3.10 DEEP BOREHOLE COMPLEX SITE (GENERIC)

Deep borehole-like waste storage facilities currently do not exist in the United States, and no actual sites for drilling a deep borehole have been proposed. Therefore, the approach to describing the environmental setting for the deep borehole is to provide a range of existing or probable environmental conditions. These conditions, to the extent possible, are determined from existing information about typical locations at either end of the range of conditions. It is assumed that these conditions, at either end of the range adequately represent the actual range of conditions. In developing a generic environmental baseline for the deep borehole site, a set of assumptions was used to help define where such a facility could be developed. The major assumptions were the following: (1) the site would be located within the contiguous United States in geologically stable Precambrian crystalline rocks; (2) the site would be located distant from international borders and any population centers; (3) the site would have reasonable access to water supplies, electrical power, and ground transportation; and (4) the site would be located so that surface waters could be sufficiently protected from construction activities and facility operations.

The optimum geographic location for a deep borehole site is an area far removed from major drainage, lakes, oceans, and areas of low population density. The topographic relief is minimal in order to provide a low differential head in groundwater. The area in the immediate vicinity of the deep borehole site is large enough to accommodate several drill sites, as previously described in Section 2.4.3, while avoiding steep surface water drainage gradients that would allow rapid distribution of contaminants in case of an accident.

The long-term performance of the deep borehole system depends primarily on the geologic system. Therefore, the most important factor that must be considered in the selection of an optimum borehole site is hydrologic isolation from the biosphere for geologic times. To achieve this degree of hydrologic isolation, the host rock must have very low matrix permeability. In addition, the locality should be in an area of low seismicity to indicate stable geology, where a possible return of glacial or pluvial climate will not cause a significant change in surface water or groundwater systems, and where there is no danger of exhumation by erosion.

An example of the low or completely undeveloped end of the range of existing conditions could be forests, grazing lands, agricultural areas, or federally owned land with almost no permanent facilities. Given the proper geologic and hydrologic conditions, and access to the transportation infrastructure, these types of areas could represent the undeveloped site in the range of environmental settings. Other locations that could be selected for a borehole site could be located in more developed areas. At the developed end of the range of environmental settings, a deep borehole site could resemble any one of the DOE sites previously described.

Should this alternative be selected, a siting study would be conducted, in addition to identifying site-specific environmental conditions and impacts in a tiered NEPA document.

3.10.1 LAND RESOURCES

The approach to defining the environmental setting for land resources is not site-specific. Consequently, a range of land-use and visual resources conditions that could exist at potential deep borehole complex site locations has been provided (see Table 3.10.1–1).

Table 3.10.1–1. Land Resources Attributes of the Generic Deep Borehole Complex Site

Land Use Attributes	
Land Area	2,000 - 20,000 ha
Land Ownership	Public or private
Existing Land Use	
Onsite	Undeveloped agricultural or industrial
Offsite	Undeveloped and/or agricultural
Land Use Compatibility	Likely
Plans, Policies, and Controls	
Jurisdiction	Federal, State, local
Enforcement	Lax to stringent
Conformance	Site-dependent
Visual Resource Attributes	
Landscape Character	
Site	Gentle relief
Viewshed	Undeveloped to agricultural
Visual Resource	
Sensitivity Level	Low to medium to high
Distance zones	Foreground, middleground, background, and seldom-seen
BLM VRM class	3 to 5
Degree of contrast	Weak to moderate

Source: LLNL 1996a.

Land Use. The potential site would require at least 2,000 ha (5,000 acres) of land area to accommodate the facility and buffer zone. The potential site could be located on public or private lands ranging up to 20,000 ha (49,420 acres). If the borehole site were located on privately-owned land, it would likely require the low to middle range of land area. If the site were located on publicly owned land (Federal, State, or local), the borehole could be part of a much larger site and could require the upper range of this land area. The range of site existing land uses would likely be undeveloped, agricultural, or industrial. Therefore, a change in site land use could occur. It is likely that land uses within the immediate vicinity of the site would range from undeveloped to agricultural (for example, cropland and grazing land) use. Due to the 1.6-km (1-mi) buffer zone surrounding the facility, it is likely that incompatibility, if any, with adjacent offsite land use would be minimized. Depending upon location, use, ownership, or management, the site could be subject to a variety of land-use plans, policies, and controls at the Federal, State, or local level. The existence and the stringency of these land-use plans, policies, and controls vary by jurisdiction. Regulations governing the type, density, and location of development are traditionally applied at the municipal (local) level through the comprehensive plan and its implementing mechanism, the zoning ordinance. Development of a privately owned site could require a change in the existing zoning classification. Development of a publicly owned site would likely conform to existing site development plans. If adjacent lands or lands that could be impacted by site development are designated as special status lands (for example, prime farmland, wild and scenic river, or wilderness study area), site development could be subject to additional controls.

Visual Resources. The complex would likely be constructed on a very small portion of the total site area. The immediate viewshed would likely range from undeveloped (for example, meadow and forest land) to agricultural lands. As discussed in Section 3.1.1, a visual resource inventory is comprised of three factors: scenic quality, distance zones, and sensitivity levels. Area sensitivity levels could range from low to high. Potential high visual sensitivity areas that could be impacted by the facilities include nearby public roadways, residential areas, and recreational/scenic areas with high user volumes. However, nearby public roadways predominately used by site workers could have a lower sensitivity level, while sensitivity levels would likely range from medium to high if nearby roads are traveled by the general public. The full range of distance zones could occur. Due to the mandatory 1.6-km (1-mi) buffer zone, it is probable that views of the facilities would predominately fall into the middleground zone. Therefore, it is likely that the degree of contrast would range from weak to moderate and that the overall visual character of the site would be consistent with a BLM VRM classification ranging from Class 3 to Class 5.

3.10.2 SITE INFRASTRUCTURE

Baseline Characteristics. The generic deep borehole site could have the baseline site infrastructure characteristics within the ranges shown in Table 3.10.2–1.

Table 3.10.2–1. Generic Deep Borehole Complex Site Baseline Characteristics

Characteristics	Site Availability
Transportation	
Roads (km)	0 to 60
Railroads (km)	0 to 20
Electrical	
Energy consumption (MWh/yr)	6,500 to 12,000
Peak load (MWe)	2 to 1,000
Fuel	
Natural gas (m^3/yr)	0 to 5,000,000
Oil (million l/yr)	0 to 100
Coal (t/yr)	0 to 200,000
Steam (kg/hr)	0 to 150,000

Source: HF DOE 1990e; INEL 1993a:5; NTS 1993a:4; OR LMES 1996i; PX 1995a:1; PX DOE 1995d; PX DOE 1996b; SRS 1993a:3.

The generic deep borehole site would be expected to be mostly open vacant land with a few widely scattered facilities. Any existing facilities would not likely be useful for the functions required in the deep borehole complex, but could possibly coexist with the developed borehole site.

The transportation infrastructure could be nonexistent on the site or could be well developed. However, the site would have reasonable access to transportation nodes with some new construction of access roads and railroad lines. There would be no surface water transportation in the vicinity.

Electricity, telecommunications, and other utilities may be available to the generic deep borehole site before development of the site. These utilities could be connected to the site or generated at the site, depending on the offsite availability. It is expected that the nearest electric utility company would be able to provide the modest borehole electricity requirements with little effect on the utility or sub-regional power pool. Typical ranges of capabilities of sub-regional power pools are shown in Table 3.10.2–2.

Natural gas, diesel, liquid propane fuel, and coal would be available from local utilities or suppliers either by pipelines or surface transportation to the borehole site.

Table 3.10.2–2. Generic Deep Borehole Complex Site Sub-Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel[a]	
Coal	14 to 59%
Nuclear	0 to 39%
Hydro/geothermal	2 to 46%
Oil/gas	<1 to 32%
Other[b]	0 to 30%
Total Annual Production	107,607,000 to 272,155,000 MWh
Total Annual Load	104,621,000 to 293,262,000 MWh
Energy Exported Annually[c]	-45,400,000 to 6,359,000 MWh
Generating Capacity	24,870 to 61,932 MWe
Peak Demand	20,578 to 57,028 MWe
Capacity Margin[d]	4,064 to 13,655 MWe

[a] Percentages do not total 100 percent due to rounding.
[b] Includes power from both utility and nonutility sources.
[c] Energy exported is not the difference of production and load due to 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.

3.10.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The meteorological and climatological conditions for the generic deep borehole site include the range of extremes in ambient temperature, windspeed and direction, and precipitation exhibited over the United States. A generic deep borehole site could exhibit a wide diversity of climatology. Therefore, no further description of meteorology and climatology has been provided with respect to a generic deep borehole site.

Ambient Air Quality. Ambient air quality conditions for the generic deep borehole site include a wide range of pollutants and conditions. Some areas do not yet meet the ambient standards for certain pollutants. Areas with air quality better than the NAAQS are designated as being in attainment; areas with worse air quality are designated as nonattainment areas. Nonattainment areas could be less desirable for a deep borehole site since more restrictive requirements would apply for pollutants for which the area is nonattaining.

Noise. Specific existing noise sources and characteristics of a generic deep borehole site cannot be described. However, it is expected that such a site would be essentially rural in character and would have typically low background sound levels. Typical DNL in the range 35 to 50 dBA (EPA 1974a:B-4) can be expected for such a rural location where noise sources may include wind, insect activity, aircraft, and agricultural activity. An area that is essentially uninhabited can be expected to have lower sound levels, with the major sources of noise possibly including an occasional airplane and natural physical phenomena such as wind, rain, and wildlife activities.

3.10.4 WATER RESOURCES

Surface Water. Availability of water is location-specific and depends on the hydrology and constraints of the local area. The availability of water supplies can be 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, with drought being an extreme example; consumption by other facilities using the same water supply; and State regulations, such as water appropriation permit requirements.

Water required for construction and operation activities may not be available to the generic deep borehole site before development of the site, depending on the site location. Water could be generated or delivered to the deep borehole site, either by pipelines or surface transportation, depending on the availability from offsite suppliers.

Surface water drainage areas could range in size from 0 to 3,200 km^2 (0 to 1,235 mi^2). Surface water resources discharge rates could range from 0 to 3,360 m^3/s (0 to 118,642 ft^3/s). Surface water reservoir storage capacity could range from 0 to 49 trillion l (0 to 13 trillion gal).

Site drainage of the generic deep borehole site must comply with the regulations of the local governing agency. The minimum design level for the Storm Water Management System is the 25-year, 6-hour storm, but potential effects of larger storms up to the 100-year, 6-hour storm would also be considered for site evaluation.

In the vicinity of the generic deep borehole site, surface water classifications could range from none (no surface water near the site) to fresh water suitable for fishing, swimming, and other primary and secondary contact recreation, and also as an existing or potential source of potable water.

The deep borehole site would be located in an area above the critical flood elevation (as determined from maps and site studies) of the potential flood source (river, dam, levee, precipitation). The deep borehole site surface facilities would be located in an area where the lowest floor of the structure, including subsurface floors, would be above the level of the 500-year floodplains. All facilities, including their basements, would be sited in an area above the 100-year floodplain.

Surface Water Quality. The quality of surface water across the nation is very diverse, affected by both natural processes and human activities. The natural quality of surface water is determined largely by the quality of its primary groundwater source, which is affected by the types of rocks through which the water moves and by various chemical processes. Absorption of atmospheric gases and assimilation of runoff and direct discharges further account for water quality differences throughout various potential generic deep borehole sites.

The range of surface water quality conditions that would be found at a generic deep borehole site is presented in Table 3.10.4–1. The amount of dissolved minerals in water (measured as dissolved solids) is a general indicator of overall inorganic water quality and, as shown in the table, could range from 10 to 174 mg/l (10 to 174 ppm). Iron and manganese could exceed water quality criteria. Nitrogen and phosphorus, which are major nutrients, contribute to the eutrophication of streams and lakes. Eutrophic waters are rich in nutrients that cause excessive growth of aquatic plants (for example, algae). Several forms of nitrogen are found in natural waters. Most common are the nitrate, nitrite, and ammonia ions. As shown in Table 3.10.4–1, nitrogen concentrations could range from 0 to approximately 2 mg/l (0 to 2 ppm), and phosphorus concentrations could range from 0 to 0.29 mg/l (0 to 0.29 ppm). The upper limits are more common in areas where there is considerable farming and soils are more likely to erode.

Table 3.10.4–1. Summary of Typical Surface Water Quality at the Generic Deep Borehole Complex Site

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Water Body Concentration	
			High	Low
Alkalinity	mg/l	NA	140	0
Alpha (gross)	pCi/l	15[b]	1.3	<0.4
Ammonia	mg/l	NA	0.25	0
Beta (gross)	pCi/l	50[c]	4.5	0.5
Calcium	mg/l	NA	9.9	0.8
Chloride	mg/l	250[d]	3.54	0.2
Chromium	mg/l	0.1[b]	0.04	0
Conductivity	µmhos/cm	NA	340	30
Dissolved oxygen	mg/l	>5.0[e]	14	6
Iron	mg/l	0.3[d]	1.5	0.02
Lead	mg/l	0.015[b]	0.013	0
Magnesium	mg/l	NA	9.3	0.5
Manganese	mg/l	0.05[d]	0.06	0
Nitrogen (as NO_2/NO_3)	mg/l	NA	2.13	0
pH	pH units	6.5-8.5[d]	8.5	6.3
Phosphorus	mg/l	NA	0.29	0
Sodium	mg/l	NA	20	0.7
Strontium-90	pCi/l	400[f]	0.33	0.01
Suspended solids	mg/l	NA	67	1
Temperature	°C	NA	35	0
Total dissolved solids	mg/l	500[d]	174	10
Uranium, Total	mg/l	0.02[c]	0.00019	0.00017
Zinc	mg/l	5.0[d]	0.6	0

[a] For comparison only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[d] National Secondary Drinking Water Regulations (40 CFR 143).
[e] Varies with pH and temperature.
[f] DOE DCG for water (DOE Order 5400.5). 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. [Text deleted.]

Note: NA=not applicable; µmhos/cm=micromhos per centimeter.

Source: DOD 1993a.

Surface Water Rights and Permits. Surface water rights concerning the water body closest to the deep borehole site could range from not being an issue (because the site does not withdraw or discharge to a surface water body, or asserts its federally reserved water withdrawal rights), to impairment of designated uses..

Discharge of a pollutant to surface water requires a permit under the NPDES. NPDES permits include effluent limitations specifying the maximum concentrations of specific pollutants that may be present in discharge water.

Groundwater. Because of their characteristic remoteness, many government facilities use groundwater from onsite wells for their primary water supply. Groundwater could be used alone during construction and operations or could be mixed with either surface water or treated reclaimed wastewater.

The proposed deep borehole site could also be located in an area with undeveloped groundwater reserves, in underlying geologic strata, that are capable of providing an adequate supply of good quality water. Site-specific hydrogeologic data would be required to evaluate the groundwater availability.

The near-surface aquifer beneath the generic deep borehole site could occur under confined to unconfined conditions. Depth to groundwater could range from 1 to 200 m (3.3 to 656 ft). Recharge could occur primarily from rainfall and surface water seepage. Common ranges of hydraulic characteristics of aquifers are presented in Table 3.10.4–2.

Table 3.10.4–2. Common Ranges of Hydraulic Characteristics of Aquifers

	Range of Conditions	
Characteristic	**Low**	**High**
Transmissivity (l per day/m)	46	46,200,000
Hydraulic conductivity (l per day/m^3)	0.0008	7,500
Recharge rate (cm/yr)	0.0025	50.8
Well yield (l/minute)	38	75,700

Source: DOD 1993a.

Aquifer classification beneath the generic deep borehole site could range from a sole-source, federally protected, or EPA Class I aquifer (an aquifer which is required to supply 50 percent or more of the drinking water for that area and for which there are no reasonable available alternative sources should the aquifer become contaminated) to a Class III aquifer (an aquifer not considered a potential source of drinking water and of limited beneficial use because the salinity is greater than 10,000 mg/l (greater than 10,000 ppm) or the groundwater is otherwise contaminated beyond levels that can be removed using reasonable methods of public water supply treatment). Most aquifers found at government-operated facilities are Class II aquifers, which are current or potential sources of drinking water.

Groundwater Quality. Groundwater quality of the near-surface aquifer in the generic site area could range from good to poor. Groundwater that would occur at the emplacement zone depth would be brine. Characteristics of this water are high salinity (indicative of long-term isolation from the biosphere), low carbonate concentrations, slightly basic and reducing geochemistry, and low thermal gradient.

Groundwater Availability, Use, and Rights. Groundwater availability could range from not an issue (because the site does not withdraw groundwater) to critical groundwater overdraft and low surface water availability relative to demand. Critical is defined as more than 1,893 million l/day (500 million gal/day) of overdraft (VDL 1990a:725). Overdraft of groundwater occurs when water is withdrawn from sources that cannot be renewed or is withdrawn more quickly than it can be recharged.

Groundwater rights for a generic deep borehole site could range from absolute ownership rule to appropriation. Under the absolute ownership rule, the owners of land overlying a groundwater resource are allowed to withdraw unlimited water from their wells for whatever purpose they choose. Under the appropriation doctrine, all water is declared to be public and subject to appropriation on the basis of the "first in time, first in right" principle and control of the well use is usually accomplished by permits.

3.10.5 GEOLOGY AND SOILS

Geology. The deep borehole site could be located in a variety of geologic settings within the contiguous United States, provided the primary deep borehole site criterium, isolation from the biosphere, can be maintained for geologic times. Two key conditions for isolation from the biosphere would be geologic stability and the very low hydraulic efficiency of potential conduits (fractures, faults) to prevent pathways for transport of disposed materials to the surface.

Possible geologic terrains could range from interior basins to stable continental crust. Surficial material could range from desert sands to glacial tills. Coastal margins, volcanic zones, and seismically active zones are, by definition, unstable and would not represent optimal locations for the deep borehole site. The topography of the deep borehole site would range from flat to hilly; areas of high relief could result in large hydraulic head differences and deep circulation. Table 3.10.5–1 illustrates some of the principal advantages and disadvantages associated with the different types of candidate geologic media.

Soils. The deep borehole site may be located in areas where the predominant soil types range from clays to sands. These soils can range from poorly- to well-drained soils. Soil erosion from past land uses, if any, can range from slight to severe. The soil erosion potential can range from slight to severe in those areas with slopes greater than 25 percent and which have been eroded in the past. Wind erosion potential can range from low to high. The soils shrink-swell potential can range from low to severe.

Table 3.10.5–1. Attributes of Different Types of Geologic Media

Medium Type	Advantages	Disadvantages	Analysis
Plutonic/Metamorphic "Basement" Rocks (for example, granite)	Salinity increases with depth; fewer fractures at depth; mechanically strong, impermeable matrix; occurs in sufficiently thick sections; many locations with large areal extent.	Limited data on conditions at depth, may be structurally complex.	No disqualifiers, potential host rock.
Tuffs (consolidated volcanic ash)	High compressive strength; high sorptivity.	Columnar joints; fractures and cavities, water may induce geochemical changes; limited geologically old occurrences (fails tectonic stability test); vertical section discontinuous; may have insufficient depth.	Not suitable due to tectonic instability and vertical discontinuity.
Rock salt (evaporite)	Isolated from aquifers; low interstitial water content; self-healing fractures due to plasticity.	Interbedded rock layers in bedded salt could act as fluid conduits, brine pockets could migrate; drilling difficulties due to plasticity; holes may close before emplacement due to plastic flow; may not be thick enough; not as old as basement rock implying less stability; mobile salt (domes) are unstable.	Probably not suitable for borehole due to unfavorable mechanical properties.
Anhydrite (evaporite)	Chemically stable; little interstitial water; hydration induced swelling may reduce permeability.	Brittle and easily fractured; not self-healing; massive swelling during hydration causes fractures and borehole instability; may not be thick enough; not as old as basement rocks implying less stability; limited areal extent.	Probably not suitable due to unfavorable mechanical properties.
Sedimentary rocks (shales)	Low interstitial permeability; high sorptivity.	Flows plastically under high stresses, may lead to borehole instability; highly fractured; not as old as basement rocks implying less stability; vertically discontinuous; may have conductive interbeds.	Probably not suitable due to vertical discontinuity and vertical fractures.
Mafic lavas (flood basalts)	Low matrix permeability; high compressive strength.	Limited occurrences, may imply tectonic instability; vertically discontinuous; interbeds may be efficient transport routes.	Probably not suitable due to vertical discontinuity and implied tectonic instability.
Unconsolidated sediments (alluvium)	Moderate to high sorptive capacity; effective radionuclide barriers.	Geologically very young implying instability; high potential for erosion or continued tectonic movements; may not be thick enough; may be too conductive.	Unsuitable due to young age and implied tectonic instability.

Source: LLNL 1996i:1.

3.10.6 BIOLOGICAL RESOURCES

Terrestrial and Aquatic Resources

The description of terrestrial and aquatic resources has been divided into natural habitats and migratory birds. In each case, an overview of these resources is given for the area within which the generic deep borehole site may be sited.

