\times10^{-2}$	5.4×10^{-3}
Copper	mg/l	1.0[c]	0.0033	<0.002
Fluoride	mg/l	4[c], 2[e]	0.3	0.1
Iodine-129	pCi/l	20[f]	0.00014	NR
Iron	mg/l	0.3[e]	0.0673	0.034
Magnesium	mg/l	NA	5.367	4.055
Manganese	mg/l	0.05[e]	0.0071	<0.0014
Nitrate	mg/l	10[c]	0.58	0.35
pH	pH units	6.5-8.5[e]	8.6	8.1
Potassium	mg/l	NA	1.225	0.087
Plutonium-239/240	pCi/l	1.2[f]	7.82×10^{-5}	$<3.25\times10^{-6}$
Sodium	mg/l	NA	2.83	2.436
Strontium-90	pCi/l	400[f]	1.37×10^{-1}	$<2.39\times10^{-2}$
Sulfate	mg/l	250[e]	11.6	8.2
Technetium-99	pCi/l	4,000[f]	0.25	NR
Tritium	pCi/l	80,000[f]	162	48.6
Uranium-234	pCi/l	20[f]	3.56×10^{-1}	1.89×10^{-1}
Uranium-235	pCi/l	24[f]	2.20×10^{-2}	$<-5.05\times10^{-4}$
Uranium-238	pCi/l	24[f]	3.19×10^{-1}	1.44×10^{-1}
Zinc	mg/l	5[e]	<0.02	<0.0026

[a] Data are average values from four separate sampling events.
[b] For comparison purposes only.
[c] National Primary Drinking Water Regulations (40 CFR 141).
[d] Proposed National Primary Drinking Water Regulations: Radionuclides (56 FR 33050).
[e] National Secondary Drinking Water Regulations (40 CFR 143).
[f] DOE Derived Concentration Guides (DCG) for water (DOE Order 5400.5), DCG values are based on a committed effective dose of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of DCG. All concentrations of radionuclides are determined by subtracting the instrument background environmental level from the monitored location. A negative or zero incremental concentration means that the concentration at the sampling location is equivalent to the background environmental level.
Note: mg/l=milligrams per liter; pCi/l=picocuries per liter; NA=not applicable; NR=not reported.
Source: HF PNL 1994a.

Tritium and nitrate plumes have been identified in the unconfined aquifer at Hanford. Because both are ubiquitous in liquid waste streams and are highly mobile in groundwater, they can be used as good indicators of the extent of groundwater contamination at Hanford. The major plume of tritium-contaminated groundwater has continued to move eastward over the years and has seeped into the Columbia River (HF PNL 1992a:157). The generalized locations of the major plumes are shown on Figure 3.2.4–2.

Groundwater Availability, Use, and Rights. Groundwater in the Pasco Basin area is used for domestic, industrial, and agricultural purposes. The principal groundwater users within Hanford are the FFTF, the PNL, and remote

Table 3.2.4–2. Groundwater Quality Monitoring in the Unconfined Aquifer at Hanford Site, 1993

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Existing Conditions 1993	
			High	Low
1,2-Dichloroethylene	mg/l	0.007[b]	180	<dL
Carbon tetrachloride	mg/l	0.005[b]	7	<dL
Cesium-137	pCi/l	120[c]	2,087[d]	<dL
Chromium	mg/l	0.1[b]	19.1	<dL
Cobalt-60	pCi/l	400[c]	423	<dL
Iodine-129	pCi/l	20[c]	64.2	<dL
Nitrate	mg/l	10[b]	870	<dL
Plutonium-239/240	pCi/l	1.2[c]	125[d]	<dL
Strontium-90	pCi/l	400[c]	7,890[e]	<dL
Technetium-99	pCi/l	4,000[c]	20,500[f]	<dL
Tetrachloroethylene	mg/l	0.005[b]	0.0059	<dL
Trichloroethylene	mg/l	0.005[b]	0.061	<dL
Tritium	pCi/l	80,000[c]	3,590,000[g]	<dL
Uranium, Total	mg/l	0.02[h]	3,320[i]	<dL

[a] For comparison purposes only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] DOE DCG for water (DOE Order 5400.5). DCG values are based on a committed effective dose of 100 mrem per year; however, because the drinking water maximum containment level is based on 4 mrem per year, the number listed is 4 percent of the DCG.
[d] Found in well 299-E28-25.
[e] Found in well 299-E28-23.
[f] Found in well 299-W19-24.
[g] Found in well 299-E17-9.
[h] Proposed National Primary Drinking Water Regulations, Radionuclides (56 FR 33050).
[i] Found in well 299-W19-29.
Note: dL=detection limit.
Source: HF PNL 1994c.

training and laboratory facilities. Currently, DOE asserts a federally reserved water withdrawal right with respect to its existing Hanford operations and withdraws approximately 195 million l/yr (51.6 million gal/yr).

3.2.5 GEOLOGY AND SOILS

Geology. Hanford is located in a portion of the Pasco Basin, a topographic and structural depression in the southwest corner of the Columbia Basin physiographic subprovince. The Columbia Basin is a subprovince of the Columbia Intermontane physiographic province and is characterized by generally low-relief hills with incised river drainages. The Columbia Plateau is that portion of the Columbia Intermontane physiographic province that is underlain by the Columbia River Basalt Group and includes the Columbia Basin (HF PNL 1994a:4.20). The site is bounded on the west, southwest, and north by anticlinal ridges that trend eastward from the Cascade Mountains; on the east by the Columbia River with its steep, west-facing white bluffs; and on the southeast by the confluence of the Yakima and Columbia Rivers.

The stratigraphy of Hanford consists of Miocene-age and younger rocks which overlay older Cenozoic sedimentary and volcaniclastic basement rock. The major geologic units underlying Hanford are, in ascending order: subbasalt (basement) rocks, the Columbia River Basalt Group, the Ellenburg Formation, the Ringold Formation, the Plio-Pleistocene unit, early "Palouse" soil, and the Hanford Formation.

The Pasco Basin is filled with greater than 3 km (1.8 mi) of basalt of the Columbia River Basalt Group that overlies probable metasedimentary and metavolcanic rocks intruded by Mesozoic granitic rocks (HF DOE 1995g:4-7). The Columbia River Basalt Group consists of an accumulation of Eocene- to Pliocene-age basalt flows emitted concurrently with basin subsidence. Within and overlying the basalt sequence are tuffs and tuffaceous sediments of the Ellenburg Formation. This unit is overlain by the Mio-Pliocene Ringold Formation, a sequence of fluvial-lacustrine gravels and sands and floodplain silts and clays. These sediments were deposited by the ancestral Columbia River and its tributaries that flowed across the Pasco Basin after volcanic activity ceased. The upper part of the Ringold Formation is represented by an approximately 12-m (40-ft) bed in the western part of Hanford. The Plio-Pleistocene unit is a locally derived unit consisting of a sidestream alluvium and/or pedogenic calcrete and occurs at the unconformity between the Ringold Formation and the Hanford Formation (HF PNL 1994a:4.27). Overlying this unit in the Cold Creek syncline area is an aeolian silt and fine grained sand (early "Palouse" soil).

The tertiary sediments and basalts were locally eroded and truncated by a sequence of gigantic floods that took place within the past 100,000 years. These floods formed a channeled scabland that crosses the central and northeastern part of Hanford. This flooding deposited as much as 162 m (532 ft) of sands, gravels (Pasco Gravel), and clays (Touchet Beds) of the Hanford Formation. These units are, in turn, overlain by Holocene aeolian, alluvial, and landslide deposits interbedded with three to four thin, regional ash falls. Tectonic activity has continued through the Holocene, as evidenced by progressive warping of the Ringold Formation, decreasing upward through the section, and tilting of the Touchet Beds.

Hanford lies on the Hanford alluvial plain. Basalt outcrops are exposed on anticlinal ridges at Gable Mountain, Gable Butte, and the Saddle Mountains in the northern part of the reservation and on Rattlesnake Hills and Yakima Ridge, overlapping the western and southwestern edges of the reservation. Other than gravel, no economically viable geologic resources have been identified at Hanford.

The Modified Mercalli Intensity (MMI) scale, which evaluates earthquake intensity, and the Richter scale, which measures an earthquake's magnitude and energy, are both used to assess potential earthquake risk. Table 3.2.5–1 illustrates the approximate correlation between the MMI scale, the Richter scale, and maximum ground acceleration.

According to the 1994 Uniform Building Code, Hanford is in seismic zone 2B (ICBO 1994a). However, for this PEIS, Uniform Building Code Seismic Zones 2A and 2B were consolidated into Seismic Zone 2 (Figure 3.2.5–1). Seismic Zones 2A and 2B differ only in that Seismic Zone 2B represents the potential for slightly more damage than 2A corresponding to an earthquake intensity VII on the MMI scale.

Table 3.2.5–1. The Modified Mercalli Intensity Scale of 1931, With Approximate Correlations to Richter Scale and Maximum Ground Acceleration[a]

Modified Mercalli Intensity[b]	Observed Effects of Earthquake	Approximate Richter Magnitude[c]	Maximum Ground Acceleration[d]
I	Usually not felt	<2	negligible
II	Felt by persons at rest, on upper floors or favorably placed	2-3	<0.003 G
III	Felt indoors; hanging objects swing; vibration like passing of light truck occurs; might not be recognized as earthquake	3	0.003 to 0.007 G
IV	Felt noticeably by persons indoors, especially in upper floors; vibration occurs like passing of heavy truck; jolting sensation; standing automobiles rock; windows, dishes, and doors rattle; wooden walls and frames may creak	4	0.007 to 0.015 G
V	Felt by nearly everyone; sleepers awaken; liquids disturbed and may spill; some dishes break; small unstable objects are displaced or upset; doors swing; shutters and pictures move; pendulum clocks stop or start		0.015 to 0.03 G
VI	Felt by all; many are frightened; persons walk unsteadily; windows and dishes break; objects fall off shelves and pictures fall off walls; furniture moves or overturns; weak masonry cracks; small bells ring; trees and bushes shake	5	0.03 to 0.09 G
VII	Difficult to stand; noticed by car drivers; furniture breaks; damage moderate in well built ordinary structures; poor quality masonry cracks and breaks; chimneys break at roof line; loose bricks, stones, and tiles fall; waves appear on ponds and water is turbid with mud; small earthslides; large bells ring	6	0.07 to 0.22 G
VIII	Automobile steering affected; some walls fall; twisting and falling of chimneys, stacks, and towers; frame houses shift if on unsecured foundations; damage slight in specially designed structures, considerable in ordinary substantial buildings; changes in flow of wells or springs; cracks appear in wet ground and steep slopes		0.15 to 0.3 G
IX	General panic; masonry heavily damaged or destroyed; foundations damaged; serious damage to frame structures, dams and reservoirs; underground pipes break; conspicuous ground cracks	7	0.3 to 0.7 G
X	Most masonry and frame structures destroyed; some well built wooden structures and bridges destroyed; serious damage to dams and dikes; large landslides; rails bent	8	0.45 to 1.5 G
XI	Rails bent greatly; underground pipelines completely out of service		0.5 to 3 G
XII	Damage nearly total; large rock masses displaced; objects thrown into air; lines of sight distorted	9	0.5 to 7 G

[a] This table illustrates the approximate correlation between the MMI scale, the Richter scale, and maximum ground acceleration.
[b] Intensity is a unitless expression of observed effects.
[c] Magnitude is an exponential function of seismic wave amplitude, related to the energy released.
[d] Acceleration is expressed in relation to the earth's gravitational acceleration (G).
Source: ICSSC 1985a; PPI 1994a.

Seismicity of the Columbia Plateau, as determined by the rate of earthquakes per area and the historical magnitude of these events, is relatively low when compared with other regions of the Pacific Northwest, the Puget Sound area, and western Montana/eastern Idaho (areas where several large earthquakes, Richter magnitude greater than 7, have occurred). Between 1870 and 1980, only five earthquakes occurred in the Columbia Plateau region that had MMI of VI or greater, and all these events occurred prior to 1937. The largest known earthquake in the Columbia Plateau (magnitude 5.75 and maximum MMI of VII) occurred in 1936 around Milton-Freewater, Oregon, approximately 100 km (62 mi) southeast of Hanford. In the central portion

of the Columbia, the largest earthquakes near Hanford were two earthquakes that occurred in 1918 and 1973. Each was approximate magnitude 4.5 and MMI V, and located north of Hanford. Most of the earthquakes in the central Columbia Plateau occur north or northeast of the Columbia River as "earthquake swarms," which are clusters of low intensity earthquakes (MMI less than V) occurring over a short period of time (HF PNL 1994a:4.36).

Most known faults at Hanford are associated with anticlinal fold axes and include thrust, reverse, and normal faults. Faulting has occurred concurrently with folding. The age of latest displacement for the major features is less than 10.5 million years, but some steep dipping faults in the Rattlesnake Hills uplift may be as young as 7,000 years. Some faults in Central Gable Mountain (north-central Hanford) are capable faults as defined in 10 CFR 100, Appendix A.

Landslides are present in the region and have been generally attributed to earthquake activity. Recent findings, however, suggest these features are actually related to glacial flooding and periods of soil saturation with water. Only the slopes of the enclosing anticlinal ridges, including Gable Mountain and White Bluffs, are steep enough for landslide concern. White Bluffs east of the Columbia River poses the greatest concern because of the clay-rich nature of some beds above the river level, the discharge of large quantities of irrigation water into the ground atop the cliffs, the surface incline toward the Columbia River, and the eastward channel migration of the Columbia and its undercutting of the adjacent bluffs. Landslides could fill the Columbia River channel and divert water onto the reservation.

Several major volcanoes are located in the Cascade Range west of Hanford, including Mount Adams, located 164 km (102 mi) from Hanford, and Mount St. Helens, located approximately 218 km (134 mi) west-southwest from Hanford. As a result of the 1980 Mount St. Helens eruption, approximately 0.1 cm (0.04 in) of volcanic ash fell in a 9-hour period at Hanford.

Soils. Hanford is primarily underlain by soils of the Ritzville-Willis, Warden-Shano, Walla-Walla-Endicott-Lickskillet, and Hezel-Quincy-Burbank associations. These soils tend to vary in texture from sand to silty and sandy loam derived from five types of parent material: recent alluvium, old alluvium (glacial outwash), windblown sand, lacustrine deposits, and loess. The mineralogy of these soils results from weathering of local basalts, igneous and metamorphic rocks exposed to the north and east. The hazard of soil erosion varies from slight to severe. Water erosion becomes more severe with increasing slope; wind erosion becomes more severe on water-eroded slopes. The soils at Hanford are considered acceptable for standard construction techniques.

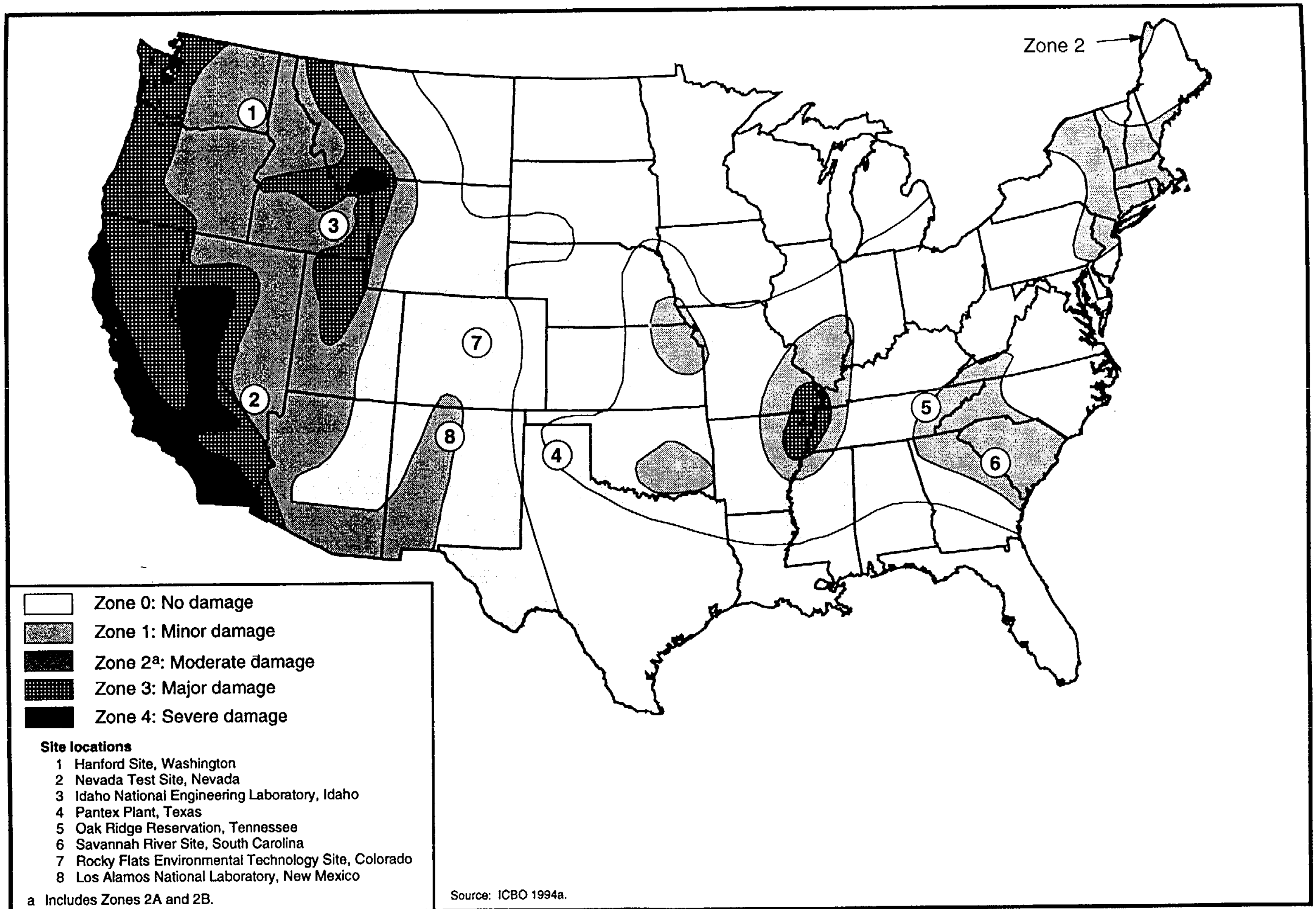

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Figure 3.2.5–1. Seismic Zone Map of the United States.

3.2.6 BIOLOGICAL RESOURCES

Terrestrial Resources. Vegetation at Hanford has been characterized as shrub-steppe. Present site development consists of clusters of large buildings that are found at widely spaced locations. Developed areas encompass about 6 percent of the site. The remaining areas of the site can be divided into 10 major plant communities (Figure 3.2.6–1). Hanford is dominated by communities in which big sagebrush is a major component. Other plant communities contain a variety of grasses and herbaceous plants. Areas previously disturbed by agricultural activities are dominated by nonnative species, such as cheatgrass. Trees are uncommon on the site, but those that are present include cottonwood and willow, which are both found near water bodies, and a few other deciduous species, which were originally planted near farmsteads as windbreaks. Nearly 600 species of plants have been identified at Hanford (DOE 1995o:4-85).

Hanford provides suitable habitat for numerous animal species, including 12 species of amphibians and reptiles, 187 species of birds, and 39 species of mammals (HF PNL 1994a:4.99,4.103). Common animal species at Hanford include the side-blotched lizard, gopher snake, western meadowlark, horned lark, Great Basin pocket mouse, and black-tailed jackrabbit. Trees planted around former farmsteads serve as nesting platforms for several species of birds, including hawks, owls, ravens, magpies, and great blue herons; these trees also serve as night roosts for bald eagles (HF PNL 1994a:4.92,4.93). The Hanford Reach of the Columbia River, including several sparsely vegetated islands, provides nesting habitat for the Canadian goose, ring-billed gull, Forster's tern, and great blue heron. Although several game animals are found at Hanford, only waterfowl hunting is permitted onsite north of the Columbia River (HF 1992a:1). Numerous raptors, such as the Swainson's hawk and red-tailed hawk, and carnivores, such as the coyote and bobcat, are found on Hanford. A variety of migratory birds has been found at Hanford. Migratory birds, as well as their nests and eggs, are protected by the *Migratory Bird Treaty Act*. Eagles are similarly protected by the *Bald and Golden Eagle Protection Act*.

Vegetative cover in the vicinity of the 200 Area, the proposed location of storage facilities, falls within the sagebrush and cheatgrass-Sandberg bluegrass community (Figure 3.2.6–1). Associated shrubs and grasses of this community include gray rabbitbrush, green rabbitbrush, hopsage, snowy buckwheat, Indian rice grass, thickspike wheatgrass, and needle-and-threadgrass. Common animal species found on the proposed site are expected to be similar to those described for Hanford as a whole.

Wetlands. Primary wetland areas at Hanford are found in the riparian zone along the Columbia River. The extent of this zone varies, but it includes large stands of willows, grasses, and other plants. This area has been extensively affected by hydropower operations at Priest Rapids Dam (DOE 1995o:4-89).

Other large areas of wetlands at Hanford can be found north of the Columbia River within the Saddle Mountain National Wildlife Refuge and the Wahluke Wildlife Unit Columbia Basin Area. These two areas encompass all the lands extending from the north bank of the Columbia River northward to the site boundary and east of the Columbia River down to Ringold Springs. Wetland habitat in these areas consists of fairly large ponds resulting from irrigation runoff. These ponds have extensive stands of cattails and other emergent aquatic vegetation surrounding the open water regions. They are extensively used as nesting sites by waterfowl (HF PNL 1994a:4.113).

On the western side of Hanford, Rattlesnake Springs supports a riparian zone of about 2.5 km (1.6 mi) in length, featuring watercress, bulrush, spike rush, cattail and peachleaf willow. Snively Springs also contains a diverse biotic community similar to Rattlesnake Springs (HF PNL 1994a:4.112).

Several semi-permanent artificial ponds and ditches that receive cooling water or irrigation wastewater are also present on Hanford near the 200 Area and support wetland vegetation (that is, cattails, reeds, and willows) around their periphery. These wetlands provide habitat for songbirds, shorebirds, and waterfowl.

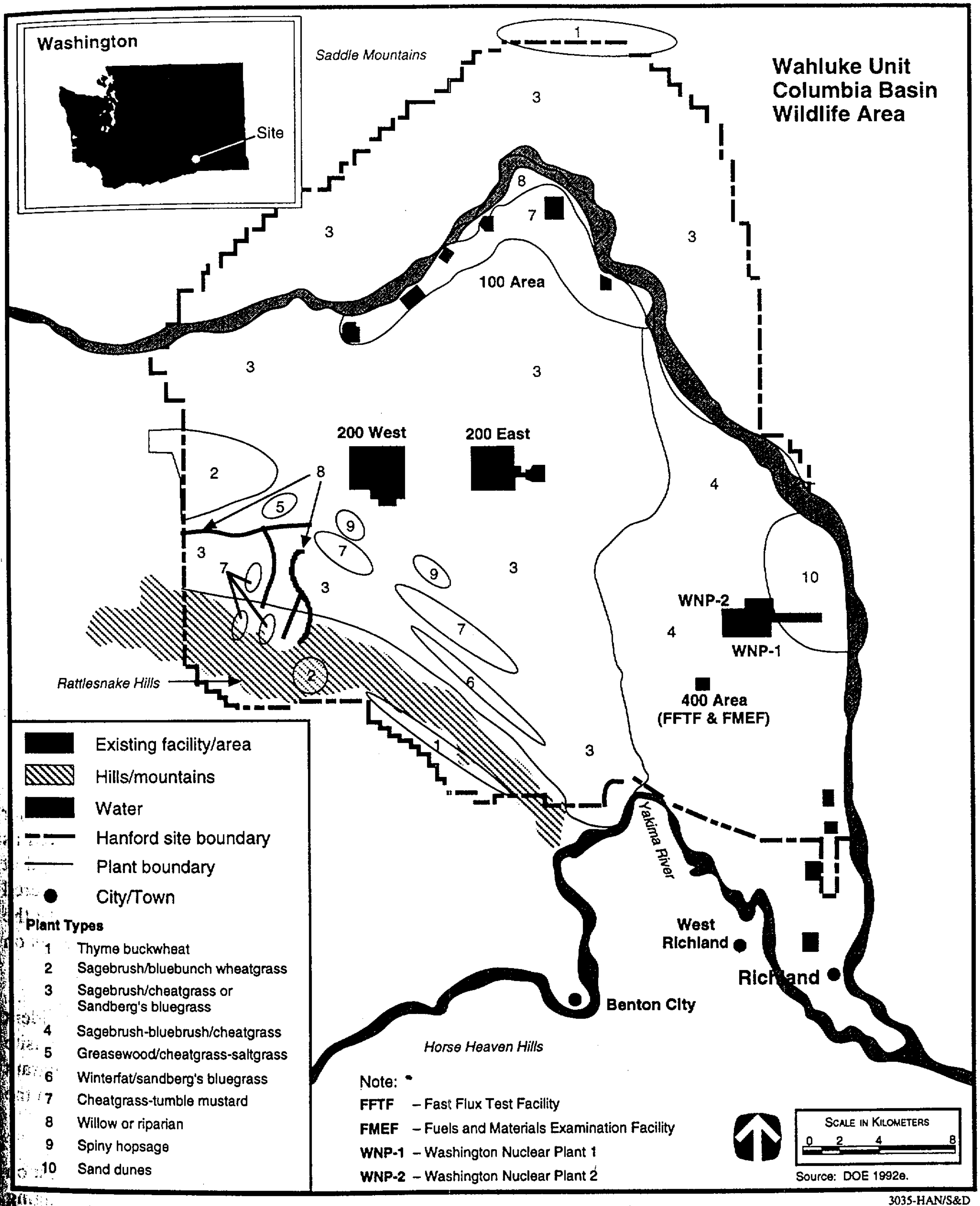


Figure 3.2.6–1. Distribution of Plant Communities at Hanford Site.

Aquatic Resources. Aquatic resources on Hanford include the Columbia River, ephemeral streams, springs, surface ponds, and ditches. The Columbia River flows along the northern and eastern edges of Hanford (HF PNL 1994a:4.106).

The Hanford Reach supports 44 anadromous and resident species of fish. Many of the fish species present in the Hanford Reach are dependent upon flowing water and rocky substrate for at least part of their life cycles. Fall chinook salmon, steelhead trout, mountain whitefish, and smallmouth bass spawn in this area. The destruction of other mainstream Columbia River spawning areas by dams has increased the relative importance of the Hanford Reach for spawning (HF PNL 1994a:4.110).

The Hanford Reach provides a migration route to upstream spawning areas for spring, summer, and fall adult chinook salmon, coho salmon, sockeye salmon, and steelhead trout. It also provides rearing habitat for the salmonid juveniles in their downstream migration to the sea. Principal resident fish species sought by anglers in the Hanford Reach include mountain whitefish, white sturgeon, smallmouth bass, crappie, catfish, walleye, and perch (HF PNL 1994a:4.110,4.112).

The Yakima River borders the southern portion of Hanford. Game fish found in the river in the vicinity of the site are smallmouth bass, steelhead trout, and channel catfish. Cold Creek and its tributary, Dry Creek, are ephemeral streams within the Yakima River drainage system along the southern boundary of Hanford. These streams do not support any fish populations (HF 1992a:2; HF PNL 1994a:4.42).

There are several springs at Hanford. Rattlesnake Springs and Snively Springs, located in the western portion of the site, form short streams which seep into the ground (Figure 3.2.4–1). None of the springs support any fish populations (HF PNL 1984a:3.40; HF PNL 1994a:4.112).

The release of wastewater at Hanford facilities has created four semipermanent artificial ponds and several ditches that did not exist before these facilities were built. These are temporary and will disappear if the industrial release of water is terminated. All of the ponds, except West Pond and one ditch on the site, support goldfish. West Pond was created by a rise in the water table and is not fed by surface flow; thus, it is alkaline and has a reduced complement of biota (Figure 3.2.4–1) (HF PNL 1978a:2,3,5,10,13).

Threatened and Endangered Species. Sixty-five federally and State-listed threatened, endangered, and other special status species may be found in the vicinity of Hanford, 13 of these are federally or State-listed as threatened or endangered (Table 3.2.6–1). Forty-one species listed in Table 3.2.6–1 have been observed at Hanford or the Hanford Reach of the Columbia River, including nine of the federally or State-listed endangered or threatened species. Once specific project site locations have been determined, site surveys will verify the presence of special status species. No critical habitat, as defined in ESA (50 CFR 17.11 and 17.12), exists on Hanford.

The bald eagle is the only federally listed species known to be found at Hanford. It is a regular winter resident along the Hanford Reach, where it forages for salmon and waterfowl. Trees in the historic Hanford Townsite area are used by eagles for perching; however, eagles do not nest at Hanford. The peregrine falcon is a migrant in the Hanford area. The Aleutian Canada goose and Oregon silverspot butterfly are not known to occur on the site.

Several State-listed animal species have been observed at Hanford. The ferruginous hawk is known to nest on transmission towers and forages over much of the site. Habitats similar to those used by this species for foraging are relatively common at Hanford; however, nesting sites are more limited (DOE 1992e:4-26). Pygmy rabbits have only rarely been seen at Hanford. [Text deleted.] Species occurring along the Hanford Reach include the American white pelican and sandhill crane. The sandhill crane is also found in upland habitats (DOE 1992e:4-27; DOE 1995o:4-93).

State-listed plant species observed at Hanford include Columbia milk-vetch, Columbia yellowcress, and dwarf desert primrose. Columbia milk-vetch has been found onsite on top of Umtanum Ridge above the Midway substation. Columbia yellowcress occurs in the wetted zone of the water's edge along the Columbia River. It has been observed between the 100 B Area and the old Hanford Townsite. Dwarf desert primrose is known to grow in Ringold Flats and in a gravel pit approximately 2.5 km (1.6 mi) north of Wye Barricade (Figure 3.2.1–1) (HF WHC 1992a:3-1,3-5,3-6). Other State-listed plant species found in the vicinity of Hanford include northern wormwood and Hoover's desert parsley.

Table 3.2.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Hanford Site

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammals			
Fringed myotis	*Myotis thysanodes*	NL	M
Long-eared myotis	*Myotis evotis*	NL	M
Long-legged myotis	*Myotis volans*	NL	M
Merriam's shrew[b]	*Sorex merriami*	NL	C
Northern grasshopper mouse[b]	*Onychomys leucogaster*	NL	M
Pacific western big-eared bat[b]	*Plecotus townsendii townsendii*	NL	C
Pallid bat[b]	*Antrozous pallidus*	NL	M
Pygmy rabbit[b]	*Brachylagus idahoensis*	NL	E
Sagebrush vole[b]	*Lagurus curtatus*	NL	M
Small-footed myotis	*Myotis ciliolabrum*	NL	M
[Text deleted.]			
Birds			
Aleutian Canada goose[c]	*Branta canadensis leucopareia*	T	E
American white pelican[b,d]	*Pelecanus erythrorhynchos*	NL	E
Ash-throated flycatcher	*Myiarchus cinerascens*	NL	M
Bald eagle[b,c,d]	*Haliaeetus leucocephalus*	T	T
Black tern[b]	*Chlidonius niger*	NL	M
Black-crowned night heron	*Nycticorax nycticorax*	NL	M
Black-necked stilt	*Himantopus mexicanus*	NL	M
Common loon[d]	*Gavia immer*	NL	C
Ferruginous hawk[b]	*Buteo regalis*	NL	T
Flammulated owl[b]	*Otus fammeolus*	NL	C
Forester's tern	*Sterna forsteri*	NL	M
Golden eagle	*Aquila chrysaetos*	NL	C
Grasshopper sparrow	*Ammodramus savannarum*	NL	M
Gray flycatcher	*Empidonax wrightii*	NL	M
Great blue heron[b]	*Ardea herodias*	NL	M
[Text deleted.]			
Lewis' woodpecker[b]	*Melanerpes lewis*	NL	C
Loggerhead shrike[b]	*Lanius ludovicianus*	NL	C
Long-billed curlew	*Numenius americanus*	NL	M
Northern goshawk[b]	*Accipiter gentilis*	NL	C
Osprey	*Pandion haliaetus*	NL	M
Peregrine falcon[b,c]	*Falco peregrinus*	E (S/A)	E
Prairie falcon[b]	*Falco mexicanus*	NL	M
Sage sparrow[b]	*Amphispiza belli*	NL	C
Sage thrasher	*Oreoscoptes montanus*	NL	C
Sandhill crane[b,d]	*Grus canadensis*	NL	E

Table 3.2.6–1. ***Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Hanford Site—Continued***

Common Name	Scientific Name	Status[a] Federal	State
Birds (continued)			
Swainson's hawk[b]	*Buteo swainsoni*	NL	C
Turkey vulture	*Cathartes aura*	NL	M
Western bluebird[b]	*Sialia mexicana*	NL	C
Western burrowing owl[b]	*Athene cunicularia hypugea*	NL	C
Western grebe	*Aechmophorus occidentalis*	NL	M
Western sage grouse[b]	*Centrocerus urophasianus phaios*	NL	C
Reptiles			
Desert night snake[b]	*Hypsiglena torquata*	NL	M
Amphibians			
Woodhouse's toad[b]	*Buo woodhousei*	NL	M
Fish			
Mountain sucker[d]	*Catostomus platyrhnchus*	NL	M
Piute sculpin[d]	*Cottus beldingi*	NL	M
Reticulate sculpin[d]	*Cottus perplexus*	NL	M
Sandroller[d]	*Percopsis transmontana*	NL	M
Invertebrates			
Columbia River tiger beetle	*Cicindela columbica*	NL	C
Giant Columbia River limpet	*Fisherola nuttalli*	NL	C
Great Columbia River spire snail[d]	*Fluminicola columbianus*	NL	C
Oregon silverspot butterfly	*Speyeria zerene hippolyta*	T	E
Plants			
Bristly cyptantha	*Cryptantha interrupta*	NL	M2
Columbia milk-vetch[b]	*Astragalus columbianus*	NL	T
Columbia yellowcress[b]	*Rorippa columbiae*	NL	E
Dense sedge[b]	*Carex densa*	NL	S
Desert dodder	*Cuscuta denticulata*	NL	M1
Dwarf desert primrose[b]	*Oenothera pygmaea*	NL	T
False-pimpernel[b]	*Lindernia dubia var. anagallidea*	NL	S
Gray cryptantha[b]	*Cryptantha leucophaea*	NL	S
Hoover's desert parsley	*Lomatium tuberosum*	NL	T
Northern wormwood	*Artemisia campestris borealis var. wormskioldii*	NL	E
Piper's daisy[b]	*Erigeron piperianus*	NL	S
Shining flatsedge[b]	*Cyperus bipartitus*	NL	S
Southern mudwort[b]	*Limosella acaulis*	NL	S
Thompson's sandwort[b]	*Arenaria franklinii var thompsonii*	NL	M2

[a] Status codes: C=State candidate; E=endangered; M=monitored animal; M1=monitored plant - Group 1 (additional field work needed); M2=monitored plant - Group 2 (unresolved taxonomic question); NL=not listed; S=State sensitive; S/A=protected under the similarity of appearance provision of the *Endangered Species Act*; T=threatened.

[b] Species observed on Hanford Site.

[c] USFWS Recovery Plan exists for this species.

[d] Occurs along the Hanford Reach of the Columbia River.

Source: 50 CFR 17.11; 50 CFR 17.12; DOE 1992e; DOE 1995o; HF PNL 1994a; HF WHC 1992a; WA DNR 1994a; WA DOW 1994a.

Sagebrush habitat is considered priority habitat by the State of Washington because of its relative scarcity in the State and its use as a nesting and breeding habitat by loggerhead shrikes, burrowing owls, sage sparrows, pygmy rabbits, sage thrashers, western sage grouse, and sagebrush voles. Most of these species have been observed at Hanford.

The proposed storage site contains sagebrush habitat that is potentially suitable for use by the species listed above. The loggerhead shrike has been frequently observed in the vicinity and is known to select tall big sagebrush as nest sites. The 200 Area also contains a portion of the foraging range of nesting ferruginous hawks (DOE 1995o:4-93).

3.2.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

Prehistoric Resources. Within the boundaries of Hanford, 248 prehistoric sites have been identified. A number of these sites have been identified along the Middle Columbia River and in inland areas away from the river but near other water sources. Some dispersed evidence of human occupation has been found in the arid lowlands. Sites include pithouse villages, campsites, cemeteries, spirit quest monuments (rock cairns), hunting camps and blinds, game drive complexes, quarries in mountains and rocky bluffs, hunting and kill sites in lowland stabilized dunes, and small, temporary camps near water located away from the river.

The NRHP lists 47 prehistoric resources at Hanford. Two of these are individual sites: the Hanford Island Site and the Paris Site. The remaining sites are divided into seven archaeological districts. Four sites, including Vernita Bridge, Tsulim, and two others, are considered eligible for the NRHP by the State Historic Preservation Officer (SHPO). In addition, a Determination of Eligibility nomination has been prepared for Gable Mountain/ Gable Butte, a traditional cultural property district (DOE 1995o:4-29).

All inventory and evaluation of cultural resources at Hanford is conducted within the framework of the *Hanford Cultural Resources Management Plan* (PNL-6942 UC-600, June 1989). Archaeological surveys have been conducted at Hanford since 1926, and slightly less than 10 percent of the area has been examined. These surveys have included studies of Gable Mountain, Gable Butte, Snively Canyon, Rattlesnake Mountain, Rattlesnake Springs, and a portion of the Basalt Waste Isolation Project Reference Repository Location. Most of the surveys have focused on islands and on a 400-m (1,312-ft) wide area on either side of the river. From 1991 through 1995, the 100 Areas were surveyed, and new sites were identified. Excavations have been conducted at several sites on the river banks and islands and at two unnamed sites. Test excavations have been conducted at the Wahluke, Vernita Bridge, and Tsulim sites, and at other sites in Benton County.

Facilities could be built or upgraded adjacent to or within the 200 or 400 Areas. An archaeological survey has been conducted in all undeveloped parts of the 200 East Area and half of the 200 West Area (HF PNL 1994a:4.127, 4.128). No prehistoric sites were identified. Because most of the 200 Areas are either developed or disturbed, it is unlikely that they contain intact archaeological deposits. Most of the 400 Area is disturbed and therefore is unlikely to contain intact prehistoric or historic sites. A cultural resources survey found 12 ha (30 acres) undisturbed in the 400 Area, and no sites were identified either within the 400 Area or within 2 km (1 mi) of the 400 Area. The *Hanford Cultural Resources Management Plan* provides for survey work before construction and has contingency guidelines for handling the discovery of previously unknown archaeological resources encountered during construction.

Historic Resources. There are 202 historic archaeological sites and other historic localities identified at Hanford. Pre-Hanford-era sites and localities include homesteads, ranches, trash scatters, dumps, gold mine tailings, roads, and townsites, including the Hanford townsite and the East White Bluffs townsite and ferry landing.

Lewis and Clark were the first European-Americans to come to this region, during their expedition of 1803 to 1806. Fur trappers soon followed. In the 1860s, settlement began in the area. Chinese miners came to work the gravel bars for gold. Farmers and cattlemen came to the area in the 1880s. The towns of Hanford, White Bluffs, and Ringold were established and grew. Two additional ferry operations, one at Wahluke and one at Richland, were established. The Hanford Engineering Works, a part of the Manhattan Project, was established in 1943. During that year, the residents were evacuated and nearly all the structures were subsequently razed. Pu produced at the Hanford 100 B-Reactor was used in the first nuclear explosion, at the White Sands Missile Range in New Mexico, and later in the bomb that was dropped on Nagasaki, Japan (DOE 1995o:4-32). The Hanford 100 B-Reactor is listed as a National Mechanical Engineering Landmark, a National Historical Civil Engineering Landmark, a National Nuclear Engineering Landmark, and is listed on the NRHP (HF PNL 1991a:6-3).

Because Hanford played an important role in the Manhattan Project and the subsequent Cold War Era, a number of its structures may be eligible for the NRHP. Although not all of these structures meet the Secretary of the Interior's 50-year requirement for eligibility, they fall under the broad themes of the Manhattan Project and Cold War Era nuclear production. They include buildings and structures found mainly in the 100, 200, and 300 Areas.

The historic White Bluffs Freight Road, once an Indian road, crosses diagonally through the 200 West Area. The road has been determined NRHP-eligible by the SHPO, but the segment in the 200 West Area is considered a noncontributing element. A 100-m (328-ft) easement protects the road. Manhattan Project and Cold War Era structures are in the 200 Areas; they have not been evaluated for NRHP eligibility.

Native American Resources. Because of its location on the Columbia and Yakima Rivers, Hanford has been home to Native Americans for thousands of years. The Wanapum and the Chamnapum band of the Yakama tribe lived along the Columbia River at what is now Hanford. Some of their descendants still live nearby at Priest Rapids, northwest of Hanford. Other groups that visited or lived intermittently at Hanford include the Palus, who lived on the lower Snake River, the Walla Walla, the Nez Perce, and the Umatilla (DOE 1995o:4-31). All these people retain secular and religious ties to the area. The Yakama, Umatilla, and Nez Perce have all been declared "Affected Indian Tribes," as defined in the NWPA of 1982. As such, these tribes and the Wanapum people, who live about 8 km (5 mi) west of the Hanford boundary, are active in decisions regarding the site. The tribes have expressed concerns regarding hunting, fishing, and pasture rights and access to plant and animal communities and important sites (HF DOE 1990e:2-20).

The Washane, or Seven Drums religion, originated among the Wanapum people on what is now Hanford and is still practiced by many people on the Yakama, Umatilla, Warm Springs, and Nez Perce Reservations. The first Washane ceremony took place at Coyote Rapids (HF DOE 1990e:3-60). Certain indigenous plants and animals found at Hanford are used in religious ceremonies. Sites sacred to Native Americans at Hanford include remains of prehistoric villages, cemeteries, ceremonial longhouses or lodges, rock art, fishing stations, and vision quest sites. Culturally important localities and geographic features include Rattlesnake Mountain, Gable Mountain, Gable Butte, Goose Egg Hill, Coyote Rapids, and the White Bluffs portion of the Columbia River.

Paleontological Resources. There are three geologic units at Hanford: the Columbia River Basalt group, the Ringold Formation, and the Hanford Formation. Pliocene and Pleistocene Age remains have been identified at Hanford. The Upper Ringold Formation dates to the Late Pliocene and contains fish, reptile, amphibian, and mammal fossil remains. Late Pleistocene Tuchet beds have yielded mammoth bones. These beds are composed of fluvial sediments deposited along ridge slopes that surround Hanford.

3.2.8 SOCIOECONOMICS

Socioeconomic characteristics described for Hanford include employment, regional economy, population, housing, community services, and local transportation. Statistics for employment and regional economy are presented for the REA that encompasses nine counties surrounding Hanford in Washington (Table L.1–1). Statistics for population, housing, community services, and local transportation are presented for the ROI, a three-county area in which 90.8 percent of all Hanford employees reside: Benton County (78.8 percent), Franklin County (8.9 percent), and Yakima County (3.1 percent) (Table L.1–2). In 1996, Hanford employed approximately 14,586 persons (approximately 4 percent of the total employment in the REA).

Regional Economy Characteristics. Selected employment and regional economy statistics for the Hanford REA are summarized in Figure 3.2.8–1. Between 1980 and 1990, the civilian labor force in the REA increased 10.3 percent to 254,777. The 1994 unemployment rate in the REA was 9.1 percent, significantly higher than the rate of 6.4 percent in Washington. In 1993, the REA per capita income of $18,501 was 15 percent lower than Washington's per capita income of $21,839.

Employment patterns in the REA parallel those in Washington, with manufacturing, retail trade, and services providing the majority of jobs. The service sector accounts for the highest percentage of employment in both the REA and Washington, 26.3 percent and 27.4 percent, respectively.

Population and Housing. Population and housing trends in the ROI are summarized in Figure 3.2.8–2. The ROI population, which totalled 379,693 in 1994, increased 19.8 percent during the period 1980 to 1994, much lower than the 29.3-percent increase in Washington. Population growth rates among the three counties composing the ROI, range from 18.1 percent in Benton County to 21.9 percent Franklin County.

Between 1980 and 1990, the number of housing units in the ROI increased by about 5 percent, compared to the 20-percent increase in Washington. However, homeowner and renter vacancy rates in 1990 were about the same in both the Hanford ROI and Washington, approximately 1 percent and 6 percent, respectively.

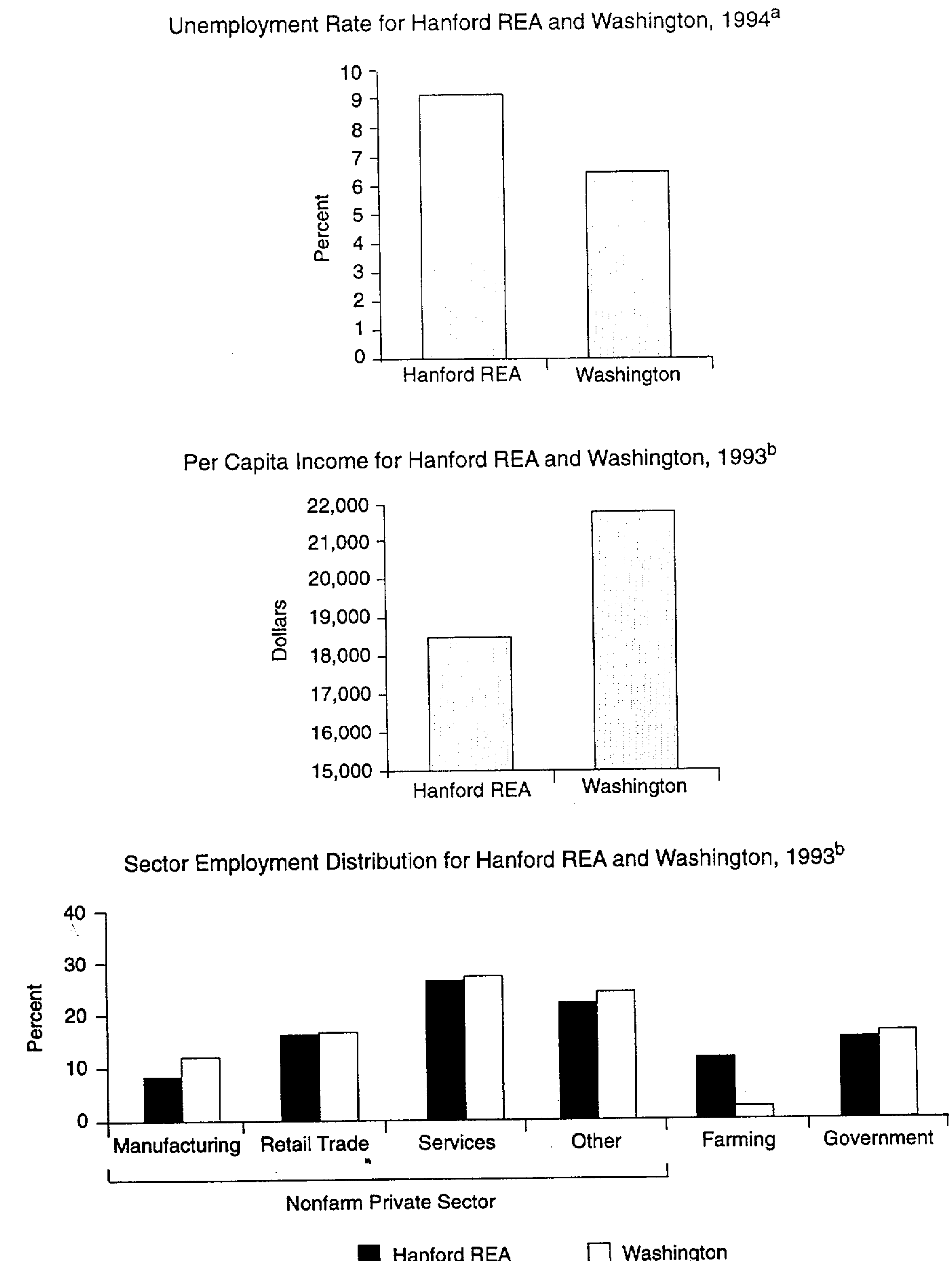
Community Services. Community services described for the Hanford ROI are education, public safety, and health care. Figure 3.2.8–3 presents school district characteristics for the Hanford ROI, and Figure 3.2.8–4 presents public safety and health care characteristics.

