4.6 Savannah River Site

SRS was established in 1950 as a nuclear materials production site and occupies approximately 198,000 acres south of Aiken, SC. The current defense program mission at SRS is to process tritium and conduct tritium recycling and filling in support of stockpile requirements. Section 3.3.6 provides a description of all the DOE missions and support facilities at SRS. The location of SRS within the South Carolina and Georgia region is illustrated in figure 4.6–1.

4.6.1 Description of Alternatives

Under the proposed action, any of the four tritium supply technologies (HWR, MHTGR, ALWR, and APT) could be located at SRS. Section 3.4.2 provides a description of these four technologies. In the event a tritium supply technology is sited at SRS, some of the tritium recycling support facilities would be upgraded to ensure compliance with ES&H requirements. The replacement tritium facility (Building 233-H) would not require upgrading since it meets current ES&H requirements. Figure 4.6.1–1 shows the locations of existing facilities within SRS and the proposed TSS, and section 3.4.3.2 describes the tritium recycling facilities upgrade at SRS.

In the event tritium supply facilities are sited at any of the four other candidate sites (INEL, NTS, ORR, and Pantex), there are two recycling options. One option would be to upgrade existing recycling facilities located at SRS for continued use. The other option would be to collocate a new recycling facility with the supply facility. In this case, the existing tritium recycling facilities at SRS would be phased out and would eventually require D&D in accordance with DOE guidelines.

Under No Action, SRS would continue to perform the missions described in section 3.3.6 to include providing stockpile support by recycling tritium and conducting tritium filling. However, DOE would have no capability to produce new tritium. Future tritium requirements would be supported, for a limited time, by recycling tritium from weapons returned from the active stockpile.

4.6.2 Affected Environment

The following sections describe the affected environment at SRS for land resources, air quality and acoustics, water resources, geology and soils, biotic resources, cultural and paleontological resources, and socioeconomics. In addition, the infrastructure at SRS, the radiation and hazardous chemical environment, and the waste management conditions are described.

4.6.2.1 *Land Resources*

The discussion of land resources at SRS includes land use and visual resources.

Land Use. SRS occupies approximately 198,000 acres in portions of Aiken, Allendale, and Barnwell counties in southwestern South Carolina, approximately 16 miles southeast of Augusta, GA. All of the land within SRS is owned by the Federal government and is administered, managed, and controlled by DOE. Generalized existing land uses at SRS and in the vicinity are shown in figure 4.6.2.1–1.

SRS land use can be grouped into three major categories: forest/undeveloped, water, and developed facility locations. Approximately 191,000 acres of SRS are undeveloped. Of this acreage approximately 138,000 acres are forest/undeveloped. A forest management program has been in effect at SRS since 1952, when it was formed through an Interagency Agreement between DOE (then the Atomic Energy Commission) and the U.S. Forest Service (WSRC 1993a:317). The majority of the woodlands area (53 percent of the total site) is in revenue producing, managed timber production. There are no prime farmlands on SRS.

In 1972, DOE designated the entire SRS as a National Environmental Research Park. The National Environmental Research Park is used by the national scientific community to study the impact of human activities on the cypress swamp, and southeastern pine and hardwood forest ecosystems (DOE 1985a:1).

As shown in figure 4.6.2.1–1, the proposed TSS would be located northeast of N-Area within approximately 600 acres of forested lands typical of SRS. The tritium recycling mission is currently located in H-Area.

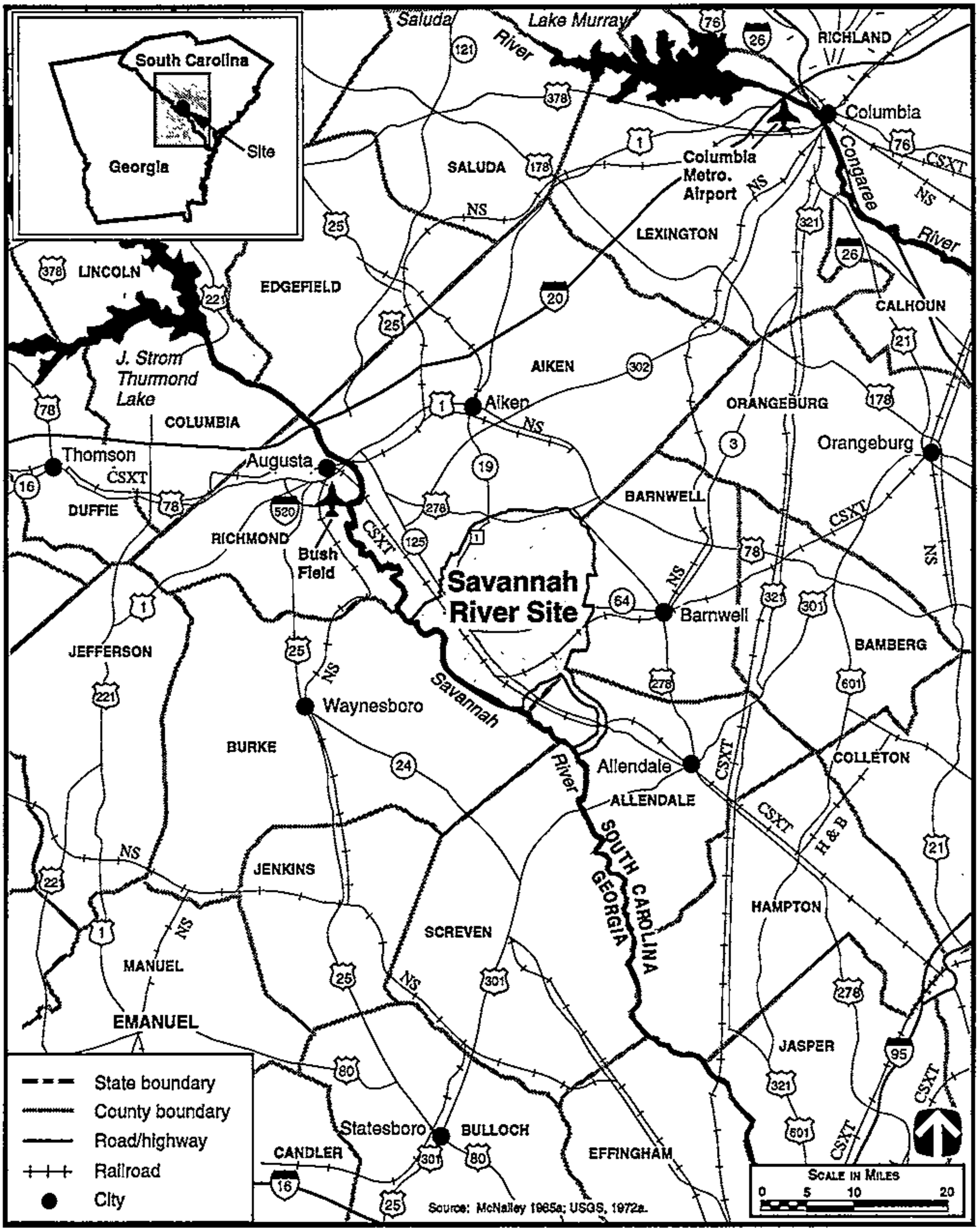

FIGURE 4.6–1.—*Savannah River Site, South Carolina, and Region.*

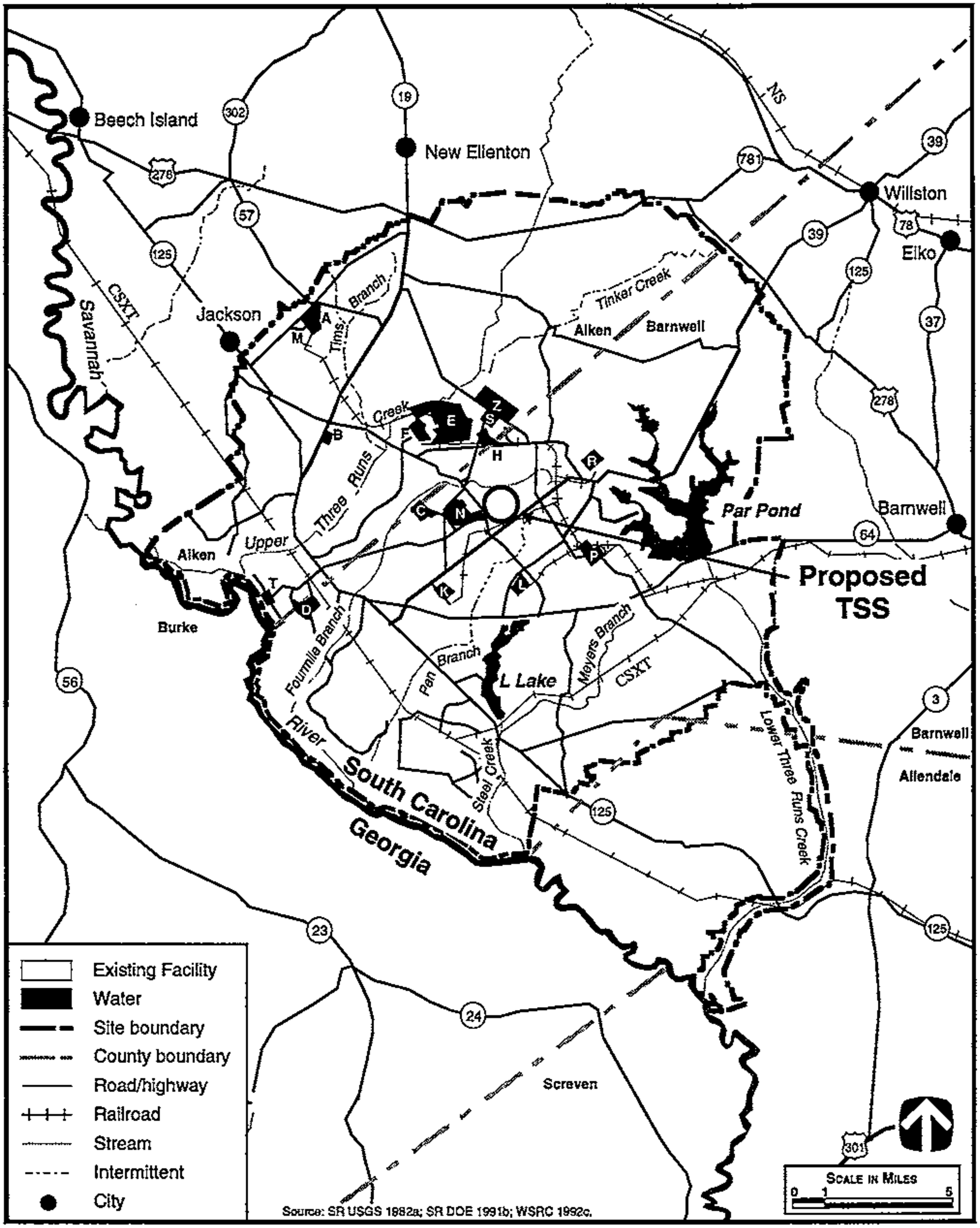

FIGURE 4.6.1–1.—*Primary Facilities and Proposed Tritium Supply Site at Savannah River Site.*

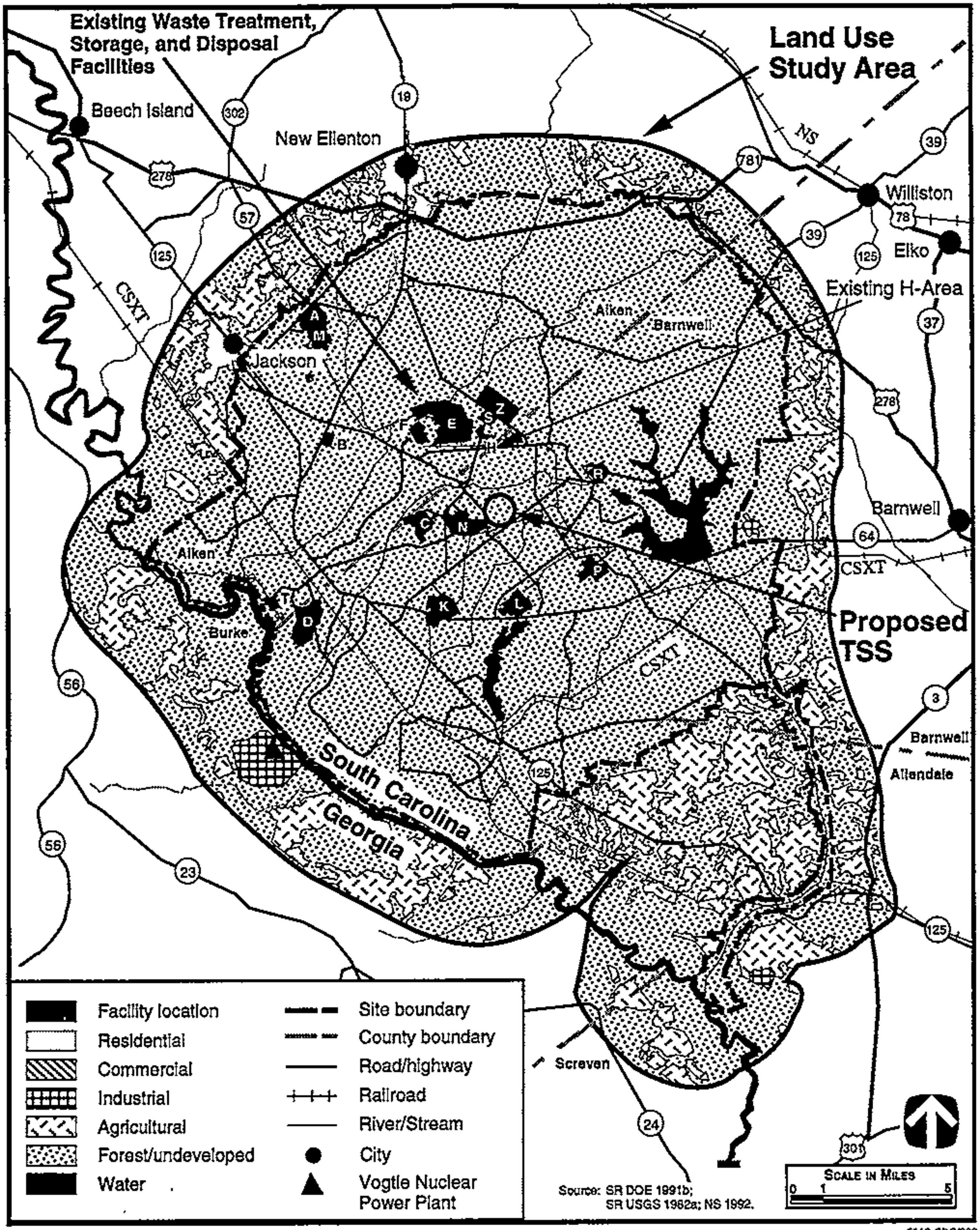

FIGURE 4.6.2.1–1.—*Generalized Land Use at Savannah River Site and Vicinity.*

Land use bordering SRS is primarily forest and agricultural, although there is a substantial amount of open water and nonforested wetlands along the Savannah River Valley. Incorporated and industrial areas are the only other significant land uses in the vicinity. There is a small amount of urban and residential development bordering SRS. The closest residences include several located to the west, north, and northeast that are within 200 feet of the site boundary.

Visual Resources. The SRS landscape is characterized by swampland and upland hills. The vegetation is composed of bottomland hardwood forests, scrub oak and pine woodlands, and swamp forests. DOE facilities are scattered throughout SRS and are brightly lit at night. The developed areas and utility corridors (transmission lines and aboveground pipelines) of SRS are consistent with Bureau of Land Management's VRM Class 5 designation. The remainder of SRS generally ranges from VRM Class 3 to Class 4.

The viewshed consists mainly of agricultural and heavily forested land, with some limited residential and industrial areas. Views are limited by rolling terrain, normally hazy atmospheric conditions, and heavy vegetation. DOE facilities are generally not visible from offsite. The only areas with high visual sensitivity levels that are presently impacted by DOE facilities are the view corridors of State Highway 125, and SRS Road 1. The few other areas that have views of SRS facilities are quite distant (5 miles or more) and have low visual sensitivity levels.

4.6.2.2 *Site Infrastructure*

SRS contains extensive production, service, and research facilities. Not all of these facilities are in operation or needed today. Section 3.3.6 describes the current missions at SRS. To support these missions, an extensive infrastructure exists as shown in table 4.6.2.2–1. Of critical importance to the proposed action is the electrical power infrastructure at each potential site. SRS is located in the Southeastern Electric Reliability Council Regional Power Pool and draws its power from the Virginia-Carolina Subregion. Characteristics of this subregion are given in table 4.6.2.2–2.

TABLE 4.6.2.2–1.—*Baseline Characteristics for Savannah River Site*

Current Characteristics	Value
Land	
Area (acres)	198,000
Roads (miles)	150
Railroads (miles)	57
Electrical	
Energy consumption (MWh/yr)	659,000
Peak load (MWe)	130
Fuel	
Natural gas (ft^3/yr)	0
Oil (GPY)	2,412,000
Coal (ton/yr)	230,000
Steam (lb/hr)	2,584,000

Source: SRS 1993a:3.

TABLE 4.6.2.2–2.—*Subregional Power Pool Electrical Summary for Savannah River Site*

Type Fuel	Production (percent)
Coal	50
Nuclear	36
Hydro/geothermal	2
Oil/gas	4
Other[a]	8
Total Annual Production: 272,155,000 MWh	
Total Annual Load: 284,556,000 MWh	
Energy Imported Annually[b]: 13,846,000 MWh	
Generating Capacity: 61,931 MWe	
Peak Demand: 55,477 MWe	
Capacity Margin[c]: 10,443 MWe	

[a] Includes power from nonutility sources only.
[b] Energy imported is not the difference of production and load due to system losses and pumped storage.
[c] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.

Source: NERC 1993a..

4.6.2.3 *Air Quality and Acoustics*

The following describes existing air quality and acoustics including a review of the meteorology and climatology in the vicinity of SRS. More detailed discussions of the air quality and acoustics methodologies, input data, and atmospheric dispersion characteristics are presented in appendix section B.1.3.6.

Meteorology and Climatology. The SRS region has a temperate climate with short, mild winters and long, humid summers. Throughout the year, it is frequently affected by warm and moist maritime air masses. The annual average temperature is 66 °F; average daily temperatures vary from 37.9 °F in January to 90.8 °F in July. The average annual precipitation is 49.7 inches (NOAA 1991b:3). Prevailing winds are from the southwest through west-northwest and from the northeast and east-northeast. The annual average wind speed is 12.8 mph. Additional information related to meteorology and climatology at SRS is presented in appendix section B.1.3.6.

Ambient Air Quality. SRS is located near the center of the Augusta-Aiken Interstate AQCR. As of 1991, the areas within SRS and its surrounding counties were in attainment with respect to the NAAQS for criteria pollutants (40 CFR 50; 40 CFR 81.311; 40 CFR 81.341). Applicable NAAQS and the ambient air quality standards for South Carolina and Georgia are presented in appendix table B.1.3.1–1.

Since the promulgation of Prevention of Significant Deterioration regulations (40 CFR 52.21) in 1977, Prevention of Significant Deterioration permits have not been required for any new SRS emission sources nor modifications required to existing permits. There are no known Prevention of Significant Deterioration Class I areas in the vicinity of SRS.

Maximum pollutant concentrations measured during 1985 at onsite air quality monitoring stations and at nearby monitoring stations outside SRS are listed in appendix table B.1.3.6–1. All concentrations measured at these stations indicate that ambient concentrations in and near SRS are within the NAAQS and applicable state ambient air quality standards with the exception of ozone (O_3). The O_3 standard was equaled at one monitoring station on 1 day in 1985 (SR DOE 1986c:166).

The emissions inventory from sources at SRS for criteria pollutants are presented in appendix table B.1.3.6–2. Historically, the primary emission sources of criteria air pollutants are the nine coal-burning and the four fuel oil-burning boilers that produce steam and electricity (A-, D-, H-, K-, and P-Areas), the fuel and target fabrication facilities (M-Area), and processing facilities (F- and H-Areas). Other emissions and sources include fugitive particulates from coal piles and coal-processing facilities, vehicles, and temporary emissions from various construction-related activities.

Hazardous/toxic air pollutant emissions from SRS operations for which an ambient standard has been adopted by the State of South Carolina Department of Health and Environmental Control include aldehydes (assumed to be formaldehyde), carbon tetrachloride, nitric acid, and 1,1,1-trichloroethane. (No ambient standards for hazardous/toxic air pollutants have been proposed or established by the State of Georgia.) The annual emission rates of hazardous/toxic air pollutants from existing facilities during 1990 and estimates of maximum 24-hour average ground-level concentrations at the site boundary are listed in appendix table B.1.3.6–3. These estimates are in compliance with applicable standards.

Table 4.6.2.3–1 presents the baseline ambient air concentration for criteria pollutants and other pollutants of concern at SRS. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

Acoustic Conditions. Major noise emission sources are primarily located in developed or active areas and include various industrial facilities, equipment, and machines. Noise emitted from the site is barely distinguishable from background noise levels at the boundary. Major noise emission sources outside of active areas consist primarily of vehicles and rail operations. Some of these offsite noise emissions can be attributed to SRS activities and have an effect on noise levels along site access highways through the nearby towns of New Ellenton, Jackson, and Aiken.

The States of Georgia and South Carolina, and the counties in which SRS is located, have not established any noise regulations that specify acceptable community noise levels, with the exception of a provision in the Aiken County Nuisance Ordinance which limits daytime and nighttime noise by frequency band (appendix table B.2.2.2–1).

TABLE 4.6.2.3–1.—*Comparison of Baseline Ambient Air Concentrations with Most Stringent Applicable Regulations and Guidelines at Savannah River Site, 1985-1987*

Pollutant	Averaging Time	Most Stringent Regulation or Guideline (μg/m³)	Baseline Concentration[a] (μg/m³)
Criteria Pollutant			
Carbon monoxide (CO)	8-hour	10,000[b]	38
	1-hour	40,000[b]	154
Lead (Pb)	Calendar quarter	1.5[b]	[c]
Nitrogen dioxide (NO_2)	Annual	100[b]	22
Ozone (O_3)	1-hour	235[b]	235
Particulate matter (PM_{10})	Annual	50[b]	28
	24-hour	150[b]	64
Sulfur dioxide (SO_2)	Annual	80[b]	16
	24-hour	365[b]	266
	3-hour	1,300[b]	1,122
Mandated by South Carolina			
Total suspended particulates (TSP)	Annual	75[d]	29
Hazardous and Other Toxic Compounds			
1,1,1–Trichloroethane	24-hour	9,550[d]	3.6
Nitric acid	24-hour	125[d]	3.2
Trichlorotrifluoroethane	24-hour	No standard	1.8

[a] The total concentration represents a conservative assessment of air quality since the concentration contributions from individual sources do not necessarily occur at the same location.
[b] Federal standard (40 CFR 50).
[c] Not estimated because the potential release is negligible.
[d] State standard (SR DHEC 1992b; SR DHEC 1991a).
Source: DOE 1992h.

4.6.2.4 *Water Resources*

This section describes the surface water and groundwater resources at SRS.

Surface Water. The most prominent hydrologic feature is the Savannah River, bordering the site for 20 miles to the southwest (figure 4.6.2.4–1). Six major streams flow through SRS into the Savannah River: Upper Three Runs Creek, Beaver Dam Creek, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek. Upper Three Runs has two tributaries, Tims Branch and Tinker Creek; Pen Branch has one tributary, Indian Grave Branch; and Steel Creek has one tributary, Meyers Branch (WSRC 1992a).

SRS withdraws surface water from Savannah River mainly for industrial water cooling purposes. A small quantity is also removed for drinking water supplies. Total water supplied from the Savannah River in 1991 was 19,840 MGY. Most of the water withdrawn is returned to the Savannah River through its onsite tributaries. Streams that received discharges from reactors in the past, especially Fourmile Branch, are still recovering from scouring or erosion impacts. The average flow of the Savannah River is 10,000 ft³/s. The lowest recorded flow, 5,368 ft³/s, occurred during a drought period from 1985 to 1988 (SR DOE 1990b). The proposed TSS could affect the Fourmile Branch drainage basin, which also receives effluents from C-, F-, and H-Areas; however, Pen Branch could also receive discharges.

There are two man-made water bodies on SRS: L-Lake, which discharges to Steel Creek; and Par Pond, which empties into Lower Three Runs Creek (WSRC 1992a).

There are approximately 190 Carolina bays scattered throughout the site. Carolina bays are naturally-

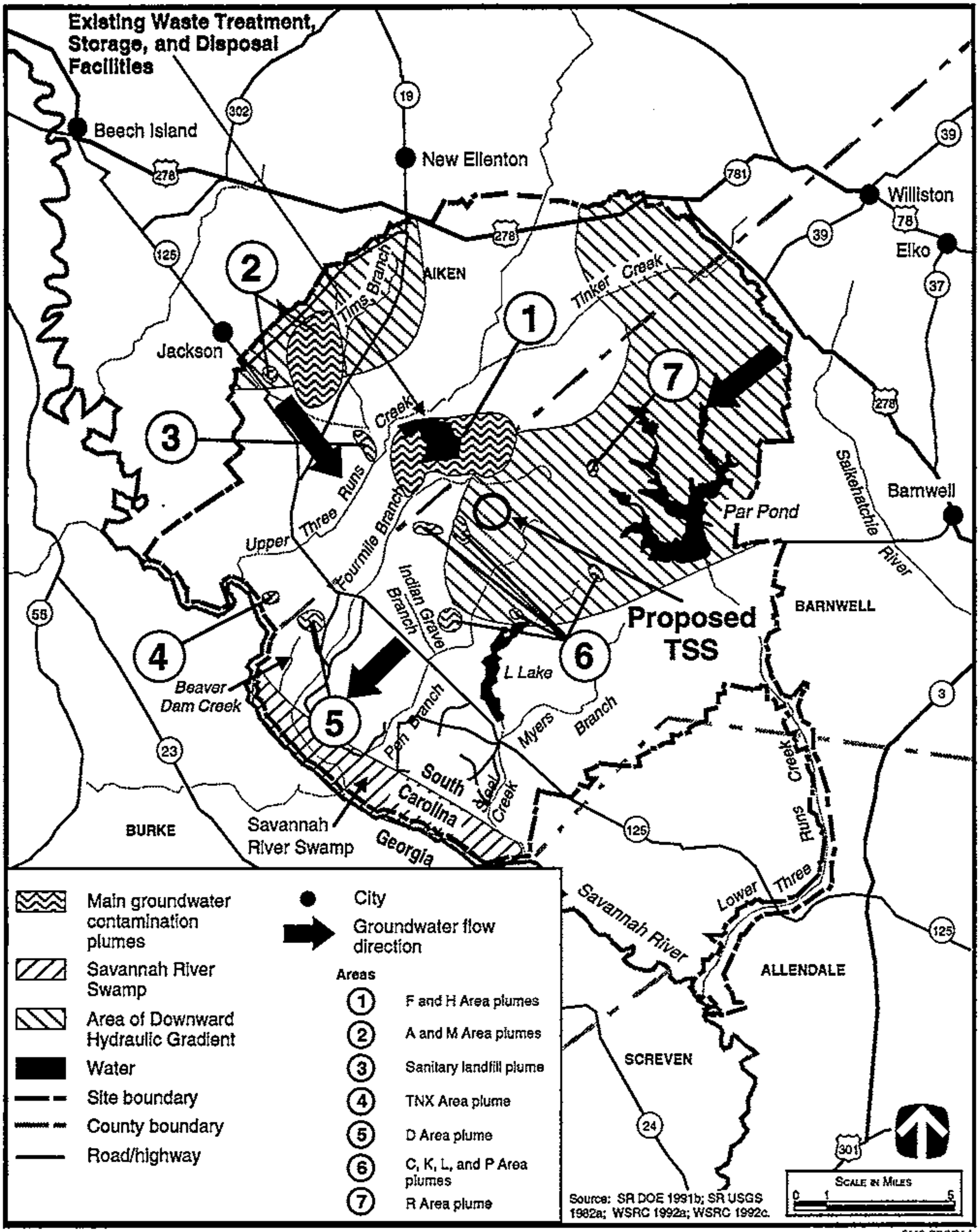

FIGURE 4.6.2.4–1.—*Surface Water Features and Groundwater Contamination Areas at Savannah River Site.*

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occurring closed depressions that may hold water (SR NERP 1989a). There are no direct discharges to the bays; however, some do receive stormwater runoff.

The proposed TSS is outside any 100-year floodplains (SR DOE 1990b). Information on the location of 500-year floodplains is currently not available; however, a site-specific assessment would be required before constructing any tritium supply and recycling facilities at SRS.

Surface Water Quality. In the vicinity of SRS, the Savannah River and onsite streams are classified as fresh water suitable for: primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the South Carolina Department of Health and Environmental Control; fishing and the survival and propagation of a balanced indigenous and aquatic community of fauna and flora; and industrial and agricultural uses (SR DHEC 1992a). Table 4.6.2.4–1 lists the surface water monitoring results for the Savannah River. No parameters exceed South Carolina water quality criteria for the Savannah River (WSRC 1992a).

In addition to water quality monitoring, SRS conducts monitoring to ensure compliance with NPDES permit limits. SRS has three NPDES permits that cover 78 outfalls. Of the 8,329 analyses performed at these outfalls in 1991, seven exceeded permit limits. Noncompliances were noted for pH, fecal coliforms, oil and grease, biological oxygen demand, flow, and total suspended solids. Except in the case of pH noncompliance, corrective actions were taken to prevent future noncompliances (WSRC 1992a).

Surface Water Rights and Permits. Surface water rights for the Savannah River are determined by the Doctrine of Riparian Rights. Under this doctrine, users of water must not adversely impact quantity or quality of water availability for downstream users.

Groundwater. Several aquifer system naming schemes have been used at SRS. For this PEIS, the most shallow aquifer will be called the water table. The water table is supported by the leaky "Green Clay" aquitard, which confines the Congaree aquifer. Below the Congaree aquifer is the leaky Ellenton aquitard, which contains the Cretaceous (or also in the past the Tuscaloosa) aquifer. In general, groundwater in the water table flows downward to the Congaree aquifer or to nearby streams that intersect the water table. Flow in the Congaree aquifer is downward to the Cretaceous aquifer or horizontally to Upper Three Runs Creek or the Savannah River, depending on the position at SRS. Groundwater in the Cretaceous aquifer discharges predominantly along the Savannah River. However, Upper Three Runs Creek also receives groundwater from the Cretaceous aquifer and this flow creates an upward gradient between the Cretaceous and Congaree aquifer over a significant portion of SRS (figure 4.6.2.4–1).

The Cretaceous aquifer is an abundant and important water resource for the SRS region. Some of the local cities (Aiken, for example) also obtain groundwater from the Cretaceous, but most of the rural population in the SRS region gets its water from the Congaree or water table. All groundwater at SRS is classified by the EPA as a Class II water source (current potential source of drinking water).

Characterization wells installed for preliminary hydrogeologic evaluation of the proposed TSS indicate that the site is located near a water table divide between Fourmile Branch and Pen Branch. That is, groundwater in the water table on the northern side of the divide flows horizontally to Fourmile Branch and on the southern side to Pen Branch. Groundwater in the water table also flows vertically to the Congaree aquifer which discharges at Upper Three Runs Creek. The Cretaceous aquifer is protected from any potential contamination at the proposed TSS by the Ellenton aquitard and the upward hydraulic gradient between the Cretaceous and Congaree aquifers. Groundwater at the proposed TSS is approximately 20 to 60 feet below the ground surface.

Groundwater Quality. Groundwater data have been obtained from SRS monitoring wells for the past several years. Groundwater quality ranges from excellent (soft and slightly acidic) to below EPA drinking water standards on several constituents in the vicinity of some waste sites. The Cretaceous aquifer is generally unaffected except for a small portion of the A-Area which has trichloroethylene. The Congaree aquifer is contaminated with trichloroethylene in much of the A- and M-Areas and also with some low levels of tritium in the General Sepa-

TABLE 4.6.2.4–1.—*Summary of Surface Water Quality Monitoring Data for the Savannah River at Savannah River Site, 1991*

Parameter	Unit of Measure	Water Quality Criteria[a]	Average Water Body Concentration
Alkalinity :	mg/l	NA	18
Alpha (gross)	pCi/l	15[b]	0.004
Aluminum	mg/l	0.05-0.2[c]	0.79[g]
Ammonia	mg/l	NA	0.12
Beta (nonvolatile)	pCi/l	50[d]	2.05
Calcium	mg/l	NA	4.4[g]
Cesium-137	pCi/l	120[e]	0.0493
Chemical oxygen demand	mg/l	NA	14
Chloride	mg/l	250[c]	7.2
Chromium	mg/l	0.1[b]	<0.02[g]
Conductivity	µmhos/cm	NA	81
Dissolved oxygen	mg/l	>5[f]	7.8
Iron	mg/l	0.3[c]	1.8[g]
Lead	mg/l	0.015[b]	0.01[g]
Magnesium	mg/l	NA	1.4[g]
Manganese	mg/l	0.05[c]	0.13[g]
Nitrogen (as NO_2/NO_3)	mg/l	NA	0.25
pH	pH units	6.5-8.5[f]	7.5[g]
Phosphorus	mg/l	NA	0.09
Plutonium-238	pCi/l	1.6[e]	0.00028
Plutonium-239	pCi/l	1.2[e]	0.0007
Sodium	mg/l	NA	10[g]
Strontium-90	pCi/l	8[b]	0.137
Sulfate	mg/l	250[c]	7.8
Suspended solids	mg/l	NA	16
Temperature	°C	32.2[f]	18
Total dissolved solids	mg/l	500[c]	64
Tritium	pCi/l	20,000[b]	3,250
Turbidity	turbidity unit	1-5[b]	10
Zinc	mg/l	5[c]	<0.01[g]

[a] For comparison only, except for parameters which have South Carolina water quality criteria.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] National Secondary Drinking Water Regulations (40 CFR 143).
[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[e] DOE's Derived Concentration Guides for water (DOE Order 5400.5). Derived Concentration Guides 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 Derived Concentration Guides.
[f] State of South Carolina state water quality criteria.
[g] Average concentrations were not calculated because of an insufficient amount of sampling. The maximum concentration is listed.
Note: NA - not applicable.
Source: WSRC 1992a.

rations Area. The water table is contaminated with solvents and/or metals and/or low levels of radionuclides at several waste sites and facilities at the F- and H-Areas. All contaminated groundwater at SRS discharges to streams on SRS or to the Savannah River.