Natural Habitats. The following description characterizes the principal vegetation types that could be found at a potential deep borehole site and is based on *Fundamentals of Ecology* and *The Study of Plant Communities: An Introduction to Plant Ecology* (Odum 1971a:377-403; Oosting 1956a:269-377). The principal vegetation types are defined by their climax vegetation (vegetation that develops following an extended time without major disturbance), a useful method of describing terrestrial resources, since vegetation types are comprised of similar groupings of flora and fauna. Although these vegetative types are a terrestrial resource classification system, the discussion of each addresses characteristic aquatic resources in the same geographical area.

Most areas have been subjected to substantial human disturbance over the past centuries, even though vegetation types are characterized by their climax vegetation. These areas now largely support successional vegetation, which can include grasses and forbs, shrubs and saplings, or forest cover comprising species other than those of the climax vegetation. Each vegetation type displays its own characteristic patterns of succession. Additionally, the boundary between any two is often a blend of characteristics from both types. The following principal vegetation types could be found at a generic deep borehole site.

Northern Coniferous Forest. Northern coniferous forest is common across much of Canada and Alaska, but within the type of area being considered for a deep borehole complex occurs only in the northern New England States. Climate is severe, with a short growing season and moderate precipitation. The principal evergreen species present in this forest include red spruce and balsam fir, which often form dense canopies under which little understory vegetation can grow. Paper birch, poplar, and aspen are common deciduous trees on disturbed sites. Animals found in northern coniferous forests within New England include moose, beaver, porcupine, boreal chickadee, red-breasted nuthatch, a variety of warblers, ring-necked snake, smooth green snake, green frog, and spotted salamander. Reptiles and amphibians are not as common in this vegetation type as in those that occur in more southerly latitudes. Aquatic habitat includes streams and lakes; bogs also commonly occur in the northern coniferous forest.

Hemlock-Hardwood Forest. Hemlock-hardwood forest is found in the northeastern and north-central part of the type of area under consideration for a deep borehole complex. This region is typified by long, cold winters and a short growing season. Although this is a northern forest type, it occurs at higher elevations along the Appalachian Mountains as far south as northern Georgia. Important tree species include hemlock, white pine, basswood, American elm, white ash, and red oak. Hemlock-hardwood forests support a diversity of animals, including red squirrel, snowshoe hare, ruffed grouse, pine siskin, and red crossbill. Reptiles and amphibians are not as numerous in this community type as in more temperate areas. The common garter snake, painted turtle, and chorus frog are found in hemlock-hardwood forests. Fast-moving streams occur within mountainous portions of this vegetation type, while lakes are common within those portions of the region that were glaciated.

Deciduous Forest. Deciduous forest occurs in most of the eastern third of the type of area under consideration for a deep borehole complex and is characterized by a moist, temperate, seasonal climate. The canopy of a deciduous forest is typically dominated by two or three species of trees. Common trees include oak, hickory, beech, and maple. A patchy to well-developed understory tree layer is found, and shrubs are common. The deciduous forest supports a variety of animal life, including the white-footed mouse, eastern gray squirrel, raccoon, gray fox, whitetail deer, black bear, wood thrush, ovenbird, downy woodpecker, worm-eating warbler, rat snake, eastern ribbon snake, American toad, and green frog. Streams and rivers are abundant in deciduous forest and include a number of major river systems, such as the Ohio.

Grassland. Grassland occurs in much of the central portion of the area under consideration. The climate is characterized by pronounced seasonality with respect to rainfall and temperature. Climax vegetation is characterized by grasses and other herbaceous plants, because there is insufficient rainfall to support forest communities. Because of the naturally fertile, nearly level soil, much of this vegetation type has been converted to farmland for producing grains and providing pasture for cattle. Fauna of grassland communities include the black-tailed prairie dog, thirteen-lined ground squirrel, horned lark, ring-necked pheasant, greater prairie chicken, prairie kingsnake, rat snake, western box turtle, chorus frog, and Great Plains toad. Playa lakes to the south and prairie pot holes to the north are important habitats for waterfowl and a number of other species of wildlife. Perennial and intermittent streams and small lakes characterize the aquatic resources of this vegetation type.

Desert. Desert occurs in much of the southwestern and western portion of the type of area under consideration for a deep borehole complex and is characterized by a scarcity of rainfall (less than 25 cm [9.8 in]) or rainfall that is very unevenly distributed. Vegetation is sparse and consists mainly of shrubs and rapidly growing annuals. During the short periods of rainfall, a large number of grasses and forbs briefly appear. Although the environment is harsh, the desert supports a variety of fauna, including the bighorn sheep, mule deer, black-tailed jackrabbit, mountain lion, coyote, javelina, golden eagle, greater roadrunner, Gambel's quail, desert tortoise, and various species of lizards and snakes. Aquatic resources are generally limited to intermittent streams and washes.

Rocky Mountain Forest. Rocky Mountain forest encompasses a number of vegetation types due to changes in environmental factors with altitude. This results in the zonation of plant communities, reflecting rapid altitude changes over short distances. A single mountainous area can feature four or five vegetation zones within a change of elevation of several thousand meters. The flora and fauna of each zone are often similar to those previously described (such as desert, grassland, deciduous forest, and northern coniferous forest). However, the zones are not always continuous nor are they always all present. Near the northern limits of this complex, the lower zones run out and the upper zones are found at relatively low altitudes. Southward, all zones are found at successively higher altitudes. Diverse freshwater aquatic habitats and species are associated with this vegetation complex.

Migratory Birds. Migratory birds include both waterfowl and the numerous other birds (for example, passerine species) that travel between breeding and wintering grounds. These species are dependent on the presence of adequate habitat along their migratory routes to provide both resting and feeding areas. The importance of these species has been recognized by the passage of the *Migratory Bird Treaty Act*. This act seeks to prevent the killing of migratory birds and the destruction of their eggs and nests.

Waterfowl. The four migratory waterfowl flyways (Pacific, Central, Mississippi, and Atlantic) represent some of the traditional routes for fall and spring migration of certain North American migratory waterfowl such as geese, swans, and cranes. While the Central and Mississippi flyways are entirely within the type of area being considered for a deep borehole complex, the Pacific and Atlantic flyways are only partially within the site area. To maintain migratory waterfowl populations, an adequate amount of open space, open water, and wetlands is necessary for foraging and refuge during migration. Wetlands also provide important breeding habitat for migratory waterfowl. Major breeding areas occur in the northern portion of the deep borehole site area. During the winter months, waterfowl migrate to the southern United States and Central America, where they congregate in wetland regions.

Other Migratory Birds. The flyways discussed above are a simplified method of describing migration paths used by certain types of waterfowl. Many other species of migratory birds follow different north-south routes across the type of area being considered for a deep borehole complex, often changing their migration paths from one year to the next. Typically, smaller birds such as rails, flycatchers, most sparrows, warblers, vireos, thrushes, and shorebirds migrate at night. Day migrants include large and small birds such as gulls, pelicans, hawks, swallows, nighthawks, and swifts (FWS 1979a:20,21,61).

Wetlands

Although wetlands occur across the entire type of area being considered for a deep borehole complex, they are most prevalent in the mid-Atlantic, southeast, south-central, and north-central portions of the site area. Major types of wetlands occurring in the site area include tidal salt marshes, freshwater marshes, northern peatlands, shrub swamps, and riparian forested wetlands. Wetlands serve important functions, including maintaining water quality, controlling floodwaters, stabilizing shorelines, and providing animal habitat and recreational uses such as hunting and fishing. Wetlands are also important in providing habitat for aquatic organisms and migratory birds, as well as for threatened and endangered plants and animals. Since it is difficult to protect surface waters and wetlands during construction drilling operations necessary for a deep borehole, wetlands typically would be avoided during selection of potential borehole drilling sites.

Threatened and Endangered Species

Threatened and endangered species could be present in each of the principal vegetation types discussed above. Over 750 threatened and endangered species occur in the United States (FWS 1995a:1-35). Endangered plants and animals often rely on sensitive environments such as wetlands for habitat. Critical habitats, geographical areas that are considered essential to the conservation of a species and that could require special management considerations or protection, can be designated and protected under the ESA. Protection of threatened and endangered species and their habitat is important for maintaining biodiversity, which is essential for full ecological functioning.

3.10.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

Prehistoric Resources. Prehistoric resources could be affected by the construction and operation of a deep borehole site. These resources may include objects, sites, or districts. Archaeological sites can include villages and campsites. Sites may yield artifacts such as stone tools and associated manufacturing debris and ceramic potsherds. Some sites may be eligible for inclusion on the NRHP.

Historic Resources. Historic resources that could be affected by construction and operation of a deep borehole site include subsurface remains of human occupation such as structural foundations of buildings, important paths or roads, and cemeteries. Some standing buildings such as commercial structures and residences may also be considered historic resources.

Native American Resources. Native American resources that could be affected by construction and operation of a deep borehole site may include sites, areas, and materials important to Native Americans for religious or heritage reasons. Sacred sites may include cemeteries, plant communities, mountains, paths, or geographical spaces that are socially identified and circumscribed. Some Native American groups could be affected and may need to be consulted if a specific site is chosen.

Paleontological Resources. Paleontological resources that could be affected by construction and operation may include fossil remains of extinct plants or animals, some rare. They can include poorly known fossil forms, well-preserved terrestrial vertebrates, unusual depositional contexts, assemblages that contain a variety of fossil forms, or deposits recovered from poorly studied regions or in unusual concentrations.

3.10.8 SOCIOECONOMICS

The generic deep borehole site could potentially affect the socioeconomic environment of an REA or an ROI. The characteristics of the REA, ROI, and communities are dependent upon geographic location. Employment and income in the economic area would be based upon industry interaction and linkages in the region. The anticipated residential distribution of project-related employees and their families would determine the ROI, and the ROI would contain all principal jurisdictions and school districts for community services likely to be affected by the proposed activity. Local transportation would consist of the existing principal road, air, and rail networks required to support the project activities.

Potential locations for a deep borehole have not been identified, so the affected environment cannot specifically be determined. The deep borehole complex would require a buffer zone of approximately 2,000 ha (4,900 acres). If the deep borehole complex were located in a largely uninhabited region, the majority of the workforce might choose to live in a more densely populated region and endure a longer commute to work. There is also the possibility of limited housing availability (and residential utilities), which could cause workers and their families to move to the more densely populated areas. It is also possible that the REA and the ROI could comprise uninhabited areas and small rural communities or contain different community types. The range of potential community types could be categorized as uninhabited regions, rural areas and small rural communities, and medium-size communities.

Uninhabited regions include unpopulated portions of the United States and Federal lands that have been set aside and are not developable. Economic activity in these regions is nonexistent. The primary issue is the availability and suitability of infrastructure and transportation networks to support the project activities.

Rural areas and small communities include areas or communities with populations of less than 50,000. These are small business centers that have a small workforce with little diversification of industries and employment. Public services, infrastructure, and transportation networks are generally limited, but capacities would vary with each location. These areas generally have small, specialized economies and relatively large basic sectors dependent on export activities.

Medium-size communities include areas with a city of at least 50,000 in population or an urbanized area of at least 50,000 with a total metropolitan population of 100,000. These communities usually operate as local or regional centers for economic activity. A local center usually has the largest community within a radius of approximately 80 km (50 mi); however, a larger regional or nationwide center is nearby for wholesaling, finance, and activities that do not involve the consumer directly. A regional center usually would be the largest community within a radius of 160 to 240 km (100 to 150 mi). The number of employment sectors is higher than in small communities, and economic relationships would exist between only a limited number of industries. Public services, transportation networks, and other infrastructures would tend to be more extensive than in smaller communities.

Communities of each category typically differ in terms of size and diversification. The vulnerability or susceptibility of a local community to changes in the economic base depends, in large part, on the strength of its economic base, as indicated by its number of employment sectors, its diversification of employment sectors, its pool of available labor, and its degree of inter-industry linkages. Inter-industry linkage is an economic relationship between two or more industries within the same market. A well developed network of mutually supporting diversified industries insulates a local economy from factors outside the region and contributes to a strong economic base. Communities with strong diversified economic bases are not affected by socioeconomic change as much as communities that have bases that rely on a single basic employment sector.

3.10.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Radiation Environment. Major sources and levels of background radiation exposure to individuals in the vicinity of a generic deep borehole site are shown in Table 3.10.9–1. Annual background radiation doses to individuals are expected to remain constant over time. The total dose is expected to change as the population size changes. Background radiation doses are unrelated to any site operations that may exist at a potential deep borehole site.

Table 3.10.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Operation at the Generic Deep Borehole Complex Site

Source	Effective Dose Equivalent (mrem/yr)
Natural Background Radiation[a]	
Cosmic and cosmogenic radiation	27 to 39
External terrestrial radiation	28 to 59
Internal terrestrial radiation	39 to 40
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	359 to 403

[a] Based on annual reports for illustrative sites and EPA 1981b.
[b] NCRP 1987a.
Note: Value for radon is an average for the United States.

Releases of radionuclides to the environment from operations at generic deep borehole sites provide another source of radiation exposure to individuals in the vicinity of the sites. Types and quantities of radionuclides released from operations in 1993 at sites at developed locations that have current nuclear activities (refer to Sections 3.2.9 through 3.7.9), which could be typical of a generic deep borehole are listed in the 1993 annual environmental reports for those sites. The range of doses to the public resulting from these releases is presented in Table 3.10.9–2. The doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1993 reports were used in the development of the reference environments (No Action) radiological releases and resulting impacts in the year 2005 (Sections 4.3.3.1.9 and 4.3.3.2.2.9). For the generic deep borehole site that is not developed and has no current nuclear activities, there would be no radionuclide releases or doses in the past. For these sites, the No Action releases and doses in the year 2005 are assumed to be zero.

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 operations in 1993 at the generic deep borehole sites addressed in Sections 3.2.9 through 3.7.9 is estimated to range from 2.9×10^{-11} to 1.5×10^{-6}. 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 deep borehole site operations ranges from about 3 chances in 100 billion to less than 2 chances in 1 million. (Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.)

Table 3.10.9–2. Radiation Doses to the Public From Normal Operation at the Generic Deep Borehole Complex Site 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	5.8×10^{-5} to 1.4	4	0 to 0.60[b]	100	5.8×10^{-5} to 3.0[c]
Population within 80 km[d] (person-rem)	None	1.4×10^{-4} to 26	None	0 to 2.0	100	1.4×10^{-4} to 28
Average individual within 80 km[e] (mrem)	None	5.0×10^{-7} to 0.030	None	0 to 0.0023	None	5.0×10^{-7} to 0.032

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that order the 10 mrem/yr limit from airborne emission is required by the CAA, the 4 mrem/yr limit is required by the SWDA, 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 (58 FR 16268). If the potential total dose exceeds the value, it is required that the contractor operating the facility notify DOE.

[b] These doses are mainly from drinking water and eating fish.

[c] This total dose includes 1 mrem/yr from direct radiation exposure.

[d] In 1993, this population ranged from 21,750 to 880,000.

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

Note: Data from annual environmental reports for those illustrative sites discussed in Sections 3.2.9 through 3.7.9; all of these sites have nuclear activities. For potential sites having no nuclear activities, the doses would be zero.

Based on the same risk estimator, a range of 7×10^{-8} to 0.013 excess fatal cancers is projected in the populations living within 80 km (50 mi) of these same illustrative sites from normal operations in 1993. To place these numbers into perspective, they can be compared with the numbers of fatal cancers expected in these populations 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 mortality rate, the number of fatal cancers expected during 1993 from all causes ranged from 44 to 1,760 in the population living within 80 km (50 mi) of the borehole site. These numbers of expected fatal cancers are much higher than the estimated range of 7×10^{-8} to 0.013 of fatal cancers that could result from operations at generic deep borehole sites in 1993. The risks and numbers of expected fatal cancers from radiation from generic deep borehole sites that currently have no nuclear activities would be zero.

Site workers receive the same dose as the general public from background radiation, but they also receive an additional dose from working in the site facilities. Table 3.10.9–3 presents the range of the average worker, maximally exposed worker, and total cumulative worker dose to workers from operations in 1992 at a generic site at developed locations that presently have nuclear activities (Sections 3.2.9 through 3.7.9). 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 excess fatal cancers to workers from site operations in 1992 is estimated to range from 8.0×10^{-4} to 0.14. For generic deep borehole sites at undeveloped locations with no nuclear activities, the occupational radiological exposure would be zero.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the 1993 annual environmental reports for the active DOE sites, representative of developed locations. The concentrations of radioactivity in various environmental media (that is, air, water, and soil) in the regions of the sites (onsite and offsite) are also presented in these reports (see Sections 3.2.9 through 3.7.9).

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 waters during swimming and soil through direct contact or via the food pathway).

Table 3.10.9–3. Radiation Doses to Workers From Normal Operation at the Generic Deep Borehole Complex Site in 1992 (Committed Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual
Average worker (mrem)	ALARA	2.6 to 27.3
Maximally exposed worker (mrem)	5,000	660 to 3,000
Total workers[b] (person-rem)	ALARA	2 to 350

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

[b] The number of badged workers in 1992 ranged from 780 to 19,500.

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

The baseline data for assessing potential health impacts from the chemical environment are those presented in Sections 3.2.3 through 3.7.3.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (that is, 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 the deep borehole site via inhalation of air containing hazardous chemicals released to the atmosphere by site 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 Sections 3.2.3 through 3.7.3. 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 for workers at a generic deep borehole site 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. Site 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 a generic deep borehole site are expected to be substantially better than required by the standards.

Health Effects Studies. Specific locations for the deep borehole complex must be designated before any reviews of epidemiologic studies in the areas can be conducted.

Accident History. Since there is no deep borehole site in operation, there is no site accident history.

Emergency Preparedness. The generic deep borehole site would have an emergency management program that could be activated in the event of an accident. The program would be compatible with all other Federal, State, and local plans and be thoroughly coordinated with all interested groups. The program would be modified, as necessary, to accommodate deep borehole operations.

3.10.10 WASTE MANAGEMENT

This section describes the range of waste management activities and regulatory framework that could exist at a generic deep borehole site. The volume of waste generated by existing DOE sites varies greatly. Existing DOE sites also have a wide range of capability in the "cradle-to-grave" management of the various categories of wastes. Sites such as INEL, Hanford, and SRS have an extensive onsite treatment, storage, and disposal capability for most waste categories. Whereas, sites such as Pantex have a limited treatment and storage capability, and with the exception of a landfill for construction debris, have no onsite disposal capability. For generic deep borehole sites that would not be on or near a DOE facility, it is highly unlikely that there would be any ongoing waste management activities, except for a possible sanitary wastewater treatment facility or sanitary landfill. There are no regulations that clearly pertain to the disposal of surplus Pu material into a deep borehole. However, the regulations that would govern the waste management activities in support of the deep borehole are well-defined. A general discussion follows to describe the range of waste management activities if a deep borehole were located on or near a DOE facility.

Spent Nuclear Fuel. There would be no spent nuclear fuel associated with a deep borehole site.

High-Level Waste. There would be no HLW associated with a deep borehole site.

Transuranic Waste. Transuranic wastes are unique to DOE. Most TRU waste exists in a solid form and is comprised of protective clothing, paper trash, rags, glass, miscellaneous tools, and equipment that have become contaminated with TRU radionuclides. Liquid TRU wastes are generated from the chemical processing for recovery of Pu or other TRU elements. TRU wastes are managed in accordance with DOE Order 5820.2A. TRU wastes are to be processed and packaged to meet the WIPP WAC or alternate treatment level and placed in interim storage while awaiting the availability of a Federal repository. Mixed TRU waste must also meet the requirements of RCRA as outlined in 40 CFR 260. The generation of TRU waste at DOE sites ranges from 0 to 638 m^3/yr (0 to 835 yd^3/yr) and from 0 to 225 m^3/yr (0 to 294 yd^3/yr) for mixed TRU (DOE 1994d:122,124).

Low-Level Waste. Low-level waste is generated at more than 30 different DOE sites and is disposed of at Hanford, NTS, INEL, ORR, SRS, and LANL. LLW is usually rags, papers, filters, tools, equipment, and discarded protective clothing contaminated with radionuclides. In accordance with DOE Order 5820.2A, LLW must be characterized with sufficient accuracy to permit proper segregation, treatment, storage, and disposal. Waste acceptance criteria are established for each LLW treatment, storage, and disposal facility. For the 30 sites that generate LLW, the generation ranged from a few cubic meters (few cubic yards) to 14,090 m^3/yr (18,430 yd^3/yr) (DOE 1994d:145). The average land usage factor for the six DOE LLW disposal facilities ranges from 3,400 to 29,700 m^3/ha (1,800 to 15,700 yd^3/acres) (DOE 1994d:141,152).