Education. Twenty-five school districts provide public education in the Hanford ROI. As shown in Figure 3.2.8–3, school districts were operating at capacities ranging from 63 percent to 125 percent in 1994. The student-to-teacher ratios in the ROI ranged from a low of 5.9:1 in the Kahlotus district to a high of 21.5:1 in the Kiona-Benton district. The average student-to-teacher ratio in the ROI was 18.9:1.

Public Safety. Fifteen city and county law enforcement agencies provide police protection in the ROI. In 1994 the highest sworn officer-to-population ratio in the ROI was 1.85 sworn officers per 1,000 persons in the city of Pasco. The ROI average officer-to-population ratio was 1.6 officers per 1,000 persons. Figure 3.2.8–4 displays the ratio of sworn police officers to population for the Hanford ROI counties and cities.

Thirty-seven fire departments provide fire protection services for the Hanford ROI. The principal municipal fire departments include both professional and volunteer staff. In 1995, the greatest staffing strength relative to population was in Franklin County, with 7.7 firefighters per 1,000 persons (Figure 3.2.8–4). The ROI average firefighter-to-population ratio was 4.0 firefighters per 1,000 persons.

Health Care. Eight hospitals serve the three-county region, with the majority operating well below capacity. In 1994, a total of 465 physicians served the ROI. Figure 3.2.8–4 shows that the average physician-to-population ratio in the ROI was 1.2 physicians per 1,000 persons, and the hospital bed-to-population ratio ranged from 2.0 beds per 1,000 persons in Benton County to 2.3 beds per 1,000 persons in Franklin and Yakima Counties.



[a] DOL 1995a.
[b] DOC 1995a.

Figure 3.2.8–1. Employment and Local Economy for the Hanford Site Regional Economic Area and the State of Washington.

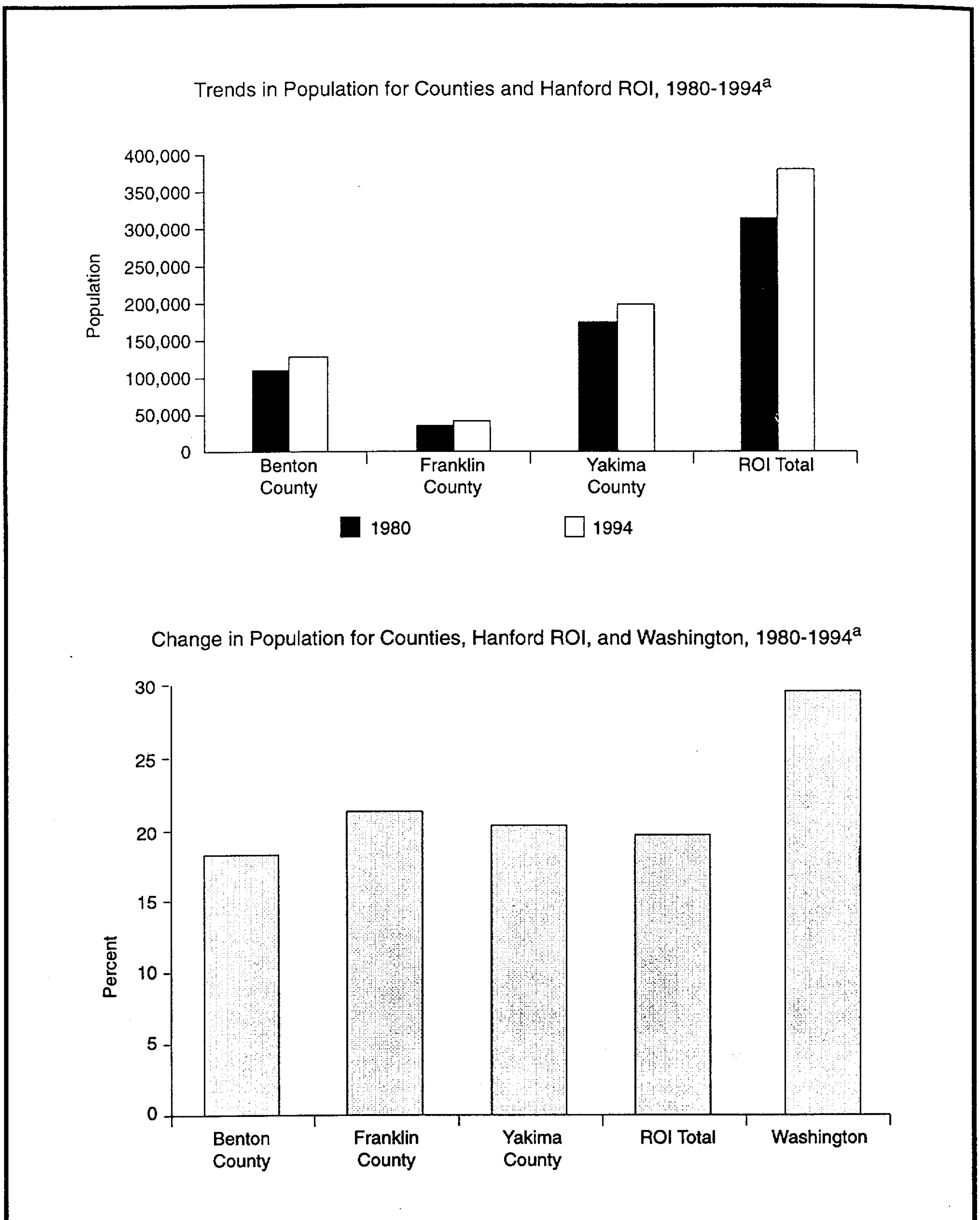
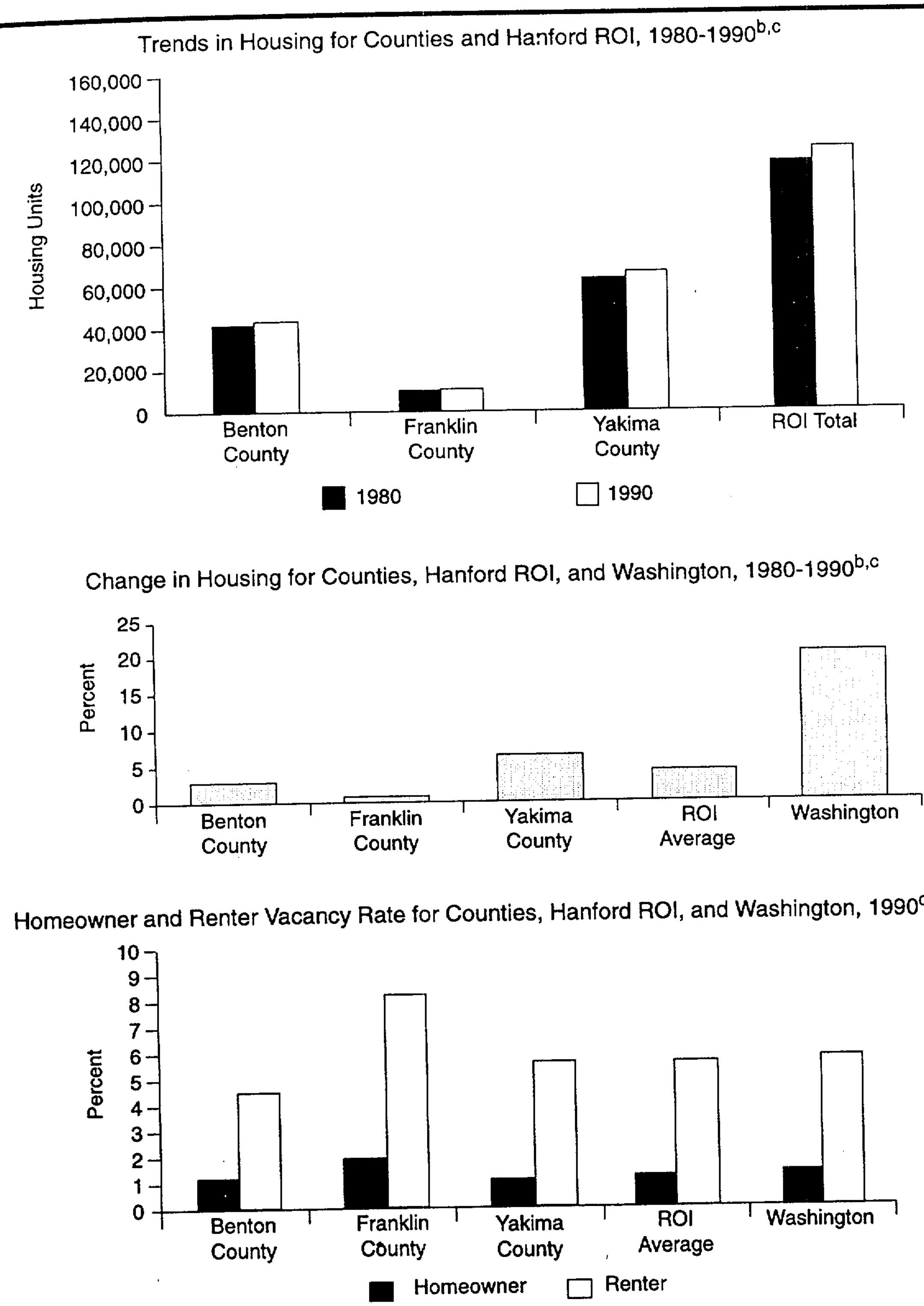
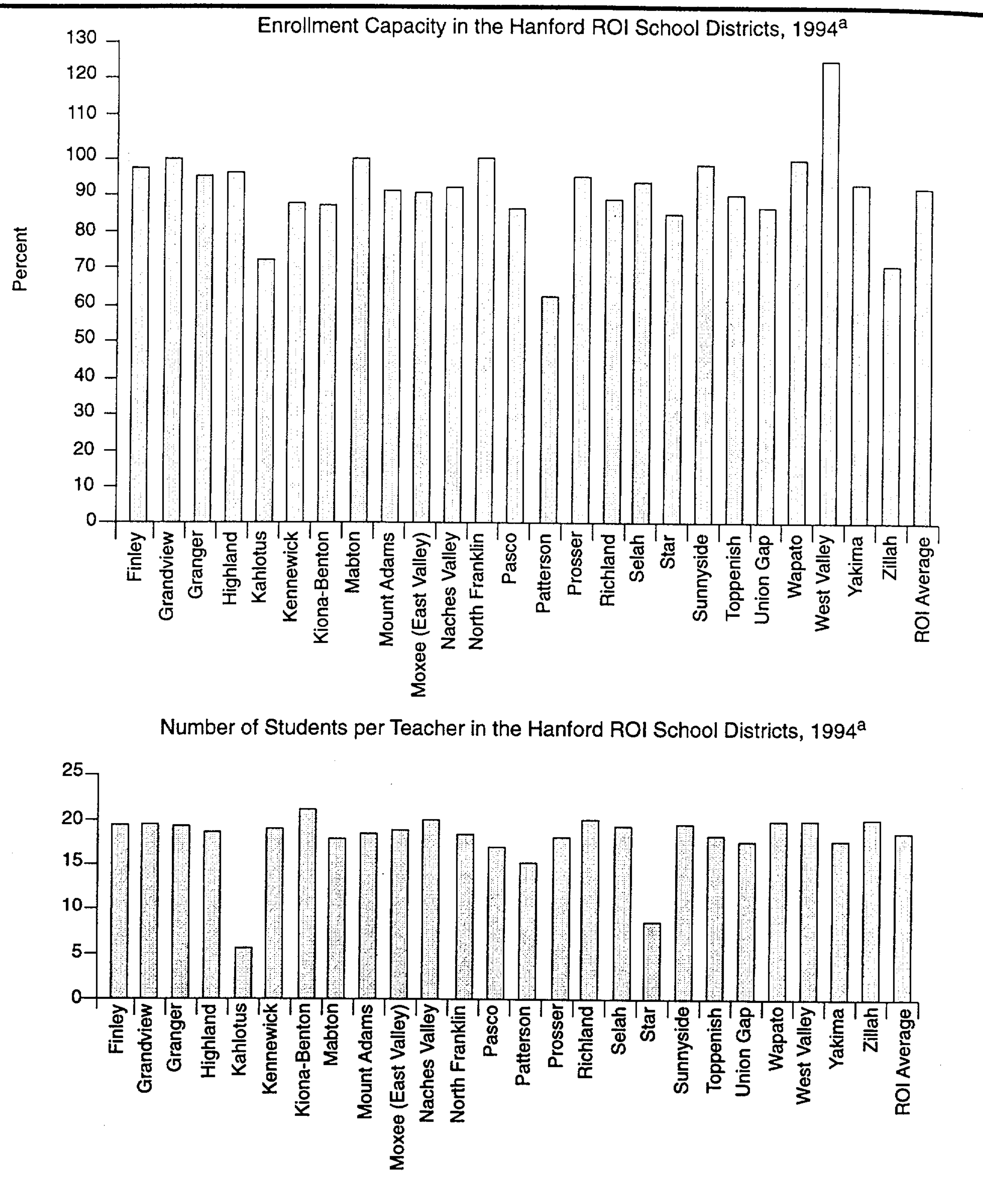


Figure 3.2.8–2. Population and Housing for the Hanford Site Region of Influence and the State of Washington.



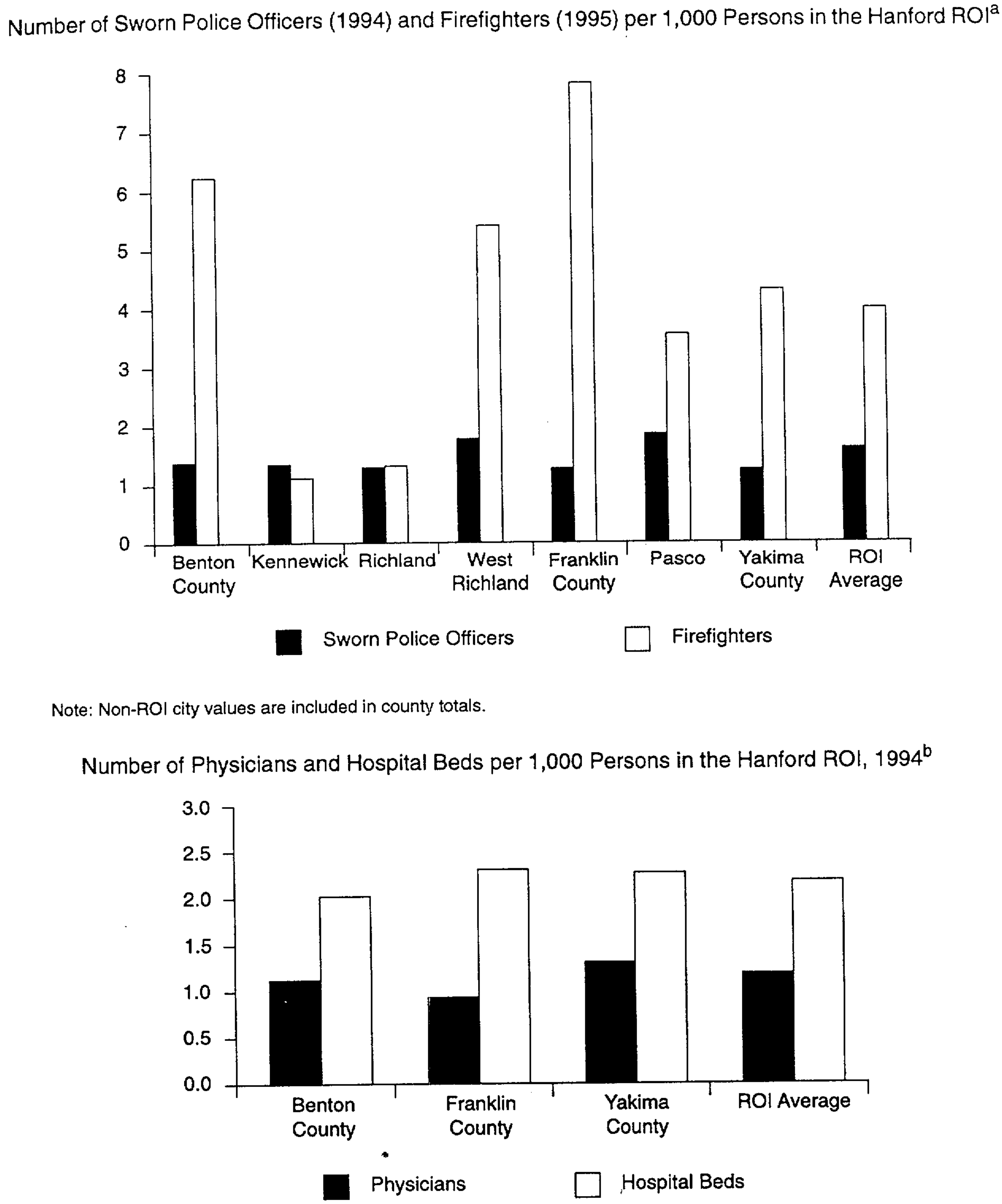
[a] Census 1994o, Census 1995a.
[b] Census 1982r.
[c] Census 1991d.

Figure 3.2.8–2. Population and Housing for the Hanford Site Region of Influence and the State of Washington—Continued.



[a] Socio 1996a.

Figure 3.2.8–3. School District Characteristics for the Hanford Site Region of Influence.



[a] Census 1995a; DOC 1996a; DOC 1996b; DOJ 1995a; Socio 1996a.
[b] AHA 1995a; AMA 1995a; Census 1995a.

Figure 3.2.8–4. Public Safety and Health Care Characteristics for the Hanford Site Region of Influence.

Local Transportation. Interstate highways and State Routes provide access between Hanford and metropolitan areas (see Figure 2.2.1–1 and Figure 2.2.1–2). The east-west highways, Interstate 90 and Interstate 84, are located north and south of the site, respectively. Interstate 90 is the major link west to Seattle and east to Spokane. Interstate 84 is the major link to Portland, Oregon. Interstate 90 and Interstate 84 are connected by Interstate 82, which is located southwest of Hanford. Interstate 182 is located southeast of the site and provides an east-west corridor linking Interstate 82 to the Tri-Cities (Richland, Kennewick, and Pasco) area.

Vehicular access to Hanford is provided by several highways. State Route 240 is the preferred route from the Tri-Cities area. State Route 240 connects to the Richland bypass highway, which interconnects with Interstate 182. State Route 243 exits the site's northwestern boundary and serves as a primary link between the site and Interstate 90. State Route 24 enters the site from the west and continues eastward across the northernmost portion of the site and intersects State Route 26 approximately 16 km (10 mi) east of the site boundary. State Route 240 traverses the site in the southwestern section.

There are no current road improvement projects that affect access to Hanford. However, two projects currently in the planning stage could affect access to Hanford in the future. These projects are a realignment of State Route 240 from Stevens Drive to State Route 224 and an asphalt overlay of State Route 24 from Taylor Ranch to State Route 241 (WA DOT 1995a:1). The one road segment in the ROI that could be affected by the storage and disposition alternatives is State Route 240 from State Route 24 to State Route 224. In 1995, this road segment operated at level of service B.

The local intercity transit system, Ben Franklin Transit, supplies bus service between the Tri-Cities and Hanford. Both private interests and Ben Franklin Transit provide van pooling opportunities in the ROI.

Onsite rail transport is provided by a short-line railroad owned and operated by DOE. There is a total of 161 km (100 mi) of track. This line connects with the Union Pacific line just south of the Yakima River. The Union Pacific line interchanges with the Washington Central and Burlington Northern and Santa Fe at Kennewick. The rail system is mainly used to deliver coal to various boiler plants at Hanford. The rail system delivers equipment and material to the various facilities when rail shipment is more convenient than truck. There is no passenger rail service at Hanford.

In the ROI, the Columbia River is used as an inland waterway for barge transportation from the Pacific Ocean. The Port of Benton provides a barge slip where shipments arriving at Hanford may be off-loaded (HF County 1996a:1). [Text deleted.]

Tri-Cities Airport located near the city of Pasco provides jet air passenger and cargo service by both national and local carriers. Numerous smaller private airports are located throughout the ROI (DOT 1992a:7-325).

3.2.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Radiation Environment. Major sources and levels of background radiation exposure to individuals in the vicinity of Hanford are shown in Table 3.2.9–1. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population changes as the population size changes. Background radiation doses are unrelated to Hanford operations.

Table 3.2.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Hanford Site Operation

Source	Effective Dose Equivalent (mrem/yr)
Natural Background Radiation[a]	
Cosmic and cosmogenic radiation	30
External terrestrial radiation	30
Internal terrestrial radiation	40
Radon in homes (inhaled)	200
Other Background Radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	365

[a] HF PNL 1994b.
[b] NCRP 1987a.
Note: Value for radon is an average for the United States.

Releases of radionuclides to the environment from Hanford operations provide another source of radiation exposure to individuals in the vicinity of Hanford. Types and quantities of radionuclides released from Hanford operations in 1993 are listed in the *Hanford Site Environmental Report for Calendar Year 1993* (PNL-9823). Doses to the public resulting from these releases are presented in Table 3.2.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1993 report were used in the development of the reference environment's (No Action) radiological releases and resulting impacts for the year 2005 (Section 4.2.1.9).

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (Section M.2.1.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from Hanford operations in 1993 is approximately 1.6×10^{-8}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of Hanford operations is less than 2 chances in 100 million. (Note that it takes several to many years from the time of radiation exposure for a cancer to manifest itself.)

Based on the same risk estimator, 1.8×10^{-4} excess fatal cancers are projected in the population living within 80 km (50 mi) of Hanford from normal operations in 1993. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based upon this mortality rate, the number of fatal cancers expected during 1993 in the population living within 80 km (50 mi) of Hanford was 760. This number of expected fatal cancers is much higher than the estimated 1.8×10^{-4} fatal cancers that could result from Hanford operations in 1993.

Table 3.2.9–2. Radiation Doses to the Public From Normal Hanford Site Operation in 1993 (Committed Effective Dose Equivalent)

	Atmospheric Releases[a]		Liquid Releases		Total	
Members of the General Public	**Standard[b]**	**Actual**	**Standard[b]**	**Actual[c]**	**Standard[b]**	**Actual**
Maximally exposed individual (mrem)	10	0.020	4	0.012	100	0.032
Population within 80 km[d] (person-rem)	None	0.25	None	0.11	100	0.36
Average individual within 80 km[e] (mrem)	None	6.6×10^{-4}	None	2.9×10^{-4}	None	9.5×10^{-4}

[a] Includes direct radiation dose from surface deposits of radioactive material.
[b] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the CAA, the 4 mrem/yr limit is required by the SDWA, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (see 58 FR 16268). If the potential total dose exceeds the value, it is required that the contractor operating the facility notify DOE.
[c] The actual dose value given in the column under Liquid Releases conservatively includes all water pathways, not just the drinking water pathway.
[d] In 1993, this population was approximately 380,000.
[e] Obtained by dividing the population dose by the number of people living within 80 km of the site.
Source: HF PNL 1994b.

Hanford workers receive the same dose as the general public from background radiation, but they also receive an additional dose from working in the facilities. Table 3.2.9–3 presents the average worker, maximally exposed worker, and total cumulative worker dose to Hanford workers from operations in 1992. These doses fall within radiological regulatory limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (Section M.2.1.2), the number of fatal cancers to Hanford workers from normal operations in 1992 is projected to be 0.10.

Table 3.2.9–3. Radiation Doses to Workers From Normal Hanford Site Operation in 1992 (Committed Effective Dose Equivalent)

	Onsite Releases and Direct Radiation	
Occupational Personnel	**Standard[a]**	**Actual**
Average worker (mrem)	ALARA	27.3
Maximally exposed worker (mrem)	5,000	3,000
Total workers[b] (person-rem)	ALARA	258

[a] DOE's goal is to maintain radiological exposure as low as reasonably achievable.
[b] The number of badged workers in 1992 was approximately 9,470.
Source: 10 CFR 835; DOE 1993n:7.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Hanford Site Environmental Report for Calendar Year 1993* (PNL-9823). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (onsite and offsite) are also presented in that document.

Chemical Environment. The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain

hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, surface water during swimming, soil through direct contact, or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are presented in Section 3.2.3.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (for example, air emissions and NPDES permit requirements) contribute toward minimizing potential health impacts to the public. The effectiveness of these controls is verified through the use of monitoring information and through inspection of mitigation measures. Health impacts to the public may occur during normal operations at Hanford via inhalation of air containing hazardous chemicals released to the atmosphere by Hanford operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous chemicals and their applicable standards are included in the data presented in Section 3.2.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Section M.3.

Exposure pathways to Hanford workers during normal operations may include inhaling the workplace atmosphere and direct contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. Hanford workers are also protected by adherence to Occupational Safety and Health Administration (OSHA) and EPA standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals utilized in the operational processes ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm. Therefore, worker health conditions at Hanford are expected to be substantially better than required by standards.

Health Effects Studies. Three epidemiological studies and a feasibility study have been conducted on communities around Hanford to determine if there are any excess cancers in the general population. One study found no excess cancers but identified an elevated rate of neural tube defects in progeny. This elevated rate was not attributed to parental employment at Hanford. A second study suggested that neural tube defects were associated with cumulative radiation exposure and also showed other defects that statistically were associated with employment at Hanford, but not with parental radiation exposure. The third study did not show any cancer risk associated with living near the facility.

Many epidemiologic studies have been carried out on the Hanford workers, including updated cohort analyses over the years. The studies have consistently shown a statistically significant elevated risk of death from multiple myeloma among Hanford male workers associated with radiation exposure. The excess was observed only among workers exposed to 10 radiation absorbed doses (rads) or more. Other studies have also identified an elevated risk of death from pancreatic cancers, but the elevated risk disappeared in a recent re-analysis of the updated cohort. Among Hanford female workers, studies have reported an elevated risk of deaths from musculoskeletal and connective tissue systems.

A more detailed description of the studies reviewed and the findings is found in Section M.4.2.

[Text deleted.]

Accident History. There have been 127 nuclear-process-related incidents with some degree of safety significance at Hanford over its period of operation. These do not include less-significant instances of radioactivity release or contamination during normal operations, which have been the subject of other reviews. The 127 incidents fall into 3 significant categories, based on the seriousness of the actual or potential consequences.

Fourteen of the incidents were Category 1, indicating that serious injury, radiation release or exposure above limits, substantial actual plant damage, or a significant challenge to safety resulted. Forty-six events were Category 2, less severe than Category 1, but involving significant cost or a less significant threat to safety. The remaining 67 incidents were Category 3, causing minor radiation exposure or monetary cost, or involving a violation of operating standards without a serious threat to safety (HF 1993a:1). [Text deleted.]

Emergency Preparedness. Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response.

Accordingly, DOE RL has developed and maintains a comprehensive set of emergency preparedness plans and procedures for Hanford to support onsite and offsite emergency management actions in the event of an accident. The DOE RL also provides technical assistance to other Federal agencies and to State and local governments. Hanford contractors are responsible for ensuring that emergency plans and procedures are prepared and maintained for all facilities, operations, and activities under their jurisdiction, and for directing implementation of those plans and procedures during emergency conditions. The DOE RL, contractor, and the State and local government plans are fully coordinated and integrated. Emergency control centers have been established by the DOE RL and its contractors for the principal work areas to provide oversight and support to emergency response actions within those areas.

3.2.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory structure and ongoing waste management activities for Hanford. A more detailed discussion of the ongoing waste management operations is provided in Section E.2.1. Table 3.2.10–1 presents a summary of waste management activities at Hanford for 1993.

The Department is working with Federal and State regulatory authorities to address compliance and cleanup obligations rising from its past operations at Hanford. The DOE is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance, with applicable requirements and financial penalties for nonachievement of agreed-upon milestones.

The EPA placed Hanford on the National Priorities List (NPL) on November 3, 1989. In accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), DOE has entered into the Tri-Party Agreement with EPA and the State of Washington to govern the environmental compliance and cleanup of Hanford. Hanford has been divided into four aggregate waste sites (100, 200, 300, and 1100 Areas). An aggressive environmental restoration program is underway involving all areas of the site, using priorities established in the Tri-Party Agreement.

Hanford is the only DOE site with a preexisting agreement (Tri-Party Agreement) that meets the legal requirements specified under *Federal Facility Compliance Act*. Having this agreement exempts Hanford from having to develop a site treatment plan. This exemption is supported by written exemptions from the State of Washington and EPA. Both agencies determined that the *Report on Hanford Site Land Disposal Restrictions for Mixed Waste*, required by the Tri-Party Agreement, meets the intent of a site treatment plan. Hanford manages spent nuclear fuel and the following waste categories: high-level, TRU, low-level, mixed, hazardous, and nonhazardous. A discussion of the waste management operations associated with each of these categories follows.

Spent Nuclear Fuel. On April 29, 1992, DOE decided to discontinue reprocessing spent nuclear fuel solely to recover valuable materials. After the completion of several ongoing programmatic and site-specific reviews pursuant to NEPA, DOE will make decisions concerning the treatment and stabilization of the current Hanford inventory of spent nuclear fuel. Currently, spent N-Reactor, Shippingport Reactor, FFTF, and miscellaneous nuclear reactor fuel is stored in water-filled basins. Since spent nuclear fuel is not classified as waste, its management does not come under the regulations that apply to hazardous wastes, but instead is regulated by DOE Orders. Decisions concerning future receipt and management of spent nuclear fuel at Hanford will be made in accordance with the amended ROD published in the *Federal Register* on March 8, 1996 (61 FR 9441), for the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F). The ROD specifies that spent nuclear fuel will be managed at Hanford, INEL, or SRS. Hanford production reactor fuel will remain at Hanford. As of 1995, Hanford has 2,133 t (2,351 tons), or 81 percent, of the total DOE existing spent fuel inventory. According to this ROD, a total of 12 shipments of non-Hanford produced reactor spent fuel will be sent from Hanford to INEL. Each shipment, either by truck or by rail, is assumed to consist of one shipping container. Hanford will not receive any additional fuel. As a result of this action, and assuming no final disposition, by the year 2035 Hanford will have 2,132 t (2,350 tons), or 78 percent, of the total existing DOE redistributed and newly generated inventory in the form of production reactor spent nuclear fuel (61 FR 9441).

A follow-on tiered, site-specific NEPA analysis for the management of the spent nuclear fuel from the K Basins was published in January 1996, *Final Environmental Impact Statement, Management of Spent Nuclear Fuel from the K Basins at the Hanford Site, Richland, Washington* (DOE/EIS-0245). Based on the analysis, an ROD was published in March 1996 (61 FR 10736). The decision consists of removing the spent nuclear fuel from the basins, vacuum drying, conditioning and sealing the spent nuclear fuel in inert-gas

Table 3.2.10–1. Spent Nuclear Fuel and Waste Management Activities at Hanford Site

Category	1993 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Spent Nuclear Fuel	None	Encapsulation	Planned	Reactor Basins. Non-Hanford production reactor spent fuel to be sent to INEL	2,133 t[a]	None—HLW Program in the future	NA
High-Level							
Liquid	None	Evaporation[b,c]	50,000[c]	Tank Farm	146,000[d]	NA	NA
Solid	None	NA	NA	NA	NA	None—HLW Program in the future	NA
Transuranic							
Liquid	None	See HLW	See HLW	Tank Farm	See HLW	NA	NA
Solid	271	None	NA	Containers on asphalt pads	15,370	None—WIPP or alternate facility in the future	None
Mixed Transuranic							
Liquid	0	See HLW	See HLW	Tank Farm	See HLW	NA	NA
Solid	98	None	NA	Containers on asphalt pads	15,370	None—WIPP or alternate facility in the future	None
Low-Level							
Liquid	None	Evaporation, separation, solidification	Evaporator in service, new vitrification facilities planned	None	NA	NA	NA
Solid	3,390	Compaction	4,000[e]	Not Stored	NA	Burial	902,900[f]
Mixed Low-Level							
Liquid	3,760	Evaporation, ion exchange[c]	50,000	Storage tanks, basins planned	446,500[g]	None	NA
Solid	1,505[h]	None	NA	RCRA facility, retrievable	1,218,700	Landfill, LLW Burial Grounds 218-E-NN	See solid LLW
Hazardous							
Liquid	See solid	None	NA	RCRA building	See solid	Commercial[i]	NA

Table 3.2.10–1. Spent Nuclear Fuel and Waste Management Activities at Hanford Site—Continued

Category	1993 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Solid	560[j]	None	NA	RCRA building	127	Commercial[i]	NA
Nonhazardous (Sanitary)							
Liquid	246,000 [k]	None	NA	None	NA	Septic tanks, french drains	Expandable
Solid	5,107	None	NA	None	NA	Richland Sanitary Landfill	Expandable
Nonhazardous (Other)							
Liquid	Included in sanitary	None	NA	None	NA	Percolation ponds, leachfields	Expandable
Solid	Included in sanitary	None	NA	None	NA	Landfill	Expandable

[a] Spent nuclear fuel is normally expressed in metric tons not cubic meters.

[b] Vitrification planned.

[c] 242-A Evaporator restarted in April 1994 after upgrades were completed. Assumes 242-A Evaporator as treatment method for liquid HLW and liquid TRU and mixed TRU.

[d] Consists of HLW and liquid TRU wastes in Double-Shell Tanks; Pu recovery and extraction aging waste. Includes 241-AN, 241-AP, 241-AW, 241-AY, 241-AZ, and 241-SY Tank Farms.

[e] Compaction by LLW Compactor (213-W).

[f] Includes the LLW Burial Grounds (unit 218-E-NN) and Low-Level Mixed Waste Disposal Facility (Project W-025).

[g] Assumes storage of liquid mixed LLW in tanks and planned basins.

[h] Consists of 1,500 m^3 of RCRA-regulated mixed LLW and 8.2 t of *Toxic Substances Control Act*-regulated mixed LLW. Volume estimate for TSCA-regulated mixed LLW was made based on a density factor of 1,500 kg/m^3.

[i] Offsite at RCRA facility.

[j] Consists of 628 t (RCRA-regulated), 72.8 t (State-regulated), and 139 t (TSCA-regulated). A volume estimate was made based on a density factor of 1,500 kg/m^3 for solids.

[k] No data. Estimate made based on employment of 14,856 and 30 gal/person/day for 250 days.

Note: NA=not applicable.

Source: 61 FR 9441; DOE 1993h; DOE 1994d; DOE 1994k; HF DOE 1993a; HF MMES 1993a; HF WHC 1995c; ORNL 1993a.

filled canisters for dry vault storage in a new facility, to be built at Hanford, for up to 40 years pending decisions on ultimate disposition.

High-Level Waste. High-level waste was generated in the recovery of uranium and Pu from spent fuel generated in the production reactors. All of this radioactive waste is considered mixed waste because of its toxic and hazardous constituents as defined by RCRA. It must be remotely handled because of its high radiation levels. The waste was generated as liquids and sludges and stored in underground tanks where the sludges and salts in the liquid have precipitated out of solution as porous solids (called salt cake) and settled to the bottom of the tanks. The liquid above the solids has been pumped from the older, single-shelled tanks into newer, double-shelled tanks. The liquids that remain in the porous salt cake will be removed by boring holes through the salt cake and extracting liquids from near the tank bottoms. The wastes are segregated and handled according to their hazardous nature (corrosivity, chemical stability, heat generation rates), and require special monitoring and venting. Cooling is needed for some of these wastes. The wastes are concentrated by evaporation and returned to the tanks for storage until final processing to a form suitable for disposal in a Federal repository. It is planned to vitrify HLW water-soluble sludges and selected radionuclides separated from liquids retrieved from the tanks. Vitrification of all waste from tanks is expected to be completed by 2028. In addition to this liquid and solid HLW, an inventory of encapsulated Cs and Sr is stored in the Waste Encapsulation and Storage Facility in a water-cooled pool. Some of this material was used as irradiation sources in, for example, radiography and food irradiation. [Text deleted.]

Transuranic Waste. Before 1970, TRU waste was buried in near-surface trenches. These wastes will require retrieval, segregation, processing, certification, and packaging before their final disposal. At the same time, the burial sites themselves will require extensive remediation. TRU wastes generated since 1970 have been separately stored in near-surface trenches (both lined and unlined) or in aboveground buildings. These wastes will also require assay, recertification, and possibly repackaging. Some TRU wastes generated since 1986 have been packaged and certified to the WIPP WAC. The best available treatment technologies will be utilized, as required, on a case-by-case basis, to process the retrieved wastes before repackaging and certification for WIPP. Storage facility expansion for these wastes at the Hanford Site Central Waste Complex is anticipated as remedial operations continue. Treatment of contact-handled TRU wastes will be provided in the future at the Waste Retrieval and Processing Facility. The waste in the underground storage tanks described in the previous HLW section contains some Pu. The final disposition of this waste awaits the development of technology and agreements with stakeholders and regulatory bodies. All currently generated contact-handled TRU waste is being placed in above-grade storage buildings at the Hanford Site Central Waste Complex and the TRU Storage and Assay Facility. TRU wastes will be maintained in storage until a suitable disposal facility is qualified for TRU waste disposal. Hanford would develop the appropriate treatment capabilities to meet the criteria of the designated repository. Mixed TRU waste quantities are included in the TRU waste category, since all these wastes are destined for ultimate disposal in WIPP depending on decisions made in the ROD associated with the supplemental EIS being prepared for the proposed continued phased development of WIPP for disposal of TRU waste.

Low-Level Waste. Low-level waste is generated when separated from HLW, TRU waste, and mixed wastes in the processing of tank wastes, and also from remediation activities. Solid LLW is accumulated at the originating sites, compacted, and shipped to the Low-Level Burial Ground in the Hanford Central Waste Complex located in the 200 West Area. Additional LLW is received from offsite generators and disposed of in a series of unlined near-surface trenches. The LLW resulting from the tank waste remediation system waste preteatment program will be vitrified by the end of 2028; as a near-term contingency, the Grout Facility will be maintained in a standby condition. The vitrifed LLW will be disposed of onsite in the 200 Area at Hanford by the tank waste remediation system program.

Mixed Low-Level Waste. Ninety-nine percent of the mixed waste at Hanford is contained in tank farms. The only treatment facility currently in place for these wastes is the 242-A Evaporator, which operates to reduce the volume of these wastes. Solid waste is segregated by its hazardous characteristics (ignitability, corrosivity,

reactivity, and toxicity) and stored in buildings in the mixed waste storage facility. Defueled submarine reactor compartments continue to be received and disposed of in earthen trenches. These compartments have contained polychlorinated biphenyls (PCBs), but the Navy has a program to remove PCBs before the compartment disposal. Previously disposed mixed waste will be evaluated, treated, and disposed of according to designated criteria. Facilities completed or under construction to treat mixed wastes at Hanford are the Effluent Retention Facility, Effluent Treatment Facility (ETF) (filtration, oxidation, and ion exchange), 200 and 300 Area Treated Effluent Disposal Facility, LLW Vitrification Facility (stabilization), and the Waste Receiving and Processing Facility. Some of these facilities are scheduled to begin operations before the year 2000 to meet legally obligated milestones established in the Tri-Party Agreement and in consent orders.

Hazardous Waste. Hazardous waste is generated by various activities at PNL and from remediation and maintenance processes onsite. Except for the Interim Hazardous Waste Treatment Facility, which performs distillation, neutralization, and solidification, there are no treatment facilities for hazardous waste at Hanford; therefore, these wastes are accumulated in satellite storage areas (for less than 90 days) or at interim RCRA-permitted facilities, such as the Nonradioactive Dangerous Waste Storage Facility (Building 616), and at PNL (Building 305-B). The waste is shipped offsite by truck using DOT-approved transporters for treatment and disposal at RCRA-permitted facilities. A facility is being planned at PNL to dispose of the small volume of PNL hazardous waste and to be used for treatment technology development and demonstration.

Nonhazardous Waste. Wastewater from the process areas is treated in the 200 West Area Treatment Facility and then discharged to percolation ponds. In the future, these waste streams will be processed in an integrated liquid effluent system using a combination of local and central treatment systems. Sanitary wastewater is discharged to individual septic tanks and subsurface disposal systems. No data are collected on these waste streams. New systems will be added as processes move to different areas of the site. Sanitary wastes are estimated from standard engineering data for Hanford. Nonhazardous solid wastes are disposed of in the 600 Area central landfill. In October 1995, it was announced that DOE and the city of Richland reached an agreement to send the site's nonregulated and nonradioactive solid wastes to the Richland Sanitary Landfill. Coal waste is disposed of in landfills near the 200 East and 200 West Area powerhouses.

3.3 NEVADA TEST SITE

The Nevada Test Site is located in the southeastern part of Nye County in southern Nevada. The location of NTS within the State of Nevada is illustrated in Figure 2.2.2–1. NTS is operated by a management and integration contractor under the direction of the Nevada Operations Office. It is a remote, secure facility for conducting underground testing of nuclear weapons and evaluating the effects of nuclear weapons on military communications systems, electronics, satellites, sensors, and other materials. The first nuclear test at NTS was conducted in January 1951. Since the signing of the *Threshold Test Ban Treaty* in 1974, it has been the only U.S. site used for nuclear weapons testing.

Approximately one-half of the land (located in the eastern and northwestern portions of the site) is used for nuclear weapons testing, one-quarter (located in the western portion of the site) is reserved for future missions, and one-quarter is used for research and development and other facility requirements. Facilities include nuclear device assembly, diagnostic canister assembly, hazardous liquid spill, and the Radioactive Waste Management Site (RWMS). Figure 2.2.2–2 indicates the location of existing facilities within NTS.

In addition, Yucca Mountain, an area located on the western boundary of the site, is being characterized as directed by the NWPA of 1982, as amended, to determine its suitability as a repository for the disposal of commercial and DOE-owned spent nuclear fuel and radioactive HLW. DOE published an NOI for the preparation of an EIS (August 7, 1995) to evaluate a proposed action to construct, operate, and eventually close a geological repository.

Activities at NTS are concentrated in several general areas. Most of the onsite work is related to defense program activities, although environmental management, other DOE, and non-DOE activities are conducted as well. NTS is a unique facility because it is a large, open area into which access is tightly controlled; it has a substantial infrastructure; and it has the capability to handle and run tests using hazardous or radioactive materials. Because of this, activities other than nuclear testing, including mobile missile transporter tests and nuclear rocket tests, have been carried out for other Federal departments and agencies.

Department of Energy Activities. The NTS was established as the site within the United States where underground testing of nuclear weapons would occur. Since that time, other missions have been added due to the nature of the site. Likewise some activities have been terminated or not actively pursued. The current missions at NTS are shown in Table 3.3–1.

Table 3.3–1. Current Missions at Nevada Test Site

Mission	Description	Sponsor
Defense	Stockpile stewardship, including the maintenance of readiness to conduct an underground nuclear test, if directed	Assistant Secretary for Defense Programs
Waste management	Safe and permanent disposal of waste through either disposal on the NTS or to offsite commercial waste treatment or disposal facilities	Assistant Secretary for Environmental Management
Environmental restoration	Identify contaminated areas and cleanup those areas, as appropriate	Assistant Secretary for Environmental Management
Nondefense research & development	Original research efforts by the DOE, universities, industry, and other federal agencies	Various Federal Departments and Agencies
Work for others	Use of NTS areas and facilities by other groups and agencies for activities such as military training exercises	Various Federal Departments and Agencies

Source: DOE 1995i.

In addition to DOE nuclear testing activities at NTS, the Defense Special Weapons Agency has conducted tests that provide DoD with data regarding vulnerability and survivability of nuclear and nonnuclear weapons systems produced by the United States. DOE defense activities at NTS are closely related to Defense Special Weapons Agency activities, with both contributing to national security. The moratorium on U.S. nuclear testing began in October 1992 in accordance with the Hatfield Amendment. At the same time, however, the President required that NTS retain the capability to resume testing if authorized. Before the moratorium, nuclear testing was limited to those tests that supported the safety and reliability of the Nation's nuclear stockpile. [Text deleted.] In July 1993, the President extended the moratorium on nuclear tests (both DOE and DoD) indefinitely, but continued to require testing capabilities at NTS.

A facility for DOE activities, the 9,300 m^2 (100,000 ft^2) DAF, is located south of Control Point One in Area 6. Both LANL and LLNL can use this facility for conducting multiple operations with high explosives and nuclear devices simultaneously. Because of its multiple facilities areas that include assembly cells, assembly bays, high bays, radiographic facilities, special nuclear materials laboratories, high explosive (HE) storage, special nuclear material storage, shipping and receiving areas, and associated administrative and support areas, all aspects of nuclear device preparations could be handled in this one facility. In addition, the facility could provide increased overall security and allow easier entrance and exit accessibility for the workers during hazardous operations. There would be no manufacturing of special nuclear material at this facility.