Based on the operating history of SRS, groundwater at the proposed TSS should meet drinking water standards. Also, results of groundwater quality measurements from two of the 16 TSS characterization wells and comparison with standards or criteria for selected quality parameters are presented in table 4.6.2.4–2. As noted from that table, when compared to national primary and secondary maximum contaminant levels, parameter concentrations are within acceptable limits except for pH in one of the wells. The elevated pH is most likely due to the well completion with grout and not actual groundwater impacts.

Groundwater Availability, Use, and Rights. SRS is one of 56 major municipal, industrial, and agricultural groundwater users in the region. Within a 20-mile radius of the site the total pumpage for these 56 users averages about 12,900 MGY (WSRC 1991c). Groundwater use at SRS totals approximately 3,146 MGY, which represents approximately 24 percent of the total groundwater used in the area.

The majority of the water supply systems within the region use groundwater, but the systems serving Aiken, North Augusta, Columbia County, and Richmond County also draw a portion of their water supplies from surface water. Currently, most county systems within the region have average daily demands of 40 to 57 percent of their design capacities (DOE 1993f).

TABLE 4.6.2.4–2.—*Groundwater Quality Monitoring Data at Savannah River Site, 1991*

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Well No. NPM 2[b]	Well No. NPM 19E[b]
Alpha (gross)	pCi/l	15[d]	<2	<2
Barium	mg/l	2[c]	0.008	0.013
Beta (nonvolatile)	pCi/l	50[d]	<2	33
Chloride	mg/l	250[e]	0.002	0.003
Iron	mg/l	0.3[e]	<0.004	0.036
Lead	mg/l	0.015[c]	<0.003	0.003
Manganese	mg/l	0.05[e]	0.015	<0.002
Nitrate	mg/l	10[c]	0.15	0.06
pH	pH units	6.5-8.5[f]	6.6	12
Phenols	mg/l	NA	<0.005	<0.005
Sulfate	mg/l	250[e]	<0.001	0.037
Total dissolved solids	mg/l	500[e]	0.029	0.023
Total organic halogens	mg/l	NA	<0.005	0.02
Total phosphates	mg/l	NA	0.09	<0.05
Total radium	pCi/l	5[g]	2	1
Tritium	pCi/l	20,000[c]	7,000	700

[a] For comparison only.
[b] All data are from wells located at the proposed TSS
[c] National Primary Drinking Water Regulations (40 CFR 141).
[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[e] National Secondary Drinking Water Regulations (40 CFR 143).
[f] South Carolina State Water Criteria.
[g] DOE's Derived Concentration Guides for water (DOE Order 5400.5). Derived Concentration Guides 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 Derived Concentration Guides.
Note: NA - not applicable.

Groundwater rights in South Carolina are traditionally associated with property ownership. The *Water Use Reporting and Coordination Act* requires all users of 100,000 gallons or more per day (36 MGY) of water to report their withdrawal rates to the South Carolina Water Resources Commission. SRS groundwater use exceeds this amount, and consequently, reports its withdrawal rates to the commission (DOE 1992e).

4.6.2.5 *Geology and Soils*

Geology. SRS is located in the Aiken Plateau portion of the Upper Atlantic Coastal Plain east of the Fall Line, a major physiographic and structural feature that separates the Piedmont and the Coastal Plain, in southeastern South Carolina.

The plateau is highly dissected, with narrow, steep-sided valleys separated by broad flat areas. In the immediate region of SRS there are no known capable faults within the definition of 10 CFR 100, Appendix A. There is evidence from subsurface mapping and seismic surveys that suggests the presence of faults beneath SRS. The largest of these is the Pen Branch fault. However, there is no evidence of movement along this fault within the last 38 million years (WSRC 1991f).

SRS lies within Seismic Zone 2 (figure 4.2.2.5–2). Since 1985 only three earthquakes, all of Richter magnitude 3.0 or less, have occurred in the immediate area of SRS. None of these earthquakes produced any damage at SRS. Historically, two large earthquakes have occurred within 180 miles of SRS. The largest of these two, the Charleston earthquake of 1886, had an estimated magnitude of 7.5. Earthquakes capable of producing structural damage to any buildings are not likely to occur in the vicinity of SRS (Stephenson 1988a). There is no volcanic hazard at SRS. The area has not experienced volcanism within the last 230 million years.

Soils. The soils of the proposed TSS are mainly sands and sandy loams. The somewhat excessively drained soils have a thick, sandy surface layer that extends to a depth of 80 inches or more in some areas (SR USDA 1990a). Many of the soils are subject to erosion, flooding, ponding, and cutbank caving. The soils at SRS are considered acceptable for standard construction techniques.

4.6.2.6 *Biotic Resources*

The following describes biotic resources at SRS including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Within each biotic resource area the discussion focuses first on SRS as a whole and then the proposed TSS. Scientific names of species identified in the text are presented in appendix C. Also presented in appendix C, is a list of threatened and endangered species that may be found on the site or in the vicinity of SRS.

Terrestrial Resources. Most of SRS has remained undeveloped since it was established in 1950. Only about 5 percent of the site is occupied by DOE facilities. Five major plant communities have been identified at SRS (figure 4.6.2.6–1). Of these, the largest is the loblolly-longleaf-slash pine community, which covers approximately 65 percent of SRS. This community type, as well as upland hardwood-scrub oak, occurs primarily in upland areas. Swamp forests and bottomland hardwood forests are found along the Savannah River and the numerous streams that traverse SRS. More than 1,300 species and variations of vascular plants have been identified on the site (DOE 1992e:4-126,4-128).

Because of the variety of plant communities on the site, as well as the region's mild climate, SRS supports a diversity and abundance of wildlife including: 43 amphibian, 58 reptile, 213 bird, and 54 mammal species. Common species at SRS include the slimy salamander, box turtle, Carolina chickadee, common crow, eastern cottontail, and gray fox (DOE 1992e:4-126,4-128; WSRC 1993b:3-5,3-39). A number of game animals are found on SRS; however, only the whitetail deer and feral hog are hunted onsite (DOE 1992e:4-128). Raptors, such as the Cooper's hawk and black vulture, and carnivores, such as the gray fox and raccoon, are ecologically important groups on SRS. A variety of migratory birds has been found at SRS. Migratory birds, their nests and eggs, are protected by the *Migratory Bird Treaty Act*. Eagles are similarly protected by the *Bald and Golden Eagle Protection Act*.

The proposed TSS is located within an area dominated by the loblolly-longleaf-slash pine community (figure 4.6.2.6–1). Reconnaissance

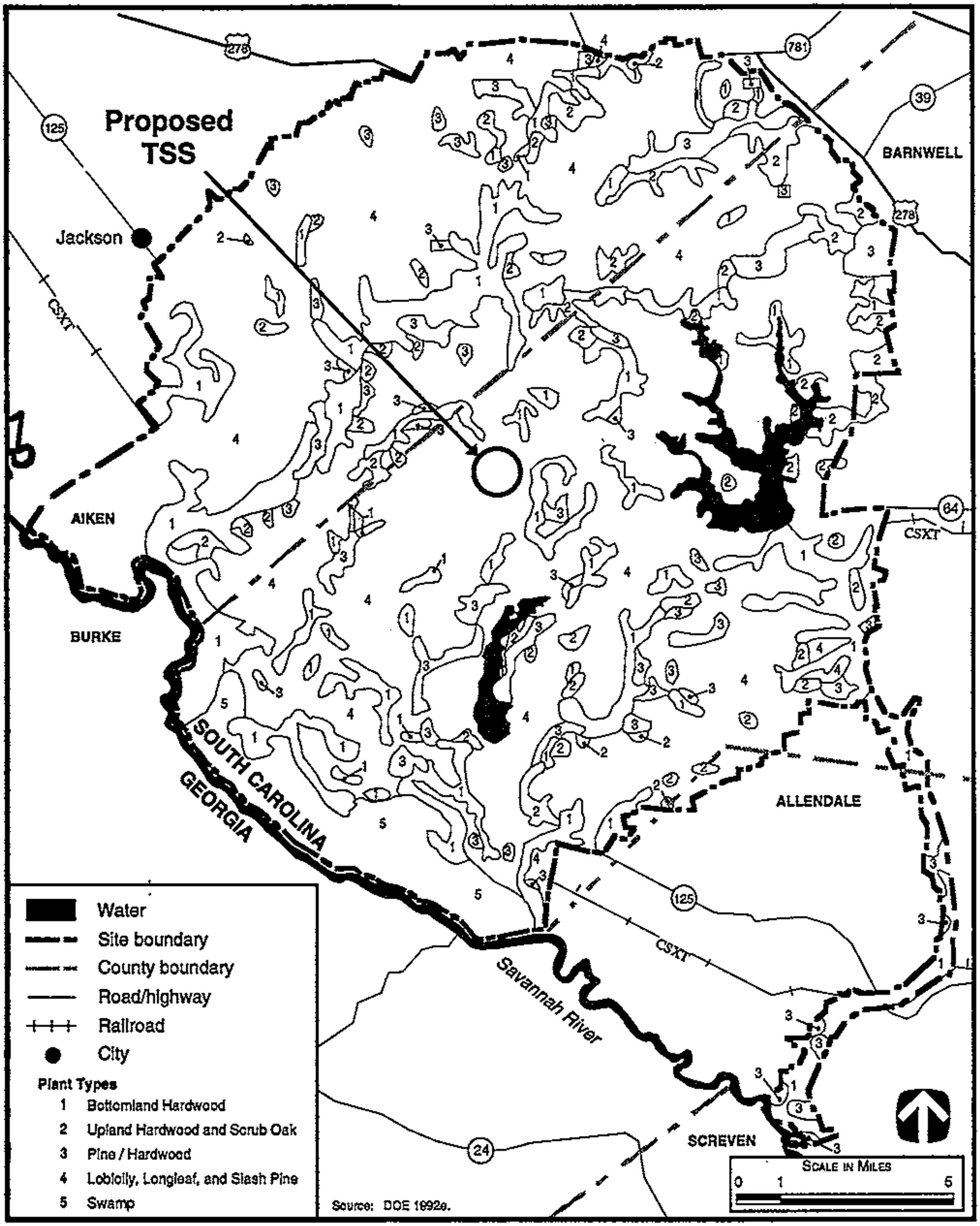

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Figure 4.6.2.6–1.—*Distribution of Plant Communities at Savannah River Site.*

surveys and analysis of aerial photographs indicate that pine plantations occupy most of the plant cover in the proposed TSS. These pine plantations contain slash pine and loblolly pine ranging in age from new plantings to immature trees. Other vegetation types found on the proposed TSS include old-field, bottomland hardwood forest, mixed forest, upland deciduous forest, grassland, and emergent wetland (DOE 1992e:4-128). Animals found on the proposed TSS are expected to be similar to those found in similar habitats elsewhere on SRS.

Wetlands. SRS contains approximately 49,000 acres of wetlands, most of which are associated with flood plains, streams, and impoundments. Wetlands on the site may be divided into the following categories: bottomland hardwoods, cypress-tupelo, scrub-shrub, emergent, and open water (WSRC 1993b:4-5). The most extensive wetland type is swamp forest associated with the Savannah River floodplain. Approximately 9,400 acres of these wetlands are found on SRS. Past releases of cooling water effluent into site streams and the Savannah River swamp have resulted in shifts in plant community composition. Changes have included the replacement of bald cypress by scrub-shrub and emergent vegetation in the swamp and reduction in bottomland forests along streams (DOE 1992e:4-128; WSRC 1989e:3-4).

Carolina bays, a type of wetland unique to the southeastern United States, are also found on SRS. Approximately 190 Carolina bays have been identified on the site. These natural shallow depressions occur on interstream areas of SRS and range from lakes to shallow marshes, herbaceous bogs, shrub bogs, or swamp forests (SR NERP 1989a:9).

A previous tritium reactor study identified approximately 46 acres of jurisdictional wetlands in the vicinity of the proposed TSS. Several of these identified wetlands occur along intermittent tributaries to Pen Branch and Fourmile Branch and are periodically flooded bottomland hardwood forest (DOE 1992e:4-128,4-129).

Rainbow Bay, a 4-acre Carolina bay situated near the proposed TSS, has been the subject of a number of ecological studies. Due to its significance as a natural resource, a 600-foot-plus buffer around Rainbow Bay has been established.

Aquatic Resources. Aquatic habitat includes man-made ponds, Carolina bays, reservoirs, and the Savannah River and its tributaries. There are more than 50 man-made impoundments located throughout the site that mainly support populations of bass and sunfish (SR DOE 1982a). Fewer than 20 Carolina bays have permanent fish populations. Species present in these bays include redfin pickerel, mud sunfish, lake chubsucker, and mosquitofish (SR NERP 1983a:39-43; SR NERP 1989a:37).

Par Pond and L-Lake support similar fish populations including largemouth bass, black crappie, and various species of pan fish. Commercial and sport fishing are not allowed on the SRS site (DOE 1992e:4-132).

The Savannah River is used for both commercial and sport fishing. Important commercial species are American shad, hickory shad, and striped bass, all of which are anadromous. The most important warm water game fish species of the Savannah River are bass, pickerel, crappie, bream, and catfish (SR DOE 1982a:4-28). In the past, water intake structures for C- and K-Reactors and the D-Area powerhouse caused annual estimated entrainment of approximately 10 percent of the fish eggs and larvae passing the intake canals during the spawning season. In addition, estimated impingement losses were approximately 7,600 fish per year (SR DOE 1987b:3-31,C-61).

Aquatic habitat in the vicinity of the proposed TSS consists of Fourmile Branch, Pen Branch, and Rainbow Bay (DOE 1992e:4-119,4-129). In the past, Fourmile Branch and Pen Branch have received thermal effluents from C- and K-Reactors, respectively. During reactor operation, fish populations in warmed portions of the streams were greatly reduced, with the mosquitofish the most commonly occurring species. During the shutdown of the reactors, fish, including largemouth bass, lake chubsucker, chain pickerel, and redbreast sunfish, have recolonized portions of Pen Branch (WSRC 1989e:4-75). DOE entered into two settlement agreements under the CWA in 1990 agreeing to address high temperature discharges and related fish kills on SRS (discussed in Appendix section A.1.5). The K-Reactor cooling tower was completed in 1992 but the reactor is in cold standby with no provision for restart. Above the reactor outfalls, both Fourmile Branch and Pen Branch are small streams that have been relatively unaffected by past SRS operations. The dominant fish in the non-heated upper reaches of Pen Branch include sunfish, bullheads, and chubsuckers (SR DOE 1987b:3-51); species composition of the upper portion of Fourmile Branch would be expected to be similar.

Threatened and Endangered Species. Sixty-one Federal- and state-listed threatened, endangered, and other special status species have been identified on and in the vicinity of SRS (appendix table C–6). Table 4.6.2.6–1 lists the species that may occur in areas on or near the proposed TSS. Field surveillance would be required to determine their presence. No critical habitat for threatened or endangered species, as defined in the *Endangered Species Act* (50 CFR 17.11; 50 CFR 17.12), exists on SRS. Suitable habitats do exist in the area of the proposed TSS for a number of Federal candidate and state special status species as noted in table 4.6.2.6–1.

There are no Federal-listed threatened and endangered species known to occur on the proposed TSS, however, several may exist in the general vicinity. Bald eagles have been observed at several locations on SRS, particularly in the vicinity of Par Pond and L-Lake. Active bald eagle nests are located 7.5 miles southwest of the proposed TSS in an area of Pen Branch and 7.5 miles southeast of the TSS just south of Par Pond (WSRC 1993b:21-27). Wood storks foraging in the Savannah River swamp have been observed near the Fourmile Branch delta 11 miles from the proposed TSS. Although suitable forage habitat for the red-cockaded woodpecker exists in the proposed TSS, the closest colony is located 8 miles away. The American alligator is a common inhabitant of Par Pond, Beaver Dam Creek, and the Savannah River swamp, all located 5 miles or more from the proposed TSS. No self-sustaining, reproducing populations of the alligator have been observed in Fourmile Branch or its delta. The shortnose sturgeon spawns in the Savannah River upstream of SRS, and larvae of this species have been collected in or near the water intake canals on the river. However, entrainment or impingement of this species at SRS water intake structures has not been documented (DOE 1992e:4-152). Another Federal-listed species, the smooth purple coneflower, has not been recorded in affected areas but could be found in the proposed TSS. Awned meadow-beauty have been found near Rainbow Bay located adjacent to the proposed TSS.

Several state special status species have also been found near Rainbow Bay, including the Cooper's hawk, two species of beak-rush, Florida false loosestrife, and green-fringed orchid.

4.6.2.7 *Cultural and Paleontological Resources*

Prehistoric Resources. Prehistoric site types on SRS consist of villages, base camps, limited activity sites, quarries, and workshops. An extensive archaeological survey program began in 1974 encompassing numerous field studies such as reconnaissance survey, shovel test transects, intensive site testing, and excavation. More than 60 percent of SRS has received some level of cultural resources evaluation. More than 800 prehistoric sites have been identified; however, fewer than 8 percent have been evaluated for eligibility to the NRHP. Of these, 10 prehistoric sites have been determined NRHP-eligible.

Several cultural resources studies including a reconnaissance survey, an intensive inventory, and site testing have been conducted for the proposed TSS. Nine prehistoric sites were recorded but none of these sites were considered NRHP-eligible.

Historic Resources. Types of historic sites include cattle ranches, farmsteads, tenant dwellings, mills, plantations and slave quarters, rice farming dikes, dams, cattle pens, ferry locations, towns, churches, schools, cemeteries, commercial building locations, trash scatters, roads, and logging railroads. Approximately 400 historic sites have been identified within SRS; approximately 10 percent have been evaluated for NRHP eligibility. Of these, 10 historic sites have been determined NRHP-eligible.

Most historic structures were demolished during the initial establishment of SRS in 1951. Two 1951 buildings are currently in use. The existing nuclear production facilities are not likely to be considered NRHP-eligible because they may lack architectural integrity, may not be representative of a particular style, and may not be contributing features to the broad theme of the Manhattan Project and initial nuclear production.

At the proposed TSS, five historic sites and two historic sites with prehistoric components have been recorded. Six sites are late 19th to early 20th century farmsteads. Three sites have been determined

TABLE 4.6.2.6–1.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found On the Site or In the Vicinity of the Proposed Tritium Supply Site at Savannah River Site*

Species	Status[a] Federal	State	Known or Potential Habitat/Location
Mammals			
Star-nosed mole	NL	UN	Low wet ground
Birds			
Bald eagle[b]	T	T	Active nest on Pen Branch and south of Par Pond
Cooper's hawk[c]	NL	UN	Broken woodland
Red-cockaded woodpecker[b]	E	SE	Pine forest
Wood stork[b,d]	E	SE	Savannah River swamp
Reptiles			
American alligator	T	NL	Savannah River swamp
Amphibians			
Carolina crawfish frog	C2	SC	Gopher tortoise and crawfish burrows
Eastern tiger salamander[d]	NL	SC	Savannah River swamp and Carolina bays
Pickerel frog[d]	NL	UN	Savannah River swamp
Fishes			
Shortnose sturgeon[b,d]	E	SE	Savannah River
Plants			
Awned meadow-beauty[c]	C2	NL	Carolina bays
Beak-rush[b] *(Rhychospora inundata)*	NL	UN	Carolina bays
Beak-rush[b] *(Rhychospora tracyi)*	NL	UN	Carolina bays
Cypress stump sedge[d]	NL	UN	Savannah River swamp
Elliott's croton	NL	UN	Carolina bays
Florida false loosestrife[c]	NL	UN	Carolina bays
Gaura	NL	UN	Stream banks, meadows, and roadsides
Green-fringed orchid[c]	NL	SL	Carolina bays, bottomland hardwoods
Little bur-head	NL	SL	Carolina bays
Nestronia	C2	NL	Upland woodlands
Quill-leaved swamp potato	NL	SL	Carolina bays
Smooth purple coneflower	E	NC	Open woodlands, roadbanks
Swamp lobelia	C2	NL	Carolina bays
Trepocarpus	NL	UN	Bottomland hardwoods
Yellow cress	NL	UN	Bottomland hardwoods
Yellow wild indigo	NL	UN	Pine forests, open woods

[a] Status code: C2 - candidate, Category 2 (possibly appropriate for protection); E - endangered; NC -national, of concern (plant); NL - not listed; SC - state, of concern (animals); SE - state, endangered (animals); SL - state, of concern (plants); T - threatened; UN - undetermined.

[b] USFWS Recovery Plan exists for this species.

[c] Species known to occur near Rainbow Bay adjacent to proposed TSS.

[d] Species occurs in discharge receiving areas.

Source: 50 CFR 17.11; 50 CFR 17.12; 55 FR 6184; 56 FR 58804; 56 FR 64229; DOE 1992e; SR NERP 1990b; SR WMRD 1991a; SR WMRD 1992a; SR WMRD 1992b; WSRC 1989e; WSRC 1993b.

NRHP-eligible because they contribute pertinent information to postbellum socioeconomic history (SRARP 1989a:81).

Native American Resources. Native American groups with traditional ties to the area include the Apalachee, Cherokee, Chickasaw, Creek, Shawnee, Westo, and Yuchi. At different times, each of these Native American groups was encouraged by the English to settle in the area in order to provide protection from the French, Spanish, or other Native American groups. Main villages of both the Cherokee and Creek were located southwest and northwest of SRS, but both groups may have used the area for hunting and gathering activities. During the early 1800s, most of the remaining Native Americans residing in the region were relocated to the Oklahoma territory.

Native American resources in the region include villages or townsites, ceremonial lodges, isolated burials, cemeteries, and areas containing traditional plants used for certain rituals. Literature reviews and consultations with Native American representatives reveal that there are some concerns related to the *American Indian Religious Freedom Act* within the central Savannah River valley; however, no specific sites at SRS have been identified. The Yuchi Tribal Organization, the National Council of the Muskogee Creek, the Indian People's Muskogee Tribal Town Confederacy, the Pee Dee Indian Association, the Ma Chis Lower Alabama Creek Indian Tribe, and the United Keetoowah Band of the Cherokees have expressed concerns for sensitive Native American resources at SRS. The Yuchi and the Muskogee Creek expressed concern for areas containing several plants traditionally used in ceremonies (SR DOE 1991e:19,21).

Paleontological Resources. Paleontological materials at SRS include: fossil plants, numerous invertebrate fossils, deposits of giant oysters (*Crassostrea gigantissima*), mollusks, and bryozoa. All paleontological materials from SRS are marine invertebrate deposits and, with the exception of the giant oysters, are relatively common fossils and are widespread; therefore, the assemblages have relatively low research potential.

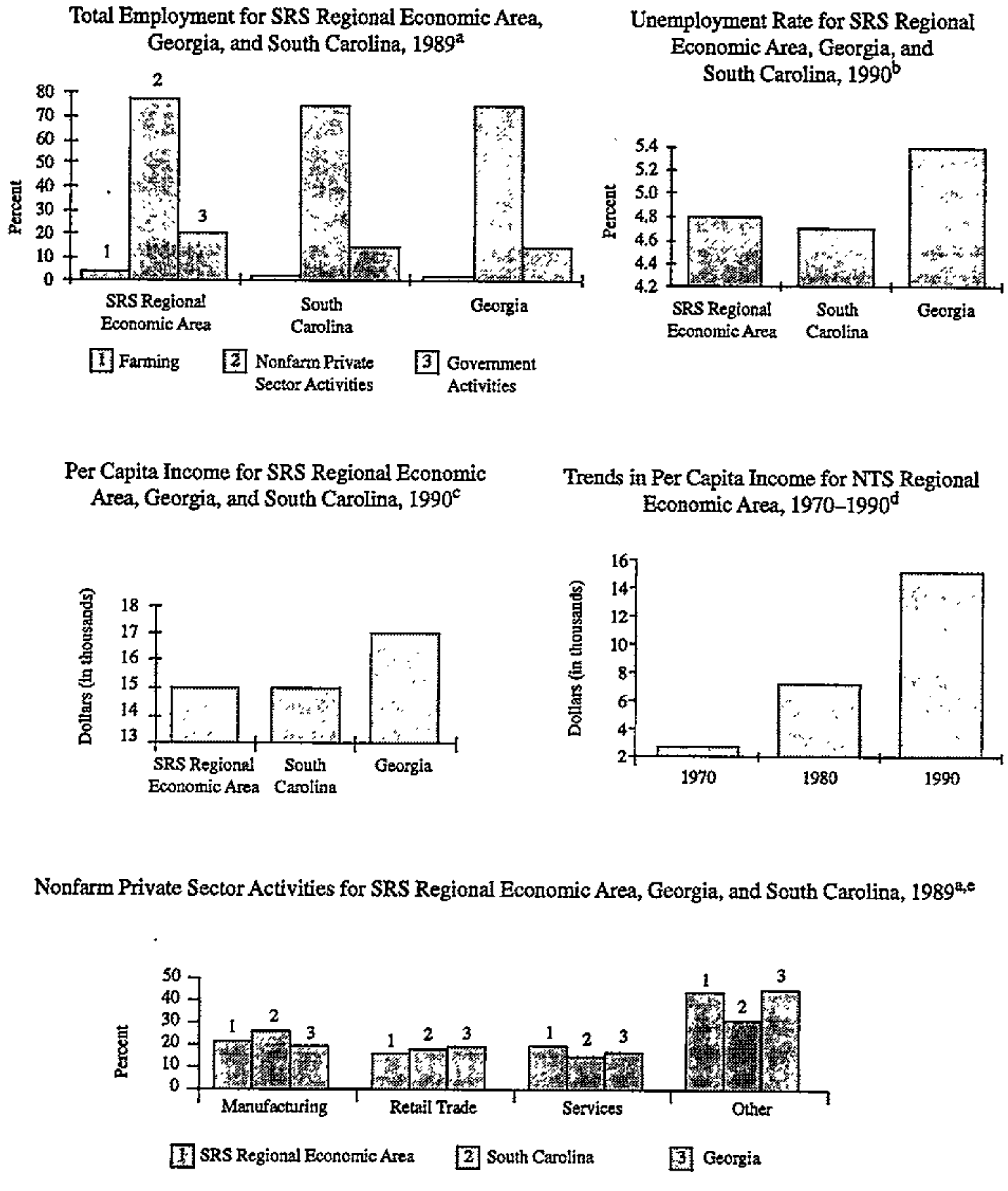
4.6.2.8 *Socioeconomics*

Socioeconomic characteristics described for SRS include employment and local economy, population, housing, public finance, and local transportation. Statistics for the regional economy characteristics are presented for the regional economic area that encompasses 26 counties around SRS (appendix table D.2.1–2). The regional economic area is a broad labor and product market-based region linked by trade among economic sectors within the region. Statistics for population and housing, public finance, and local transportation are presented for the ROI, a 4-county area in which 87 percent of all SRS employees reside: Aiken County (52 percent) and Barnwell County (7 percent) in the State of South Carolina; and Columbia County (11 percent) and Richmond County (17 percent) in the State of Georgia. (See figure 4.6–1 for a map of counties and cities.) Fiscal characteristics of the jurisdictions in the ROI are presented in the public finance section in appendix tables D.3–79 and D.3–80. The school districts most likely to be affected by the proposed action include those in Aiken, Columbia, and Richmond counties and Barnwell County Districts 19, 29, and 45. Assumptions, assessment methodologies, and supporting data are presented in appendix D.

Regional Economy Characteristics. Employment and local economy statistics for the regional economic area are given in appendix table D.3–73 and summarized in figure 4.6.2.8–1. Between 1970 and 1990, the civilian labor force in the regional economic area increased 86 percent. The unemployment rate in the regional economic area in 1990 was slightly higher than the State of South Carolina but about 0.4 percent lower than the State of Georgia. The 1990 per capita income in the regional economic area was the same as that of the State of South Carolina but 12 percent below the State of Georgia's per capita income.

As shown in figure 4.6.2.8-1, the percentage of total employment involving farming in the regional economic area was double the percent for the States of South Carolina and Georgia. The percentage in governmental activities was 25 percent higher. Nonfarm private sector activities of manufacturing, retail trade, and services were similar in the regional economic area and the two states, except that manufacturing in the State of South Carolina represented a 20 percent larger share than in either the regional economic area or the State of Georgia.

In 1990, SRS employed 22,290 persons (4.6 percent of the total regional economic area employment), increasing from 5,737 persons in 1970. Historical



[a] SR Census 1991c; SR Census 1991d.
[b] Appendix table D.3–73; DOL 1993a.
[c] Appendix table D.3–73; DOC 1993a.
[d] Appendix table D.3–73.
[e] DOL 1989a.

FIGURE 4.6.2.8–1.—***Economy for Savannah River Site Regional Economic Area.***

and future employment at SRS and the distribution of SRS employees by place of residence in the ROI are presented in appendix tables D.2.1–1 and D.3–72, respectively.

Population and Housing. Population and housing distribution in the ROI is presented in appendix tables D.3–75 and D.3–77 and summarized in figure 4.6.2.8–2. The percentage increase in population in the ROI from 1970 to 1990 was similar to the States of South Carolina and Georgia except for Columbia County which experienced a 196-percent increase. With the exception of two counties, the percentage increase in housing units between 1970 and 1990 was similar to or just below the percentage increase for the two states. Columbia County experienced a 252-percent increase which is higher than the percentage increase for the two states. Conversely, Barnwell County experienced a 2-percent increase which is lower than the percentage increase for the two states. Homeowner and rental vacancy rates in the ROI in 1990 were similar to these experienced by the States of South Carolina and Georgia.

Public Finance. Financial characteristics of the local jurisdictions in the ROI that are most likely to be affected by the proposed action include total revenues and expenditures of each jurisdiction's general fund, special revenue funds, and, as applicable, debt service, capitol project, and expendable trust funds. School district boundaries may or may not coincide with county or city boundaries, but the districts are presented under the county where they primarily provide services. Major revenue and expenditure fund categories for counties, cities, and school districts are presented in appendix tables D.3–79 and D.3–80, and figure 4.6.2.8–3 summarizes local government's revenues less its expenditures.

Local Transportation. SRS is served by more than 200 miles of primary roads and more than 1,000 miles of unpaved secondary roads. The primary highways used by SRS commuters are State Routes 19, 64, and 125; 40, 10, and 50 percent of the workers use these routes, respectively (figure 4.6–1). Significant congestion occurs during peak traffic periods onsite on Road 1-A and on State Routes 19 and 125 and U.S. Route 278 at SRS access points (Wilbur Smith Associates 1989). Long delays are also experienced offsite along Interstate 20 and U.S. Routes 1 and 25 where they cross the Savannah River. SRS is currently implementing changes to remedy the congestion at some access points.

Rail service in the ROI is provided by the Norfolk Southern Corporation and CSX Transportation. SRS is provided rail access via Robbins Station on the CSX Transportation line. In addition, SRS maintains 50 miles of onsite track for internal uses (WSRC 1990c).

Waterborne transportation is available via the Savannah River. Currently, the Savannah River is used primarily for recreation (WSRC 1990c). No commercial waterborne vessel docking facilities exist at SRS.

Columbia Metropolitan Airport in the city of Columbia and Bush Field in the city of Augusta receive jet air passenger and cargo service from both national and local carriers. Numerous smaller private airports are located in the ROI (DOT 1991a).

4.6.2.9 *Radiation and Hazardous Chemical Environment*

The following provides a description of the radiation and hazardous chemical environment at SRS. Also included are discussions of health effects studies, emergency preparedness considerations, and an accident history.

Radiation Environment. Major sources of background radiation exposure to individuals in the vicinity of SRS are shown in table 4.6.2.9–1. All annual doses to individuals from background radiation are expected to remain constant over time. Accordingly, the incremental total dose to the population would result only from changes in the size of the population. Background radiation doses are unrelated to SRS operations.