Mixed Low-Level Waste. Mixed LLW at DOE sites includes a variety of contaminated materials, including air filters, cleaning materials, engine oils and grease, paint residues, photographic materials, soils, building materials, and plant equipment being decommissioned. In accordance with the *Federal Facility Compliance Act* of 1992, each DOE site that generates, stores, or treats mixed LLW has developed a Site Treatment Plan. The Site Treatment Plan lays out the development of technologies and capacities needed to treat mixed LLW to the standards required by RCRA. With approval of the plans, the regulatory agency issued an order requiring compliance with the approved plan. For those DOE sites that generated mixed LLW in 1993, the generation ranged from less than 1 m^3 (1.3 yd^3) to 1,900 m^3 (2,485 yd^3) (DOE 1994d:241).

Hazardous Waste. Hazardous wastes generated by DOE facilities include solvent rags, analytical laboratory chemicals, photographic shop wastes, spent solvents, waste oil, and paint wastes. Hazardous wastes are managed in accordance with RCRA as outlined in 40 CFR 260. Most DOE sites ship their hazardous wastes offsite to commercial RCRA-permitted facilities under contract, using DOT-registered transporters.

Nonhazardous Waste. The DOE generates the same kinds of liquid and solid nonhazardous wastes that any industrial facility would generate. Liquid nonhazardous wastes may undergo a wastewater treatment process before discharge to a publicly owned treatment works or surface waters. Wastewater treatment processes may include a neutralization of acidic or basic wastewater or flocculation/clarification. These liquid wastes are regulated by the CWA and are treated and discharged in accordance with NPDES permits and other state and local guidelines. Solid nonhazardous wastes are disposed of in onsite sanitary landfills that are owned and operated by DOE or shipped offsite to municipal landfills for disposal. The operation and management of solid nonhazardous wastes are regulated under the provisions of RCRA, Subtitle D.

3.11 MIXED OXIDE FUEL FABRICATION SITE (GENERIC)

For the generic MOX fuel fabrication facility, the environmental baseline is representative of an existing reactor fuel fabrication facility currently operating in the contiguous United States. Nuclear fuel fabrication on a commercial scale in the United States is currently limited to five major nuclear fuel fabricators. The five existing reactor fuel fabrication sites that were used as the basis for creating the generic environment are the following:

- ABB–Combustion Engineering, Hematite, MO
- Framatome Commercial Nuclear Fuel Plant, Lynchburg, VA
- General Electric Nuclear Production Facility, Wilmington, NC
- Siemens Nuclear Power Corporation, Richland, WA
- Westinghouse Columbia Fuel Facility, Columbia, SC

The commercial nuclear fuel facilities are primarily engaged in the manufacture of fuel assemblies for commercial nuclear reactors, both BWRs and PWRs. In general, the operations consist of receiving LEU hexafluoride (UF_6); converting the UF_6 to produce UO_2 powder; and processing the UO_2 through pressing and sintering, fuel rod loading and sealing, and fuel assembly fabrication. The fabrication varies in both process and magnitude from site to site.

Currently, there are no commercial U.S. fuel fabrication facilities licensed to process MOX fuel. Processing of MOX fuel in commercial facilities would require licensing by the NRC. The NRC licensing application process includes compliance with site-specific NEPA requirements.

Department of Energy Activities. There are no major DOE activities at these commercial facilities.

Non-Department of Energy Activities. The range of primary missions of the commercial fuel fabrication facilities are as follows: one fabrication facility limits current operation to only loading fuel rods for PWRs; others provide a wide range of fuel fabrication for PWRs only or BWRs only; and one facility fabricates fuel for both BWRs and PWRs.

3.11.1 LAND RESOURCES

The approach to defining the generic MOX fuel fabrication site environmental setting for land resources is not site-specific. Consequently, a range of land use and visual resources conditions has been provided (see Table 3.11.1–1).

Table 3.11.1–1. Land Resources Attributes of the Generic Mixed Oxide Fuel Fabrication Site

Land Use Attributes	
Land Area	30 ha to 695 ha
Land Ownership	Public or Private
Percent of Site Area Developed	2 to 20 percent
Existing Land Use	
Onsite	Industrial; Undeveloped
Offsite	Forest land; Agriculture; Residential; Commercial; and/or Industrial
Land Use Compatibility	Likely
Plans, Policies, and Controls	
Jurisdiction	DOE; other Federal; State; local
Enforcement	Lax to stringent
Conformance	Likely
Visual Resource Attributes	
Landscape Character	
Site	Flat to gently rolling topography
Viewshed	Small to medium size urbanized area; surrounding agriculture; and/or forest
Visual Resource	
Sensitivity level	Low to medium to high
Distance zones	Foreground, middleground, background, and seldom-seen
BLM VRM class	4 to 5
Degree of contrast	Weak to moderate

Source: BW NRC 1976a; BW NRC 1983b; CE 1989a; GE 1989a; GE 1989b; GE 1989c; GE NRC 1984a; NRC 1981b; NRC 1982a; SPC 1992a; WEC 1975a.

Land Use. The land area requirement for a site would range from 30 ha to 695 ha (74 acres to 1717 acres). Plant facilities would be sited upon only a portion of the total site area, with the developed portion likely to range from 2 to 20 percent. The range of land uses for the undeveloped portion of the site would be grassland, forest, or swampland.

The location of a generic MOX fuel fabrication site would likely range in distance from less than 1 km to 5 km (0.6 mi to 3.1 mi) from the nearest community. Although a site could be located within a city corporate limit, it is more likely to be further from the closest city or metropolitan area, ranging between 6 and 56 km (3.7 and 34.8 mi) distant.

Land uses within the site vicinity would be described as rural, with forest land and agricultural uses predominating. The full range of land uses could include undeveloped uses such as forest and agriculture to developed uses such as residential, commercial, and industrial. The nearest residence would range from 200 to 800 m (656 to 2,625 ft) from the site boundary.

Depending on location, the site could be subject to a variety of land-use plans, policies, and controls at the Federal, State, and local level. The existence and stringency of these plans, policies, and controls could vary by jurisdiction. However, it is likely that site development would be in conformance with land-use plans, policies, and controls, and be compatible with adjacent land use.

Visual Resources. The visual environment of the site would likely be characterized by level to gently rolling topography. The site would be a developed area that contains facilities and activities, surrounded by undeveloped land. The viewshed would likely be rural with a low population density and with forested and agricultural uses predominating. Facilities would likely be visually unobtrusive due to site design, earthwork, and landscaping. The full range of sensitivity levels, and distance zones could occur (see Section 3.1.1 for discussion of visual resource inventory). Public viewpoints could include public access roadways, urbanized areas, and water-based recreational uses. It is likely that the degree of contrast would range from weak to moderate. The site would likely range from a Class 4 to Class 5 BLM VRM designation.

3.11.2 SITE INFRASTRUCTURE

Baseline Characteristics. The baseline characteristics for a generic MOX fuel fabrication site are provided in Table 3.11.2–1. Characteristics of a regional power pool to supply the generic MOX fuel fabrication site are given in Table 3.11.2–2.

Table 3.11.2–1. Generic Mixed Oxide Fuel Fabrication Site Baseline Characteristics

Characteristics	Site Availability
Transportation	
Roads (km)	3 to 9
Railroads (km)	0 to 4.3
Electrical	
Energy consumption (MWh/yr)	49,500 to 72,000
Peak load (MWe)	0.5 to 10
Fuel	
Natural gas (m^3/yr)	0 to 102,800,000
Oil (l/yr)	0 to 9,130,000
Coal (t/yr)	0 to 208,700
Steam (kg/hr)	0 to 11,000

Source: CFFF 1995a:1; GE 1995a:1; SPC 1995a:1.

Table 3.11.2–2. Generic Mixed Oxide Fuel Fabrication Site Sub-Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel[a]	
Coal	14 to 59%
Nuclear	0 to 39%
Hydro/geothermal	2 to 46%
Oil/gas	<1 to 32%
Other[b]	0 to 30%
Total Annual Production	107,607,000 to 272,155,000 MWh
Total Annual Load	104,621,000 to 293,262,000 MWh
Energy Exported Annually	-45,400,000 to 6,359,000 MWh
Generating Capacity	24,870 to 61,932 MWe
Peak Demand	20,578 to 57,028 MWe
Capacity Margin[c]	4,064 to 13,655 MWe

[a] Percentage does not total 100 percent due to round-off error.
[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.

3.11.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The meteorological and climatological conditions for potential generic MOX fuel fabrication sites in the United States include a wide range of extremes in ambient temperature, windspeed and direction, and precipitation. Therefore, no further description of meteorology and climatology has been provided with respect to a generic site.

Ambient Air Quality. Ambient air quality conditions at representative existing fuel fabrication sites in the United States include a wide range of pollutants and conditions. The existing commercial fuel fabrication sites are all expected to comply with the ambient air quality standards. None of these sites is located in a nonattainment area.

Noise. Specific existing noise sources and characteristics of a generic MOX fuel fabrication site cannot be described. However, it is expected that the area near such a site would be essentially rural in character and would have typically low background sound levels. Typical DNL in the range 35 to 50 dBA (EPA 1974a:B-4) can be expected for such a rural location where noise sources may include wind, insect activity, aircraft, and agricultural activity. Existing industrial noise sources and traffic noise at the site would result in higher background noise levels near the site and along site access routes.

3.11.4 WATER RESOURCES

Surface Water. Major surface water features in the generic MOX fuel fabrication site could range from none to a large navigable river. The average flow rate of these water bodies could range from 0 to 3,360 m^3/s (0 to 118,658 ft^3/s). Other surface water features could include small streams bordering the site with average flows ranging from comparable to the main surface water body's to negligible in comparison.

Stormwater control retention/drainage ponds could be present at the site. These ponds would probably discharge to the nearest surface water body, or to natural drainage channels. Portions of the site could be located within the 100-year floodplain.

Surface Water Quality. In the vicinity of the generic MOX fuel fabrication site, the surface water bodies could range from being classified as fresh water suitable for drinking water, contact recreation, and propagation of fish and aquatic life, to not suitable for drinking, bathing, or commercial shellfishing. The range of concentrations of typical surface water quality parameters that could be encountered at a generic site is the same as was presented in Table 3.10.4–1.

The generic commercial MOX fuel fabrication site would have an NPDES permit(s) that would dictate the acceptable levels of specific parameters in the liquid effluents that would be discharged to a nearby surface water body.

Surface Water Rights and Permits. Surface water rights concerning the water body near the generic MOX fuel fabrication site would involve non-impairment of designated uses.

Groundwater. The near-surface aquifer beneath the generic MOX fuel fabrication site would occur under unconfined conditions and could range in average thickness from 5 to more than 20 m (16.4 to more than 66 ft). Depth to groundwater could range from near the ground surface to more than 200 m (656 ft). The aquifer material could range from sand and gravel to saprolite, or highly weathered bedrock. In general, the generic MOX fuel fabrication site would obtain groundwater from a confined aquifer underlying the near-surface aquifer. The confined aquifer would have an abundant supply of good quality groundwater.

Recharge to the near-surface aquifer would be primarily from rainfall and would occur in areas located up to 10 km (6.25 mi) from the site. Groundwater flow would typically be from these recharge areas towards the major surface water feature.

In areas surrounding the generic MOX fuel fabrication site, groundwater would be used for domestic, agricultural, and industrial purposes. The classification of the aquifer would be a Class II aquifer (that is, currently being used or a potential source of drinking water).

Groundwater Quality. Groundwater quality of the near-surface aquifer in the site area would range from good to fair. The ranges of hydraulic characteristics of the aquifer are presented in Table 3.10.4–2.

Groundwater Availability, Use, and Rights. Groundwater rights concerning the aquifer(s) near the generic MOX fuel fabrication site could range from having potential for local restrictions on pumping to a reasonable use doctrine concerning neighboring landowners water availability.

3.11.5 GEOLOGY AND SOILS

Geology. The physiography of a generic MOX fuel fabrication site could range from a flat, nearly featureless plain to a highly dissected plain of arid to humid environments. Similarly, the area geology could range from alluvium to thick sequences of unconsolidated marine sediments, glaciofluvial material, and crystalline and sedimentary bedrock. These materials could range in age from Cenozoic to Precambrian (recent to over 600 million years).

A generic MOX fuel fabrication site could be located in Seismic Zones 1 to 3, which suggests there could be minor to major levels of damage in the event of an earthquake (Figure 3.2.5–1). [Text deleted.] The geologic terrain for Seismic Zones 1 through 3 of those areas considered for the generic MOX fuel fabrication site could have a history of seismic activity that ranges from low to severe. The nearest capable fault could be within 250 km (155 mi) of the generic MOX fuel fabrication site. The nearest local earthquake with a MMI of V could be within 170 km (106 mi) from a generic MOX fuel fabrication site (Table 3.2.5–1). The nearest epicenter from a damaging earthquake (MMI of VII or greater) could be approximately 170 km (106 mi) from a generic MOX fuel fabrication site.

Although the generic MOX fuel fabrication site is not located within a region of active volcanism, it could be located within approximately 164 km (102 mi) of a volcano.

Soils. The generic MOX fuel fabrication site could be located where the predominant soil types are loamy sands to loamy clays. These soils could range from poorly to excessively drained. The erosion potential could range from minor to severe in those areas with slopes greater than 25 percent and that have been eroded in the past. The soil's shrink-swell potential could range from minimal to severe, which is acceptable for standard construction techniques, depending upon the engineering controls employed. Wind erosion potential could range from minimal to severe.

3.11.6 BIOLOGICAL RESOURCES

The affected environment for the generic MOX fuel fabrication site is based on a review of biological conditions characteristic of several commercial reactor fuel fabrication facilities currently operating in the United States. Biological resources at a given site could vary from those typically associated with the principal vegetation type of the area due to a variety of factors, including previous disturbance by man. The principal vegetation types found within these representative environments include deciduous forest, southeastern evergreen forest, and grassland. With the exception of southeast evergreen forest, biological resources found within these vegetation types are discussed in Section 3.10.6.

Southeast Evergreen Forest. Southeast evergreen forest occurs along the Atlantic coastal plain from the mid-Atlantic States to Florida and along the northern Gulf Coast. The climate varies from distinct seasonal changes in the mid-Atlantic region to only minor seasonal variation in Florida and along the Gulf Coast. Pines, such as pitch, longleaf, and slash, are the dominant tree species within this vegetation type. Pine forests owe their origin and maintenance to their resistance to fire, which inhibits the growth of deciduous species. In the absence of fire, this forest type would be replaced by oak-hickory dominated forest. Animals associated with the southeast evergreen forest include the whitetail deer, opossum, gray fox, northern bobwhite, wild turkey, eastern bluebird, morning dove, eastern diamondback rattlesnake, American alligator and pine woods treefrog. Streams and rivers within this vegetation type are generally slow moving and are often bordered by forested swamps and bottomland hardwood forests.

3.11.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

Prehistoric Resources. Prehistoric resources may be affected by the construction and operation of the generic MOX fuel fabrication facility. These resources may include objects, sites, or features such as remains of storage pits, or hearths. Archaeological sites may include hunting and butchering sites and campsites. Sites may yield artifacts such as stone tools and associated manufacturing debris, and ceramic potsherds.

Historic Resources. Historic resources that could be affected by construction and operation may include subsurface remains of human occupation such as structural foundations of buildings, important paths or roads, and cemeteries. Some standing buildings such as commercial structures and residences also may be considered historic resources.

Native American Resources. Native American resources could be affected by construction and operation of this facility. Resources may include sites, areas, and materials important to Native Americans for religious or heritage reasons. Sacred sites may include cemeteries, plant communities, mountains, paths, or geographical spaces that are socially identified and circumscribed. Some Native American groups could be affected and would need to be consulted if a specific site is chosen.

Paleontological Resources. Paleontological resources could be affected. These resources may include fossil remains of extinct plants or animals, some rare. They can include poorly known fossil forms, well-preserved terrestrial vertebrates, unusual depositional contexts, assemblages that contain a variety of fossil forms, or deposits recovered from poorly-studied regions or in unusual concentrations.

3.11.8 SOCIOECONOMICS

The generic MOX fuel fabrication site could potentially affect the socioeconomic environment of a given REA or ROI. The characteristics of the REA, ROI, and community are dependent upon geographic location. For employment and income, the economic area would be based upon industry interaction and linkages in the region. The anticipated residential distribution of project-related employees and their families would determine the ROI. This ROI would contain all principal jurisdictions and school districts likely to be affected by the proposed activity.

Because specific sites have not been proposed for the generic MOX fuel fabrication facility, representative sites have been used to describe the affected environment. Five existing facilities encompassing three location types were used as representative sites to develop a range of conditions for discussion in this section. Two of the sites, A and B, are located in medium communities located in urban areas. The third site, C, is a small community tied to a large metropolitan area. Medium-size communities and the vulnerability or susceptibility of a local community to changes in the economic base are characterized in Section 3.10.8.

Small communities tied to large metropolitan areas would be characterized by a rural ROI within a large metropolitan REA. The ROI would have attributes similar to rural areas and small rural communities. The population would normally be less than 50,000. There would be small business centers with a small work force and little local diversification of industries and employment. However, the large metropolitan area nearby should provide employment for a significant portion of the rural community's population. The resulting increase in tax base and diversification of employment would strengthen the community's economic base and allow for a higher level of community services than found in a more isolated rural area. Infrastructure and transportation networks would normally be more developed in the rural community linked to a large metropolitan area than in a more isolated community. This would be due, in part, to the requirement for good commuting routes to the large metropolitan area. The large metropolitan area to which the rural community is linked would have a population of at least 1 million. These communities would usually be independent centers of large-scale financial, wholesaling, and service activity. These areas would typically have high population densities and numerous employment centers. Economically supportive relationships between industries would be developed, and a large pool of labor would exist. Large and diverse metropolitan areas would provide a wide range of goods and services to local residents.

Socioeconomic characteristics described for the generic MOX fuel fabrication site include employment and local economy, population and housing, and local transportation. The communities of three typical sites were assessed. Site A, which had a 1992 population of 34,201 and a total urban population of more than 100,000, represents the smaller medium-size community being assessed; Site B, with a 1992 population of 98,832, represents the larger medium-size community being assessed. Site C was a small community whose population was incorporated into the population of the surrounding county. Site C was located approximately 16 km (10 mi) from a small community of 4,096 persons (1992 population) and about 64 km (40 mi) from a large metropolitan area of approximately 1.5 million persons. Statistics for employment and local economy were based on the REA for each site. Statistics for the remaining socioeconomic characteristics were based on the sites' ROIs.

Regional Economy Characteristics. Selected employment and regional economy statistics for each typical site's REA are discussed in this section and displayed in Figure 3.11.8–1. Between 1980 and 1990, the civilian labor force in the REA encompassing Site A increased 9.9 percent to the 1990 level of 254,800, and in Site B increased 19 percent to the 1990 level of 399,100. Site C had a 12.6 percent increase (the 1990 civilian labor force was 1,476,800). The 1994 unemployment for the REA encompassing Site A was 9.1 percent while Site B had unemployment of 6 percent. The unemployment for Site C was 5.3 percent. The 1993 per capita income was $18,501 and $16,832 for Sites A and B, respectively. Site C had a 1993 per capita income of $20,554.

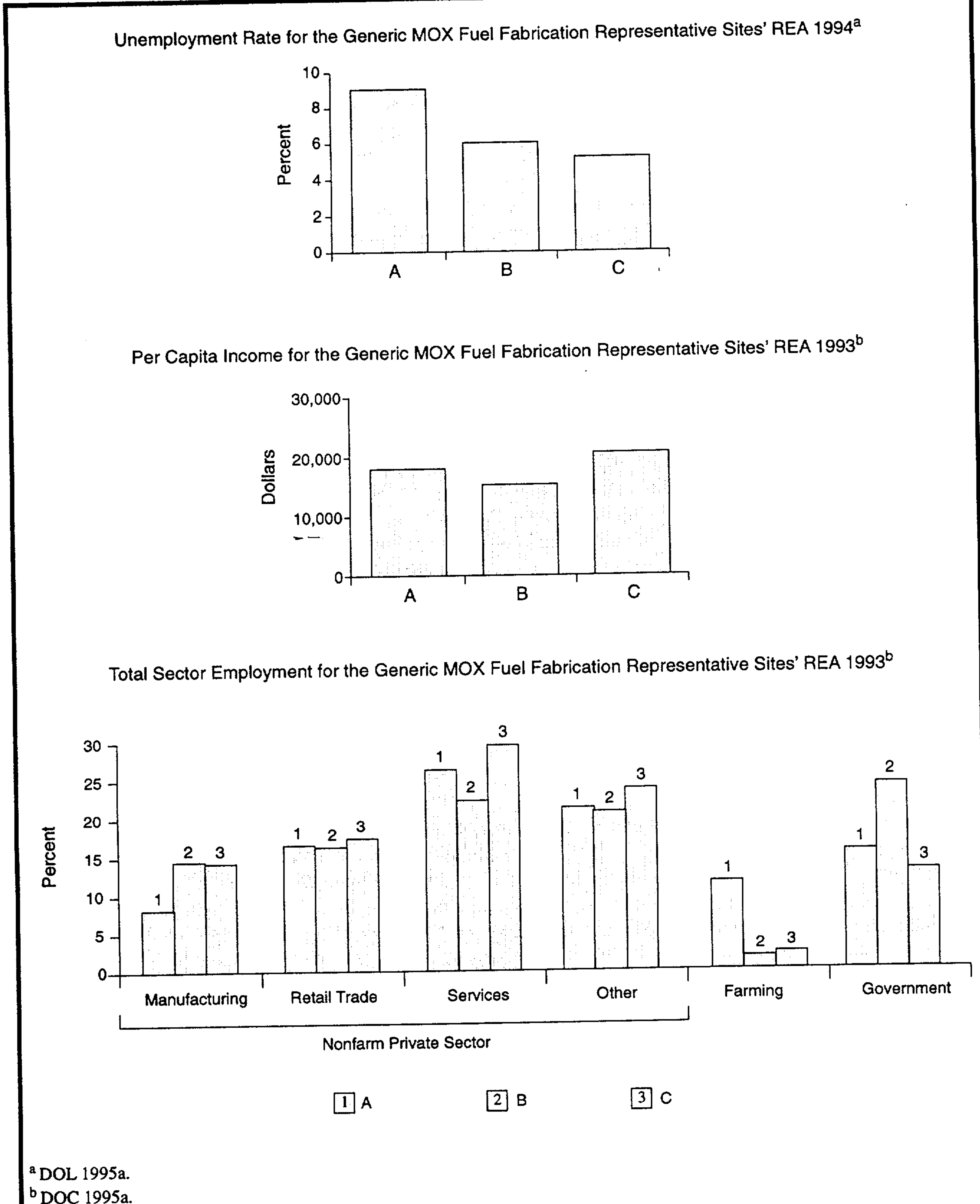


Figure 3.11.8–1. Employment and Local Economy for the Generic Mixed Oxide Fuel Fabrication Representative Sites' Regional Economic Area.