There are active radioactive and mixed waste disposal areas onsite in Areas 3 and 5. The only major environmental management facility anticipated for NTS is a waste management facility to handle TRU wastes. A major program to characterize the groundwater at NTS is in progress to determine regional flow paths and rates and to detect any migration of contamination from past nuclear testing.

Although the principal activity at NTS has been the underground testing of nuclear devices, DOE is also involved in a number of other activities, including:

- The Yucca Mountain site in southern Nevada is being evaluated for its suitability as a repository to dispose of commercial and DOE-owned spent nuclear fuel and HLW. The Yucca Mountain Site Characterization Office (YMSCO) is conducting the site characterization activities and reports directly to Office of Civilian Radioactive Waste Management. However, because Yucca Mountain is collocated with NTS, the DOE Nevada Operations Office provides some administrative support services to YMSCO.

- The Spill Test Facility in Area 5 was completed in 1986. It is operated on a fee basis for commercial users as a basic research tool to study the dynamics of accidental releases of hazardous materials and to evaluate the effectiveness of various foams and fire retardants in accidents involving chemicals and hazardous materials.

Non-Department of Energy Activities. The main non-DOE activity at NTS was the Defense Special Weapons Agency's use of the site as a nuclear weapons effects testing facility in Area 12. Weapons effects tests were conducted to study a number of nuclear effects, including x-rays, gamma rays, neutrons, electromagnetic pulse, air blast, ground and water shock, propagation, and temperature. These tests assessed military systems in a nuclear environment. These tests were carried out in underground tunnels, including the P-Tunnel which is being considered for long-term storage alternatives in this PEIS. Various other military exercises and training activities are currently carried out at NTS.

3.3.1 LAND RESOURCES

Land Use. The NTS occupies approximately 350,000 ha (approximately 864,000 acres) (NT DOE 1996c:4-1; NT DOE 1994d:2) in southern Nye County of southern Nevada, with the southwestern boundary located approximately 16 km (10 mi) from California. The town of Indian Springs and Indian Springs Air Force Auxiliary Field in northeast Clark County, Nevada, are located 39 km (24.2 mi) southeast of the NTS boundary. All of the land within NTS is owned by the Federal Government and is administered, managed, and controlled by DOE. NTS is entirely bordered by Federal land—to the north, east, and west by Nellis Air Force Range, and to the south by land administered by the BLM.

In the mid-1800s, lands that now comprise NTS were included within the boundary of the Ruby Valley Treaty between the United States and the Western Bands of the Shoshone Indians. In 1951, the Shoshone tribe sought compensation for the loss of aboriginal title to these lands and was later awarded $26 million (NT DOE 1995e:2). The land area that today constitutes the current NTS configuration was withdrawn from all forms of appropriation under the public land laws, including mining and mineral-leasing laws through four Public Land Orders and a Memorandum of Understanding with the U.S. Air Force (NT DOE 1996c:4-5, 4-8, 4-9). The NTS boundary is defined by the four land withdrawals (NT DOE 1996f:2). On February 12, 1952, Public Land Order 805 reserved approximately 176,040 ha (435,00 acres) of land for use by the Atomic Energy Commission (AEC) as a weapons testing site. Approximately 15,540 ha (38,400 acres) were reserved for the use of the AEC in connection with NTS under Public Land Order 1662 on June 20, 1958. The lands described under this Public Land Order are not considered for any storage and disposition alternative and therefore are not addressed in this PEIS (NT DOE 1996c:4-5).

On December 19, 1961, approximately 128,691 ha (318,000 acres) of land previously reserved for use by the U.S. Air Force were transferred to the jurisdiction of the AEC for use in connection with NTS for test facilities, roads, utilities, and safety distances under Public Land Order 2568. Approximately 8,542 ha (21,108 acres) of land were reserved for the jurisdiction of the AEC for use in connection with NTS on August 3, 1965 under Public Land Order 3759. The northern portions of Areas 19 and 20, which encompass approximately 42,994 ha (106,240 acres), is managed by DOE as part of NTS in accordance with a 1963 Memorandum of Understanding with the U.S. Air Force. This memorandum was superseded by a Memorandum of Understanding between the U.S. Air Force and DOE/NV in 1982 (NT DOE 1996c:4-5). Therefore, the NTS site boundary does not include Pahute Mesa (NT DOE 1996f:2).

Existing Land Use. Generalized land uses at NTS and its vicinity are shown in Figure 3.3.1–1. NTS is divided into three major regions (Figure 3.3.1–2). The northern and eastern regions of NTS constitute the underground nuclear weapons test area. Nuclear test ranges are located at Yucca Flat, Pahute Mesa, Rainier Mesa, and Buckboard Mesa. The southwestern region of NTS (Area 25) provides support for nonweapons and nonnuclear weapons programs, such as the site characterization studies at Yucca Mountain, and for short-term activities, such as the Nuclear Weapons Accident Exercises conducted by the Nuclear Emergency Search Team. The remaining region contains the nonnuclear explosives test area and primary administrative and support area of NTS. NTS is subdivided into numbered areas, many of which are used or reserved for specific purposes.

In 1992, DOE designated all of NTS as a NERP. The NERP is used by the national scientific community as an outdoor laboratory for research on the effects of human activities on the desert ecosystem (DOE 1994u:v,31). There is no prime farmland present within NTS. Past agricultural activities were limited to an EPA agricultural and animal radiological research facility that closed in 1981. Offsite agricultural activity occurs on the south side of U.S. Route 95 and is limited to a cattle allotment granted by the BLM.

The Timber Mountain Caldera National Natural Landmark is located in the northwest portion of NTS. It is separated from much of NTS by mountains along its eastern border. A recommendation to include approximately 539,000 ha (1,333,000 acres) of the Desert National Wildlife Range (DNWR), which is managed by the USFWS, in the National Wilderness Preservation System has been tabled (NV FWS 1994a:3-5,3-6). This

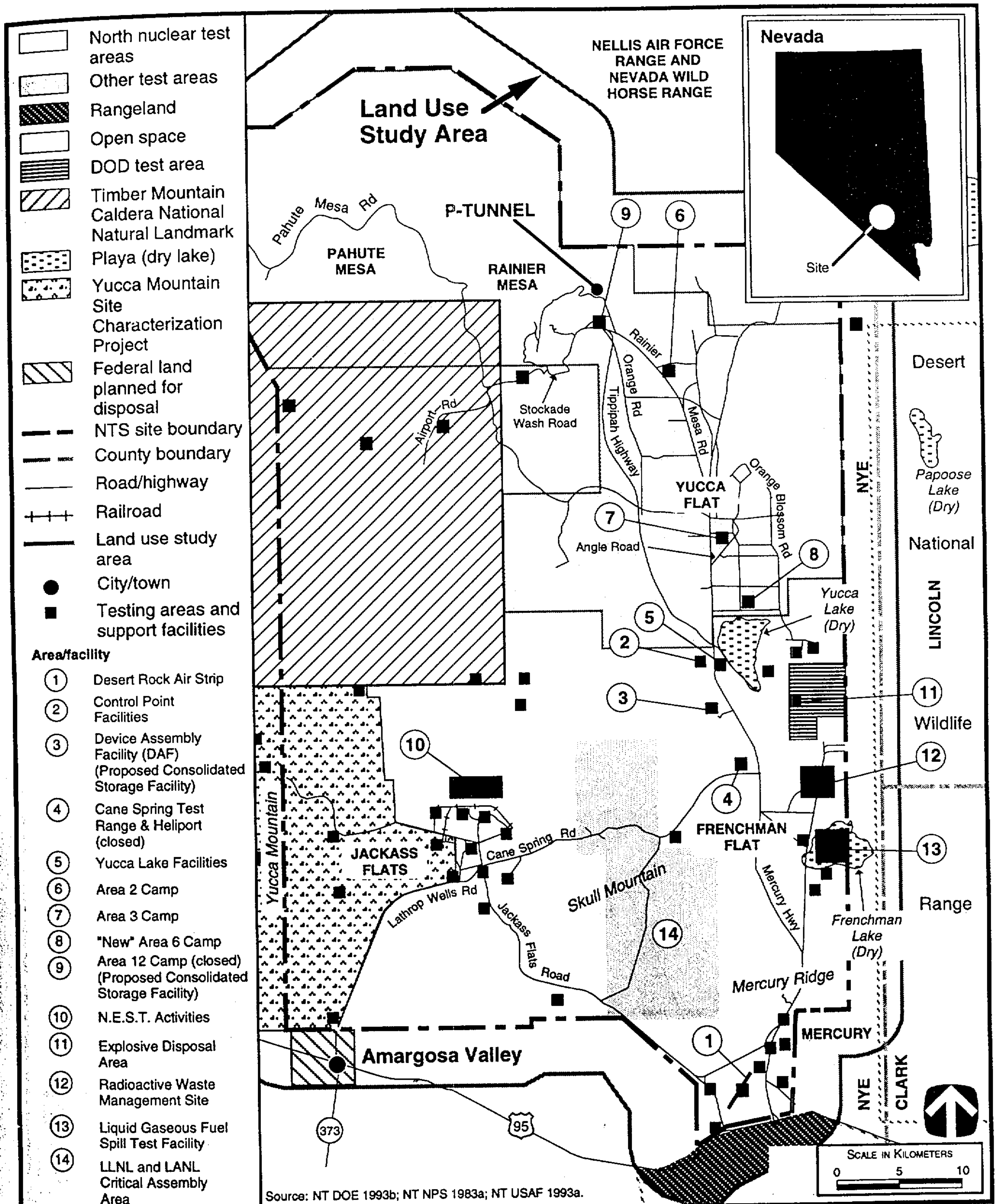


Figure 3.3.1–1. Generalized Land Use at Nevada Test Site and Vicinity.

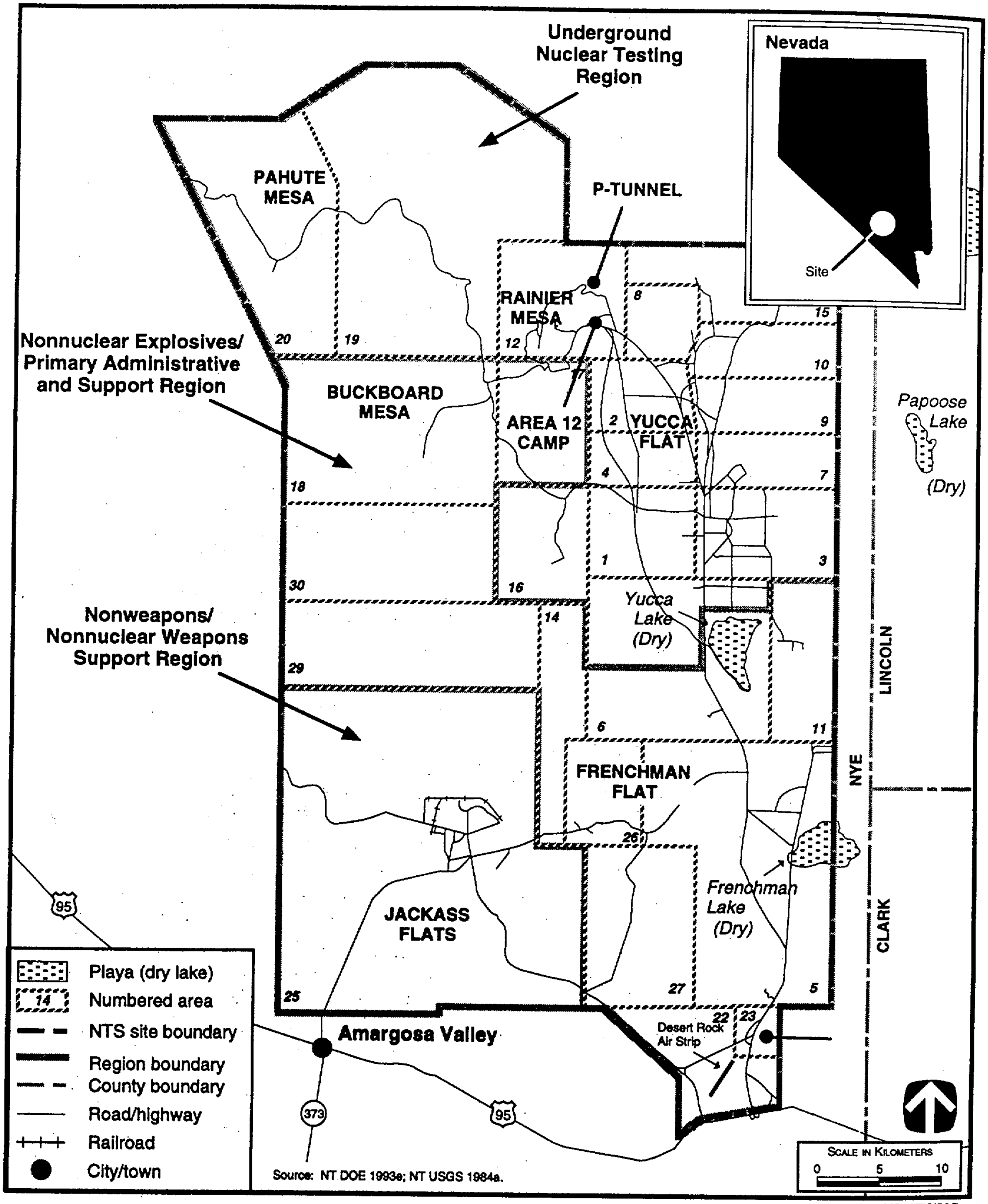


Figure 3.3.1–2. Generalized Regions at Nevada Test Site.

area of the DNWR is also part of the Nellis Air Force Range; it is jointly managed by the U.S. Air Force and USFWS. Public entry to this part of the wildlife range is generally prohibited by the Air Force, however, public entry that is allowed onto the DNWR does not occur in areas with views of NTS (NTS 1995a:6). The closest residence is located 2 km (1.3 mi) south of the NTS boundary, in the unincorporated town of Amargosa Valley.

Land-Use Planning. The Department has prepared a sitewide EIS for NTS that analyzes the environmental impacts associated with managing NTS and its resources. Four alternatives, including No Action, are presented in the EIS, with land-use and zoning categories described for each alternative. Land-use planning does not occur at the State level in Nevada; however, counties and other municipalities may plan if they so choose. The recently adopted Nye County comprehensive plan is a policy document that permits Nye County to begin a process of establishing a comprehensive land-use plan and zoning ordinance. No municipalities within Nye County have adopted land-use plans, policies, or controls (NT County 1995a:1).

Visual Resources. The NTS is located in a transition area between the Mojave Desert and the Great Basin. Vegetation characteristic of both deserts are found on NTS. The topography of NTS consists of a series of north-south oriented mountain ranges separated by broad, low-lying valleys and flats. Site topography is also characterized by the presence of numerous subsidence craters resulting from past nuclear testing. The southwestern Nevada volcanic field, which includes portions of NTS, is a nested, multicaldera volcanic field. The facilities of NTS are widely distributed across this desert setting.

The area surrounding NTS is unpopulated to sparsely populated desert and rural lands. Access to areas that would have views of NTS is controlled by NTS or the U.S. Air Force; therefore, there are few viewpoints accessible to the general public. Public viewpoints of NTS along U.S. Route 95, the principal highway between Tonopah and Las Vegas, are limited to Mercury Valley due to the various mountain ranges surrounding the NTS southern boundary. The primary viewpoint in the Mercury Valley is a roadside turnoff containing Nevada Historical Marker No. 165 of the Nevada State Park System, entitled "Nevada Test Site." The NTS facilities within 8 km (5 mi) are visible from this viewpoint. The main base camp at Mercury, located in Area 23, is well defined at night by facility lighting. The developed areas of NTS are consistent with a BLM VRM Class 5 designation. Other areas range from Class 2 to Class 4.

3.3.2 SITE INFRASTRUCTURE

Baseline Characteristics. Activities at NTS are concentrated at facilities in several general areas. Section 3.3 describes current NTS missions. To support these missions, an extensive infrastructure exists, as shown in Table 3.3.2–1.

Table 3.3.2–1. Nevada Test Site Baseline Characteristics

Characteristics	Current Usage	Site Availability
Transportation		
Roads (km)	640	1,100[a]
Railroads (km)	0	0
Electrical		
Energy consumption (MWh/yr)	121,460	176,844
Peak load (MWe)	27	45
Fuel		
Natural gas (m^3/yr)	0	0
Oil (l/yr)	5,716,000	5,716,000
Coal (t/yr)	0	0
Steam (kg/hr)	0	0

[a] Includes paved and unpaved roads.
Source: NTS 1993a:4.

The onsite transportation capability at NTS provides for safe and secure movement of nuclear materials. Movements are made via truck to and around the site. Improved and unimproved roads cover most of the NTS. Railbeds have existed in both Areas 25 and 26 for experimental purposes. These railbeds are neither maintained nor connected. Currently, there is no operating rail on NTS.

The regional electric power pool in which NTS is located, and from which it draws power, is the California-Southern Nevada Power Area. Electricity is provided by two independent 138-kilovolt (kV) lines. The capacity of the system is approximately 45 MWe. The site is near a major electrical hub that ties into several other areas.

Coal, nuclear, hydroelectric and geothermal, and oil and gas all contribute significantly to the region's electrical power system. Generating capacity margin for the regional pool is at 21 percent of current peak demand (see Table 3.3.2–2).

The NTS water supply system consists of 13 supply wells, pumps, booster pumps, and many sumps, reservoirs, chlorinator water softeners, and 160 km (100 mi) of supply lines. This water system is capable of producing 284 million l/week (75 million gal/week).

A major facility that could be used to store materials within the scope of this PEIS is the P-Tunnel complex located in Area 12 in the northern portion of NTS. This facility is a 1,000 m (3,281 ft) tunnel with multiple side drifts and an average earth cover of approximately 260 m (853 ft). The tunnel and drifts vary in dimension, but most are larger than 4 m (13 ft) in diameter and are lined with shotcrete. The Defense Special Weapons Agency used the P-Tunnel to perform underground nuclear effects tests.

Table 3.3.2–2. California–Southern Nevada Sub-Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel	
Coal	14%
Nuclear	15%
Hydro/geothermal	19%
Oil/gas	22%
Other[a]	30%
Total Annual Production	246,012,000 MWh
Total Annual Load	293,262,000 MWh
Energy Imported Annually[b]	45,400,000 MWh
Generating Capacity	61,681 MWe
Peak Demand	57,028 MWe
Capacity Margin[c]	11,809 MWe

[a] Includes power from both utility and nonutility sources.

[b] Energy imported is not the difference of production and load due to positive net pumped storage.

[c] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.

Source: NERC 1993a.

3.3.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The climate at NTS and in the surrounding region is characterized by limited precipitation, low humidity, and large diurnal temperature ranges. The lower elevations are characterized by hot summers and mild winters, which are typical of other Great Basin desert areas. As elevation increases, precipitation increases and temperatures decrease (NT DOE 1986b:3-46).

The average annual temperature at NTS is 19.5 °C (67.1 °F); temperatures range from an average daily minimum of 0.9 °C (33.6 °F) in January to an average daily maximum of 41.1 °C (105.9 °F) in July. The average annual precipitation at NTS is 10.5 cm (4.13 in). Prevailing winds at NTS vary by location. The average annual windspeed is 4.2 m/s (9.4 mph) (NOAA 1994d:3). Additional information related to meteorology and climatology at NTS is presented in Appendix F.

Ambient Air Quality. The NTS is located within the Nevada AQCR (#147). The region is designated as an attainment area (40 CFR 81.329) with respect to NAAQS for criteria pollutants. Applicable NAAQS and Nevada State ambient air quality standards are presented in Appendix F.

Two PSD (40 CFR 52.21) Class I areas in the vicinity of NTS are Grand Canyon National Park, approximately 193 km (120 mi) southeast of the site, and Sequoia National Park, California, approximately 169 km (105 mi) west-southwest of the site. Since the creation of the PSD program in 1977, no PSD permits have been required for any emissions source at NTS.

The primary emission sources of criteria air pollutants at NTS include particulates from construction and other surface disturbances, fugitive dust from unpaved roads, various pollutants from fuel-burning equipment, incineration, open burning, and volatile organic chemicals (VOCs) from fuel storage facilities. A summary of emission estimates for sources at NTS is presented in Appendix F.

Table 3.3.3–1 shows the site baseline ambient air concentrations for criteria pollutants and other pollutants of concern at NTS. No hazardous air pollutants or other toxic compound sources are indicated. Baseline concentrations are in compliance with applicable guidelines and regulations. Elevated levels of O_3 and PM_{10} may occur occasionally because of pollutants transported into the area by wind or because of local sources of fugitive particulates. Concentrations of other criteria pollutants are low because there are no large emission sources nearby. The nearest nonattainment area is the Las Vegas area (40 CFR 81.329), located approximately 105 km (65 mi) southeast of NTS.

Noise. Major noise emission sources within NTS include various industrial facilities, equipment and machines (for example, cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials handling equipment, and vehicles), and aircraft operations. No known noise surveys have been conducted at NTS to determine background sound levels. Most industrial facilities at NTS are at sufficient distance from the site boundary that noise levels at the boundary from these sources would not be measurable or would be barely distinguishable from background noise levels.

The acoustic environment around NTS is primarily uninhabited desert and small rural communities. In the uninhabited desert, the major sources of noise are natural physical phenomena, such as wind, rain, and wildlife activities, and an occasional airplane. The wind is the predominant noise source. Desert noise levels as a function of wind have been measured at an upper limit of 22 dBA for a still desert and 38 dBA for a windy desert (Webb 1983a:170). A background sound level of 30 dBA is probably a reasonable estimate. This agrees with other estimates of sound levels for rural areas. Annual rural-community day and night average sound levels (DNL) have been estimated in the range of 35 to 50 dBA and are considered to be a reasonable estimate for Indian Springs, Mercury, and the town of Amargosa Valley (EPA 1974a:B-4). Except for the prohibition of nuisance noise, neither the State of Nevada nor its local governments have established specific numerical environmental noise standards applicable to NTS.

Table 3.3.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Nevada Test Site, 1990-1992

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] ($\mu g/m^3$)	Baseline Concentration[b] ($\mu g/m^3$)
Criteria Pollutants			
Carbon monoxide	8-hour	10,000[c]	2,290
	1-hour	40,000[c]	2,748
Lead	Calendar Quarter	1.5[c]	d
Nitrogen dioxide	Annual	100[c]	d
Ozone	1-hour	235[c]	e
Particulate matter less than or equal to 10 microns in diameter	Annual	50[c]	9.4
	24-hour	150[c]	106
Sulfur dioxide	Annual	80[c]	8.4
	24-hour	365[c]	94.6
	3-hour	1,300[c]	725
Mandated by the State of Nevada			
Hydrogen sulfide	1-hour	112[f]	d

[a] The more stringent of the Federal and State standards is presented if both exist for the averaging time.
[b] Modeled concentration based on permit data except for CO which are monitored values.
[c] Federal and State standard.
[d] No sources of this pollutant have been identified.
[e] Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. See Section 4.1.3 for a discussion of ozone-related issues.
[f] State standard.
Source: 40 CFR 50; NT REECO 1990a; NV DCNR 1992a; NV DCNR 1995a.

3.3.4 WATER RESOURCES

Surface Water. There are no continuously flowing streams on NTS. The most noticeable natural hydrologic features of NTS are the playas (lake beds) that collect stormwater runoff. Runoff in the eastern half of the site ultimately collects in the playas of Yucca Flat and Frenchman Flat. In the northeastern portion, runoff drains outside the test site and onto the Nellis Air Force Range Complex. In the western half and southernmost portion, runoff is carried offsite towards the Amargosa Desert. Figure 3.3.4–1 shows the location of the playas and flats. A few natural springs can be found at NTS. Surface water is not used at NTS.

There have been no studies conducted to assess 500-year floodplain boundaries at NTS. Two 100-year flood analyses have been conducted; these analyses show no runoff from a 100-year storm affecting the proposed project areas. One analysis was for Jackass Flats, but it is not near the proposed project areas. The 100-year floodplain study has been completed for the radioactive waste management site located in Area 5. This showed water flowed to the Frenchman Lake region of Area 5. However, the proposed project areas are in a region where flash flooding occurs due to locally isolated intense convection storms. These floods normally last less than 6 hours (NT DOE 1992d:4-27).

Surface Water Quality. There are no NPDES permits for the site as there are no wastewater discharges to onsite or offsite surface waters. However, the State has issued sewage discharge permits for sewage lagoons and ponds for NTS facilities. Because there are no surface waters at or near the proposed project area, and because there will be no withdrawal or discharge to natural surface waters at NTS, the assessment of surface water quality is not applicable.

Surface Water Rights and Permits. Surface water rights are not an issue because NTS facilities do not withdraw surface water for use nor do they discharge effluents directly to natural surface waters.

Groundwater. The NTS is located within three groundwater subbasins of the Death Valley Groundwater Basin. Groundwater beneath the eastern portion of NTS is located in the Ash Meadows Subbasin; the western portion is located in the Alkali Flat Furnace Creek Ranch Subbasin; and a small part of the northwestern corner is located in the Oasis Valley Subbasin (Figure 3.3.4–2). The actual subbasin boundaries, however, are poorly defined. Three general aquifers are present at NTS: the Lower Carbonate (the deepest), the Volcanic, and the Valley-Fill (the shallowest) (NT DOE 1992d:4-14). Other aquifers are present to a limited extent under the area, but their water-bearing potential has not been thoroughly investigated. Limited aquifers may occur in other volcanic units, including lava flows and bedded tuffs.

The Lower Carbonate is the regional aquifer and is comprised of carbonate rocks of Middle Cambrian through Devonian age. The saturated thickness of this confined aquifer ranges from approximately 100 m to over 1,000 m (328 ft to over 3,280 ft). This aquifer drains in a south-southwest direction, under Yucca and Frenchman Flats, toward Ash Meadows (NT DOE 1992d:4-14). However, due to the large topographic changes across the area and the importance of fractures to groundwater flow in this aquifer, local flow directions can vary significantly from this regional trend. The unconfined Volcanic and Valley-Fill aquifers range in thickness from close to 0 to about 610 m (2,000 ft) and occur in the Frenchman and Yucca Flats drainage basins, respectively (NT DOE 1992d:4-17).

Depth to groundwater at NTS ranges from approximately 150 m to over 700 m (492 ft to over 2,300 ft). It is approximately 490 m (1,607 ft) at Yucca Flat, 250 m (820 ft) at Frenchman Flat, and over 700 m (2,300 ft) at Pahute Mesa. However, there are areas of perched water that lie at considerably shallower depths.

Recent estimates of the perennial yield of all NTS aquifers (that is, the total amount that can be removed on an annual basis without resulting in a net depleting of the groundwater reservoir) range from 57 billion l (15 billion gal) (NT USGS 1988a) to 38 billion l (10 billion gal) (NT DOE 1992b:41-43). Groundwater is recharged from infiltration of precipitation in the northern and eastern mountain ranges and from underflow from upgradient

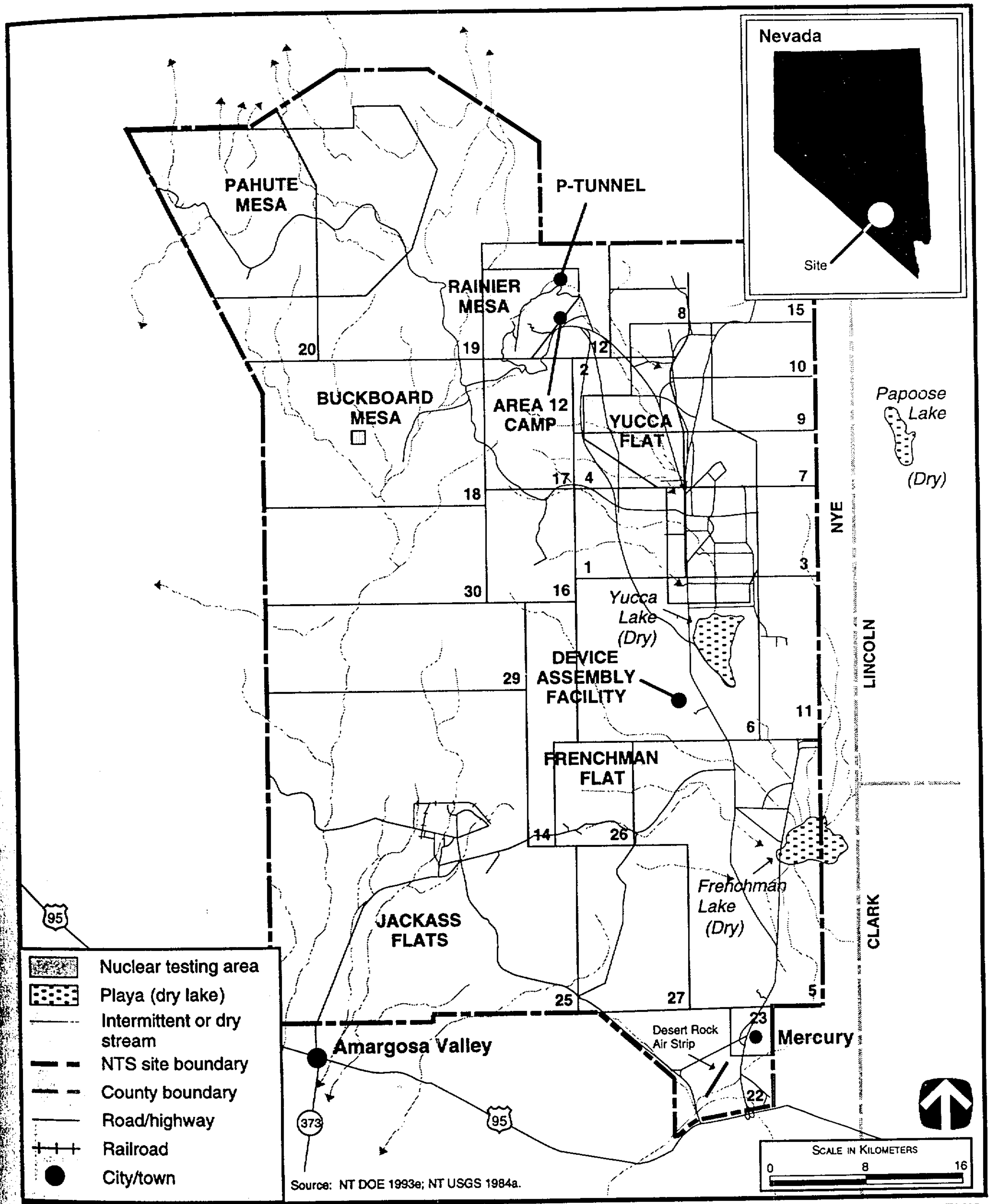


Figure 3.3.4–1. Surface Water Features at Nevada Test Site.

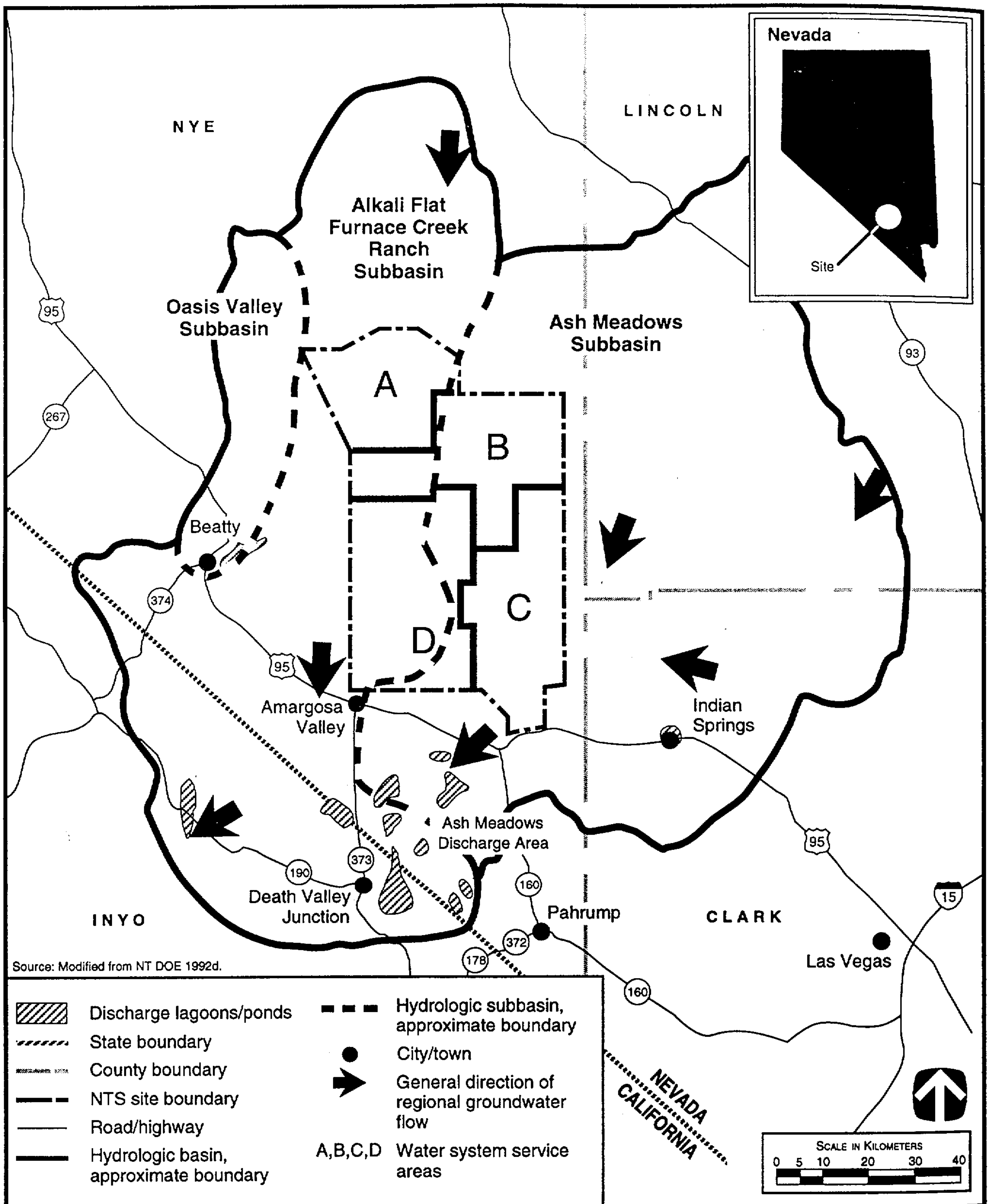


Figure 3.3.4–2. Groundwater Hydrologic Units at Nevada Test Site and Vicinity.

areas. Natural discharge from the aquifers primarily occurs from evaporation and transpiration in the Amargosa Valley (including Ash Meadows) and Death Valley areas (Figure 3.3.4–2).

Devils Hole is a water-filled limestone cavern near Ash Meadows, approximately 48 km (29.8 mi) southwest of the NTS southern boundary, and is known to contain the endangered Devils Hole pupfish. Groundwater pumping at Ash Meadows was curtailed by order of the U.S. Supreme Court in order to protect the endangered Devils Hole pupfish by maintaining water levels at Devils Hole. Studies have shown, however, that historical pumping at NTS at rates that exceed current rates was probably unrelated to observed declines at Devils Hole (NT DOE 1993b:4-27).

Groundwater Quality. Currently, aquifers beneath NTS have not been classified by EPA. However, during an independent study (NT DOE 1989a:11), the aquifers beneath NTS were classified as Class IIa and Class IIb (groundwater currently used for drinking water). In 1972, the DOE Nevada Operations Office instituted a Long-Term Hydrological Monitoring Program to be operated by the EPA under an Interagency Agreement. Groundwater is monitored on and around NTS, and at two off-NTS sites in Nevada. Only wells drilled previously for water supply or exploratory purposes are being used in the monitoring program. In compliance with the SDWA and a State of Nevada drinking water supply system permit, drinking water wells and industrial use distribution systems are sampled and analyzed on a monthly basis. Groundwater samples collected are analyzed for a standard suite of parameters and constituents, including radioactive materials, nonradioactive materials, hydrogen-ion concentration (pH), total dissolved solids (TDS) and other field parameters.

Groundwater under portions of NTS has been affected as a result of nuclear testing activities conducted during the last 43 years. Additionally, 20 percent of the tests have been conducted below the water table or have been close enough that effects have extended below it. Table 3.3.4–1 shows the groundwater quality at NTS.

Table 3.3.4–1. Groundwater Quality Monitoring at Nevada Test Site, 1993

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Potable Water Distribution System	
			High	Low
Alkalinity	mg/l	NA	270	64
Alpha (gross)	pCi/l	15[b]	11	0.62
Arsenic	mg/l	0.05[b]	0.012	<0.003[c]
Barium	mg/l	2.0[b]	0.15	0.00
Beta (gross)	pCi/l	50[d]	13	3.2
Chromium	mg/l	0.1[b]	<0.005[c]	<0.005[c]
Lead	mg/l	0.015[b]	<0.005[c]	<0.005[c]
Nitrate	mg/l	10[b]	6.8	1.2
pH	pH units	6.5-8.5[e]	8.66	7.70
Sodium	mg/l	NA	103	30
Total dissolved solids	mg/l	500[e]	639	283
Tritium	pCi/l	80,000[f]	120	0.93

[a] For comparison purposes only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] Below detection limit.
[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[e] National Secondary Drinking Water Regulations (40 CFR 143).
[f] DOE DCG for water (DOE Order 5400.5). DCG values are based on a committed effective dose of 100 mrem per year. However, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG.

Note: NA=not applicable.
Source: NT DOE 1994b.

Due to the past nuclear testing activities at NTS, radionuclide monitoring has been an important component of the groundwater monitoring program at the site. In general, tritium is the only radionuclide that appears in sampled water. Samples collected in 1993 show tritium concentrations ranging from 120 pCi/l (454 pCi/gal), in a non-potable supply well located in the northwestern part of NTS, to 0.93 pCi/l (3.5 pCi/gal), in a potable supply well located in the southeastern part of NTS. Subsurface migration of tritium to offsite areas is possible, but the probability of tritium reaching offsite wells or springs is minimal. It is also thought that the Lower and Upper Carbonate aquifers would most likely be the aquifers in which tritium might migrate to offsite areas.

Groundwater Availability, Use, and Rights. Groundwater is the only local source of industrial and drinking water supply in the NTS area. Numerous production wells are located on NTS and distributed among various areas of the site. Figure 3.3.4–2 shows how the NTS water system has been divided into four water service areas (A, B, C, and D) based on the location of the water supply system and support facilities. Water usage on NTS is largely for potable, construction, and dust control purposes. Water supply wells at NTS draw water from the Lower and Upper Carbonate, the Volcanic, and the Valley-Fill aquifers. The total water usage in 1994 was 2,400 million l/yr (634 million gal/yr), of which 1.3 million l/yr (343.3 million gal/yr) were withdrawn from the Ash Meadows Subbasin, and 1,100 million l/yr (290.5 million gal/yr) were withdrawn from the Alkali Flat Furnace Creek Ranch Subbasin (Figure 3.3.4–2). The pumping capacity for all the water supply wells at NTS is estimated at 14,800 million l/yr (3,900 million gal/yr) (NTS 1993a:6).

The State of Nevada strictly controls all surface and groundwater withdrawals. The Appropriation Doctrine governs the acquisition and use of water rights. However, it is an established principle that when land is withdrawn from public use and reserved for Federal purposes, the Government's right to associated water may be implied. NTS has been withdrawn from public use and thus possesses an unqualified water right sufficient to meet the purposes of the NTS land withdrawal, subject to water rights that existed at the time the land for NTS was withdrawn.

Since the Federal Government has not waived its sovereign immunity with respect to Nevada's well drilling laws, it is not subject to these requirements. While DOE Nevada Operation Office is not legally required to follow Nevada water appropriation and well drilling requirements, there is no objection to responding to requests for information and cooperating in other respects with the Nevada Division of Water Resources as a gesture of goodwill.

3.3.5 GEOLOGY AND SOILS

Geology. The NTS is located in the southern part of the Great Basin section of the Basin and Range physiographic province in an intermediate position between the high, topographically closed basins in central Nevada and the low, connected basins of the Amargosa Desert-Death Valley region to the southwest. NTS consists of three flats (Yucca, Jackass, and Frenchman) surrounded by mountains. Local geology is characterized by mountains of Precambrian and Paleozoic sedimentary rocks and Tertiary volcanic tuffs and lavas. Sedimentary rocks are complex, folded, and faulted carbonates in the upper and lower parts and shale and sandstone in the middle section. Volcanic rocks are predominantly Tertiary tuffs with some basalts and scattered granitic plutons. Potential geologic resources within the NTS boundaries include silver, gold, tungsten, molybdenum, zeolites, barite, and fluorite.

The general region has been tectonically active in the recent past and has numerous faults. NTS lies in an area of moderate historic seismic activity on the southern margin of the southern Nevada, East-West Seismic Belt in Seismic Zones 2 and 3, indicating that moderate-to-major damage could occur as a result of an earthquake (Figure 3.3.5–1). More than 4,000 earthquakes have been recorded within a 241-km (150-mi) radius of NTS. Most of these were minor events, with Richter magnitudes of less than 5.5 and MMIs that may correlate to maximum ground acceleration of 0.03 gravity (Figure 3.3.5–1). The largest seismic event on record took place 161 km (100 mi) west in Owens Valley, California, and had an estimated Richter magnitude of 8.3 (NT DOE 1988a:3-117). On June 29, 1992, an earthquake of magnitude 5.6 occurred in the southwest corner of the site under Little Skull Mountain (Figure 3.3.5–1). The maximum ground acceleration from this earthquake was approximately 0.21 g at Amargosa Valley.

The Yucca and Carpetbag Faults were active during the Late Quaternary, and both are considered to be capable faults by the definition outlined in 10 CFR 100, Appendix A. The Yucca Fault has undergone surface rupture within the past few thousand to tens-of-thousands of years. Some earthquakes can be directly associated with the fault trace and also beyond the south end of the mapped section in the Yucca Pass, suggesting that the fault may continue in that direction. No significant vertical surface displacement has occurred on the Carpetbag Fault system during the past 150,000 years, but there is evidence of episodes of fracturing and possible minor faulting from 30,000 to 240,000 years ago, with average recurrence interval of about 25,000 years for the last 125,000 years. The Carpetbag Fault has been mapped in the subsurface beyond the southern end of Yucca Basin and may project to the northeast. Possible magnitude, intensity, and acceleration of earthquakes along the Yucca and Carpetbag Faults have not been estimated.

The Cane Spring Fault does not show Holocene displacement but is thought to have been the source of a 4.3 Richter magnitude earthquake in 1971. The maximum credible earthquake associated with the Cane Spring Fault is expected to produce a peak acceleration of 0.67 g with a 6.7 Richter magnitude. The recurrence interval is estimated to be 10,000 to 30,000 years. The Cane Spring Fault extends to the southwest and is connected in the deep subsurface to a third capable fault, the Rock Valley Fault, which has been the epicenter for several earthquakes of Richter magnitudes between 3 and 4 since 1992.

The most recent volcanic activity in the immediate area was 0.3 million years ago, and the likelihood for renewed activity in the next 10,000 years is slight (NT LANL 1983a:7). NTS lies approximately 241 km (150 mi) southeast of the Long Valley area of California, an area of potential volcanic eruption of the Mount St. Helens type.

Soils. Soils at NTS include three major types: shallow soils developed in the uplands and mountains; soils on valley fill and nearly-level-to-moderately sloping outwash plains, alluvial fans, and fan aprons; and playas and soils on nearly level flats and basins. Possible erosion hazards range from slight to severe while the shrink-swell potential ranges from low to high for some of these soils. The potential for wind erosion and shrink-swell increases in the playas and basins. The potential for water erosion increases with increasing slope. The soils at NTS are considered acceptable for standard construction techniques.

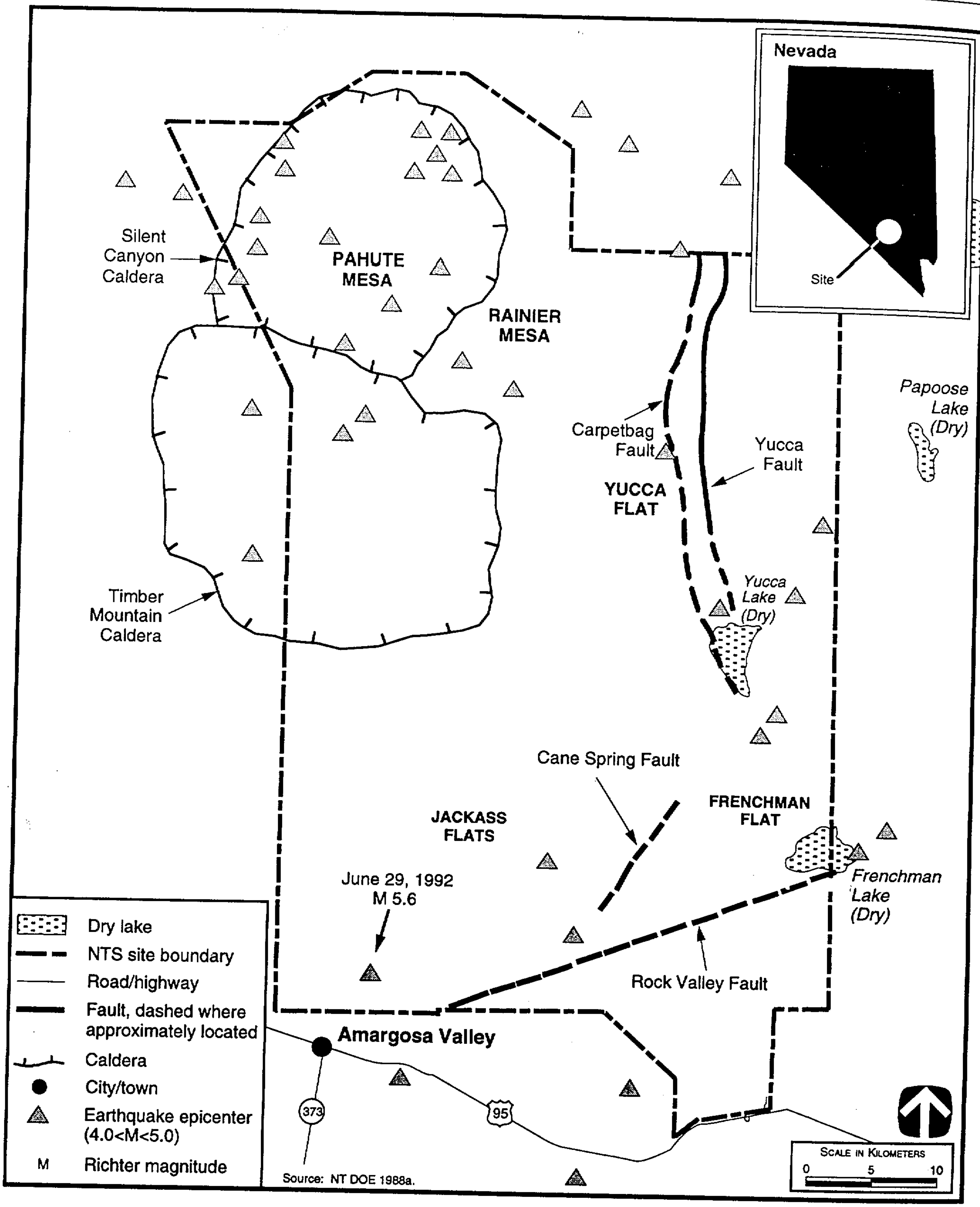


Figure 3.3.5–1. Major Fault Systems, Calderas, and Historic Earthquakes in the Nevada Test Site Region.