Releases of radionuclides to the environment from SRS operations provide another source of radiation exposure to individuals in the vicinity of SRS. The radionuclides and quantities released from SRS operations in 1992 are listed in the *Savannah River Site Environmental Report for 1992* (WSRC-TR-93-075). The doses to the public resulting from these releases are presented in table 4.6.2.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1992

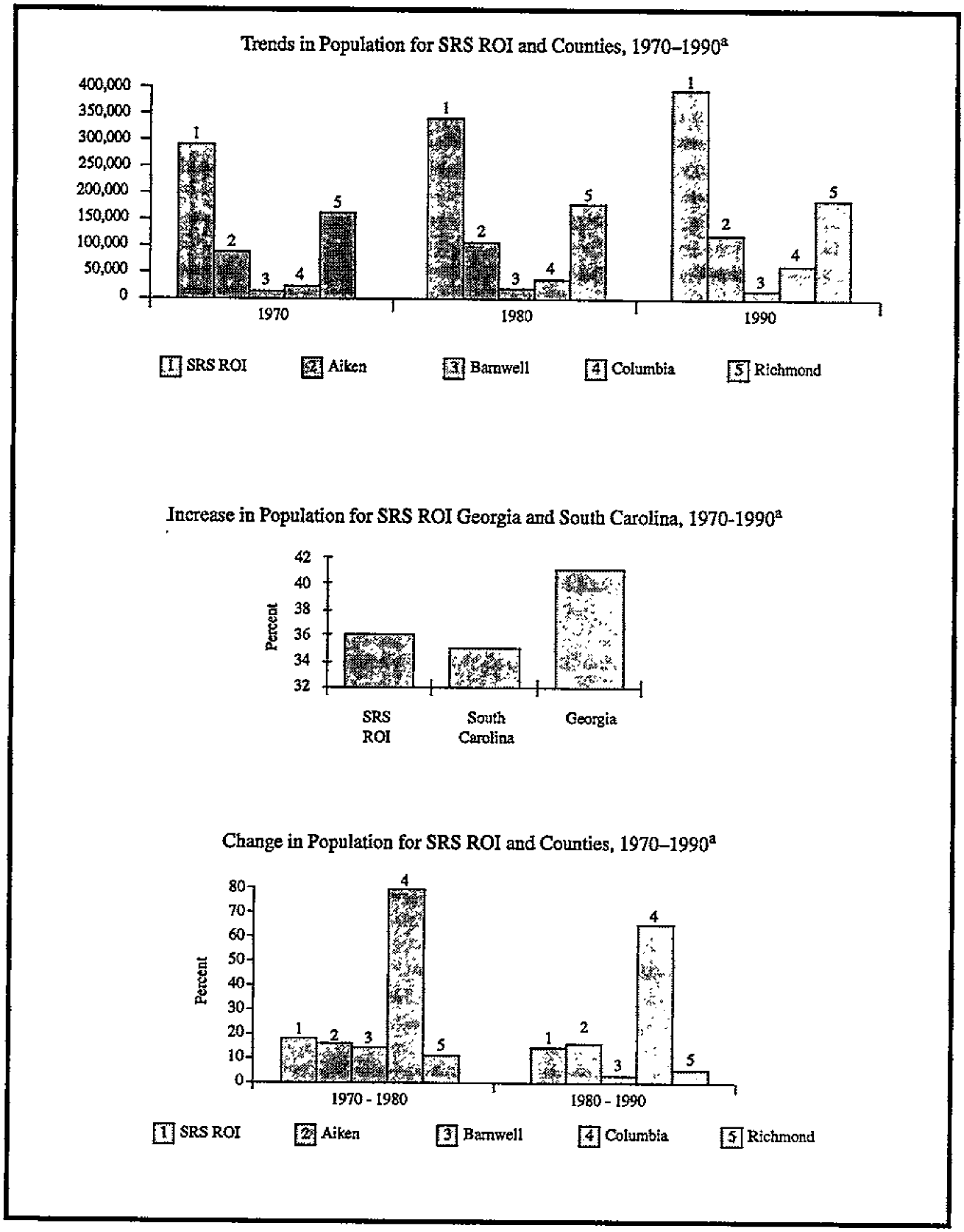
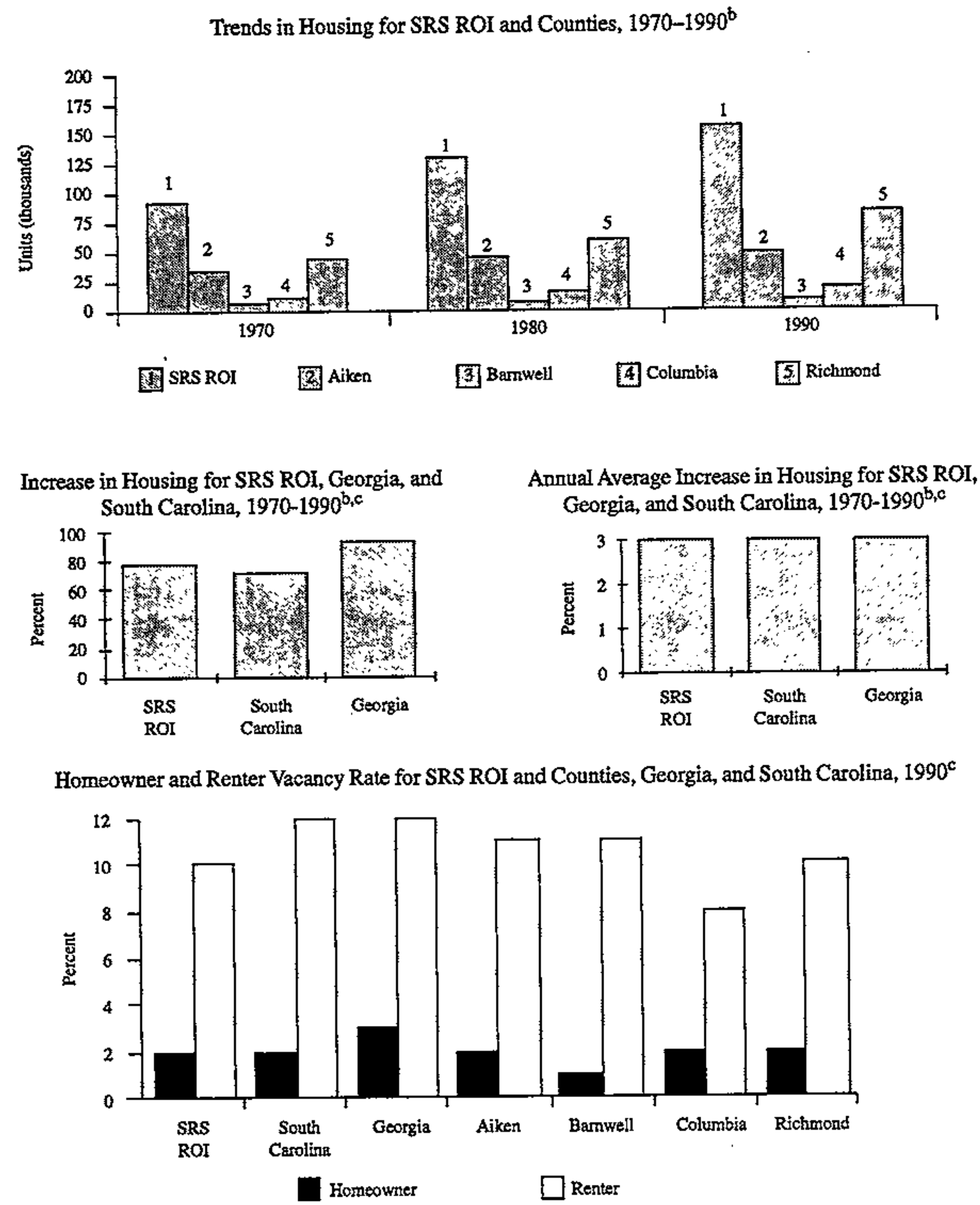
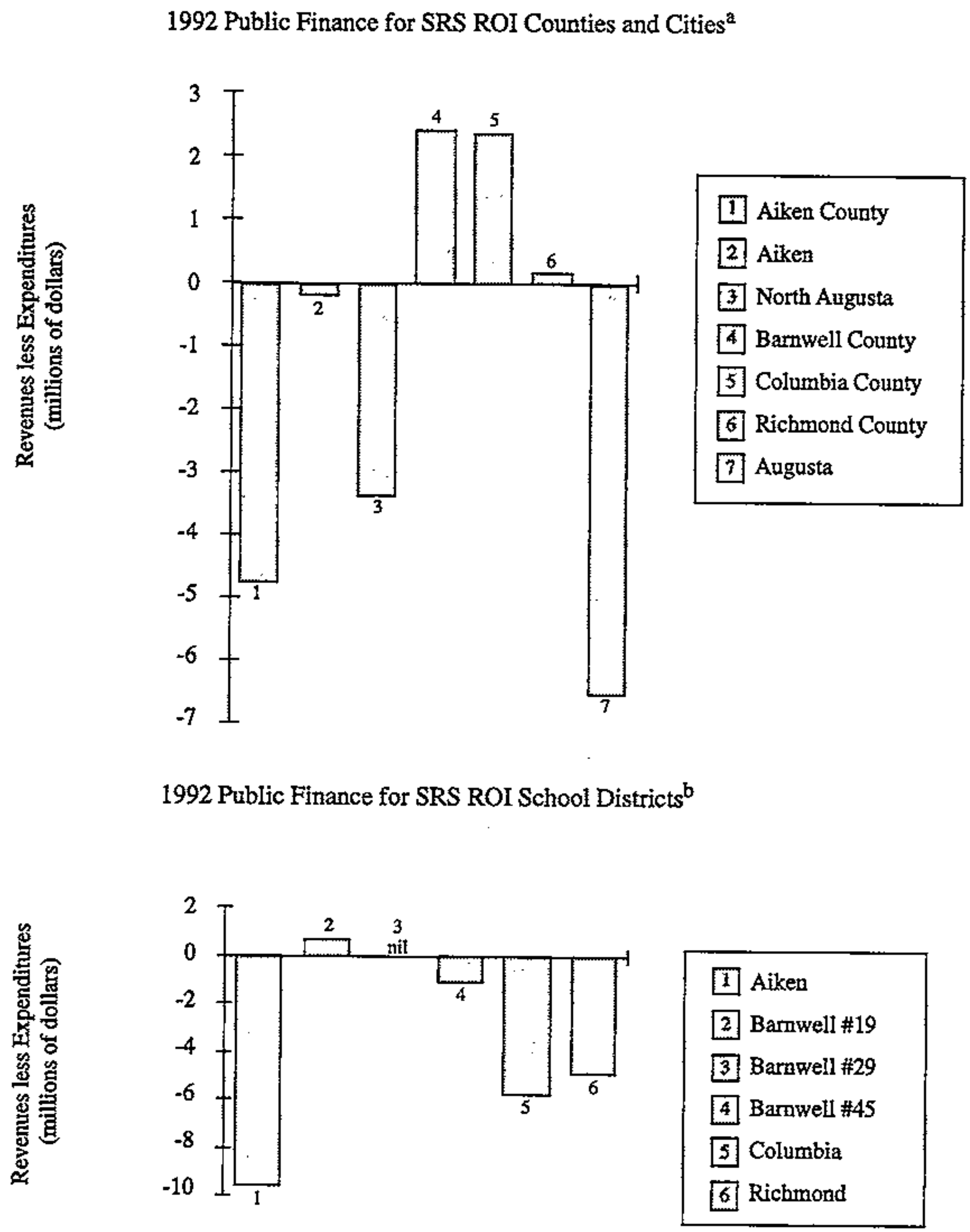


FIGURE 4.6.2.8–2.—***Population and Housing for Savannah River Site Region of Influence*** [Page 1 of 2].



[a] Appendix table D.3–75.
[b] Appendix table D.3–77.
[c] Census 1972a; Census 1982a; SR Census 1991a; SR Census 1991b.

FIGURE 4.6.2.8–2.—*Population and Housing for Savannah River Site Region of Influence* **[Page 2 of 2].**



[a] SR City 1992a; SR County 1992a.
[b] SR School 1992a.

FIGURE 4.6.2.8–3.—*1992 Local Government Public Finance for Savannah River Site Region of Influence.*

TABLE 4.6.2.9–1.—*Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Savannah River Site Operations, 1992*

Source	Committed Effective Dose Equivalent (mrem/yr)
Natural Background Radiation[a]	
Cosmic and cosmogenic radiation	33
External terrestrial radiation	43
Internal terrestrial radiation	39
Radon in homes (inhaled)	200
Other Background Radiation[b]	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	380

[a] WSRC 1993a. Value for radon is an average for the United States.
[b] NCRP 1987a.

report were used in the development of the reference environment (No Action) radiological releases at SRS in the year 2010 (section 4.6.3.9). Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (appendix section E.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from SRS operations in 1992 is estimated to be approximately 1.4×10^{-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 SRS operations is less than 2 chances in 10 million. (Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.)

Approximately 4.5×10^{-3} excess fatal cancers were estimated from normal operations in 1992 to the population living within 50 miles of SRS. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate, associated with cancer, for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this national mortality rate, the number of fatal

TABLE 4.6.2.9–2.—*Doses to the General Public from Normal Operations at Savannah River Site, 1992 (committed effective dose equivalent)*

	Atmospheric Releases		Liquid Releases		Total	
Affected Environment	**Standard**[a]	**Actual**[b]	**Standard**[a]	**Actual**[b,c]	**Standard**[a]	**Actual**
Maximally exposed individual (mrem)	10	0.14	4	0.13	100	0.27
Population within 50 miles[d] (person-rem)	None	6.4	None	2.5	100	8.9
Average individual within 50 miles[e] (mrem)	None	0.01	None	NA	None	0.014

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem per year limit from airborne emissions is required by the *Clean Air Act*, the 4 mrem per year limit is required by the *Safe Drinking Water Act*, and the total dose of 100 mrem per year is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 58 FR 16268 (10 CFR 834). If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.
[b] WSRC 1993a.
[c] The actual dose value given in the column under liquid releases conservatively includes all water pathways, not just the drinking water pathway. The population dose includes contributions to Savannah River users downstream of SRS to the Atlantic Ocean.
[d] In 1992, this population was approximately 620,100.
[e] Obtained by dividing the population dose by the number of people living within 50 miles of the site.
Note: NA - not applicable.

cancers from all causes expected during 1992 in the population living within 50 miles of SRS was 1,240. This number of expected fatal cancers is much higher than the estimated 4.5×10^{-3} fatal cancers that could result from SRS operations in 1992.

Workers at SRS receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. Table 4.6.2.9–2 includes the average, maximum, and total occupational doses to SRS workers from operations in 1992. These doses fall within radiological limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (appendix section E.2), the number of excess fatal cancers to SRS workers from operations in 1992 is estimated to be 0.14.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Savannah River Site Environmental Report for 1992* (WSRC-TR-93-075). The concentrations of radioactivity in various environmental media (e.g., air, water, and soil) in the site region (onsite and offsite) are also presented in this reference.

Chemical Environment. The background chemical environment important to human health consists of: the atmosphere, which may contain toxic chemicals that can be inhaled; drinking water, which may contain toxic chemicals that can be ingested; and other environmental media with which people may come in contact (e.g., 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 sections 4.6.2.3 and 4.6.2.4.

Health impacts to the public can be minimized through effective administrative and design controls for decreasing pollutant releases to the environment and achieving compliance with permit requirements (e.g., air emissions and NPDES permit requirements). 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 SRS via inhalation of air containing pollutants released to the atmosphere by SRS 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.

TABLE 4.6.2.9–3.—*Doses to the Worker Onsite from Normal Operations at Savannah River Site, 1992 (committed effective dose equivalent)*

Affected Environment	Onsite Releases and Direct Radiation	
	Standard[a]	Actual[b]
Average worker (mrem)	None	17.9
Maximally exposed worker (mrem)	5,000	3,000
Total workers (person-rem)	None	350

[a] 10 CFR 835. DOE's goal is to maintain radiological exposures as low as reasonably achievable.
[b] DOE 1993n:7. The number of badged workers in 1992 was approximately 19,500.

Baseline air emission concentrations for hazardous/toxic air pollutants and their applicable standards are presented in section 4.6.2.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous/toxic chemicals is presented in appendix section E.3.

Health impacts to SRS workers during normal operation may include those from inhalation of the workplace atmosphere, drinking SRS potable water, and possible other 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 detailed estimation and summation of these impacts. However, the workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. SRS workers are also protected by adherence to occupational standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Monitoring ensures that these standards are not exceeded. Additionally, DOE requirements (DOE Order 3790.1B) 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 SRS are expected to be substantially better than required by the standards.

Health Effects Studies. Two published epidemiological studies on the general population in communities surrounding SRS have been conducted. One study found no evidence of excess cancer mortality, whereas another study reported an excess in leukemia and lung cancer deaths along with other statistically nonsignificant excess deaths. An excess in leukemia deaths has been reported among hourly workers at SRS. For a more detailed description of the studies reviewed and the findings, refer to appendix section E.4.6

Accident History. Beginning in 1974 and continuing into 1988, there was a series of releases from the tritium facilities at SRS. These releases have been traced to aging equipment in the tritium processing facility and are one of the reasons for the construction of a replacement tritium facility at SRS. A detailed description and study of these incidents and their consequences to the offsite population has been documented by SRS. Between 1974 and 1988, there were 13 inadvertent tritium releases. The most significant were in 1981, 1984, and 1985 when 32,934, 43,800, and 19,403 Ci of tritiated water vapor, respectively, were released (WSRC 1991a). In the period 1989 through 1992 there were 20 inadvertent releases, all with little or no offsite dose consequences. The largest of these recent releases occurred in 1992 when 12,000 Ci of tritium were released (SRS 1993a:3).

Emergency Preparedness. In the event of an accident each DOE site has established an emergency management program. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response. Section 4.1.9 provides a description of DOE's emergency preparedness program.

The Emergency Preparedness Facility at SRS provides overall direction and control for onsite responses to emergencies and coordinates with Federal, state, and local agencies and officials on the technical aspects of the emergency.

The SRS Emergency Operations Facility consists of several centers, described below, that provide distinct emergency response support functions:

- The SRS Operations Center coordinates the initial response to all SRS emergencies and is equipped to function as the heart of SRS's emergency response communications network.
- The Technical Support Center provides command and control of emergency response activities for the affected facility or operational area.
- The Emergency Operations Center provides command and control of emergency response activities for SRS locations outside of the affected area.
- The Security Management Center coordinates activities relating to the security and safeguarding of materials by providing security staff in the affected area and contractor management in the Emergency Operations Center.
- The Dose Assessment Center is responsible for assessing the health and environmental consequences of any airborne or aqueous releases of radioactivity or toxic chemicals and recommends onsite and offsite protective actions to other centers.

4.6.2.10 *Waste Management*

This section outlines the major environmental regulatory structure and ongoing waste management activities for SRS. A more detailed discussion of the ongoing waste management operations is provided in appendix section H.2.5. Table 4.6.2.10–1 presents a summary of waste management at SRS for 1991.

The Department is working with Federal and state regulatory authorities to address compliance and

TABLE 4.6.2.10–1.—*Spent Nuclear Fuel and Waste Management at Savannah River Site* [Page 1 of 2]

Category	1991 Generation (yd^3)	Treatment Method	Treatment Capacity (yd^3/yr)	Storage Method	Storage Capacity (yd^3)	Disposal Method	Disposal Capacity (yd^3)
Spent Nuclear Fuel	None	None	None	Pools	Sized to current inventory	None–eventually, repository	NA
High-Level							
Liquid	4,715 (952,508 gal)	Settle, store, separate, evaporate	76,250 (15,398,000 GPY)	F &H Area Tank Farm	308,000 (62,200,000 gal)	NA	NA
Solid	None	NA	NA	NA	NA	NA	NA
Transuranic							
Liquid	None	NA	NA	NA	NA	NA	NA
Solid	1,804	None	None	Pads, buildings	26,513	None–Federal repository in the future	None
Low-Level							
Liquid	99,500 (20,092,000 gal)	Adsorption, evaporation, filtration, neutralization, saltstone	3,924,000 (792,700,000 GPY)	Ponds, tanks-awaiting processing	NA	NA	NA
Solid	31,113	Compaction	73,250	NA	NA	Trench, caissons	1,400,000
Mixed Low-Level							
Liquid	1,366 (275,900 gal)	Stabilization, adsorption, neutralization, precipitation, filtration, ion exchange, evaporation	76,700 (15,500,000 GPY)	RCRA permit Bldgs. E, 600, 700	Included in solid	None	None
Solid	37	None	NA	RCRA permit Bldg. 600	1,519	None	None
Hazardous							
Liquid	Included in solid	None	None	DOT containers	Included in solid	Offsite	NA
Solid	115	None	None	DOT containers	7,300	Offsite	NA

TABLE 4.6.2.10–1.—*Spent Nuclear Fuel and Waste Management at Savannah River Site* [Page 2 of 2]

Category	1991 Generation (yd^3)	Treatment Method	Treatment Capacity (yd^3/yr)	Storage Method	Storage Capacity (yd^3)	Disposal Method	Disposal Capacity (yd^3)
Nonhazardous (Sanitary)							
Liquid	915,841 (185,000 gal)	Filter, settle, strip	1,300,000 (265,000,000 GPY)	Flowing ponds	NA	Permitted discharge	Varies by each permitted outfall
Solid	111,518	Compaction—reduces volume to 27,900 yd^3 for disposal	Expandable, as required	NA	NA	Landfill (onsite) offsite disposal is being investigated	Expandable, as required
Nonhazardous (Other)							
Liquid	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary
Solid	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary

Source: DOE 1992f; DOE 1993g; SR MMES 1993a.

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

EPA has placed SRS on the NPL and has identified approximately 150 potential operable units. In accordance with CERCLA, DOE entered into a Federal Facility Agreement with the EPA and the State of South Carolina, effective January 15, 1993, to coordinate cleanup activities at SRS under one comprehensive strategy. The Federal Facilities Agreement combines the RCRA Facility Investigation Program Plan under RCRA with a CERCLA cleanup program entitled the RCRA Facility Investigation Remedial Investigation Program Plan.

SRS manages spent nuclear fuel and the following waste categories: HLW, TRU, LLW, mixed, hazardous, and nonhazardous. SRS has an aggressive waste minimization program in progress to vastly improve the operation of existing and planned liquid and solid waste generating, treatment, and storage facilities. A disciplined approach to these activities is being developed based on technology and experience from the commercial nuclear industry. This approach already has reduced the generation of TRU waste (48 percent), LLW (13 percent), mixed waste (96 percent), and hazardous wastes (58 percent) (DOE 1993e:I-18). A discussion of the waste management operations associated with each of these categories follows.

Spent Nuclear Fuel. On April 29, 1992, DOE decided to discontinue reprocessing spent nuclear fuel solely to recover fissile and fertile materials. After the completion of several ongoing programmatic and site-specific reviews pursuant to the *National Environment Policy Act,* DOE will make decisions concerning the treatment and stabilization of the current SRS inventory of spent nuclear fuel, and the use and subsequent decontamination and decommissioning of both the F- and H-Canyons facilities. With the shutdown of the K- and L-Reactors at SRS, no new spent fuel is expected to be generated in the future from existing SRS operations. However, SRS may continue to receive spent fuel from offsite facilities, and treat and stabilize that fuel for long-term storage. Future receipt and management of spent nuclear fuel at SRS will be in accordance with the ROD published in the *Federal Register* (60 FR 28680) on June 1, 1995, for the *Department of Energy Programmatic Spent Nuclear Fuel Management* and *INEL Environmental Restoration and Waste Management Programs Final EIS.* The ROD for the EIS on the *Proposed Policy for the Acceptance of U.S. Origin Foreign Research Reactor Spent Nuclear Fuel* is not expected to be published until early 1996.

High-Level Waste. Liquid HLW at SRS is made up of many waste streams generated during the recovery and purification of transuranic products and unburned fissile material from spent reactor fuel elements. These wastes are treated prior to their transfer to underground tanks in F- and H-Area Canyons where they are separated by waste form, and radionuclide and heat content. Processes that treat liquid HLW routinely are separation, evaporation and ion exchange. Cesium is removed from the condensate prior to transfer to the Effluent Treatment Facility where the concentrate is treated as low-level process wastewater. The decontaminated salt solution resulting from the in-tank precipitation process is sent with residues from the Effluent Treatment Facility to the Defense Waste Processing Z-Area Saltstone Facility where it is mixed with a blend of cement, flyash, and blast furnace slag to form a low-level grout. The grout is pumped into disposal vaults where it hardens for permanent disposal. The remaining high-level salt is precipitated and the precipitate and high-level sludge will be permanently immobilized as a glass solid cast in stainless steel containers at the Defense Waste Processing Facility Vitrification Plant. The stainless-steel containers will be decontaminated to DOT standards, welded closed, and temporarily stored onsite for eventual transport to and disposal in a permanent Federal repository. Once the current inventory of spent nuclear fuel is processed, no new HLW is expected to be generated.

Transuranic Waste. Under the Federal Facility Compliance Agreement on RCRA land disposal restrictions signed by EPA and DOE on March 13, 1991, SRS is required to prepare TRU waste for shipment. SRS will continue storing certified TRU waste at the TRU waste storage pads until it can be shipped to

WIPP once that facility can demonstrate compliance with the requirements of 40 CFR 191 and 40 CFR 268 or to another TRU waste disposal facility should WIPP prove unsatisfactory. Should additional treatment be necessary for disposal at WIPP, SRS would develop the appropriate treatment capability. This agreement, which must be modified if DOE determines that no TRU waste will be shipped from SRS by July 30, 1999, should form the basis for the site-specific treatment plan required of all DOE facilities storing mixed wastes by the *Federal Facility Compliance Act* of 1992. All TRU waste currently generated is stored in containers on aboveground pads. Since April 1986, newly-generated TRU waste has been received at the Experimental TRU Waste Assay Facility where the drums are weighed and assayed to determine whether the waste is contaminated to a level greater than 100 nCi/g and to determine other information required by the current WIPP waste acceptance criteria. Drums certified for shipment to WIPP are placed in interim storage on concrete pads in E-Area pending startup of WIPP. Drums that contain less than 100 nCi/g are segregated and are eventually sent to LLW disposal (<10 nCi/g) or managed as TRU waste until performance modeling and waste acceptance criteria for onsite disposal have been finalized (if >10 nCi/g and <100 nCi/g).

The TRU Waste Facility is scheduled to begin waste retrieval operations in 2007. The TRU Waste Facility will retrieve and process existing retrievable stored TRU waste and prepare it for certification and permanent disposal at WIPP or disposal onsite as LLW. Because all of the TRU waste placed on the aboveground pads prior to January 1990 is suspected of having hazardous constituents, a RCRA Part B permit application has been submitted for the TRU waste storage pads and the Experimental TRU Waste Assay Facility/Waste Certification Facility. The waste is currently being stored under RCRA interim status/regulations.

Low-Level Waste. The bulk of liquid LLW is aqueous process waste including effluent cooling water, purge water, water from storage basins for irradiated reactor fuel or target elements, distillate from the evaporation of process waste streams, and surface water runoff from areas where there is a potential for radioactive contamination. Liquids are processed to remove and solidify the radioactive constituents and to release the balance of the liquids to permitted discharge points within standards established by the terms of the regulatory permit. Solid LLW which is routinely handled includes operating and laboratory waste, contaminated equipment, reactor and reactor fuel hardware, spent lithium-aluminum targets, and spent deionizer resin from reactor basins. Solid LLW is separated by radiation levels into low and intermediate categories. Solid LLW that radiates less than 200 mrem per hour at 5 cm from the unshielded container is considered low-activity waste. If it radiates greater than 200 mrem per hour at 5 cm from the unshielded container, it is considered intermediate-activity waste. Intermediate activity tritium waste is intermediate-activity waste with greater than 10 Ci of tritium per container. The primary disposal mode for solid LLW is burial in engineered earthen trenches. Saltstone generated in the solidification of decontaminated salts extracted from HLW is disposed of as LLW in a separate facility in enclosed vaults. In 1993, disposal of LLW began in a 100-acre site expansion in the north portion of E-Area. This disposal facility is projected to meet solid LLW storage/requirements to include LLW from DOE offsite facilities such as Pinellas for the next 20 years.

Mixed Low-Level Waste. The Federal Facility Compliance Agreement signed by EPA and DOE on March 13, 1991, addresses SRS compliance with RCRA land disposal restrictions pertaining to past, ongoing, and future generation of mixed LLW (mostly solvents, dioxin, and California list wastes contaminated with tritium). SRS is allowed to continue to operate, generate, and store mixed wastes subject to land disposal restrictions; however, in return, SRS will report to EPA the characterization of all solid waste streams disposed of in land disposal units at SRS and will submit a plan for waste minimization to EPA for review. Schedules for measures to provide compliance through construction of the Consolidated Incineration Facility (scheduled to start pending permits and agreements) and the Hazardous Waste/Mixed Waste Storage Facility are included in this agreement.

The Consolidated Incineration Facility will treat mixed LLW and liquid hazardous waste. The hazardous waste/mixed waste disposal vaults are scheduled to be available in late 1996. Mixed waste is currently placed in interim storage in the E-Area solid waste disposal facility and in two buildings in G-Area. These RCRA-permitted facilities will be used until completion of the Consolidated Incineration Facility and the Hazardous Waste/Mixed Waste Storage Facility. *The Federal Facility Compliance Act* of 1992 requires DOE facilities storing mixed wastes to develop site-specific treatment plans and to submit the plans for approval. The requirements of the Federal Facility Compliance Agreement are summarized in appendix section A.1.5, and would form the basis for the SRS site-specific plan. South Carolina has the option to waive development of a site-specific plan by becoming a signatory to the existing Federal Facility Compliance Agreement.

Hazardous Waste. Lead, mercury, cadmium, 1,1,1-trichloroethane, leaded oil, trichlorotrifluoroethane, benzene, and paint solvents are typical hazardous wastes generated at SRS. Unlike most other DOE facilities, SRS is presently constructing and plans to construct hazardous waste treatment and disposal facilities onsite. All hazardous wastes are stored in DOT-approved containers onsite in RCRA-permitted facilities in the 700-Area. To allow the site to maintain its current storage capabilities, some of the waste is shipped offsite to commercial RCRA-permitted treatment and disposal facilities using DOT-certified transporters. A Hazardous/Mixed Waste Disposal Facility that will employ a variety of treatment processes should be completed by 2004 to treat, store, and dispose of hazardous and mixed wastes that cannot be managed at existing or other planned facilities.

Nonhazardous Waste. Twenty wastewater treatment plants are operated in 13 SRS operations production areas. A new centralized sanitary wastewater collection and treatment facility required by the Settlement Agreement signed on February 27, 1990, became operational in 1994. This facility includes a primary sanitary sewer collection system, a central sanitary wastewater treatment facility, and ultraviolet disinfection systems for the remaining facilities in D-, K-, L-, P-, and TNX-Areas. SRS wastewater is currently treated at small package plants by the extended aeration process. The wastewater treatment plant effluent is disinfected by liquid sodium hypochlorite addition. The solid sludge is disposed of in the SRS-operated sanitary landfill. The existing landfill site has documented groundwater contamination and is currently operating under an expired state permit. The state has not reissued the permit but continues to allow SRS to operate under the conditions of the expired permit. The landfill is divided into three sections: (1) the original landfill, (2) the southern expansion, and (3) the northern expansion. The original landfill and the southern expansion have reached their capacity. If current generation rates continue, the northern expansion is expected to provide capability until 1997. The northern expansion will cease operations when an offsite permitted commercial waste disposal facility and contractor is selected.

4.6.3 Environmental Impacts

This section describes the environmental impacts of constructing and operating various tritium supply technologies and upgraded recycling facilities at SRS which are described in sections 3.4.2 and 3.4.3. It begins by describing potential impacts to existing and planned facilities at SRS, followed by descriptions of potential impacts and the environmental impacts of the proposed action on potentially affected environmental resources. The section concludes by describing the potential impacts of tritium supply and recycling on human health during normal operation, the consequences of facility accidents, and regulatory considerations and waste management. Each description addresses the effects of No Action and the potential impacts and environmental impacts of constructing and operating both a tritium supply facility and an upgraded recycling facility at SRS.

4.6.3.1 *Land Resources*

Construction and operation of a tritium supply facility and upgraded recycling facilities at SRS would affect land resources, including land use and visual resources. Potential impacts to these resources are summarized below.

SRS has sufficient land area to accommodate any of the proposed tritium supply technologies. New facilities would be located in the designated 600-acre TSS, surrounded by a 1-mile-wide buffer, all within the SRS boundary. The TSS would be located in the central portion of SRS, near other onsite areas of industrial land use (figure 4.6.2.1–1). The land is undeveloped and designated for industrial use. Tritium supply facilities are not expected to be visible from viewpoints with high levels of sensitivity; however, vapor plumes from cooling towers would result in additional visual impacts. The tritium recycling mission would continue in upgraded existing facilities located in H-Area (figure 4.6.2.1–1). The following sections present the effects of the proposed action on land resources.

Land Use

No Action. Under No Action, DOE would continue existing and planned land use activities at SRS. The K-Reactor would remain in cold standby with no provision for restart, and the F- and H-Canyon operations would eventually be shut down; however, these facilities would remain in place until turned over to environmental management for disposition. Any impacts to land use from environmental management actions would be independent of and unaffected by this proposed action.

Tritium Supply. Any one of the tritium supply technologies (section 3.4.2) could be sited at SRS in the proposed TSS (figure 4.6.2.1–1). Adequate undeveloped land exists for the tritium supply technologies, which are presented in table 4.6.3.1–1. Prime farmland, agricultural activities, or special National Environmental Research Parks study areas would not be affected. Construction and operation of these facilities would be consistent with SRS future land use plans. The only impact would be the use of undeveloped SRS land. Land requirements would be largest for the MHTGR and least for the APT.

TABLE 4.6.3.1–1.—*Potential Changes to Land Use Resulting from Tritium Supply Technologies and Recycling at Savannah River Site*

Indicator	Tritium Supply Technologies				Tritium Recycling Upgrade
	HWR	MHTGR	ALWR[a]	APT[b]	
Land requirements[c] (acres)	260	360	350	173	0
Available land[d,e] (percent)	0.1	0.2	0.2	0.1	0

[a] Land requirements for both Large and Small ALWR are the same.
[b] Land requirement for both Phased and Full APT are the same.
[c] Land area requirements are estimated to be the same for construction and operation. Tritium extraction included in tritium supply.
[d] Undeveloped land is approximately 191,000 acres.
[e] Any land requirement less than 100 percent means sufficient land.
Source: DOE 1994a; FDI 1993d; FDI 1994a; FDI 1994b; SNL 1993a; SR DOE 1991b.

No tritium facilities would be constructed offsite, and offsite land use would not be directly affected. Offsite land is available and could be converted to residential developments to house workers. Such development would be subject to local land use controls and zoning ordinances, which vary by jurisdiction.

Less Than Baseline Operations. Operation of the HWR, MHTGR, or ALWR at reduced capacity to meet a tritium supply requirement less than baseline, or the construction and operation of a Phased APT would not change potential baseline tritium requirement land use impacts described above. Land requirements would be the same in both operation scenarios.

Multipurpose Reactor. The land requirements for the multipurpose MHTGR and ALWR (section 4.8.3.2 and 4.8.3.3) with recycling would be 729 and 479 acres, respectively. The site requirements for the multipurpose MHTGR exceed the 600 acre TSS study area; however, the proposed TSS is in an area where the additional land requirements for the MHTGR would not result in potential conflicts with site land use or development plans. The 729 and 479 acres represent less than 0.4 and 0.3 percent, respectively, of the available land at SRS. Construction and operation of the multipurpose MHTGR and ALWR would not affect prime farmland, agricultural activities, National Environmental Research Park study areas, or other land uses on the site.

Tritium Recycling Upgrade. Upgrade of existing tritium recycling facilities would not result in any additional land disturbance; therefore, there would be no land use impacts.

Tritium Recycling Phaseout. In the event the tritium supply technology is collocated with a new tritium recycling facility at a site other than SRS, the existing tritium recycling mission would be phased out at SRS. It is anticipated that the existing tritium recycling facilities would remain in place following phaseout; therefore, no onsite impacts to land use are expected.

Potential Mitigation Measures. No mitigation measures are proposed.

Visual Resources

No Action. Under No Action, no new construction or demolition activities are anticipated that would result in Bureau of Land Management's VRM classification change. The existing SRS landscape character would still range from VRM Class 3 to Class 5 (higher to lower aesthetic value).

Tritium Supply. Views of the construction and operation of the HWR, MHTGR, and ALWR would be similar to other large industrial facilities at SRS. Views of the APT construction and operation would be much less obtrusive because most of the facility has a lower profile than other technologies due to its low profile cooling system. Construction of any tritium supply facility would change the VRM classification from Class 4 to Class 5 at the TSS. The proposed TSS would be approximately 4 miles from State Highway 125, the nearest public access points with a high sensitivity level. Views from this roadway would be blocked by heavy vegetation, forested areas, and terrain. Therefore, construction and operation of the proposed facilities would not attract the attention of the average observer and visual impacts would be minimal. There would be no change in the overall appearance of SRS from key viewpoints with high sensitivity levels. The use of an evaporative cooling system on the HWR, MHTGR, or ALWR would potentially result in large cooling towers (up to 50 stories high) and visible plumes during certain atmospheric conditions. The cooling system of the APT would have no visible plume.

Less Than Baseline Operations. Baseline visual impacts would not change due to operation of the HWR, MHTGR, or ALWR at reduced tritium capacity or the construction and operation of a Phased APT.

Tritium Recycling Upgrade. Because no new facilities would be constructed to upgrade the existing tritium recycling mission no visual impacts would be anticipated.