Figure 3.11.8–1 displays the division of employment involving farming, nonfarm private sector, and government employment around each representative site. The portion of total REA employment involving farming was 12 percent at Site A and 2 percent at Site B. Government activities accounted for 15 and 24 percent of the total regional employment at sites for A and B, respectively. Employment involving manufacturing was 8 percent of the total employment in the region surrounding Site A and 14 percent in the region around Site B. Retail trade activities represented approximately 16 percent of the nonfarm private sector employment for Site A and Site B. Service activities represented a 26-percent share of this employment for Site A, and a 22 percent share at Site B.

For Site C, the portion of total employment involving farming and government activities was 2 percent and 13 percent, respectively. The nonfarm private sector activities of manufacturing and retail trade represented 14 percent and 17 percent, respectively, of the total regional employment. Employment in the service sector was 29 percent.

Population and Housing. Population and housing trends in the ROIs of the three typical communities are presented in Figure 3.11.8–2. The ROI population increases for Sites A and B between 1980 and 1994 were 19.8 percent (average annual increase of 1.3 percent) and 18.1 percent (average annual increase of 1.3 percent), respectively. The number of housing units, between 1980 and 1990, in the ROI increased 5.4 percent for Site A and 21.6 percent for Site B. The 1990 ROI homeowner vacancy rates were 1.3 percent for Site A and 1.9 percent for Site B, while the renter vacancy rates were 5.6 percent and 8.9 percent for Sites A and B, respectively.

The ROI surrounding Site C experienced a 5.2-percent (average annual increase of 0.4 percent) increase in population, between 1980 and 1994, and an 11.9-percent increase in the number of housing units between 1980 and 1990. The 1990 homeowner and renter vacancy rates were 1.8 and 9.1 percent, respectively.

Community Services and Local Transportation. These characteristics are dependent upon a geographic location. The ROI would determine all principal jurisdictions and school districts likely to be affected by the proposed activity. Local transportation would be the existing principal road, air, and rail networks required to support the project activities.

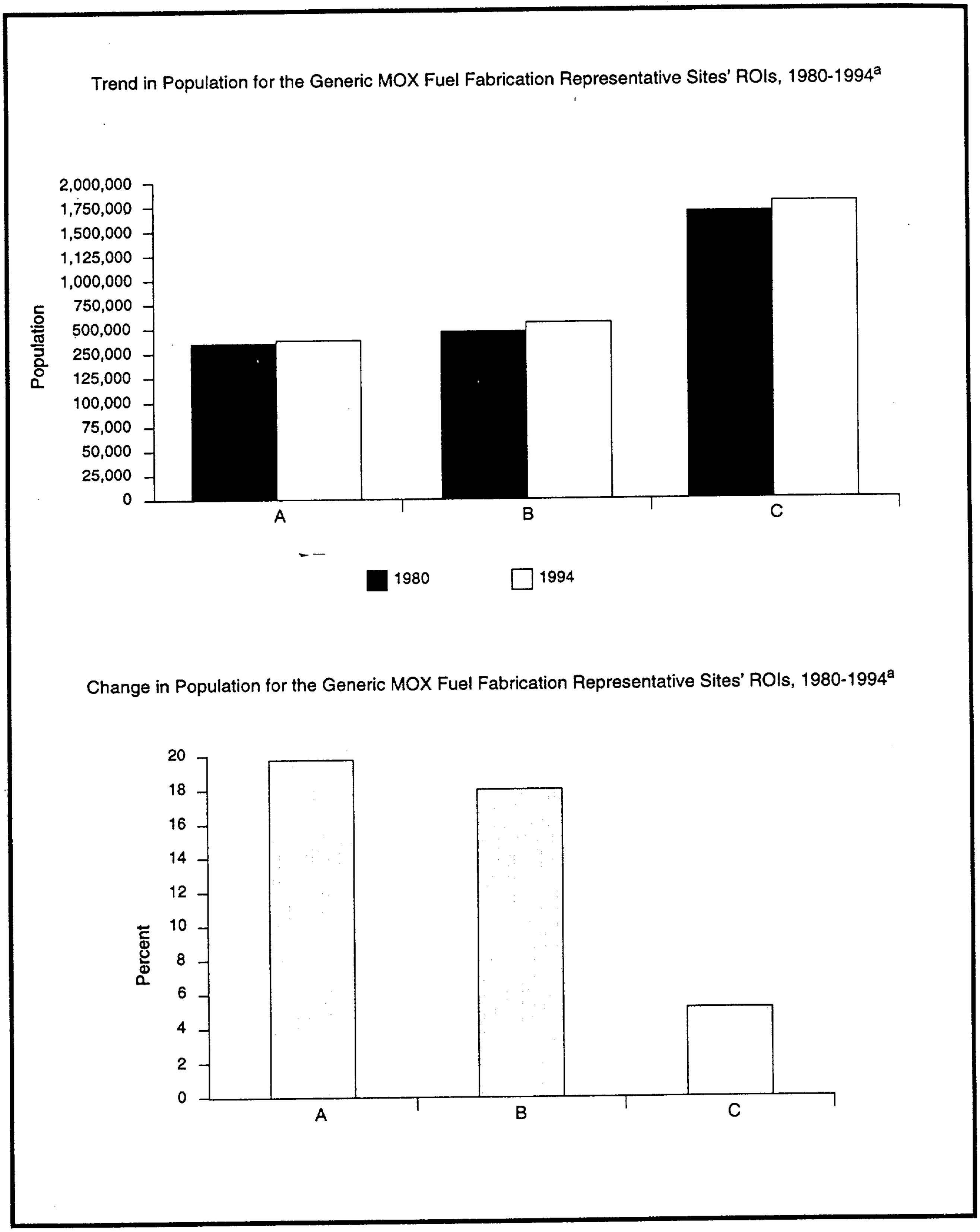
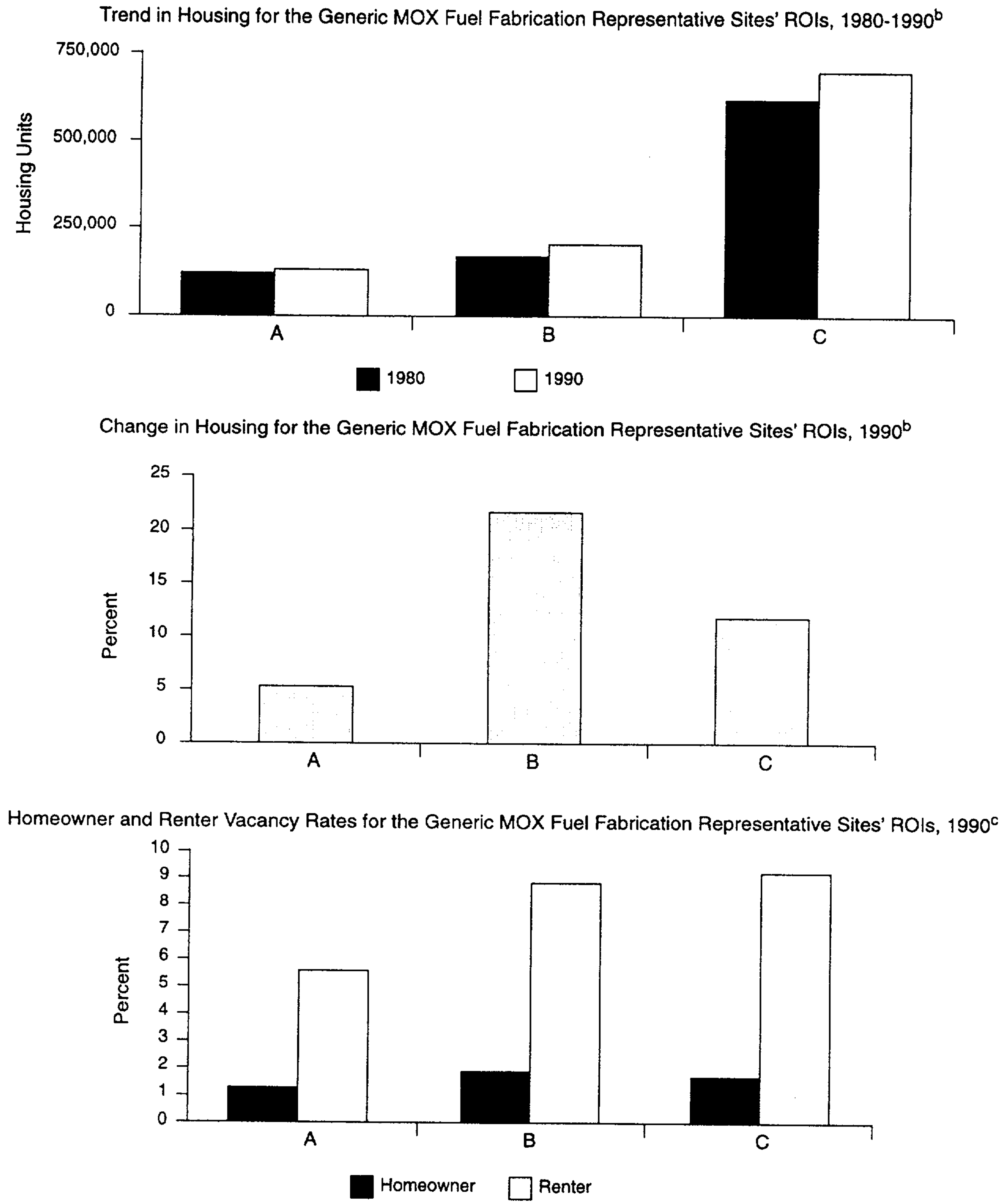


Figure 3.11.8–2. Population and Housing for the Generic Mixed Oxide Fuel Fabrication Representative Sites' Region of Influence.



[a] Census 1983b; Census 1983k; Census 1983m; Census 1995a.
[b] Census 1982c; Census 1982f; Census 1982r; Census 1991b; Census 1991d; Census 1991f.
[c] Census 1991b; Census 1991d; Census 1991f.

Figure 3.11.8–2. Population and Housing for the Generic Mixed Oxide Fuel Fabrication Representative Sites' Region of Influence—Continued.

3.11.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Radiation Environment. Major sources and levels of representative background radiation exposure to individuals in the vicinity of a generic MOX fuel fabrication site are shown in Table 3.11.9–1. 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 normal facility operation.

Table 3.11.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Operation at the Generic Mixed Oxide Fuel Fabrication Site

Source	Effective Dose Equivalent (mrem/yr)
Natural Background Radiation	
Cosmic and cosmogenic radiation[a,b]	27 to 28
External terrestrial radiation[a]	15 to 44
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	346 to 376

[a] Based on 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 normal facility operations provide another source of radiation exposure to individuals in the vicinity of a given site. For a range of existing conditions, types and quantities of radionuclides released from operations at a generic MOX fuel fabrication site is based on 1994 radiological effluent release reports for existing representative commercial fuel fabrication sites involved in the processing and fabrication of uranium ore into reactor fuel. The doses to the public resulting from these releases are presented in Table 3.11.9–2. These doses fall within radiological limits (40 CFR 61, 40 CFR 141, and 40 CFR 190) and are small in comparison to background radiation. The releases listed in the 1994 reports were used in the development of the reference environment's (No Action) radiological releases and resulting impacts at the generic MOX fuel fabrication sites in the year 2005 (Section 4.3.5.1.9).

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 operations at the representative fuel fabrication sites in 1994 is estimated to range from 2.5×10^{-7} to 5.5×10^{-7}. 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 operations at the representative fuel fabrication site ranges from less than 3 in 10 million to less than 6 in 10 million. (Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.)

Based on the same risk estimator, a range of 1.8×10^{-4} to 5.8×10^{-3} excess fatal cancers is projected in populations living within 80 km (50 mi) of the representative fuel fabrication sites from normal operations in 1994. To place these numbers into perspective, they can be compared with the numbers of fatal cancers expected in these

Table 3.11.9–2. Radiation Doses to the Public From Normal Operation at the Generic Mixed Oxide Fuel Fabrication Site in 1994 (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	0.058 to 0.50	4	0.002 to 1.0	25	0.50 to 1.1
Population within 80 km[b] (person-rem)	None	0.30 to 11.1	None	0.050 to 0.48	None	0.35 to 11.6
Average individual within 80 km[c] (mrem)	None	5.7×10^{-4} to 0.013	None	9.5×10^{-5} to 5.7×10^{-4}	None	6.7×10^{-4} to 0.014

[a] The standards for individuals are given in 40 CFR 61, 40 CFR 141, and 40 CFR 190. As discussed in these regulations, the 10 mrem per year limit from airborne emissions is required by the CAA, the 4 mrem per year is required by the SDWA, and the total dose of 25 mrem per year is the limit from all pathways combined.

[b] In 1994, this population ranged from 525,000 to 848,000.

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

Source: BW 1995b:1; WEC 1975a; WEC 1995a:1.

populations from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was approximately 0.2 percent per year (Almanac 1993a:839). Based on this mortality rate, the number of fatal cancers expected to occur during 1994 from all causes ranged from 1,050 to 1,700 in the population living within 80 km (50 mi) of a fuel fabrication site. These numbers of expected fatal cancers are much higher than the estimated range of 1.8×10^{-4} to 5.8×10^{-3} fatal cancers that could result from operations at commercial fuel fabrication sites in 1994.

Site workers receive the same dose as the general public from background radiation but also receive an additional dose from working in the site facilities. Table 3.11.9–3 presents the range of the average worker, maximally exposed worker, and total cumulative worker dose from operations at the representative fuel fabrication sites in 1993. These doses fall within radiological regulatory limits (10 CFR 20). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (Section M.2.1.2), the number of excess fatal cancers to workers from site operations in 1993 is estimated to range from 0.0028 to 0.039.

Table 3.11.9–3. Radiation Doses to Workers From Normal Operation at the Generic Mixed Oxide Fuel Fabrication Site in 1993 (Committed Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual
Average worker (mrem)	ALARA	33 to 159
Maximally exposed worker (mrem)	5,000	<3,000
Total workers (person-rem)	ALARA	7.0 to 98

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

Source: 10 CFR 20; NRC 1995b.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the 1994 effluent release reports and environmental reports. The concentrations of radioactivity in various environmental media (including air, water, and soil) in the regions of the sites (onsite and offsite) are also presented in those reports.

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 waters during swimming and 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 3.11.3.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (that is, 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 the fuel fabrication site via inhalation of air containing hazardous chemicals released to the atmosphere by site 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.

A discussion of ambient air quality is given in Section 3.11.3. As stated in that section, air quality is expected to be in compliance with applicable standards. Information about estimating health impacts from hazardous chemicals is presented in Section M.3.

Exposure pathways for workers at the fuel fabrication site 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. Site 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. Therefore, worker health conditions are expected to be substantially better than required by the standards.

Health Effects Studies. Specific locations for the MOX fuel fabrication facilities must be designated before any reviews of epidemiologic studies in the areas can be conducted.

Accident History. Domestic MOX fuel fabrication facilities do not presently exist. Consequently, there is no accident history available.

Emergency Preparedness. The generic MOX fuel fabrication site would develop an emergency management program which would be activated in the event of an accident. The program would be compatible with all other Federal, State, and local plans and is thoroughly coordinated with all interested groups. [Text deleted.]

3.11.10 WASTE MANAGEMENT

This section describes the range of waste management activities and the regulatory framework that exist at a generic fuel fabrication site in the United States. These commercial facilities would need to be licensed by NRC to handle Pu. To meet the requirements of their NRC license, the generic fuel fabrication site complies with Federal and State regulations of water, air, and land disposal in addition to facility permits. Agencies responsible for enforcement and inspection at a commercial nuclear fuel fabrication facility include the NRC, EPA, and the State's appropriate regulatory agencies. State agencies govern effluent discharge; nonhazardous waste disposal; hazardous waste treatment, storage, and disposal; underground storage tanks; incineration; and transport of hazardous waste.

A generic fuel fabrication site receives low-enriched UF_6 and/or UO_2 (made from natural or depleted uranium) as powder. The UO_2 powder is pressed into pellets, which are sintered, ground to final size, and loaded into fuel rods that are then fabricated into reactor fuel bundles. Wastes produced at this site are categorized as low-level, mixed low-level, hazardous, and nonhazardous. Activities at a generic fuel fabrication site that generate waste include uranium blending; pelleting; sintering; grinding; coating; fuel rod loading and inspection; scrap recovery; incineration of low-level radioactive, mixed low-level, hazardous, and nonhazardous wastes; recovery of zirconium and copper; waste compaction; and waste processing and research related to the recovery of uranium. Incoming materials to the site includes zircalloy tubing, UO_2, nitric acid, water, and natural gas. Exit streams from the site typically include product fuel elements and assemblies; recovered metals; and gaseous, liquid, and solid waste.

The low-level, mixed, hazardous, and nonhazardous wastes are treated to reduce either volume or toxicity for subsequent recycle, storage, or disposal. The quantity of waste and the characteristics of the waste would depend on the fabrication process and the method of treatment used. The following discussions describe the waste management practices that are used at a generic fuel fabrication site.

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

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

Transuranic Waste. The site does not generate or manage TRU waste.

Low-Level Waste. The site produces both liquid and solid LLW; however, liquid LLW is processed for uranium scrap recovery and dried to solids before disposal. Liquid LLW is generated in uranium recovery and gaseous emissions cleanup operations. Many of the manufacturing operations are dry chemical reactions, thus minimizing the generation of liquid LLW. Manufacturing process liquid wastes include acid dissolution, washwater from the laundry and personnel stations, analytical laboratory liquids, and scrubber water from the acid treatment and incineration operations.

The liquid LLW generated can be treated using evaporation, filtration, centrifugation, or ion exchange in a liquid radioactive waste treatment facility. After the complete treatment process, final dried solids are produced that can either be incinerated for further uranium recovery or packaged for offsite disposal at a licensed LLW disposal facility. Liquid effluents from the process can be transferred to a retention tank system and ultimately released to a sanitary sewer or into the local river in accordance with the generic fuel fabrication site's NPDES permit.

Solid waste that is categorized as LLW results from uranium recovery, liquid waste management, and incineration; this waste includes paper, small pieces of equipment, sludge, and miscellaneous trash. Another form of solid LLW results from gaseous waste streams with measurable amounts of radioactive materials that are passed through HEPA filters. These filters are disposed of as LLW. The solid waste produced can be incinerated, and the remaining packaged for offsite disposal. A supercompactor can exist onsite that compacts

208-l (55-gal) drums containing LLW. At a generic fuel fabrication site, the total solid LLW volume is expected to be approximately 41 m^3/yr (54 yd^3/yr).

Mixed Low-Level Waste. The generic fuel fabrication site could processes uranium-containing material using distillation. The sludge bottoms from this process are categorized as mixed LLW. The mixed waste is packaged and stored onsite at a dedicated facility until disposal becomes feasible. The volume of mixed waste generated annually at a generic fuel fabrication site is estimated to be 2 m^3/yr (2.6 yd^3/yr).

Hazardous Waste. Liquid hazardous wastes generated at a generic fuel fabrication site results from acid pickling, metals cleaning, and emissions control operations. Solid hazardous wastes are generated through the liquid hazardous waste treatment operations. The primary treatment methods that are used for liquid hazardous wastes are advanced wastewater treatment, lagoons, precipitation, and retention tanks pending discharge to the local river or sewer system in accordance with the site's NPDES permit. Sludges from these processes are recycled or packaged and shipped offsite for treatment and disposal.