3.3.6 Biological Resources

Terrestrial Resources. The NTS lies in a transition area between the Mojave and Great Basin Deserts. As a result, flora and fauna that are characteristic of both deserts are found within the site boundaries (NT ERDA 1976a:34). Approximately 33 km^2 (12.7 mi^2) of NTS have been developed, which represents about 1 percent of the site; thus, natural plant communities are found across most of NTS (NT DOE 1988d:3,4,6,7). The site has been divided into nine major plant communities, as shown in Figure 3.3.6–1.

Of the plant communities present onsite, the mountains, hills and mesas, sagebrush, creosote bush, and hopsage-desert thorn communities are the most extensive. Saltbush and desert thorn communities occupy more limited areas adjacent to the playas in Frenchman and Yucca Flats. Introduced plants such as red brome, cheatgrass, and Russian thistle have become important species in some areas. These plants rapidly invade disturbed areas and delay revegetation by native species (NT Hunter 1991a:1 of abstract). A total of 711 taxa of vascular plants have been identified on or near NTS (NT ERDA 1976a:34).

Terrestrial wildlife found on NTS includes 33 species of reptiles, 222 species of birds, and 49 species of mammals (NT Greger 1992a; NTS 1990a:1; NTS 1990a:2). Species common to NTS include the side-blotched lizard, western shovel-nosed snake, black-throated sparrow, red-tailed hawk, Merriam's kangaroo rat, and Great Basin pocket mouse. Water holes, both natural and manmade, are important to many species of wildlife, including game animals such as pronghorn and mule deer (NT Greger nda). Hunting is not permitted anywhere on NTS. Raptors such as the turkey vulture and rough-legged hawk, and carnivores such as the long-tailed weasel and bobcat, are two ecologically important groups on NTS. A variety of migratory birds has been found at NTS. Migratory birds, as well as their nests and eggs, are protected by the *Migratory Bird Treaty Act*. Eagles are similarly protected by the *Bald and Golden Eagle Protection Act*.

Vegetative cover in the area of Frenchman Flat proposed for the consolidated Pu storage facility (which is also the assumed analysis site for a number of disposition alternatives) falls primarily within the creosote bush community (Figure 3.3.6–1). Fauna found in this area would be expected to be closely associated with Mojave desert fauna, and species could include the banded gecko, desert iguana, Gambel's quail, greater roadrunner, round-tailed ground squirrel, and cactus mouse. Vegetation within the alternative consolidated Pu storage facility site (P-Tunnel location) falls within the mountains, hills, and mesas and blackbrush communities. Fauna found in this more northerly location would be most closely associated with Great Basin desert fauna. Animal species present could include the sagebrush lizard, western skink, Great Basin pocket mouse, and Great Basin kangaroo rat (NT ERDA 1976a:47,48,56).

Wetlands. The NWI maps of NTS have not been prepared nor have wetlands been delineated on the site. However, small wetland areas (less than 0.4 ha [1 acre]) may be associated with NTS springs (NTS 1992a:5). There are no known wetlands in either of the proposed storage facility sites.

Aquatic Resources. Potential aquatic habitat on NTS includes surface drainages, playas, springs, and manmade reservoirs. There are no continuously flowing streams on the site and permanent surface water sources are limited to a few small springs. These surface drainages, playas, and springs are unable to support permanent fish populations (DOE 1995w:2.4-61,2.4-62). Manmade water reservoirs located throughout the site support three introduced species of fish: bluegill, goldfish, and golden shiners (NTS 1992a:6). There are no known aquatic resources in either of the proposed storage facility sites.

Threatened and Endangered Species. There are nine federally and State-listed threatened, endangered, and other special status species found in the vicinity of NTS. Eight of these are federally or State-listed as threatened or endangered or protected under State law (Table 3.3.6–1). Eight species listed in Table 3.3.6–1 have been observed on NTS. Once specific project locations have been determined, site surveys will verify the presence of special status species. No critical habitat for threatened or endangered species, as defined in the ESA (50 CFR 17.11; 50 CFR 17.12), exists on NTS.

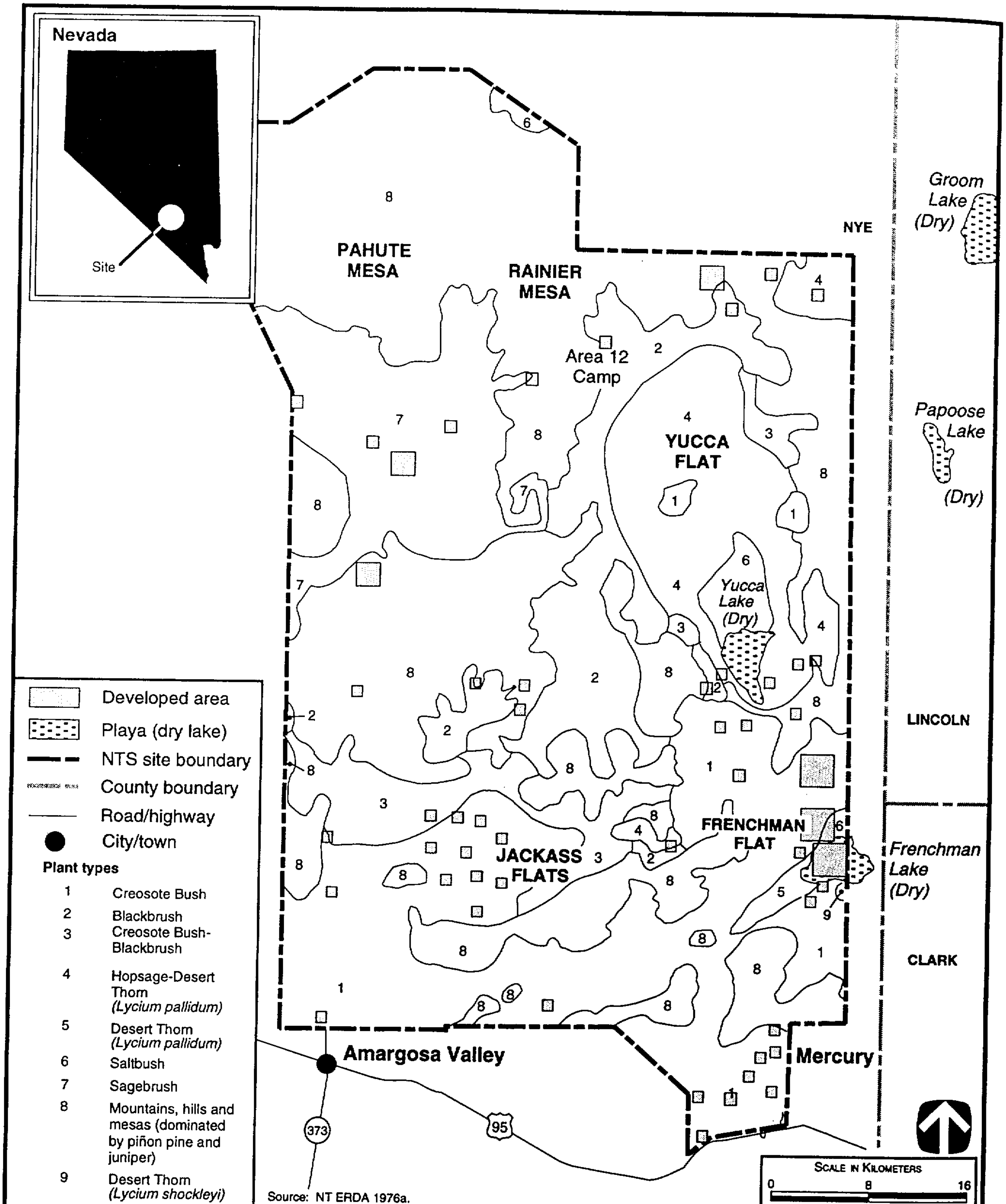


Figure 3.3.6–1. Distribution of Plant Communities at Nevada Test Site.

Table 3.3.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Nevada Test Site

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammal			
[Text deleted.]			
Spotted bat[b]	*Euderma maculatum*	NL	T
[Text deleted.]			
Birds			
American peregrine falcon[c,d]	*Falco peregrinus anatum*	E	T
Arctic peregrine falcon[c]	*Falco peregrinus tundrius*	E(S/A)	T
Bald eagle[b,d]	*Haliaeetus leucocephalus*	T	T
[Text deleted.]			
Mountain plover[b]	*Charadrius montanus*	C	NL
[Text deleted.]			
Reptiles			
[Text deleted.]			
Desert tortoise[b,e]	*Gopherus agassizii*	T	T
Fish			
Devils Hole pupfish[d,f]	*Cyprinodon diabolis*	E	E
Plants			
[Text deleted.]			
Beatley milkvetch[b]	*Astragalus beatleyae*	NL	CE
[Text deleted.]			
Mojave fishhook cactus[b]	*Sclerocactus polyancistrus*	NL	CY
[Text deleted.]			

[a] Status codes: C=Federal candidate; CE=critically endangered by authority of NRS 527.270 (State Division of Forestry); CY=protected by authority of NRS 522.60–.120 (Nevada Cacti and Yucca Law); E=endangered; NL=not listed; S/A=protected under the similarity of appearances provision of the ESA; T=threatened.
[b] Species recorded on NTS.
[c] Peregrine falcon seen on NTS; however not identified to subspecies level.
[d] USFWS Recovery Plan exists for this species.
[e] Species known to occur on the proposed new consolidated storage facility site.
[f] Only known location of this species is outside the NTS 48.3 km southwest of the proposed new consolidated storage facility site. This species is included here due to offsite groundwater concerns.
Note: Nevada Department of Wildlife is currently revising the state threatened and endangered species list.
Source: 50 CFR 17.11; 50 CFR 17.12; 61 FR 7596; DOE 1995w; NT DOE 1995j; NT DOE 1996c; NT DOI 1995a; NT ERDA 1976a; NV FWS 1989a; NV NHP 1995a.

The federally and State-listed peregrine falcon and bald eagle are considered rare migrants to NTS. The threatened desert tortoise is the only resident species known to inhabit NTS that is protected under ESA. The range of the desert tortoise lies in the southern third of the site (Figure 3.3.6–2). The abundance of tortoises on NTS is considered low to very low relative to other areas within this species' geographic range. Densities of tortoises on NTS range from 0 to 17 individuals per square kilometer (0 to 45 individuals per square mile), with most habitats probably having densities of 0 to 8 individuals per square kilometer (0 to 20 individuals per square mile) (NT DOE 1991b:3-23). The only known population of the Devils Hole pupfish lives in Devils Hole, a water-filled limestone cavern in Ash Meadows, approximately 48 km (29.8 mi) southwest of NTS. There is concern over the survival of the pupfish and other sensitive species found in the Ash Meadows area due to the threat of declining water levels (NT DOI 1991a:1,4-6; NT ERDA 1977a:2-134,2-135,4-28,4-29).

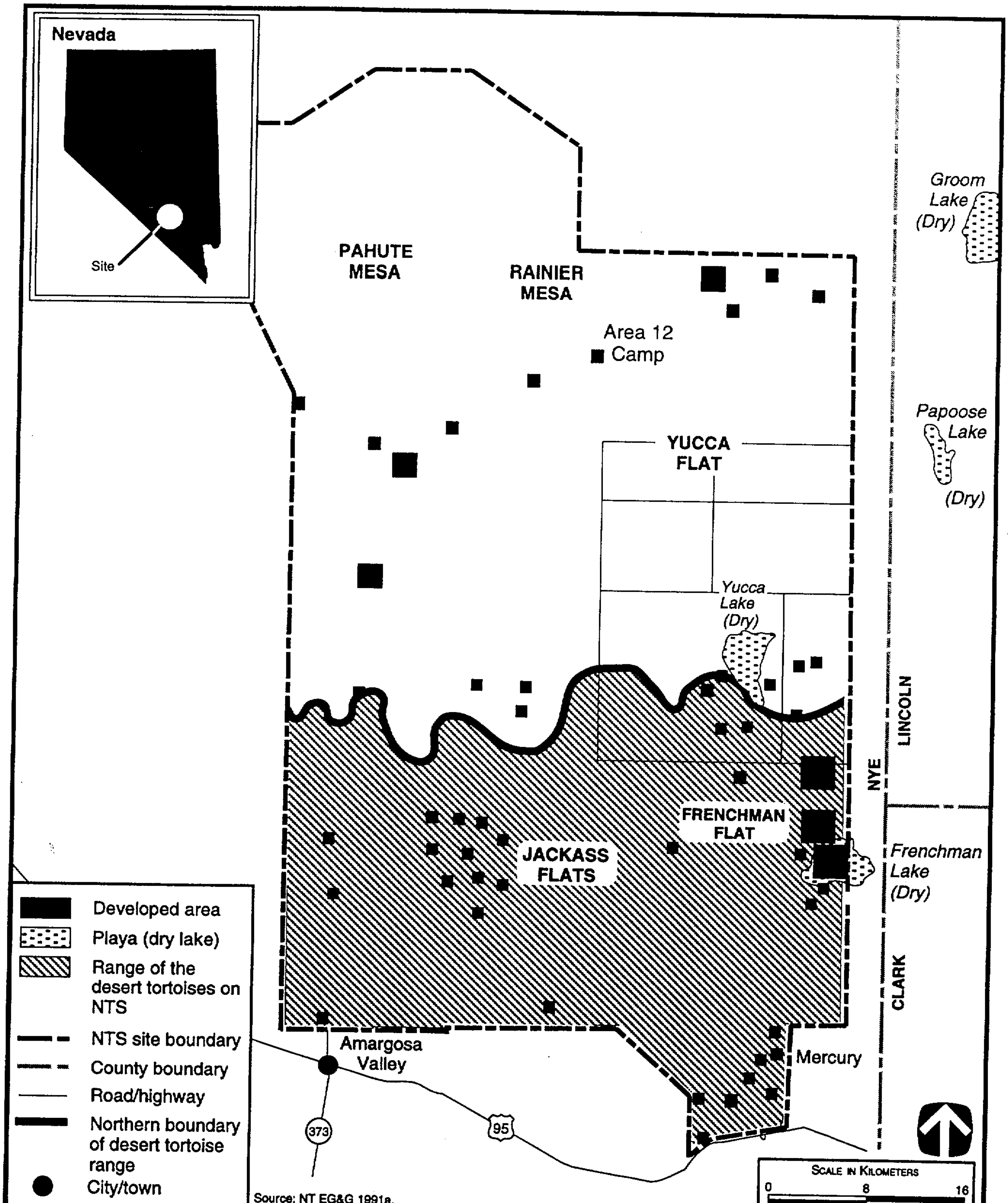


Figure 3.3.6–2. Distribution of Desert Tortoise at Nevada Test Site.

Table 3.3.6–1 identifies two State-protected plant species at NTS. [Text deleted.] The Federal-candidate mountain plover is a migrant species that has also been observed onsite. Although their distribution is unclear, the spotted bat has been recorded on NTS (Table 3.3.6–1).

The area within Frenchman Flat proposed for storage facilities (which is also the assumed analysis site for a number of disposition alternatives) is within the range of the desert tortoise. Both tortoise remains and scat have been observed in the proposed site area (NT EG&G 1991a:14,15,31). The alternate storage facility location (P-Tunnel project location) lies far north of the desert tortoise range. Occurrence of other special status species around the proposed project locations is unknown.

3.3.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

Prehistoric Resources. [Text deleted.] Prehistoric site types identified on NTS include habitation sites with wood and brush structures, windbreaks, rock rings, and cleared areas; rockshelters; petroglyphs (rock art); hunting blinds; rock alignments; quarries; temporary camps; milling stations; roasting ovens or pits; water caches; and limited activity locations. Milling stations are especially prevalent near the Yucca Lake playa margins. Several prehistoric rockshelters have been identified on Hogback Ridge. Approximately 6 percent of NTS has been inventoried for cultural resources. This includes all lands managed through a Memorandum of Agreement with Nellis Air Force Base. Excluding sites in the Yucca Mountain project area, approximately 1,600 prehistoric sites have been recorded. Hundreds of prehistoric sites have been identified in both Yucca Flat and Frenchman Flat; some of which may be eligible for listing on the NRHP. Additional prehistoric sites may occur in unsurveyed portions of NTS.

Historic Resources. Historic site types on NTS include mines and prospects, trash dumps, settlements, campsites, ranches, homesteads, developed spring heads, roads, trails, and nuclear weapons development sites. Historic resources associated with nuclear testing are common in both Yucca and Frenchman Flats. Nuclear test site structures and associated debris, including instrumentation stands and temporary storage bunkers, are also located within NTS. The test site area at Frenchman Flat, which includes the remains of many of these structures, has been recommended to the SHPO as a historic district. Excluding the Yucca Mountain project area, over 60 historic sites have been recorded. The only site currently listed on the NRHP is Sedan Crater. The crater was created in 1962 as part of the Plowshare Program, whose aim was to identify peaceful uses for nuclear explosions. It is located in Yucca Flat. The Emigrant Trail used by the "49ers" that traverses the southwestern corner of NTS is considered eligible for inclusion on the NRHP. Additional historic sites may occur in unsurveyed portions of NTS.

Native American Resources. The lands and resources of NTS have held an important place in the lives of Native Americans for centuries, and the area has been used continuously by many tribes. At the time of European-American contact, southern Nevada was inhabited by the Western Shoshone and the Southern Pahute. These peoples lived together in small groups from the spring through the fall. During winter, villages composed of several families were established in warmer places, close to preserves of pine nuts, seeds, and dried meats. Groups came to NTS from a broad region during the hunting season and relied on both animal and plant resources there that were crucial for their survival and cultural practices.

The NTS contains numerous ceremonial resources and power places that are critical for the continuation of Native American culture, religion, and society. Until the mid-1900s, traditional festivals involving religious and secular activities attracted Native American people to the area from as far as western California. There are numerous resources at NTS that are important to Native American groups. These resources include burials, ceremonial sites, musical stones, medicine rocks, petroglyphs, and traditional use areas. Local plants important in ritual and ceremonial activities include jimsonweed, juniper, greasewood, creosote, Indian tobacco, piñon pine, buckbush, and scrub oak. Concern has been expressed about the availability and accessibility of such resources.

Consultation with Native American cultural and religious leaders has been conducted for other projects at or near NTS to identify traditional cultural resources that may be affected by Federal actions and to obtain Native American recommendations for mitigating potential impacts on traditional cultural resources. DOE has established ongoing consultation with 17 Native American tribal organizations that have cultural ties to NTS. According to the American Indian Writers Subgroup of the Consolidated Group of Tribes and Organizations (CGTO), despite the loss of some traditional lands to pollution and reduced access, the Native American people have neither lost their ancestral ties to nor have forgotten their cultural resources on NTS. There is continuity in the Native American use of and broad cultural ties to NTS. Native American people continue to value and recognize the central role of these lands in their continued survival (NT DOE 1996c:4-162).

Paleontological Resources. The surface geology of NTS is characterized by alluvium-filled valleys surrounded by ranges composed of Precambrian and Paleozoic sedimentary rocks and Tertiary volcanic tuffs and lavas. The Precambrian and Paleozoic rocks at NTS represent relic deposits made in shallow water at the submerged edge of a continental platform that ran from Mexico to Alaska and existed throughout most of the Paleozoic. Although the Precambrian sedimentary deposits contain no fossils or only a few poorly preserved fossils, the Paleozoic marine limestones are moderately to abundantly fossiliferous. Marine fossils found in the same Paleozoic formations on Nellis Air Force Range, adjacent to NTS to the north, include trilobites, conodonts, ostracods, solitary and colonial corals, brachiopods, algae, gastropods, and archaic fish. These fossils, however, are relatively common and have low research potential.

Tertiary volcanic deposits are not expected to contain fossils; however, the Late Pleistocene terrestrial vertebrate fossils of the Rancholabrean Land Mammal Age could be expected in the Quaternary deposits. The possibility of finding mammoth, horse, camel, and bison remains might be expected because such fossils have been found at Tule Springs, 56 km (35 mi) from the southern edge of NTS, and in Nye Canyon. Fossils found at Tule Springs include bison, deer, a small donkey-like horse, camel, Columbia mammoth, ground sloth, giant jaguar, bobcat, coyote, muskrat, and a variety of rabbits, rodents, and birds. This paleontological assemblage has high research potential. Although no known fossil localities have been recorded to date, Quaternary deposits with paleontological materials may occur on NTS. Other Pleistocene resources include pack rat middens, which are studied by scientists at the University of Nevada, Reno, the Desert Research Institute, and the New Mexico Institute of Mines and Technology to investigate paleoclimatic regimes.

3.3.8 SOCIOECONOMICS

Socioeconomic characteristics described for NTS include employment, regional economy, population, housing, community services, and local transportation. Statistics for employment and regional economy are presented for the REA that encompasses 11 counties surrounding NTS in Nevada, Arizona, and Utah (Table L.1–1). Statistics for population, housing, community services, and local transportation are presented for the ROI, a two-county area in which 97 percent of all NTS employees reside: Clark County (82 percent) and Nye County (15 percent). In 1991, NTS employed approximately 7,700 persons (2.1 percent of the total REA employment) (Table L.1–3). [Text deleted.]

Regional Economy Characteristics. Selected employment and regional economy statistics for the REA are summarized in Figure 3.3.8–1. The civilian labor force in the REA increased approximately 64 percent between 1980 and 1990, reaching 506,394 in the latter year. Total employment in the REA was 587,533 in 1994. In that year, the regional unemployment rate in the REA was 6.1 percent, comparable to the rate in Arizona (6.4 percent) and Nevada (6.2 percent), but much higher than the rate in Utah (3.7 percent). The 1993 per capita income in the REA was $20,561, lower than Nevada's per capita income of $22,727, but higher than the per capita income in Arizona or Utah, $18,085 and $16,354, respectively.

Employment patterns in the REA parallel those in Arizona, Nevada, and Utah, with manufacturing, retail trade, and service providing the majority of nonfarm private sector jobs. The service sector is the primary source of employment in both the REA and Nevada providing 43.5 percent and 43.4 percent of jobs, respectively. This sector is less dominant in Arizona and Utah, accounting for 30.2 percent and 28.6 percent of total employment in those states, respectively.

Population and Housing. Population and housing trends in the ROI are summarized in Figure 3.3.8–2. Population in the ROI increased 103.4 percent between 1980 and 1994, reaching 960,088 at the end of the period. This rate of increase surpassed Nevada's population growth of 82.0 percent during the same period.

The total number of housing units in the ROI also increased significantly between 1980 and 1990, increasing by 65.9 percent compared to a 52.6 percent increase within Nevada. In 1990, homeowner and renter vacancy rates in the NTS ROI were similar to those in Nevada, approximately 2 percent and 9 percent, respectively.

Community Services. Community services described for the NTS ROI are education, public safety, and health care. Figure 3.3.8–3 presents school district characteristics for the NTS ROI, and Figure 3.3.8–4 presents public safety and health care characteristics.

Education. Two school districts provide public education services and facilities in the NTS ROI. During the 1994-95 school year, the Nye County School District had an enrollment of 4,170 students while the Clark School District had an enrollment of 156,348 students. The two school districts operated at 85 and 100 percent of capacity, respectively, as shown in Figure 3.3.8–3. The average student-to-teacher ratio in the ROI was 19.6:1.

Public Safety. Five city and county law enforcement agencies provide police protection in the ROI. In 1994, the highest ratio of sworn officer-to-population in the two-county region was in Nye County, with 3.3 officers per 1,000 persons. The average ROI officer-to-population ratio was 2.0 officers per 1,000 persons. [Text deleted.]

During 1995, a total of 1,505 regular and volunteer firefighters provided fire protection services to the ROI. The rural county departments include both professional and volunteer staff, while the city districts are exclusively professional. Among the firefighting departments, the Nye County Fire Department has the highest firefighter-to-population ratio with 6.1 firefighters per 1,000 persons, although most of the firefighters are

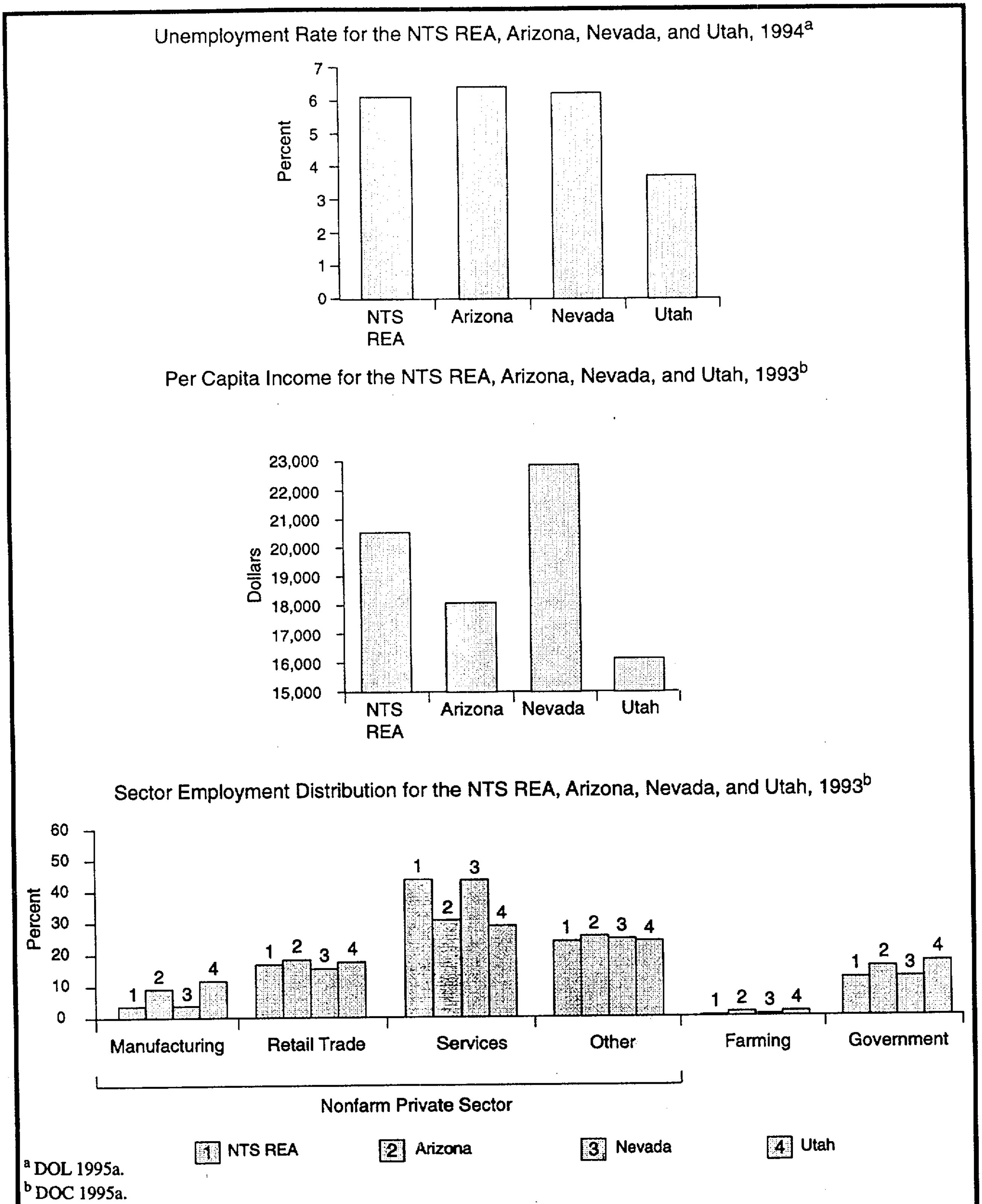


Figure 3.3.8–1. Employment and Local Economy for the Nevada Test Site Regional Economic Area and the States of Arizona, Nevada, and Utah.

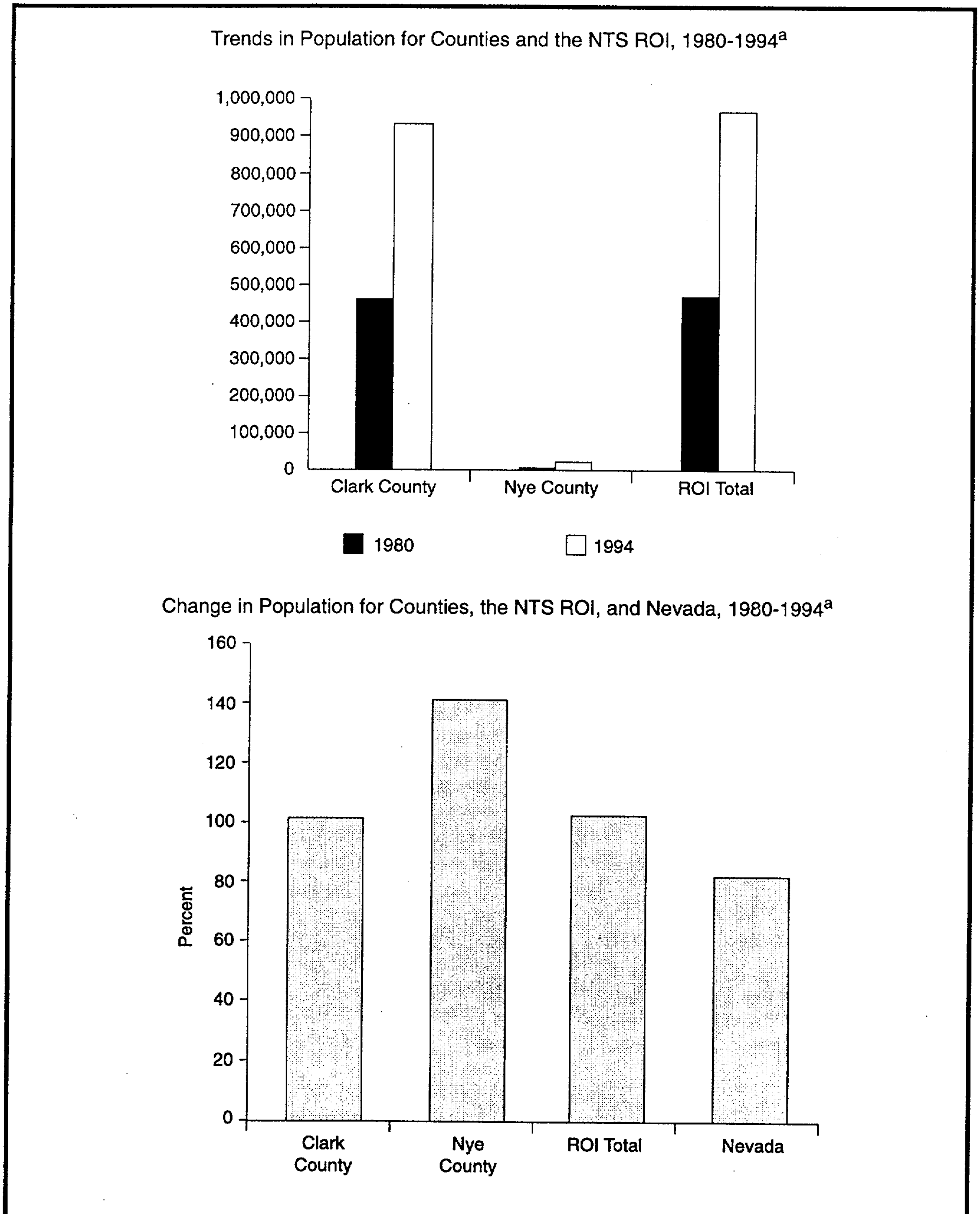
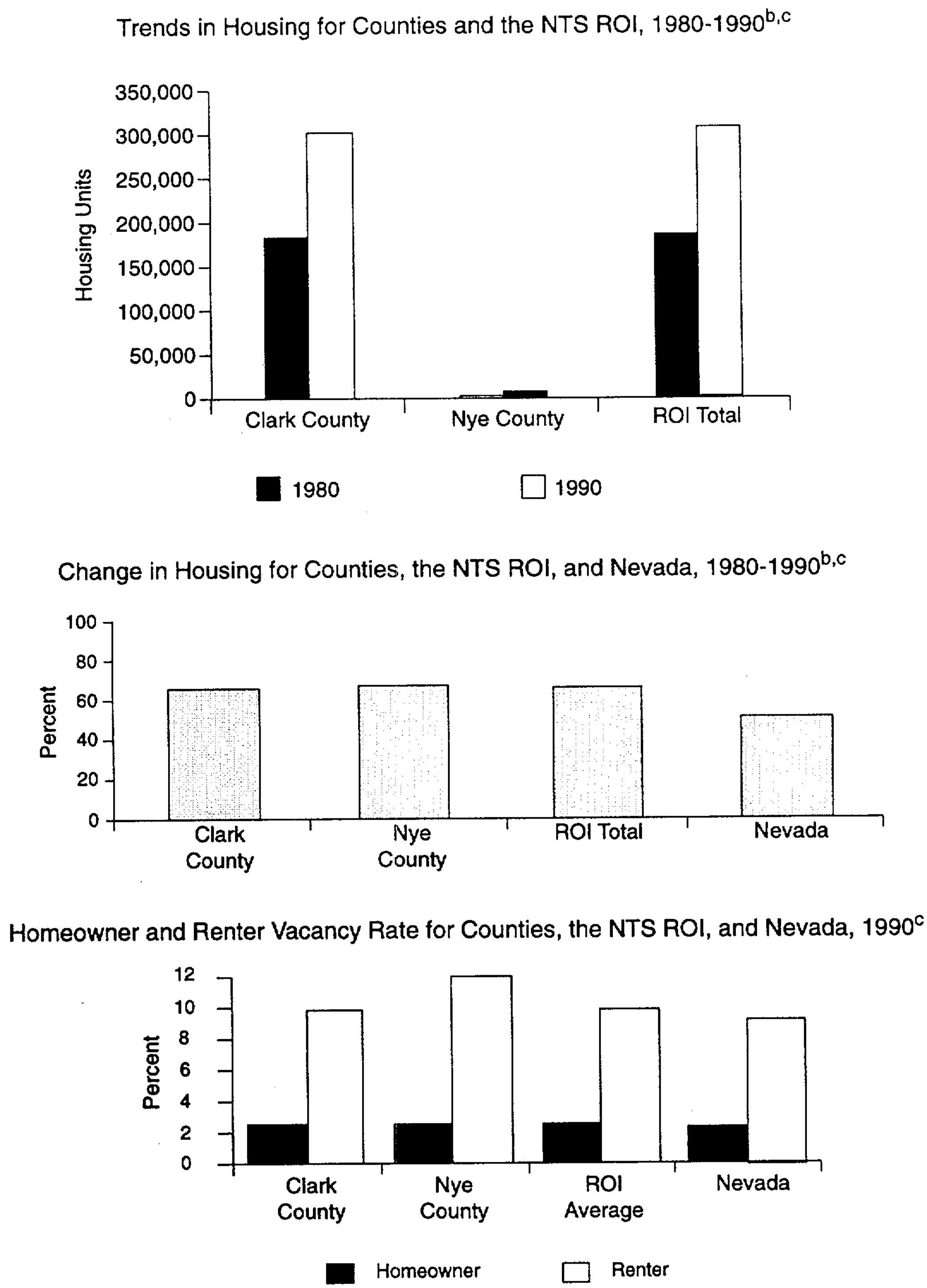
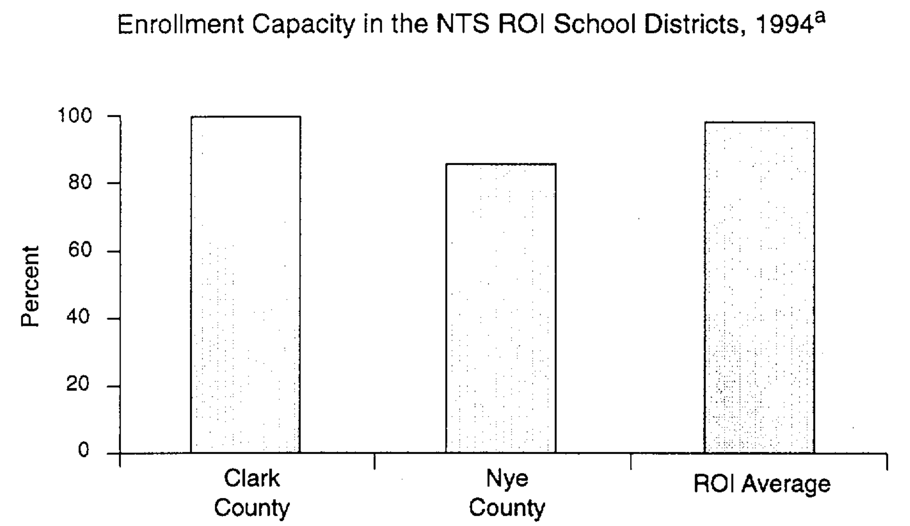


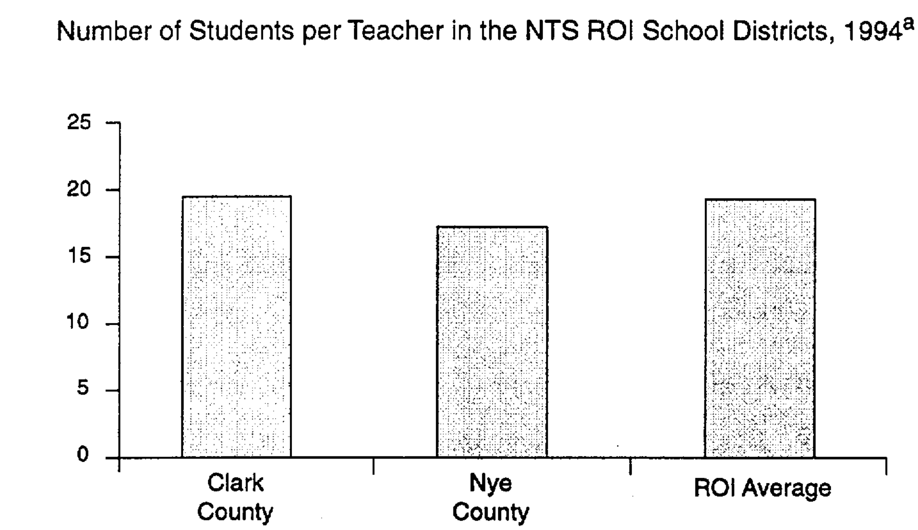
Figure 3.3.8–2. Population and Housing for the Nevada Test Site Region of Influence and the State of Nevada.



[a] Census 1994o; Census 1995a.
[b] Census 1982a.
[c] Census 1991g.

Figure 3.3.8–2. Population and Housing for the Nevada Test Site Region of Influence and the State of Nevada—Continued.

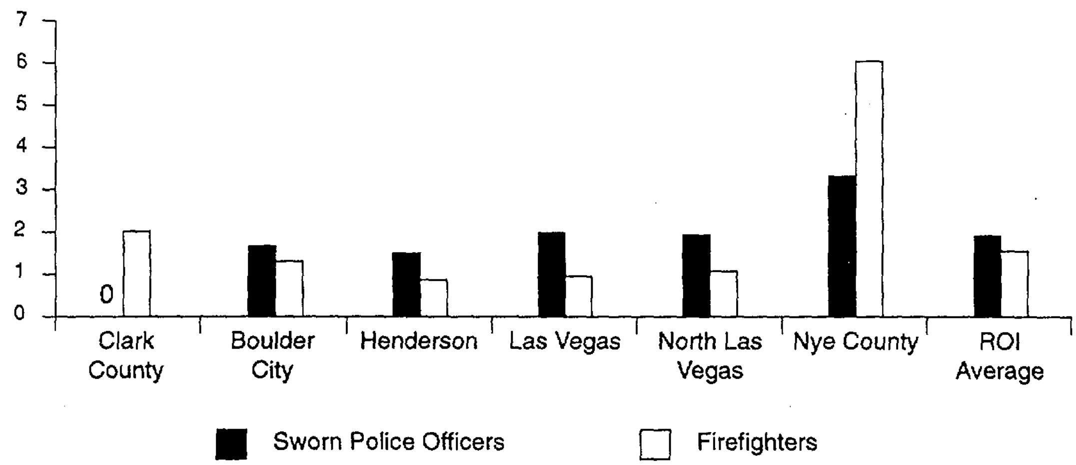




[a] Socio 1996a.

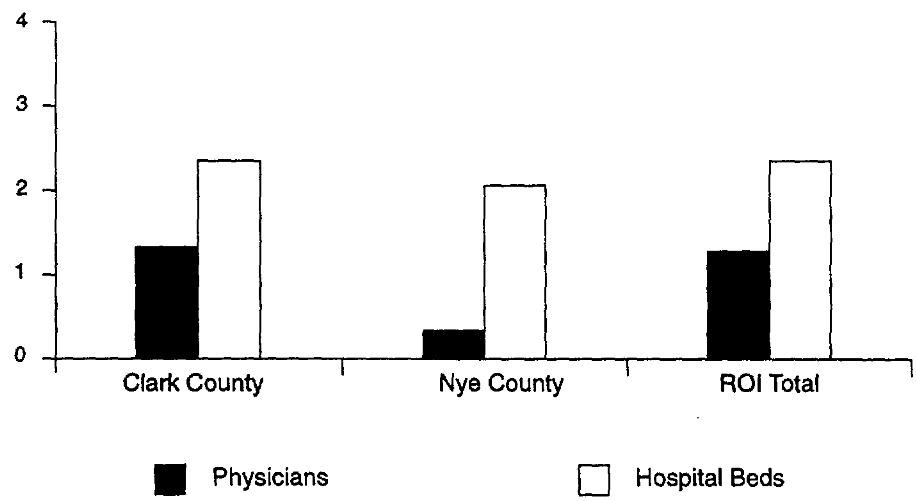
Figure 3.3.8–3. School District Characteristics for the Nevada Test Site Region of Influence.

Number of Sworn Police Officers (1994) and Firefighters (1995) per 1,000 Persons in the NTS ROI[a]



Note: Non-ROI city values are included in county totals. The Las Vegas police force also serves unincorporated Clark County.

Number of Physicians and Hospital Beds per 1,000 Persons in the NTS ROI, 1994[b]



[a] Census 1995a; DOC 1996a; DOC 1996b; DOJ 1995a; Socio 1996a.
[b] AHA 1995a; AMA 1995a; Census 1995a.

Figure 3.3.8–4. Public Safety and Health Care Characteristics for the Nevada Test Site Region of Influence.

volunteers (Figure 3.3.8–4). [Text deleted.] The average ROI firefighter-to-population ratio was 1.6 firefighters per 1,000 persons.

Health Care. Nine hospitals serve the two-county region, all operating well below capacity. In 1994, a total of 1,244 physicians served the ROI. Figure 3.3.8–4 shows that the physician-to-population ratio ranged from 0.3 physicians per 1,000 persons in Nye County to 1.3 physicians per 1,000 persons in Clark County. The ROI average physician-to-population ratio was 1.3 physicians per 1,000 persons. The hospital bed-to-population ratio ranged from 2.1 beds per 1,000 persons in Nye County to 2.4 beds per 1,000 persons in Clark County.

Local Transportation. Vehicular access to NTS is provided by U.S. Route 95 to the south (see Figure 2.2.2–1 and Figure 2.2.2–2). [Text deleted.] Road segments providing access to NTS experience little traffic congestion outside of the Las Vegas metropolitan area. There are no current or planned road improvement projects that would affect access to NTS (NV DOT 1995a:1).

Two road segments in the ROI could be affected by the storage and disposition alternatives. The first is U.S. 95 from Business Route U.S. 95 to just south of Nevada State Route 160. This segment operated at level of service A in 1995. The second is U.S. 95 from just south of Nevada State Route 160 to just south of Nevada State Route 266. This segment operated at level of service C in 1995.

Although there is no public transportation system serving NTS, a contract bus service for workers is available at a nominal cost. The major railroad in the ROI is the Union Pacific Railroad located approximately 80 km (50 mi) east of NTS near Las Vegas. There are no navigable waterways within the ROI.

McCarran International Airport in Las Vegas provides jet air passenger and cargo service from both national and local carriers. Numerous smaller private airports are located throughout the ROI.

3.3.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Radiation Environment. Major sources and levels of background radiation exposure to individuals in the vicinity of NTS are shown in Table 3.3.9–1. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population changes as the population size changes. Background radiation doses are unrelated to NTS operations.

Table 3.3.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Nevada Test Site Operation

Source	Effective Dose Equivalent (mrem/yr)
Natural Background Radiation	
Cosmic and external terrestrial radiation[a]	74
Internal terrestrial radiation[b]	39
Radon in homes (inhaled)[b]	200
Other Background Radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	378

[a] Derived from information on cosmic and terrestrial radiation given in EPA 1981b.
[b] NCRP 1987a.
Note: Value for radon is an average for the United States.

Releases of radionuclides to the environment from NTS operations provide another source of radiation exposure to individuals in the vicinity of NTS. Types and quantities of radionuclides released from NTS operations in 1993 are listed in the *U.S. Department of Energy Nevada Operations Office Annual Site Environment Report–1993* (DOE/NV/11432-123). The doses to the public resulting from these releases are presented in Table 3.3.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1993 report were used in the development of the reference environment's (No Action) radiological releases and resulting impacts at NTS in the year 2005 (Section 4.2.2.9).