Tritium Recycling Phaseout. The existing tritium recycling facilities would remain in place following phaseout. There would be no change in the existing landscape character; therefore, no impacts to visual resources are expected.

Potential Mitigation Measures. The use of alternative cooling systems (such as low-profile cooling towers or mechanical draft dry cooling towers) would reduce the visual impacts caused by vapor plumes from the HWR, MHTGR, or ALWR. The selection of a specific cooling system would be evaluated in site-specific tiered NEPA documents.

4.6.3.2 *Site Infrastructure*

This section discusses the site infrastructure for No Action and the modifications needed for actions due to construction and operation of a new tritium supply facility as well as upgrade and phaseout of the existing tritium recycling facility. With the exception of the APT, the SRS infrastructure would be capable of supporting any one of the proposed tritium supply technologies without major modifications to the existing infrastructure. A comparison of site infrastructure and facilities resource needs for tritium supply and phaseout of the existing tritium recycling facilities is presented in table 4.6.3.2–1. The upgraded recycling facilities would require only a slight change of resource requirements above those of the current recycling facilities included in the No Action baseline. Therefore, the upgraded tritium recycling facilities operational data is not included separately in table 4.6.3.2–1, but is included in No Action.

No Action. The missions discussed in section 3.3.6 would continue under No Action. As shown in table 4.6.3.2–1, the site infrastructure would continue to adequately support the future missions to include tritium recycling. The shutdown of the F- and H-Canyons by 2005 would further reduce infrastructure needs.

Tritium Supply and Recycling Upgrade. The modification to the infrastructure at SRS to support the various tritium supply technologies are summarized in table 4.6.3.2–1. Adequate electrical energy is available from the subregional power grid to accommodate each of the tritium supply technologies (table 4.6.3.2–2). The alternatives would require between 0.35 and 5.27 percent of the Virginia-Carolina Subregion power pool capacity margin, and between 0.13 and 1.95 percent of the Southeastern Electric Reliability Council regional power pool capacity margin. For all technologies, the existing SRS transmission lines and facilities would need to be upgraded for the increased and redistributed electrical load.

Construction of approximately 6 miles of additional primary and secondary access roads and 6 miles of railroad right-of-way would be required for the HWR, MHTGR, and ALWR. The APT would require an additional 3 miles of access road. Interconnection requirements are not expected to change appreciably when specific-site adaptations are completed.

The Unconsolidated Tritium Recycling Upgrade described in section 3.4.3.2 is designed to meet DOE Order 5480.28, "Natural Phenomena Hazard Mitigation," affects five buildings and is the one evaluated in this PEIS. These upgrades would basically involve the addition of wall bracing and cross bracing to beams, strengthening some exterior walls and reinforcing building frames.

Tritium Recycling Phaseout. Tritium recycling operations are currently performed in the H-Area in existing buildings. If SRS is selected as the site for a new tritium supply, tritium recycling would continue at SRS in upgraded facilities. However, if another site is selected to receive a new tritium supply with a collocated recycling facility, the tritium recycling functions at SRS would be phased out. As shown in table 4.6.3.2–1, this phaseout would have minimal impact on the site infrastructure.

Less Than Baseline Operations. In the event that only the steady state component of the baseline tritium requirement is required, the impacts on the site infrastructure would change for some technologies. There would be no appreciable change for the HWR, MHTGR, and ALWR technologies. The Phased APT would reduce electrical consumption by approximately 30 percent but the fuel, onsite transportation infrastructure, and power line requirements would not change.

Multipurpose Reactor. The MHTGR or ALWR multipurpose reactor option described in section 4.8.3 could be sited at SRS. The site infrastructure impacts would vary depending on the technology.

The MHTGR multipurpose reactor option would require construction of the Pit Disassembly/Conversion Facility described in section 4.8.3.1 along with three additional MHTGR reactor modules. Fabrication of the plutonium-oxide fuel could be accomplished in the fuel fabrication facility already included in the tritium supply MHTGR design. Operation of this facility along with the six module MHTGR multipurpose reactor would increase the total site electrical requirement by about 273,000 MW per year (26 percent) and the total site fuel requirement by about 651,000 GPY (2 percent) over that for operation of the three module tritium supply MHTGR.

TABLE 4.6.3.2–1.—*Modifications to Site Infrastructure for Tritium Supply Technologiesand Recycling Phaseout at Savannah River Site*

Alternative	Transportation		Electrical		Fuel		
	Road (miles)	Railroad (miles)	Energy[a] (MWh/yr)	Peak Load (MWe)	Oil[b] (GPY)	Natural Gas (million ft^3/yr)	Coal (tons/yr)
Current Resources	150	57	1,672,000	330	2,412,000	0	230,000
No Action							
Total site requirement	150	57	794,000	116	2,412,000	0	244,000
Change from current resources	0	0	-878,000	-214	0	0	14,000
Heavy Water Reactor							
Total site requirement	156	63	1,164,000	167	4,073,000	0	244,000
Change from current resources	6	6	-508,000	-163	1,661,000	0	14,000
Modular High Temperature Gas-Cooled Reactor							
Total site requirement	156	63	1,054,000	152	2,532,500	0	244,000
Change from current resources	6	6	-618,000	-178	120,500	0	14,000
Large Advanced Light Water Reactor							
Total site requirement	156	63	1,494,000	212	2,612,000	0	244,000
Change from current resources	6	6	-178,000	-118	200,000	0	14,000
Small Advanced Light Water Reactor							
Total site requirement	156	63	1,174,000	168	2,522,000	0	244,000
Change from current resources	6	6	-498,000	-162	110,000	0	14,000
Full Accelerator Production of Tritium							
Total site requirement	159	63	4,534,000	666	2,425,200	0	244,000
Change from current resources	9	6	2,862,000	336	13,200	0	14,000
Phased Accelerator Production of Tritium							
Total site requirement	159	63	3,194,000	471	2,425,200	0	244,000
Change from current resources	9	6	1,522,000	141	13,200	0	14,000
Recycling Facility Phaseout							
Total site requirement	150	57	770,000	113	2,352,000	0	238,800
Change from current resources	0	0	-902,000	-217	-60,000	0	8,800

[a] The electrical energy available is greater than current usage (No Action).

[b] Oil is the primary utility fuel at SRS and all of the tritium supply natural gas requirements have been converted to oil equivalents: natural gas is assumed to be 1,000 Btu per ft^3, and fuel oil (8 lb/gal) is assumed to be 19,000 Btu per pound.

Note: A negative number (-) indicates that sufficient resources exist to meet the demands.

Source: DOE 1995d; DOE 1995e; DOE 1995f; NERC 1993a; SNL 1995a; SR DOE 1995a.

TABLE 4.6.3.2–2.—*Impacts on the Subregional Electrical Power Pool from Tritium Supply Technologies at Savannah River Site*

Tritium Supply Technology	Peak Power Required (MWe)	Capacity Margin (percent)	Annual Energy Required (MWh)	Total Electricity Production (percent)
Heavy Water Reactor	51	0.49	370,000	0.14
Modular High Temperature Gas-Cooled Reactor	36	0.35	260,000	0.10
Large Advanced Light Water Reactor	96	0.92	700,000	0.27
Small Advanced Light Water Reactor	52	0.50	380,000	0.14
Full Accelerator Production of Tritium	550	5.27	3,740,000	1.37
Phased Accelerator Production of Tritium	355	3.40	2,400,000	0.88

Source: DOE 1995d; DOE 1995e; DOE 1995f; NERC 1993a; SNL 1995a; SR DOE 1995a.

The ALWR multipurpose reactor option would require construction of the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility described in section 4.8.3.1. Operation of this facility along with the ALWR multipurpose reactor would increase the total site electrical requirement by about 20,000 MWh per year (less than 2 percent) and the total site fuel requirement by about 830,000 GPY (2 percent) over that for operation of the tritium supply ALWR.

Accelerator Production of Tritium Power Plant. A dedicated gas-fired power plant at SRS to provide the necessary power for the APT could be constructed (see section 4.8.2.2). This would decrease the annual amount of electricity required to be purchased from commercial sources by up to 3,740,000 MWh per year for the Full APT and 2,400,000 MWh for the Phased APT. Although SRS now has no natural gas supply, a pipeline could be installed within existing rights-of-way. This gas plant would require 54,200 million ft^3 per year of natural gas to provide the Full APT requirement of 3,740,000 MWh per year and 34,800 million ft^3 per year of natural gas to provide the Phased APT requirement of 2,400,000 MWh per year.

Potential Mitigation Measures. The siting of a new tritium supply would not require infrastructure enhancements in most common support areas to mitigate environmental impacts. Siting of new roads, railroad spurs, and utility infrastructure could follow existing rights-of-way to minimize impacts to natural resources. Where new rights-of-way would need to be constructed, alignments should consider existing sensitive habitat (e.g., wetlands, streams, and vegetation) to minimize the potential for impacting these resources. As a potential mitigation measure, a consolidated tritium recycling upgrade which entails the relocation of all tritium processing and handling functions from Building 232-H to buildings 233-H and 234-H could be done. This would be in addition to the unconsolidated upgrade modifications except for Building 232-H. This upgrade would allow Building 232-H to be closed. While this consolidation would slightly increase construction resource requirements, it would result in decreases in some operational resources, manpower requirements, and tritium emissions and waste.

4.6.3.3 *Air Quality and Acoustics*

Construction and operation of a tritium supply technology and the upgrade of recycling facilities at SRS would generate criteria and toxic/hazardous pollutants that have the potential to exceed Federal and state ambient air quality standards and guidelines. To determine the air quality impacts, criteria and toxic/hazardous concentrations from each technology have been compared with Federal and state standards and guidelines. Impacts for radiological airborne emissions are discussed in section 4.6.3.9.

In general, all of the proposed technologies would emit the same types of air pollutants during construction. Emissions would typically not exceed Federal, state, or local air quality regulations or guidelines, except that PM_{10} concentrations may be close to or exceed the 24-hour standard during peak construction periods, which is not uncommon for large construction projects.

During operation, impacts from each of the tritium supply technologies with respect to the concentrations of criteria and toxic/hazardous air pollutants are predicted to be in compliance with Federal, state, and local air quality regulations or guidelines. The estimated pollutant concentrations presented in table 4.6.3.3–1 for each of the tritium supply technologies and upgrade of recycling facilities indicate little difference between technologies with respect to impacts to air quality.

The Prevention of Significant Deterioration regulations, which are designed to protect ambient air quality in attainment areas, apply to new sources and major modifications to existing sources. Based on the emission rates presented in appendix table B.1.4–5, Prevention of Significant Deterioration permits may be required for each of the proposed tritium supply technologies at SRS. This may require "offsets," reductions of existing emissions, to permit any additional or new emission source.

Noise emissions during either construction or operation are expected to be low. Air quality and acoustic impacts for each technology are described separately. Supporting data for the air quality and acoustics analysis, including modeling results, are presented in appendix B.

Air Quality

An analysis was conducted of the potential air quality impacts of emissions from each of the tritium supply technologies. The air quality modeling analysis used the Industrial Source Complex Short-Term model recommended by EPA. The resulting air quality concentrations were then evaluated against local, state, air quality regulations, and NAAQS (40 CFR 50). Potential exceedance of Prevention of Significant Deterioration (40 CFR 52.21) increments for PM_{10}, SO_2, or $NO_2$was also determined.

No Action. No Action utilizes estimated air emissions data from operations in the year 2010 assuming continuation of site missions as described in section 3.3.5. These data reflect conservative estimates of criteria and toxic/hazardous emissions. The emission rates for the criteria and toxic/hazardous pollutants for No Action are presented in appendix table B.1.4–5. Table 4.6.3.3–1 presents the No Action concentrations. Pollutant concentrations are in compliance with all air quality regulations and guidelines. It is conservatively assumed that PM_{10} concentrations are equal to TSP concentrations. The air quality in 2010 is expected to improve in comparison to the baseline air quality presented in section 4.6.2.3.

Tritium Supply and Recycling Upgrade. Alternatives for SRS consist of the four candidate technologies: HWR, MHTGR, ALWR, and APT, combined with upgraded recycling facilities. Air pollutants would be emitted during construction of the tritium supply technologies. The principal sources of such emissions during construction include the following:

- Fugitive dust from land clearing, site preparation, excavation, wind erosion of exposed ground surfaces, and operation of a concrete batch plant.

- Exhaust from, and road dust raised by, construction equipment, vehicles delivering construction material, and vehicles carrying construction workers.

PM_{10} concentrations are expected to be close to or exceed the 24-hour ambient standard during the peak construction period. Exceedances would be expected to occur during dry and windy conditions. Appropriate control measures would be followed, such as watering to reduce emissions. With the exception of PM_{10}, it is expected that concentrations of all other pollutants at the SRS boundary would remain within applicable Federal and state ambient air quality standards.

Air pollutant emission sources associated with the operation of each of the technologies include all or part of the following:

- Increased operation of existing boilers to generate additional steam for space heating.

- Operation of diesel generators and periodic testing of emergency diesel generators.

- Exhaust from, and road dust raised by, vehicles delivering supplies and bringing employees to work.

Appendix table B.1.4–5 presents emissions from each of the proposed tritium supply technologies. There are no gaseous releases associated with the APT, although emissions are associated with operation of the tritium supply facility and with upgraded tritium recycling facilities (SNL 1995a).

TABLE 4.6.3.3–1.—*Estimated Cumulative Concentrations of Pollutants Resulting from Tritium Supply Technologies and Upgraded Recycling Including No Action at Savannah River Site* [Page 1 of 2]

Pollutant	Averaging Time	Most Stringent Regulation or Guideline ($\mu g/m^3$)	2010 No Action ($\mu g/m^3$)	Tritium Supply Technologies and Upgraded Recycling: HWR ($\mu g/m^3$)	MHTGR ($\mu g/m^3$)	ALWR ($\mu g/m^3$)	APT ($\mu g/m^3$)	Tritium Recycling Phaseout ($\mu g/m^3$)	Tritium Upgrade ($\mu g/m^3$)
Criteria Pollutant									
Carbon monoxide (CO)	8-hour	10,000	14	14	15	14	14	14	0.4
	1-hour	40,000	28	29	31	29	29	28	0.8
Lead (Pb)	Calendar Quarter	1.5	[a]	[a]	[a]	[a]	[a]	[a]	[a]
Nitrogen dioxide (NO_2)	Annual	100	10	10	10	10	10	10	0.1
Ozone (O_3)	1-hour	235	235	235	235	235	235	235	[a]
Particulate matter (PM_{10})[b]	Annual	50	28	28	28	28	28	28	0.02
	24-hour	150	58	59	59	59	59	58	0.4
Sulfur dioxide (SO_2)	Annual	80	13	13	13	13	13	13	0.1
	24-hour	365	182	184	184	184	184	182	1.7
	3-hour	1,300	378	382	382	382	382	378	3.8
Mandated by South Carolina									
Total suspended particulates[b]	Annual	75	28	28	28	28	28	28	<0.01
Hazardous and Other Toxic Compounds									
Acetylene	24-hour	[c]	[a]	0.3	0.3	0.3	0.3	[a]	[a]
Acrolein	24-hour	1.25	0.1	0.1	0.1	0.1	0.1	0.1	[a]
Acrylonitrile	24-hour	22.5	0.1	0.1	0.1	0.1	0.1	0.1	[a]
Ammonia	24-hour	[c]	[a]	[a]	[a]	0.6	[a]	[a]	[a]
Antimony	24-hour	2.5	0.03	0.03	0.03	0.03	0.03	0.03	[a]
Benzene	24-hour	150	69.7	69.7	69.7	69.7	69.7	69.7	[a]
Cadmium	24-hour	0.25	0.03	0.03	0.03	0.03	0.03	0.03	[a]
Cadmium oxide	24-hour	0.25	0.03	0.03	0.03	0.03	0.03	0.03	[a]
Chlorine	24-hour	75	3.7	3.7	3.7	3.7	3.7	3.7	[a]
2,4-Dinitrotoluene	24-hour	1.5	0.6	0.6	0.6	0.6	0.6	0.6	[a]
Dioctyl phthalate	24-hour	50	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Ethyl alcohol	24-hour	[c]	[a]	0.1	0.1	0.1	0.1	[a]	[a]
Ethyl benzene	24-hour	4,350	0.7	0.7	0.7	0.7	0.7	0.7	[a]
Ethylene glycol	24-hour	650	0.3	0.3	0.3	0.3	0.3	0.3	[a]
Formic acid	24-hour	225	0.9	0.9	0.9	0.9	0.9	0.9	[a]
Hexane	24-hour	200	0.1	0.1	0.1	0.1	0.1	0.1	[a]

TABLE 4.6.3.3–1.—*Estimated Cumulative Concentrations of Pollutants Resulting from Tritium Supply Technologies and Upgraded Recycling Including No Action at Savannah River Site* [Page 2 of 2]

Pollutant	Averaging Time	Most Stringent Regulation or Guideline (μg/m³)	2010 No Action (μg/m³)	Tritium Supply Technologies and Upgraded Recycling: HWR (μg/m³)	MHTGR (μg/m³)	ALWR (μg/m³)	APT (μg/m³)	Tritium Recycling Phaseout (μg/m³)	Tritium Upgrade (μg/m³)
Hazardous and Other Toxic Compounds (Continued)									
Hydrogen chloride	24-hour	175	87.1	87.1	87.1	87.1	87.1	87.1	a
Hydrogen sulfide	24-hour	140	2.6	2.6	2.6	2.6	2.6	2.6	a
Manganese	24-hour	25	0.2	0.2	0.2	0.2	0.2	0.2	a
Mercury	24-hour	0.25	0.1	0.1	0.1	0.1	0.1	0.1	a
Methane	24-hour	c	a	0.3	0.3	0.3	0.3	a	a
Methyl alcohol	24-hour	1,310	0.2	0.3	0.3	0.3	0.3	0.2	0.1
Methyl ethyl ketone	24-hour	14,750	2.5	2.5	2.5	2.5	2.5	2.5	a
Methyl isobutyl ketone	24-hour	2,050	1.3	1.3	1.3	1.3	1.3	1.3	a
Methyl tert-butyl ether	24-hour	c	1.0	1.0	1.0	1.0	1.0	1.0	a
Methylene chloride	24-hour	8,750	0.7	0.7	0.7	0.7	0.7	0.7	a
Nickel	24-hour	0.5	0.1	0.1	0.1	0.1	0.1	0.1	a
Nickel oxide	24-hour	5	0.03	0.03	0.03	0.03	0.03	0.03	a
Nitric acid	24-hour	125	1.5	2.1	1.5	9.3	1.5	1.5	a
Sodium hydroxide	24-hour	20	0.2	0.2	0.2	0.2	0.2	0.2	a
Sulfuric acid	24-hour	10	0.03	0.03	0.03	0.03	0.03	0.03	a
Tetrachloroethylene	24-hour	3,350	16.2	16.2	16.2	16.2	16.2	16.2	a
Toluene	24-hour	2,000	0.9	0.9	0.9	0.9	0.9	0.9	a
1,1,1-Trichloroethane	24-hour	9,550	0.7	0.8	0.7	3.3	0.7	0.7	a
1,1,2-Trichloroethane	24-hour	273	0.1	0.1	0.1	0.1	0.1	0.1	a
Trichloroethylene	24-hour	6,750	5.5	5.5	5.5	5.5	5.5	5.5	a
Trichloromethane	24-hour	250	15.9	15.9	15.9	15.9	15.9	15.9	a
Trichlorotrifluoroethane	24-hour	c	a	4.8	a	a	a	a	a
Xylene	24-hour	4,350	11.6	11.6	11.6	11.6	11.6	11.6	a

[a] No sources indicated.

[b] It is conservatively assumed that all PM_{10} concentrations are TSP concentrations.

[c] There is no standard.

Note: Concentrations for tritium supply and upgraded recycling and phaseout of tritium recycling include 2010 No Action concentrations. To determine the concentration of pollutants from each tritium supply technology, subtract the pollutant concentration for tritium upgrade from each of the tritium supply and upgraded recycling concentrations.

Note: DOE is committed to the phaseout of ozone-depleting substances and will discontinue use of these substances according to EPA phaseout schedules.

Source: DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; SR DHEC 1991a; SR DOE 1995a; SRS 1993a:3.

Emissions from the Large ALWR were used to determine pollutant concentrations since these represent the maximum emission rates from either the Large or Small ALWR. Concentrations from operation of the tritium supply and upgraded recycling facilities at SRS are presented in table 4.6.3.3–1. Pollutant concentrations, combined with No Action concentrations, are in compliance with all applicable Federal and state standards.

Pollutant emissions resulting from the operation of tritium supply technologies alone (HWR, MHTGR, ALWR, and APT) consist of criteria pollutants from the operation of boilers and diesel generators and toxic/hazardous pollutant emissions from facility processes. Criteria pollutant emissions from the MHTGR are the highest among the other tritium supply technologies and would increase existing total site criteria pollutant emissions by less than 5 percent above No Action emissions. Concentrations of criteria and toxic/hazardous pollutants, added to No Action concentrations, are in compliance with Federal and state standards.

Less Than Baseline Operations. Air emissions from the HWR would be reduced slightly when operated at reduced capacity. However, the reduction would be negligible since most emissions are attributed to support equipment and facilities that are not related to the reactor operating level. The MHTGR or ALWR would have no change in air emission since it would continue to operate at the same level as the baseline requirement to maintain power levels for steam or electrical production. The Phased APT construction and operation emissions and impacts would be the same as the Full APT.

Accelerator Production of Tritium Power Plant. Operation of a 500 to 600 MWe natural gas electric generating facility (section 4.8.2.2) would generate a substantial amount of emissions consisting of sulfur dioxide, particulate matter, nitrogen oxides, carbon monoxide, and volatile organic compounds.

These emissions would be controlled using the best available control technology to minimize impacts and comply with the NAAQS and state mandated emission standards. Estimated emissions are based upon emission factors for a large controlled gas turbine (EPA 1995a; SPS 1995a). Table B.1.3.1-3 presents the emission factors and resulting annual emission rates for a 600 MWe natural gas-fired turbine power plant.

For a natural gas-fired power plant located at SRS, the increase in carbon monoxide emissions with respect to the 2010 No Action emissions at SRS would be approximately 16 percent (75 tons per year); for nitrogen oxides the increase would be approximately 10 percent (314 tons per year); for particulate matter the increase would be approximately 34 percent (179 tons per year); for sulfur dioxide the increase would be less than 1 percent (5 tons per year). In addition, the gas turbine generating facility would generate 215 tons per year of volatile organic compounds, 126 tons per year of methane, 58 tons per year of ammonia, 29 tons per year of nonmethane hydrocarbons, and 24 tons per year of formaldehyde.

Any power plant facility constructed to meet the power needs of the APT would be required to meet the Federal NAAQS and state mandated regulations for toxic/hazardous pollutants. Appropriate pollution control equipment would be incorporated into the design of that facility to meet these standards.

Phaseout Tritium Recycling. Phaseout of the tritium recycling facilities at SRS will reduce the criteria and toxic/hazardous pollutant emissions. The concentrations of pollutants resulting from this phaseout result in a net reduction of criteria and toxic/hazardous pollutant concentrations with respect to the No Action pollutant concentrations. The concentrations of criteria and toxic/hazardous air pollutants resulting from the phaseout of the tritium recycling facilities are in compliance with all applicable standards.

Potential Mitigation Measures. Potential mitigation measures during construction include: watering to reduce dust emissions; applying non-toxic soil stabilizers to all inactive construction areas, cover, water, or apply non-toxic soil binders to exposed piles (i.e., gravel, sand, and dirt); suspend all excavation and grading operation when wind speeds warrant; pave construction roads that have a traffic volume of more than 50 daily trips by construction equipment; use electricity from power poles rather than temporary gasoline and diesel power generators. Potential mitigation measures during operation include incorporating additional HEPA filters to reduce particulate emissions from processing facilities; substituting cleaning solvents which are less toxic for those which present health hazards or exceed the applicable standards; and switching from coal or fuel oil to natural gas to reduce criteria pollutants.

Acoustics

The location of the tritium supply technologies relative to the site boundary and sensitive receptors was examined to determine the contribution to noise levels at these locations and the potential for onsite and offsite impacts.

No Action. Continuation of operation at SRS would not appreciably change traffic noise and onsite operational noise from current levels (section 4.6.2.3). Sources of nontraffic noise associated with operation are located at sufficient distances from offsite noise sensitive receptors that the contribution to offsite noise levels would continue to be small.

Tritium Supply and Recycling Upgrade. Noise sources during construction may include heavy construction equipment and increased traffic. Increased traffic would occur onsite and along offsite major transportation routes used to bring construction material and workers to the site.

Most nontraffic noise sources associated with operation of any of the tritium supply technologies and recycling upgrade would be located at sufficient distance from offsite areas that the contribution to offsite noise levels would continue to be small. Due to the size of SRS, noise emissions from construction and operation activities would not be expected to cause annoyance to the public.

Noise impacts associated with increased traffic on access routes, would be considered in tiered NEPA documents. Some nontraffic noise sources associated with construction and operation of the tritium supply technologies and recycling upgrade may be located close enough to offsite noise receptors that they could experience some increase in noise levels.

Less Than Baseline Operations. Baseline noise impacts would not change due to reactors operating at reduced tritium capacity or the construction and operations of a Phased APT.

Potential Mitigation Measures. Potential measures to minimize noise impacts on workers include the use of standard silencing packages on construction equipment and providing workers in noisy environments with appropriate hearing protection devices meeting OSHA standards. As required, noise levels would be measured in worker areas, and a hearing protection program would be conducted.

4.6.3.4 *Water Resources*

Environmental impacts associated with the construction and operation of each of the proposed tritium supply technologies at SRS would affect surface water and groundwater resources. The proposed site for the tritium supply facility would be outside the 100-year floodplain; however, information on the location of the 500-year floodplain at SRS is currently unavailable. Groundwater will be used for construction and operation of the tritium facilities. The water withdrawals from groundwater would not adversely impact regional groundwater levels. No wastewater would be discharged directly to groundwater; therefore, groundwater quality will not be affected. Any construction-related impacts would be mitigated by standard erosion control practices.

Surface water from the Savannah River would be used for cooling system makeup. The greatest possible demand would not exceed 3 percent of the river's minimum flow. During operation of the tritium supply and upgraded recycling facilities, treated wastewater would be discharged to nearby streams. Cooling system blowdown from the tritium supply facility would also be discharged directly to a nearby stream. All discharges would be monitored to comply with NPDES permit limits. During operation, stormwater runoff would be collected and treated, if necessary, before discharge to natural drainage channels.

Table 4.6.3.4–1 presents existing surface water and groundwater resources and the potential impact of the proposed tritium supply technologies and operation of the existing upgraded recycling facilities. Resource requirements shown in this table represent the total requirements at the site, including No Action.

TABLE 4.6.3.4–1.—*Potential Changes to Water Resources Resulting from Tritium Supply Technologies and Recycling at Savannah River Site* [Page 1 of 2]

Affected Resource Indicator	No Action	Tritium Supply Technologies						Tritium Recycling Upgrade[b]	Tritium Recycling Phaseout
		HWR	MHTGR[a]	Large ALWR[a]	Small ALWR[a]	Full APT	Phased APT		
Construction (2005)									
Water Availability and Use									
Water source	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
Total groundwater requirement[c] (MGY)	3,146	3,167	3,164	3,179	3,166	3,154	3,154	0.1	NA
Percent increase in projected groundwater use (3,146 MGY)	0	<1	<1	1	<1	<1	<1	NA	NA
Water Quality									
Wastewater discharge to surface waters (MGY)	NA	16.5	13.6	27.5	15.5	0.3	0.3	0.03	NA
Percent change in stream flow[d]	NA	1	1	2	1	<0.1	<0.1	NA	NA
NPDES permit required	NA	Yes	Yes	Yes	Yes	Yes	Yes	NA	NA
Operation (2010)									
Water Availability and Use									
Cooling system makeup (MGY) (from surface water)	Included in total	5,852	3,970	15,510	7,150	1,193	763	36	NA
Other facility operations (MGY) (from groundwater)	Included in total	48	30	90	50	7	7	15	-134.5
Total surface water requirement[e] (MGY)	19,840	25,692	23,810	35,350	26,990	21,033	20,603	36	NA
Total groundwater requirement[e] (MGY)	3,146	3,194	3,176	3,236	3,196	3,153	3,153	15	-134.5
Percent change in flow from withdrawals[f]	0	<1	<1	1	<1	<1	<1	NA	NA
Percent of projected groundwater use	0	2	1	3	2	<1	<1	NA	-4.3

TABLE 4.6.3.4–1.—*Potential Changes to Water Resources Resulting from Tritium Supply Technologies and Recycling at Savannah River Site* [Page 2 of 2]

		Tritium Supply Technologies							
Affected Resource Indicator	No Action	HWR	MHTGR[a]	Large ALWR[a]	Small ALWR[a]	Full APT	Phased APT	Tritium Recycling Upgrade[b]	Tritium Recycling Phaseout
Water Quality									
Wastewater discharge to surface waters[g] (MGY)	52.3	100	82	142	102	59	59	31	-0.4
Percent change in stream flow[d]	4	3	2	7	4	4	4	NA	-3.2
Blowdown discharge to surface waters (MGD)	Included in WW	9.6	6.7	25.8	11.7	1	0.66	NA	NA
Percent change in stream flow[h]	NA	168	117	453	205	18	12	NA	NA
NPDES permit required	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	NA
Floodplain									
Action in 100-year floodplain	NA	No	No	No	No	No	No	No	No
Critical actions in 500-year floodplain	NA	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain	Uncertain
Floodplain assessment required	NA	Yes 500-year	Yes 500-year	Yes 500-year	Yes 500-year	Yes 500-year	Yes 500-year	Yes 500-year	Yes 500-year

[a] Operation water requirements for MHTGR and ALWR include utilization of steam turbine generators.

[b] Resource requirements for tritium recycling upgrade do not include No Action.

[c] Total water requirements at SRS are calculated by adding No Action requirements (3,146 MGY) with that for each tritium supply technology HWR (21.3 MGY), MHTGR (17.8 MGY), ALWR (33.3 for Large and 20 MGY for Small), APT (8.3 MGY for Full and Phased), and tritium recycling upgrade (0.1 MGY).

[d] Percent change in stream flow from wastewater discharge is from Fourmile Branch's minimum flow of 5.8 ft^3/s.

[e] Total water requirements at SRS are calculated by adding No Action requirements for surface water (19,840 MGY) with that for each tritium supply technology HWR (5,852 MGY), MHTGR (3,970 MGY), ALWR (15,510 MGY for Large and 7,150 MGY for Small), APT (1,193 MGY for Full and 763 MGY for Phased), and tritium recycling upgrade (36 MGY); and for groundwater (3,146 MGY) with HWR (48 MGY), MHTGR (30 MGY), ALWR (90 MGY for Large and 50 MGY for Small), and APT (7 MGY for Full and Phased), and tritium recycling upgrade (15 MGY).

[f] Percent change in stream flow from withdrawals is calculated from the Savannah River's minimum flow of 5,368 ft^3/s.

[g] Tritium supply technologies wastewater discharges to surface water include No Action. Tritium recycling upgrade would discharge an additional 31 MGY.

[h] Blowdown is expected to occur once a day over a 1-hour period, rather than continuously over the course of the day. As such, the discharge rate would be much greater for a shorter period of time. Percent change in stream flow from blowdown discharge is calculated from Fourmile Branch's minimum flow of 5.8 ft^3/s. Annual blowdown discharge is calculated based on a 240-day year.

Note: NA - not applicable; WW - wastewater.

Note: Construction impacts are considered to be temporary, lasting only throughout the construction period.

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; SR DOE 1995a; SRS 1993a:3.

Surface Water

No Action. Under No Action, no additional impacts to surface water resources are anticipated beyond the effects of existing and future activities, which are independent of and unaffected by the proposed action. A description of the activities that would continue at SRS is provided in section 3.3.6. Because of termination of the K-Reactor and the F- and H-Canyons operations, surface water withdrawals from the Savannah River would decrease to less than 2 percent of the river's minimum flow. As a result of reduction in discharges to site streams, water quality should improve and impaired streams should recover.

Tritium Supply. Due to the location of the proposed TSS, the most likely stream to receive discharge during construction and operation is Fourmile Branch. During construction of any tritium supply technologies, no surface water withdrawals would be made. Treated sanitary wastewater released to surface streams would not exceed approximately 2 percent of the minimum flow of Fourmile Branch. All discharges would be monitored to comply with NPDES permit limits and other discharge requirements. The primary impacts during construction would be soil erosion of disturbed land and siltation in surface drainage channels. To minimize soil erosion impacts, required NPDES stormwater management and erosion control measures would be employed. In most cases, impacts from runoff would be temporary and manageable.

In addition to wastewater effluent, the MHTGR and APT would require dewatering because of construction activities below the water table. The amount of dewatering discharges would depend on hydrologic and engineering conditions of the site. These discharges could either be directed to Fourmile Branch or Par Pond and are expected to exhibit low turbidity and not require settling basins. However, temporary sediment basins to remove soil particles could be built as part of standard soil erosion and sediment control plans for the site. Dewatering discharges to Fourmile Branch could cause stream bank erosion, increased turbidity, stream bed scouring, and potential flooding. More detailed analyses would be conducted during site-specific NEPA studies. Construction of an HWR or ALWR would require much less dewatering; therefore the impacts on Par Pond, Fourmile Branch or the Savannah River are expected to be minor.

Operation of the Large ALWR would require the most cooling water, 15,510 MGY, approximately 1.2 percent of the Savannah River's minimum flow, and would not be expected to affect downstream users. The water requirement for the other tritium supply technologies would require less than 50 percent of the Large ALWR cooling water requirement. The greatest operational treated wastewater discharge would be 90 MGY from the Large ALWR. Fourmile Branch near the proposed TSS is an area of low instream flow and was determined by an SRS study to be acceptable for sanitary water discharges. The 90 MGY would comprise approximately 7 percent of the minimum flow of Fourmile Branch and would not be expected to adversely impact stream hydrology. All discharges would be required to comply with NPDES permit limits. Stormwater runoff from the main tritium supply plant area would be collected in detention ponds, monitored, and if clean, discharged to nearby streams. Stormwater from outside the main plant area, except those facilities that require onsite management controls by regulation such as sanitary wastewater treatment plants and landfill areas, would be discharged to nearby steams.