Nonhazardous Waste. Liquid sanitary waste is processed at a generic fuel fabrication site. The primary treatment methods for this waste include sanitary treatment, aeration, and chlorination. As with the other treatment processes for liquid waste, the effluent is ultimately discharged into the local river or sewer system in accordance with the site's NPDES permit. Solid nonhazardous waste at the generic fuel fabrication site includes miscellaneous trash and paper, classified paper, and scrap zirconium and copper. Miscellaneous trash is sorted and packaged for onsite or offsite disposal.

3.12 EXISTING LIGHT WATER REACTOR SITE (GENERIC)

Currently in operation are 110 commercial nuclear power reactors located at 72 sites in 32 of the contiguous United States. Of these, 58 sites are located east of the Mississippi River. Most of this nuclear capacity is located in the Northeast (New England States, New York, and Pennsylvania), the Midwest (Illinois, Michigan, and Wisconsin), and the Southeast (the Carolinas, Georgia, Florida, and Alabama). No commercial nuclear power plants are located in Alaska or Hawaii. Approximately half of these 72 sites contain 2 or 3 nuclear units per site. Typically, nuclear power plant sites are located on, and are situated near, flat-to-rolling countryside in wooded or agricultural areas. More than 50 percent of the sites have 80 km (50 mi) population densities of less than 77 persons per km^2 (200 persons per mi^2), and over 80 percent have 80 km (50 mi) densities of less than 193 persons per km^2 (500 persons per mi^2). Site areas range from 34 to 12,000 ha (84 to 30,000 acres). Almost 60 percent of the plant sites encompass 200 to 800 ha (500 to 2,000 acres). Larger land-use areas associated with plant cooling systems include reservoirs, artificial lakes, and buffer areas. Because it is beyond the scope of this PEIS to analyze all of them, the environmental baseline for the existing LWR was developed as a generic environmental site description that is representative of an existing reactor site located somewhere in the contiguous United States.

A sample of reactors from across the United States was compiled in order to generate generic operating characteristics for a commercial LWR, since no specific site or reactor has been selected. The sample was studied in detail to determine valid, applicable characteristics that could be used to describe a generic reactor using MOX fuel. The sample sites would not be an exhaustive list of potential sites but are used to define the generic affected operational and environmental characteristics. The sample includes eight operating high power (greater than 1,200 MWe) PWRs and four BWRs built after 1975. Characteristics of these 12 were felt to be representative of both reactor types, since none of the 12 experienced any unusual operating conditions over the operating period reviewed. Where possible, data was averaged for the 5-year period to smooth out unusually low or high values due to shutdowns for reasons other than normal refueling or maintenance activities.

Data for each reactor characteristic were taken from calendar years 1988 to 1992 (ORNL 1995b:A-5). Entries for all 12 plants were used to determine an average for each operational characteristic (for example, waste generated).

For determining the environmental setting (for example, land area) of the generic reactor site, a second set of 10 reactors at 5 existing commercial reactor sites located across the United States were selected. These sites were as follows:

- Byron #1 and #2, IL
- Catawba #1 and #2, SC
- LaSalle #1 and #2, IL
- Palo Verde #1, #2, and #3, AZ
- WNP #2, WA

3.12.1 LAND RESOURCES

The approach to defining the environmental setting for land resources is not site specific. Consequently, a range of land use and visual resources conditions for a generic existing LWR site has been provided (see Table 3.12.1–1).

Table 3.12.1–1. Land Resources Attributes of the Generic Existing Light Water Reactor Site

Land Use Attributes	
Land Area	419 ha to 1,640 ha[a]
Land Ownership	Public or private
Percent of Site Area Developed	
With cooling towers	3 to 9 percent
With cooling lakes	67 to 76 percent
Existing Land Use	
Onsite	Industrial; Undeveloped
Offsite	Forest land; Agriculture; Residential; Commercial; and/or Industrial
Land Use Compatibility	Likely
Plans, Policies, and Controls	
Jurisdiction	DOE; Other Federal; State; local
Enforcement	Lax to stringent
Conformance	Likely
Visual Resource Attributes	
Landscape Character	
Site	Flat to gently rolling topography; adjacent to large water body
Viewshed	Small to medium size urbanized area; surrounding agriculture; and/or forest
Visual Resource	
Sensitivity level	Low to medium to high
Distance zones	Foreground, middleground, background, and seldom-seen
BLM VRM class	5 (developed area)
Degree of contrast	NA (existing)

[a] Land area already dedicated.
Note: NA=not applicable.
Source: NRC 1982b.

Land Use. The land area requirement for a generic existing LWR site could range from 419 to 1,640 ha (1,035 to 4,050 acres). However, this land area has already been dedicated; additional land area is not required. Plant facilities would probably be sited on 3 to 9 percent of the total site area. For sites that utilize cooling ponds instead of cooling towers, facilities could occupy a larger percentage of total site area (67 to 76 percent). The site could contain multiple (ranging from one to three) nuclear units. The area of the site not utilized for facilities and activities would be left undeveloped, and the range of land uses would likely be forested land, open space, or reserve/refuge.

The location of a generic existing LWR site would range between 3 to 55 km (2 to 34 mi) from the nearest city. The site would likely be further from the closest metropolitan area, up to 80 km (50 mi) distant. The site would be located adjacent to a large water body, such as a lake or river. Land use in the site vicinity could range from

agricultural or forest uses to developed land uses such as residential, commercial, or industrial. The nearest residence to a generic existing LWR site would range from 1 to 6.5 km (0.6 to 4 mi) distant.

As this is an existing condition, site development would be in conformance with land-use plans, policies, and controls. Likewise, land-use incompatibility would not be an issue.

Visual Resources. The visual environment of a generic existing LWR site would likely be characterized by flat to gently rolling topography adjacent to a large water body. The site would be a developed area that contains facilities and activities, encompassed by an undeveloped buffer area. The viewshed would likely include a small- to medium-sized urbanized area with surrounding forest and agricultural use. Depending on topography, atmospheric conditions, vegetation, and distance, the facilities of a generic existing LWR site could be visible from adjacent viewpoints. Stack plumes from cooling towers could be visible under most meteorological conditions. Median visible plume lengths would usually range from less than 500 m (1,640 ft) in summer to 1000 m (3,280 ft) in winter (NRC 1981a:5-6,5-7). The facilities would be brightly lit at night. The range of public viewpoints could include public access roadways, urbanized areas, and recreation/scenic areas with high user volumes. The full range of sensitivity levels, and distance zones would occur (see Section 3.1.1 for discussion of visual resource inventory). Since the site would be adjacent to a large water body, it would be likely that distance zones would range from foreground to middleground. The developed areas of a generic existing LWR site would likely be consistent with a BLM VRM classification Class 5.

3.12.2 SITE INFRASTRUCTURE

Baseline Characteristics. Extensive infrastructures exist to support individual reactor sites as shown by the range of values displayed in Table 3.12.2–1. Approximately one-half of the 72 reactor sites in the United States contain two or three nuclear units. Larger land-use areas associated with plant cooling systems include reservoirs, artificial lakes, and buffer areas. Road infrastructure is needed for personnel access and intersite transportation requirements. Railroad infrastructure is required to support shipments of fuels, spent fuels, and outsized structural components among other items. Some sites are situated on navigable waters.

The reactor sites are located in a regional electric power pool made up of its parent utilities and a number of subregions. These power pools draw their electrical power from a variety of generating sources, as shown in Table 3.12.2–2.

Table 3.12.2–1. Generic Existing Light Water Reactor Site Baseline Characteristics

Characteristics	Site Availability
Transportation	
Roads (km)	5 to 20
Railroads (km)	0 to 12
Electrical	
Energy consumption (MWh /yr)	700,000 to 1,100,000
Peak load (MWe)	96 to 140
Fuel	
Oil (l/yr)	approximately 757,000

Source: ORNL 1995b.

Table 3.12.2–2. Generic Existing Light Water Reactor Site Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel[a]	
Coal	14 to 59%
Nuclear	0 to 39%
Hydro/geothermal	2 to 46%
Oil/gas	<1 to 32%
Other[b]	0 to 30%
Total Annual Production	107,607,000 to 272,155,000 MWh
Total Annual Load	104,621,000 to 293,262,000 MWh
Energy Exported Annually	-45,400,000 to 6,359,000 MWh
Generating Capacity	24,870 to 61,932 MWe
Peak Demand	20,578 to 57,028 MWe
Capacity Margin[c]	4,064 to 13,655 MWe

[a] Does not total 100 percent due to range at power pools used to estimate the generic site.

[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.

3.12.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The meteorological and climatological conditions at the representative existing LWR sites in the United States include a wide range of extremes in ambient temperature, wind speed and direction, and precipitation. Therefore, no further description of meteorology and climatology has been provided with respect to a generic site.

Ambient Air Quality. Ambient air quality conditions at the representative existing LWR sites in the United States include a wide range of pollutants and conditions. Table 3.12.3–1 presents the baseline ambient air concentrations for criteria pollutants at a representative existing LWR site. As show in this table, the existing LWR site is expected to comply with the ambient air quality standards. Some of the existing LWR sites evaluated are located near or within nonattainment areas for PM_{10}, O_3, and CO.

Table 3.12.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at the Generic Existing Light Water Reactor Site

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] (μg/m^3)	Baseline Concentration (μg/m^3)
Criteria Pollutants			
Carbon monoxide	8-hour	10,000	<0.01
	1-hour	40,000	<0.01
Lead	Calendar Quarter	1.5	b
Nitrogen dioxide	Annual	100	0.05
Ozone	1-hour	235	c
Particulate matter less than or equal to 10 microns in diameter	Annual	50	<0.01
	24-hour	150	0.015
Sulfur dioxide	Annual	80	0.04
	24-hour	365	0.15
	3-hour	1,300	0.35
Hazardous and Other Toxic Compounds			
No sources indicated			

[a] The Federal standards are presented.

[b] No sources indicated.

[c] Ozone, as a criteria pollutant, is not directly emitted nor monitored by the sites. See Section 4.1.3 for a discussion of ozone-related issues.

Source: 40 CFR 50; TVA 1974b.

Noise. Specific existing noise sources and characteristics of a generic existing LWR site cannot be described. However, it is expected that the area near such a site would be essentially rural in character and would have typically low background sound levels. Typical DNL in the range 35 to 50 dBA can be expected for such a rural location (EPA 1974a:B-4) where noise sources may include wind, insect activity, aircraft, and agricultural activity. Existing industrial noise sources and traffic noise at the site would result in higher background noise levels near the site and along site access routes.

3.12.4 WATER RESOURCES

Surface Water. Major surface water features in the generic existing LWR site area could range from a large navigable river to a large lake. The average flow rate of these water bodies could range from 28 to 3,360 m^3/s (989 to 118,658 ft^3/s). Other surface water features could include large ponds and/or small streams bordering the site.

Stormwater control retention/drainage ponds could be present at the site. These ponds would probably discharge to the nearest large surface water body.

Surface Water Quality. In the vicinity of the generic existing LWR site, the surface water bodies could range from being unclassified to classified as fresh water suitable for public and food processing water supply. The range of concentrations of typical surface water quality parameters that could be encountered at generic sites was presented in Table 3.10.4–1. High nutrient loads, low dissolved oxygen, and moderately high bacteria count could be encountered in the nearby large surface water body.

The generic existing LWR site would have an NPDES permit(s) that would dictate the acceptable levels of specific parameters in the liquid effluents that would be discharged to a nearby surface water body.

Surface Water Rights and Permits. Surface water rights concerning the large water body near the existing LWR site would involve non-impairment of designated uses.

Groundwater. The near-surface aquifer beneath the generic existing LWR site would occur under unconfined conditions and could range in average thickness from approximately 5 to 55 m (16 to 180 ft). Depth to groundwater could range from near the ground surface to 12 m (39 ft). The aquifer material could range from glacial drift to saprolite. In general, the generic existing LWR site would obtain groundwater from a confined aquifer underlying the near-surface aquifer. The confined aquifer would have an abundant supply of groundwater, although groundwater levels could be declining in the area. Water quality could range from good to fair.

Recharge to the near-surface aquifer would be primarily from rainfall and would occur in areas located from near the site to more than 16 km (10 mi) away from the site. Groundwater flow would typically be from these recharge areas towards the major surface water feature.

In areas surrounding the typical generic existing LWR site, groundwater would be used for domestic, industrial, agricultural, and municipal supply purposes. The classification of the aquifer beneath the site would be a Class II aquifer (that is, currently being used or a potential source of drinking water).

Groundwater Quality. Groundwater quality of the near-surface aquifer in the site area would range from good to fair. The range of hydraulic characteristics of the groundwater that might be encountered is presented in Table 3.10.4–2.

Groundwater Availability, Use, and Rights. Groundwater rights concerning the aquifer(s) near the generic existing LWR site could range from having potential for local restrictions on pumping to a reasonable use doctrine concerning neighboring landowners water availability.

3.12.5 GEOLOGY AND SOILS

Geology. The physiography of an existing LWR site could range from a flat nearly featureless plain to a highly dissected plain of arid to humid environments. The geology could range from alluvium to thick sequences of unconsolidated marine sediments, glaciofluvial material, and crystalline and sedimentary bedrock. These materials could range in age from Cenozoic to Precambrian (recent to over 600 million years).

The existing LWR sites could be located in Seismic Zones 0 to 2, which suggests there could be no to moderate levels of damage in the event of an earthquake (Figure 3.2.5–1). The geologic settings for Seismic Zones 0 to 2 considered for the existing LWR sites have histories of seismic activity that range from low to high. The location of the nearest capable fault could range from within the site boundaries to 350 km (217 mi) away from existing LWR sites. The nearest known epicenter of a damaging earthquake (MMI of VII or greater [Table 3.2.5–1]) could be approximately 350 km (217 mi) from existing LWR sites.

The existing LWR sites are not located within a region of active volcanism; however, an existing LWR site could be located within 164 km (102 mi) of a volcano.

Soils. The existing LWR sites could be located where the predominant soil types are loamy clays to gravel silty loams. These soils range from moderate to well drained soils. The erosion potential could range from minor to severe in those areas with slopes greater than 25 percent and which have been eroded in the past. The soils shrink-swell potential could range from low to severe, which is acceptable for standard construction techniques, depending upon the engineering controls employed. Wind erosion potential ranges from minor to severe.

3.12.6 BIOLOGICAL RESOURCES

Generic existing LWR sites are located within a number of the principal vegetation types. Vegetation types characteristic of the representative generic existing LWR sites used for this analysis include deciduous forest, grassland, desert, and southeast evergreen forest. Biological resources found within these vegetation types are described in Section 3.10.6 and 3.11.6. At a given site, biological resources could vary from those typically associated with the principal vegetation type of the area due to a variety of factors, including previous disturbance by man.

3.12.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

Prehistoric Resources. Prehistoric resources in the vicinity of the existing LWR site may include sites, districts, or isolated artifacts. Archaeological sites may represent occupation during the Archaic through later prehistoric periods and can include hunting and butchering sites, cemeteries, campsites, and tool manufacturing areas. They may yield artifacts such as stone tools and associated manufacturing debris, and ceramic potsherds. Some sites may have been determined eligible for inclusion on the NRHP by the SHPO. Prehistoric resources are most likely to be affected by ground disturbance. No impacts to prehistoric resources are anticipated because this alternative does not involve new facility construction.

Historic Resources. Historic resources may include cemeteries, remains of commercial or residential structures, or standing structures. Some sites may be eligible for inclusion on the NRHP.

Native American Resources. To date, no Native American resources have been identified at the generic existing LWR site, but they may exist. Such resources can include cemeteries, geological or geographic elements (such as mountains or creeks), certain species of animals or plants, architectural structures (such as pueblos), battlefields, or trails. Such resources are objects or areas that are important to Native American groups for religious or historical reasons. There also may be visual impacts to Native American resources.

Paleontological Resources. To date, no paleontological resources have been identified at the generic existing LWR site. However, some fossil-bearing strata may exist that contain rare fossils or fossil assemblages.

3.12.8 SOCIOECONOMICS

The generic existing LWR site could potentially affect the socioeconomic environment of a given REA or ROI. The characteristics of the REA, ROI, and community are dependent upon geographic location. For employment and income, the economic area would be based upon industry interaction and linkages in the region. The anticipated residential distribution of project-related employees and their families would determine the ROI. This ROI would contain all principal jurisdictions and school districts likely to be affected by the proposed activity.

Because specific commercial LWR sites have not been proposed for burning MOX fuel, representative sites have been used to describe the affected environment. Five existing reactors encompassing four location types were used as representative sites to develop a range of conditions for discussion in this section. The first two communities, Sites A and B, are small communities tied to large metropolitan areas. Site C is a medium-size community near a large metropolitan area. The fourth site, Site D, is a medium-size community located in an urbanized area.

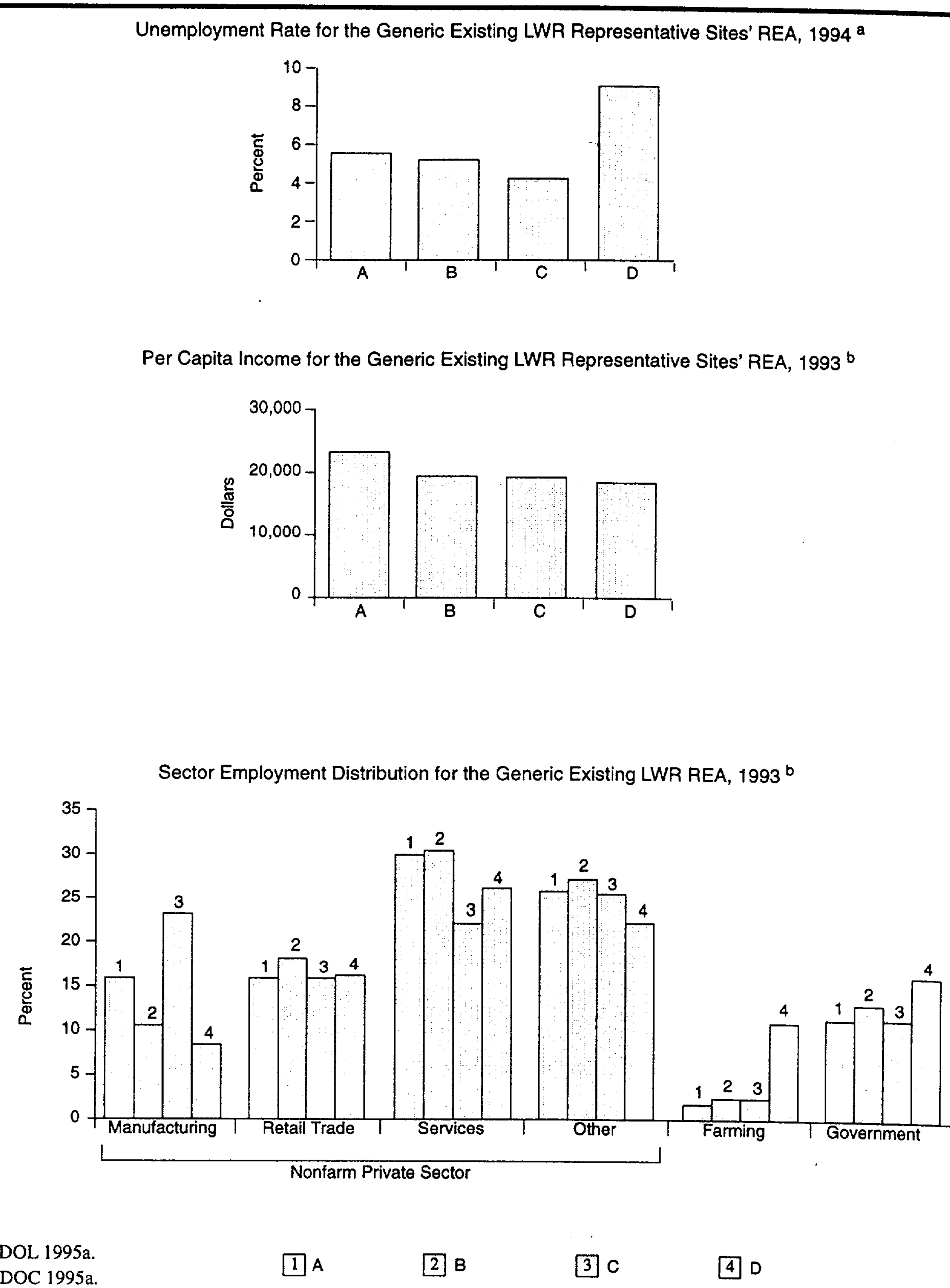
Small communities were characterized in Section 3.11.8. Medium-size communities and the vulnerability or susceptibility of a local community to changes in the economic base were described in Section 3.10.8. However, the specific communities discussed in this section are different from those discussed in Section 3.11.8.