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (Section M.2.1.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from NTS operations in 1993 is estimated to be 2.4×10^{-9}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of NTS operations is about 2 chances in 1 billion. (Note that it takes several to many years from the time of radiation exposure for a cancer to manifest itself.)

Based on the same risk estimator, 6×10^{-6} excess fatal cancers are projected in the population living within 80 km (50 mi) of NTS from normal operations in 1993. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this national rate, the number of fatal cancers expected during 1993 from all causes in the population living within 80 km (50 mi) of NTS was 44. This number of expected fatal cancers is much higher than the estimated 6×10^{-6} fatal cancers that could result from NTS operation in 1993.

Table 3.3.9–2. Radiation Doses to the Public From Normal Nevada Test Site Operation in 1993 (Committed Effective Dose Equivalent)

Members of the General Public	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual	Standard[a]	Actual	Standard[a]	Actual
Maximally exposed individual (mrem)	10	0.0048	4	0	100	0.0048
Population within 80 km[b] (person-rem)	None	0.012	None	0	100	0.012
Average individual within 80 km[c] (mrem)	None	5.5×10^{-4}	None	0	None	5.5×10^{-4}

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the CAA, the 4 mrem/yr limit is required by the SDWA, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (see 58 FR 16268). If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.

[b] In 1993, this population was approximately 21,750.

[c] Obtained by dividing the population dose by the number of people living within 80 km of the site.

Source: NT DOE 1994b.

The NTS workers receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. Table 3.3.9–3 presents the average worker, maximally exposed worker, and total cumulative worker dose to NTS workers from operation in 1992. These doses fall within radiological regulatory limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (Section M.2.1.2), the number of fatal cancers to NTS workers from normal operation in 1992 is estimated to be 0.0008.

Table 3.3.9–3. Radiation Doses to Workers From Normal Nevada Test Site Operation in 1992 (Committed Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual
Average worker (mrem)	ALARA	2.6
Maximally exposed worker (mrem)	5,000	750
Total workers[b] (person-rem)	ALARA	2

[a] DOE's goal is to maintain radiological exposure as low as reasonably achievable.

[b] The number of badged workers in 1992 was approximately 780.

Source: 10 CFR 835; DOE 1993n:7.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *U.S. Department of Energy Nevada Operations Office Annual Site Environment Report–1993* (DOE/NV/11432-123). The concentrations of radioactivity in various environmental media (including air and water) and in animal tissue in the site region (onsite and offsite) are also presented in the same document.

Chemical Environment. The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in

contact (for example, soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in Section 3.3.3.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (for example, air emissions and NPDES permit requirements), contribute toward minimizing potential health impacts to the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at NTS via inhalation of air containing hazardous chemicals released to the atmosphere by NTS operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous chemicals and their applicable standards are included in the data presented in Section 3.3.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Section M.3.

Exposure pathways to NTS workers during normal operations may include inhaling the workplace atmosphere and direct contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. NTS workers are also protected by adherence to OSHA and EPA standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that reflects the frequency and amounts of chemicals utilized in the operation processes ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm. Therefore, worker health conditions at NTS are expected to be substantially better than required by standards.

Health Effects Studies. The epidemiologic studies on groups surrounding NTS have concentrated on health effects in soldiers and children associated with nuclear testing rather than operation emissions. Results are contradictory regarding the observed leukemia incidence and deaths in exposed children, with some studies reporting excess, whereas others report no excess. Analytical methods used in some of these studies were questionable. For soldiers, the results regarding leukemia and polycythemia vera differ from two studies relating to nuclear test explosions. However, reanalyses showed leukemia, respiratory, and other cancers to be associated only with exposure to higher doses (for example, more than 300 millirem [mrem] for leukemia cases). For a more detailed description of the study findings reviewed, refer to Section M.4.3.

Accident History. Nuclear testing began at NTS in 1951. There were some 100 atmospheric nuclear explosions before the Limited Test Ban Treaty was implemented in 1963. Since then, all nuclear tests have been conducted underground.

Since 1970, there have been 126 nuclear tests, which resulted in a release to the atmosphere of approximately 54,000 Curies (Ci) of radioactivity. Of this amount, 11,500 Ci were accidental due to containment failure (massive releases or seeps) and late-time seeps (small releases after a test when gases diffuse through pore spaces of the overlying rock). The remaining 42,500 Ci were operational releases. From the perspective of human health risk, if the same person had been standing at the boundary of NTS in the area of maximum concentration of radioactivity for every test since 1970, that person's total exposure would be equivalent to 32 extra minutes of normal background exposure, or the equivalent of one-thousandth of a single chest x ray (OTA 1989a:4,5). [Text deleted.]

Emergency Preparedness. Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response.

The *NTS Emergency Preparedness Plan* is designed to minimize or mitigate the impact of any emergency upon the health and safety of employees and the public. The plan integrates all emergency planning into a single entity to minimize overlap and duplication and to ensure proper responses to emergencies not covered by a plan or directive. The manager of the DOE Nevada Operations Office has the responsibility to manage, counter, and recover from an emergency occurring at NTS.

The plan provides for identification and notification of personnel for any emergency that may develop during operational and nonoperational hours. The Nevada Operations Office receives warnings, weather advisories, and any other communications that provide advance warning of a possible emergency. The plan is based upon current DOE Nevada Operations Office vulnerability assessments, resources, and capabilities regarding emergency preparedness.

3.3.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory structure and ongoing waste management activities for NTS. A more detailed discussion of the ongoing waste management operations is provided in Section E.2.2. Table 3.3.10–1 presents a summary of waste management activities at NTS for 1993.

The Department is working with Federal and State regulatory authorities to address compliance and cleanup obligations rising from its past operations at NTS. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements and financial penalties for nonachievement of agreed-upon milestones.

The Department has decided that underground testing areas should be governed pursuant to the provisions of CERCLA. Preliminary Assessment/Site Investigation Reports and a Hazardous Ranking System package were provided to the EPA for use in determining whether or not NTS should be included on the NPL. In May 1993, the State of Nevada issued a letter to DOE indicating it did not appear that EPA would make a decision on the NPL status of the NTS in the near future. DOE has published the *NTS Site Treatment Plan* and *Federal Facility Compliance Act Consent Order* addressing environmental restoration and waste management on NTS. A mutual consent agreement between the State of Nevada and DOE, updated in June 1995, permits NTS to use the available capacity of the TRU Waste Storage Pad for the storage of onsite generated mixed waste that does not meet RCRA land disposal provisions.

The DOE Nevada Operations Office completed a waste minimization plan for NTS in 1991 and created an organization whose mission is to promote waste minimization and pollution prevention and to ensure compliance with DOE requirements. NTS currently generates waste from ongoing operations and remediation associated with past activities and receives waste from other DOE facilities. NTS manages the following waste categories: TRU, low-level, mixed, hazardous, and nonhazardous. A discussion of the waste management operations associated with each of these categories follows.

Spent Nuclear Fuel. The NTS does not generate or manage spent nuclear fuel.

High-Level Waste. The NTS does not generate or manage HLW.

Transuranic Waste. From 1974 to 1990, 612 m^3 (800 cubic yards [yd^3]) of mixed TRU waste was received from LLNL and is stored on an 8,300-m^2 (89,300-ft^2) asphalt storage pad at Area 5 of NTS (NT REECO 1995a:21). DOE and the State of Nevada signed a Settlement Agreement and NTS received a RCRA Part B Permit in July, 1992, allowing the DOE Nevada Operations Office to retain this inventory of mixed TRU waste subject to an appropriate permitting process. None of these waste packages are WIPP-certified. They will have to be certified before shipment to WIPP depending on decisions made in the ROD associated with the supplemental EIS being prepared for the proposed continued phased development of WIPP for disposal of TRU waste. These wastes have been moved to a 1,995-m^2 (21,470-ft^2) polyvinyl chloride-coated polyester fabric-covered building for storage until WIPP is determined to be a suitable disposal facility pursuant to the requirements of 40 CFR 191 and 40 CFR 268 (NT DOE 1996b:BV-38). If WIPP is suitable, this mixed TRU waste will not have to be treated before disposal. NTS has areas of Pu-contaminated soil for which treatment technology is being developed. This activity may produce additional volumes of TRU or mixed TRU waste.

Low-Level Waste. In eight areas at NTS, LLW has been generated and disposed of, but currently only Areas 3 and 5 are active for disposal. Bulk waste is disposed of in Area 3, and packaged classified and unclassified waste is disposed of in Area 5. Disposal of onsite waste began in 1971, and in 1978 operations expanded to receive wastes generated offsite. In 1995, 15 generators shipped LLW to NTS for disposal. An additional 9 generators are applying or awaiting for approval (NT DOE 1996c:4-48,4-49). As of September 1994, approximately 300,000 m^3 (392,000 yd^3) in Area 3 (NT DOE 1996c:4-33) and, as of December 1993, approximately

Table 3.3.10–1. Waste Management Activities at Nevada Test Site

Category	1993 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Transuranic[a]	None	None	None	Containers on covered asphalt pad	612[b]	None–WIPP or alternate facility in the future	NA
Low-Level							
Liquid	Included in solid	None	None	None	None	None	None[c]
Solid	178[d]	None	None	None	None	Shallow burial and greater confinement	500,000[e]
Mixed Low-Level							
Liquid	None	None	None	Containers on TRU waste storage pad	1,150	None	None
Solid	None	None	None	Containers on TRU waste storage pad	Same as liquid	Shallow burial	90,626[f]
Hazardous							
Liquid	34.6[g]	None	Planned	RCRA-permitted storage	62[h]	Contracted offsite	NA
Solid	Included in liquid[i]	None	None	RCRA-permitted storage	Included in liquid	Contracted offsite	NA
Nonhazardous (Sanitary)							
Liquid	Included in solid	Septic fields	As required	None	None	Septic fields	As required
Solid	7,170[g]	None	None	None	None	Landfill (onsite)	Expandable as required: as of November 1994, 459,000 m^3 available[j]
Nonhazardous (Other)							
Liquid	Included in sanitary	Septic fields	As required	None	None	Septic fields	As required
Solid	Included in sanitary	None	None	None	None	Landfill (onsite)	Expandable as required

[a] All TRU waste at NTS is considered to be mixed until further characterization is completed.
[b] 612 m^3 TRU (LLNL waste) stored pending WIPP availability. An additional capacity of 528 m^3 is available for mixed LLW storage.
[c] 408 m^3 was previously disposed, but liquid LLW is no longer disposed.
[d] Additional volume of LLW disposed of from on and offsite locations was 18,604 m^3.
[e] Area 3 and 5.
[f] Pit 3, Area 5 RWMS.
[g] Assumes a density factor of 1.0 t/m^3.
[h] Area 5 Hazardous Waste Storage Unit.
[i] Includes 2.5 m^3 TSCA waste.
[j] Disposal capacity is composed of three landfills.
Note: NA=not applicable.
Source: DOE 1995w; NT DOE 1994f; NT DOE 1996b; NT REECO 1994a; NT REECO 1995a; NTS 1993a:4; NTS 1995a:3.

167,400 m^3 (218,900 yd^3) in Area 5 (NT REECO 1994a:12) of LLW have been disposed of. Standard shallow land burial techniques have been employed.

Mixed Low-Level Waste. Disposal of mixed waste received from RFETS has taken place at NTS. Environmental restoration at NTS facilities could generate additional volumes of mixed wastes which will require some form of treatment. Mixed waste generated in the State of Nevada that meets land disposal restrictions of RCRA can be disposed of in the Area 5 Mixed Waste Disposal Unit, Pit 3. [Text deleted.] The Nevada Division of Environmental Protection provides RCRA oversight for NTS. The 1992 revised RCRA Part B Permit application, to include a separate mixed waste storage and disposal unit at NTS, in accordance with the provisions of the *Federal Facility Compliance Act*, has been submitted to the State of Nevada. A mutual consent agreement between the State of Nevada and DOE permits the storage of mixed LLW on the TRU waste storage pads. DOE has published the *NTS Site Treatment Plan* and *Federal Facility Compliance Act Consent Order* that establishes the basis for mixed LLW treatment, storage, and disposal at NTS.

Hazardous Waste. Hazardous wastes result from ongoing operations that utilize solvents, lubricants, fuel, Pb, metals, motor oil, and acids. Hazardous wastes are accumulated at satellite areas, stored at the Area 5 RCRA-permitted hazardous waste storage unit, and shipped offsite by truck using DOT-approved transporters to a commercial RCRA-permitted facility. Additional accumulation areas and new equipment are planned to prevent the possibility of cross contamination with radioactive wastes (creating mixed wastes) in handling these materials. PCB-contaminated waste is accumulated and stored in the Area 6 *Toxic Substances Control Act* (TSCA) Waste Accumulation Unit. Accumulated PCB waste is shipped offsite to a commercial TSCA treatment, storage, and disposal facility. Hazardous waste generation is decreasing as the result of an aggressive waste minimization program and will substantially decrease in the future due to the present moratorium on nuclear testing.

Nonhazardous Waste. Nonhazardous sanitary wastes are expected to be generated at the current rates for several years into the future, then decline assuming the present moratorium on underground weapons testing continues. Liquid nonhazardous wastes are disposed of in septic tanks, sumps, or in ponds; solid wastes are disposed of in landfills at various locations on the site. Recycling of paper, metals, glass, plastics, and cardboard has already resulted in some decreases in waste quantities. Solid waste landfills located in Areas 6, 9, and 23 are in use for the disposal of solid nonhazardous wastes. The Area 6 landfill is a Class III landfill that accepts hydrocarbon-burdened soil and debris. The Area 9 landfill is a Class II landfill as it accepts less than 18 t (20 tons) of solid waste per day. The Area 9 landfill is allowed to receive all types of nonhazardous solid waste, excluding radioactive waste, free liquids, and asbestos. Its current capacity is approximately 990,000 m^3 (1.3 million yd^3). Due to changes in State regulatory requirements, the Area 9 landfill will undergo partial closure and reopen as a Class III construction and demolition landfill. The Area 23 landfill receives all types of nonhazardous solid waste with nonpathogenic hospital waste, dead animals, and asbestos-containing materials being buried in separate cells that are identified by concrete markers. The current capacity is approximately 450,000 m^3 (589,000 yd^3). The Area 23 landfill is scheduled to remain in operation as a Class II landfill after modification to comply with the new State regulations (NT DOE 1996c:4-37).

3.4 IDAHO NATIONAL ENGINEERING LABORATORY

The Idaho National Engineering Laboratory is located in southeastern Idaho near Idaho Falls (Figure 2.2.3–1). The main site is 55 km (34 mi) west of Idaho Falls, 61 km (38 mi) northwest of Blackfoot, and 35 km (22 mi) east of Arco. There are also DOE activities in Idaho Falls. The facility has approximately 445 km (277 mi) of roads, both paved and unpaved, and 48 km (30 mi) of railroad track.

There are 450 buildings and 2,000 support structures at INEL with more than 279,000 m^2 (3,000,000 ft^2) of floor space in varying conditions of utility (Figure 2.2.3–2). INEL has approximately 25,100 m^2 (270,000 ft^2) of covered warehouse space and an additional 18,600 m^2 (200,000 ft^2) of fenced yard space. The total area of the various machine shops is 3,035 m^2 (32,665 ft^2).

There have been 52 research and test reactors at INEL used over the years to test reactor systems, fuel and target design, and overall safety. In addition to its nuclear reactor research, other INEL facilities are operated to support nuclear operations. These facilities include HLW and LLW processing and storage sites, hot cells, analytical laboratories, machine shops, laundry, railroad, and administrative facilities. Other activities include management of one of DOE's largest storage sites for LLW and TRU waste. Until 1992, spent reactor fuels were reprocessed at the ICPP to recover enriched uranium and other isotopes. Due to a DOE decision to terminate spent fuel reprocessing, the ICPP was transferred to the DOE Office of Environmental Management (EM) Program for disposition. The ICPP contains the waste calcination facility, which processes liquid HLW streams to a calcined solid (granular form). Beginning in the early part of the next century, the waste immobilization facility will convert the calcined solids into a glass ceramic for ultimate disposal in a Federal repository. Additionally, miscellaneous spent fuel from both DOE and commercial sources is scheduled for interim storage at the ICPP. Within the existing security perimeter, the Fuel Processing Restoration Facility is a special nuclear material storage and processing facility that is 95-percent complete and has never been operated.

Department activities at INEL have been divided among eight distinct and geographically separate function areas as listed in Table 3.4–1. The current functions at INEL can be further grouped into two major categories: EM activities and other DOE activities.

Department of Energy Activities. Environmental management activities include R&D for waste processing at the Power Burst Facility and providing waste management expertise to the RWMC. The Power Burst Facility supports facilities in R&D for waste reduction programs and the Boron Neutron Capture Therapy Program. Waste management efforts at INEL are directed toward safe and environmentally sound treatment, storage, and disposal of radioactive, hazardous, and sanitary waste generated from facility operations. Major waste reduction facilities include the Waste Engineering Development Facility, the Waste Experimental Reduction Facility, and the Mixed Waste Storage Facility.

The following additional DOE activities are located at INEL (see Figure 2.2.3–2):

- The Test Area North (TAN) complex is the northernmost facility within INEL and consists of several experimental reactors and support facilities conducting R&D activities on reactor performance. These facilities include the technical support facility, the containment test facility, the water reactor research test facility, and the inertial engine test facility. The inertial engine test facility has been abandoned, and no future programs are planned. The remaining facilities support ongoing programs.

- Materials testing and environmental monitoring activities were conducted in the Auxiliary Reactor Area. The facilities in this area are scheduled for D&D.

- The ANL-W facility area consists of several major complexes, including EBR II, Transient Reactor Test Facility, ZPPR, HFEF, FCF, and FMF. The EBR II was being used to demonstrate the Integral Fast Reactor concept. The Transient Reactor Test Facility and the ZPPR are used to conduct reactor

Table 3.4–1. Current Missions at Idaho National Engineering Laboratory

Mission	Description	Sponsor
Argonne National Laboratory-West	Perform breeder reactor irradiation tests Provide storage of Pu material	Office of Nuclear Energy; Assistant Secretary for Environmental Management
Radioactive Waste Management Complex	Provide waste management functions for present and future site and Department needs	Assistant Secretary for Environmental Management
Power Burst Area	Perform waste processing, technology research, and development. Provide interim storage for hazardous wastes	Assistant Secretary for Environmental Management
Test Area North	Perform research on reactor safety operations and conduct a specific manufacturing capability project	Office of Nuclear Energy
Test Reactor Area	Perform irradiation service, develop nuclear instruments, and conduct safety programs. Develop methods to meet radioactive release limits	Office of Nuclear Energy; Office of Naval Reactors
Idaho Chemical Processing Plant	Operations are focused on spent fuel storage and high level waste processing	Assistant Secretary for Environmental Management
Naval Reactors Facility	Standby facility for conducting ship propulsion reactor research and training	Office of Naval Reactors
Central Facilities Area	Provide centralized support services for the site	Idaho Operations Office

Source: INEL 1995a:1.

reactor analysis and safety experiments. The HFEF provides a large inert-atmosphere containment for handling and examining irradiated reactor fuel. The FCF has been modified for the Integral Fast Reactor program to demonstrate remote reprocessing and refabrication in the fuel cycle. The FMF is used to manufacture metallic fuel elements for the fuel cycle and store Pu material.

- Supporting facilities at ANL-W include the Radioactive Liquid Waste Treatment Facility, the Radioactive Scrap and Waste Facility, the Radioactive Sodium Storage Facility, and the Sodium Process Facility. The Radioactive Liquid Waste Treatment Facility processes low-level (aqueous) liquid waste. TRU waste from ANL-W is stored at the Radioactive Scrap and Waste Facility. Contact-handled mixed waste is stored in the Radioactive Sodium Storage Facility (sodium-contaminated), and remote-handled mixed waste is stored at the Radioactive Scrap and Waste Facility. The Sodium Process Facility was built to process reactor sodium.

- The Test Reactor Area (TRA) contains the Advanced Test Reactor. This reactor is used for irradiation testing of reactor fuels and material properties; instrumentation for naval reactors; and production of radioisotopes in support of nuclear medicine, industrial applications, research, and product sterilization. Wastes from this facility are handled by the RWMC.

- The Naval Reactors Facility is operated for DOE and the U.S. Navy by Westinghouse Electric Corporation under jurisdiction of DOE's Pittsburgh Naval Reactors Office. Included at this facility are the submarine prototypes and the expended core facility. Activities include testing of advanced design equipment and new systems for current naval nuclear power propulsion plants and obtaining data for future designs.

- The Central Facilities Area (CFA) provides sitewide support services, including transportation, shop services, health services, radiation monitoring, and administrative offices.

Non-Department of Energy Activities. Non-DOE activities at INEL include research being conducted by NOAA, USGS, and various institutions of higher learning. These activities support the designation of INEL as a National Environmental Research Park (NERP).

3.4.1 LAND RESOURCES

Land Use. The INEL is located within Bingham, Bonneville, Butte, Clark, and Jefferson Counties, 35.4 km (22 mi) west of downtown Idaho Falls in southeastern Idaho. The site covers approximately 230,700 ha (570,000 acres), all of which is owned by the Federal Government and is administered, managed, and controlled by DOE. The Federal Government also owns approximately 75 percent of the land bordering INEL; this land is administered by the BLM. Twenty-four percent of adjacent land is privately owned, with the remaining 1 percent held by the State of Idaho.

Existing Land Use. Generalized land uses at INEL and in the vicinity are shown in Figure 3.4.1–1. About 2 percent of the land within INEL (4,600 ha [11,400 acres]) is used for operating areas and facilities. The developed INEL facilities are situated within a central core area of 91,000 ha (225,000 acres) designated as open space. A buffer zone consisting of 139,600 ha (345,000 acres) surrounding the central core area has been created within INEL boundaries. The BLM has entered into a Memorandum of Understanding with DOE to permit private individuals to graze livestock on the buffer zone rangeland. However, the grazing of livestock is prohibited within the central core area and within 3.2 km (2 mi) of any nuclear facilities. Other agricultural activities consist of approximately 56 ha (138 acres) of irrigated cropland located adjacent to State Routes 28 and 33, and west of the Mud Lake community. No prime farmland lies within the INEL boundaries. In 1975, DOE designated most of INEL as an NERP. It is used by the national scientific community as an outdoor laboratory for research on changes to the natural environment caused by human activities.

Offsite land use within 3.2 km (2 mi) of INEL is shown in Figure 3.4.1–1. This offsite land is primarily used for livestock and agricultural purposes. The closest residence to INEL boundary is 300 m (984 ft) east of the site (approximately 11 km [7 mi] northwest of the unincorporated community of Mud Lake).

Two National Natural Landmarks border INEL: Big Southern Butte (2.4 km [1.5 mi] south) and Hell's Half Acre (2.6 km southeast [1.6 mi]). A portion of Hell's Half Acre National Natural Landmark is designated as a Wilderness Study Area. The Black Canyon Wilderness Study Area is located adjacent to INEL and 15 km (9 mi) west-northwest of TAN. The BLM is considering the Black Canyon Wilderness Study Area for Wilderness Area designation (DOE 1995v:4.5-2). The Cedar Butte Wilderness Study Area is located 4 km (2 mi) south of INEL and 14 km (9 mi) southeast of EBR-I. The BLM does not recommend the Cedar Butte Wilderness Study Area for Wilderness Area designation.

Land-Use Planning. Lands surrounding INEL are subject to Federal and State planning laws and regulations. Land-use planning in Idaho is derived from the *Local Planning Act* of 1975, which requires that each county adopt its own land-use planning and zoning guidelines. County plans applicable to lands bordering INEL include the *Clark County Planning and Zoning Ordinance and Land Use Plan*, the *Bonneville County Comprehensive Plan*, the *Bingham County Zoning Ordinance and Planning Handbook*, the *Jefferson County Comprehensive Plan*, and the *Butte County Comprehensive Plan* (DOE 1995v:4.2–5). Land-use planning for INEL administrative and laboratory facilities located in the city of Idaho Falls is subject to Idaho Falls planning and zoning restrictions. The Idaho Falls zoning ordinance designates these INEL facility areas as I&M-1, Industrial and Manufacturing (IN City 1995a:1).

Visual Resources. The INEL generally consists of open desert land containing sagebrush. The surrounding volcanic cones, domes, and mountain ranges are visible throughout INEL. Much of INEL is the typical open, undeveloped, desert landscape characteristic of the Snake River Plain. The generally low-density character of the INEL facilities have the appearance of commercial/industrial complexes and are dispersed throughout the site. The approximate height of these structures ranges from 3 m (10 ft) to 30 m (100 ft), with a few stacks and towers that reach 76 m (250 ft). Although many INEL facilities are visible from highways, most facilities are located over 0.8 km (0.5 mi) from public roads (DOE 1995v:4.5-1). Industrial use of the developed area within INEL is consistent with a BLM VRM Class 5 designation; other areas range from VRM Class 2 to Class 4.

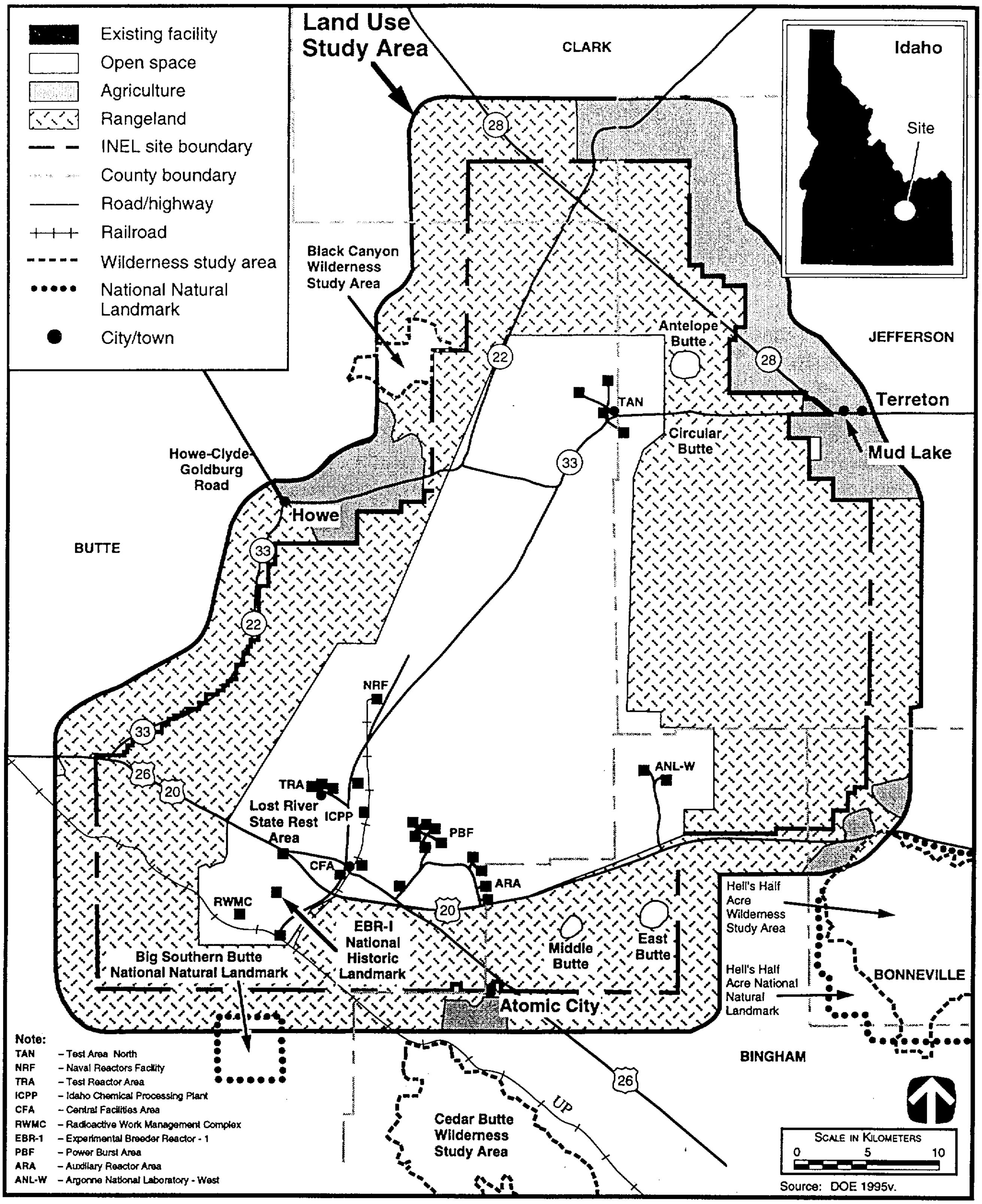


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Figure 3.4.1–1. Generalized Land Use at Idaho National Engineering Laboratory and Vicinity.

The Lost River State Rest Area, located along U.S. Route 20/26 (Figure 3.4.1–1), is approximately 5 km (3 mi) southwest of the TRA. Views from the Black Canyon Wilderness Study Area (Figure 3.4.1–1) include agricultural land use and the facilities of INEL. INEL facilities are visible from the Cedar Butte Wilderness Study Area. Views of the facilities from these Wilderness Study Areas are distant and therefore have a minor effect on the overall natural appearance of the area. Craters of the Moon National Monument and Wilderness Area are both approximately 20 km (12.5 mi) southwest from the closest INEL boundary.

3.4.2 SITE INFRASTRUCTURE

Baseline Characteristics. The INEL contains extensive production, service, and research facilities. Not all of these facilities are in operation or are needed today. To support site missions, an extensive infrastructure exists, as shown in Table 3.4.2–1. Pu remaining from various research programs is stored at the ANL-W site in the ZPPR and FMF vaults. The road infrastructure provides intrasite transportation requirements. The railroad infrastructure supports large-volume deliveries of coal and oversized structural components. INEL does not have a connection to local natural gas lines.

Table 3.4.2–1. Idaho National Engineering Laboratory Baseline Characteristics

Characteristics	Current Usage	Site Availability
Transportation		
Roads (km)	445[a]	445[a]
Railroads (km)	48	48
Electrical		
Energy consumption (MWh/yr)	232,500	394,200
Peak load (MWe)	42	124
Fuel		
Natural gas (m^3/yr)	0	0
Oil (l/yr)[b]	5,820,000	16,000,000
Coal (t/yr)	11,340	11,340
Steam (kg/hr)	40,800	40,800

[a] Includes paved and unpaved roads.
[b] Amount includes fuel oil and propane.
Source: DOE 1995j; INEL 1993a:5.

The subregional electrical power pool area in which INEL is located and from which it draws its power is the Northwest Power Pool Area, a part of the Western Systems Coordinating Council. INEL draws its electrical power predominantly from hydroelectric and coal-fired power generating plants. Characteristics of this power pool are given in Table 3.4.2–2.

Table 3.4.2–2. Northwest Sub-Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel[a]	
Coal	34%
Nuclear	3%
Hydro/geothermal	46%
Oil/gas	7%
Other[b]	11%
Total Annual Production	256,404,000 MWh
Total Annual Load	250,045,000 MWh
Energy Exported Annually	6,359,000 MWh
Generating Capacity	49,596 MWe
Peak Demand	33,325 MWe
Capacity Margin[c]	13,655 MWe

[a] Percentages do not total 100 percent due to rounding.

[b] Includes power from both utility and non utility sources.

[c] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.

Source: NERC 1993a.

3.4.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The climate at INEL and in the surrounding region is characteristically that of a semiarid steppe. The average annual temperature at INEL is 5.6 °C (42.0 °F); average monthly temperatures range from a minimum of -8.8 °C (16.1 °F) in January to a maximum of 20.0 °C (68 °F) in July. The average annual precipitation at INEL is 22.1 cm (8.7 in) (IN DOE 1989b:55,77). Prevailing winds at INEL are southwest to west-northwest with a secondary maximum frequency from the north-northeast to northeast. The average annual windspeed is 3.4 m/s (7.5 mph). Additional information related to meteorology and climatology at INEL is presented in Appendix F.

Ambient Air Quality. The INEL is located within the Eastern Idaho Intrastate AQCR (#61). None of the areas within INEL and its surrounding counties are designated as nonattainment areas (40 CFR 81.313) with respect to the NAAQS for criteria pollutants (40 CFR 50). The nearest nonattainment area for particulate matter is in Pocatello, about 80 km (50 mi) to the south. Applicable NAAQS and Idaho State ambient air quality standards are presented in Appendix F.

Three PSD (40 CFR 52.21) Class I areas have been designated in the vicinity of INEL: Craters of the Moon National Monument, Idaho, approximately 53 km (33 mi) west-southwest from the center of the site; Yellowstone National Park, Idaho-Wyoming, approximately 143 km (89 mi) east-northeast from the center of the site; and Grand Teton National Park, Wyoming, approximately 145 km (90 mi) east from the center of the site (IN DOE 1991b:4-11).

Since the creation of the PSD program in 1977, PSD permits were obtained by INEL for two major emission sources: the Coal-Fired Steam-Generating Facility next to the ICPP and the Fuel Processing Restoration Facility, which is not expected to be operated (IN DOE 1980a; IN DOE 1988h).

Historically, the primary emission sources of criteria air pollutants at INEL are the calcination of liquid waste, the combustion of coal for steam generation at the ICPP, and the combustion of fuel oil for heating at various INEL facilities. Other emissions and sources include fugitive particulates from waste-burial activities and coal piles, other processes, vehicles, and temporary emissions from various construction activities. A total of 26 toxic air pollutants have been identified that are emitted from existing INEL facilities in quantities exceeding the screening levels established by the State of Idaho (ID DHW 1995a:103-116; ID DHW 1995b:116-119). Emission estimates for these sources are presented in Appendix F.

Ambient concentration limits for hazardous and toxic air pollutants (to be used by the State as one of the criteria in evaluating construction permit applications for a new emission source) have been adopted by the Idaho Department of Health and Welfare (ID DHW 1995a:103-116; ID DHW 1995b:116-119). The annual emission rates of hazardous and toxic air pollutants from existing INEL facilities during 1990 are listed in Appendix F.

Table 3.4.3–1 presents the baseline ambient air concentrations for criteria pollutants and other pollutants of concern at INEL. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

Noise. Major noise emission sources within INEL include various industrial facilities, equipment, and machines (for example, cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials handling equipment, and vehicles). Most INEL industrial facilities are at a sufficient distance from the site boundary that noise levels at the boundary from these sources would not be measurable or would be barely distinguishable from background noise levels.

Table 3.4.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Idaho National Engineering Laboratory, 1990

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] (μg/m³)	Baseline Concentration (μg/m³)
Criteria Pollutants			
Carbon monoxide	8-hour	10,000[b]	284
	1-hour	40,000[b]	614
Lead	Calendar Quarter	1.5[b]	0.001
Nitrogen dioxide	Annual	100[b]	4
Ozone	1-hour	235[b]	c
Particulate matter less than or equal to 10 microns in diameter	Annual	50[b]	5
	24-hour	150[b]	80
Sulfur dioxide	Annual	80[b]	6
	24-hour	365[b]	135
	3-hour	1,300[b]	579
Mandated by the State of Idaho			
Total suspended particulates	Annual	60[d]	5
	24-hour	150[d]	80
Hazardous and Other Toxic Compounds			
Acetaldehyde	Annual	0.45[e]	0.011
Ammonia	Annual	180[e]	6.0
Arsenic	Annual	0.00023[e]	0.00009
Benzene	Annual	0.12[e]	0.029
Butadiene	Annual	0.0036[e]	0.001
Carbon tetrachloride	Annual	0.067[e]	0.0060
Chloroform	Annual	0.043[e]	0.00040
Cyclopentane	Annual	17,000[e]	2.7
Formaldehyde	Annual	0.077[e]	0.012
Hexavalent chromium	Annual	0.000083[e]	0.00006
Hydrazine	Annual	0.00034[e]	0.000001
Hydrochloric acid	Annual	7.5[e]	0.98
Mercury	Annual	1[e]	0.042
Methylene chloride	Annual	0.24[e]	0.006
Naphthalene	Annual	500[e]	18
Nickel	Annual	0.0042[e]	0.0027
Nitric acid	Annual	50[e]	0.64
Perchloroethylene	Annual	2.1[e]	0.11
Phosphorus	Annual	1[e]	0.30
Potassium hydroxide	Annual	20[e]	0.20
Proprionaldehyde	Annual	4.3[e]	0.30
Styrene	Annual	1,000[e]	1.3
Toluene	Annual	3,750[e]	370
Trichloroethylene	Annual	0.077[e]	0.00097

Table 3.4.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations and Guidelines at Idaho National Engineering Laboratory, 1990—Continued

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] (μg/m³)	Baseline Concentration (μg/m³)
Hazardous and Other Toxic Compounds (continued)			
Trimethylbenzene	Annual	1,230[e]	100
Trivalent chromium	Annual	5[e]	0.036

[a] The more stringent of the Federal and State standard is presented if both exist for the averaging time.
[b] Federal and State standard.
[c] Data not available from source document.
[d] State standard.
[e] Acceptable air concentrations listed in Rules for the Control of Air Pollution in Idaho apply only to new (not existing) sources and are used here as reference levels.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. See Section 4.1.3 for a discussion of ozone-related issues.

Source: 40 CFR 50; DOE 1995v; ID DHW 1995a; ID DHW 1995b.

Existing INEL-related noises of public significance are from the transportation of people and materials to and from the site and in-town facilities via buses, trucks, private vehicles, helicopters, and freight trains. Noise measurements along U.S. Highway 20 about 15 m (50 ft) from the roadway indicate that the sound level from traffic ranges from 64 to 86 dBA (IN DOE 1990b:62), and that the primary source is buses (71 to 80 dBA). While few people reside within 15 m (50 ft) of the roadway, the results indicate that INEL traffic noise might be objectionable to members of the public residing near principal highways or busy bus routes. The acoustic environment along the INEL site boundary in rural areas and at nearby areas away from traffic noise is typical of a rural location, with DNL in the range of 35 to 50 dBA (EPA 1974a:B-4). Except for the prohibition of nuisance noise, neither the State of Idaho nor its local governments have established any regulations that specify acceptable community noise levels.

3.4.4 WATER RESOURCES

Surface Water. Flowing surface water in the INEL area consists of three intermittent streams that drain the adjacent mountains: Big Lost River, Little Lost River, and Birch Creek. The streams usually begin to flow in the spring and are dry by early- to mid-summer. The Big Lost River and Birch Creek are the only surface waters that flow onto the site on a regular basis. The Little Lost River does not enter the site under normal flow conditions. Since much of the flow in these streams is diverted upstream for irrigation, it is possible that several years can pass without any flow entering the INEL boundaries. The USGS is responsible for monitoring the streams, but the only onsite monitoring station is for the Big Lost River. Surface water features near INEL are depicted in Figure 3.4.4–1.

The Big Lost River flows onto the site at the southern part of its western boundary and flows northeastward to the Big Lost River sinks (Playas 1 through 3) (DOE 1992e:4-66). Water flow in the Big Lost River is controlled by the MacKay Dam located approximately 73 km (45 mi) upstream from INEL. Local rainfall and snowmelt are the primary contributors to the surface water flows. Most precipitation is rapidly infiltrated into the soil or evaporated.

Surface water is not used on INEL as a source of drinking water, nor is it used as a receptor for wastewater discharge. Nonradioactive liquid effluents are disposed of primarily to a waste ditch, a lined evaporation pond, an industrial waste pond, five different seepage ponds, and sewage treatment facilities.

Several areas of INEL, such as TAN, TRA, and CFA currently divert stormwater into drainage ditches and discharge flow into soils away from the work area. A large drainage ditch equipped with an automatic sampler surrounds the RWMC to ensure that radionuclides are not transported from the area by stormwater.

Flooding at INEL by the Big Lost River has largely been averted by a flood diversion system constructed in 1958 and upgraded in 1984. The flood diversion system consists of a small dam to direct flow through a diversion channel into four spreading areas (IN DOE 1991b:4-17). The flood diversion system is designed to contain a 300-year flood.

Surface Water Quality. The Big Lost River (from its source to the playas) is designated by the Idaho Department of Health and Welfare's Water Quality Standards and Wastewater Treatment Requirements for the following uses: agricultural and domestic water supply, cold water biota, salmonid spawning, primary and secondary contact recreation, and special resource waters (ID DHW 1992a).

The USGS is responsible for monitoring the surface water quality at INEL. The most recent water samples collected within the facility boundaries were collected from the Big Lost River below the diversion dam in June 1995, when the river flowed for several weeks. The results of the analysis and the Idaho Water Quality Standards for the Protection of Domestic Water Supplies are presented in Table 3.4.4–1. The analytical results indicate that there are no parameters in exceedance of the water quality criteria.

Surface Water Rights and Permits. Surface water rights are not an issue at INEL because INEL facilities do not withdraw surface water for use nor do they discharge effluents directly to natural surface waters.

Groundwater. The Snake River Plain Aquifer, classified by EPA as a Class I sole source aquifer, is located beneath the entire INEL site and covers a total area of approximately 24,860 km^2 (9,600 mi^2) in southeastern Idaho. The aquifer serves as a primary source for drinking water and crop irrigation in the Snake River Basin (IN DOE 1995f:99). It is composed of 610 to 3,048 m (2,000 to 10,000 ft) of lava flows, rhyolite, and interbedded sediments and is believed to contain 1,200 to 2,500 trillion l (317 to 660 trillion gal) of water.

Water from Henry's Fork of the Snake River infiltrates the subsurface and supplies a significant amount of water to the Snake River Plain Aquifer below INEL. Additional recharge to the aquifer comes from the Big Lost River,

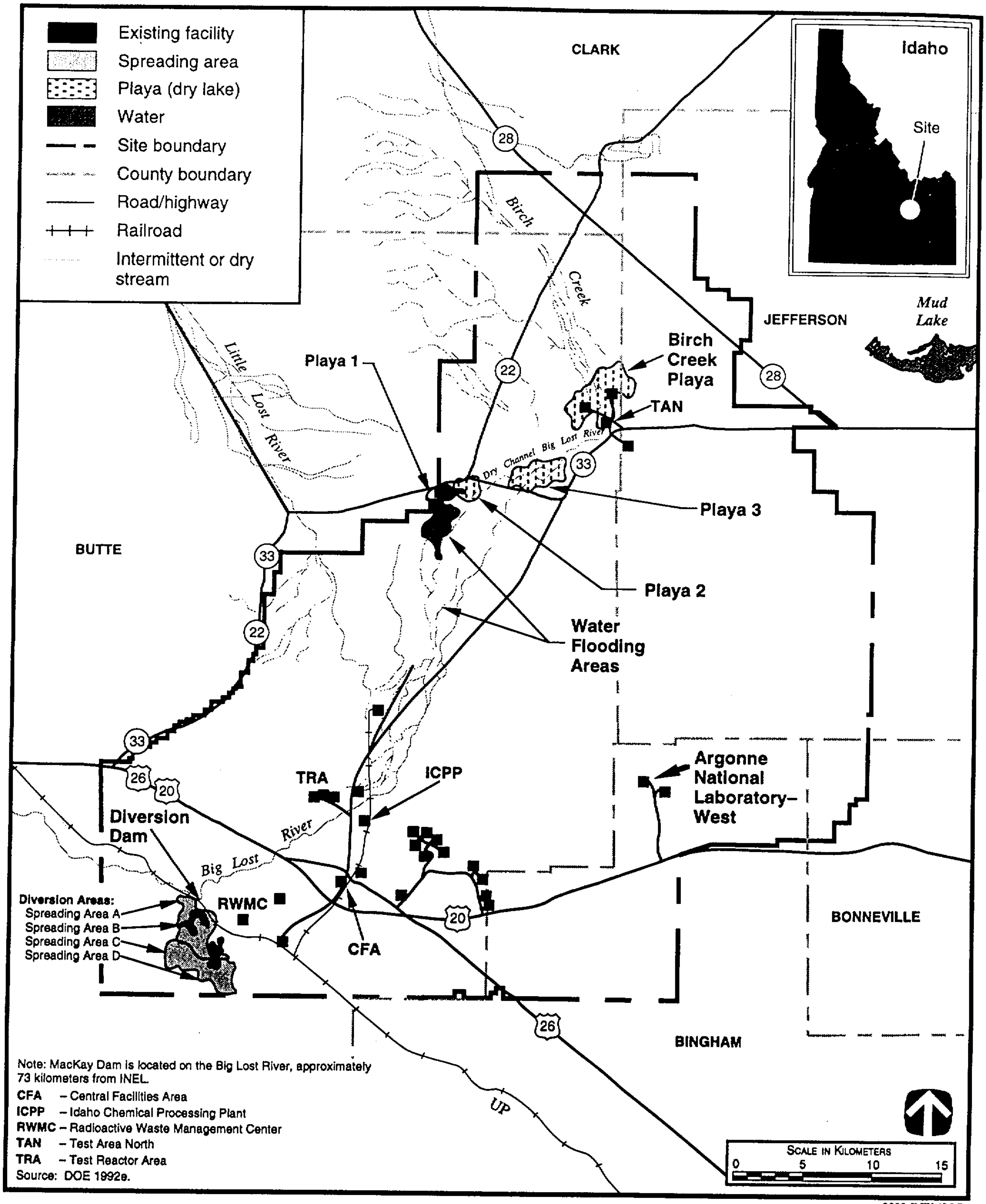

Figure 3.4.4–1. Surface Water Features at Idaho National Engineering Laboratory.

Little Lost River, and Birch Creek, which originates in the mountains to the northwest of INEL, flows onto the site during a few months of the year, and sinks into its porous soils. Precipitation and snowmelt also contribute to its recharge. Local groundwater movement is complicated, but overall, groundwater flows laterally at an average rate of 1.5 to 6.1 m (4.9 to 20 ft) per day to the south and southwest, as shown in Figure 3.4.4–2. The groundwater emerges in springs (about 8 trillion l [2.1 trillion gal] annually) along the Snake River from Milner (located to the west of Burley) to Bliss, Idaho, and from Blackfoot to American Falls Reservoir in the region west of Pocatello, Idaho (IN DOE 1995f:3). Depth to the water table ranges from 60 m (200 ft) below the ground surface in the northeast corner of INEL to 300 m (1,000 ft) in the southeast corner (DOE 1992e:4-69).