In addition to treated wastewater, cooling system blowdown discharges are anticipated. Cooling system blowdown activities discharge great quantities over a short period of time. An SRS study has examined six alternative routes for disposal of blowdown water that included Fourmile Branch, Par Pond, L Lake, Indian Grave Branch, and Savannah River. The evaluation of these alternatives was based on ecology, flow impacts, capability to assimilate discharge, impact on the biotic community, impact on existing permits, cost estimate, and feasibility. These evaluations identified Par Pond as the option with the least potential for environmental impact. The Large and Small ALWR would release 26 and 12 million gallons, respectively, as blowdown during 1 hour each day. All other tritium supply technologies would discharge approximately 50 percent less than the Large ALWR. Blowdown from the Large ALWR would temporarily increase the minimum flow rate of Fourmile Branch by approximately 456 percent. These discharges would increase stream velocity, causing scouring of stream beds, erosion of stream channels, increased turbidity, resuspension and mobilization of contaminated sediments, and potential flooding of areas. In addition to impacts from the velocity of the blowdown, the temperature of the discharges could also affect receiving waters. Releases to Par Pond would reduce impacts from thermal discharges. Par Pond was designed as a recirculating cooling reservoir for several SRS reactors. Several precooling ponds (Ponds 2, 5, and C and a canal system) are tributaries to Par Pond. This system was designed to handle cooling water flows approximately 30 times greater than the proposed tritium supply technologies blowdown discharges. Currently, water is added to the system to maintain water levels. The precooling ponds are undergoing recovery from past thermal impacts of cooling water discharges. Discharge of blowdown to these ponds would not affect the flow, but some lake enrichment and biotic changes are possible. Blowdown discharges to Par Pond could reduce the amount of makeup water, but not eliminate, the need for makeup water from the Savannah River. The various blowdown disposal options would be evaluated in site-specific tiered NEPA documents. All discharges to surface waters are subject to and required to comply with NPDES permit requirements.

Blowdown would also contain concentrated chemicals and diffused tritium. Depending on the operation of the system, blowdown chemical and tritium concentrations would range between 2.5 and 5 times the river water concentrations. Previous studies of tritium concentrations in liquid discharges from reactors operating at higher production rates than anticipated for the proposed facilities showed that the concentration in the Savannah River after dilution did not exceed the water quality standard of 20,000 pCi/l (40 CFR 141). For the purpose of this analysis, it is anticipated that any release of tritium from the proposed facilities would not exceed the water quality standard for tritium and would comply with NPDES discharge requirements. For information on the radiological constituents present in cooling system blowdown and their human health impacts, refer to section 4.6.3.9.

Tritium supply facilities would be located at elevations approximately 50 feet higher than Fourmile Branch and at a distance of approximately 1 mile at its closest point. No tritium supply facilities would be located within a 100-year floodplain. However, there is no information on the location of the 500-year floodplain at SRS. Because the tritium supply facility may constitute a critical action, an assessment of the 500-year floodplain would be required before construction activities were initiated. This study would be done for site-specific assessments. However, where a potential exists for flooding impacts, design mitigation measures would be considered and addressed in site-specific tiered NEPA documents.

Less Than Baseline Operations. Baseline requirement surface water impacts would not be reduced appreciably due to changes in reactor (HWR, MHTGR, or ALWR) operating tritium capacities. A slight reduction in the volume and temperature of cooling water discharges would be expected for the HWR because of the lower thermal output of the reactor. The MHTGR or ALWR water requirements and discharges would not change from the baseline requirement in order to maintain power production; therefore, the potential impacts would remain the same.

Operation of the Phased APT would require 763 MGY (table 4.6.3.4–1), a 3.8-percent increase over projected No Action water use. This is approximately 430 MGY less than the amount required by the Full APT, and is 0.06 percent of the Savannah River's minimum flow. The 59 MGY of wastewater discharges from the Phased APT would not exceed 4.3 percent of Fourmile Branch's minimum flow and should not have any downstream effects. The Phased APT will discharge 0.66 million gallons of blowdown water during a 1-hour period every day. This is a little over one-half of the amount of blowdown discharge for the Full APT (1 MGD), and is 12 percent of Fourmile Branch's minimum flow. This discharge is less than the blowdown of the other technologies and its impacts would be less than but similar to those of other technologies. All other requirements of the Phased APT are identical to those of the Full APT.

Multipurpose Reactor. For the multipurpose MHTGR, a Pit Disassembly/Conversion Facility would be constructed and operated to support the reactors. During construction, the multipurpose MHTGR and the Pit Disassembly/Conversion Facility would require approximately 24.33 MGY, which would be a 37 percent increase over the surface water requirements for the MHTGR tritium supply facility, and 0.01 percent of the Savannah River's minimum flow. Water use during operation of the MHTGR multipurpose reactor (7,200 MGY) and the Pit Disassembly/Conversion Facility

(10 MGY) would total 7,210 MGY and would be a 78 percent increase over the surface water use for the MHTGR tritium supply facility, and is 3.5 percent of the Savannah River's average flow.

During construction, approximately 20.5 MGY of wastewater would be generated and during operations approximately 67.8 MGY. The wastewater would be treated prior to being released to NPDES permitted outfalls. These amounts represent an increase of 51 and 128 percent, respectively, over the discharges generated by the MHTGR tritium supply facility and are 0.01 and 0.03 percent of the Savannah River's average flow.

Water requirements during construction and operation of an ALWR multipurpose reactor would be the same as previously discussed for an ALWR tritium supply facility. However, as discussed in section 4.8.3, a Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would have to be constructed and operated in conjunction with an ALWR multipurpose reactor. During construction (0.5 MGY) and operation (10 MGY) of a Pit Disassembly Conversion/Mixed-Oxide Fuel Fabrication Facility, surface water use would increase 1.5 percent and less than one percent, respectively, over the construction and operation surface water use at the ALWR tritium supply facility. When combined with the ALWR multipurpose reactor during construction and operation, water use would represent 0.02 and 8 percent, respectively, of the Savannah River's minimum flow.

Approximately 30.8 MGY of wastewater would be generated during construction and 100 MGY during operation of a multipurpose ALWR with a Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility. These amounts represent an increase of 12 and 11 percent, respectively, over the discharges generated by the ALWR tritium supply facility and are 0.01 and 0.05 percent, respectively, of the Savannah River's minimum flow.

Accelerator Production of Tritium Power Plant. If the APT technology is selected, a dedicated power plant, as discussed in section 4.8.2.2 could be used to support the technology at SRS. Water requirements for the natural gas-fired power plant operations would be approximately 80 MGY in addition to the surface water requirements previously discussed for the APT. Operation of the Full APT and the dedicated power plant would require total site surface water withdrawals of 21,113 MGY and would be a 6-percent increase over projected No Action water use (19,840 MGY). This is approximately 1.7 percent of the Savannah River minimum flow, and would not be expected to affect downstream users and would be less than a 1-percent increase over total site surface water requirements of the Full APT (21,033 MGY alone).

Demineralized backwash generated during operation would contain dilute concentrations of trace metals and low-to-moderate concentrations of calcium, sodium, and sulfate. With the appropriate wastewater treatment prior to discharge, no impacts to surface water quality would be expected.

Tritium Recycling Phaseout. Phaseout of the tritium recycling facilities would result in a negligible decrease in withdrawals from the Savannah River. Wastewater discharges would continue to Upper Three Runs Creek and Fourmile Branch but, due to the phaseout of tritium recycling, would decrease by 0.3 percent and 3.2 percent, respectively. Discharges to Fourmile Branch would still increase stream flow by almost 250 percent. Stream flows of this rate could impede the stream's ability to recover from previous impacts or continue to erode stream banks, cause flooding, increase turbidity, or scour stream beds.

Tritium Recycling Upgrade. The existing tritium recycling facilities would be upgraded and would continue to use both surface water and groundwater to meet operational water requirements. No increase in the discharge of effluents to onsite streams is anticipated.

Potential Mitigation Measures. Surface water impacts associated with construction could be mitigated by applying standard erosion control practices. Dewatering discharges, depending upon the amount, could be released to the Par Pond system to avoid potential impacts to Fourmile Branch. During operation, cooling system blowdown discharges could be released to energy dissipating structures, such as plunge or stilling basins. Lined conveyance channels with additional energy dissipation features could be designed to further reduce the velocity of flow prior to entering the natural stream channel. Discharges could also be directed through a series of detention ponds to reduce discharge velocities and allow the water to cool. Another option for the disposal of blowdown is to discharge to Pond 2, and from there the flow would go to Pond 5, to Pond C, to Par Pond, and to Lower Three Runs Creek, which is a tributary to the Savannah River. Such a discharge would not be expected to have any thermal impacts on Par Pond because the tritium supply cooling systems would be designed to meet applicable South Carolina requirements for thermal releases. During both construction and operation periods, the new Central Sanitary Treatment Facility at SRS could treat wastewater from the proposed TSS. The treatment facility would have adequate capacity; the discharge is to Fourmile Branch.

Groundwater

No Action. Under No Action, as discussed in section 3.3.6, the existing missions at SRS would continue with total groundwater usage of 3,146 MGY. Section 4.6.2.4 describes existing groundwater conditions at SRS. With the shutdown of the K- and L-Reactors and phaseout of the F- and H-Canyons operations, it is expected that groundwater use would decrease and groundwater quality would not be further degraded. Table 4.6.3.4–1 shows the amount of groundwater required for construction and operation of the proposed tritium supply technologies and their comparisons with SRS's projected groundwater usage.

Groundwater Availability and Use

Tritium Supply. Groundwater required for construction of either an HWR (21.3 MGY), MHTGR (17.8 MGY), ALWR (33.3 MGY for Large and 20 MGY for Small), or an APT (8.3 MGY) would represent less than a 1-percent increase over the projected groundwater withdrawal. These amounts are not expected to cause any drawdown impacts.

Groundwater required for operation and the percent increase in projected water use are shown in table 4.6.3.4–1. Previous studies using numerical simulations of groundwater withdrawals up to 528 MGY from the Cretaceous aquifer indicate that although simulated drawdown was as much as 6.8 feet at the well head, drawdowns were smaller in overlying aquifers and did not extend beyond SRS boundaries in any aquifer. The studies concluded that withdrawing this amount of water or less would not adversely impact regional groundwater levels. Therefore, the productivity of this aquifer is sufficient to support construction and operation of the HWR, MHTGR, ALWR, and APT technologies. If needed, surface water instead of groundwater could be used for potable water and operation of support facilities.

Less Than Baseline Operations. Baseline requirement groundwater impacts would not be reduced appreciably due to changes in HWR, MHTGR, or ALWR operating tritium capacities. All groundwater requirements and potential impacts of the Phased APT are identical to those of the Full APT.

Multipurpose Reactor. If an MHTGR or ALWR multipurpose reactor were to be constructed at SRS, a Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility or a Pit Disassembly/Conversion Facility would have to be constructed in conjunction with the reactors. Water for both of the reactors and support facilities would be obtained from surface water resources with no plans to withdraw groundwater during operations.

During construction, groundwater dewatering effluent volume and activities might increase due to the additional excavation required for the three added reactor modules. Site specific analysis would be needed to identify the extent and severity of impacts to groundwater resources during excavation activities.

During operations, wastewater and sanitary water would continue to be treated before being released to surface waters, to minimize potential impacts to groundwater resources.

Accelerator Production of Tritium Power Plant. If the APT technology is selected, a dedicated power plant, as discussed in section 4.8.2.2, could be used to support the technology at SRS. Water requirements for the natural gas-fired power plant operations (approximately 80 MGY) would be obtained from surface water resources with no plans of withdrawal from groundwater resources.

Demineralized backwash generated during operations would contain dilute concentrations of trace metals and low-to-moderate concentrations of calcium, sodium, and sulfate. With the appropriate wastewater treatment prior to discharge, no impacts to surface water quality would be expected.

Tritium Recycling Upgrade. As discussed in section 3.4.3.2 the existing tritium recycling facilities at SRS would be upgraded. No new buildings would be constructed, rather construction would primarily be internal building renovations and modifications. Therefore, there should be no additional water use or impacts to water quality.

During operation, the upgraded tritium recycling facilities would require approximately 51 MGY of water. Of this, 36 MGY would be used for cooling system makeup which is approximately 1.5 percent over the operational water requirements withdrawn from the Savannah River. Groundwater required for other facility operations (15 MGY) is 0.5 percent of the projected groundwater use. Therefore, no adverse impacts are anticipated to available water supplies.

Tritium Recycling Phaseout. In the event a new tritium supply and recycling facility is constructed at a site other than SRS, the existing tritium recycling mission would be phased out at SRS. Phaseout of the tritium recycling facilities would decrease water withdrawals from the groundwater aquifers by 134.5 MGY. The reduced amount would not adversely impact groundwater levels or groundwater quality.

Groundwater Quality

Tritium Supply. During construction of either a MHTGR or an APT, excavation would be required to extend to a depth of approximately 160 feet and 50 feet, respectively. This construction would not extend below the base of the water table aquifer. A clay slurry trench could be used to accomplish the subterranean construction. In this technique, a cylindrical trench, large in diameter and deeper than the reactor or APT site, would be filled with a slurry of bentonite clay and water as the trench was created. The clay slurry would provide sufficient lateral support to keep the trench walls from caving in while the soil in the trench was moved from the surface to bedrock or into a firm subterranean formation. The clay slurry also would provide hydrostatic head to reduce the flow of underground water into the trench. Once excavation was complete, concrete would be pumped through a pipe to the bottom of the trench, and the trench would be filled from the bottom up as the excess was recovered. The earthen walls of the trench would serve as forms for the concrete. The water table drawdown resulting from dewatering the construction area could possibly induce horizontal flow of the contaminated groundwater (located less than one-half mile away), toward the excavated area from the SRS facilities surrounding the site. However, the concrete wall around the excavated area would prevent this flow. During excavation activities, groundwater would be monitored to avoid contaminated water from entering the construction area. Because the dewatering of the water table aquifer would create an upward gradient between aquifers, any potentially contaminated water in the excavated area would not likely migrate into the underlying aquifers. Therefore, the dewatering process would have little effect upon any designated CERCLA areas at SRS. During the CERCLA process, if it is found that groundwater contamination is spreading, a pump and treat system would be indicated and would be initiated regardless of the tritium supply project.

During construction and operation of any of the tritium supply technologies, there are no plans for direct discharge to groundwater (also see surface water section 4.6.3.4). As a result, impacts to groundwater quality at SRS are not expected.

Any potential salt coming from the tritium supply cooling tower would have originated from the Savannah River. Because the salt is concentrated in a wet cooling tower, it may damage vegetation in a small area near the facility. At SRS there is adequate rainwater and groundwater flow such that any salt concentrations from the cooling tower would be flushed into the groundwater and diluted. The groundwater and surface water systems are connected such that the salt originating from the Savannah River and reaching the groundwater will return to the river and the total amount of salt in the ecological system would remain the same.

Less Than Baseline Operations. Impacts to groundwater quality from the HWR, MHTGR, or ALWR would be the same as the baseline tritium requirement. Potential groundwater quality impacts of a Phased APT would be the same as described above for the Full APT.

Tritium Recycling Upgrade. During construction and operation, there would be no direct wastewater discharge to groundwater. All wastewater effluent would be treated onsite and discharged to surface waters through NPDES-permitted outfalls (also see discussion on surface water). As a result, minimal impacts are anticipated to groundwater quality.

Tritium Recycling Phaseout. Phaseout of the tritium recycling facilities would reduce wastewater discharge into surface waters. Therefore, no impact to groundwater quality is anticipated.

Potential Mitigation Measures. Impacts from construction and dewatering activities may require mitigation. Mitigation measures which could be implemented during construction of either a MHTGR or an APT include continuous groundwater monitoring in the construction area during and after construction, and use of recharge wells to minimize the amount of groundwater from contaminated areas reaching the excavated area. During operation, the use of surface water instead of groundwater for potable water and operation of support facilities should be maximized.

4.6.3.5 *Geology and Soils*

Construction of tritium supply facilities at SRS would have no impact on geological resources. Hazards posed by geological conditions to construction and operation of a tritium supply facility at SRS are minor. Construction would disturb up to a few hundred surface acres of soil depending on the tritium technology. Control measures would be used to minimize soil erosion. Impacts would depend on the specific soil units in the disturbed area, the extent of land disturbing activity, and the amount of soil disturbed. Potential changes to geology and soils associated with the construction and operation of a tritium supply technology, tritium extraction facility, and upgrade of existing recycling facilities are discussed below.

No Action. Under No Action, DOE would continue existing and planned activities at SRS. The K-Reactor would remain in cold standby with no provision for restart, and the F- and H-Canyons operations would eventually be shut down. These facilities would remain in place until turned over to environmental management for disposition. Any impacts to geology and soils from environmental management actions would be independent of and unaffected by the proposed action.

Tritium Supply. No potential project impacts to geologic conditions were identified. Design of the facilities would ensure compatibility with existing geologic conditions.

There are no known capable faults within the boundaries of SRS. There is little chance for ground rupture as a result of an earthquake. Ground shaking is more likely. Intensities as high as VII on the modified Mercalli scale are possible but infrequent and are not likely at SRS during the life of the proposed project. Ground shaking could affect the integrity of poorly designed or nonreinforced existing structures but would not affect newly designed facilities. Based on the seismic history of the area, a low seismic risk exists at SRS but this should not preclude safe construction and operation of the tritium supply facilities. In addition, all facilities would be designed for earthquake-generated ground acceleration in accordance with DOE Order 5480.28 and accompanying safety guides.

Volcanic activity is not a factor anywhere in the region and is extremely unlikely to impact the project. It is also highly unlikely that landslides, sinkhole development, or other nontectonic movements would affect project activities. Slopes and underlying foundation materials are stable.

Properties and conditions of soils underlying the proposed TSS have no limitations on construction. Soils would be impacted during construction and operation of the tritium facilities. The amount of acreage that would be potentially disturbed is shown in table 4.6.3.1–1.

The soil disturbance from construction of new facilities could be as much as 360 acres for a MHTGR. Disturbance would occur at building, parking, and construction laydown areas, destroying the soil profile, and leading to a possible temporary increase in erosion as a result of stormwater runoff and wind action. Soil losses would depend on frequency of storms; wind velocities; size and location of the facilities with respect to drainage and wind patterns; slopes, shape, and area of the tracts of ground disturbed; and, particularly during the construction period, the duration of time the soil is bare. Construction of both the MHTGR and the APT would also necessitate deep excavations to accommodate reactor modules and an accelerator tunnel, respectively (sections 3.4.2.2 and 3.4.2.4). A considerable volume of soil would be removed as a result of excavations. Most of the material removed would be sand or shale fragments derived from bedrock and could be stockpiled for use as fill. Some of this material could be used to cover the accelerator tunnel of the APT. Site-specific NEPA studies would evaluate in detail impacts to geology and soils at SRS resulting from deep excavations required for the MHTGR and the APT and would identify appropriate mitigation measures.

Net soil disturbance during operations would be less than for construction, because areas temporarily used for laydown would be restored. Although erosion from stormwater runoff and wind action could occur occasionally during operations, they are anticipated to be minimal.

Appropriate erosion and sediment control measures would be used to minimize soil loss. Wind erosion is likely to occur on an intermittent basis, depending on the wind velocities, the amount of soil exposed, and the effectiveness of control measures.

Less Than Baseline Operations. Under the less than baseline operations, geology and soil impacts would not change for the HWR, MHTGR, or ALWR technologies. Disturbed acreage for the Phased APT would be the same as the baseline tritium requirement for the Full APT; therefore, impacts would be the same.

Tritium Recycling Upgrade. The upgrade of tritium recycling facilities at SRS would not disturb any soil because no new construction would be required. The construction laydown area in the immediate vicinity of upgrade buildings would be temporarily disturbed. The upgrade would not affect existing geologic conditions and should not preclude safe construction and operation of the upgraded facilities.

Tritium Recycling Phaseout. In the event a new tritium supply facility is located at a site other than SRS, the existing tritium recycling mission would be phased out at SRS. The existing tritium recycling facilities would remain in place following phaseout; therefore, no onsite impacts to geology or soils are anticipated.

Multipurpose Reactor. The multipurpose MHTGR would disturb an additional 270 acres of land to accommodate the construction of three additional reactor modules and a Pit Disassembly/Conversion Facility. The additional land area disturbances would result in the destruction of the soil profile and potential temporary increase in erosion as a result of stormwater runoff and wind action. The three additional reactor modules would also double the excavation requirements over that for the tritium supply MHTGR. The excavated soil would substantially increase the volume of soil needing storage and/or disposal. Impacts on ground water resources from the excavation are not expected to change substantially from that expected from three reactor modules. Groundwater flow direction may be influenced in the immediate construction area from the extent of the excavation. However, appropriate engineering measures are available to minimize potential groundwater infiltration into the excavation and groundwater impacts.

Construction impacts for the multipurpose ALWR would be the same as those described for the tritium supply ALWR. Additional soil impacts would be expected from the construction of the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility needed to support the multipurpose ALWR. Approximately 129 acres would be disturbed for the new facility, destroying the soil profile and leading to a possible temporary increase in erosion as a result of stormwater runoff and wind action. Soil losses would depend on frequency of storms; wind velocity; location of the facility with respect to drainage and wind pattern; slope, shape, and area of the tracts of ground disturbed; and the duration of time the soil is bare.

Soil impacts during operation are expected to be minimal. Appropriate erosion and sediment control measures would be used to minimize any long-term soil losses.

Potential Mitigation Measures. Mitigation measures would be required to control erosion of soil, especially during construction. Potential mitigation measures include accepted standard practices for erosion, sediment, and dust control such as silt fences, sediment traps, runoff diversion dikes, drainageways, sedimentation ponds, establishment of ground cover and windbreaks, grading of slopes, and construction of berms or other controls appropriate to the site. Standard control for wind erosion, such as wetting the surface, could be done on a day-to-day basis. Exposing only small areas for limited periods of time, as necessary, would also reduce erosional effects. After the construction period, long-term control measures could include grading, revegetation, or landscaping.

4.6.3.6 *Biotic Resources*

Construction and operation of a tritium supply technology and upgrade of existing recycling facilities at SRS would affect biotic resources. Impacts resulting from the construction of the HWR, MHTGR, ALWR, or Full APT to meet the baseline tritium requirement would occur only at the beginning of the project lifecycle.

The less than baseline tritium requirement Phased APT could incur some additional construction-related impacts if expansion is needed to meet baseline tritium requirements. The potential impacts would be minor since the expansion would occur in the already developed main plant site. Impacts to terrestrial resources would result from the loss of habitat during construction and operation.

Impacts to wetlands would be avoided to the extent possible or mitigated in accordance with U.S. Army Corps of Engineers permit requirements. Water withdrawals would cause some minor increases in impingement and entrainment. During construction and operation, dewatering discharge and cooling system blowdown could impact wetlands and aquatic ecosystems; however, with appropriate mitigation, impacts to these resources could be reduced.

Federal-listed threatened or endangered species potentially affected by the proposed action are the short-nosed sturgeon and wood stork. Several special status species could be affected because of the destruction of plant species and less mobile animal species during construction. Where potential conflicts occur, mitigation measures would be developed in consultation with the USFWS. Consultation would be conducted during site-specific tiered NEPA document preparation. Table 4.6.3.6–1 summarizes the potential changes to biotic resources at SRS resulting from the proposed action. As noted in the table, no major differences in impacts to biotic resources exist between the four tritium supply technologies.

The following discussion of impacts from a multipurpose reactor and a dedicated power plant for the APT applies to the biotic resources at SRS as a whole. Where potential impacts to a specific biotic resource are notable for the tritium supply technologies, the discussion on multipurpose reactors identifies the potential impacts to the same resource.

TABLE 4.6.3.6–1.—*Potential Impacts to Biotic Resources Resulting from Tritium Supply Technologies and Recycling During Construction and Operation at Savannah River Site*

Affected Resource Indicator	No Action	Tritium Supply Technologies: HWR	MHTGR	ALWR	APT	Tritium Recycling Upgrade
Acres of habitat disturbed	0	260	360	350	173	0
Wetlands potentially impacted	None	Yes	Yes	Yes	Yes	None
Aquatic resources potentially impacted	None	Yes	Yes	Yes	Yes	None
Number of threatened and endangered species potentially affected[a]	0/0	2/20	2/20	2/20	2/20	0/0

[a] The number of threatened and endangered species are represented by two data inputs (a/b) where: a is the number of Federal-listed threatened and endangered species, and b is the number of all other special status species (i.e., Federal candidate and/or state-listed species) that are potentially impacted.

Source: DOE 1992k; DOE 1992o.

Multipurpose Reactor. The selection of the multipurpose reactor option could result in additional impacts to biotic resources at SRS. The MHTGR Pit Disassembly/Conversion Facility and the ALWR Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would require an additional 129 acres of land. However, it is expected that during the design phase, land requirements for this facility would be substantially reduced when integrated into the reactor and recycling facility design. In addition to the fuel fabrication facility, an MHTGR would require three additional modules which would displace about 240 acres. Thus, total land requirements for the MHTGR and ALWR multipurpose reactors would be 931 and 691 acres, respectively. In general, impacts to terrestrial resources and threatened and endangered species would be similar to, but greater than, those described for the tritium supply and recycling facility.

Although the fuel fabrication facility would require some additional water, construction and operation of the MHTGR would greatly increase both water use and discharge. Selection of the ALWR as the multipurpose reactor would not result in an increase in water use or wastewater discharge beyond the increase required for the fuel fabrication facility. If the MHTGR option is selected, impacts to wetlands and aquatic resources would be greater than those described for construction and operation of the three module MHTGR. Mitigation measures would be required to lessen impacts to these resources.

For both the MHTGR and ALWR multipurpose reactor options, impacts to threatened and endangered species would be similar to, but greater than, those described for the tritium supply and recycling facility. This is the case since more land and water would be required.

Accelerated Production of Tritium Power Plant. A dedicated natural gas-fired power plant, similar to that described in section 4.8.2.2, could be an option to support an APT at SRS. This facility, which would be constructed on the proposed TSS, would occupy 25 acres of land. Construction of the gas-fired power plant would increase the land disturbance associated with the APT from 375 to 400 acres. This would result in a slight increase in impacts to biotic resources over those described for the tritium supply and recycling facility. Infrastructure requirements, such as parking and laydown areas, would be incorporated into and take advantage of similar requirements associated with the APT. Rights-of-way would be sited to take advantage of existing corridors to the maximum extent practical. Since wet cooling towers would be used, impacts to vegetation from salt drift are possible.

Direct and indirect impacts to wetlands resulting from construction of a power plant would be similar to those described for the APT. If new intake and discharge structures are required, wetlands bordering the affected water body could be impacted. Also, the discharge of cooling and other wastewater could adversely affect any wetlands in the vicinity of the outfall. Any impacts to wetlands would require a permit from the U.S. Army Corps of Engineers and all discharges would be required to meet NPDES permit and state water quality requirements.

Direct and indirect impacts resulting from construction of a natural gas-fired power plant would be similar to those described for the APT. Construction of new intake and discharge structures, if required, could adversely impact aquatic resources by disturbance of the stream bottom. Downstream impacts could result from sedimentation and turbidity. Such impacts would be temporary in nature. Operational impacts could include impingement and entrainment of aquatic organisms. Also, if discharges represented a large proportion of the stream flow of the receiving water body, streambed scouring and subsequent increases in turbidity and downstream sedimentation could affect aquatic habitat, including spawning habitat. Thermal impacts from the discharge of cooling tower blowdown are also possible. Many of these potential impacts could be reduced through proper design of intake and discharge structures and by taking water from and discharging it to larger water bodies. All effluent discharges would be required to meet NPDES permit and state water quality requirements.

Impacts from construction and operation of a power plant on threatened and endangered species would be similar to those described for the APT. Results of preactivity surveys associated with the APT would also apply to the power plant. If new intake and discharge structures are required, preactivity surveys would also be required for these structures.

Terrestrial Resources

No Action. Under No Action, missions described in section 3.3.5 would continue at SRS. This would result in no changes to current terrestrial conditions at the site described in section 4.6.2.6.

Tritium Supply. Construction and operation of the HWR, MHTGR, ALWR, or APT would result in the disturbance of approximately 260 acres, 360 acres, 350 acres, or 173 acres, respectively, or less than 0.2 percent of SRS (table 4.6.3.6–1). These acreages include areas on which permanent tritium supply facilities would be constructed, as well as areas revegetated following construction. Vegetation within the proposed TSS would be lost during land-clearing activities. The majority of the proposed TSS consists of old fields and pine plantations that are common on SRS and throughout the region (SR DOE 1991b:4.3). Bottomland hardwoods and wetlands would be avoided to the extent possible.

Construction of a tritium supply facility would have some adverse effects on animal populations. Less mobile animals, such as amphibians, reptiles, and small mammals, within the project area would be destroyed during land-clearing activities. Construction activities would cause larger mammals and birds to move to similar habitat nearby. Nests of migratory birds and young animals living within the proposed TSS could be lost during construction. Upon completion of construction, revegetated areas would be of minimal value to most types of wildlife because they would be maintained as landscaped areas.

During tritium supply operation, drift from cooling towers may cause salt deposition on surrounding land areas and vegetation. Previous studies for a tritium production reactor at SRS predicted that 13 acres would receive salt deposition at a rate of 15.2 pounds per acre per month. This is the deposition rate at which salt stress symptoms could become evident on sensitive plants (DOE 1992e:5-213). Although specific data are not available, all the potential tritium supply technologies would use less water than the previous design. Assuming similar parameters for the previous and current designs, impact from salt drift is expected to be less for the proposed tritium supply technologies. The potential impact to natural vegetation would be reduced because a portion of the salt drift would fall on developed areas in the vicinity of the cooling tower.

Activities associated with tritium supply facility operations, such as noise and human presence, could affect wildlife living immediately adjacent to the facility. These disturbances may cause some species to move from the area.

Tritium Recycling Upgrade. Upgrade of the tritium recycling facilities is not expected to impact terrestrial resources since all construction activities would take place within existing facilities.

Less Than Baseline Operations. Operation of the HWR, MHTGR, or ALWR at reduced tritium production capacity would have the same impacts described above for production at baseline tritium requirements.

Construction-related impacts of the less than baseline tritium requirement Phased APT would be similar to those described above. Some additional construction-related impacts could occur if expansions is needed to meet baseline tritium requirements. The potential impacts would be minor since the expansion activities would occur in the already developed main plant site.

Potential Mitigation Measures. The loss of habitat due to construction and operation of a tritium supply facility may be mitigated by revegetating with native species where possible. Disturbances to wildlife in areas adjacent to new facilities could be minimized by preventing workers from entering undisturbed areas. It may be necessary to survey the proposed construction site for the nests of migratory birds or eagles prior to construction and/or avoid clearing operations during the breeding season.

Wetlands

No Action. Under No Action, the missions described in section 3.3.5 would continue at SRS. Because these facilities are already in place, no construction impacts would occur. Also, normal operations are not expected to adversely impact site wetlands. The continued shutdown of K-, L-, and P-Reactors would allow continued recovery of wetlands along the Steel Creek and Pen Branch stream corridors.

Tritium Supply. Since the majority of the proposed TSS is upland, the facility could be located to avoid direct impacts to wetlands. Implementation of soil erosion and sediment control measures would control secondary impacts. Impacts to wetlands resulting from the construction of intake or outfall structures would be temporary. Any unavoidable displacement of wetlands would be made in accordance with the U.S. Army Corps of Engineers permit requirements.

Construction wastewater discharge to Fourmile Branch would be minimal (section 4.6.3.4) and would not be expected to affect wetlands associated with the stream. However, without mitigation, de-watering discharge from an MHTGR or APT could result in adverse effects to Fourmile Branch and the Savannah River swamp. Stream bank scouring could cause a loss of vegetation bordering Fourmile Branch and could result in sediment build up in the Savannah River swamp. This could in turn cause swamp forest vegetation to be replaced by scrub/shrub or emergent vegetation. If dewatering discharge is directed to Par Pond, these impacts would be avoided. The controlled release of water from Par Pond would preclude impacts to wetlands associated with Lower Three Runs Creek.

Cooling system blowdown would be directed to either Fourmile Branch or Par Pond. Intermittent discharges of large volumes of water from cooling system blowdown to Fourmile Branch could adversely impact wetlands bordering the stream and the Savannah River swamp. Sediment build up in the Savannah River swamp resulting from streambed scouring could result in swamp forest vegetation being replaced by scrub/shrub or emergent vegetation. Also, erosion of stream banks could result in the loss of wetland vegetation. Thermal impacts to wetlands were not predicted for a previous larger tritium reactor planned for SRS (DOE 1992e:5-215); thus, such impacts are not expected for the proposed tritium supply technologies. All discharges would be required to comply with NPDES permit requirements.

As an alternative to discharging blowdown water from Fourmile Branch, water from cooling tower blowdown could be discharged to Par Pond via precooling ponds (i.e., Pond 2, Pond 5, and Pond C). Makeup water currently is pumped into Par Pond from the Savannah River to maintain its level and the proper rate of flow in Lower Three Runs Creek (DOE 1992e:4-119). If blowdown water from a tritium supply facility is sent to Par Pond, no impacts to wetlands would be anticipated since there would be no change in the level of Par Pond or the flow rate of Lower Three Runs Creek. Under this discharge alternative, sanitary wastewater would be discharged to Fourmile Branch. Due to the small volume of discharge, impacts to wetlands would not be expected. All discharges would be through NPDES-permitted outfalls. Impacts are not expected from salt deposition because the tritium supply facility could be sited away from wetlands and potential impacts would be limited to a relatively small area.

Tritium Recycling Upgrade. Upgrading the tritium recycling facilities would have no effect on wetlands because all construction activities would take place within existing facilities. Normal operation of the upgraded facilities would not impact site wetlands since liquid effluents would not be released to site streams.

Less Than Baseline Operations. Operation of the HWR, MHTGR, or ALWR at reduced tritium production capacity would have the same wetland impacts described above for the baseline tritium production requirement. However, operation of the HWR at reduced capacity would potentially reduce slightly the volume and temperature of cooling water discharges. The MHTGR- or ALWR-related wetland impacts would not change from the baseline tritium production requirement consequences since the reactor would operate at the same level to maintain power levels for steam or electrical production. Construction and operation of a Phased APT would have similar wetlands impacts as described for the Full APT.

Potential Mitigation Measures. Construction impacts to wetlands could be avoided by siting facilities in areas away from wetland habitat, and implementing effective soil erosion and sediment control measures. The use of detention ponds would reduce the impact of discharges to wetlands associated with Fourmile Branch. Any unavoidable impacts would be mitigated according to DOE policy set forth in 10 CFR 1022 and in accordance with U.S. Army Corps of Engineers requirements. All effluent discharges to wetlands would be regulated through the provisions of an NPDES permit.

Aquatic Resources

No Action. Under No Action, the missions described in section 3.3.5 would continue at SRS. This would result in no change to current aquatic conditions at the site. However, the continued shutdown of K-, L-, and P-Reactors would allow continued recovery of aquatic habitat along Steel Creek and Pen Branch corridor and a reduction in entrainment and impingement impacts.