Socioeconomic characteristics described for the generic existing LWR site include employment and local economy, population and housing, and local transportation. Site A, which had a 1992 population of 2,604, was located about 160 km (100 mi) from a large metropolitan area. Site B, with a 1992 population of 5,236, was located approximately 8 km (5 mi) from a small community and approximately 64 km (40 mi) from a large metropolitan area. Site C, with a 1992 population of 44,384, was located approximately 16 km (10 mi) from a medium-size community and approximately 48 km (29.8 mi) from a large metropolitan area. Site D, a medium-size community, had a 1992 population of 34,201 and a total urban population of more than 100,000. Statistics for employment and local economy were based on the REA for each site. Statistics for the remaining socioeconomic characteristics were based on the sites' ROIs.

Regional Economy Characteristics. Employment and regional economy statistics for each representative site's REA are discussed in this section and displayed in Figure 3.12.8–1. Between 1980 and 1990, the civilian labor force in the REA encompassing Site A increased 7.7 percent to the 1990 level of 4,811,800, and for Site B increased 49.6 percent to the 1990 level of 1,162,300. The civilian labor force for Site C, located near a large metropolitan area, increased 21.9 percent to the 1990 level of 862,500. The civilian labor force for Site D, located in an urbanized area, increased 9.9 percent to 254,800 persons. The 1994 unemployment rates in the two small communities' (A and B) REAs were 5.6 percent and 5.2 percent, respectively. Sites C and D had unemployment of 4.3 percent and 9.1 percent, respectively. The 1993 per capita incomes were $23,634 at Site A and $19,497 at Site B. Sites C and D had per capita incomes of $19,489 and $18,501, respectively.

Figure 3.12.8–1 displays the division of employment involving farming, nonfarming, and government sectors for each typical site. For the two small representative communities, the portions of total employment involving farming in the REAs were about 1 percent. Governmental activities for Sites A and B represented about 12 percent and 14 percent, respectively. Manufacturing was 16 percent of the total employment for site A and 10 percent for site B. Retail trade accounted for 16 percent and 18 percent of the total sector employment for Sites A and B, respectively. Service activities represented a 30-percent share of the total employment for Sites A and B.

For Sites C and D, the portion of total employment was about 1 percent and 12 percent for farming and 11 and 15 percent for governmental activities, respectively. The nonfarm private sector activities of retail trade and services were 16 and 22 percent of total employment, respectively, for Site C and 16 and 26 percent,



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

Figure 3.12.8–1. Employment and Local Economy for the Generic Existing Light Water Reactor Representative Sites' Regional Economic Area.

respectively, for Site D. Employments for manufacturing were 23 and 8 percent of total employment for Sites C and D, respectively.

Population and Housing. Population and housing trends in the representative ROIs are presented in Figure 3.12.8–2. The ROI population increase for the two small communities, A and B, between 1980 and 1994 were 6.4 (average annual increase of 0.5 percent) and 54.6 (average annual increase of 3.9 percent) percent, respectively. The number of housing units in the ROI increased 8.9 percent for Site A and 55.8 percent for Site B between 1980 and 1990. The 1990 ROI homeowner vacancy rates were 1.1 and 3.9 percent, while the renter vacancy rates were 5.9 and 16.4 percent for Sites A and B, respectively.

The ROIs surrounding Sites C and D experienced an 31.8-percent (average annual increase of 2.3 percent) and 19.8-percent (average annual increase of 1.4 percent) increase in population, between 1980 and 1994, and a 32.7- and 5.4-percent increase, respectively, in the number of housing units between 1980 and 1990. The 1990 homeowner and renter vacancy rates were 2.0 and 8.9 percent for Site C and 1.3 and 5.6 percent for Site D.

Community Services and Local Transportation. These characteristics are dependent upon a geographic location. The ROI would determine all principal jurisdictions and school districts likely to be affected by the proposed activity. Local transportation would be the existing principal road, air, and rail networks required to support the project activities.

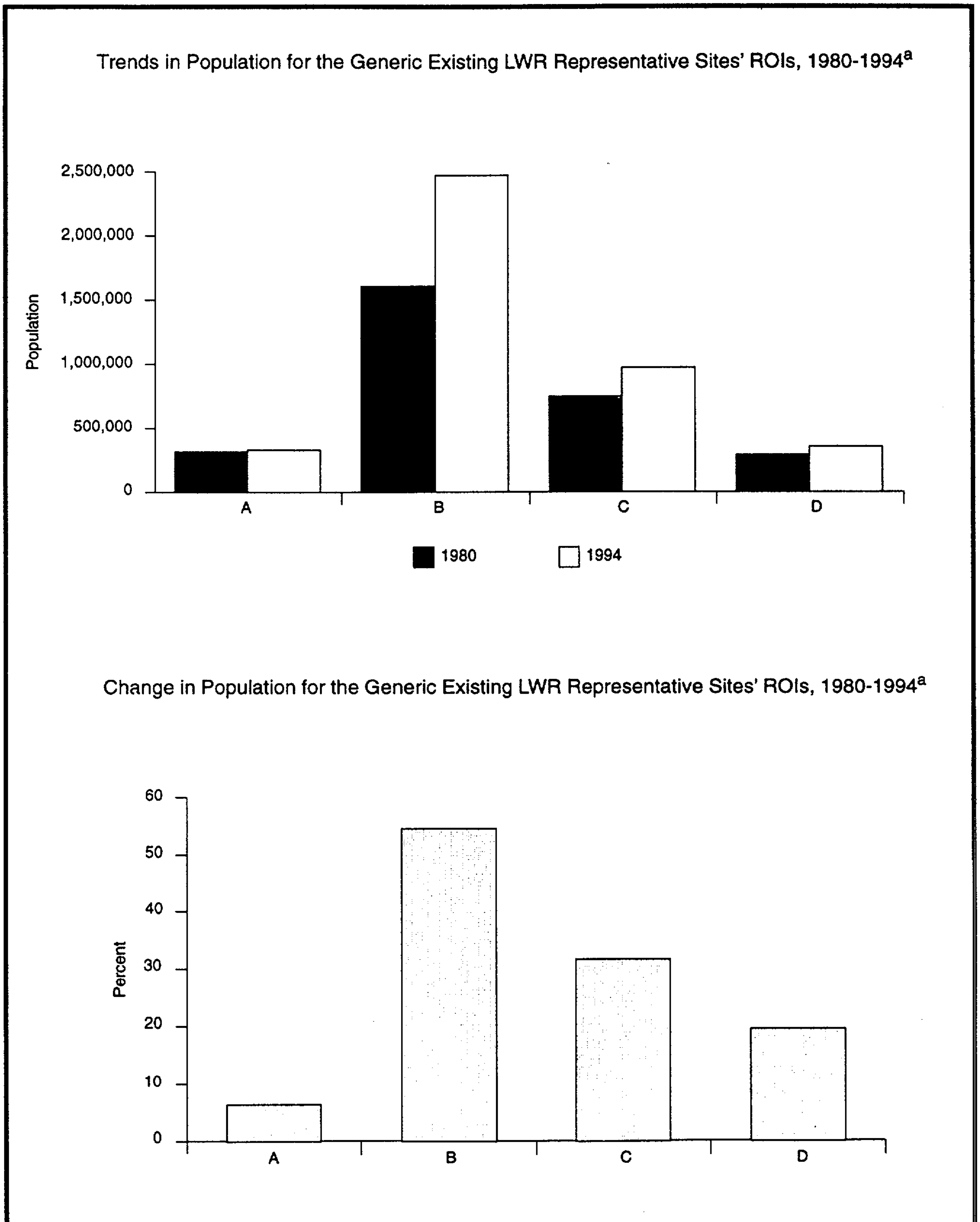
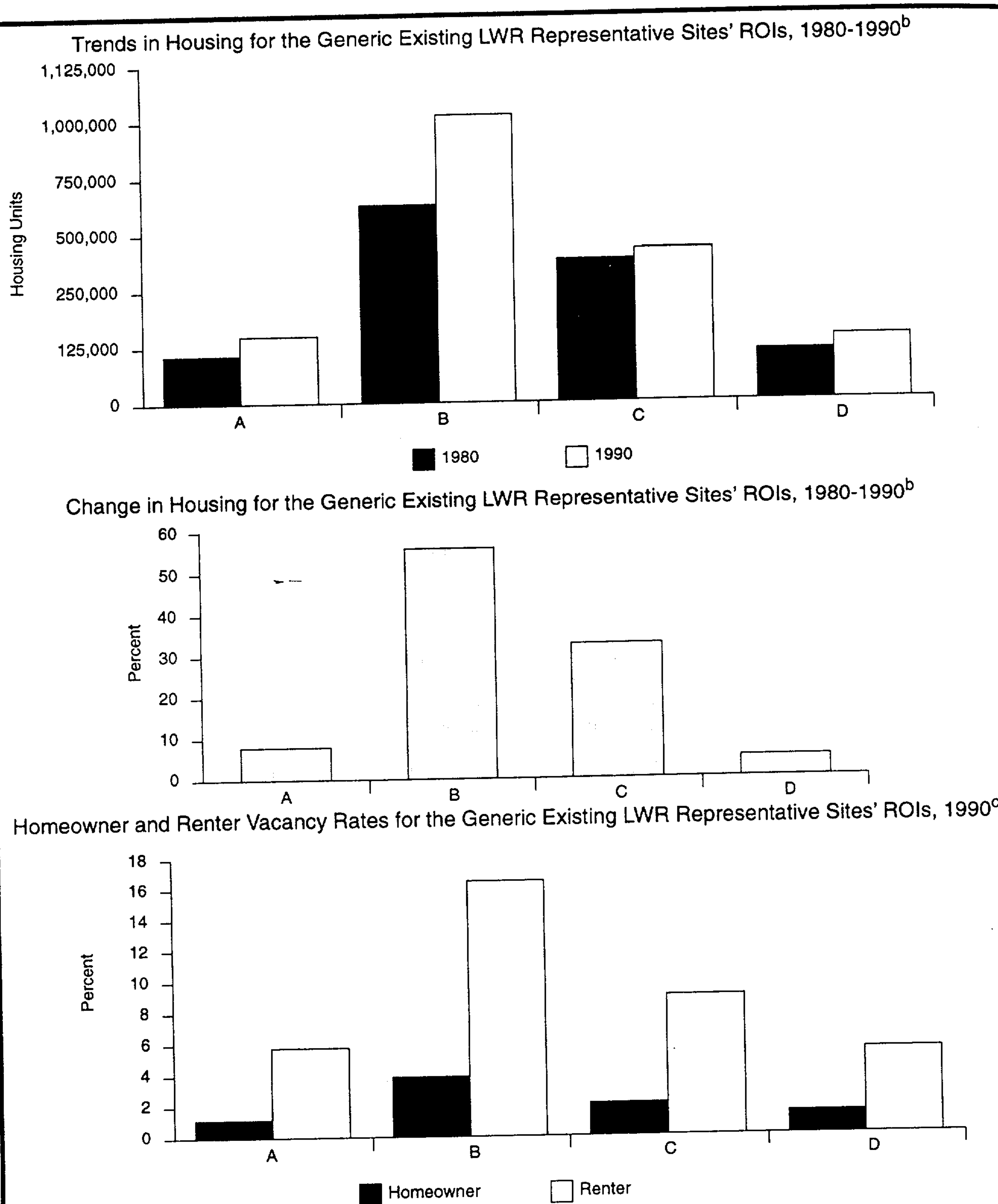


Figure 3.12.8–2. ***Population and Housing for the Generic Existing Light Water Reactor Representative Sites' Region of Influence.***



[a] Census 1983b; Census 1983f; Census 1983k; Census 1983m; Census 1995a.
[b] Census 1982c; Census 1982e; Census 1982m; Census 1982r; Census 1991b; Census 1991d; Census 1991q; Census 1991r.
[c] Census 1991b; Census 1991c; Census 1991d; Census 1991q.

Figure 3.12.8–2. Population and Housing for the Generic Existing Light Water Reactor Representative Sites' Region of Influence—Continued.

3.12.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Radiation Environment. Major sources and levels of background radiation exposure to individuals in the vicinity of the generic existing LWR site are shown on Table 3.12.9–1. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population size changes as the population size changes. Background radiation doses are unrelated to LWR site operations.

Table 3.12.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Operation at the Generic Existing Light Water Reactor Site

Source	Effective Dose Equivalent (mrem/yr)
Natural Background Radiation	
Cosmic radiation[a]	27 to 29
Cosmogenic radiation[b]	1
External terrestrial radiation[a]	29 to 30
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	361 to 364

[a] Based on information 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 generic existing LWR site operations provide another source of radiation exposure to individuals in the vicinity of generic existing LWR sites. Types and quantities of radionuclides released from generic existing LWR site operations in 1994 are listed in the 1994 radiological effluent release reports for the reference sites. The doses to the public resulting from these releases are presented in Table 3.12.9–2. These doses fall within radiological guidelines and limits (10 CFR 50, Appendix I and 40 CFR 190) and are small in comparison to background radiation.

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 operations at the generic existing LWR site in 1994 is estimated to range from 3.9×10^{-9} to 7.0×10^{-7}. 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 LWR site operations ranges from about 4 in 1 billion to 7 in 10 million. (Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.)

Based on the same risk estimator, a range of 1.0×10^{-5} to 6.7×10^{-3} excess fatal cancers is projected in the population living within 80 km (50 mi) of the generic existing LWR site from normal operations in 1994. To place these numbers into perspective, they can be compared with the numbers of fatal cancers expected in these populations 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 mortality rate, the number of fatal cancers expected during 1994 from all causes in the population living within 80 km (50 mi) of the generic existing LWR site

Table 3.12.9–2. Radiation Doses to the Public From Normal Operation at the Generic Existing Light Water Reactor Site in 1994 (Committed Effective Dose Equivalent)

Members of the General Public	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual	Standard[a]	Actual	Standard[a]	Actual[b]
Maximally exposed individual (mrem)	5	1.3×10^{-3} to 1.10	3 per reactor	0 to 0.29	25	7.8×10^{-3} to 1.39
Population within 80 km[c] (person-rem)	None	0.016 to 13.3	None	0 to 1.28	None	0.020 to 13.3
Average individual within 80 km (mrem)[d]	None	6.3×10^{-5} to 6.8×10^{-3}	None	0 to 8.9×10^{-4}	None	7.9×10^{-5} to 6.8×10^{-3}

[a] The standards for individuals are given in 10 CFR 50 Appendix I and 40 CFR 190. As discussed in Appendix I of 10 CFR 50, the 5 mrem/yr value is an airborne emission guideline and the 3 mrem/yr per reactor value is a liquid release guideline. Meeting these guideline values serves as a numerical demonstration that doses are as low as is reasonably achievable. The total dose of 25 mrem/yr is the limit from all pathways combined as given in 40 CFR 190.

[b] Totals cannot be obtained by summing the atmospheric and liquid release components since these component entries can be for different reactor sites.

[c] This population ranges from 252,000 to 1,960,000.

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

Source: HNUS 1996a.

ranged from 505 to 3,920. These numbers of expected fatal cancers are much higher than the estimated range of 1.0×10^{-5} to 6.7×10^{-3} fatal cancers that could result from operations at the generic existing LWR site in 1994.

At the generic existing LWR site, workers receive the same dose as the general public from background radiation but also receive an additional dose from working at the site. Table 3.12.9–3 presents the range of the average worker, maximally exposed worker, and total worker dose from operations at the generic existing LWR site in 1993. These doses fall within radiological regulatory limits (10 CFR 20). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (Section M.2.1.2), the number of excess fatal cancers to generic existing LWR site workers from operations in 1993 is estimated to range from 0.16 to 0.34.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the reference sites' environmental reports and environmental monitoring reports. The concentrations of radioactivity in various environmental media (including air, water, and soil) in the regions of the generic existing LWR site (onsite and offsite) are also presented in those documents.

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 waters during swimming and 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 3.12.3.

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 generic existing LWR sites via inhalation of air containing hazardous chemicals released to the atmosphere by site operations. Risks to public health from other

Table 3.12.9–3. ***Doses to Workers From Normal Operation at the Generic Existing Light Water Reactor Site in 1993 (Committed Effective Dose Equivalent)***

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual
Average worker (mrem)	ALARA	114 to 322
Maximally exposed worker (mrem)	5,000	2,000 to 3,000
Total workers[b] (person-rem)	ALARA	396 to 854

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

[b] The number of badged workers in 1993 ranged from 2,650 to 4,370.

Source: 10 CFR 20; NRC 1995b.

possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

A discussion of ambient air quality is included in Section 3.12.3. As stated in that section, air quality is expected to be are in compliance with applicable standards. Information about estimating health impacts from hazardous chemicals is presented in Section M.3.

Exposure pathways for generic existing LWR site workers during normal operation may include inhaling the workplace atmosphere and direct contact with hazardous materials associated with work assignments. Occupational exposure 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. At the generic existing LWR site, 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. Worker health conditions at the generic existing LWR site are expected to be substantially better than required by the standards.

Health Effects Studies. Specific locations for the generic existing LWR must be designated before any reviews of epidemiologic studies in the areas can be conducted.

Accident History. Commercial LWR's that utilize uranium fuel have been in operation in the United States for many years. Accident information for these reactors, where applicable, can be found in documentation available from the NRC. Estimates of potential accidents and their consequences can also be found in safety analysis reports and probabilistic risk assessments prepared by the reactor owners and filed with the NRC. There are no domestic commercial reactors that utilize MOX fuel and consequently there is no information available regarding England accident history for MOX fueled reactors.

Emergency Preparedness. The generic existing LWR site has an emergency management program that would be activated in the event of an accident. The programs are compatible with the other Federal, State, and local plans and are thoroughly coordinated with all interested groups. Programs would be modified, if necessary, to accommodate MOX fueled reactor operations.

3.12.10 WASTE MANAGEMENT

Because of the increased disposal costs for LLW, utility companies have undertaken major volume reduction and waste minimization efforts. These efforts include segregation, decontamination, minimizing the exposure of materials and tools to the contaminated environment, and sorting. Compaction, consolidation, and the monitoring of waste streams to reduce the volume of LLW requiring storage and to lessen the exposure of routine equipment to the reactor environment have been the most effective volume reduction strategies. Between 1981 and 1985 there was a 48-percent decrease in LLW volumes from commercial pressurized LWRs. Current industry-wide volume reduction practices include ultra-high pressure compaction of waste drums, incineration of waste oils and resins, mobile thin-film evaporation, waste crystallization, and asphalt solidification of resins and sludges (NRC 1996b:6-40).

Nuclear power plants currently operating typically have waste minimization programs in place to minimize both the volume and cost impact of waste generation. In existing operating plants, a number of the design considerations that affect the plant waste streams are already in place, and improvements in waste management are continually being implemented. Waste minimization steps include more economical use of disposables or elimination of disposables in favor of recyclables. Process improvements aimed at more efficient use of ion exchange resins and reductions of waste streams from the waste processes are being implemented. In general, wastes generated by operating plants have been decreasing in recent years. The amount of waste generation is reported by each utility on a quarterly basis. Table 3.12.10–1 provides a range of waste volumes based on site-specific data from existing representative LWRs.

Spent Nuclear Fuel. After removal from the reactor, spent nuclear fuel is stored in racks in pools to isolate it from the environment and to allow the fuel rods to cool. Current plans call for spent nuclear fuel to be ultimately disposed of in a deep-geological repository. Because of the delay in siting the repository and interim monitored retrievable storage facilities, utility companies have been faced with the rapid filling of their spent fuel pools. The utility companies have been expanding pool storage, building above-ground dry storage, using longer fuel burnup to reduce the amount of spent fuel requiring interim storage, and shipping the spent nuclear fuel to other plants (NRC 1996b:6-70). When moved to another location, spent nuclear fuel is shipped in casks that are designed to withstand severe transportation accidents and are resistant to small-arms fire and HE detonations (NRC 1996b:6-34).

The average number of spent nuclear fuel assemblies discharged ranges from 64 to 88 for the 8 PWR and 187 to 191 for the 4 BWR existing plants used in the analysis. Licensed spent fuel pool storage capacity (number of assemblies) ranges from 756 to 1,542 for the 8 PWR plants, and 2,040 to 4,020 for the 4 BWR plants.

High-Level Waste. The generic existing LWR would not generate or manage HLW.

Transuranic Waste. The generic existing LWR would not generate or manage TRU waste.