Table 3.4.4–1. Summary of Big Lost River Surface Water Quality Monitoring at Idaho National Engineering Laboratory, 1995

Parameter	Unit of Measure	Water Quality Criteria[a]	Maximum Water Body Concentration
Arsenic	mg/l	0.05[b]	.0002
Barium	mg/l	1.0[c]	<0.0085
Cadmium	mg/l	0.005[b]	<0.001
Chromium	mg/l	0.05[c]	0.0042
Lead	mg/l	0.015[b]	<0.001
Mercury	mg/l	0.002[b,c]	<0.0001
pH	pH units	6.5-8.5[c]	8.4
Selenium	mg/l	0.01[b,c]	0.001
Silver	mg/l	0.05[b,c]	<0.001
Temperature	°C	22[c]	15

[a] For comparison purposes only.
[b] National Primary Drinking Water Regulation (40 CFR 141).
[c] State of Idaho Water Quality Criteria.
Source: ID DHW 1992a; IN USGS 1995a.

Perched water tables occur in the INEL area. The presence of these perched water bodies is believed to be beneficial to water quality in the Snake River Plain Aquifer. These perched water bodies slow waste migration, allow for radioactive decay, and spread any waste plumes over a wider area for greater dilution (DOE 1992e:4-70).

Groundwater Quality. There are several "networks" of monitoring wells drilled and maintained by USGS. These include the INEL-wide facility groundwater monitoring group and well networks for RCRA- and CERCLA-required monitoring. Groundwater beneath INEL is monitored by groups including USGS, DOE's site contractor, LITCO, other DOE contractors, and the State of Idaho. USGS has drilled more than 120 wells in the Snake River Plain Aquifer and 100 in the perched zone on and near INEL. Water supply wells, monitoring wells, and offsite water supply wells are routinely sampled for chemical and radiological constituents (DOE 1992e:4-70).

Historically, there has been radionuclide contamination of the Snake River Plain Aquifer. Between 1952 and 1988, approximately 30,900 Ci of tritium were disposed of into wells and infiltration ponds at INEL (mainly from the ICPP, TRA, and also the TAN). No tritium is currently disposed of to the groundwater at INEL, but large tritium plumes are present in the Snake River Plain Aquifer and in perched groundwater under the ICPP and TRA (Figure 3.4.4–2) (IN USGS 1988a:7). Tritium occurs at elevated levels in some monitoring wells and has been detected in groundwater near the southern boundary of INEL, 14.5 km (9 mi) south of the ICPP and TRA. The average concentration of tritium in water from six INEL production wells has remained constant since 1990 (IN DOE 1995f:72). In 1994, the highest tritium concentrations occurring in INEL drinking water were in the area of the CFA; the concentration ranged from 12,600 to 18,000 pCi/l (47,697 to 68,138 pCi/gal) (IN DOE

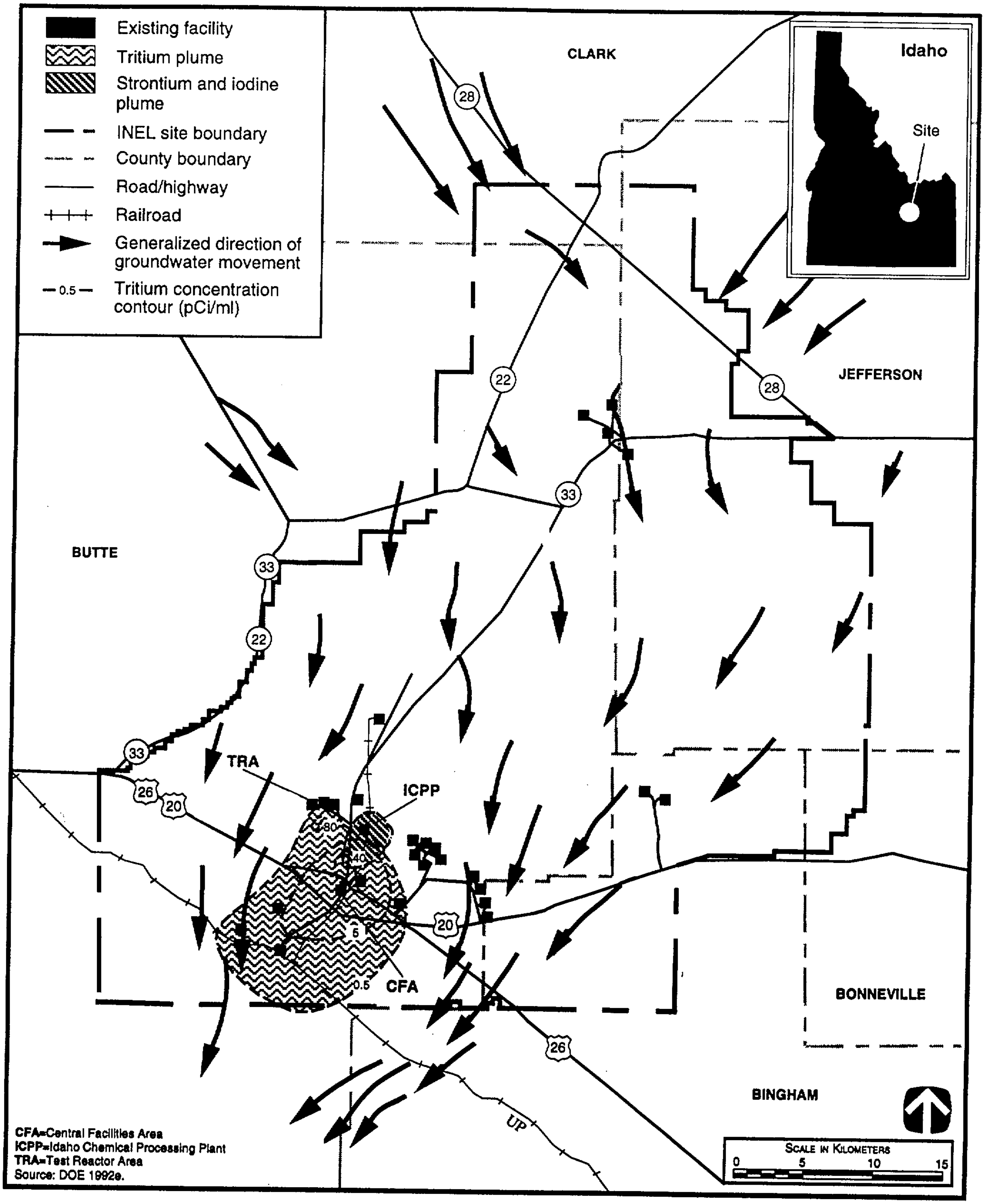

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Figure 3.4.4–2. Generalized Groundwater Flow and Groundwater Contamination at Idaho National Engineering Laboratory and Vicinity.

1995f:71). The elimination of tritium disposal, coupled with its radioactive decay, and dilution and dispersion within the groundwater reservoir are factors contributing to a 93-percent decrease in tritium concentration levels from 1961 to 1994.

Other radionuclides of significance include Cs-137, I-129 and Sr-90. Cs-137 is strongly adsorbed on mineral grains in the soils, so it is unlikely that it will reach the aquifer in significant amounts. As shown in Figure 3.4.4–2, plumes have been delineated for Sr and I.

Groundwater contamination from the injection well at TAN is being remediated as specified in a 1994 ROD and subsequent Fact Sheet. Another 1994 ROD addresses groundwater contamination at RWMC. Buried drums in this area released VOCs (for example, trichloroethylene) that have migrated downward to the Snake River Plain Aquifer. However, concentrations of these compounds were found to be below drinking water standards (IN DOE 1995f:32).

Samples from 32 offsite USGS wells beyond the southern and western site boundaries were taken in 1994. All gross alpha concentrations were within the expected concentration range for naturally occurring alpha activity in the aquifer underlying the INEL and surrounding areas. According to USGS reports, alpha-emitting wastes from site operations have not migrated far from their entrance into the aquifer near ICPP (IN DOE 1995f:69). None of the offsite water samples collected during 1994 contained detectable concentrations of tritium or gross beta activity radionuclides.

Nonradioactive wastes, including sodium chloride, sulfuric acid, sodium hydroxide, and organics, have also been discharged to ponds within many of the operating areas. In the past, wastewater has also been injected into deep disposal wells at the TRA and ICPP. The TDS concentrations of the injected wastewaters were approximately twice those present in the natural groundwater (IN USGS 1988a:20). There are no plans to use injection wells for future wastewater disposal. Monitoring of the Snake River Plain Aquifer for nonradiological constituents, including sodium chloride, total chromium, trace metals, and nitrates, showed concentrations for these contaminants to be at or below background levels at least 4 km (2.5 mi) inside the nearest site boundary (IN DOE 1994c:54).

Only nonradioactive and nonhazardous liquid wastes are currently discharged into the sanitary and service waste disposal systems. All hazardous and radioactive wastes are stored or disposed of in approved facilities designed to preclude further groundwater contamination. Groundwater quality data is shown in Table 3.4.4–2.

Groundwater Availability, Use, and Rights. The Snake River Plain Aquifer is the source of all water used at INEL. The combined pump capacity of the 27 onsite production wells averaged approximately 7.9 billion l/yr (2.1 billion gal/yr) from 1982 through 1985. This is 0.3 percent of the 2.44 trillion l/yr (645 billion gal/yr) of groundwater withdrawn from the aquifer in the Eastern Snake River Plain. Most of the water withdrawn from the aquifer in the Eastern Snake River Plain (2.34 trillion l/yr [619 billion gal/yr]) is used for agriculture. After use and treatment, approximately 63 percent of the quantity of groundwater withdrawn at INEL is disposed of in wells and ponds (DOE 1992e:4-73).

In the INEL ROI, Idaho Falls, Pocatello, and Rigby maintain water supply systems. All of the community drinking water systems draw their raw water from the Snake River Plain Aquifer. In 1991, the combined water supply capacity for these systems was approximately 538 million l/day (142.1 million gal/day). The combined demand averaged about 204 million l/day (53.9 million gal/day), or 38 percent of capacity.

The Department holds a Federal Reserved Water Right for the INEL site, which permits a water pumping capacity of 2.3 m^3/s (80 ft^3/s) and a maximum water consumption of 43 billion l/yr (11.4 billion gal/yr) for drinking, process water, and noncontact cooling (DOE 1992e:4-74). Because it is a Federal Reserved Water Right, INEL's priority on water rights dates back to its establishment in 1950. The legal and administrative framework for the water rights adjudication process is currently being evaluated for the State of Idaho.

Table 3.4.4–2. Groundwater Quality Monitoring at Idaho National Engineering Laboratory, 1994

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Drinking Water and Production Wells	
			High	Low
1-Dichlorobenzene	mg/l	0.075[b]	0.0007	0.0007
1,1,1-Trichloroethane	mg/l	0.2[b]	0.0028	<dL
Alpha (gross)	pCi/l	15[b]	2.8	<dL
Barium	mg/l	1.0[c]	0.09	0.003
Beta (gross)	pCi/l	50[d]	8.0	<dL
[Text deleted.]				
Carbon tetrachloride	mg/l	0.005[b]	0.0006	<dL
Chloroform	mg/l	0.1[b]	0.0047	<dL
Chromium	mg/l	0.05[b]	0.007	0.003
Strontium-90	pCi/l	400[e]	0.8	<dL
Tetrachloroethylene	mg/l	0.005[b]	0.0047	<dL
Trichloroethylene	mg/l	0.005[b]	0.0166	<dL
Tritium	pCi/l	80,000[e]	18,000	1,300

[a] For comparison purposes only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] State water quality criteria.
[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[e] DOE's DCG for water (DOE Order 5400.5). DCG values are based on a committed effective dose equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG.

Note: dL=detection limit.
Source: IN DOE 1995f.

3.4.5 GEOLOGY AND SOILS

Geology. The INEL occupies a relatively flat area on the northwestern portion of the Eastern Snake River Plain. The INEL area consists of a broad plain that has been built up from the eruptions of multiple flows of basaltic lava. INEL is bordered by Centennial Range Mountains on the north and the overthrust belt on the east. The Eastern Snake River Plain consists of Miocene and younger volcanic rocks that probably rest upon older sedimentary and plutonic rocks, as well as faulted remains of Eocene volcanic rocks. Within INEL, economically viable sand, gravel, and pumice resources have been identified. Several quarries have supplied these materials to various onsite construction projects.

The oldest faults in the region occur both to the north and south of INEL and are approximately 40 to 65 million years old. The Arco Segment of the Lost River Fault and the Howe Segment of the Lemhi Fault are range-front normal faults associated with the Basin and Range Province and have been active during recent geologic time (100,000 to 15,000 years ago); they are considered to be the closest capable faults to INEL by the definition outlined in 10 CFR 100, Appendix A. These faults terminate approximately 30 km (19 mi) from the INEL boundary (Figure 3.4.5–1).

The INEL is located in Seismic Zone 2B. For this PEIS, Uniform Building Code Seismic Zones 2A and 2B are included in Seismic Zone 2 (Figure 3.2.5–1), indicating that moderate damage could occur as a result of an earthquake. Seismic Zone 3 is located in adjacent regions to the north, east, and south of INEL.

The INEL is situated on the Eastern Snake River Plain, an area of low seismicity. The Plain is bordered by the seismically active Centennial Tectonic Belt to the north and the Intermountain Seismic Belt to the east and southeast. Historical and recent seismic data cataloged by NOAA, the National Earthquake Information Center (NEIC), the University of Utah, and the INEL Seismic Network indicates that earthquakes in the region occur primarily in the Intermountain Seismic Belt and Centennial Tectonic Belt (including the mountains and valleys of the Basin and Range province which bound the Plain on the north and south) (IN DOE 1991b:4-28). The seismic characteristics of the Plain and the adjacent Basin and Range province are different; earthquakes and active faulting are associated with the Basin and Range tectonic activity, whereas the Plain has historically experienced few and small earthquakes (DOE 1995j:4.6-1).

[Text deleted.] Historically there have been several earthquakes in the region surrounding INEL (Figure 3.4.5–1). However, none of these occurred within approximately 48 km (30 mi) of the site. The largest historic earthquake near INEL took place in 1983, approximately 107 km (66 mi) to the northwest, near Borah Peak in the Lost River Range. The earthquake had a Richter magnitude of 7.3 with a resulting peak ground acceleration of 0.022 to 0.078 g at INEL (DOE 1995j:4.6-1). An earthquake of greater than 5.5 magnitude can be expected approximately every 10 years within a 321-km (200-mi) radius of INEL.

The only recorded earthquake on the Eastern Snake River Plain with a Richter magnitude greater than 5.5 was the 1905 event that had a magnitude of 5.7. Recent interpretations of the event, however, have suggested that its epicenter was more likely to have been in Utah or Nevada. The distribution of earthquakes at and near INEL from 1884 to 1989 (Figure 3.4.5–1) clearly shows that the Eastern Snake River Plain has a low rate of seismicity.

Volcanic hazards at INEL can come from sources inside or outside the Snake River Plain. Volcanic hazards include the effects of lava flows, ground deformation (fissures, uplift, subsidence), volcanic earthquakes (associated with magmatic processes as distinct from earthquakes associated with tectonics), and ash flows or airborne ash deposits. Most of the basaltic volcanic activity occurred from 4 million to 2,100 years ago at the Craters of the Moon National Monument 20 km (12.5 mi) southwest of INEL. The rhyolite domes along the Axial Volcanic Zone formed between 1.2 and 0.3 million years ago and have a recurrence interval of about 200,000 years. Therefore, the probability of future dome formation affecting INEL site facilities is very low (DOE 1995j:4.6-9).

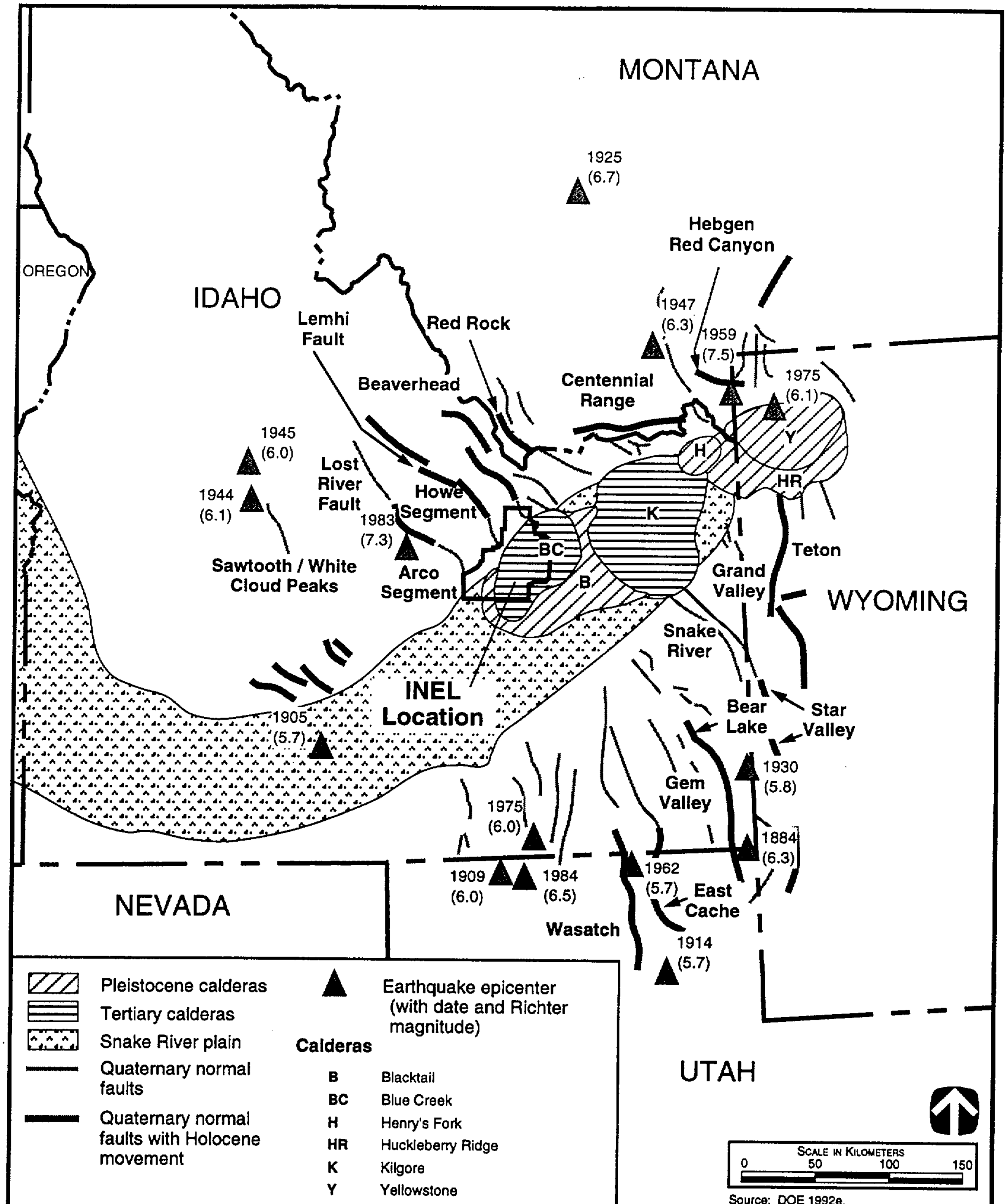

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Figure 3.4.5–1. Major Fault Systems, Calderas, and Historic Earthquakes in the Idaho National Engineering Laboratory Region.

Catastrophic Yellowstone type volcanic eruptions have occurred three times in the past 2 million years, but the INEL site lies more than 160 km (99 mi) southwest from the Yellowstone Caldera rim, and high-altitude winds would not disperse Yellowstone ash in the direction of INEL. Additionally, the infrequency, distance, and unfavorable dispersal of pyroclastic flows or ash fallout from future Yellowstone eruptions are not expected to affect the INEL site (DOE 1995j:4.6-9).

Basaltic lava flows and eruptions from fissures or vents have been considered in this PEIS. Based on a probability analysis of the volcanic history in and near the southcentral INEL area, the Volcanism Working Group estimated that the conditional probability that basaltic volcanism would affect a south-central INEL site location is less than 2.5×10^{-5} per year (once per 40,000 years or longer), where the hazard associated with Axial Volcanic Zone volcanism is greatest. The probability of a volcanic event affecting INEL site facilities farther north, where both silicic and basaltic volcanism have been older and less frequent, is estimated to be less than 1.0×10^{-6} per year (once every million years or longer). The statistics of 116 measured INEL-area lava flow lengths and areas were used to define the two lava flow hazard zones (Figure 3.4.5–2). The mean lava flow length plus one standard deviation from the mean corresponds to 14 km (8.7 mi). The hazard for a particular site within or near a volcanic zone is much lower, typically by an order of magnitude or more, and must be assessed on a site-specific basis (DOE 1995j:4.6-9).

Soils. The INEL soils are derived from volcanic and clastic rocks from nearby highlands (IN DOE 1986a:4). In the southern part of INEL, the soils are gravelly to rocky and generally shallow. The northern portion is composed mostly of unconsolidated clay, silt, and sand. Generally, the soils are acceptable for standard construction techniques and consist of wind-blown sand and silt lying in patches over a bedrock of basaltic lava. These soils have a low-to-moderate water erosion hazard and a moderate-to-high wind erodibility. Shrink-swell potential is generally low to moderate.

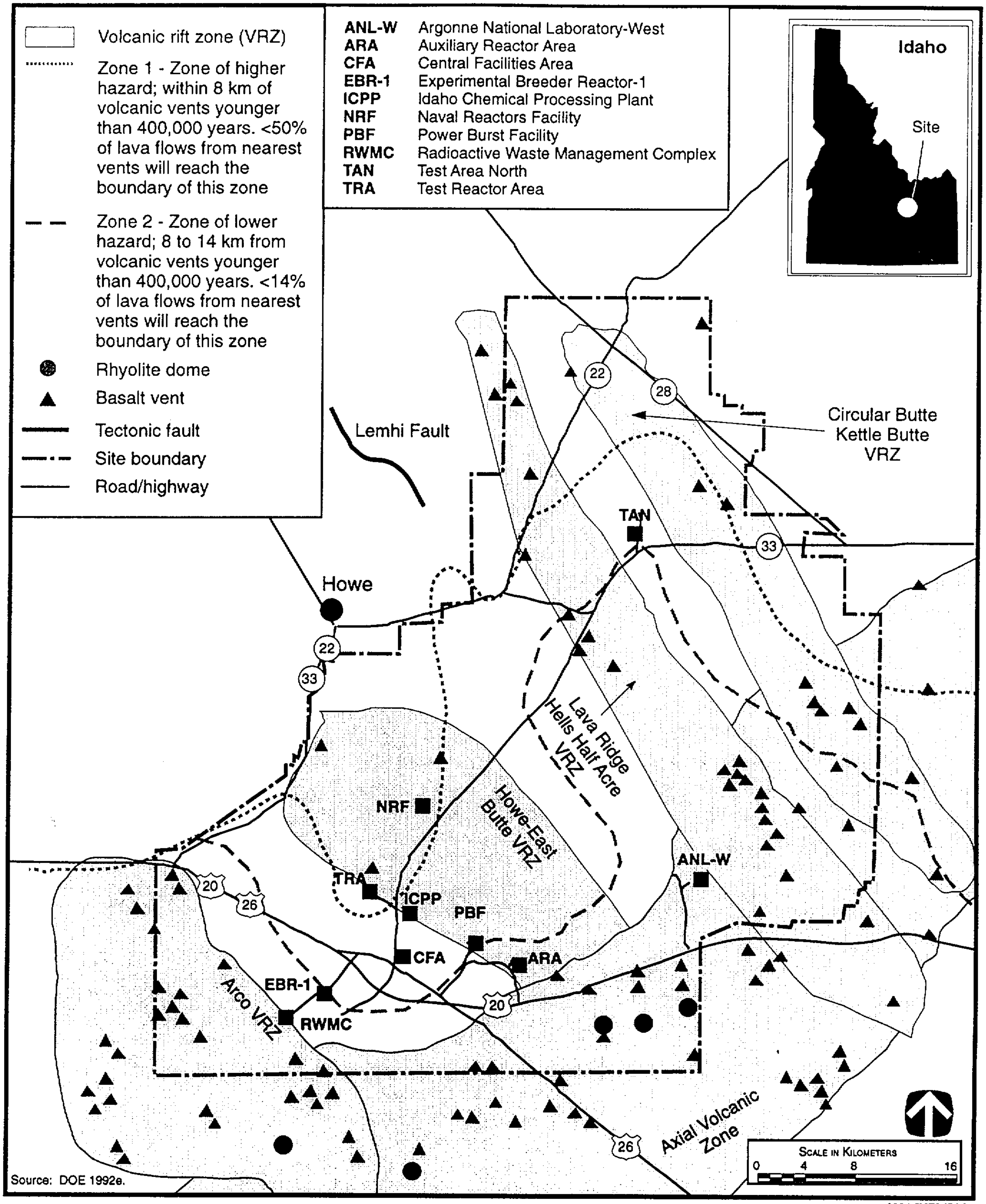

Figure 3.4.5–2. Major Volcanic Rift and Lava Flow Hazard Zones at the Idaho National Engineering Laboratory Region.

3.4.6 Biological Resources

Terrestrial Resources. The INEL lies in a cool desert ecosystem dominated by shrub-steppe communities. Most land within the site is relatively undisturbed and provides important habitat for species native to the region. Facilities and operating areas occupy 2 percent of INEL; approximately 60 percent of the area around the periphery of the site is grazed by sheep and cattle (DOE 1992e:4-76). Although sagebrush communities occupy about 80 percent of INEL, a total of 20 plant communities have been identified (IN DOE 1986a:4) (Figure 3.4.6–1). The interspersion of low and big sagebrush communities in the northern portion of INEL, and the juniper communities located in the northwestern and southeastern portions of the site are considered sensitive habitats (IN DOE 1986a:4,8). The former provides critical winter and spring range for sage grouse and pronghorn, while the latter is important to nesting raptors and songbirds. Riparian vegetation, primarily cottonwood and willow, along the Big Lost River and Birch Creek also provides nesting habitat for hawks, owls, and songbirds (DOE 1992e:4-76). In total, 398 plant taxa have been documented on INEL (IN DOE 1978a:129-131).

The INEL supports numerous animal species, including 1 amphibian, 9 reptile, 184 bird, and 37 mammal species (DOE 1992e:4-76). Common animals on INEL include the short-horned lizard, gopher snake, sage sparrow, Townsend's ground squirrel, and black-tailed jackrabbit. Important game animals include the sage grouse, mule deer, elk, and pronghorn. During some winters, 4,500 to 6,000 pronghorn, or about 30 percent of Idaho's total population, may be found on INEL. Pronghorn wintering areas are located in the northeastern portion of the site, in the area of the Big Lost River sinks, in the west-central portion of the site along the Big Lost River, and in the south-central portion of the site (IN DOE 1978a:221-222). Hunting is permitted only within about 1 km (0.6 mi) of the northern site boundary. Pronghorn, which is the only species taken, are hunted in order to control damage to agricultural land (INEL 1992a:2). Numerous raptors, such as the golden eagle and prairie falcon, and carnivores, such as the coyote and mountain lion, are also found on INEL. A variety of migratory birds has been found at INEL. Migratory birds, as well as their nests and eggs, are protected by the *Migratory Bird Treaty Act*. Eagles are similarly protected by the *Bald and Golden Eagle Protection Act*.

Within the proposed site for the storage facility (which is also the assumed analysis site for the evolutionary LWR), shallow soils (which occupy most of the area) are dominated by big sagebrush (Figure 3.4.6–1). In low-lying areas of deep soil, the dominant vegetation is perennial grasses. Isolated stands of juniper also exist in the area. Cheatgrass, an aggressive European annual that readily replaces native species in disturbed areas, is also present. Elk use areas in the vicinity of the site during the fall, winter, and spring, but pronghorn use is relatively low. Pronghorn wintering areas are located no closer than about 6.5 km (4 mi) from the site area. Sage grouse are known to use the site but not for breeding. The isolated stands of juniper in the area provide potential nesting habitat for hawks and owls (DOE 1992e:4-76).

Wetlands. The NWI maps prepared by the USFWS have been completed for most of INEL. The NWI maps indicate that the primary wetland areas are associated with the Big Lost River, the Big Lost River spreading areas, and the Big Lost River sinks, although smaller (less than about 0.4 ha [1 acre]) isolated wetlands also occur. Wetlands associated with the Big Lost River are classified as riverine/intermittent, indicating a defined stream channel with flowing water during only part of the year.

The Big Lost River spreading areas and Big Lost River sinks are seasonal wetlands and are located approximately 15 km (9.3 mi) southwest and 24 km (14.9 mi) north of the proposed new consolidated Pu storage facility site (and analysis site for the evolutionary LWR), respectively (Figure 2.3–3). These areas can provide more than 809 ha (2,000 acres) of wetland habitat during wet years. Riparian wetland vegetation exists along the Big Lost River and along Birch Creek. Plants found along the Big Lost River, which is located about 2.5 km (1.6 mi) west of the proposed site, are in poor condition due to recent years of only intermittent flows.

Aquatic Resources. Aquatic habitat on INEL is limited to the Big Lost River, Little Lost River, Birch Creek, and a number of liquid-waste disposal ponds (see Figure 3.4.4–1). All three streams are intermittent and drain

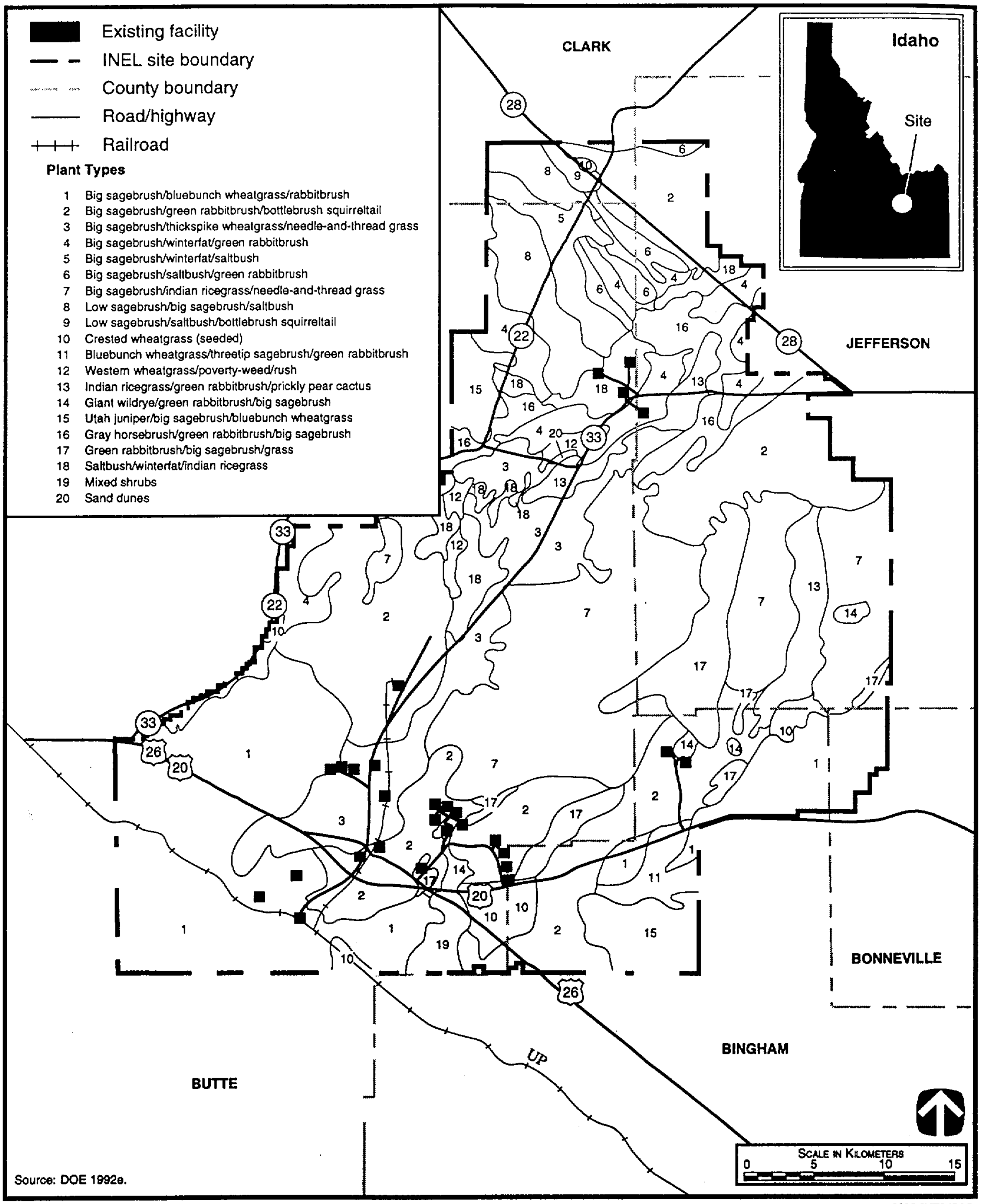

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Figure 3.4.6–1. Distribution of Plant Communities at Idaho National Engineering Laboratory.

into four sinks in the north-central part of INEL. Historically, six species of fish have been observed in the Big Lost River: brook trout, rainbow trout, mountain whitefish, speckled dace, shorthead sculpin, and kokanee salmon (DOE 1992e:4-78; DOE 1992h:G-11).

The Little Lost River, located west of INEL, and Birch Creek, located north of the proposed new consolidated Pu storage facility site (and assumed analysis site for the evolutionary LWR), enter INEL only during periods of high flow (IN EG&G nda:22). Surveys of fish in these surface water bodies have not been conducted. The liquid waste disposal ponds on INEL, while considered aquatic habitat, do not support fish (INEL 1992a:4). No aquatic habitat occurs on the proposed site, which is located about 2.5 km (1.6 mi) east of the Big Lost River.

Threatened and Endangered Species. Nineteen federally and State-listed threatened, endangered, and other special status species may be found on and in the vicinity of INEL. Two of these species are federally and State-listed as threatened or endangered (Table 3.4.6–1). Twelve species listed in Table 3.4.6–1 have been observed at INEL, including the two threatened and endangered species. Once specific project locations have been determined, site surveys will determine the presence of special status species. No critical habitat for threatened or endangered species, as defined in the ESA (50 CFR 17.11; 50 CFR 17.12), exists on INEL (DOE 1992e:4-78).

The bald eagle has rarely been seen in the western and northern portions of INEL. The peregrine falcon has only occasionally been observed in the northern portions of the site. [Text deleted.]

Several of the species listed in Table 3.4.6–1 may occur in the vicinity of the proposed storage site (and assumed location for the evolutionary LWR). The pygmy rabbit is common at INEL, but its distribution is patchy (DOE 1995j:4.9-4). The Townsend's western big-eared bat (which roosts in caves at INEL) and the other bat species have not been observed in the area of the proposed site but could potentially occur. [Text deleted.]

The State of Idaho does not maintain a list of threatened or endangered plant species. Plants that are considered rare in Idaho are included in a State Watch List. The tree-like oxytheca, listed by the State as a sensitive species, has been found in the area of the proposed site (DOE 1992e:4-79).

Table 3.4.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Idaho National Engineering Laboratory

Common Name	Scientific Name	Status[a]	
		Federal	**State**
Mammals			
Fringed myotis	*Myotis thysanodes*	NL	SSC
[Text deleted.]			
Pygmy rabbit[b]	*Brachylagus idahoensis*	NL	SSC
[Text deleted.]			
Spotted bat	*Euderma maculatum*	NL	SSC
Townsend's western big-eared bat[b]	*Plecotus townsendii townsendii*	NL	SSC
Western pipistrelle	*Pipistrellus hesperus*	NL	SSC
[Text deleted.]			
Birds			
American white pelican	*Pelecanus erythrorhynchos*	NL	SSC
Bald eagle[b,c]	*Haliaeetus leucocephalus*	T	E
Common loon	*Gavia immer*	NL	SSC
[Text deleted.]			
Great egret	*Casmerodius albus*	NL	SSC
Northern goshawk	*Accipiter gentilis*	NL	SSC
Peregrine falcon[b,c]	*Falco peregrinus*	E (S/A)	E
[Text deleted.]			
Plants[d]			
King's bladderpod[b]	*Lesquerella kingii var. cobrensis*	NL	M
Lemhi milkvetch[b]	*Astragalus aquilonius*	NL	S
Nipple cactus[b]	*Coryphantha missouriensis*	NL	M
Painted milkvetch[b]	*Astragalus ceramicus var. apus*	NL	M
Plains milkvetch[b]	*Astragalus gilviflorus*	NL	SP1
Spreading gilia[b]	*Ipomopsis polycladon*	NL	SP2
Tree-like oxytheca[b]	*Oxytheca dendroidea*	NL	S
Winged-seed evening primrose[b]	*Camissonia pterosperma*	NL	S

[a] Status codes: E=endangered; M=monitor; NL=not listed; S=sensitive; S/A=protected under the similarity of appearance provision of the ESA; SP1=State Priority 1 (in danger of becoming extinct in the state); SP2=State Priority 2 (likely to be classified as Priority 1 if factors contributing to decline remain unchanged); SSC=State special concern.

[b] Species observed on INEL.

[c] USFWS Recovery Plan exists for this species.

[d] State status of plant species is designated by the Idaho Native Plant Society.

Source: 50 CFR 17.11; 50 CFR 17.12; DOE 1992e; DOE 1995j; ID DFG 1994a; IN DOE 1984a.

3.4.7 Cultural and Paleontological Resources

Prehistoric Resources. Prehistoric resources identified on INEL include residential bases, campsites, rock shelters, hunting blinds, rock alignments, lithic quarries, and limited activity locations, including lithic and ceramic scatters, hearths, and concentrations of fire-affected rock. As of 1994, over 100 cultural resources surveys had been conducted, and approximately 4 percent of INEL had been inventoried for cultural resources (DOE 1995v:4.4-1). Resources include 688 prehistoric sites and 753 prehistoric isolates. Of the prehistoric sites that have been recorded, approximately 95 percent are lithic scatters or locations. Most sites have not yet been formally evaluated and are considered potentially eligible for the NRHP. Additional NRHP-eligible sites are likely to occur on INEL. A Draft Cultural Resources Management Plan has been prepared and is currently in the comment stage.

Historic Resources. Thirty-eight historic sites and 27 historic isolates have been identified on INEL; most are related to either agriculture (for example, homesteads and irrigation canals) or ranching (for example, sheep and cattle camps). Goodale's Cutoff, a spur of the Oregon Trail, is still recognizable in the southwestern corner of INEL. Experimental Breeder Reactor I, the first reactor to achieve a self-sustaining chain reaction using Pu instead of uranium as the principal fuel component, is listed on the NRHP and is designated a National Historic Landmark. Various other nuclear reactors and associated buildings, such as those at Auxiliary Reactor Area-I, -II, -III, the Borax Reactor, Materials Test Reactor, Engineering Test Reactor, and the Hot Shop, are considered eligible for the NRHP. Although such facilities are not yet 50 years old, they are of exceptional scientific and engineering significance and have played major roles in the development of nuclear science since World War II. Based on current studies, additional historic sites are likely to occur in unsurveyed portions of INEL.

Native American Resources. At the time of European-American contact, the area was inhabited by nomadic hunters and gatherers consisting of two linguistically distinct groups: the Shoshone and the Bannock. Horses enabled the Shoshone and Bannock to increase their foraging range, congregate in larger groups, and protect their possessions from other groups. Winter camps were reportedly scattered along major river drainages. Groups dispersed during the other seasons, probably moving across what is now INEL as they used floral and faunal resources, and obsidian from Big Southern Butte or Howe Point.

Important Native American resources that might be found in the proposed project area include buttes, caves, village shrines, rock art, burials, vision quest sites, and plants such as bluegrass, willow, and cattail. It is worth noting that many natural resources at INEL are viewed as cultural resources by Native Americans. As one example, sagebrush is used as a tool, for clothing, and for medicinal purposes. INEL recently initiated general consultation with the Shoshone-Bannock tribe and a Working Agreement between the two groups exists. While specific sites or traditional use areas have not yet been identified, the Shoshone and Bannock tribes consider INEL part of their ancestral homeland and have expressed support for the use of scientific methods to preserve cultural resources.

Paleontological Resources. The Snake River Plain is composed of numerous superimposed basalt lava flows that came from low-shield volcanoes, fissures, and tubes during the last two billion years. Except for a small area of Paleozoic deposits in the northwest corner of INEL, almost 75 percent of the facility is basalt flows covered with loess. The remainder of INEL (primarily in the north and northwest portions of the facility) is alluvial and aeolian sediments; fluvial sediments are found along the drainages.

As of 1994, 31 fossil localities have been identified at INEL. Fluvial sediments have yielded Late Pleistocene terrestrial vertebrate fossils, including mammoth, mastodon, horse, camel, and bison. Gastropods, microfauna, plant fossils, opal phytoliths, and pollen have also been recovered. Volcanic tubes and blisters serve as sediment traps and many in the older basalt flows contain fossils of small and medium-sized mammals. While most of these fossils date to the Holocene (within the last 10,000 years), some date to the Pleistocene-Holocene transition of about 11,500 years ago. Because these assemblages may contain both vertebrate and floral remains, such localities would have high research potential.

3.4.8 SOCIOECONOMICS

Socioeconomic characteristics described for INEL include employment and regional economy, population and housing, community services, and local transportation. Statistics for employment and regional economy are presented for the REA that encompasses 13 counties around INEL located in Idaho and Wyoming (Table L.1–1). Statistics for population and housing, community services, and local transportation are presented for the ROI, a five-county area (located in Idaho) in which 97.2 percent of all INEL employees reside: Bannock County (5.6 percent), Bingham County (12.6 percent), Bonneville County (69.2 percent), Butte County (2.5 percent), and Jefferson County (7.3 percent). [Text deleted.] In 1996, INEL employed 6,547 persons (IN DOE 1996b:1) (This total does not include some contractor employees.)

Regional Economy Characteristics. Selected employment and regional economy statistics for the INEL REA are summarized in Figure 3.4.8–1. Between 1980 and 1990, the civilian labor force in the REA increased 10.4 percent to the 1990 level of 119,700. The 1994 unemployment in the REA was 5.4 percent, which was about the same as the unemployment for Idaho (5.6 percent) and Wyoming (5.3 percent). The region's per capita income of $16,674 in 1993 was approximately 5 percent less than Idaho's per capita income of $17,511 and 15.4 percent less than Wyoming's per capita income of $19,719.

In 1993, the percentage of total employment involving the private sector activity of retail trade was similar in the REA (18 percent), Idaho, and Wyoming as shown in Figure 3.4.8–1. Service activities in the REA (27 percent of total employment) represented about a 4- and 4.5-percent greater share than in Idaho and Wyoming, respectively. Manufacturing in the REA (9 percent) represented a 3-percent smaller share of total employment than in Idaho and a 6-percent larger share than in Wyoming.

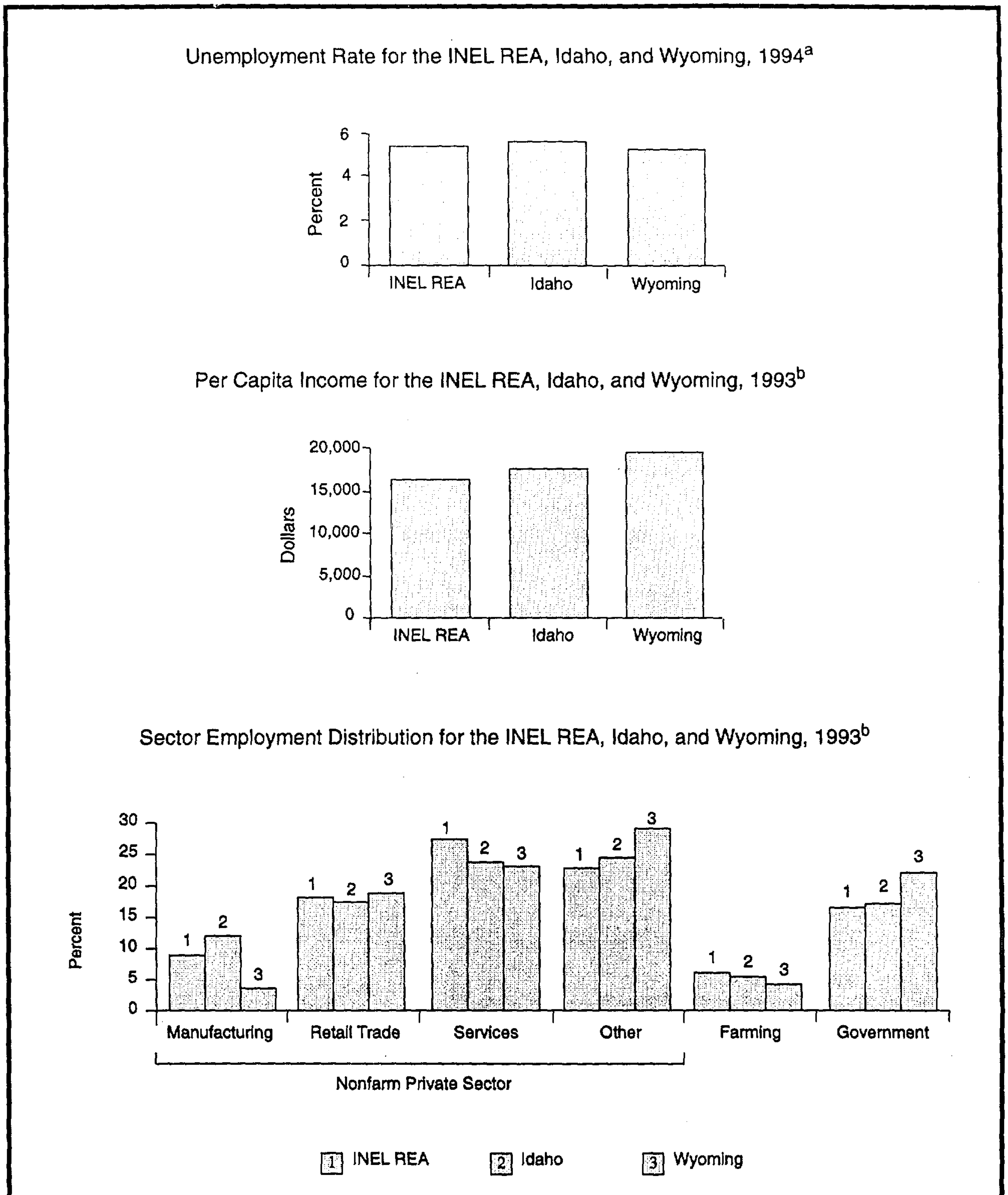
Population and Housing. In 1994, the ROI population totaled 212,610. Between 1980 and 1994, the ROI population grew by 14.0 percent, compared to 20.0 percent in Idaho. Within the ROI, Jefferson County experienced the largest increase at 20.4 percent, while Butte County's population decreased by 8.9 percent. Population and housing trends are summarized in Figure 3.4.8–2.