Tritium Supply. Stormwater runoff during construction of an HWR, MHTGR, ALWR, or APT at SRS could cause temporary water quality changes in Fourmile Branch, Pen Branch, and in Carolina bays. Increased turbidity could impact some fish spawning and feeding habitats. Fish populations would probably move to less disturbed areas of the stream and recolonize disturbed areas shortly after construction is complete and water quality improves. Construction of intake and discharge facilities would result in the temporary loss of habitat in the affected water bodies.

During construction, wastewater would be discharged to Fourmile Branch. These discharges would be minimal (section 4.6.3.4) and would not be expected to affect aquatic resources. Dewatering discharge from an MHTGR or APT could, without mitigation, result in increases in stream flow. Impacts to aquatic resources could result from streambed scouring, sedimentation and flooding, and could include changes in existing plant and animal communities. Directing dewatering discharge to Par Pond would preclude impacts to Fourmile Branch. Because Par Pond currently receives makeup water in order to maintain its present level, the addition of dewatering discharge would not impact the pond and, in fact, would lessen the makeup water requirements. The rate at which water is released from Par Pond to Lower Three Runs Creek would not change and therefore not affect the aquatic resources in the stream.

Operation of the HWR, MHTGR, ALWR, or APT would withdraw water from the Savannah River. The volume of water withdrawn represents a small percentage of the average flow of the river and would not affect its flow (section 4.6.3.4). However, an increase in entrainment and impingement of fish could occur. Based on previous studies for a large tritium production reactor at SRS (DOE 1992e:5-218) and monitoring of past SRS operations (WSRC 1989e:4-506), fish populations should not be adversely affected by entrainment losses from operation of a new tritium supply facility. Similarly, impingement losses should not adversely impact fish populations. Studies have shown that SRS operations have a low rate of impingement relative to power plants operating in the southeastern United States (DOE 1992e:5-218; WSRC 1989e:4-506). Impact to anadromous fish (e.g., striped bass and several species of shad) due to entrainment and impingement, would also be relatively low and would not adversely affect their populations. In compliance with the *Anadromous Fish Conservation Act*, populations of anadromous fish species on or near SRS would be sustained and their movement unobstructed by project construction and operation.

During operation, nonhazardous wastewater would be discharged to Fourmile Branch. Flow increases are not expected to adversely impact stream hydrology (section 4.6.3.4). Discharge of water from cooling system blowdown from an HWR, MHTGR, ALWR, or APT would be directed to either Fourmile Branch or Par Pond. Without mitigation, intermittent discharges of large volumes of water from blowdowns would greatly increase the flow rate of Fourmile Branch (section 4.6.3.4), causing flooding and stream bed scouring. These discharges could alter the aquatic ecosystem by displacing existing plant and animal communities. Previous studies for a large tritium production reactor indicated that water temperatures of discharges were expected to be within the thermal tolerance limits of native warm water fish species. The temperature of water from blowdown discharges were also expected to be within normal water temperatures for each season and were not expected to alter the distribution or abundance of aquatic organisms in receiving waters. However, the temperature of blowdown water discharged to Fourmile Branch was predicted to exceed the maximum temperature differential of 2.8 °C between effluent and receiving stream during the cooler months of the year. Such an exceedance would require a Section 316(a) demonstration of a balanced biotic community (DOE 1992e:5-219).

Discharge of blowdown to Par Pond would have no adverse flow impacts since the reservoir currently receives makeup water at rates greater than the predicted discharge rate for potential tritium supply technologies. In fact, projected discharges could reduce the need for makeup water for Par Pond. Thermal impacts to Par Pond would not be expected since discharged water would pass through a series of precooling ponds designed to meet the State of South Carolina requirements for thermal releases to Class B waters; however, the recovery of the precooling ponds from past thermal discharges would be affected.

Regardless of the location of the outfall, all discharges would be required to meet NPDES requirements.

Tritium Recycling Upgrade. Upgrading the tritium recycling facility would have no impact on aquatic resources because all construction activities would take place within existing structures. Normal operation of the upgraded facility would not impact aquatic resources because liquid effluents would not be relegated to site streams.

Less Than Baseline Operations. Operation of the HWR, MHTGR, or ALWR at reduced tritium production capacity would have similar impacts to aquatic resources as described above for the baseline tritium production requirement. However, operation of the HWR at reduced capacity would potentially reduce the volume and temperature of cooling water discharges and may result in less aquatic resource impacts. The MHTGR or ALWR related aquatic resource impacts would not change from the baseline tritium production requirements consequences since the reactor would operate at the same level to maintain power levels for steam or electrical production. Construction and operation of a Phased APT would have similar aquatic resource impacts as described for the Full APT.

Potential Mitigation Measures. Impacts to aquatic resources could be mitigated by implementing a soil erosion and sediment control plan to reduce turbidity, and through the use of discharge detention ponds, avoid large increases in the rate of stream flow. Intake structures could be designed and operated to reduce intake flow rates, thereby reducing impingement and entrainment losses.

Threatened and Endangered Species

No Action. Under No Action, the missions described in section 3.3.5 would continue, with no change in impacts to threatened and endangered species at SRS.

Tritium Supply Facility. Special status species that would potentially be impacted by the construction of a tritium supply facility include the awned meadow-beauty (Federal candidate, Category 2), green-fringed orchid, eastern tiger salamander (state, species of concern), Florida false loosestrife, beak-rush, star-nosed mole, and Cooper's hawk (state, undetermined). If present, individuals of each of these species could be destroyed, except the Cooper's hawk which could be temporarily displaced during construction. A pre-activity survey would be required prior to construction to determine the occurrences of these and other special status species including the Federal-listed smooth purple coneflower (see table 4.6.2.6–1).

Impacts to special status species during facility operations would be minimal. The short-nosed sturgeon (Federal, endangered) has been observed in the Savannah River where cooling water would be withdrawn. Sturgeon eggs tend to sink and are strongly adhesive and gelatinous, which limits their downstream transport and dispersal through the water column. Thus, sturgeon eggs do not have a high entrainment risk. The preference of sturgeon larva for benthic habitat and the ability of juvenile and adult sturgeon to attain swimming speeds above the water intake velocity demonstrate the unlikelihood of impingement losses of this species (DOE 1992e:5-222). Cooling system blowdown discharged to Fourmile Branch could cause an increase in stream depth which could disrupt the foraging activities of the wood stork (Federal, endangered).

Tritium Recycling Upgrade. Upgrading the tritium recycling facilities would not impact threatened and endangered species since all construction activities would take place within existing structures. Normal operation of the upgraded facilities would not adversely effect threatened and endangered species.

Less Than Baseline Operations. Operation of the HWR, MHTGR, or ALWR at reduced tritium production capacity would be expected to result in similar impacts to threatened, endangered, or sensitive species as described for the baseline tritium production requirement. Construction and operation of a Phased APT also would have similar impacts on the Federal-listed, Federal candidate, and state-listed species discussed above for the baseline tritium production requirement.

Potential Mitigation Measures. Disturbance of threatened, endangered, and special status species would be avoided where possible. Land clearing could be scheduled to avoid the nesting season of protected bird species. Where appropriate, a habitat restoration or propagation program could be attempted for plants when their disturbance is unavoidable. Potential impacts to the foraging activities of the wood stork could be mitigated by the use of detention ponds to control the cooling system blowdown discharge flow rate and avoid drastic stream depth increases. An alternative measure would be to direct cooling system blowdown water to Par Pond.

A biological assessment describing the impacts to Federal-listed species resulting from the proposed development of a tritium supply technology at SRS was previously submitted to the USFWS for evaluation. Further consultation with the USFWS would be required if SRS is selected as the location for the tritium supply facility and, if necessary, a detailed plan to mitigate impacts to Federal-listed threatened and endangered species at SRS would be developed. Currently, no critical habitat has been designated for threatened and endangered species at SRS.

4.6.3.7 *Cultural and Paleontological Resources*

Cultural and paleontological resources may be affected directly through ground disturbance during construction, building modifications, visual intrusion of the project to the historic setting or environmental context, visual and audio intrusions to Native American resources, reduced access to traditional use areas, and unauthorized artifact collecting and vandalism. Intensive cultural resources surveys and site evaluations have not been conducted for the majority of the proposed TSS. Site-specific surveys and evaluations would be conducted in conjunction with tiered NEPA document. Although the location and acreage for the proposed tritium supply facilities will vary, their potential effects on cultural and paleontological resources are based primarily on the amount of ground disturbance; therefore, the facilities with the greatest ground disturbance will have the greatest potential effect on cultural and paleontological resources. Three NRHP-eligible historic sites and some important Native American resources may be affected by the proposed action. Effects to prehistoric and paleontological resources will be negligible.

Multipurpose Reactor. Total land requirements for the MHTGR and ALWR multipurpose reactors would be 931 and 691 acres, respectively. NRHP-eligible prehistoric and historic sites, Native American resources, and paleontological resources may occur within these acreages and may be affected by the construction of a multipurpose reactor. Paleontological resources are limited at SRS to common assemblages with relatively low research potential; therefore, impacts are expected to be limited. In general, impacts to prehistoric and historic resources and Native American resources would be similar to, but potentially greater than, those described for the tritium supply and recycling facility.

Prehistoric and Historic Resources

No Action. Under No Action, DOE would continue existing and planned missions at SRS. Any impacts to prehistoric and historic resources from these missions would be independent of and unaffected by the proposed action.

Tritium Supply. Land disturbance for the proposed tritium supply facilities (section 3.4) would range from 360 acres for the MHTGR to 173 acres for the smallest facility (APT) (section 4.6.3.1). Acreages for the HWR and ALWR would be 260 and 350, respectively. Three NRHP-eligible historic sites occur within the acreage that would be disturbed during construction. No NRHP-eligible prehistoric sites occur. Any project-related effects to NRHP-eligible resources will be addressed in tiered NEPA documentation. Because operation of facilities does not involve additional ground disturbance or increased activity, prehistoric or historic sites would not be affected.

Less Than Baseline Operations. No change in impacts to prehistoric and historic resources would be expected from operating the HWR at reduced capacity. Impacts for the MHTGR or ALWR would also not change from that described for the baseline requirement because the MHTGR or ALWR would not be a reduced size or operate at reduced capacity.

Construction and operation of the Phased APT would not change the expected impacts from the baseline tritium requirement since the disturbed area would be the same.

Tritium Recycling Upgrade. Because the upgrade of tritium recycling facilities does not involve ground disturbance, increased activity, or external building modifications, prehistoric and historic sites would not be affected.

Tritium Recycling Phaseout. In the event that a tritium supply technology and new recycling facility is constructed at a site other than SRS, the existing tritium recycling mission would be phased out at SRS. The existing tritium facilities would remain in place following phaseout; therefore, no onsite impacts to prehistoric or historic resources are expected.

Potential Mitigation Measures. If NRHP-eligible sites cannot be avoided through project design or siting, then the potential exists for an adverse effect. A Programmatic Memorandum of Agreement exists between the DOE, the South Carolina SHPO, and the Advisory Council on Historic Preservation for implementing the Archaeological Resources Management Plan. The plan describes intensive inventory and evaluation studies, data recovery plans, site treatments, and monitoring programs to be conducted if NRHP-eligible resources would be adversely affected. Mitigation measures for specific NRHP-eligible sites would be identified during preparation of tiered NEPA documents.

Native American Resources

No Action. Under No Action, DOE would continue existing and planned missions at SRS. Any impacts to Native American resources from these missions would be independent of and unaffected by the proposed action.

Tritium Supply. Some Native American resources may occur within the acreages to be disturbed during construction of the tritium supply facilities. These Native American resources could include villages, traditional plant gathering areas, cemeteries, and burials. Operation of facilities may create audio or visual intrusions on Native American sacred sites in the vicinity or reduce access to traditional use areas. Specific concerns about the presence, type, and locations of Native American resources would be identified through consultation with the potentially affected Native American tribes, and any project-related effects would be addressed in tiered NEPA documents.

Less Than Baseline Operations. Impacts to Native American resources would not change due to less than baseline operation of the HWR, MHTGR, or ALWR. Construction and operation of a Phased APT would have similar impacts on Native American resources as those described for the baseline tritium requirement Full APT.

Tritium Recycling Upgrade. Because the upgrade of tritium recycling facilities does not involve ground disturbance or increased activity, Native American resources would not be affected.

Tritium Recycling Phaseout. Because phaseout of tritium recycling capabilities does not involve ground disturbance or increased activity, Native American resources would not be affected.

Potential Mitigation Measures. If Native American resources cannot be avoided through project design and siting, then acceptable mitigation measures to lessen the effect on these resources would be determined in consultation with potentially affected Native Indian groups. In accordance with the *Native American Graves Protection and Repatriation Act* and the *American Indian Religious Freedom Act*, such mitigations may include, but not be limited to, appropriate relocation of human remains, planting vegetation screens to reduce visual and noise intrusions, increasing access to traditional use areas during operation, or transplanting or harvesting important Native American plant resources.

Paleontological Resources

No Action. Under No Action, DOE would continue existing and planned missions at SRS. Any impacts to paleontological resources from these missions would be independent of and unaffected by the proposed action.

Tritium Supply. Fossiliferous geological formations with surface exposures occur within areas designated for the proposed tritium supply facilities. All known paleontological materials consist of relatively common and widespread invertebrate fossils, and these assemblages have relatively low research potential. Consequently, while there may be effects on paleontological resources, impacts would be considered negligible for all the proposed tritium supply technologies at SRS.

Less than Baseline Operations. No change in impact to paleontological resources would be expected due to reduced operation of the HWR, MHTGR, or ALWR. Construction of a Phased APT would have the same impact on paleontological resources as the Full APT.

Tritium Recycling Upgrade. Because the upgrade of tritium recycling facilities does not involve ground disturbance or increased activity, paleontological resources would not be affected.

Tritium Recycling Phaseout. Because phaseout of tritium recycling facilities does not involve ground disturbance or increased activity, paleontological resources would not be affected.

Potential Mitigation Measures. Because impacts to paleontological resources would by negligible, no mitigation measures are necessary.

4.6.3.8 *Socioeconomics*

Locating any of the tritium supply technologies and upgrading the existing recycling facilities at SRS would affect socioeconomics in the region. Section 3.2 provides descriptions for No Action, the tritium supply technologies with the tritium recycling facilities upgrade, and the phaseout of the tritium recycling mission. Each of these actions would create changes in some of the communities in both the ROI and the regional economic area.

If tritium supply technology is located with the recycling facility at SRS, the in-migrating population could increase the demand for housing units. Additionally, there would be an associated increased burden on community infrastructure and subsequent effects on the public finances of local governments in the ROI. The increase of population could also burden transportation routes in the ROI.

Phaseout of the tritium recycling mission at SRS would also adversely affect the ROI through out-migration, housing vacancies, and unemployment. There would be a reduction in the demand for community services and infrastructure, but there would also be reductions in tax revenues.

During the construction period, the greater changes in socioeconomic characteristics would result from the ALWR and APT. During operation, the HWR, MHTGR, and ALWR would exhibit similar characteristics. The APT would result in the smallest changes during operation. None of these tritium supply technologies would increase population, the need for additional housing, or local government spending in the ROI beyond 3 percent over No Action during peak construction or operation. Although the greatest percent increases in employment, population and housing, and public finance during construction and operation occur in the peak years of 2005 and 2010, respectively, the annual average increases in the ROI over the construction period (2001 to 2005) are between 1 percent and 2 percent and less than 1 percent during operation (2010 to 2050). Between peak construction (2005) and full operation (2010), average annual growth varies from decreases of 1 percent to increases of 1 percent.

The effects of locating any of the tritium supply technologies and upgrading existing recycling facilities at SRS are summarized in section 4.6.3. The following sections describe the effects that locating one of these technologies or phasing out the tritium recycling mission would have on the local region's economy and employment, population, housing, public finances, and local transportation.

Employment and Local Economy

Changes in employment and levels of economic activity in the 26-county regional economic area from the proposed siting of tritium supply technologies and tritium recycling facilities upgrade or phaseout of the tritium recycling mission at SRS are described in this section. Although specialized personnel, materials, and services required for construction and operation would be imported from outside the area, a significant portion of these requirements would be available in this regional economic area. Figures 4.6.3.8–1 through 4.6.3.8–3 present the potential changes in employment and local economy that would occur with all of the technologies and recycling facilities upgrade and tritium recycling phaseout.

No Action. Under No Action, employment at SRS decreased to approximately 20,300 persons in 1994. This is a decrease of about 2,000 persons from the 1990 employment. SRS employment is projected to total almost 16,900 persons in 2010 and remain at this level through 2020. Historical and future employment projections at SRS are presented in appendix table D.2.1–1. The total SRS payroll was approximately $1.23 billion in 1994 and is projected to total $1.09 billion in 2010.

Total employment in the regional economic area is projected to grow less than 1 percent annually between 2001 and 2005, reaching approximately 559,900 persons, and to decrease by less than 1 percent annually between 2010 and 2020, reaching 564,500 persons. The unemployment rate in the regional economic area is expected to remain at 4.8 percent between 2001 and 2020. Per capita income is projected to increase from $18,300 to $21,000 during this 20-year period. No Action estimates are presented in appendix table D.3–73.

Tritium Supply and Tritium Recycling Upgrade. Construction activities would begin between 2001 and 2003 and would be completed between 2007 and

2009. Upgrade of the tritium recycling facilities is expected to be completed between 2004 and 2007. Phasing in of employment for the operation of the tritium supply and the upgraded recycling facilities would begin in 2007 or 2009, peak at full employment by 2010, and continue at this level into the future.

Locating any of the tritium supply technologies and upgrading the tritium recycling facilities at SRS would create new jobs (direct) at the site. Additional indirect job opportunities, such as community support services, would also be created in the regional economic area as a result of these new jobs. The total new jobs (direct and indirect) created would reduce unemployment and increase income in the economic region surrounding SRS during both the construction and operation periods of the proposed action.

Construction. Siting a tritium supply technology and upgrading the tritium recycling facilities at SRS would require a total of approximately 6,470 to 12,700 worker-years of activity over a 5- to 9-year construction period. This construction-related employment would indirectly create other jobs in the regional economic area and total employment would grow at an annual average rate of 1 percent, until the peak year of 2005. Between peak construction (2005) and full operation (2010), average annual growth in employment would increase by much less than 1 percent for all of the tritium supply technologies and recycling facilities upgrade. Figure 4.6.3.8–1 gives the estimates of total project-related jobs (direct and indirect) that would be created during peak construction (year 2005) for each of the tritium supply technologies with the tritium recycling facilities upgrade.

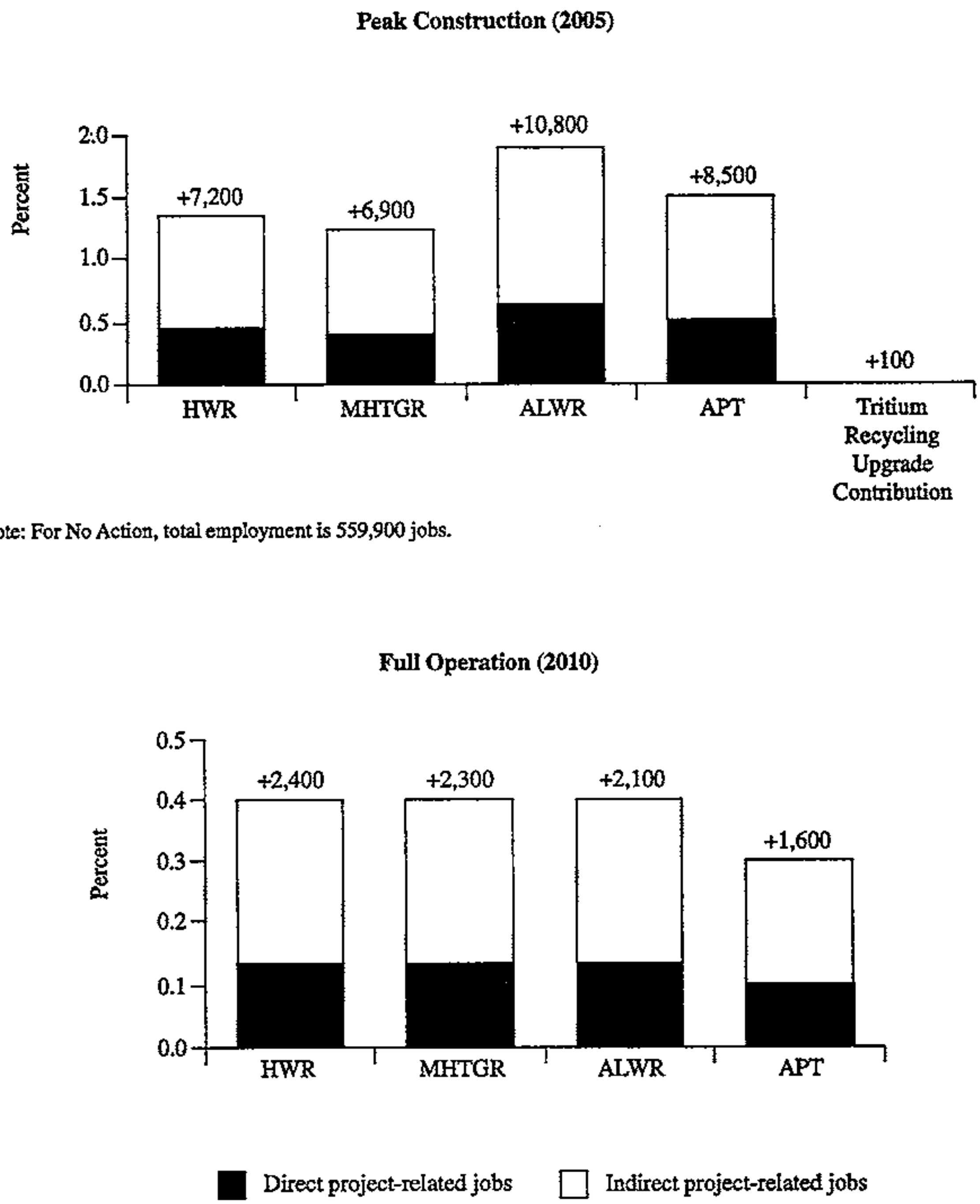
As employment opportunities would increase in the regional economic area due to the proposed action, the unemployment rate would be reduced from the No Action estimate of 4.8 percent. Figure 4.6.3.8–2 presents a comparison of unemployment rates for the different tritium supply technologies and recycling facilities upgrade during peak construction in 2005. During the project's peak construction phase, the unemployment rate would range from a high of 4 to 3.9 percent, depending upon the tritium supply technology selected.

Income in the regional economic area would also increase, particularly during peak construction as shown in figure 4.6.3.8–2. Per capita income is expected to increase slightly at an annual average of about 1 percent until the peak year of construction, 2005. Between 2005 and 2010, annual average growth in per capita income is also expected to increase by 1 percent for all of the tritium supply technologies. In comparison, under No Action, per capita income is expected to increase 1 percent annually during both periods.

Operation. Siting a tritium supply technology would help offset the employment and income losses at SRS from the approximately 2,000 jobs lost between 1990 and 1994. The upgrade of tritium recycling would not create any additional facilities jobs at SRS. Employment for operation would begin phasing in as construction nears completion and the construction-related employment begins phasing out. It is expected that full operation employment would peak in 2010 and continue at this level into the future. Figure 4.6.3.8–1 gives the total project-related jobs projections (direct and indirect) for each of the tritium supply technologies with the upgrade of the tritium recycling facilities for the year 2010. Annual average growth in total employment would be flat between 2010 and 2020, similar to the No Action annual average growth rate.

Creation of additional job opportunities would also reduce the unemployment rate below that projected for No Action. Figure 4.6.3.8–2 presents the differences in unemployment rates during the first year of full operation employment (2010) for each of the tritium supply technologies with the upgraded tritium recycling facilities. From 2010 to 2020, unemployment would be reduced from the No Action projection of 4.8 percent to between 4.6 and 4.5 percent, depending upon the technology selected for the proposed action.

Income would also increase slightly in the regional economic area as a result of the proposed action. Per capita income differences for tritium supply technologies with the upgraded tritium recycling facilities for the year 2010 are given in figure 4.6.3.8–2. Per capita income annual average increases would be about 1 percent between 2010 to 2020 for any of the tritium supply technologies located with the recycling facilities upgrade at SRS. The No Action projected annual average increase during the same period would also be approximately 1 percent.



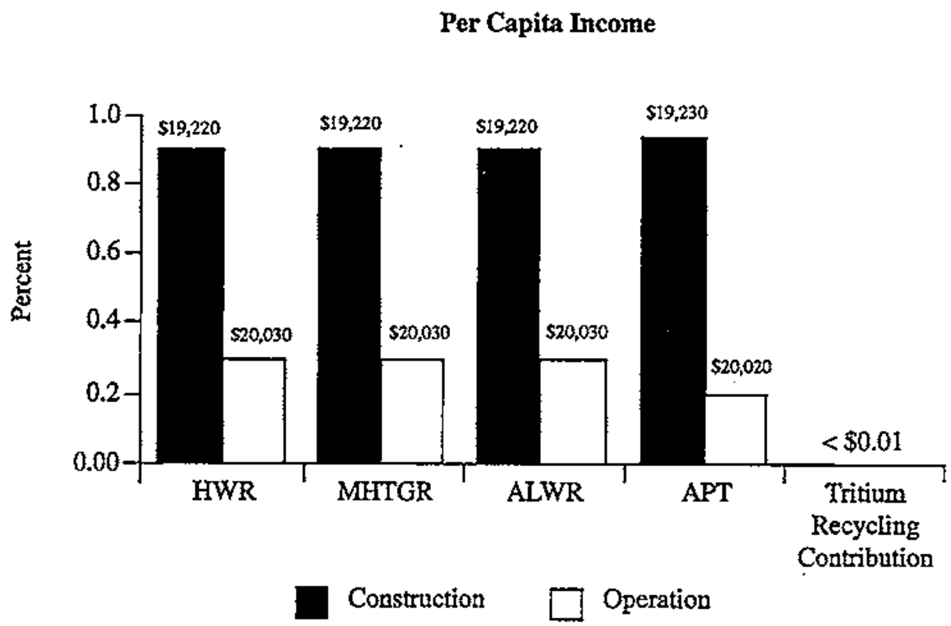
Note: For No Action, total employment is 559,900 jobs.

Note: For No Action, total employment is 574,700 jobs. The percent increase in total employment during construction and operation was calculated by dividing the total project-related jobs by the total employment for No Action. The upgrade of tritium recycling facilities would not contribute to the total project-related employment.

Source: Appendix table D.3–74.

FIGURE 4.6.3.8–1.—*Total Project-Related Employment (Direct and Indirect) and Percentage Increase Over No Action from Tritium Supply Technologies with Recycling Upgrade for Savannah River Site Regional Economic Area.*

Note: The upgrade of tritium recycling facilities would not affect the unemployment rate.



Note: For No Action, per capita income is projected to be $19,050 in 2005 and $19,980 in 2010.

Note: The upgrade of tritium recycling facilities would not contribute to per capita income increases during peak construction and full operation.

Source: Appendix table D.3–74.

FIGURE 4.6.3.8–2.—*Unemployment Rate, Per Capita Income, and Percentage Increase Over No Action from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Regional Economic*

Tritium Recycling Phaseout. Phasing out the tritium recycling mission at SRS would result in the loss of 800 total jobs (300 direct and 500 indirect). The unemployment rate in the regional economic area would increase from a No Action estimate of 4.8 percent to 4.9 percent. Also as a result of phasing out the tritium recycling mission, per capita income in the regional economic area would be reduced by approximately $20. Effects on employment and income from phasing out the tritium recycling mission in 2010 are provided in figure 4.6.3.8–3.

Less Than Baseline Operations. Tritium supply technologies that provide less than the baseline tritium operation capacities are described in section 3.1. These options may or may not be collocated with the tritium recycling facilities. The options include lowering the power in the HWR, using fewer target rods in the MHTGR or ALWR, and the phased approach for the APT.

Construction. The less than baseline operations case for the HWR, MHTGR, and ALWR would have the same construction workforce requirements as discussed in the tritium supply and recycling upgrade section. Therefore, employment and economic effects in the region would be the same.

The Phased APT would require the same total number of construction workers as the Full APT, but the construction period would span from 1999 to 2008 instead of from 2003 to 2007. Additionally, peak construction would occur in 2003 instead of 2005. The effects on the regional economic area's employment, unemployment rate, and per capita income as a result of constructing the Phased APT with the tritium recycling upgrade are presented in appendix table D.3–74. Generally, average annual increases in employment and income are lower than the Full APT, but these increases are over a longer period of time. These increases are between 1 and 2 percent, the same as the No Action estimates.

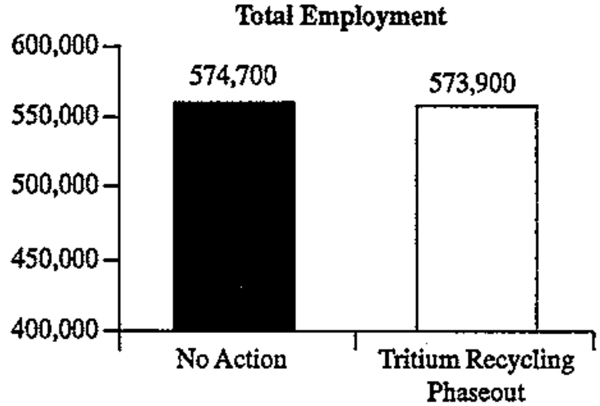
Operation. Operation workforce requirements for the less than baseline case for the HWR, MHTGR, ALWR, and the Phased APT would be the same as those described in the tritium supply and recycling upgrade section. Thus, regional employment and economic effects would be the same.

Multipurpose Reactor. Construction activities for the multipurpose reactor would begin in 2001 and would be completed by 2009. Phasing in of employment for the operation of the multipurpose reactor would begin in 2007, peak at full employment by 2010, and continue at that level into the future. Because this option would perform three processes, it would result in greater changes in employment and local economy characteristics than any of the four tritium supply technologies.

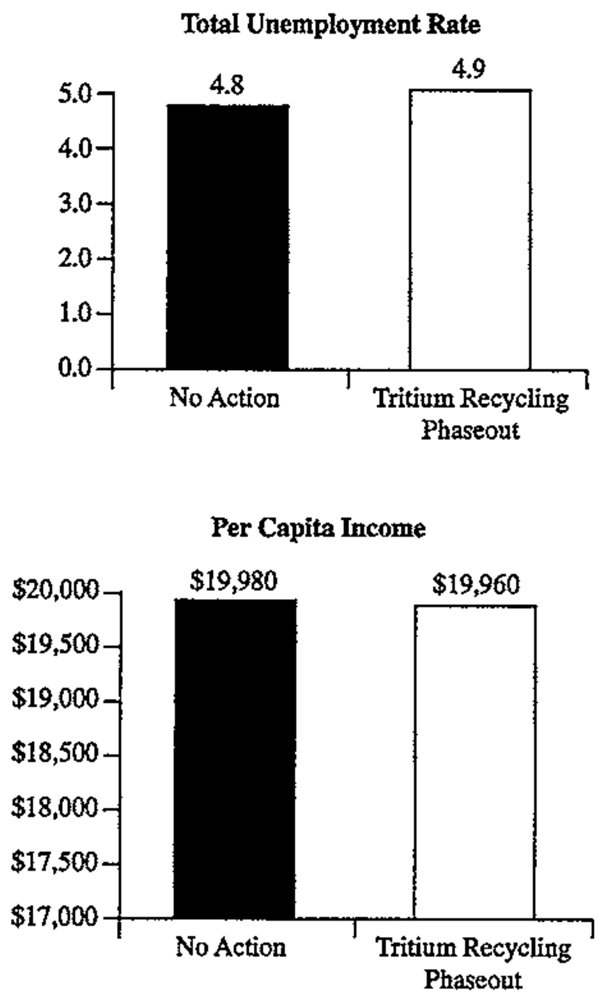
Construction. Siting the multipurpose reactor and upgrading tritium recycling at SRS would require 18,240 worker-years of activity over a 9-year period. Employment characteristics, unemployment rates, and per capita income characteristics during construction of the multipurpose reactor and tritium recycling upgrade are presented in appendix table D.3–74A. From the first year of construction to the peak year (2005), average annual increases in employment and per capita income would be 2 percent. Between 2005 and 2010, employment growth would be flat and per capita income would increase on an annual average of 1 percent. The unemployment rate during peak construction for this option would be 3.9 percent.

Operation. Operation employment for the multipurpose reactor would begin phasing in toward the end of the construction period and reach full employment in 2010. Full employment is expected to be maintained for the life of the facility. Employment characteristics, unemployment rates, and per capita income characteristics during operation of the multipurpose reactor and tritium recycling upgrade are presented in appendix table D.3–74A. During operation annual employment growth would be flat and annual average growth in per capita income would be less than 1 percent. The unemployment rate for the multipurpose reactor with the recycling upgrade would be 4.2 percent.

Accelerator Production of Tritium Power Plant. Construction activities for the APT power plant would begin in 2003 and would be completed by 2007. Phasing in of employment for the operation of the APT power plant would begin in 2007, peak at full employment by 2010, and continue at that level into the future. This option is similar to the APT with an addition of a gas power plant. The changes in



Note: Tritium recycling phaseout would result in a 0.14-percent decrease in total employment from No Action. Total direct and indirect employment lost would be approximately 800 jobs.



Note: Tritium recycling phaseout would result in a 0.09-percent decrease in per capita income from No Action.
Source: Appendix table D.3–74.

FIGURE 4.6.3.8–3.—*Total Employment, Unemployment Rate, and Per Capita Income for No Action and Tritium Recycling Phaseout for Savannah River Site Regional Economic Area, 2010.*

employment and local economy would be similar, but greater than those resulting from the APT.

Construction. Siting this option with an upgraded recycling facility at SRS would require 6,700 worker-years of activity over a 5-year period. Employment characteristics, unemployment rates, and per capita income characteristics during construction of this option are presented in appendix table D.3–74A. From the first year of construction to the peak year (2005), average annual increases in employment and per capita income would be 1 percent. Between 2005 and 2010, employment and per capita income would increase on an annual average of 1 percent. The unemployment rate during peak construction for this option with or without a recycling facility would be 3.8 percent.

Operation. Operation employment for the APT power plant would begin phasing in toward the end of the construction period and reach full employment in 2010. Full employment is expected to be maintained for the life of the facility. Employment characteristics, unemployment rates, and per capita income characteristics during operation of the APT power plant with the tritium recycling upgrade are presented in appendix table D.3–74A. During operation annual employment growth would be flat and average annual growth in per capita income would be 1 percent. The unemployment rate for the APT power plant with the recycling upgrade would be 4.6 percent.