Low-Level Waste. Liquid LLW generated in pressurized LWRs could be classified as either clean waste, dirty waste, turbine building floor drain water, or steam generator blowdown. Clean wastes come from equipment leaks and drains, certain valve and pump seal leakoffs not collected in the reactor coolant drain tank, and other aerated leakage sources. Primary coolant is also considered a clean waste. Liquid wastes collected in the containment building sump, auxiliary building sumps and drains, laboratory drains, sample station drains, and other miscellaneous floor drains are termed dirty wastes because of their moderate conductivity. Clean and dirty wastes will have variable radioactivity content. Detergent wastes, which consist of laundry wastes and personnel and equipment decontamination wastes, normally have a low radioactivity content. Turbine building floor drain water usually exhibits high conductivity with low radionuclide content. Depending on the amount of primary-to-secondary leakage, steam generator blowdown could have relatively high concentrations of radionuclides. The chemical and radionuclide content of the waste would determine the type and degree of treatment before

Table 3.12.10–1. Existing Light Water Reactor Site Waste Management Characteristics

Characteristic	BWR Range	BWR Average	PWR Range	PWR Average	All Plants Average	All Plants Low	All Plants High
LLW shipped (m^3/yr)	367.21 to 936.25	572.61	57.04 to 636.85	178.22	309.69	57.04	936.25
Number LLW shipments/year	39.50 to 108.25	62.84	6.00 to 31.00	16.17	31.73	6.00	108.25
Stored mixed waste/ 1000 MWe (m^3/yr)	Not reported	Not reported	Not reported	Not reported	101.90	Not reported	Not reported
Licensed spent fuel pool storage capacity (number of assemblies)	2,040 to 4,020	3,176	756 to 1,542	1,214	1,868	756	4,020
Average number of assemblies discharged	187 to 191	190	64 to 88	72	111	64	191

Source: ORNL 1995b.

storage for reuse or discharge to the environment. Operating plants have steadily increased the degree of processing, storing, and recycling of liquid radioactive waste (NRC 1996b:2-5).

Solid LLW is generated by the removal of radionuclides from the liquid radioactive waste streams, the filtration of airborne gaseous emissions, and the removal of contaminated material from various reactor areas. The concentrated liquids, filter sludges, waste oils, and other liquid sources are segregated by type, flushed to storage tanks, stabilized for packaging in a solid form by dewatering, and slurried into 0.2 m^3 (0.3 yd^3) steel drums. Other solid LLW consists of spent HEPA filters and wastes from plant modifications and routine maintenance activities such as contaminated protective clothing, paper, rags, glassware, compactible and noncompactible trash, and non-fuel irradiated reactor components and equipment. Tools and other material exposed to the reactor environment would also be considered solid LLW. Compactible solid LLW is taken to an offsite or onsite volume reduction facility before disposal. Solid LLW is stored in shielded prefabricated steel buildings or other facilities until suitable for disposal at an approved LLW disposal facility (NRC 1991a:2-15).

Low-level waste from BWRs primarily consists of concentrated waste from the reactor water cleanup and condensate demineralizer systems and waste generated during maintenance activities (for example, protective clothing, replaced equipment, and so forth). The average annual (1988 to 1992) volume of LLW shipped from a typical BWR unit ranges from 367 to 936 m^3/yr (480 to 1,224 yd^3/yr). The average annual (1988 to 1992) volume of LLW shipped from a typical PWR unit ranges from 57 to 637 m^3/yr (75 to 833 yd^3/yr). For 1993 and 1994, the per-unit volume of waste for all domestic BWRs has fallen to less than 200 m^3/yr, 18 percent under the 1995 industry goal of 245 m^3/yr. The average number of LLW shipments/year from a typical BWR unit ranges from 40 to 108. The average number of LLW shipments/year from a typical PWR unit ranges from 6 to 31. For 1993 and 1994, the per-unit volume of waste for all domestic PWRs has fallen to less than 50 m^3/yr (65.4 yd^3/yr), 45 percent under the 1995 industry goal of 110 m^3/yr (144 yd^3/yr) (ORNL 1995b:B-8).

Mixed Low-Level Waste. Mixed waste generated by a nuclear power plant covers a broad spectrum of waste types. The vast majority of mixed waste in storage at nuclear plants is chlorinated fluorocarbons and waste oil. Mixed LLW is stored onsite until treatment and disposal is available at an offsite RCRA-permitted facility. Because of the occupational exposure from testing radioactive wastes to determine if they are chemically hazardous, the utilities have been looking at ways to eliminate, or at least minimize, the generation of mixed wastes. These efforts include removing and separating hazardous constituents from radioactive streams by remote methods; minimizing the use of solvents exposed to the reactor environment; relying on substitute processes; and recycling and reusing cleaning materials, resins, and waste oils (NRC 1996b:6-66). Stored mixed LLW/1,000 MWe averages 102 m^3/yr (133 yd^3/yr) for all 12 existing plants studied.

Hazardous Waste. Hazardous wastes are generated from nonradioactive materials such as wipes contaminated with oils, lubricants, and cleaning solvents that are used outside the reactor environment. Hazardous wastes are packaged and shipped to offsite RCRA-permitted treatment and disposal facilities.

Nonhazardous Waste. Nonhazardous wastes include boiler blowdown, water treatment wastes, boiler metal cleaning wastes, floor and yard drain wastes, stormwater runoff, and sewage wastes. Depending on the design of the individual reactor, other small volumes of wastewater are released from other plant systems or combined with the cooling water discharges. Sanitary wastes that cannot be processed by onsite waste treatment systems are collected by independent contractors and trucked to offsite treatment facilities (NRC 1996b:6-86).

3.13 PARTIALLY COMPLETED REACTOR SITE

For this PEIS, the approach used to define the environmental setting for a partially completed reactor site was to use data from a representative site. Consequently, the environmental resource/issue areas are described in a general sense; not for a specific site.

The representative site used in this case is the partially completed Bellefonte Nuclear Plant, located in northeast Alabama along the Tennessee River. Principal structures include two reactor containment buildings, a turbine building, an auxiliary building, a condenser circulating water pumping station, two diesel generator buildings, a river intake pumping station, natural draft cooling towers, a transformer yard, 500-kV and 161-kV switchyards, and a sewage treatment facility.

3.13.1 LAND RESOURCES

For the partially completed reactor site, the representative environmental setting attributes for land use and visual resources are shown in Table 3.13.1–1.

Table 3.13.1–1. Land Resources Attributes of the Partially Completed Reactor Site

Land Use Attributes	
Land Area	600 ha[a]
Land Ownership	Public
Existing Land Use	
Onsite	Industrial
Offsite	Predominately forest and agricultural use; some urban/developed
Land Use Compatibility	Likely
Plans, Policies, and Controls	
Jurisdiction	DOE; other Federal; State; local
Enforcement	Lax to stringent
Conformance	Likely
Visual Resource Attributes	
Landscape Character	
Site	Flat valley; adjacent to large water body
Viewshed	Urban-industrial nodes; low-density residential; agricultural; and forest
Visual Resource	
Sensitivity Level	High
Distance Zones	Foreground, middleground, background, and seldom-seen
BLM VRM Class	5 (developed land)
Degree of Contrast	Weak to none

[a] Land area already dedicated.
Source: TVA 1974a; TVA 1974b; TVA 1995b:1.

Land Use. The partially completed reactor site consists of approximately 600 ha (1,500 acres) of land. However, this land area has already been dedicated; additional land area is not required to complete construction. Land use within the ROI is comprised of predominately forest and agricultural use, with some urban and developed land. Many communities adjacent to the site have corporate limits far exceeding actual developed areas and could accommodate additional development. The nearest town is located approximately 5 km (3 mi) from the site.

Completion of site development for industrial purposes would conform with the proposed land use of the site and its vicinity (urban and industrial development) as designated by the appropriate governmental plans, policies, and controls, and be compatible with adjacent land uses.

Visual Resources. The visual landscape of the partially completed reactor site is characterized by a flat valley adjacent to a reservoir and a river. The visual landscape of the site reflects that of an industrialized facility. The viewshed includes hilly land with urban-industrial nodes surrounded by low-density residential development scattered among agricultural uses and forest lands.

As discussed in Section 3.1.1, a visual resource inventory is composed of three factors: VRM classification, distance zones, and sensitivity levels. Distance zones with viewpoints include foreground, middleground,

background, and seldom-seen. Due to the site location adjacent to a large body of water, the immediate vicinity is likely to be subject to high user volumes associated with recreational use. Because of the proximity to urban development and a high-use recreational area, it is likely that the facilities would be visible from viewpoints with high sensitivity levels. However, since the partially completed reactor site represents an existing condition, contrasts created by new development are considered weak to none. The developed areas of the site are consistent with a VRM classification Class 5.

3.13.2 SITE INFRASTRUCTURE

Baseline Characteristics. The partially completed reactor site has the infrastructure shown in Table 3.13.2–1. The road infrastructure would be needed primarily for personnel access to the site. The railroad infrastructure is required for spent fuel shipments and oversized structural components. The site is situated on a navigable river with a small docking facility to accommodate barge traffic.

Table 3.13.2–1. Partially Completed Reactor Site Baseline Characteristics

Characteristics	Site Availability
Transportation	
Roads (km)	8
Railroads (km)	6
Electrical	
Energy consumption (MWh/yr)	1,100,000
Peak load (MWe)	140
Fuel	
Oil (l/yr)	757,000

Source: LLNL 1996g.

The sub-regional electric power pool for the site has the characteristics depicted in Table 3.13.2–2.

Table 3.13.2–2. Partially Completed Reactor Site Sub-Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel[a]	
Coal	49%
Nuclear	39%
Hydro/geothermal	11%
Oil/gas	<1%
Other[b]	0%
Total Annual Production	159,842,000 MWh
Total Annual Load	156,987,000 MWh
Energy Exported Annually[c]	2,407,000 MWh
Generating Capacity	33,370 MWe
Peak Demand	28,127 MWe
Capacity Margin[d]	4,550 MWe

[a] Percentage does not total 100 percent due to rounding.
[b] Includes power from both utility and nonutility sources.
[c] Energy exported is not the difference of production and load due to system losses and 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.

3.13.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The climate at the representative partially completed reactor site and the surrounding region is characterized as temperate, with warm, humid summers and cool, variable winds. The average annual temperature is 15.7 °C (60.3 °F); average daily temperatures range from a minimum of -1.6 °C (29.2 °F) in January to a maximum of 31.7 °C (89.0 °F) in July (NOAA 1994c:3). The average annual precipitation is approximately 145.3 cm (57.2 in). Higher frequencies of winds are from the southeast, southwest, and northwest (TVA 1974b:1.2-7).

Ambient Air Quality. Ambient air quality conditions at the representative partially completed reactor site were reviewed. The site is located in an area that has been designated attainment with the NAAQS. There is no PSD Class I areas in the vicinity of the site. The site is expected to comply with the ambient air quality standards.

Noise. [Text deleted.] The area near the representative partially completed reactor site is rural in character and is expected to have typically low background sound levels. Typical DNL in the range of 35 to 50 dBA could be expected for such a rural location (EPA 1974a:B-4) where noise sources would include wind, insect activity, aircraft, and agricultural activity.

3.13.4 WATER RESOURCES

Surface Water. Major surface water features at the partially completed reactor site include a large navigable river that has been dammed to create a reservoir with a surface area of about 275 km^2 (106 mi^2) and a total volume of water of approximately 1.2 trillion l (317 billion gal). Average flow at the site is approximately 89 billion liters/day (23.5 billion gal/day). Other surface water features include small streams bordering the site.

Stormwater control retention/drainage ponds are present at the facility. These ponds discharge into the reservoir via Town Creek.

Surface Water Quality. The surface water body in the vicinity of the partially completed reactor site is classified as fresh water suitable for the following: primary and secondary contact recreation; a source of drinking water, after conventional treatment in accordance with State and local requirements; fishing and the survival and propagation of a balanced indigenous aquatic community of flora and fauna; and industrial and agricultural uses. The range of concentrations of typical surface water quality parameters at the site are presented in Table 3.10.4–1.

Surface Water Rights and Permits. Surface water rights concerning the large water body near the partially completed reactor site involve non-impairment of designated uses.

Groundwater. The near-surface aquifer beneath the site occurs under unconfined conditions. Typical aquifer material is highly weathered sedimentary bedrock overlying slightly fractured bedrock with no evidence of major solution channels.

Although the reservoir near the site supplies most of the potable water to nearby users, both private and public uses of groundwater occur in areas surrounding the site. The classification of the aquifer beneath the site is a Class II aquifer, that is, currently being used, or a potential source of drinking water.

Groundwater Quality. Groundwater quality of the near-surface aquifer at the site ranges from good to fair. The range of hydraulic characteristics of the groundwater that might be encountered at the partially completed reactor site is presented in Table 3.10.4–2.

Groundwater Availability, Use, and Rights. Groundwater rights concerning the aquifer(s) near the partially completed reactor site would be associated with the reasonable use doctrine. Under this doctrine, landowners can withdraw groundwater to the extent that they must exercise their rights in accordance with the similar rights of others.

3.13.5 GEOLOGY AND SOILS

Geology. The partially completed reactor site is defined as being located in a flat valley surrounded by an area consisting of alternating valleys and hills. This area could be underlain by rocks composed of dolomite, limestone, and shale of Paleozoic age (225 to 600 million years).

The partially completed reactor site is located in Seismic Zone 1, which suggests there could be minor levels of damage in the event of an earthquake (Figure 3.2.5–1). The nearest potential earthquake with an MMI of V could be located within approximately 8 km (5 mi) from the partially completed LWR site (Table 3.2.5–1). The nearest known epicenter of a damaging earthquake (MMI of VII or greater) could be approximately 80 km (50 mi) from the partially completed reactor site. The partially completed LWR facility is not located in a volcanically active region.

Soils. The partially completed reactor site is located where the predominant soil types range from loamy clays to loamy sands. These soils range from poorly to well drained soils. The erosion potential could range from minor to severe in those areas with slopes greater than 25 percent and that have been eroded in the past. The soil's shrink-swell potential could range from low to severe, which is acceptable for standard construction techniques, depending upon the engineering controls employed. Wind erosion potential could range from minor to severe.

3.13.6 BIOLOGICAL RESOURCES

The representative partially completed reactor site is located within the deciduous forest vegetation type. Biological resources found within this vegetation type are discussed in Section 3.10.6. At a given site, biological resources could vary from those typically associated with the principal vegetation type identified above due to a variety of factors, including previous disturbance by man.

3.13.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

Prehistoric Resources. Prehistoric resources at the representative partially completed reactor site may include sites, districts, or isolated artifacts. Archaeological sites located at the generic site may represent occupation during the Archaic, Woodland, or Mississippian periods, and could include hunting and butchering sites and short occupation campsites, or long-term occupation sites with remains of structures, hearths, and storage pits. They may yield artifacts such as stone tools and associated manufacturing debris, and ceramic potsherds. Some sites may have been determined eligible for inclusion on the NRHP by the SHPO.

Historic Resources. Historic resources may include cemeteries, remains of residential or commercial structures, standing structures, or roads. Some sites may be eligible for inclusion on the NRHP, and some may be listed with the SHPO.

Native American Resources. Native American resources may exist at the site. These resources can include objects, areas, or natural resources that are important to Native American groups for religious or historical reasons. Such resources can include cemeteries, geological or geographical elements such as mountains or creeks, certain species of animals or plants, or trails. There could also be visual impacts to Native American resources.

Paleontological Resources. To date no paleontological resources have been identified for the partially completed reactor site. The site is located on limestone formations. These formations can be fossil-bearing, so some paleontological resources may exist within the site boundaries.

3.13.8 SOCIOECONOMICS

Operation of the representative partially completed reactor site could potentially affect the socioeconomic environment of a given REA or ROI. The characteristics of the REA, ROI, and community depend upon geographic location. For employment and income, the economic area would be based upon industry interaction and linkages in the region. The anticipated residential distribution of project-related employees and their families would determine the ROI. This ROI would contain all principal jurisdictions and school districts for community services likely to be affected by the proposed activity. Local transportation would be the existing principal road, air, and rail networks required to support the project activities.

The representative site is located in a small community approximately 104 km (64.6 mi) from an urbanized area. Statistics for employment and regional economy are presented for the REA that encompasses 12 counties around the representative site. Statistics for the remaining socioeconomic characteristics are presented for the ROI, a three-county area (Counties A, B, and C) surrounding the site.

Regional Economy Characteristics. Selected employment and regional economy statistics for the representative site's REA are given in Figure 3.13.8–1. Between 1980 and 1990, the civilian labor force in the REA increased 20.3 percent to the 1990 level of 430,100. The 1994 unemployment in the REA was 6.1 percent, which was approximately equal to unemployment for the representative State (6.0 percent). The per capita income in 1993 was $17,796, which was similar to the State's per capita income of $17,129.

As shown in Figure 3.13.8–1, farming represented 4 percent and governmental activities 18 percent of the total employment within the site's REA. This compares with the State rates of 3 and 18 percent for farming and government employment, respectively. Nonfarm private sector activities of manufacturing, retail trade, and services were 24, 16, and 21 percent, respectively, of the total regional employment for the representative site's REA. These were slightly different than the representative State's percentages for manufacturing (18 percent), retail trade (16 percent), and services (23 percent).

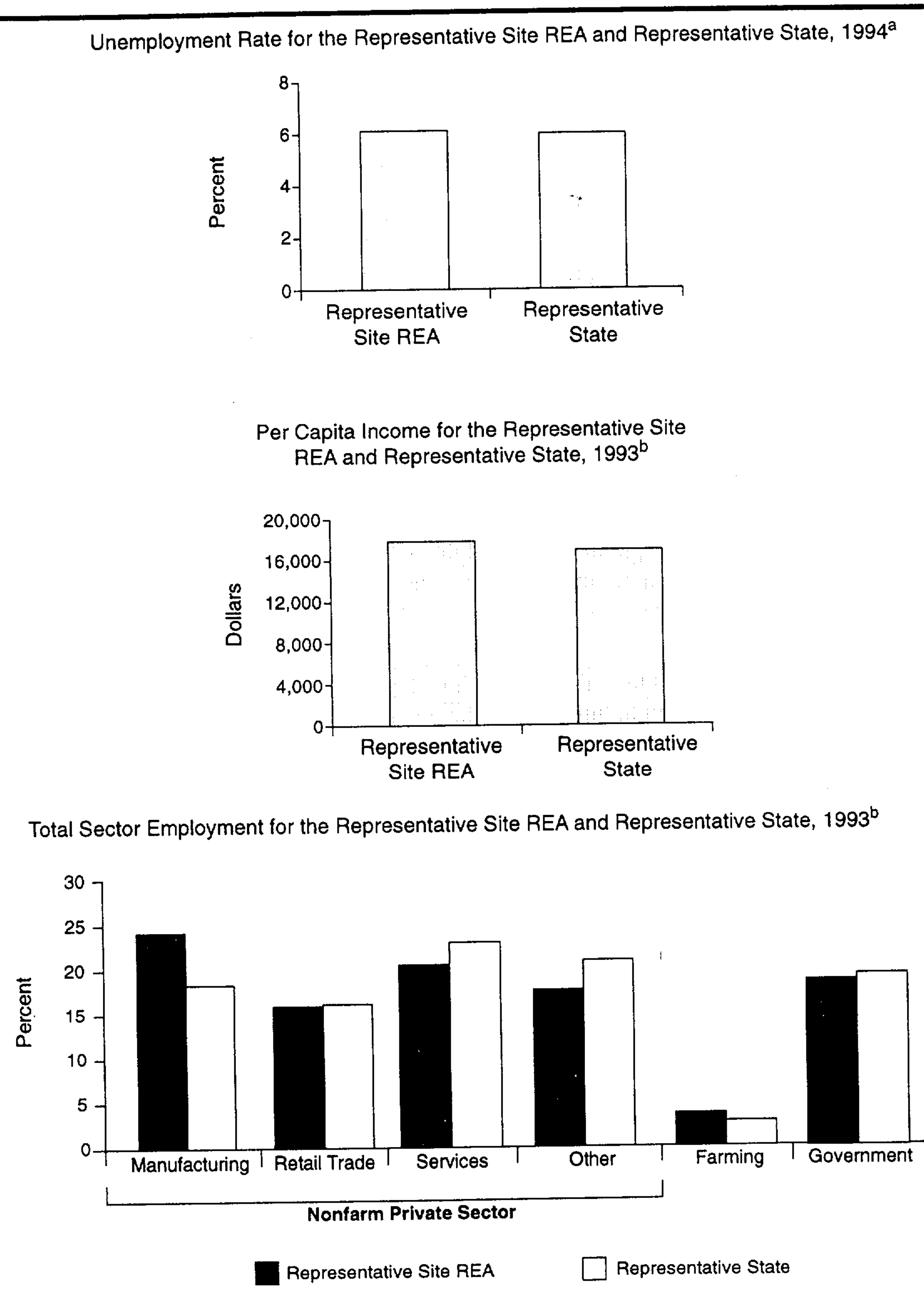
Population and Housing. Population in the ROI increased 20.9 percent from 1980 to 1994, compared to 8.3 percent in the representative State. The number of housing units increased 25.9 percent between 1980 and 1990, which was approximately 10 percent greater than the increase in the number of housing units for the entire State. The 1990 ROI homeowner vacancy rate, 1.9 percent, and the rental vacancy rate, 9.2 percent, were similar to those experienced in the representative State. Population and housing trends are summarized in Figure 3.13.8–2.

Community Services. Education, public safety, and health care characteristics were used to assess the level of community service in the representative ROI. These characteristics are summarized in Figures 3.13.8–3 and 3.13.8–4.