The increase in the total number of housing units in the ROI between 1980 and 1990, 6.5 percent, was approximately 3.5 percent less than the increase in the number of housing units in Idaho. The total number of housing units in the ROI for 1990 was 71,025. The 1990 ROI homeowner and renter vacancy rates, 2.2 and 8.5 percent, respectively, were similar to those in Idaho.

Community Services. Education, public safety, and health care characteristics were used to assess the level of community services in the INEL ROI. Figure 3.4.8–3 presents school district characteristics for the INEL ROI. Figure 3.4.8–4 presents public safety and health care characteristics.

Education. In 1994, 14 school districts provided public education services and facilities in the INEL ROI. As shown in Figure 3.4.8–3, these school districts operated at between 38-percent (Swan Valley School District) and 101.2-percent (Firth School District) capacity. The average student-to-teacher ratio for the INEL ROI in 1994 was 18.5:1. The Shelley School District had the highest ratio at 22.2:1.

Public Safety. City, county, and State law enforcement agencies provided police protection to the residents in the ROI. In 1994, a total of 340 sworn police officers were serving the five-county ROI. Idaho Falls employed the largest number of officers (82) and Bannock County had the highest officer-to-population ratio (2.5 sworn officers per 1,000 persons). The average ROI officer-to-population ratio was 1.6 officers per 1,000 persons. Figure 3.4.8–4 compares police force strengths across the ROI.



[a] DOL 1995a.
[b] DOC 1995a.

Figure 3.4.8–1. Employment and Local Economy for the Idaho National Engineering Laboratory Regional Economic Area and the States of Idaho and Wyoming.

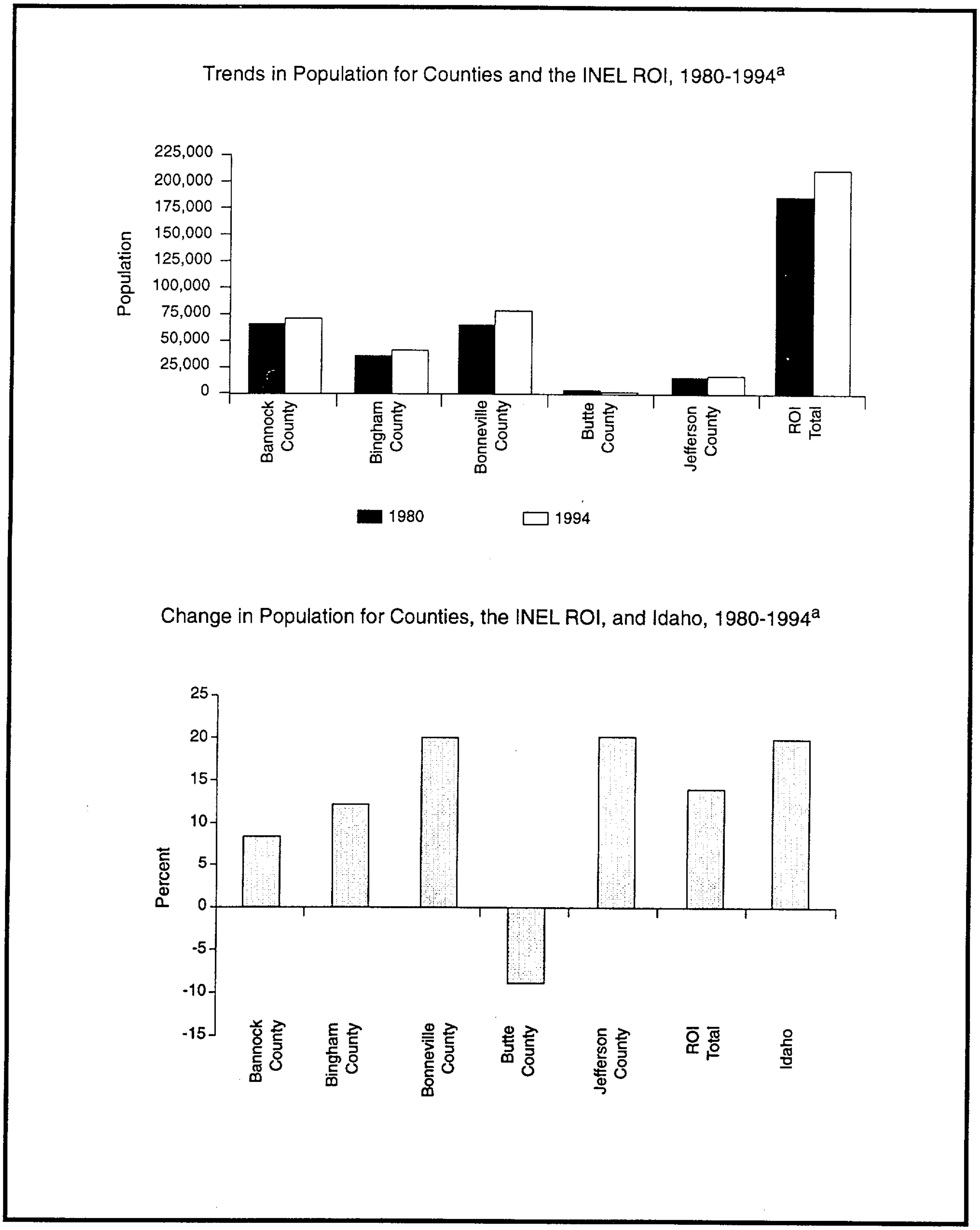
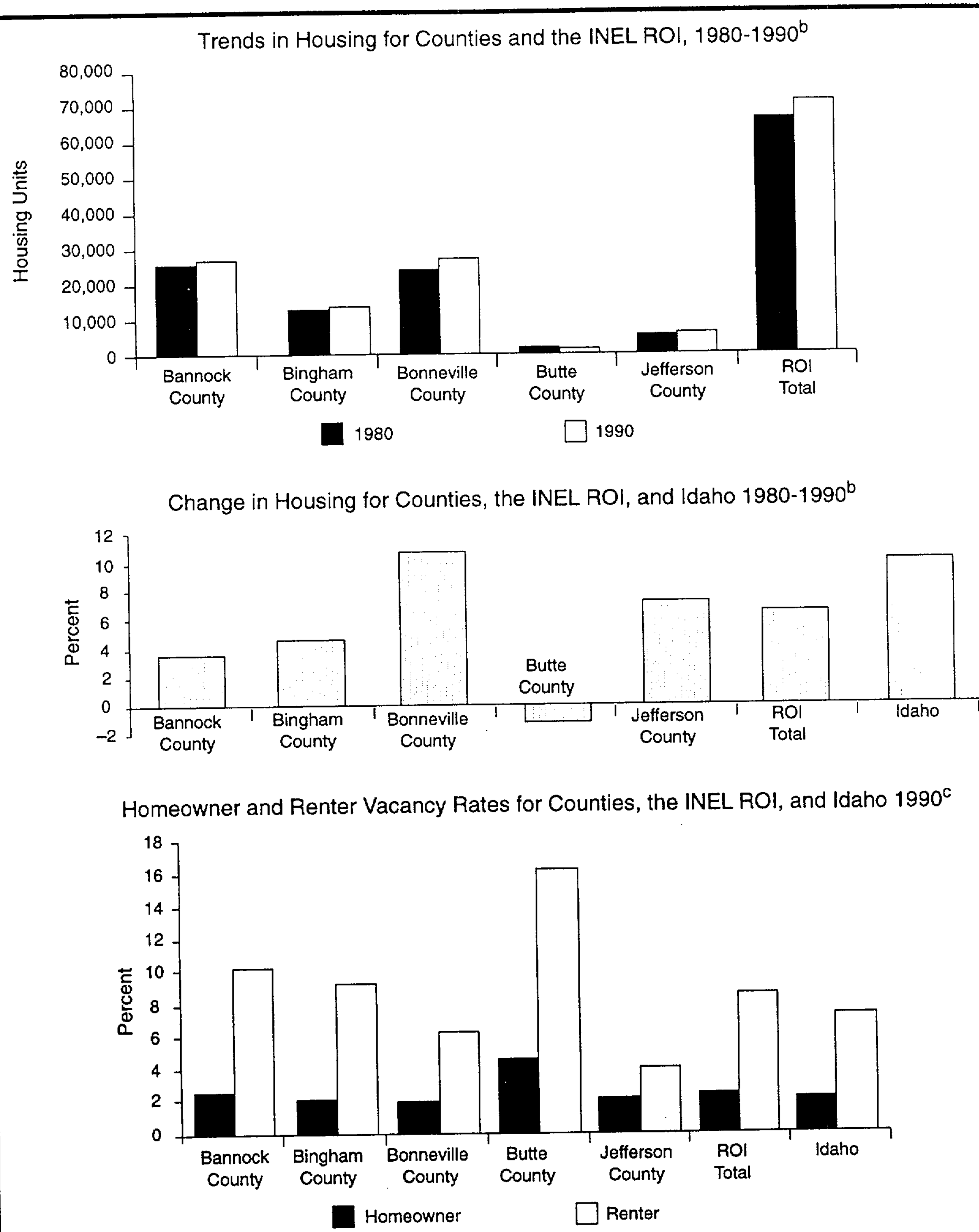
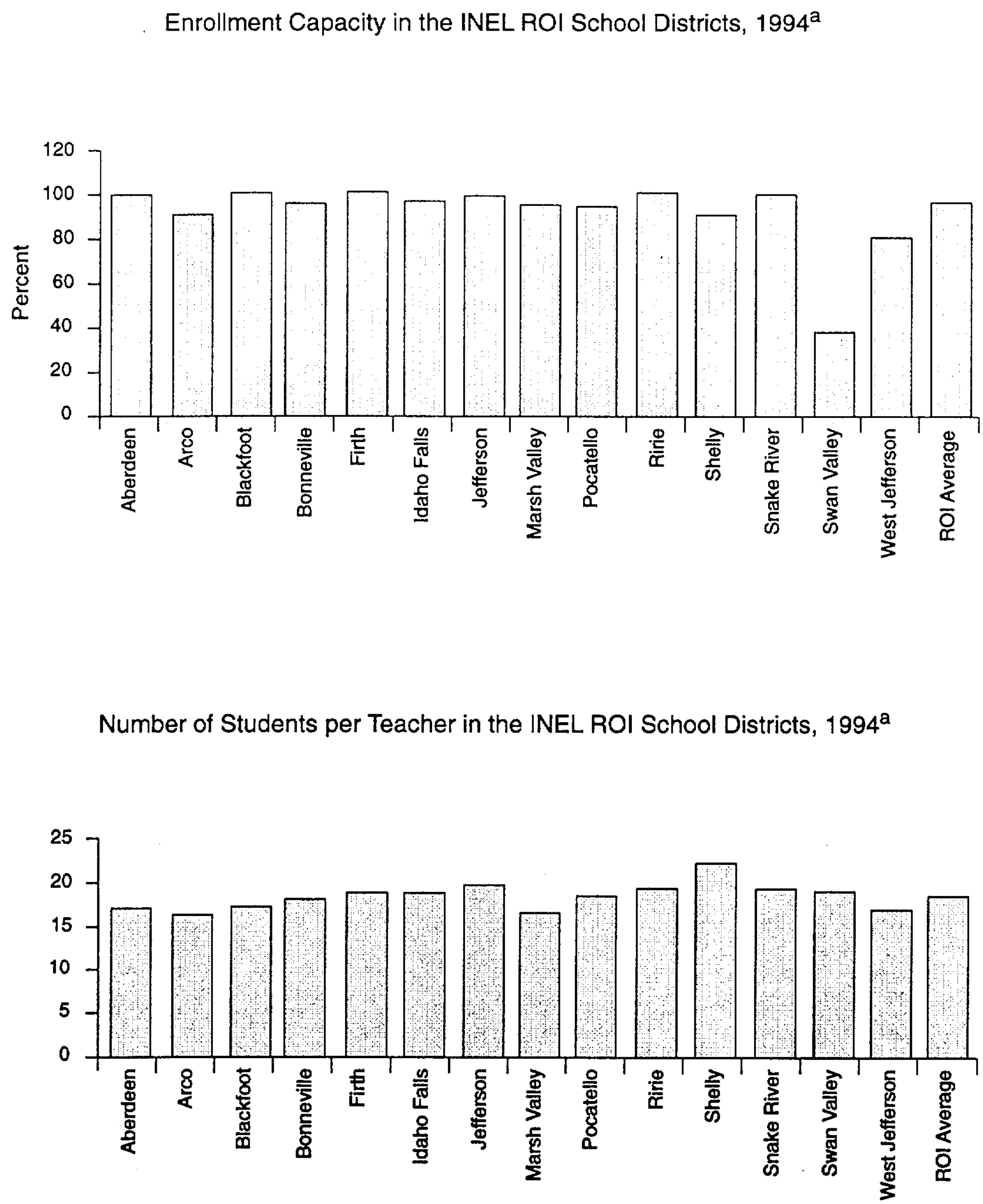


Figure 3.4.8–2. Population and Housing for the Idaho National Engineering Laboratory Region of Influence and the State of Idaho.



[a] Census 1983h; Census 1995a.
[b] Census 1982i; Census 1991n.
[c] Census 1991n.

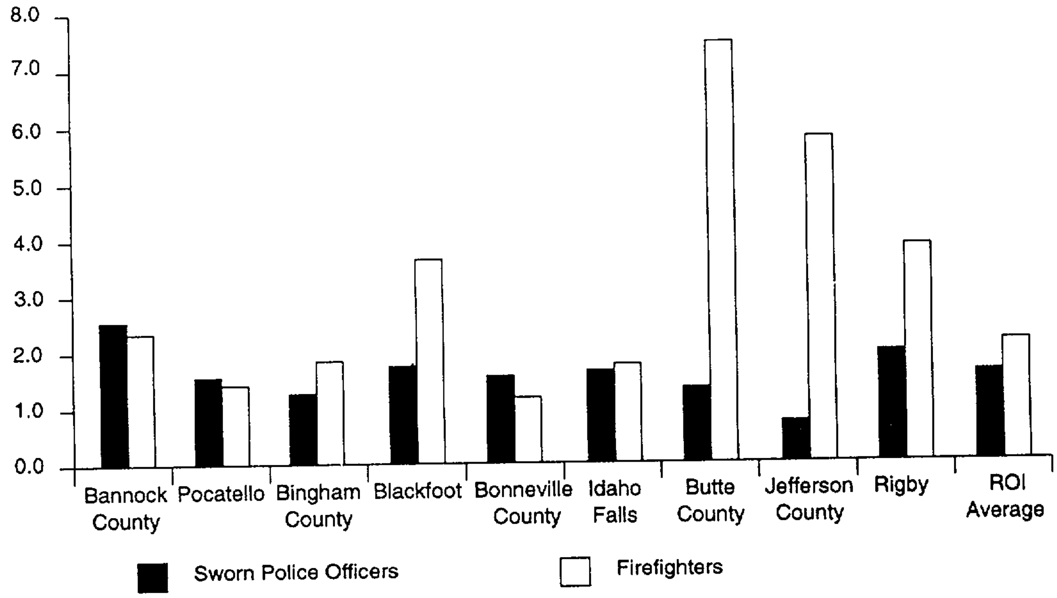
Figure 3.4.8–2. Population and Housing for the Idaho National Engineering Laboratory Region of Influence and the State of Idaho—Continued.



Source: Socio 1996a.

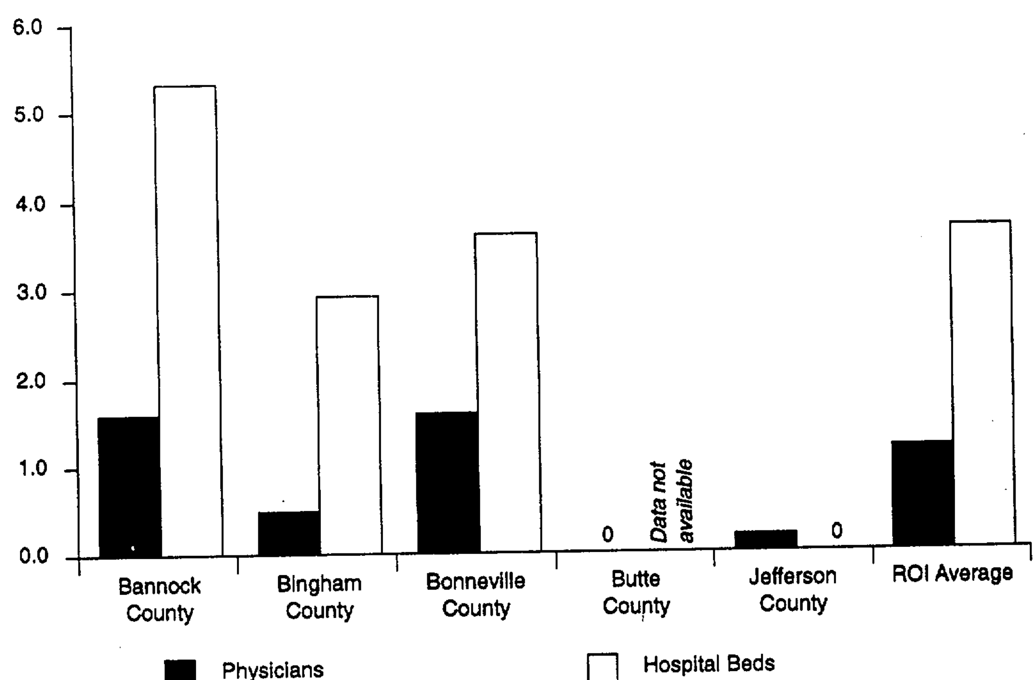
Figure 3.4.8–3. School District Characteristics for the Idaho National Engineering Laboratory Region of Influence.

Number of Sworn Police Officers (1994) and Firefighters (1995) per 1,000 Persons in the INEL ROI[a]



Note: Except for ROI cities, city sworn police officers and firefighters are included in the county totals.

Number of Physicians and Hospital Beds per 1,000 Persons in the INEL ROI, 1994[b]



[a] Census 1993n; Census 1995a; DOC 1994j; DOC 1996a; DOC 1996b; DOJ 1995a; Socio 1996a.
[b] AHA 1995a; AMA 1995a; Census 1995a.

Figure 3.4.8–4. Public Safety and Health Care Characteristics for the Idaho National Engineering Laboratory Region of Influence.

Fire protection services in the INEL ROI were provided by 465 paid and volunteer firefighters in 1995. The district with the highest firefighter-to-population ratio was located in Butte County, with 7.5 firefighters per 1,000 persons, as indicated in Figure 3.4.8–4. Jefferson County employed the greatest number of firefighters (90). The average firefighter-to-population ratio in the ROI was 2.2 per 1,000 persons.

Health Care. There were five hospitals serving the five-county ROI in 1994. Figure 3.4.8–4 displays the hospital bed-to-population ratios for the INEL ROI counties. During 1994, all hospitals were operating at below capacity, with hospital occupancy rates ranging from 48.0 percent in Bannock County to 60.8 percent in Bingham County.

In 1994, a total of 264 physicians served the ROI, with the majority (129) located in Bonneville County. Figure 3.4.8–4 shows that the physician-to-population ratios for the ROI ranged from no physicians in Butte County to 1.6 physicians per 1,000 persons in Bonneville County and Bannock County. The average ROI physician-to-population ratio was 1.2 physicians per 1,000 persons.

Local Transportation. Vehicular access to INEL is provided by U.S. Routes 20 and 26 to the south and State Routes 22 and 33 to the north. U.S. Routes 20 and 26 and State Routes 22 and 33 all share rights-of-way west of INEL (see Figure 2.2.3–1 and Figure 2.2.3–2).

There is one current road improvement project affecting access to INEL. U.S. Route 20 is being upgraded from two to four lanes and turn lanes are being added at intersections from 2 to 5 km (1 to 3 mi) west of Idaho Falls. In addition, there are four planned road improvement projects that could affect future access to INEL. The first is an upgrade from two to four lanes and the addition of turn lanes at intersections from 5 to 8 km (3 to 5 mi) west of Idaho Falls. The second is the resurfacing of State Route 33 from the intersection of State Routes 28 and 33 to 13 km (8 mi) east of this intersection. The third is the resurfacing of Interstate 15 from Fort Hall to South Blackfoot. The last is the asphalt chip seal of U.S. Route 26 from the U.S. Route 20 and U.S. Route 26 intersection to Blackfoot (ID DOT 1995a:1).

There are two road segments that could be affected by the storage and disposition alternatives. The first road segment is U.S. Route 20 from U.S. Routes 26 and 91 at Idaho Falls to U.S. Route 26 East. In 1995 this road segment operated at level of service D. The second road segment is U.S. Routes 20 and 26 from U.S. Route 26 East to State Routes 22 and 33. This segment operated at level of service B in 1995.

The Department shuttle vans provide transportation between INEL facilities and Idaho falls for the 4,000 DOE and contractor personnel who work at INEL. The major railroad in the ROI is the Union Pacific Railroad. The railroad's Blackfoot-to-Arco branch provides rail service to the southern portion of INEL. A DOE-owned spur connects the Union Pacific Railroad to INEL by a junction at Scovill Siding. There are no navigable waterways within the ROI capable of accommodating waterborne transportation of material shipments to INEL.

Fanning Field in Idaho Falls and Pocatello Municipal Airport in Pocatello provide jet air passenger and cargo service for both national and local carriers. Numerous smaller private airports are located throughout the ROI.

3.4.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Radiation Environment. Major sources and levels of background radiation exposure to individuals in the vicinity of INEL are shown in Table 3.4.9–1. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population changes as the population size changes. Background radiation doses are unrelated to INEL operations.

Table 3.4.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Idaho National Engineering Laboratory Operation

Sources	Effective Dose Equivalent (mrem/yr)
Natural Background Radiation[a]	
Cosmic radiation	39
External terrestrial radiation	59
Internal terrestrial	40
Radon in homes (inhaled)	200
Other Background Radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	403

[a] IN DOE 1994c.
[b] NCRP 1987a.
Note: Value for radon is an average for the United States.

Releases of radionuclides to the environment from INEL operations provide another source of radiation exposure to individuals in the vicinity of INEL. Types and quantities of radionuclides released from INEL operations in 1993 are listed in *The Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1993* (DOE/ID-12082 [93]). The doses to the public resulting from these releases are presented in Table 3.4.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1993 report were used in the development of the reference environment's (No Action) radiological releases and resulting impacts at INEL in the year 2005 (Section 4.2.3.9).

Based on a risk estimator of 500 cancer deaths per 1 million person-roentgen equivalent man (rem) to the public (Section M.2.1.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from INEL operations in 1993 is estimated to be 1.5×10^{-8}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of INEL operations is about 2 chances in 100 million. (Note that it takes several to many years from the time of radiation exposure for a cancer to manifest itself.)

Based on the same risk estimator, 1.5×10^{-4} excess fatal cancers are projected in the population living within 80 km (50 mi) of INEL from normal operations in 1993. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this national mortality rate, the number of fatal cancers expected during 1992 from all causes in the population

Table 3.4.9–2. Radiation Doses to the Public From Normal Idaho National Engineering Laboratory Operation in 1993 (Committed Effective Dose Equivalent)

Members of the General Public	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual	Standard[a]	Actual	Standard[a]	Actual
Maximally exposed individual (mrem)	10	0.030	4	0	100	0.030
Population within 80 km[b] (person-rem)	None	0.30	None	0	100	0.30
Average individual within 80 km[c] (mrem)	None	0.0025	None	0	None	0.0025

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the CAA, the 4 mrem/yr limit is required by the SDWA, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (see 58 FR 16268). If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.

[b] In 1993, this population was approximately 121,500.

[c] Obtained by dividing the population dose by the number of people living within 80 km of the site.

Source: IN DOE 1994c.

living within 80 km (50 mi) of INEL was 243. This number of expected fatal cancers is much higher than the estimated 1.5×10^{-4} fatal cancers that could result from INEL operations in 1993.

Idaho National Engineering Laboratory workers receive the same doses as the general public from background radiation but also receive an additional dose from working in the facilities. Table 3.4.9–3 presents the average worker, maximally exposed workers, and total cumulative worker dose to INEL workers from operations in 1992. These doses fall within radiological regulatory limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (Section M.2.1.2), the number of fatal cancers to INEL workers from normal operations in 1992 is estimated to be 0.030.

Table 3.4.9–3. Radiation Doses to Workers From Normal Idaho National Engineering Laboratory Operation in 1992 (Committed Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual
Average worker (mrem)	ALARA	14.2
Maximally exposed worker (mrem)	5,000	1,000
Total workers[b] (person-rem)	ALARA	75

[a] DOE's goal is to maintain radiological exposure as low as reasonably achievable.

[b] The number of badged workers in 1992 was approximately 5,270.

Source: 10 CFR 835; DOE 1993n:7.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in *The Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1993* (DOE/ID-12082[93]). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (onsite and offsite) are also presented in that document.

Chemical Environment. The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, surface water during swimming, or soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in Section 3.4.3.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (for example, air emissions and NPDES permit requirements), contribute toward minimizing potential health impacts to the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at INEL via inhalation of air containing hazardous chemicals released to the atmosphere by INEL operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway. At INEL, the risk to public health from water ingestion and direct exposure pathways is low because the surface water resource (Big Lost River) is not used for drinking or as a receptor for wastewater discharges.

Baseline air emission concentrations for hazardous chemicals and their applicable standards are included in the data presented in Section 3.4.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Section M.3.

Exposure pathways to INEL workers during normal operation may include inhaling the workplace atmosphere and direct contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. INEL workers are also protected by adherence to OSHA and EPA standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that reflects the frequency and amounts of chemicals utilized in the operational processes ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm. Therefore, worker health conditions at INEL are expected to be substantially better than required by the standards.

Health Effects Studies. No occupational epidemiological studies have been conducted at INEL to date, but two epidemiological studies have been conducted on communities surrounding INEL to determine if there are any excess cancers in the general population. No excess cancer mortality was reported, although excess cancer incidence was observed. However, no association of the excess cancer incidence with INEL was established. For a more detailed description of the study findings reviewed, refer to Section M.4.4.

Accident History. A recent study, the *Idaho National Engineering Laboratory Historical Dose Evaluation* (DOE/ID-12119), was conducted by DOE to estimate the potential offsite radiation doses for the entire operating history of INEL. Releases resulted from a variety of tests and experiments as well as a few accidents at INEL. The study concluded that these releases contributed to the total radiation dose during test programs of the 1950s and early 1960s. The frequency and size of releases has declined since that time. Based on information reported in the study, there have been no serious unplanned or accidental releases of radioactivity or other hazardous substance at INEL facilities in the last 10 years of operation. [Text deleted.]

Emergency Preparedness. Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered.

The emergency management program incorporates activities associated with emergency planning, preparedness, and response.

Participating government agencies whose plans are interrelated with the INEL Emergency Plan for Action include the State of Idaho, Bingham County, Bonneville County, Butte County, Clark County, Jefferson County, the Bureau of Indian Affairs, and Fort Hall Indian Reservation. INEL contractors are responsible for responding to emergencies that occur at their facilities. When an emergency condition exists at a contractor facility, the Emergency Action Director is responsible for recognition, classification, notifications, and protective action recommendations. At INEL, emergency preparedness resources include fire protection from onsite and offsite locations and radiological and hazardous chemical material response. Emergency response facilities include an emergency control center at each facility, at the INEL warning communication center, and at the INEL site emergency operations center. There are also seven INEL medical facilities available to provide routine and emergency service.

3.4.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory structure and ongoing waste management activities for INEL. A more detailed discussion of the ongoing waste management operations is provided in Section E.2.3. Table 3.4.10–1 presents a summary of waste management activities at INEL for 1992.

The Department is working with Federal and State regulatory authorities to address compliance and cleanup obligations arising from its past operations at INEL. DOE is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements and financial penalties for nonachievement of agreed-upon milestones.

The EPA placed INEL on the NPL on December 21, 1989. DOE has entered into a Federal Facility Agreement and Consent Order with EPA and the State of Idaho to coordinate cleanup activities at INEL under a comprehensive strategy. This agreement integrates DOE's CERCLA response obligations with RCRA and *Hazardous Waste Management Act* of 1986 corrective action obligations. In this process, INEL has been divided into 10 waste area groups. Each group is subdivided into separate operable units composed of potential release sites that are considered together for assessment and cleanup activities. Ongoing assessments are characterizing the nature and extent of contamination. Aggressive plans are in place to achieve early remediation of sites that represent the greatest risk to workers and the public. The goal is to complete remediation of contaminated sites at INEL to support delisting from the NPL by 2019. INEL manages spent nuclear fuel and the following waste categories: high-level, TRU, low-level, mixed, hazardous, and nonhazardous. A discussion of the waste management operations associated with each of these categories follows.

Spent Nuclear Fuel. Spent nuclear fuel had been stored and processed at the ICPP. Processing was terminated with DOE's decision to halt reprocessing of spent nuclear fuel. INEL has received spent nuclear fuel from Three Mile Island, reactor tests, and the gas-cooled reactor and Naval Reactors Programs. Spent nuclear fuel from these programs and from reactor experiments at INEL is in storage in various locations. The bulk of the fuel is stored at the ICPP. Interim management of the spent nuclear fuel (pending the availability of a geologic repository) will be in accordance with the ROD published in the *Federal Register* on June 1, 1995 (60 FR 28680) and amended on March 8, 1996 (61 FR 9441), for the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F). As a result of this ROD as amended, INEL will manage DOE's non-aluminum-clad spent fuel. This will require 114 shipments of aluminum-clad spent fuel to SRS and receipt of 1,133 shipments of non-aluminum-clad spent fuel. This spent fuel then will be placed in interim storage.

High-Level Waste. High-level waste at INEL was generated in the process of extracting useful isotopes from spent nuclear fuel at the ICPP. Most of this fuel was from the Naval Reactors Program. Most aqueous solutions from spent nuclear fuel processing and isotope extraction were concentrated by evaporation and separated into LLW and HLW streams in the Process Equipment Waste Evaporator. The liquid HLW is stored in subsurface tanks and then transformed into solid metallic oxides in a granular form by calcination. The calcine is stored in stainless steel bins in near-surface concrete vaults where it awaits further processing into a form suitable for emplacement in a Federal repository. As a result of the ROD for the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F), calcination will resume until all liquid HLW is calcined. This will permit INEL to meet the requirements of a December 1991 consent order with the State of Idaho and EPA to cease use of existing storage tanks without constructing new tanks. Subsequently, the calcined waste will be treated to meet RCRA provisions on a schedule to be negotiated with the State of Idaho under the *Federal Facility Compliance Act.*

Table 3.4.10–1. Spent Nuclear Fuel and Waste Management Activities at Idaho National Engineering Laboratory

Category	1992 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Spent Nuclear Fuel	1.4 t[a,b] heavy metal	Conditioning and stabilization	Under assessment[c]	Pools, dry facility	261 t[c,d] heavy metal	None—High-Level Waste Program in the future	None
High-Level							
Liquid	560[b]	Evaporation, calcination	470[e]	Tank farm, after evaporation prior to calcination	13,400[f]	NA	NA
Solid[g]	None[b]	Decontamination, filter leach	238[h]	Bins inside concrete vaults	7,110[i]	None—High-Level Waste Program in the future	None
Transuranic							
Liquid	None	NA	NA	NA	NA	NA	NA
Solid	1	Decontamination, filter leach, calcination	595[j]	Asphalt pads and vaults in the ground or under earthen cover or tarps	206,000[k]	None—WIPP or alternate facility in the future	None
Low-Level							
Liquid	None	Evaporation, Ion exchange	11,600[l]	Tank farm after evaporation prior to calcination	With HLW	NA	NA
Solid	11,300	Incineration and compaction	3,350[m]	NA	NA	Onsite burial	180,000[n]
Mixed							
Liquid	5	Evaporation, fractionation, and calcination	11,600[l]	Tank farm	With HLW	None	None
Solid	51	Incineration and compaction	3,350[m]	Mixed waste storage facilities	115,000[o]	None	None

Table 3.4.10–1. Spent Nuclear Fuel and Waste Management Activities at Idaho National Engineering Laboratory—Continued

Category	1992 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Hazardous							
Liquid	Included in solid	Offsite and percolation ponds	Under assessment[c]	Percolation ponds	Under assessment[c]	Offsite	NA
Solid	835[p]	Offsite	NA	Hazardous waste storage facility	Under assessment[c]	Offsite	NA
Nonhazardous (Sanitary)							
Liquid	50,800	Percolation ponds	NA	NA	NA	NA	NA
Nonhazardous (Other)							
Liquid	Included in sanitary	Recycle	NA	NA	NA	NA	NA
Solid	62,000	Segregate and recycle	NA	NA	NA	Industrial and asbestos waste landfills	1,830,000 to 3,060,000[q]

[a] Spent nuclear fuel is normally expressed in metric tons, not cubic meters.
[b] 1993 data.
[c] Capacity will be increased to accommodate ROD from the *DOE Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement*, as amended.
[d] Current capacity includes ICPP, TAN, ANL-W, NRF, PBF, and TRA.
[e] New waste calcining facility.
[f] ICPP tank farm.
[g] Solid HLW produced by calcination of liquid HLW.
[h] ICPP debris treatment, HEPA filter leach.
[i] ICPP calcine bin sets.
[j] ICPP new waste calcining facility, debris treatment, HEPA filter leach.
[k] ANL-W, ICPP, RWMC.
[l] Liquid effluent treatment facility, potable water treatment, new waste calcining facility.
[m] ICPP debris treatment, HEPA filter leach, waste experimental reduction facility, lead treatment sodium processing facility, TAN cask dismantlement.
[n] 37,000 m^3 available as of 1991. Additional 67,000 m^3 expansion capacity potentially available.
[o] ANL-W, ICPP, PBF, RWMC, TAN.
[p] 760 m^3 recyclable.
[q] Remaining capacity.
Note: NA= not applicable; WERF= Waste Experimental Reduction Facility.
Source: 60 FR 28680; 61 FR 9441; DOE 1995i; DOE 1995v; IN DOE 1995d; INEL 1993a:5.

Transuranic Waste. Transuranic wastes are stored at the RWMC. This inventory represents more than half of the total DOE inventory. There is very little TRU waste generation at INEL. Most of the TRU waste in storage was received from RFETS. As a result of the ROD from the *Department of Energy Programmatic Spent Nuclear Fuel and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F), and pending the ROD to be issued from the *DOE Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive Hazardous Waste* (DOE/EIS-0200-D) and in compliance with the *INEL Site Treatment Plan*, INEL may receive TRU waste from other facilities for treatment. After treatment, the waste would be returned to the generator for storage and eventual transport to a Federal repository. TRU wastes are currently being stored pending approval of WIPP as a repository for these wastes. Assuming WIPP is determined to be a suitable repository for these wastes, pursuant to the requirements of 40 CFR 191 and 40 CFR 268, these wastes will be treated to meet the WIPP WAC and packaged in accordance with DOE and DOT requirements for transport to WIPP for disposal depending on decisions made in the ROD associated with the supplemental EIS being prepared for the proposed continued phased development of WIPP for disposal of TRU waste.

Before 1970, when the AEC first required segregation of TRU wastes from other wastes, TRU wastes were buried in earthen trenches at the RWMC. This waste must be retrieved and repackaged to meet the current WIPP WAC. Wastes generated or received from offsite since 1970 are stored in a form designed for eventual retrieval. Since 1972, TRU wastes have been stored on Pad A in the RWMC. Most of this waste will require certification and repackaging. A new facility, the Advanced Mixed Waste Treatment Project, is being designed to accomplish this task. Some waste has radioactivity levels high enough that there are no certified or licensed transportation capabilities for it. Further study will be required for its eventual disposal. While the EPA has issued a notice of noncompliance for TRU waste stored at the RWMC, a proposed plan for the treatment and storage of TRU wastes has been documented in the Federal Facility Agreement and Consent Order, which addresses EPA and State of Idaho concerns, while also meeting DOE's concerns for worker protection. Some of the waste now handled as TRU or mixed TRU is alpha-contaminated LLW and mixed LLW. A strategy for treatment and disposal of this waste has yet to be established. Onsite and offsite treatment is being investigated.

Low-Level Waste. The bulk of LLW generated at INEL is the result of work in contaminated areas and consists of materials such as rags, bags, scrap metal, and used protective clothing. A large volume of LLW is generated in the D&D activities associated with environmental restoration. In addition, small amounts of LLW may be received from offsite for treatment and disposal. These materials must be treated by the operating facility to meet the WAC of the receiving facility, and conformity to these criteria must be verified by the receiving facility. Solid LLW at INEL is sent to the Waste Experimental Reduction Facility for compaction, sizing, incineration, and stabilization before shipment for disposal at the RWMC. The Waste Experimental Reduction Facility will be used to incinerate LLW. It is undergoing modifications to processes and procedures and is expected to be in operation in mid-1996.

Mixed Low-Level Waste. The volume of mixed LLW generated at INEL is small. Mixed LLW is stored in several areas onsite awaiting treatment capacities to be developed to treat the specific nature of a wide variety of different mixed waste streams. As a result of the ROD (60 FR 28680) from the *DOE Programmatic Spent Fuel and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final EIS* (DOE/EIS-0203-F), pending the ROD from the *DOE Waste Management Programmatic Environmental Impact Statement for the Managing Treatment, Storage, and Disposal of Radioactive Hazardous Waste* (DOE/EIS-0200-D), and in compliance with the consent order resulting from the *INEL Site Treatment Plan*, INEL may accept offsite mixed LLW for treatment. Waste residuals would be returned to the generator or shipped elsewhere for disposal. Mixed LLW is planned to be processed to RCRA Land Disposal Restriction (LDR) treatment standards through the Waste Experimental Reduction Facility incinerator beginning in June 1996, in the Advanced Mixed Waste Treatment Project beginning June 1998 through June 2000, and in the Sodium Processing Facility in March 1997. The use of commercial treatment facilities is also being considered. Large volumes of wastewater are processed in the Process Equipment Waste Evaporator, resulting in a

concentrated mixed waste that is sent to the HLW tank farm and eventually stabilized in a fluidized bed calciner. Condensate from the Process Equipment Waste Evaporator is converted into a concentrated acidic solution in the Liquid ETF. This concentrate is either recycled as a scrubber solution for the calciner or sent to the HLW tank farm for storage. The Liquid ETF eliminates residual discharge of hazardous and radioactive contaminants into wastewater percolation ponds, which was the former practice, in accordance with a consent order signed on October 7, 1992. Current mixed waste plans are documented in the *INEL Site Treatment Plan*, which was prepared in compliance with the *Federal Facility Compliance Act* of 1992.

Hazardous Waste. Hazardous wastes are generated at separate facilities at INEL and are staged for shipment offsite to commercial RCRA-permitted treatment and disposal facilities. Offsite shipments are surveyed to determine that the wastes have no radioactive content (are not mixed waste). The major onsite RCRA-permitted hazardous waste storage facility is located in the CFA. The Waste Handling Facility Project at ANL-W will be implemented to handle ANL-W waste. A recycling program has been established, and in 1992, 760 m^3 (994 yd^3) of hazardous wastes were recycled.

Nonhazardous Waste. Nonhazardous waste generated at INEL facilities is disposed of onsite in a landfill complex in the CFA and at the Bonneville County landfill. The onsite landfill complex contains separate areas for sanitary, industrial, and asbestos waste. Sewage is directed to surface impoundments in accordance with terms of the October 7, 1992, consent order, and the water is allowed to evaporate. The resulting sludge is placed in the landfill. Solids are separated and reclaimed where possible. The goal of the INEL waste minimization program is to reduce the nonhazardous waste quantities generated by 50 percent over the next 5 years. The landfill area at INEL is 4.8 ha (12 acres) and is being expanded by 91 ha (225 acres) to provide capacity for at least the next 30 years (60 FR 28680).

3.5 PANTEX PLANT

Pantex is located in the Texas Panhandle in Carson County along U.S. Highway 60 and lies about 27 km (17 mi) northeast of downtown Amarillo. Figure 2.2.4–1 indicates the location of Pantex, and Figure 2.2.4–2 shows the location of primary facilities and industrial zones within the site's boundary.

Pantex lies on the Llano Estacado (staked plains) portion of the Great Plains. The topography at Pantex is relatively flat, characterized by rolling grassy plains and numerous natural playa basins. The term "playa" is used to describe the more than 17,000 ephemeral lakes in the Texas Panhandle, usually less than 1 km (0.6 mi) in diameter, that receive water runoff from the surrounding area. The region is a semiarid farming and ranching area. Pantex is surrounded by agricultural land, but several significant industrial facilities are also located nearby.

Pantex is Government-owned and contractor-operated. The Mason & Hanger-Silas Mason Company has been the operating contractor since 1956. Since 1991, the environmental, health, and safety programs have been subcontracted to Battelle Memorial Institute.

Pantex was first used by the U.S. Army for loading conventional ammunition shells and bombs from 1942 to 1945. In 1951, the AEC arranged to begin rehabilitating portions of the original plant and constructing new facilities for nuclear weapons operations. The current missions are shown in Table 3.5–1. Weapons assembly, disassembly, and stockpile surveillance activities involve handling (but not processing) of encapsulated uranium, Pu, and tritium, as well as a variety of nonradioactive hazardous or toxic chemicals. Environmental restoration of the facility is a recent addition to operations at the plant.

Table 3.5–1. Current Missions at Pantex Plant

Mission	Description	Sponsor
Plutonium Storage	Provide storage of pits from dismantled nuclear weapons	Assistant Secretary for Defense Programs
High Explosive(s) Components	Manufacture for use in nuclear weapons	Assistant Secretary for Defense Programs
Weapon Assembly	Assemble new nuclear weapons for the stockpile	Assistant Secretary for Defense Programs
Weapon Maintenance	Retrofit, maintain, and repair stockpile weapons	Assistant Secretary for Defense Programs
Quality Assurance	Stockpile quality assurance testing and evaluation	Assistant Secretary for Defense Programs
Weapon Disassembly	Disassemble stockpile weapons as required	Assistant Secretary for Defense Programs
Test/Training Programs	Assemble nuclear weapon-like devices for training	Assistant Secretary for Defense Programs
Weapons Dismantlement	Dismantle nuclear weapons no longer required	Assistant Secretary for Defense Programs
Development Support	Provide support to design agencies as requested	Assistant Secretary for Defense Programs
Environmental Management	Environmental Restoration and Waste Management Activities	Assistant Secretary for Environmental Management

Source: PX 1995a:2

Department of Energy Activities. All DOE activities at Pantex, except for environmental restoration and some waste management programs, fall under the DOE Office of the Assistant Secretary for Defense Programs (DP). Historically, DOE's national security mission for Pantex primarily included assembly and delivery to DoD of a variety of nuclear weapons. Today, the primary role of Pantex is the disassembly of U.S. nuclear weapons being returned to DOE by DoD. This operation is in compliance with the negotiated downsizing of the United States and the former Soviet nuclear forces. Disassembly of a nuclear weapon includes removal of the fissile material. Subsequent storage of pits is the mission of major relevance to this PEIS.

Other activities that have been, and will continue to be, conducted under DOE's national security mission include certain maintenance and monitoring activities of the remaining nuclear weapons stockpile, modification and assembly of existing nuclear weapons systems, and production of HE components for nuclear weapons. DOE also conducts quality evaluation of weapons, quality assurance testing of weapons components, and R&D activities supporting nuclear weapons at the plant. DOE's responsibilities are mandated by statutes, Presidential directives, and congressional authorization and appropriations.

Waste management operations at Pantex in the near term (1996 to 1997) would add facilities to enhance capabilities to adequately handle existing waste streams. Improved facilities for hazardous waste staging, treatment, and storage would be coupled with increased use of commercial offsite facilities to treat mixed waste streams. The change in mission emphasis from assembly to disassembly of nuclear weapons would cause an increase in some waste streams and a decrease in others. New waste-handling capacities would be required to meet this need, but upon completion of the current backlog of dismantlements due to stockpile reduction, waste generation would decrease.

Non-Department of Energy Activities. Texas Tech University pursues agricultural activities on both DOE-owned and DOE-leased property.

3.5.1 LAND RESOURCES

Land Use. Pantex is located within Carson County in the Panhandle region of Texas, 27 km (17 mi) east-northeast of downtown Amarillo. Pantex operational activities are situated within 6,030 ha (14,900 acres) of land, of which approximately 3,683 ha (9,100 acres) are owned by the Federal Government and the remaining 2,347 ha (5,800 acres) are leased from Texas Tech University primarily to provide a safety and security buffer zone. All owned and leased buildings on the site are administered, managed, and controlled by DOE. DOE owns an additional remote tract of 436 ha (1,077 acres) of undeveloped land at Pantex Lake located approximately 4 km (2.5 mi) northeast of the main plant site. This property is held by DOE to retain the water rights. Total Pantex area equals 6,466 ha (15,977 acres).

Existing Land Use. Generalized land uses at Pantex and the vicinity are shown on Figure 3.5.1–1. The Texas Tech Agriculture Research operations use DOE-owned land not actively used for Pantex operations, as well as the property leased to DOE for agricultural purposes. Agricultural activities generally consist of dry farming and livestock grazing. A limited amount of crop irrigation occurs. Soil map units classified as prime farmland soils by the U.S. Department of Agriculture, National Resources Conservation Service exist onsite. However, the potential for farmland conversion by activities at Pantex is not an issue since Pantex is exempt from compliance with the *Farmland Protection Policy Act* (PX DOE 1995a:1). Land area leased from Texas Tech also contains one residence and one trailer located approximately 6 km (3.7 mi) southwest of the weapons assembly and disassembly and HE production core (PX DOE 1996b:4-94).

The land surrounding Pantex is rural private property. The closest offsite residences are approximately 48 m (157 ft) from the plant boundary in the western and northeastern sectors. Most of the surrounding land is prime farmland when irrigated, with the exception of the area northwest of the plant site, which is rangeland. Some property owners have enrolled their land in the Federal Conservation Reserve Program. Under terms of the program, the land is placed in a dormant state for 10 years and cannot be cultivated or grazed. The majority of the land, however, is cultivated. The land is generally dry farmed; however, some fields are irrigated from local playas or from the Ogallala Aquifer. The Iowa Beef Packers, Inc., packing plant is the only industrial activity within 3.2 km (2.0 mi) of Pantex.