Population and Housing

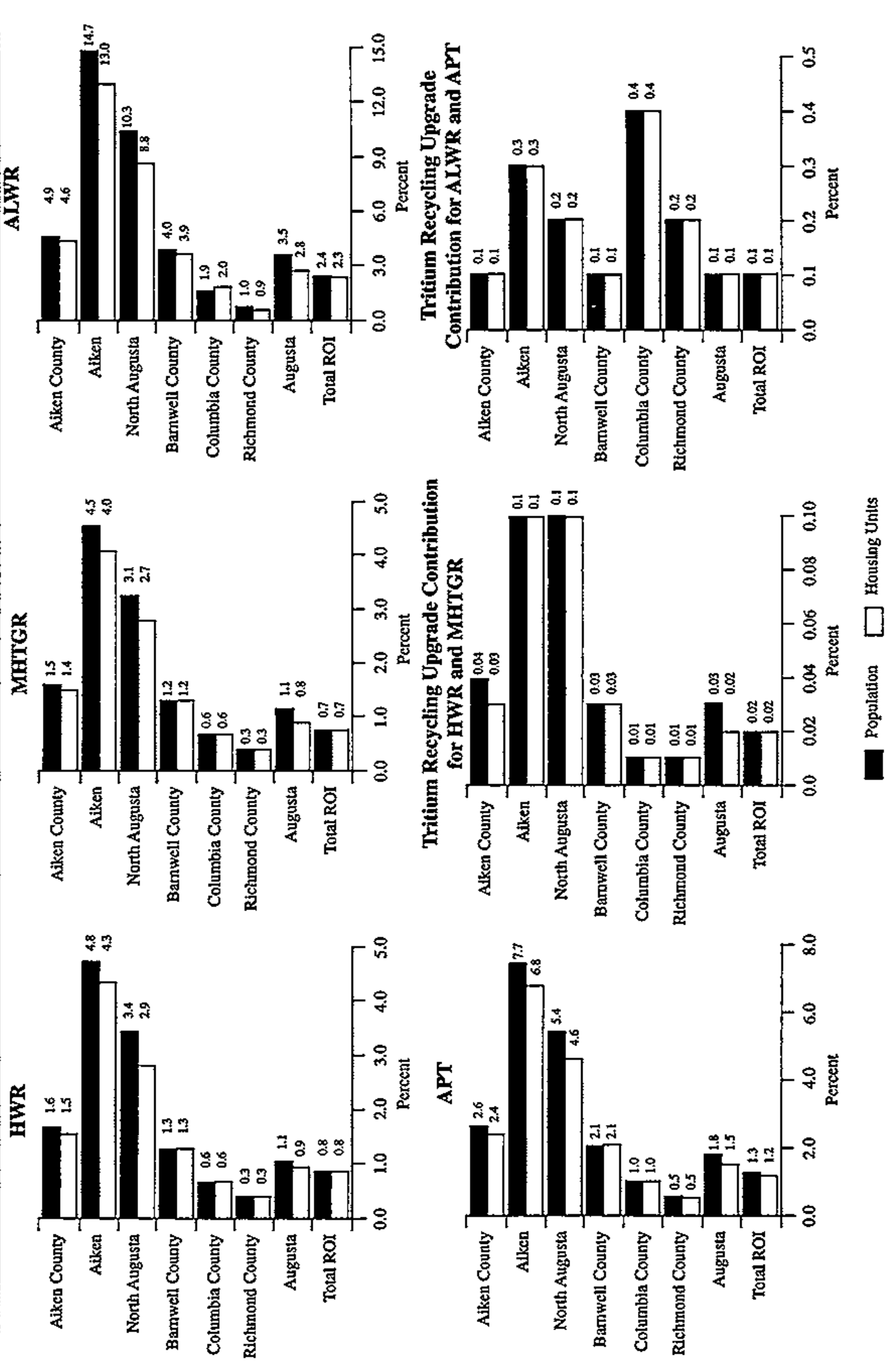
Changes to ROI population and housing expected from the proposed location of a tritium supply technology and the upgraded tritium recycling facility at SRS are described in this section. If a tritium supply technology is located at SRS, additional population could be expected to in-migrate to the SRS region, and these people would be expected to reside in cities and counties within the ROI in the same relative proportion as the existing population. Increases in population could lead to a demand for additional housing units beyond existing vacant housing available during construction or operation phases of the proposed action. Alternatively, the phaseout of the tritium recycling mission could lead to population out-migration and an increase in housing vacancies in the ROI. Figures 4.6.3.8–4 through 4.6.3.8–6 present the changes in population and housing for the tritium supply technologies and tritium recycling facilities and tritium recycling phaseout.

No Action. Population and housing annual average increases between 2001 and 2005 are projected to be less than 1 percent. Future annual average increases are also projected to be less than 1 percent between 2005 and 2010. Population in the ROI is estimated to reach 454,900 in 2010 and 473,000 in 2020. Total housing units in the ROI are estimated to reach 181,400 in 2010 and 188,400 in 2020. No Action estimates are presented in appendix tables D.3–75 and D.3–77.

Tritium Supply and Tritium Recycling Upgrade. The location of a tritium supply technology and upgraded tritium recycling facility would increase population and housing demands in the ROI slightly (2 percent) over No Action projections during peak construction. The effects are expected to be fewer (much less than 1 percent) during the operation phase of the proposed action.

Construction. Construction activities would be phased over a 5- to 9-year period. Figure 4.6.3.8–4 illustrates that during peak construction (2005), the ALWR and APT would create the largest population and housing demand increases over No Action, and the HWR and MHGTR would have the least effects. The increase in population could require some additional housing units beyond what are currently available in the existing housing mix. However, any requirements for additional housing units in the ROI would be at annual average increases of 1 percent in the first 3 years of construction of the ALWR. Between 2005 and 2010, population annual average growth in the ROI would be flat. The other tritium supply technologies would have annual average population and housing demand growth of less than 1 percent. Therefore, there would not be any major effects on any of the ROI communities.

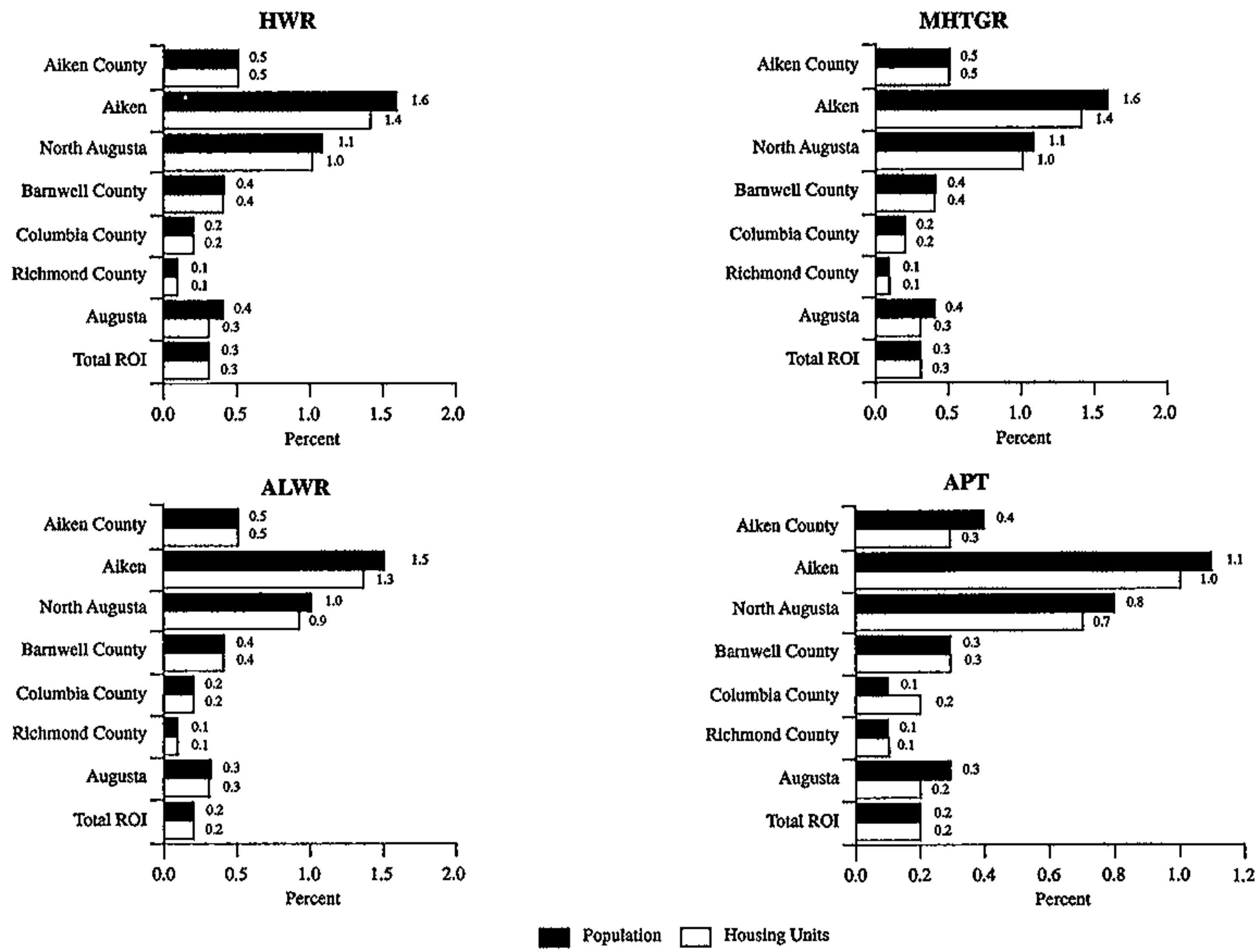
Operation. Operation of tritium supply technology and upgraded tritium recycling facilities is expected to reach full employment by 2010. In-migrating population is expected to demand housing units similar to the existing housing mix in the ROI. Figure 4.6.3.8–5 shows that population increases and potential demand for additional housing units over No Action projections are almost negligible (much less than 1 percent) in this peak year. Given that the



Note: For No Action, population and housing in the ROI total 442,600 persons and 176,500 units, respectively. For county and city population and housing breakdowns, see appendix tables D.3–76 and D.3–78.

Source: Appendix tables D.3–76 and D.3–78.

FIGURE 4.6.3.8–4.—*Total Population and Housing Percentage Increase Over No Action During Peak Construction from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Region of Influence, 2005.*



Note: For county and city population and housing breakdowns, see appendix tables D.3–76 and D.3–78.
Source: Appendix tables D.3–76 and D.3–78.

FIGURE 4.6.3.8–5.—*Total Population and Housing Percentage Increase Over No Action at Full Operation from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Region of Influence, 2010.*

operations of the proposed action would be phased in over a 4-year period, it is expected that existing vacancies would absorb much of this new demand and that No Action requirements would be exceeded by very few units. The upgrade of tritium recycling facilities would not contribute to population growth.

Tritium Recycling Phaseout. Phasing out the tritium recycling mission at SRS would result in the loss of 800 jobs (300 direct and 500 indirect). Annual average growth in population and housing resulting from the phaseout would be the same as No Action. Effects on population and housing from this phaseout are presented in figure 4.6.3.8–6.

Less Than Baseline Operations. Population increases and housing demands would be the same or lower during construction and operation of tritium supply technologies operated at less than baseline tritium requirements than the alternatives discussed in the tritium supply and recycling upgrade section.

Construction. Population increases and housing demands would be the same as those given in figure 4.6.3.8–4 for the HWR, MHTGR, and ALWR. The Phased APT will increase population and housing demand during construction to the same level as the Full APT, but this will occur over a longer construction period with lower average annual increases (much less than 1 percent). Also, the peak construction year would be 2003 instead of 2005. The effects of the Phased APT with the recycling upgrade on population and housing are given in appendix tables D.3–76 and D.3–78, respectively.

Operation. The effects on population and housing of operating the HWR, MHTGR, ALWR and Phased APT at less than baseline tritium requirements would be the same as those given in figure 4.6.3.8–5.

Multipurpose Reactor. Locating the multipurpose reactor with an upgraded recycling facility at SRS would not increase population and housing demands more than 4 percent over No Action projections during the construction period and 1 percent during operation.

Construction. Because this option would perform three processes, it would result in greater changes in population and housing characteristics than any of the four tritium supply technologies. Changes to population and housing characteristics resulting from the multipurpose reactor with the tritium recycling upgrade are presented in appendix tables D.3–76A and D.3–78A. Population and housing growth in the ROI would be at an annual average rate of 1 percent until 2005 and would be flat between 2005 and 2010.

Operation. Full employment levels for the multipurpose reactor would be reached by 2010. As illustrated in appendix tables D.3–76A and D.3–78A, potential demand for housing units would be less than 1 percent in the first year of full employment. It is expected that existing vacancies would absorb most of this new demand as employment would be phased in from 2007 through 2010.

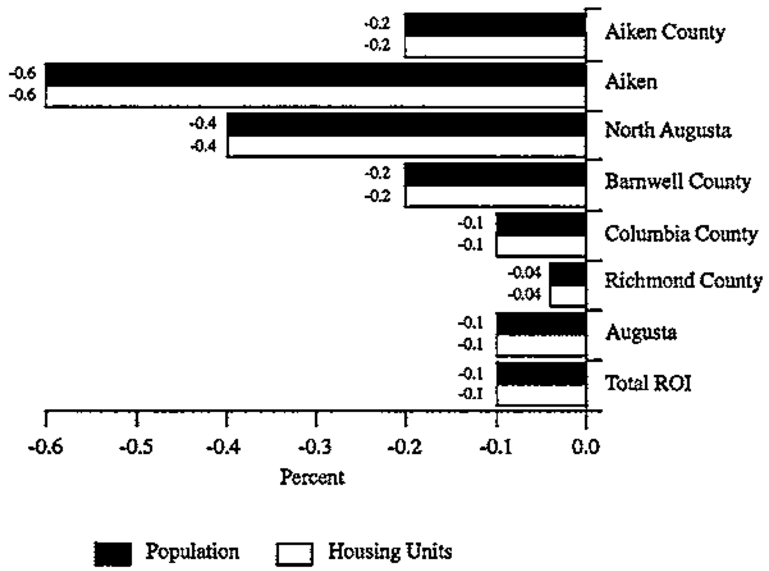
Accelerator Production of Tritium Power Plant. Locating the APT power plant with the recycling facility upgrade at SRS would not increase population and housing demands more than 2 percent over No Action projections during the construction period and 1 percent during operation.

Construction. This option is similar to the APT with an addition of a gas power plant. The changes in population and housing demands would be similar, but greater than those resulting from the APT. Changes to population and housing characteristics resulting from APT power plant with the recycling upgrade are presented in appendix tables D.3–76A and D.3–78A. Population and housing growth in the ROI would be at an annual average rate of 1 percent until 2005 and would be flat between 2005 and 2010.

Operation. Full employment levels for the accelerator production of tritium power plant would be reached by 2010. As illustrated in appendix tables D.3–76A and D.3–78A, potential demand for housing units would be less than 1 percent in the first year of full employment. It is expected that existing vacancies would absorb most of this new demand as employment would be phased in from 2007 through 2010.

Public Finance

Fiscal changes could occur in some ROI local jurisdictions from the proposed action. Factors influencing these changes include residence of project-related employees and their dependents, cost and duration of construction, and economic conditions in the ROI once the tritium supply and upgraded recycling facilities are operational.



Note: For No Action, population and housing in the ROI total 442,600 persons and 176,500 units, respectively. For county and city population and housing breakdowns, see appendix tables D.3–76 and D.3–78.

Source: Appendix tables D.3–76 and D.3–78.

FIGURE 4.6.3.8–6.—*Total Population and Housing Percentage Decrease Under No Action from Tritium Recycling Phaseout for Savannah River Site Region of Influence, 2010.*

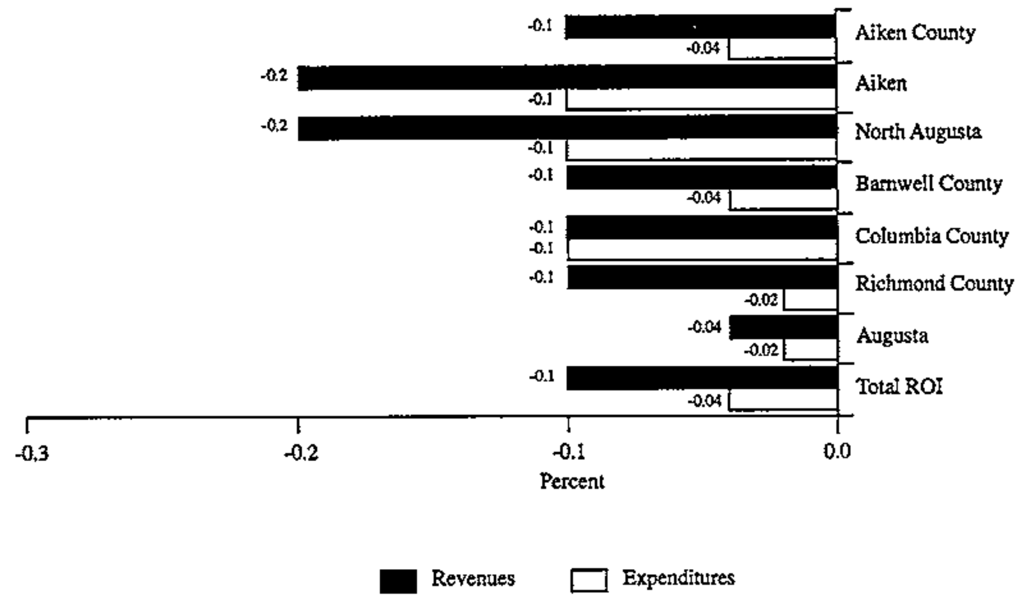
Implementing the proposed action at SRS would increase population, resulting in more revenues for ROI local jurisdictions. Additional population would also increase public service expenditures.

Phaseout of the tritium recycling mission could result in a decrease in total revenues due to the outmigration of workers and their dependents. These revenue reductions may require the cities, counties, and school districts in the ROI to develop alternative revenue sources or reduce expenditures. Figures 4.6.3.8–7 through 4.6.3.8–12 present the potential fiscal changes that would occur with the different tritium supply technologies and the upgraded tritium recycling facilities and with the phaseout of the tritium recycling mission.

No Action. Appendix tables D.3–79 and D.3–80 present the 1992 public finances for ROI local jurisdictions. Appendix tables D.3–81 through D.3–84, present the impacts from the tritium supply technologies and upgraded recycling facilities compared to No Action construction and operation for the local counties, cities, and school districts. Between 2001 and 2005, ROI counties, cities, and school districts are projected to increase total revenues on an annual average of less than 1 percent. Total expenditures are also projected to increase on an annual average of less than 1 percent for ROI counties, cities, and school districts between 2001 and 2005. Additionally, between 2005 and 2010, total revenues and expenditures are expected to increase annually by less than 1 percent.

Between 2010 and 2020, projected annual average increases in total revenues are less than 1 percent for counties, cities, and school districts in the ROI. Total expenditures are also projected to increase on an average by less than 1 percent or less for ROI jurisdictions between 2010 and 2020.

Tritium Supply and Tritium Recycling Upgrade. The proposed action at SRS would create some fiscal benefits to local jurisdictions within the ROI. Some local government finances would be affected during the construction and operation phases of the proposed action. Construction-related effects on revenues and expenditures could span a 5- to 9-year period with the peak occurring in 2005. The effects of the operation phase would peak in 2010 and remain at this level throughout the life of the proposed action.



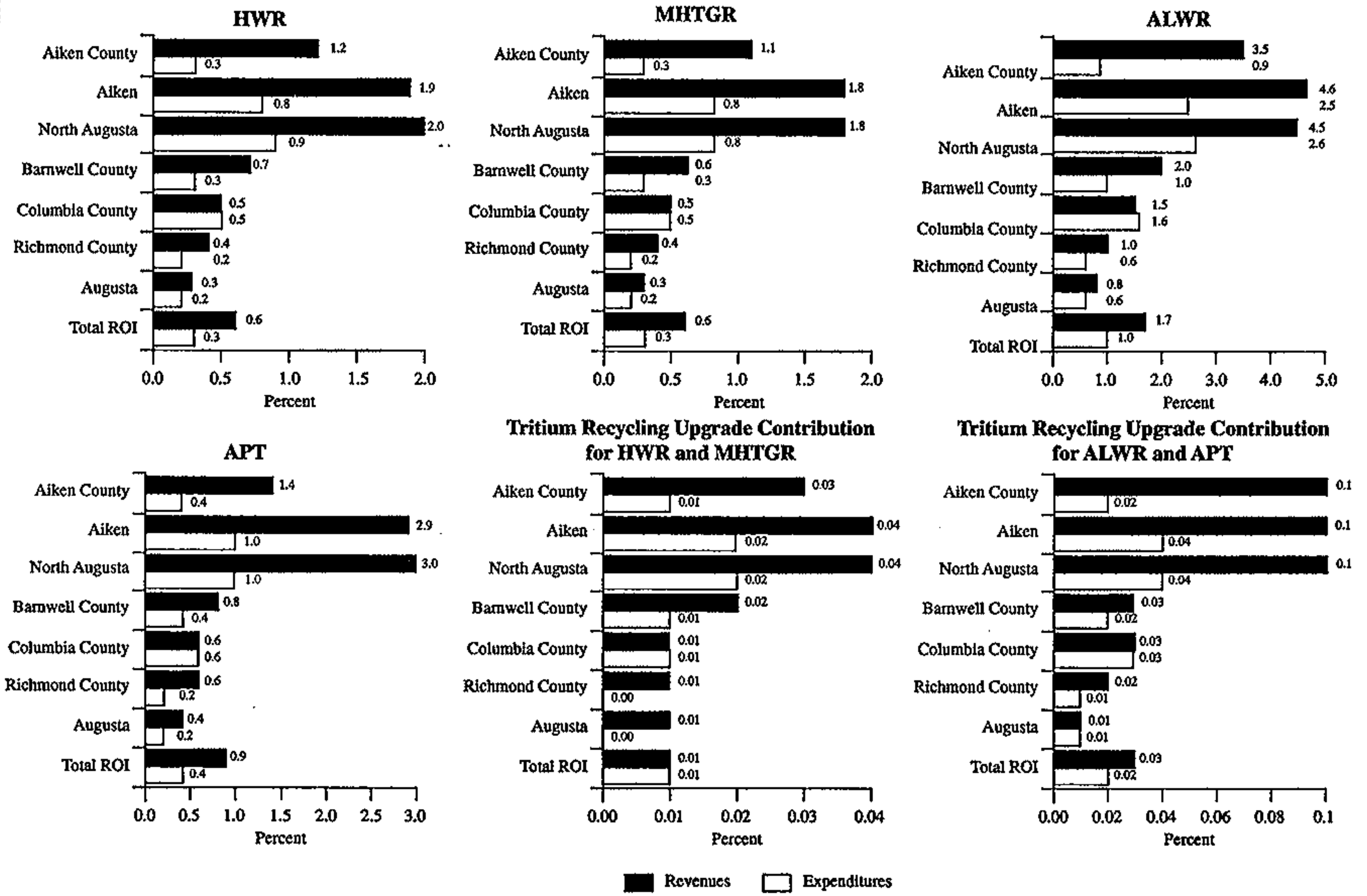
Note: For a complete breakdown of county and city revenues and expenditures, see appendix table D.3–82.
Source: Appendix table D.3–82.

FIGURE 4.6.3.8–7.—***County and City Total Revenues and Expenditures Percentage Decrease from No Action for the Tritium Recycling Phaseout for Savannah River Site Region of Influence, 2010.***

Construction. The public finances of counties, cities, and school districts within the ROI would be affected by the construction-related activities associated with the proposed action. Initially, there would be slight increases to some local government jurisdictions' revenues and expenditures, which would peak in 2005 and then decline as construction neared completion. Figures 4.6.3.8–8 and 4.6.3.8–10 present the revenue and expenditure changes of ROI local government jurisdictions and school districts over No Action during peak construction for the four tritium supply technologies with the upgraded tritium recycling facilities. Under the No Action estimates, local government revenues would increase at an annual average of 1 percent, and most local government expenditures would increase annually by 1 percent. Between 2005 and 2010 under these two scenarios, revenues and expenditures would grow less than 1 percent annually. With the ALWR, revenues and expenditures would increase between 4 percent to less than 1 percent in the first 3 years of construction. After the peak construction year, annual average growth in revenues and expenditures would be flat until 2010. With the HWR, MHTGR, and APT revenues and expenditures would increase annually less than 1 percent between 2002 and 2005 and then grow annually much less than 1 percent until 2010.

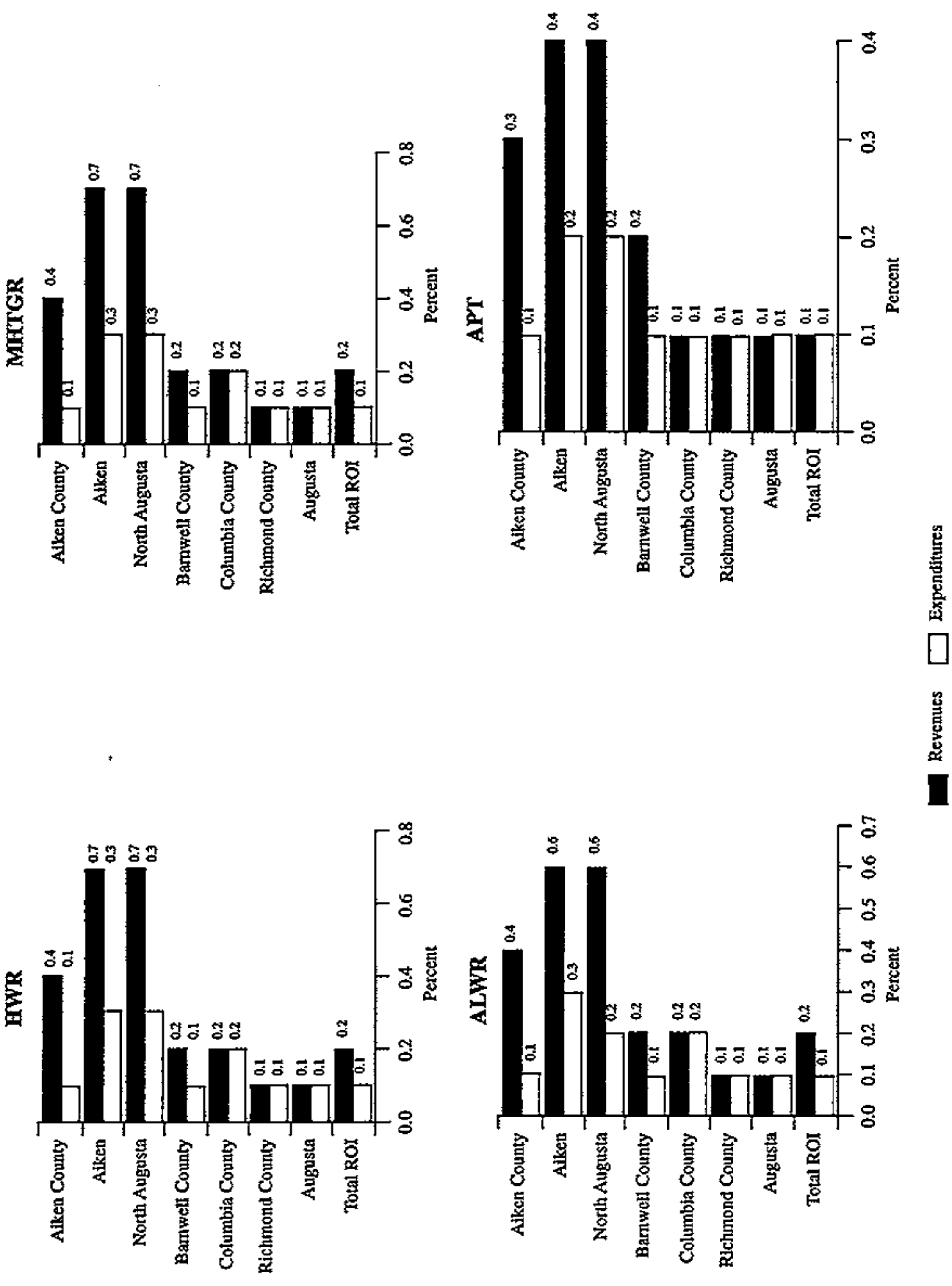
Operation. The effects of phasing in operation together with the phasing out of construction on ROI local government finances would be fewer than the effects at peak or full operation (2010). The effects that the four tritium supply technologies and the upgraded tritium recycling facilities would have on county, city, and school district revenues and expenditures are presented in figures 4.6.3.8–5 and 4.6.3.8–11. The upgrade of recycling facilities would not contribute to revenue and expenditure increases. Between 2010 and 2020, revenues are expected to increase slightly at an average annual rate of less than 1 percent for all jurisdictions. Expenditures also would increase to the year 2020 at an annual average of less than 1 percent. No Action local government revenues would also increase at an average annual rate of less than 1 percent, and expenditures for most ROI local governments would grow annually at less than 1 percent.

Tritium Recycling Phaseout. Phasing out the tritium recycling mission at SRS would result in a decrease in total revenues due to out-migration. The projected decreases in total revenues from baseline conditions are less than 1 percent for all ROI counties, cities, and school districts. Total expenditures would also decrease by less than 1 percent for all ROI jurisdic-



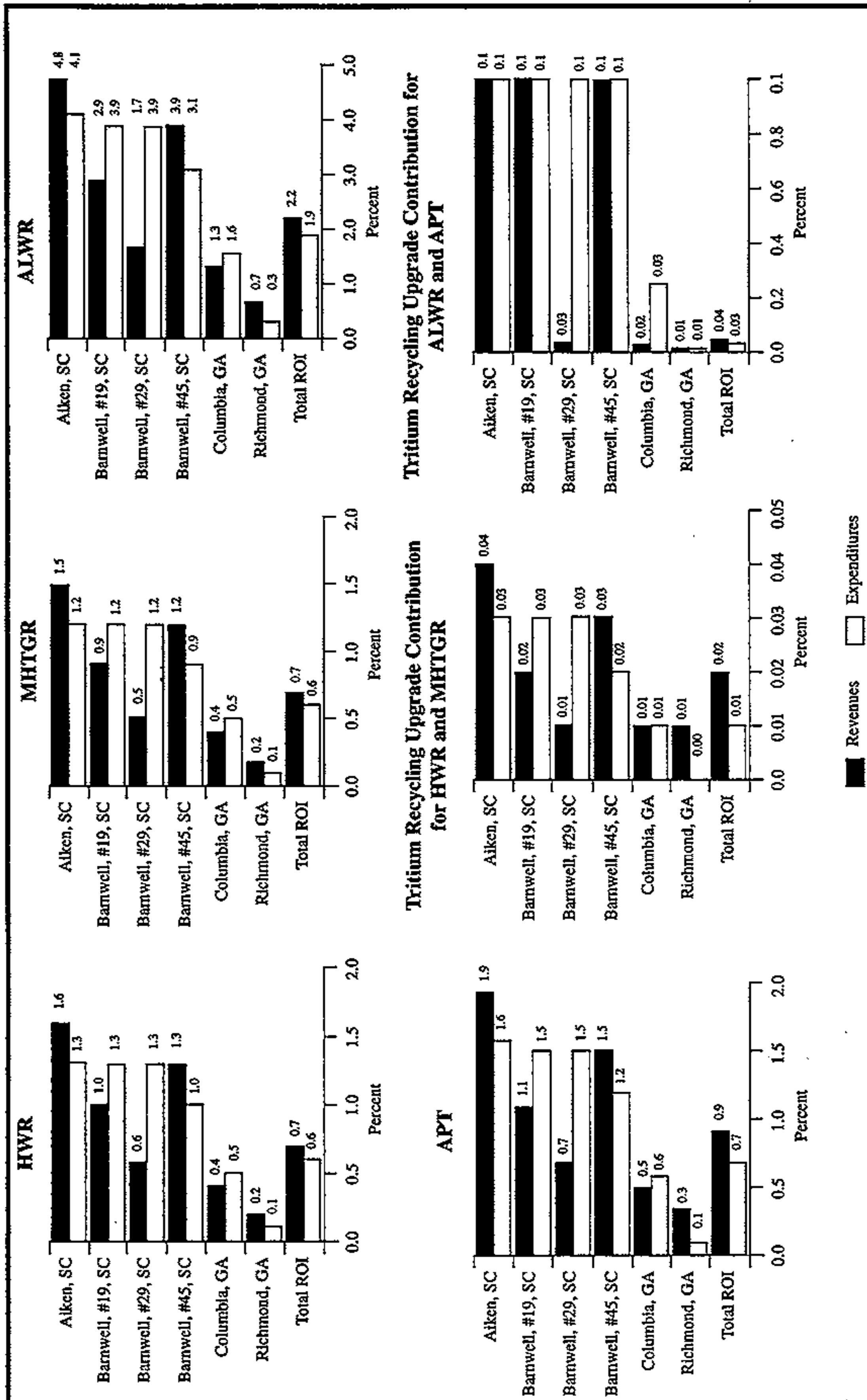
Note: For a complete breakdown of county and city revenues and expenditures, see appendix table D.3–81.
Source: Appendix table D.3–81.