Education. In 1994, six school districts provided public education services and facilities in the representative ROI. As seen in Figure 3.13.8–3, these school districts operated between 69.7-percent and 100-percent capacity. The average student-to-teacher ratio for the ROI was 15.5:1.

Public Safety. City, county, and State law enforcement agencies provided police protection to the residents in the ROI. In 1994, a total of 546 sworn police officers were serving the three-county ROI. The average officer-to-population ratio in the ROI was 1.5 officers per 1,000 persons. Figure 3.13.8–4 compares police force strengths across the ROI.

Fire protection services in the representative ROI were provided by 1,490 paid and volunteer firefighters in 1995. The average firefighter-to-population ratio in the ROI was 4.1 firefighters per 1,000 persons, as indicated in Figure 3.13.8–4.



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

Figure 3.13.8–1. Employment and Local Economy for the Representative Partially Completed Reactor Site Regional Economic Area and the Representative State.

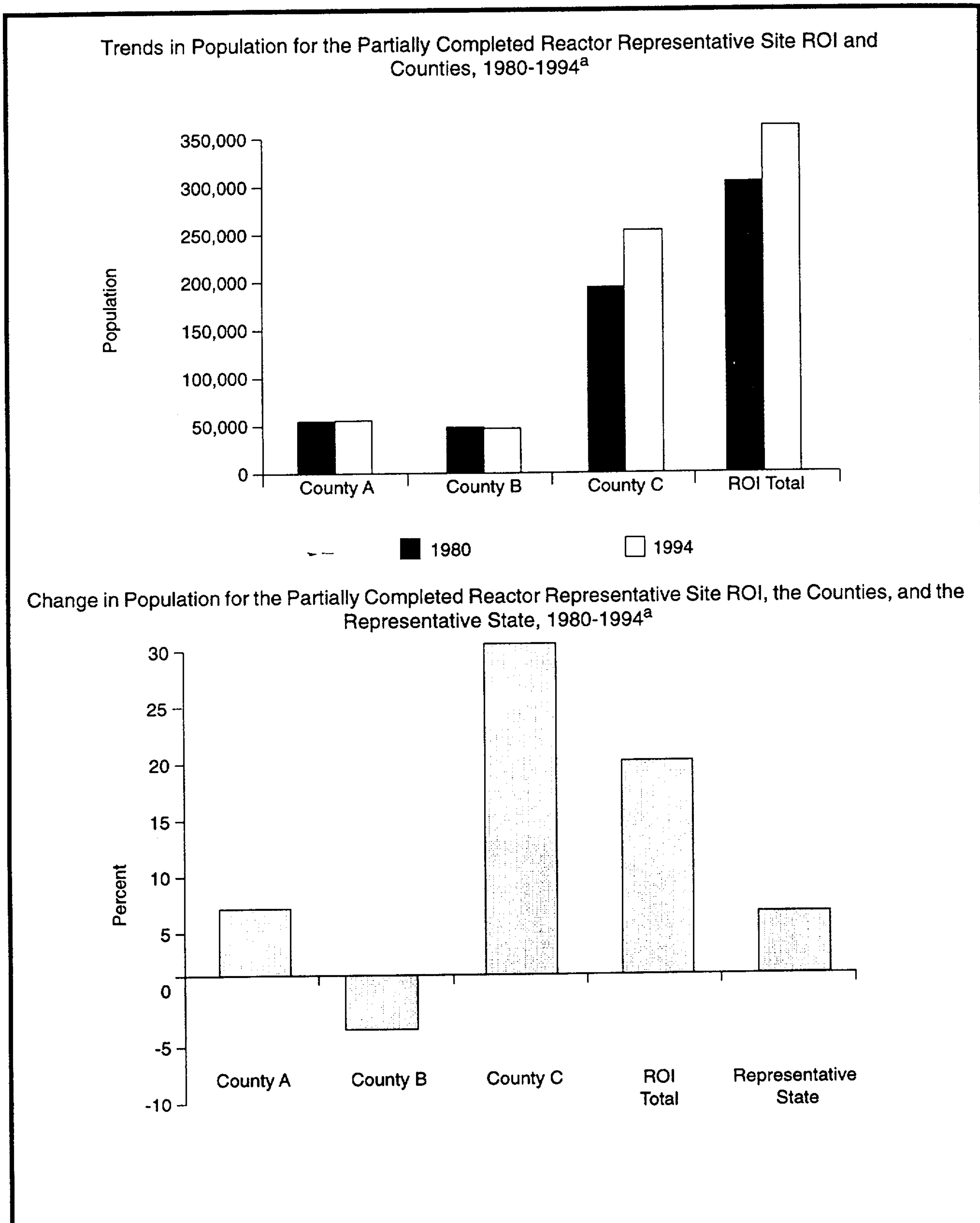
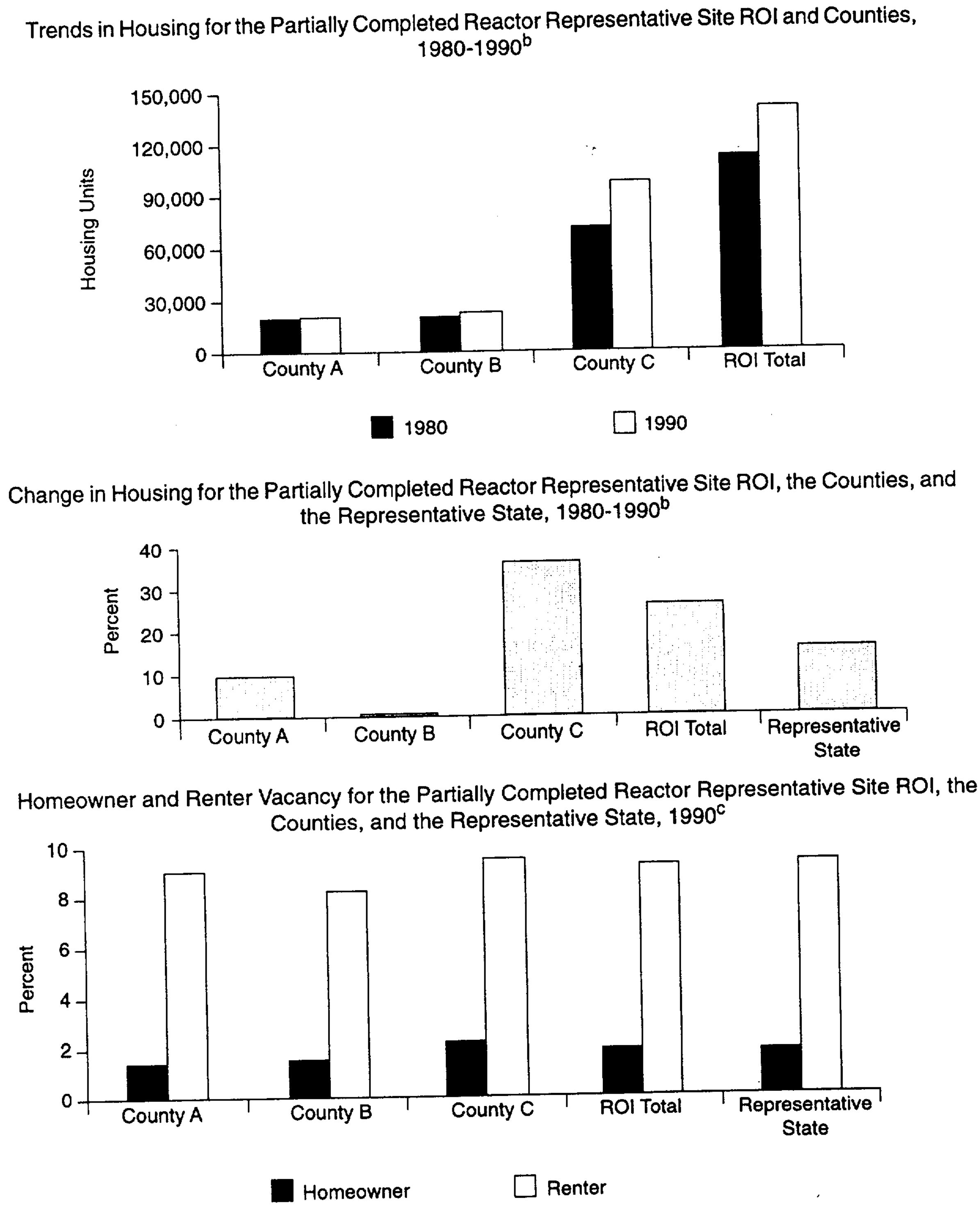
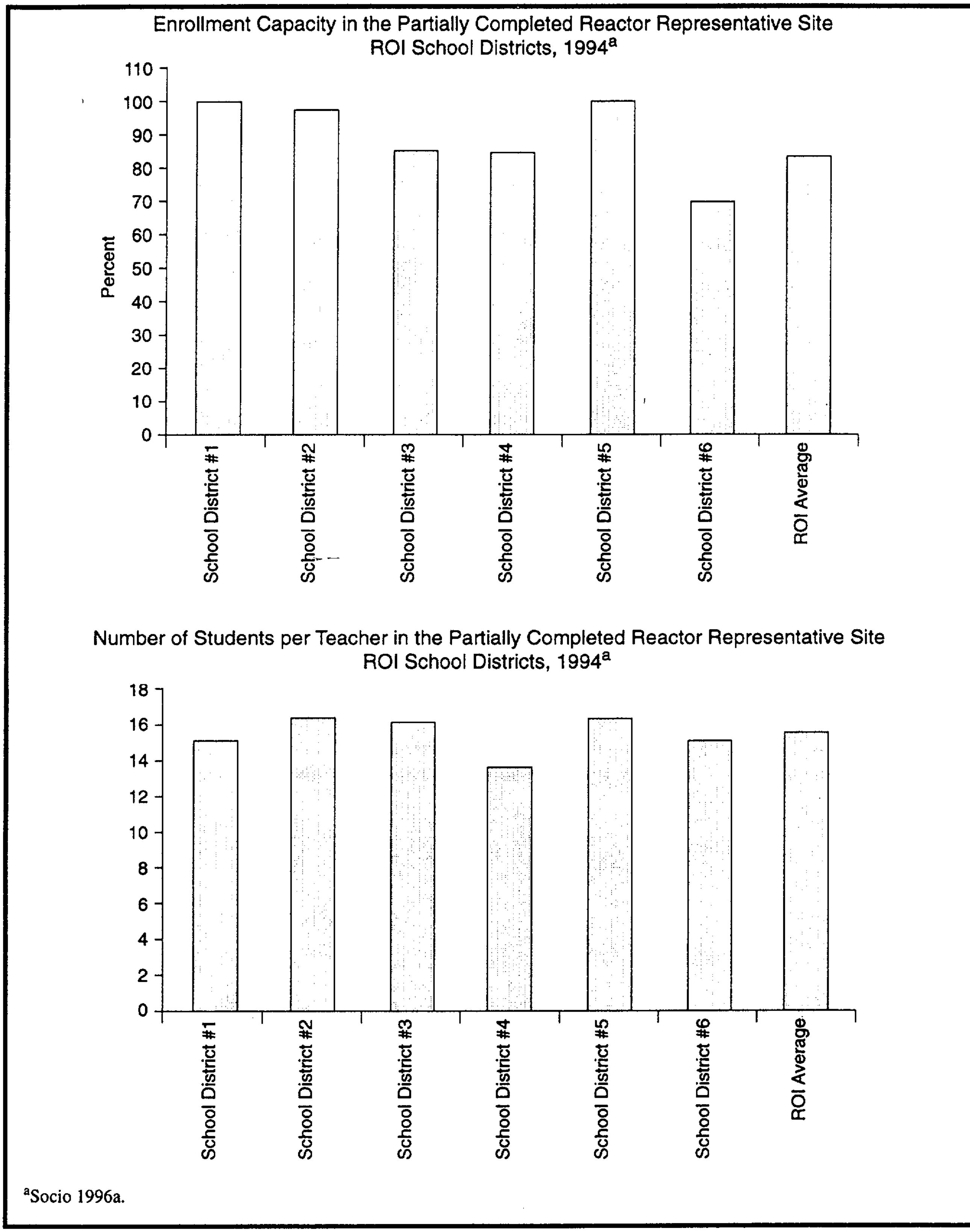


Figure 3.13.8–2. ***Population and Housing for the Representative Partially Completed Reactor Site Region of Influence and the Representative State.***



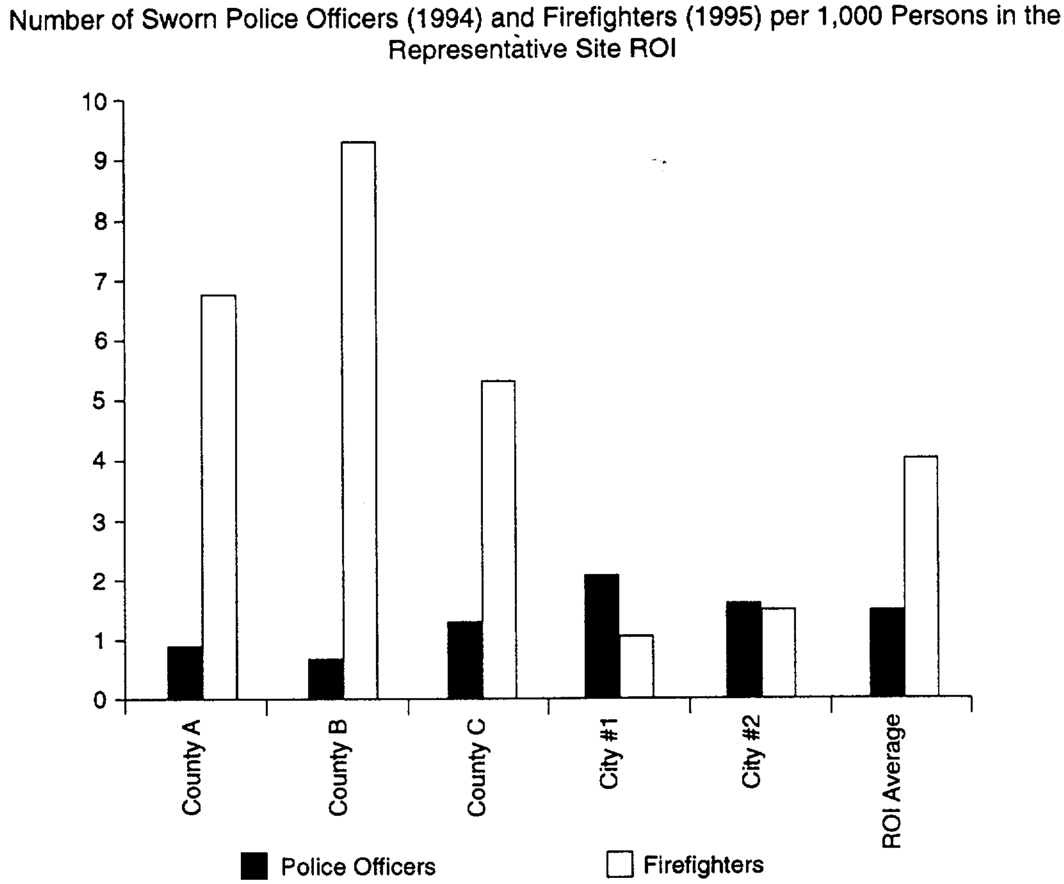
[a] Census 1983j; Census 1995a.
[b] Census 1982q; Census 1991p.
[c] Census 1991p.

Figure 3.13.8–2. Population and Housing for the Representative Partially Completed Reactor Site Region of Influence and the Representative State—Continued.

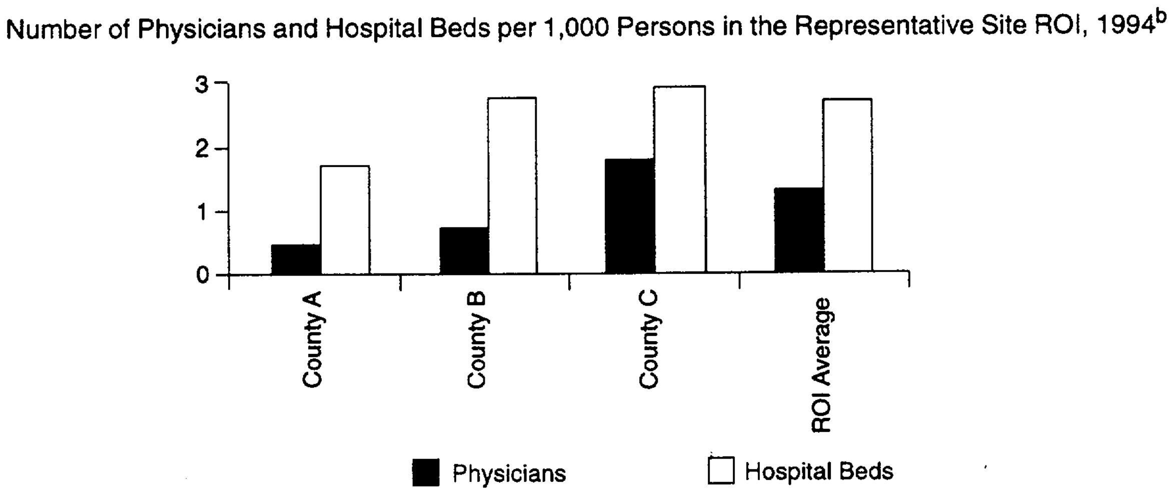


[a]Socio 1996a.

Figure 3.13.8–3. School District Characteristics for the Representative Partially Completed Reactor Site Region of Influence.



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



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

Figure 3.13.8–4. Public Safety and Health Care Characteristics for the Representative Partially Completed Reactor Site Region of Influence.

Health Care. Seven hospitals served the three-county ROI, with all operating below capacity. Figure 3.13.8–4 displays the hospital bed-to-population ratios for the ROI counties. The average ROI hospital occupancy rate was 58.9 percent in 1994, and a total of 525 physicians served the ROI. The average physician-to-population ratio for the ROI was 1.4 per 1,000 persons.

Local Transportation. Local transportation consists of the existing principal road, air, and rail networks required to support the project activities. Transportation networks in the smaller communities would generally be limited. However, due to its proximity to an urbanized area, the transportation networks at the representative site would be more extensive than in a more secluded community.

3.13.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Radiation Environment. Major sources and levels of background radiation exposure to individuals in the vicinity of the representative partially completed reactor site (and to any onsite workers) are shown on Table 3.13.9–1. 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.

Table 3.13.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Operation at the Partially Completed Reactor Site

Source	Effective Dose Equivalent (mrem/yr)
Natural Background Radiation	
Cosmic radiation[a]	28
External terrestrial radiation[a]	29
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	361

[a] Derived from information 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 an operational nuclear reactor site would provide another source of radiation exposure to members of the public. However, because the partially completed reactor has never operated, releases of radionuclides from it, and the resulting doses and health effects, are taken to equal zero for the existing conditions.

Similarly, the nonoperational status of the reactor precludes exposure of workers to radioactivity. The associated doses and health effects to workers are also taken to equal zero for the existing conditions.

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 waters during swimming and 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 3.13.3.

Health Effects Studies. Specific locations for the partially completed reactor must be designated before any reviews of epidemiologic studies in the areas can be conducted.

Accident History. Since the reactor has never operated at the site, there is no site accident history.

Emergency Preparedness. Sites that are licensed by the NRC must have an emergency management program that would be activated in the event of an accident. The program must be compatible with all other Federal, State, and local plans and be thoroughly coordinated with all interested groups. The program would have to be developed and approved before operation of the completed reactor.

3.13.10 WASTE MANAGEMENT

This section addresses the management of wastes associated with a representative partially completed reactor site. Because construction of the reactors at the site has been deferred, the only activities currently at the site are maintenance and limited engineering design work.

Spent Nuclear Fuel. No spent nuclear fuel is currently generated by this facility.

High-Level Waste. No HLW is currently generated by this facility.

Transuranic Waste. No TRU waste is currently generated by this facility.

Low-Level Waste. No LLW is currently generated by this facility.

Mixed Low-Level Waste. No mixed LLW is currently generated by this facility.

Hazardous Waste. The representative partially completed reactor is considered a small quantity hazardous waste generator (less than 100 kg/month [220 lb/month]) as defined in 40 CFR 261.5. Hazardous wastes currently generated from maintenance activities include Pb, spent solvents, and used oils. Approximately 454 kg (1,000 lbs) per year is currently generated. Hazardous wastes are packaged and shipped offsite to the TVA hazardous waste storage facility at Muscle Shoals, Alabama. Once sufficient quantities have accumulated, the hazardous wastes are shipped to commercial RCRA-permitted treatment and disposal facilities.

Nonhazardous Waste. Liquid sanitary wastewater from the representative partially completed reactor site is sent to the Hollywood sewer system and eventually treated at the Hollywood Sanitary Treatment Plant. Solid nonhazardous wastes such as desiccants and normal housekeeping trash is collected in dumpsters and transported offsite to a permitted landfill by a commercial contractor. Large desiccants are packaged in drums and transported to a permitted landfill by the commercial contractor.