Land-Use Planning. Within the State of Texas, land-use planning occurs only at the municipal level. The city of Amarillo comprehensive plan has designated land for future growth. The direction for future residential development is anticipated to occur toward the southwest, away from Pantex. The East Planning Area of the city, which extends to within 3.2 km (2 mi) of Pantex, has historically been one of the slower growing residential areas. Because of the presence of the airport and industrial use in this area, the comprehensive plan encourages compatible use rather than residential use. The largest residential area in the East Planning Area is the base housing of the former Amarillo Air Force Base. The base housing has been converted to rental housing and is located approximately 8 km (5 mi) southwest of the plant boundary.

Visual Resources. Pantex is sited within a landscape typical of the High Plains region of Texas consisting of cultivated cropland and rangeland. Pantex consists of operational facilities of the plant and the inactive facilities of the former World War II ammunition plant. These industrial land uses are surrounded by cropland and rangeland that blend into the offsite viewscape. The developed areas of Pantex are consistent with VRM Class 5 designation. The remainder of Pantex ranges from VRM Class 3 to Class 4.

Public access within Pantex and its buffer areas is strictly controlled and limited to authorized personnel, visitors, and the agricultural lessee and sublessees. Public access adjacent to the plant perimeter is limited to three Texas Farm-to-Market Roads and U.S. Route 60. The most visible, and therefore most sensitive, viewpoint of Pantex facilities is located 2.4 km (1.5 mi) southeast at the intersection of U.S. Route 60 and Texas Farm-to-Market Road 2373. U.S. Route 60 is part of the Texas Plains Trail, a scenic road with Pantex a designated point of interest. The view of the plant along this highway is visible, appearing as low clusters of buildings on a flat horizon. Because of their height, the cylindrical water towers are the most visible feature. The operations areas

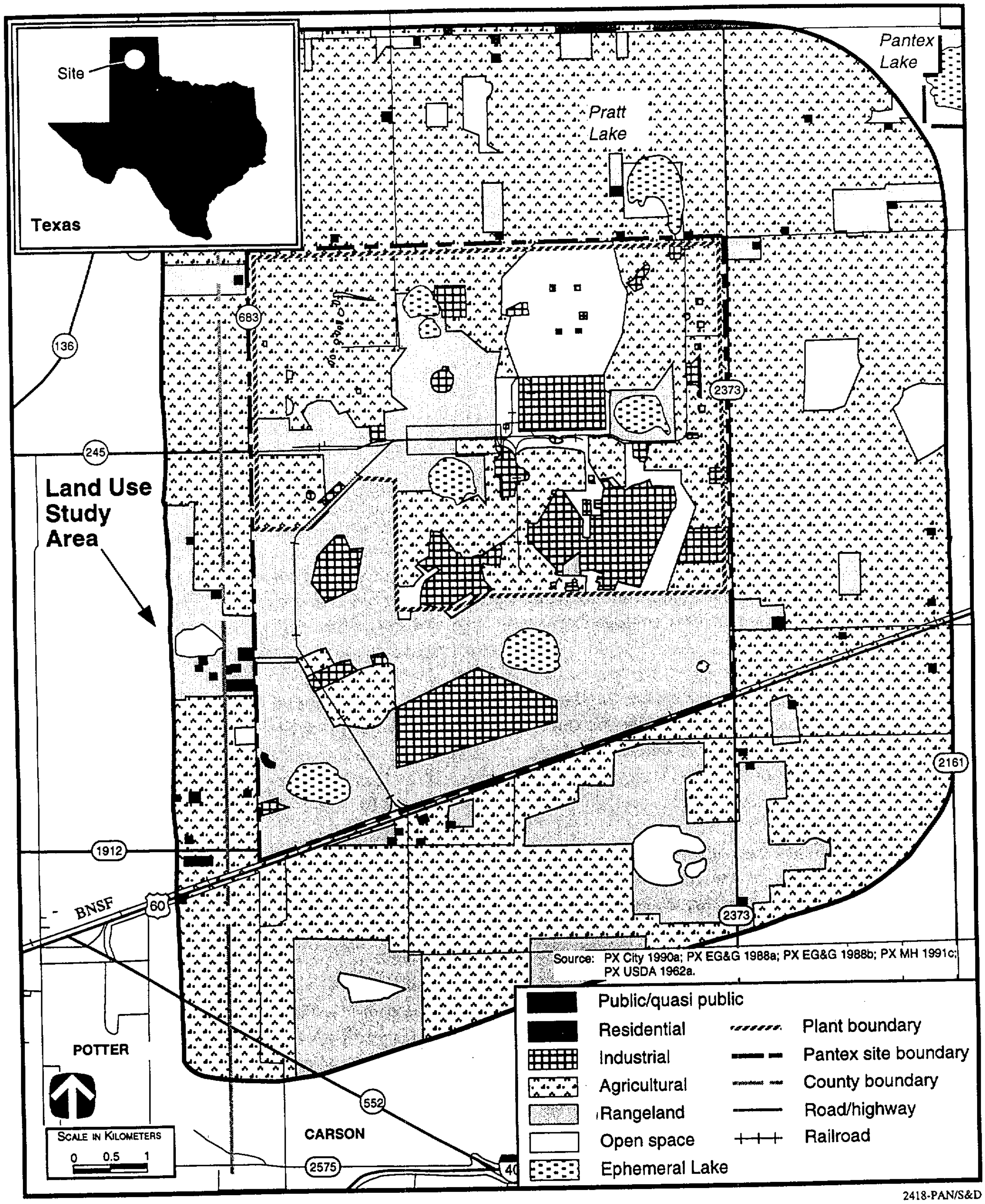


Figure 3.5.1–1. Generalized Land Use at Pantex Plant and Vicinity.

are well defined at night by the intense security lighting. The plant operations areas are also visible from Interstate 40, with the closest viewpoint being the rest area approximately 10 km (6 mi) away. This viewpoint is similar to that described for U.S. Route 60, but because of the greater distance, the plant facilities are not as prominent. The plant facilities are generally visible from the low-density rural housing that surrounds the site.

3.5.2 SITE INFRASTRUCTURE

Baseline Characteristics. Section 3.5 describes current Pantex missions. Baseline characteristics are shown in Table 3.5.2–1.

Table 3.5.2–1. Pantex Plant Baseline Characteristics

Characteristics	Current Usage	Site Availability
Transportation		
Roads (km)	76	76
Railroads (km)	27	27
Electrical		
Energy consumption (MWh/yr)	84,420	201,480
Peak load (MWe)	13.6	23
Fuel		
Natural gas (m^3/yr)	14,600,000	289,000,000
Oil (l/yr)	1,775,720	1,775,720
Coal (t/yr)	0	0
Steam (kg/hr)	59,524	68,040

Source: PX 1995a:1; PX DOE 1995d; PX DOE 1996b.

Pantex is tied to the Burlington Northern Santa Fe Railroad, formerly known as the Atchison, Topeka, and Santa Fe Railroad, through a spur that enters the plant from the southwest running just north of U.S. Highway 60. This spur provides access to the entire Burlington Northern Santa Fe system as well as to other railroads. Currently, the spur is being used only for concrete shipments.

Electric generating capacities by fuel types within the sub-regional power pool supplying power to Pantex provide the larger fractions by coal, oil, and gas turbine production, respectively. The remaining is provided by small amounts of nuclear, hydroelectric, and other sources. The sub-regional electric power pool from which Pantex draws its power is the West Central Power Pool. The sub-regional power pool electrical summary is shown in Table 3.5.2–2.

Natural gas at Pantex is supplied by Anthem Energy. From calendar year 1987 through fiscal year 1994, gas use has generally increased from a low of 11,889 million m^3 (424,605 million ft^3) in 1988 to a high of 15,033 million m^3 (536,893 million ft^3) in 1993. Both current and future supplies appear to be adequate. Much of the region is underlain by natural gas deposits, and there are consequently many small local suppliers in addition to the major companies.

Five wells, which are pumped into a common line and into ground storage tanks, supply water to Pantex. There are a total of 24.2 million l (6.4 million gal) of ground storage capacity. Two elevated storage tanks totaling 1,374,000 l (363,000 gal) provide pressure to the system. Water use at Pantex has ranged from 1,052 to 1,192 million l (278 to 315 million gal) annually from 1989 through 1993. In addition, water sold to Texas Tech University ranged from 235 to 344 million l (62 to 91 million gal) annually during the same period.

Operations at Pantex are housed in 476 buildings, containing 230,200 m^2 (2,483,000 ft^2) of work space. Magazines in Zone 4 consist of 95 buildings used for staging nuclear weapons, storage of explosives, and interim storage of pits. Current pit storage capability consists of 22 Modified Richmond and Steel Arch Construction magazines, all of which have necessary utility support and material access control. Current capacity for pit storage is 20,000 pits.

Table 3.5.2–2. West Central Sub-Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel[a]	
Coal	59%
Nuclear	7%
Hydro/geothermal	1%
Oil/gas	32%
Other[b]	1%
Total Annual Production	107,607,000 MWh
Total Annual Load	104,681,000 MWh
Energy Exported Annually[c]	2,926,000 MWh
Generating Capacity	24,642 MWe
Peak Demand	20,578 MWe
Capacity Margin[d]	4,064 MWh

[a] Percentages do not total 100 percent due to rounding.
[b] Includes power from both utility and non-utility sources.
[c] Energy exported is not the difference of production and load due to negative net pumped storage.
[d] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.
Source: NERC 1993a.

3.5.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The climate at Pantex and in the surrounding region is characterized as semi-arid with hot summers and relatively cold winters. The average annual temperature in the Amarillo region is 13.8 °C (56.9 °F); temperatures range from an average daily minimum of -5.7 °C (21.8 °F) in January to an average daily maximum of 32.8 °C (91.1 °F) in July. The average annual precipitation is 49.7 cm (19.6 in). Prevailing wind directions at Pantex are from the south to southwest. The average annual windspeed is 6.0 m/s (13.5 mph) (NOAA 1994c:3). Additional information related to meteorology and climatology at Pantex is presented in Appendix F.

Ambient Air Quality. Pantex is located within the Amarillo-Lubbock Intrastate AQCR (#211), which is currently designated as "attainment" or "unclassified" by EPA (40 CFR 81.344) with respect to the NAAQS for criteria pollutants (40 CFR 50). Appendix F lists the NAAQS for these criteria pollutants. These standards have been adopted by the State of Texas (TX NRCC 1995b:28). There are no PSD Class I areas within 100 km (62 mi) of Pantex.

Historically, the primary emission sources of criteria pollutants at Pantex are the steam plant boilers, the explosives burning operation, and emissions from onsite vehicles (PX DOE 1983a:3-8,3-11). Potential emission sources of hazardous/toxic air pollutants include the high explosives synthesis facility, the explosives burning operation and paint spray booths, miscellaneous laboratories, and other small operations. With the exception of thermal treatment of HE at the Burning Ground, most stationary points of nonradioactive atmospheric releases are from fume hoods and building exhaust systems with HEPA filters.

Table 3.5.3–1 presents the baseline ambient air concentration for criteria pollutants and other pollutants of concern at Pantex. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

Noise. Major noise emission sources within Pantex include various industrial facilities, equipment, and machines (for example, cooling systems, transformers, engines, pumps, boilers, steam vents, construction and materials handling equipment, vehicles, weapons firing, alarms, and explosives detonation). Most Pantex industrial facilities are at a sufficient distance from the site boundary to make noise levels at the boundary from these sources barely distinguishable from background noise. However, some noise from explosives detonation can be heard at residences north of the site and weapons firing can be heard at residences west of the site.

The acoustic environment along the Pantex boundary and at nearby residences away from traffic noise is typical of a rural location, with DNL in the range of 35 to 50 dBA (EPA 1974a:B-4). Noise survey results in areas adjacent to Pantex indicate that ambient sound levels are generally low, with natural sounds and distant traffic being the primary sources. Traffic, aircraft, trains, and agricultural activities result in higher short-term levels especially near roads (PX DOE 1995i:11-1,11-23). Traffic is the primary source of noise at the site boundary and at residences located near roads. Plant traffic contributes little to overall traffic noise. However, traffic noise is expected to dominate sound levels along major roads in the area, such as U.S. Route 60. The residents that have the highest potential for being affected by noise from plant traffic along Pantex access routes are those living along Farm-to-Market Roads 2373 and 683.

Other sources of noise include aircraft, wind, insect activity, and agricultural activity. Except for the prohibition of nuisance noise, neither the State of Texas nor its local governments have established any regulations that specify acceptable community noise levels.

Table 3.5.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Pantex Plant, 1993

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] (μg/m³)	Baseline Concentration (μg/m³)
Criteria Pollutants			
Carbon monoxide	8-hour	10,000[b]	161
	1-hour	40,000[b]	924
Lead	Calendar Quarter	1.5[b]	0.01
Nitrogen dioxide	Annual	100[b]	0.90
Ozone	1-hour	235[b]	[c]
Particulate matter less than or equal to 10 microns in diameter	Annual	50[b]	8.73
	24-hour	150[b]	88.5
Sulfur dioxide	Annual	80[b]	<0.01
	24-hour	365[b]	<0.01
	3-hour	1,300[b]	<0.01
	30-minute	1,045[d]	<0.01
Mandated by the State of Texas			
Hydrogen fluoride	30-day	0.8[d]	<0.27
	7-day	1.6[d]	<0.27
	24-hour	2.9[d]	0.27
	12-hour	3.7[d]	0.38
	3-hour	4.9[d]	1.52
Hydrogen sulfide	30-minute	111[d]	[e]
Sulfuric acid	24-hour	15[d]	[e]
	1-hour	50[d]	[e]
Total suspended particulates	3-hour	200[d]	[e]
	1-hour	400[d]	[e]
Hazardous and Other Toxic Compounds			
1,1,1-Chloroethane	30-minute[f]	500[d]	127
	Annual	50[d]	0.53
1,1,2-Trichloroethane	30-minute[f]	550[d]	17.3
	Annual	55[d]	0.08
2-Nitropropane	30-minute[f]	50[d]	8.55
	Annual	5[d]	0.04
Alcohols	30-minute[f]	[g]	195
	Annual	[g]	0.70
Benzene	30-minute[f]	30[d]	19.40
	Annual	3[d]	0.05
Carbon disulfide	30-minute[f]	30[d]	22.60
	Annual	3[d]	0.09
Carbon tetrachloride	30-minute[f]	126[d]	19.7
	Annual	13[d]	0.08
Chlorobenzene	30-minute[f]	460[d]	19.5
	Annual	46[d]	0.08

Table 3.5.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Pantex Plant, 1993—Continued

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] (μg/m³)	Baseline Concentration (μg/m³)
Hazardous and Other Toxic Compounds (continued)			
Chromium	30-minute[f]	1[d]	0.10
	Annual	0.1[d]	0.002
Cresol	30-minute[f]	5[d]	0.41
	Annual	h	0.002
Cresylic acid	30-minutef	5[d]	0.51
	Annual	h	0.002
Dibenzofuran	30-minute[f]	h	0.001
	Annual	h	0.00002
Ester glycol ethers	30-minute[f]	h	35.9
	Annual	h	0.15
Ethyl benzene	30-minute[f]	2,000[d]	31.1
	Annual	434[d]	0.13
Ethylene dichloride	30-minute[f]	40[d]	9.58
	Annual	4[d]	0.04
Formaldehyde	30-minute[f]	15[d]	0.37
	Annual	1.5[d]	0.004
Hydrogen chloride	30-minute[f]	75[d]	5.98
	Annual	0.1[d]	0.09
Ketones	30-minute[f]	h	33.4
	Annual	h	0.14
Mercury	30-minute[f]	0.5[d]	0
	Annual	0.05[d]	0
Methanol	30-minute[f]	2,620[d]	245
	Annual	262[d]	0.58
[Text deleted.]			
Methyl ethyl ketone	30-minute[f]	3,900[d]	1,400
	Annual	590[d]	5.10
Methylene chloride	30-minute[f]	260[d]	180
	Annual	26[d]	0.74
Methyl isobutyl ketone	30-minute[f]	2,050[d]	4.45
	Annual	205[d]	0.02
Naphthalene	30-minute[f]	440[d]	0.005
	Annual	50[d]	0.0001
[Text deleted.]			
Nitrobenzene	30-minute[f]	24[d]	0.51
	Annual	5[d]	0.002
Phenol	30-minute[f]	154[d]	0.03
	Annual	19[d]	0.0006
Tetrachloroethylene	30-minute[f]	340[d]	17.6
	Annual	34[d]	0.07

Table 3.5.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Pantex Plant, 1993—Continued

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] (μg/m³)	Baseline Concentration (μg/m³)
Hazardous and Other Toxic Compounds (continued)			
Toluene	30-minute[f]	1,880[d]	568
	Annual	188[d]	1.73
Trichloroethene	30-minute[f]	[h]	51.1
	Annual	[h]	0.21
Trichloroethylene	30-minute[f]	1350[d]	51.1
	Annual	135[d]	0.21
Triethylamine	30-minute[f]	40[d]	1.08
	Annual	4[d]	0.002
Xylene	30-minute[f]	3,700[d]	145
	Annual	434[d]	0.47

[a] The more stringent of the Federal and State standard is presented if both exist for the averaging time.
[b] Federal and State standard.
[c] Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. See Section 4.1.3 for a discussion of ozone-related issues.
[d] State standard.
[e] Data not available from source document.
[f] 1-hour predicted concentrations were used for the 30-minute standard.
[g] The Texas Natural Resources Conservation Commission does not have an Effects Screening Level (ESL) for the family of alcohols. If ambient levels of air contaminants exceed the screening levels, it does not necessarily indicate a problem. It is just a trigger for a more in-depth review. The most stringent ESL for a single alcohol may be exceeded if applied to the family of alcohols.
[h] No State standard for indicated averaging time.
Source: 40 CFR 50; PX DOE 1996b; TX ACB 1987a; TX NRCC 1992a; TX NRCC 1995a.

3.5.4 WATER RESOURCES

Surface Water. There are no streams or rivers at Pantex, and all site water requirements are met by groundwater. All surface water drains to playas, natural closed depressions that collect runoff to form ephemeral lakes. There are seven playas associated with Pantex. Playas 1 through 3 are located on DOE-owned property, Playas 4 and 5 are on DOE-leased property, Pantex Lake (also a playa) is located approximately 4 km (2.5 mi) northeast of the site boundary, and Pratt Lake is located just north of the site boundary (Figure 3.5.4–1). The only major stream in the area is the Canadian River, which is located approximately 40 km (25 mi) north of Pantex. Since surface runoff at the Plant flows into all playa basins, the Canadian River is not affected by activities at Pantex.

Playas are a significant part of the surface and subsurface hydrologic systems at Pantex. All playas at the site receive stormwater runoff from Pantex vicinity. Playa 1 receives continuous discharges from the Pantex Wastewater Treatment Facility. Steam condensate, noncontact cooling water from buildings, and stormwater runoff are directed to Playas 1, 2, and 4. Playa 3 receives stormwater runoff from the Pantex Burning Ground. Pantex activities have not discharged to Playa 5, but past activities included discharge of treated effluents to Pantex Lake. There are also a number of playas adjacent to Pantex that receive drainage from perimeter portions of the site. Playas provide a source of groundwater recharge, although the rate of recharge is unknown. Studies currently are being conducted to determine this rate.

Because there are no onsite or nearby flowing streams, floodplains exist only in association with the playas. A previous floodplain assessment concluded that the only incidence of flooding would be at some sites including the wastewater treatment plant of Playa 1 and some relict World War II bunkers southwest of Playa 4 (LLNL 1988a:XV). This limited flooding would not affect the operations at Pantex. The 500-year floodplain is also associated with the playas; its boundaries generally follow those of the 100-year floodplain and typically extend only up to several hundred feet beyond the 100-yr boundaries. The exception is Playa 3 where the 500-yr and Standard Project Flood runoff into Playa 3 will overflow out of the drainage basin creating shallow (less than 30 cm [1 ft]) flooding of the drainage basins for Playas 1 and 2. The 100-year floodplain associated with Pratt Lake extends into the far northeast corner of Pantex.

Surface Water Quality. The NPDES program of the CWA is administered by EPA in the State of Texas. In addition, discharge of wastewaters to waters defined as "Waters of the United States" within the State of Texas requires a wastewater discharge permit from the Texas Natural Resources Conservation Commission (TNRCC) in accordance with the Texas Water Code (PX Battelle 1992a:2-12).

In November 1990, Pantex submitted an NPDES permit application for Playas 1, 2, and 4, which is currently under review by Region 6 of EPA. Pantex also submitted an NPDES stormwater discharge permit application in October 1991. The NPDES stormwater permit was issued in February 1995.

The TNRCC allows Pantex to discharge wastewaters into Playas 1 and 2. In December 1990, Pantex filed an application to modify its wastewater discharge permit to allow discharge of both industrial wastewater and rainwater runoff into Playa 4. An application for a renewal of the TNRCC wastewater discharge permit #2296 is on file and is currently under negotiation. Surface water quality sampling results from 1994 confirm that Pantex was in compliance with all discharge water quality regulations for Playa 1. With exception of a high water level in Playa 1 in July 1994, due to a rainfall event, all permit requirements were met (PX DOE 1995d:2-10).

Surface water monitoring is conducted at Playas 1, 2, 3, at the main plant, at Pantex Lake, and at Bushland Playa, an offsite control playa (60 km [37.5 mi] southwest of Pantex) used for comparative purposes. There are some differences in the parameters monitored among the playas, but the results of the 1994 monitoring activities at Playa 1 are presented as representative of the water quality of all the playas at Pantex (Table 3.5.4–1). Bushland Playa contained water in August, September, November, and December in 1994; results were within historical limits.

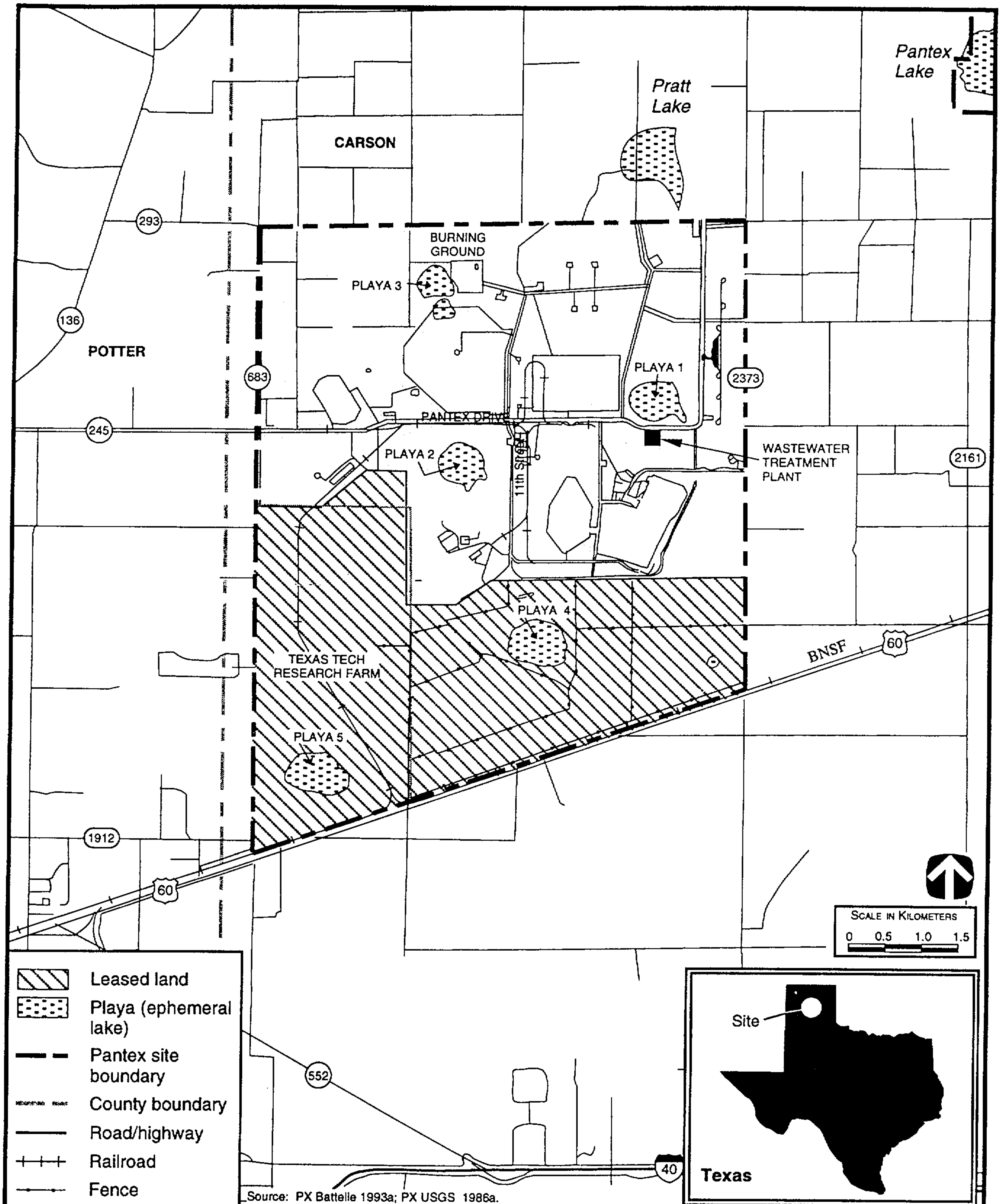


Figure 3.5.4–1. Surface Water Features at Pantex Plant.

Table 3.5.4–1. Summary of Playa 1 Surface Water Quality Monitoring at Pantex Plant, 1994

Parameter	Unit of Measure	Water Quality Criteria[a]	Water Body Concentration	
			High	Low
Alpha (gross)	pCi/l	15[b]	7±3	0±4
[Text deleted.]				
Ammonia (as N)	mg/l	NA	1.5	0.095
Arsenic	mg/l	0.05[b,c]	0.01	0.004
Barium	mg/l	2.0[b]	0.3	0.1
Beta (gross)	pCi/l	50[d]	22±4	8±6
[Text deleted.]				
Cadmium	mg/l	0.005[b]	<dL[e]	<dL[e]
Chloride	mg/l	250[f]	270	16
Chromium	mg/l	0.1[b]	0.01	0.003
Copper	mg/l	1.0[f]	0.01	0.005
Cyanide	mg/l	0.2[b]	0.009	0.005
Fluoride	mg/l	2[f],4[b]	2.4	0.48
HMX*	mg/l	NA	<dL[e]	<dL[e]
Iron	mg/l	0.3[f]	11	0.51
Lead	mg/l	0.015[b]	0.005	0.002
Manganese	mg/l	0.05[f]	0.4	0.07
Mercury	mg/l	0.002[b]	0.0002	0.0002
Oil and grease	mg/l	NA	14	0.48
PETN*	mg/l	NA	<dL[e]	<dL[e]
Plutonium-239/240	pCi/l	1.2[g]	0.03±0.01	0±0.03
Radium-226	pCi/l	5.0[b]	0.6±0.4	0.1±0.2
Radium-228	pCi/l	5.0[b]	1.1±0.7	0±0.5
RDX*	mg/l	NA	<dL[e]	<dL[e]
Sulfate (as SO_4)	mg/l	250[f]	80.2	4
TNT*	mg/l	NA	<dL[e]	<dL[e]
Tritium	pCi/l	80,000[g]	0.23±0.21	0±0.15
Uranium-234	pCi/l	20[g]	4.3±0.4	0±0
Uranium-238	pCi/l	24[g]	2.1±0.3	0.1±0.1
Zinc	mg/l	5.0[f]	0.08	0.006

[a] For comparison purposes only.

[b] National Primary Drinking Water Regulations (40 CFR 141).

[c] Texas State water quality criteria. Parameters are considered in exceedance only when their concentrations surpass State water quality criteria. General criteria do not apply to instances in which surface water, as a result of natural phenomena, exhibit characteristics beyond the limits established.

[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).

[e] All samples were below detection limit. Detection limits varied throughout the year.

[f] National Secondary Drinking Water Regulations (40 CFR 143).

[g] DOE DCG for water (DOE Order 5400.5). DCG values are based on a committed effective dose equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG. All concentrations of radionuclides are determined by subtracting the instrument background environmental level from the monitored concentration. A negative or zero incremental concentration means that the concentration at the sampling location is equivalent to the environmental level.

Note: *=high explosive(s) compounds; NA=not applicable; dL= detection limit.

Source: PX DOE 1995d.

Surface Water Rights and Permits. Water rights in Texas fall under the Doctrine of Prior Appropriations. Under this doctrine, the user who first appropriated water for a beneficial use has priority to use available water supply over a user claiming rights at a later time. Courts also recognize riparian rights legally granted from Spanish-American Agreements. The TNRCC is the administrator for water rights and is the permit-issuing authority.

Groundwater. Pantex is located on the Texas High Plains aquifer system, which is the southernmost extension of a regional aquifer that extends from Texas to South Dakota (PX WDB 1993a:1). The two principal water-bearing units beneath Pantex and adjacent areas are the Ogallala Aquifer and the Dockum Group Aquifer. In addition, perched groundwater occurs locally, particularly under the southeast portion of Pantex, at approximate depths ranging from 64 to 88 m (210 to 290 ft) (PX DOE 1996b:4-65). The occurrence of perched groundwater has been attributed to a fine-grained zone of silty sands and clays that limits the downward movement of groundwater. Perched groundwater collects in buried gravel and sand channel deposits that are on top of the fine-grained zone. Deep wells in the northeast corner of Pantex, completed at depths of 183 to 244 m (600 to 800 ft) into the Ogallala Formation, have provided the water supply at Pantex for over 40 years. In 1994, Pantex reported a total production of 836 million l (221 million gal) of water from onsite production wells (PX DOE 1996b:4-77) and has a capacity to produce 1,900 million l/yr (500 million gal/yr) (PX DOE 1995g:10).

The Ogallala Aquifer beneath Pantex has not been classified by EPA. However, it is the only source of drinking water for Pantex. Depth to water in the Ogallala Aquifer ranges from 104 m (340 ft) at the southern boundary of DOE-leased property at Pantex to 140 m (460 ft) at the northern boundary (PX DOE 1996b:4-57). The saturated thickness of the Ogallala Formation ranges from 15.2 m (50 ft) to more than 120 m (400 ft), and in some areas it is capable of yielding in excess of 4,000 lpm (1,060 gal/min), or 2.1 billion l/yr (554.8 million gal/yr) (PX DOE 1996b:4-69). Estimates of annual recharge rates to the Ogallala Aquifer vary from 0.02 to 4.1 cm/yr (0.01 to 1.6 in/yr) (PX DOE 1996b:4-69, 4-71) based on earlier studies that investigated slow regional infiltration of precipitation and recent studies that explored percolation of water through playa lakes and leakage from the Dockum Group Aquifer into the Ogallala Aquifer (PX WDB 1993a:2).

The withdrawal of water from the Ogallala Aquifer continues to exceed recharge, causing water levels to decline in the Pantex area at a rate of approximately 0.6 to 1.5 m/yr (2 to 5 ft/yr) (PX DOE 1995d:1-9). From 1980 to 1990, the city of Amarillo well field north of Pantex experienced up to 20 m (60 ft) of water-level decline, which may have contributed to a depression in the groundwater surface northeast of Pantex (PX WDB 1993a:11). In 1990, the recoverable volume of water in storage and available for use in the Ogallala Aquifer in the High Plains aquifer system was estimated at 515 trillion l (136 trillion gal) (PX DOE 1996b:4-71). The groundwater flow direction beneath Pantex is to the northeast (PX DOE 1995d:1-8). Figure 3.5.4–2 shows the direction of the groundwater flow in the Ogallala Aquifer beneath Pantex.

An agreement between Pantex and the city of Amarillo is currently being negotiated to develop reclaimed wastewater from the city of Amarillo Hollywood Road Wastewater Treatment Plant. The plant is currently discharging approximately 9,671 million l/yr (2,555 million gal/yr) of the advanced treated wastewater and will be discharging approximately twice that much by 2010. The use of reclaimed wastewater could curtail the annual decline rate of the Ogallala Aquifer.

Groundwater Quality. Pantex's groundwater monitoring program includes monitoring wells distributed throughout the facility and onsite Ogallala production wells. Groundwater samples collected from the monitoring wells that tap the perched and Ogallala aquifers are analyzed for a standard suite of parameters and constituents, including volatile organics, HE, pesticides, herbicides, semivolatile organics, trace metals, radioactive materials (including gross alpha and gross beta measurements), and field parameters (including total dissolved solids and pH).

Historically, only limited metal contamination has been found in some of the wells monitoring the Ogallala Aquifer. Table 3.5.4–2 shows the water quality in the Ogallala Aquifer in 1994. Groundwater samples from the perched zone, however, contain a variety of constituents that are either above background levels or drinking

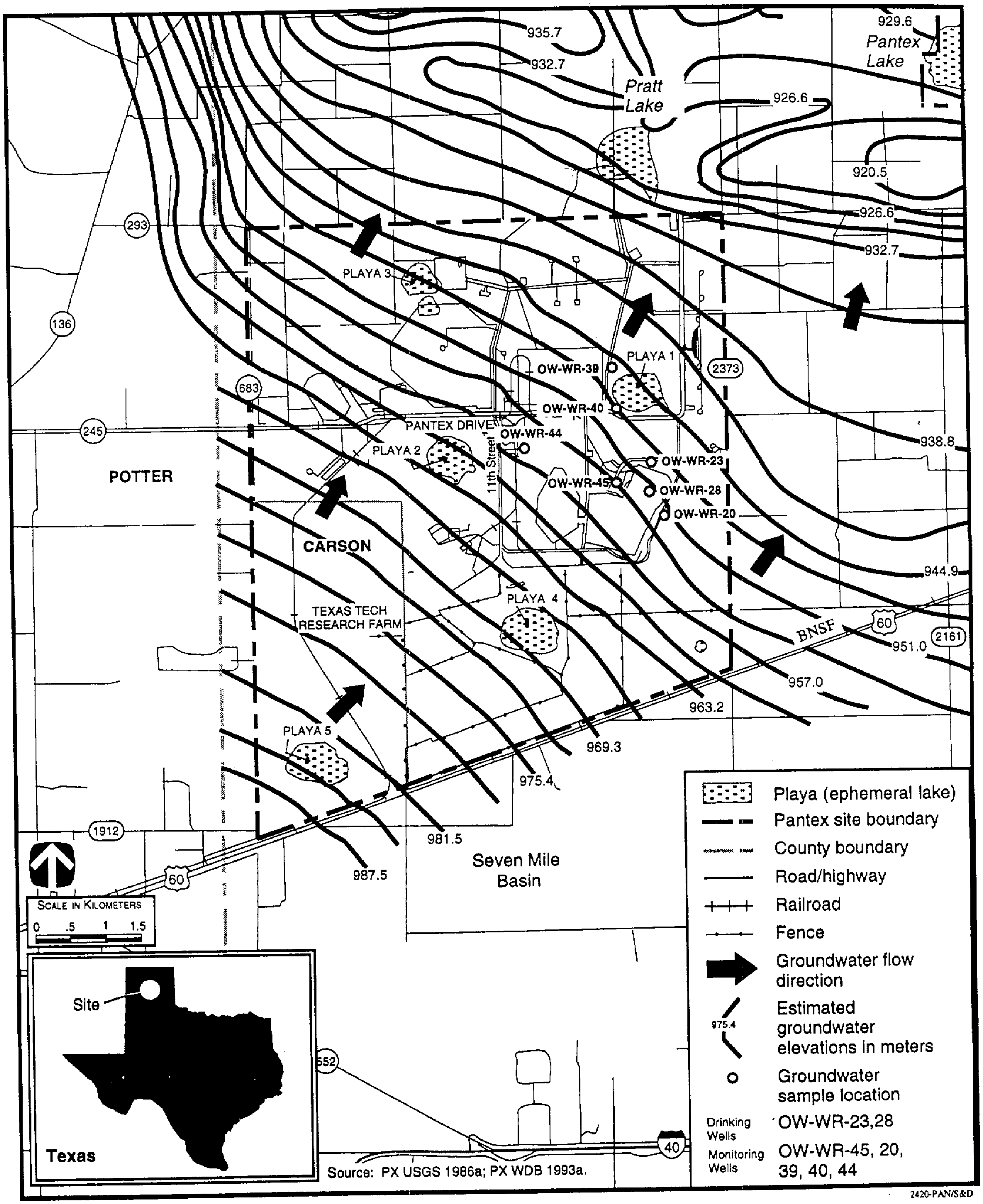


Figure 3.5.4–2. Water Table Elevations for the Ogallala Aquifer at Pantex Plant.

Table 3.5.4–2. Groundwater Quality Monitoring (Ogallala Aquifer Wells) at Pantex Plant, 1994

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Drinking Water Wells		Monitoring Wells	
			High	Low	High	Low
1,2-Dichloroethane	mg/l	0.005[b]	<0.005	<0.005	<0.005	<0.005
Barium	mg/l	2.0[b]	0.16	0.1	0.19	0.12
Chromium	mg/l	0.1[b]	0.007	<0.005	0.007	<0.005
Copper	mg/l	1.0[c]	0.046	<0.005	0.01	<0.005
HMX*	mg/l	NA	<0.020	<0.020	<0.020	<0.020
Iron	mg/l	0.3[c]	0.06	<0.01	1.49	<0.01
Lead	mg/l	0.015[b]	<0.005	<0.005	0.007	<0.005
Nitrate	mg/l	10[b]	1.85	1.37	2.19	0.767
pH	pH units	6.5-8.5[c]	7.7	7	8.1	6.7
RDX*	mg/l	NA	<0.020	<0.020	<0.020	<0.020
Sulfate	mg/l	250[c]	23	21	26	16
Total dissolved solids	mg/l	500[c]	320	240	384	210
Total organic carbon	mg/l	NA	1	<1	2	<1
Total organic halogens	mg/l	NA	5	<1	23	<3
Trichloroethylene	mg/l	0.005[b]	<0.005	<0.005	<0.005	<0.005
Tritium	pCi/l	80,000[d]	0.25	<MDA[e]	0.14	<MDA[e]
Uranium-234	pCi/l	20[d]	4.8	3.7	5.5	0.8
Uranium-238	pCi/l	24[d]	2.8	1.5	2.8	0.9
Zinc	mg/l	5.0[c]	0.18	<0.005	1.9	<0.005

[a] For comparison purposes only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] National Secondary Drinking Water Regulations (40 CFR 143).
[d] DOE DCG for water (DOE Order 5400.5). DCG values are based on 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG.
[e] Results were less than the Minimum Detectable Activity (MDA).
Note: *=high explosive(s) compounds; NA=not applicable.
Source: PX DOE 1995d.

water standards or are not naturally occurring. These include 1,2-dichloroethane, trichloroethylene, chromium, iron, and the HE RDX and HMX. Table 3.5.4–3 shows the water quality in the perched zone in 1994. Groundwater quality in the perched aquifer has been affected by activities that have occurred over the past 40 years at Pantex. Since the perched aquifer is the shallowest water-bearing zone in the area, it is the first groundwater unit affected by migration of contaminants that were released from past industrial operations. These operations generated HE materials, organic solvents, and metals in liquid and solid waste. The direction and rates of contaminant movement of the perched aquifer are still under investigation, but are expected to be controlled by the location of buried channel deposits, direction and rate of groundwater movement, and source areas of historical contamination. Contaminants are believed to have reached the perched aquifer through historical vertical infiltration from ditches, landfills, and other past localized source areas. Downward migration of perched groundwater could potentially affect the groundwater quality of the underlying Ogallala Aquifer. However, no contamination from HE, organic compounds, or radionuclides has been detected in Ogallala wells onsite (PX DOE 1996b:4-77). In 1995, trace levels (less than 1 part per billion) of RDX were detected in wells tapping the upper portion of the Ogallala east of the plant.

Groundwater Availability, Use, and Rights. Five production wells in the northeast corner of Pantex serve the plant's industrial and potable water needs. During 1994, the plant pumped 836 million l (221 million gal) of

Table 3.5.4–3. Groundwater Quality Monitoring (Perched Zone Wells) at Pantex Plant, 1994

Contaminant	Unit of Measure	Water Quality Criteria and Standards[a]	Water Body Concentration	
			High	Low
1,2-Dichloroethane	mg/l	0.005[b]	0.14	<0.005
Alpha (gross)	pCi/l	15[b]	11	<MDA[c]
Barium	mg/l	2.0[b]	0.25	0.047
Beta (gross)	pCi/l	50[d]	13	<MDA[c]
Chromium	mg/l	0.1[b]	1.95	<0.005
Copper	mg/l	1.0[e]	0.01	<0.005
HMX*	mg/l	NA	0.07	<0.02
Iron	mg/l	0.3[e]	3.55	<0.01
Lead	mg/l	0.015[b]	<0.005	<0.005
Nitrate	mg/l	10[b]	4.8	<0.01
pH	pH units	6.5-8.5[e]	9.0	6.7
RDX*	mg/l	NA	1.1	<0.020
Sulfate	mg/l	250[e]	56	12
Total dissolved solids	mg/l	500[e]	518	160
Total organic carbon	mg/l	NA	15	<1
Total organic halogens	mg/l	NA	259	<1
Trichloroethylene	mg/l	0.005[b]	0.15	<0.005
Tritium	pCi/l	80,000[f]	0.33	<MDA[c]
Uranium-234	pCi/l	20[f]	5.5	0.8
Uranium-238	pCi/l	24[f]	3.0	0.2
Zinc	mg/l	5.0[e]	0.684	<0.005

[a] For comparison purposes only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] Results were less than the MDA.
[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[e] National Secondary Drinking Water Regulations (40 CFR 143).
[f] DOE DCG for water (DOE Order 5400.5). DCG values are based on 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG.

Note: The following wells were used to determine the contaminant range:
PM-19 (Perched Monitoring Northwest Playa One)
PM-20 (Perched Monitoring Zone 12 Sensor Bed)
PM-38 (Perched Monitoring Northeast Playa One)
PM-44 (Perched Monitoring Building 16-1)
PM-45 (Perched Monitoring Southeast Building 12-2)
PM-106 (Perched Monitoring Northeast Plant)
*=high explosive(s) compounds; NA=not applicable.

Source: PX DOE 1995d.

water from the Ogallala Aquifer, while the city of Amarillo pumped 23.9 billion l (6.3 billion gal) from its Carson County well field located north and northeast of the plant (PX DOE 1996b:4-77). The estimated sustainable groundwater producing capacity of the Ogallala is approximately 2 billion l/yr (0.528 billion gal/yr). Pantex Lake, located adjacent to the Amarillo water-well field, is available for drilling additional water wells if needed for future Pantex operations.

The Ogallala Formation is also a source of municipal and industrial water for nearby towns and cities and for irrigation water to nearby farms. In the Pantex area, the cities of Amarillo and Canyon maintain community

water systems (see Figure 2.2.4–1 for regional map). The city of Amarillo draws its raw water from groundwater and Lake Meredith and has the capacity to supply 103,660 million l/yr (27,376 million gal/yr). The city of Canyon maintains the capacity to supply approximately 9,490 million l/yr (2,506 million gal/yr) from its own wells and may purchase up to 6,935 million l/yr (1,831 million gal/yr) from the city of Amarillo.

Groundwater is controlled by the individual landowner in Texas. The TNRCC and the Texas Water Development Board are the two State agencies with major involvement in groundwater fact finding, data gathering, and analysis. Groundwater management is the responsibility of local jurisdictions through Groundwater Management Districts. The Pantex facility is located in Panhandle Groundwater District 3, which has the authority to require permits and limit the quantity of water pumped. Presently, the Panhandle Groundwater District does not limit the quantity of water pumped.

3.5.5 GEOLOGY AND SOILS

Geology. Pantex is located on the Southern High Plains of the Texas Panhandle. The topography at Pantex consists of flat to gently rolling plains. There are no unique geologic landforms, and the only distinctive features are playas that are spaced more or less uniformly throughout the site. The playas are about 500 to 1,000 m (1,640 to 3,280 ft) across, with clay bottoms and depths to approximately 9 m (30 ft).

Pantex is underlain by the Blackwater Draw Formation which consists of a sequence of buried soils with an upper unit consisting of silt, clay, and caliche and a 12- to 23-m (39- to 76-ft thick) lower unit consisting of silty sand with caliche. The Ogallala Formation underlies the Blackwater Draw Formation and consists of interbedded sands, silts, clays, and gravels. The Ogallala Formation is underlain by the sedimentary rocks of the Dockum Group which are underlain by the Upper and Middle permian layers, which are composed predominantly of thick and widespread deposits of salt. The Lower Permian consists predominantly of complex accumulations of shale, limestone and argillaceous limestone, and dolomite. Some Permian formations of the Southern High Plains contain salt beds. The dissolution of these beds have resulted in sinkholes and fractures in nearby Armstrong and Hutchinson Counties, Texas. No sinkholes or fractures have been identified in Carson County. Recent work using shallow seismic data has determined that the structure beneath the playas on Pantex Plant and adjacent areas shows displacement of Ogallala strata. This displacement is attributed to the dissolution of underlying salt beds (PX DOE 1996b:4-31). No economically viable geologic resources have been identified at Pantex.

No capable faults as defined in 10 CFR 100, Appendix A, are present in the vicinity of Pantex. Three major subsurface faults and one minor surface fault occur near the Pantex site area (PX DOE 1995i:2-11). The longest fault, approximately 250 km (155 mi) long, is located about 40 km (25 mi) north of the site. A 70-km (43-mi) long fault is located about 8 km (5 mi) south of the site and a 64-km (40-mi) long fault is located about 11 km (7 mi) north of the site. The minor fault is surficial, about 6 km (4 mi) long, and located about 32 km (20 mi) northwest of the site.

Pantex lies on the boundary zone between Seismic Zones 0 and 1, indicating little or no damage could occur as a result of an earthquake (Figure 3.2.5–1). This area is relatively free from earthquakes. Twenty-five earthquakes with MMIs of VI (Table 3.2.5–1) have been recorded in the Texas Panhandle (PX DOE 1996b:4-33). There is no volcanic hazard at Pantex because there are no known areas of active volcanism in the Texas Panhandle.

Soils. Pantex is underlain by soils of the Pullman-Randall association. The Pullman-Randall soil association consists of nearly level to gently sloping deep noncalcareous clays and clay loams. Pullman soils underlie most of the Pantex area, but Randall soils occur in the vicinity of the playas and depressions. Water and wind erosion and shrink-swell potential are moderate to high for most of the soil units (PX USDA 1962a:2,9-15; PX USDA 1980a:32). However, the soils at Pantex are acceptable for standard construction techniques.