FIGURE 4.6.3.8–8.—*County and City Revenues and Expenditures Percentage Increase Over No Action During Peak Construction from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Region of Influence, 2005.*



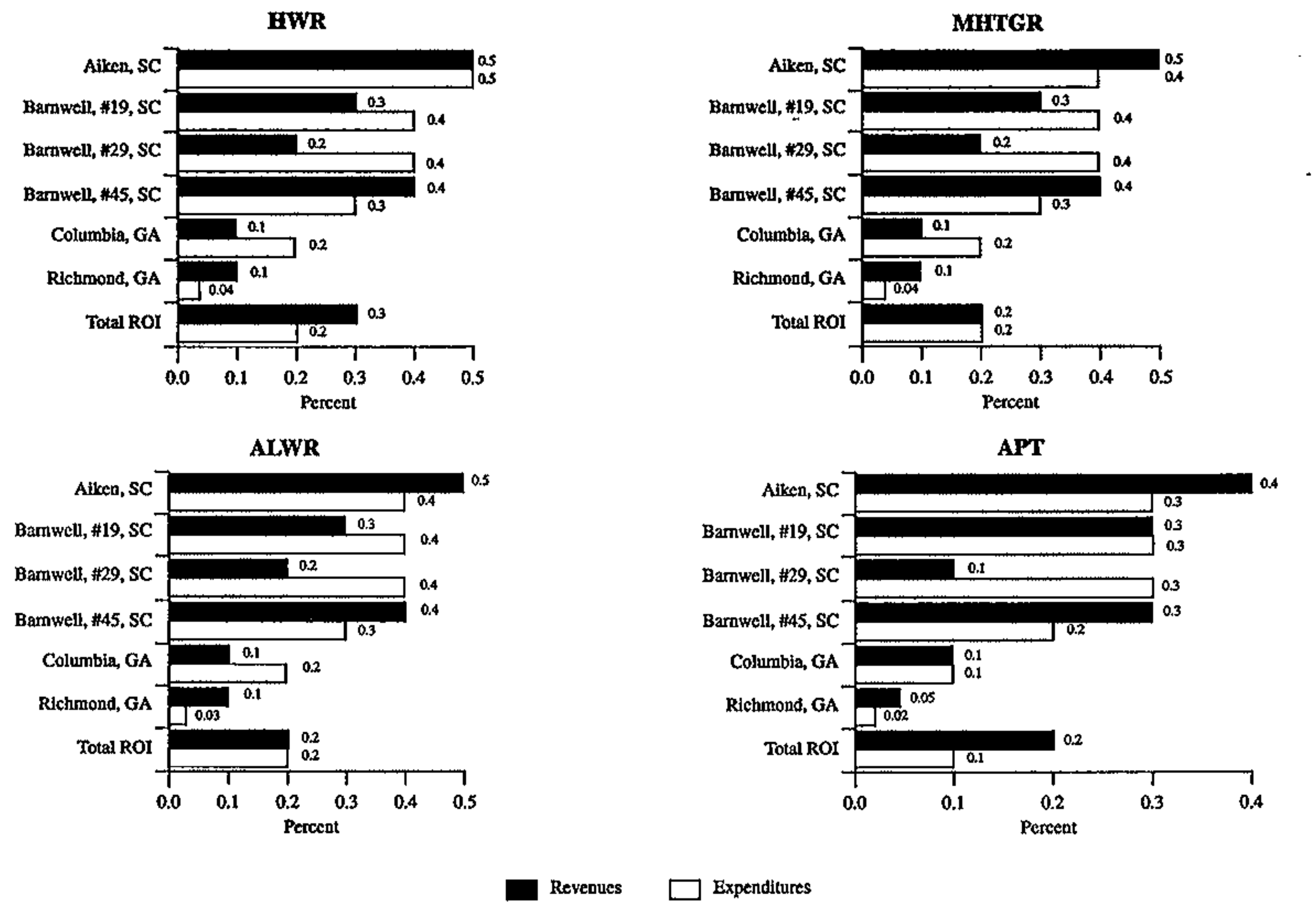
Note: For a complete breakdown of county and city revenues and expenditures, see appendix table D.3–82.
Source: Appendix table D.3–82.

FIGURE 4.6.3.8–9.—***County and City Revenues and Expenditures Percentage Increase Over No Action at Full Operation from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Region of Influence, 2010.***



Note: For a complete breakdown of school district revenues and expenditures, see appendix table D.3–83.
Source: Appendix table D.3–83.

FIGURE 4.6.3.8–10.—*School District Total Revenues and Expenditures Percentage Increase Over No Action During Peak Construction from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Region of Influence, 2005.*



Note: For a complete breakdown of school district revenues and expenditures, see appendix table D.3–84.
Source: Appendix table D.3–84.

FIGURE 4.6.3.8–11.—*School District Total Revenues and Expenditures Percentage Increase Over No Action at Full Operation from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Region of Influence, 2010.*

tions. Effects on public finance from phasing out the tritium recycling mission are provided in figures 4.6.3.8–7 and 4.6.3.8–12.

Less Than Baseline Operations. The fiscal benefits that local jurisdictions would accrue from the location of a tritium supply technology alone or collocated with recycling would be the same or less if the tritium supply technology is operated at less than baseline tritium requirements.

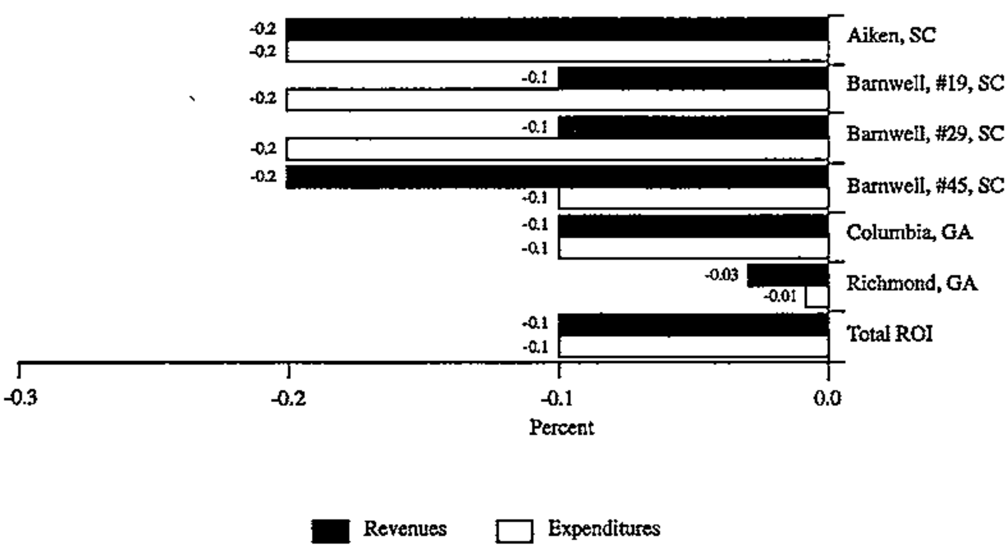
Construction. Increases in local jurisdictions' revenues and expenditures would be the same as those given in figures 4.6.3.8–8 and 4.6.3.8–10 if the HWR, MHTGR, and ALWR is built. If the Phased APT is constructed, the effects would peak in 2003 instead of 2005, and increases would be on an annual average lower. Appendix tables D.3–81 through D.3–84 give the revenue and expenditure changes as a result of constructing the Phased APT with the tritium recycling upgrade for all ROI jurisdictions.

Operation. Operation of the HWR, MHTGR, ALWR, and Phased APT at less than baseline tritium requirements would have the same effects on local jurisdictions' finances as those presented in figures 4.6.3.8–5 and 4.6.3.8–11.

Multipurpose Reactor. Locating the multipurpose reactor with the tritium recycling upgrade at SRS would create greater changes in public finance characteristics than the four tritium supply technologies because this option would perform three processes. Public finance characteristics for the multipurpose reactor with the upgrade are presented in appendix tables D.3-81A through D.3-84A.

Construction. Between the first year of construction and the peak year, 2005, revenues and expenditures in the local jurisdictions would increase annually by 1 percent. Between 2005 and 2010, growth of revenues and expenditures would generally be flat for most jurisdictions.

Operation. From the first year of full operation, 2010, to 2020, revenues and expenditures are generally expected to increase by less than 1 percent for most cities, counties, and school districts.



Note: For a complete breakdown of school district revenues and expenditures, see appendix table D.3–84.
Source: Appendix table D.3–84.

FIGURE 4.6.3.8–12.—*School District Total Revenues and Expenditures Percentage Decrease Under No Action from the Tritium Recycling Phaseout for Savannah River Site Region of Influence, 2010.*

Accelerator Production of Tritium Power Plant. Locating the APT power plant with the tritium recycling upgrade at SRS would create similar, but greater changes in public finance characteristics than the APT tritium supply technology. Public finance characteristics for the APT power plant with the upgrade are presented in appendix tables D.3-81A through D.3 84A.

Construction. Between the first year of construction and the peak year, 2005, revenues and expenditures in the local jurisdictions would increase annually between 1 and 3 percent. Between 2005 and 2010, growth of revenues and expenditures would be flat for most jurisdictions.

Operation. From the first year of full operation, 2010, to 2020, growth in revenues and expenditures is generally expected to increase by less than 1 percent for most cities, counties, and school districts.

Potential Mitigation Measures. Adding new missions to SRS would create new jobs and generally benefit the local economy through increased earnings in the ROI. Some mitigation measures may be required, such as Federal aid to local school districts where additional school age children would attend as a result of the proposed action. These new missions at SRS would increase population and the demand for additional housing units. Temporary housing units and mobile homes would help to alleviate the demand for new housing during the construction phase of the proposed action. Generally, construction would be phased over a 5- to 9-year period with peak construction occurring in 2005. Phasing the start of operation employment and training between 2005 and 2010 would reduce the annual level of housing demand and smooth the peak and valley effect that would occur between peak construction and full operation.

Also, if the tritium recycling facilities is consolidated instead of the unconsolidated upgrade used in this analysis, the effects on population increase and housing demand would be lower because of reduced workforce requirements. If the tritium recycling mission is phased out at SRS, and this mission is relocated to another site, unavoidable adverse economic consequences and out-migration of population would occur. Housing vacancies would also occur as a result of out-migration. These adverse effects could be reduced if the tritium recycling mission is phased out over time rather than in the single year 2010.

Although the effects of the tritium recycling mission phaseout to the region would be small, DOE is concerned about these workers and has developed proposals for mitigating employment effects. DOE is implementing a comprehensive economic adjustment program for all DOE facilities that would accomplish Congressional objectives established in the *National Defense Authorization Act* of 1993 (Section 3161).

DOE's economic adjustment initiatives aimed at mitigating job reductions include:

- Announce workforce changes early in order to spread required layoffs rather than all in one action.
- Work with the local community to help define and obtain funding for economic development initiatives.
- Coordinate with Federal and state agencies to provide retraining assistance. Eligible defense programs workers could enter retraining programs for new jobs in Environmental Restoration and Waste Management.
- Continue health benefits.
- Where appropriate, DOE would offer cash incentives to encourage early retirements or voluntary separations.
- Establish employee and outplacement assistance programs Complex-wide. Employees subject to layoffs at one site would receive preference for hiring at other sites.

Some of the tritium recycling mission workers could be redeployed to meet other SRS mission requirements or new missions such as decommissioning and decontamination, or be transferred to another site where the tritium recycling mission would be located.

Local Transportation

The following is a description of the effects on local transportation resulting from locating new missions at SRS. Construction and operation of a tritium supply technology and the upgraded tritium recycling facilities are expected to increase traffic volume and flow on site access routes.

No Action. Under No Action, the worker population at SRS would not increase. Therefore, any increases in traffic would not be the result of DOE-related activities at SRS. Access to the nearest interstate highway is 30 miles via 2-lane roads that pass through congested and populated areas. Other nearby interstate highways are 50 miles via predominantly 2-lane roads that pass through rural areas and small towns. The ROI would rarely be affected by winter weather conditions that would restrict access to the site. Traffic conditions on site access roads would remain as described in section 4.6.2.8.

Tritium Supply and Tritium Recycling Upgrade. Locating any of the tritium supply technologies with the upgraded tritium recycling facilities at SRS would result in increases, depending on the technology, of worker population at the site. Traffic conditions on site access roads leading to and from SRS would worsen due to increased traffic volume and flow rates. The primary access route to SRS is State Route 125. This route would carry the greatest increase in traffic from site development. Currently, this route and secondary branches leading to the various internal areas of SRS are congested during peak travel time. Locating the MHTGR or ALWR at SRS would have the greatest effect of the tritium supply technologies on traffic volume and flow (Huber 1990).

Tritium Recycling Phaseout. Phaseout of the tritium recycling mission would decrease worker population enough to change traffic conditions on site access roads leading to and from SRS, but this decrease would help reduce traffic volume and flow and improve traffic conditions only slightly.

Less Than Baseline Operations. The effects on traffic volume and flow would be the same whether or not the HWR, MHTGR, or ALWR were operated at baseline or less than baseline tritium requirements. Construction of the Phased APT would increase traffic volume and flow during the construction phase but less than that for the Full APT.

Potential Mitigation Measures. Mitigation of traffic conditions may be necessary due to the proposed action at SRS. Mitigation could include the widening and extension of State Route 125, the primary access route to SRS, as well as possible realignment of roadways and construction of interchanges at roadway intersections overburdened by increased vehicle traffic and congestion. In addition, internal access routes connecting State Route 125 with the project area could be upgraded to carry the increased load.

4.6.3.9 *Radiological and Hazardous Chemical Impacts During Normal Operation and Accidents*

This section describes the impacts of radiological and hazardous chemical releases resulting from either normal operation or accidents at facilities involved with the tritium supply technologies and recycling at SRS. The section first describes the impacts from normal operation followed by a description of impacts from facility accidents.

During normal operation at SRS, all tritium supply technologies would result in impacts that are within regulatory limits. The risk of adverse health effects to the public and to workers would be small.

For facility accident impacts, the results indicate that for all tritium supply technology alternatives, the risk of fatal cancers (taking into account both the portability of the accident and its consequences) from an accidental release of radioactive or hazardous chemical substances at SRS is low when compared to fatal cancers from all causes, even for a severe accident.

The impact methodology is described in section 4.1.9. Summaries of the radiological and chemical impacts associated with normal operation are presented in tables 4.6.3.9–1 and 4.6.3.9–2, respectively. Summaries of impacts associated with postulated accidents are given in tables 4.6.3.9–3, 4.6.3.9–4, and 4.6.3.9–5. Detailed results are presented in appendix E for normal operation and appendix F for accidents.

Normal Operation

No Action. The current missions at SRS are described in section 3.3.5. The site has identified those facilities that will continue to operate and others, if any, which will become operational by 2010. Based on projected operations, the radiological and chemical releases for 2010 and beyond were developed and used in the impact assessments.

Radiological Impacts. As shown in table 4.6.3.9–1, No Action would result in a calculated annual dose of 2.9 mrem to the maximally exposed member of the public, which projects to an estimated fatal cancer risk of $5.7x10^{-5}$ from 40 years of total site operation. This annual dose includes a dose from liquid releases of 0.077 mrem and a dose from atmospheric releases of 2.8 mrem. Both the liquid and atmospheric doses are within radiological limits, and when combined are 0.91 percent of the natural background radiation dose received by the average person near SRS.

The population dose from total site operation in 2030 was calculated to be 250 person-rem which projects to an estimated 4.9 fatal cancers from 40 years of total site operation. The population dose includes 0.45 person-rem from liquid releases and 250 person-rem from atmospheric releases, and would be approximately 0.11 percent of the annual dose received by the surrounding population from natural background radiation.

The annual average dose to a site worker resulting from No Action would be 32 mrem, which projects to an estimated fatal cancer risk of $5.2x10^{-4}$ from 40 years of site operation. The annual dose to the total site workforce would be 480 person-rem, which projects to an estimated 7.7 fatal cancers from 40 years of total site operation.

Hazardous Chemical Impacts. As shown in table 4.6.3.9–2, No Action would result in a calculated HI of 0.70 and a cancer risk of $3.2x10^{-5}$ to the maximally exposed member of the public. The calculated worker HI would be 1.8 with a cancer risk of $5.9x10^{-3}$. The HI value is within the acceptable regulatory health limits for the maximally exposed member of the public, but exceeds the EPA action level of 1.0 for the onsite worker, based on EPA's regulations for public exposure limits and OSHA's regulations for worker exposure limits. However, recalculating the HI for specific target organs or tissues reduces the HIs for chemicals with related non-cancer adverse effects. These effects are presented in appendix table E.3–1. The cancer risks for the maximally exposed member of the public and the onsite worker at SRS are also in excess of the typical threshold of regulatory concern of $1x10^{-6}$. For details on the derivation of these HIs and cancer risks, see appendix table E.3.4–29 and summary table E.3.4–36.

Tritium Supply and Recycling Upgrade. There will be no radiological releases during the construction of upgraded tritium recycling facilities that are associated with all tritium supply technologies under consideration. Limited hazardous chemical releases are anticipated as a result of construction activities. However, their concentration will be within the regulated exposure limits and would not result in any adverse health effects. During normal operation, there would be both radiological and hazardous chemical releases to the environment and also direct in-plant exposures. The impacts from radiological and hazardous chemicals from each tritium supply technology are the summations of the impacts from the various facilities in operation for that technology. The resulting doses and potential health effects to the public and workers from each technology are described below.

Radiological Impacts. Radiological impacts resulting from normal operation of various tritium supply technologies and upgraded recycling facilities at SRS are listed in table 4.6.3.9–1. The supporting analysis is provided in appendix section E.2.8.2.

The doses to the maximally exposed member of the public from annual site operation at SRS range from 2.5 mrem for both the APT with the helium-3 target and the Phased APT, to 4.1 mrem for the Large ALWR. From 40 years of operation, the corresponding risks of fatal cancer to this individual would range from $5.1x10^{-5}$ to $8.1x10^{-5}$. As a result of total site operations in the year 2030, the population doses would range from 220 to 340 person-rem for the same technologies, respectively. The corresponding numbers of fatal cancers in this population from 40 years of operation would range from 4.4 to 6.8.

The annual dose to the total site workforce would range from 510 person-rem for the MHTGR to

TABLE 4.6.3.9–1.—*Potential Radiological Impacts to the Public and Workers Resulting from Normal Operation of Tritium Supply Technologies and Recycling at Savannah River Site*

Affected Environment	No Action	Tritium Supply Technologies and Recycling[a]								
		HWR	MHTGR	Large ALWR	Small ALWR	Full APT		Phased APT	Tritium Recycling Upgrade	Tritium Recycling Phaseout
						Helium-3 Target System	SILC Target System	Helium-3 Target System		
Maximally Exposed Individual[b] (Public)										
Atmospheric Releases										
Dose[c] (mrem/yr)	2.8	3.4	3	3.9	3.6	2.5	2.8	2.5	2	0.47
Percent of natural background[d]	0.89	1.1	0.94	1.2	1.1	0.78	0.89	0.78	0.63	0.15
40-year fatal cancer risk	$5.6x10^{-5}$	$6.9x10^{-5}$	$5.9x10^{-5}$	$7.8x10^{-5}$	$7.1x10^{-5}$	$4.9x10^{-5}$	$5.6x10^{-5}$	$4.9x10^{-5}$	$4.0x10^{-5}$	$9.4x10^{-6}$
Liquid Releases										
Dose[c] (mrem/yr)	0.077	0.16	0.077	0.16	0.26	0.077	0.077	0.077	0.077	0.077
Percent of natural background[d]	0.024	0.052	0.024	0.052	0.084	0.024	0.024	0.024	0.024	0.024
40-year fatal cancer risk	$1.5x10^{-6}$	$3.3x10^{-6}$	$1.5x10^{-6}$	$3.3x10^{-6}$	$5.3x10^{-6}$	$1.5x10^{-6}$	$1.5x10^{-6}$	$1.5x10^{-6}$	$1.5x10^{-6}$	$1.5x10^{-6}$
Atmospheric and Liquid Releases[b]										
Dose[c] (mrem/yr)	2.9	3.6	3	4.1	3.7	2.5	2.9	2.5	2.1	0.55
Percent of natural background[d]	0.91	1.1	0.97	1.3	1.2	0.81	0.91	0.81	0.66	0.17
40-year fatal cancer risk	$5.7x10^{-5}$	$7.2x10^{-5}$	$6.1x10^{-5}$	$8.1x10^{-5}$	$7.5x10^{-5}$	$5.1x10^{-5}$	$5.7x10^{-5}$	$5.1x10^{-5}$	$4.1x10^{-5}$	$1.1x10^{-5}$
Population Within 50 Miles										
Atmospheric and Liquid Releases										
Year 2030										
Dose (person-rem)	250	300	260	340	310	220	250	220	180	37
Percent of natural background[d]	0.11	0.13	0.11	0.15	0.13	0.093	0.11	0.093	0.075	0.016
40-year fatal cancers	4.9	6.1	5.2	6.8	6.2	4.4	4.9	4.4	3.6	0.73
Workers Onsite										
Average site worker dose[c] (mrem/yr)	32	34	33	42	38	33	33	33	4	32
40-year fatal cancer risk	$5.2x10^{-4}$	$5.4x10^{-4}$	$5.3x10^{-4}$	$6.7x10^{-4}$	$6.1x10^{-4}$	$5.3x10^{-4}$	$5.3x10^{-4}$	$5.3x10^{-4}$	$6.5x10^{-5}$	$5.2x10^{-4}$
Total site workforce dose (person-rem/yr)	480	520	510	650	580	520	522	520	1.6	480
40-year fatal cancers	7.7	8.3	8.2	10.0	9.3	8.3	8.4	8.3	0.026	7.7

[a] Includes the impacts from No Action facilities which includes existing tritium recycling. Existing tritium recycling and upgraded tritium recycling result in the same impacts.
[b] The location of the maximally exposed individual varies depending on the tritium supply technology.
[c] The applicable radiological limits for an individual member of the public are 10 mrem per year resulting from site operations for the air pathways, 4 mrem per year from the drinking water pathway, and 100 mrem per year from all pathways combined (DOE Order 5400.5) The radiological limit for an individual worker is 5,000 mrem per year (10 CFR 835).
[d] Natural background levels: to the average individual is 315 mrem per year; to the population in the year 2030 is 233,300 person-rem.
Note: SILC - spallation-induced lithium conversion.
Source: Model results. See appendix sections E.2.2 and E.2.8.

TABLE 4.6.3.9–2.—*Potential Hazardous Chemical Impacts to the Public and Workers Resulting from Normal Operation at Savannah River Site*

Health Impact	No Action	Tritium Supply Technologies[a, b] HWR	MHTGR	ALWR	APT	Tritium Recycling Upgrade
Maximally Exposed Individual (Public)						
Hazard Index	0.7	0.7	0.7	0.71	0.7	$2.5x10^{-6}$
Cancer risk	$3.3x10^{-5}$	$3.3x10^{-5}$	$3.3x10^{-5}$	$3.3x10^{-5}$	$3.3x10^{-5}$	0
Worker Onsite						
Hazard Index[c]	1.8	1.8	1.8	1.9	1.8	$2.8x10^{-5}$
Cancer risk	$5.9x10^{-3}$	$5.9x10^{-3}$	$5.9x10^{-3}$	$5.9x10^{-3}$	$5.9x10^{-3}$	0

[a] Includes impacts from No Action.
[b] To determine the contribution from any of the tritium supply technologies, subtract the tritium recycling values from the Hazard Index or the cancer risk, respectively.
[c] The Hazard Index for the onsite worker is computed by using the permissible exposure limit as the denominator rather than the reference concentration which is used for the maximally exposed member of the public (appendix E).
Source: Model result. See appendix table E.3.4–1.

650 person-rem for the Large ALWR. The corresponding annual average doses to a site worker would be 33 mrem for the MHTGR, and 42 mrem for the Large ALWR. The risks and numbers of fatal cancers among workers from 40 years of operation are included in table 4.6.3.9–1.

Based on the radiological impacts associated with normal operation as described above, all of the tritium supply technologies and upgrade recycling facilities are acceptable for siting at SRS. All resulting doses are within radiological limits and are well below levels of natural background radiation.

Hazardous Chemical Impacts. Hazardous chemical impacts resulting from normal operation of tritium supply technologies at SRS are listed in table 4.6.3.9–2. HIs for the maximally exposed member of the public range from 0.7 (HWR, MHTGR, and APT) to 0.71 for the ALWR with a cancer risk of $3.3x10^{-5}$ for all technologies due to No Action. The worker HIs are 1.8 for HWR, MHGTR, and APT, and 1.9 for ALWR with cancer risks of $5.9x10^{-3}$ due to No Action alone. Only the public HI value is within acceptable regulatory health limits. However, the cancer risk for workers at $5.9x10^{-3}$ and the public at $3.3x10^{-5}$ exceeds the typical threshold of regulatory concern of $1x10^{-6}$. For details on the derivation of these HIs and cancer risks, see appendix tables E.3.4–30 through E.3.4–33, and summary table E.3.4–36.

New Tritium Extraction Facility. A new tritium extraction facility would need to be constructed and operated at SRS to support the commercial reactor alternative. This facility is described in section 3.4.4.

There would be no radiological releases and only minor hazardous chemical releases during the construction of the new tritium extraction facility. Potential concentrations would be expected to be within the regulated exposure limits and would not result in any adverse health effects. During normal operation, there would be radiological releases to the environment via the air pathway and also direct in-plant exposures; releases of hazardous chemicals to the environment would be negligible. The resulting doses and potential health effects to the public and workers are described below.

Radiological Impacts. The release of airborne tritium to the environment would result in a calculated dose of 0.35 mrem to the maximally exposed member of the public from annual facility operations. This projects to an estimated fatal cancer risk of $7.0x10^{-6}$ from 40 years of operation. The population dose from operations in the year 2030 is calculated to be 30 person-rem, which projects to an estimated 0.6 fatal cancers from 40 years of facility operation. These impacts are all small fractions of those associated with total site operations under the No Action alternative (table 4.6.3.9–4).

The average annual dose to a worker in the new tritium extraction facility would be approximately 10 mrem, which projects to a fatal cancer risk of 1.6×10^{-4} from 40 years of facility operation. The annual dose to the entire facility workforce is estimated to be about 0.10 person-rem, which projects to 1.6×10^{-3} fatal cancers from 40 years of facility operation. The impacts to the average worker from operations associated with the tritium extraction facility would be less than those to the average SRS worker and would represent an extremely small fraction of the impacts to the total site workforce under the No Action alternative (table 4.6.3.9–4).

Hazardous Chemical Impacts. The impacts to the maximally exposed individual of the public and to the onsite worker resulting from the normal operations of the tritium extraction facility at SRS would be less than those described for the upgraded tritium recycling facility (table 4.6.3.9–2). There would be no cancer risk to the maximally exposed member of the public or SRS worker.

Tritium Recycling Facility Upgrade

Radiological Impacts. The tritium recycling facilities upgrade is described in section 3.4.3.2. The radiological impacts to the general public will not change from those of No Action with operation of the upgraded tritium recycling facilities. This is because upgrading will not change the radiological releases from the facility from those that would result from existing facilities. The radiological impacts to workers will effectively remain the same because the workforce associated with operations will change only slightly.

Hazardous Chemical Impacts. The impacts to the maximally exposed individual of the public and to the onsite worker resulting from normal operation of the upgraded tritium recycling facilities at SRS are listed in table 4.6.3.9–2. The calculated HI for the maximally exposed member of the public is 2.5×10^{-6} with no cancer risk. The worker HI and cancer risk were calculated to be 2.8×10^{-5} and 0, respectively. If the supply technologies is placed at a site other than SRS and the recycling upgrade was implemented at SRS, the hazardous chemical impact would either remain the same as No Action or show a slight reduction to workers and the public. This means that the HI for workers and cancer risks to the public and workers would exceed acceptable regulatory health limits due to the No Action contribution. It is to be noted, however, that the tritium recycling upgrade alone is well within the limits because the fraction it contributes is only $1/3.6 \times 10^{6}$ of the total risk. For details on the derivation of these HIs and cancer risks, see appendix tables E.3.4–34 and E.3.4–36.

Tritium Recycling Phaseout. If tritium recycling is performed at another site, existing recycling and extraction facilities at SRS would be phased out. The annual dose to the maximally exposed individual will decrease to a value that is 2.4 mrem less than the No Action dose (table 4.6.3.9–1). The estimated risk of fatal cancer to this individual would decrease by 4.6×10^{-5} over 40 years of total site operation. The elimination of the tritium recycling and extraction processes at SRS would also result in a decrease of 213 person-rem to the population within 50 miles in the year 2030, and 4.2 fewer fatal cancers over 40 years of operation compared with continued No Action operation. The doses and associated health effects among workers would remain virtually the same as for No Action.

Hazardous Chemical Impacts. The impacts to the maximally exposed individual of the public and to the onsite worker resulting from normal operation with a phaseout of the tritium recycling function are listed in table 4.6.3.9–2. The calculated HI for the maximally exposed member of the public is 0.70 with a cancer risk of 3.2×10^{-5}. The worker HI and cancer risk were calculated to be approximately 1.8 and 5.9×10^{-3}, respectively. The HI for the maximally exposed member of the public is within the acceptable regulatory health limits based on EPA's regulations for public exposure limits during an 8 hour work period. The cancer risks for both the maximally exposed member of the public and onsite workers exceed the typical threshold of regulatory concern of 1×10^{-6}. For details on the threshold of these HIs and cancer risks, see appendix table E.3.4–35 and summary table E.3.4–36.

Less Than Baseline Operations. The normal operation radiological impacts for the HWR operating at reduced tritium production capacity to meet a less than baseline operations requirement would be proportioned to the level of operation (approximately 50 percent of baseline). The MHTGR or ALWR normal operation radiological impacts would not change because the reactor would maintain power requirements to produce steam or electricity.

The Phased APT is already less than the baseline tritium requirement and thus the impacts are as presently given in the PEIS.

Potential Mitigation Measures. Radioactive and hazardous chemical airborne emissions to the general population and onsite exposures to workers could be reduced by implementing the latest technology for process and design improvements. For example, to reduce public exposure from emissions, improved methods could be used to remove radioactivity from the releases to the environment. Similarly, the use of remote, automated, and robotic production methods are examples of techniques that are being developed which could reduce worker exposure. Substitution of less toxic/noncancer causing solvents would result in reductions of the HI and possible complete elimination of the cancer risk.

The incorporation of an alternate upgraded tritium recycling plant, which would include transferring certain functions to the Replacement Tritium Facility, would reduce the annual release of airborne tritium by 12,000 Ci. This would result in annual dose reductions of 0.8 mrem to the maximally exposed member of the public and 70 person-rem to the 50-mile population for each tritium supply technology. For example, the corresponding annual doses associated with the HWR alternative would decrease from 3.6 mrem to 2.7 mrem, and from 300 to 230 person-rem. For 40 years of operations, the annual dose reductions would project to a decreased fatal cancer risk to the individual of 1.6×10^{-5} and 1.4 fewer fatal cancers in the population for each supply alternative.

Facility Accidents

No Action. Under No Action, tritium recycling will continue to be performed in Building 233-H, the Replacement Tritium Facility. All reactors previously used for tritium production operations have already been shut down.

The potential accidents and their consequences are documented in safety analysis reports that have been prepared for the existing tritium recycling facilities. The major hazards associated with the operation of these facilities is the release of tritium to the environment. Other facilities at SRS such as the F- and H-Canyons, Defense Waste Processing Facility, Plutonium Fuel Fabrication Facility, Receiving Basin for Off-Site Fuel and various laboratories will continue to operate or be shut down. Potential accidents and consequences for these facilities are documented in existing safety analysis reports.

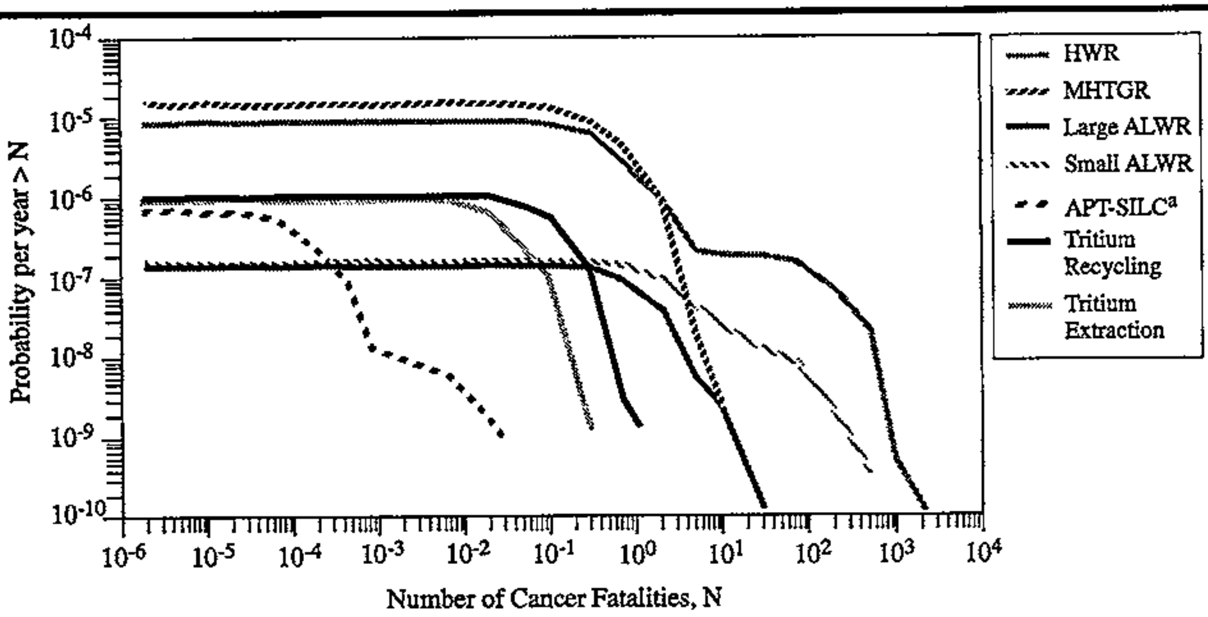
As shown in table 4.6.3.9–3, the highest consequence accident under No Action for tritium operation would be an earthquake-induced leak/ignition and fire in the Unloading Station Carousel A Reservoir. The analysis postulated the release of 8.4×10^{6} Ci of tritium in oxide form to the environment. If this accident occurred, it could result in 0.15 cancer fatalities to the population within 50 miles of the site. The risk of this accident, that takes both accident probability and consequence into account, would be approximately 3.0×10^{-6} cancer fatalities per year for the same population.

Figure 4.6.3.9–1 shows the number of latent cancer fatalities that may result for each technology, including tritium extraction and recycling, if an accident were to occur. Specifically, each curve in the figure shows the conditional probability (vertical axis) that the number of cancer fatalities (horizontal axis) will be exceeded if the accident occurred. The curves do not reflect the probability of the accident.

TABLE 4.6.3.9–3.—*Radioactive Release Accidents and Consequences for Existing No Action Tritium Recycling Operations at Savannah River Site*

Accident Description	Beyond Design-Basis Earthquake
Accident frequency (per year)	2.0×10^{-5}
Consequence	
Maximally Exposed Individual	
Dose (rem)	0.045
Cancer fatalities	2.2×10^{-5}
Risk (cancer fatalities per year)	4.4×10^{-10}
Population Within 50 Miles	
Dose (person-rem)	300
Cancer fatalities	0.15
Risk (cancer fatalities per year)	3.0×10^{-6}

Note: Model results.



[a] The helium-3 target systems for the Full and Phased APT are bounded by the APT with the spallation-induced lithium conversion (SILC) target system shown in this figure.

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FIGURE 4.6.3.9–1.—*High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Functions for Tritium Supply and Recycling Severe Accidents at Savannah River Site.*

The secondary impacts of accidents affect elements of the environment other than humans. For example, a radiological release may contaminate farmland, surface and underground water, recreational areas, industrial parks, historical sites, or the habitat of an endangered species. As a result, farm products may have to be destroyed; the supply of drinking water may be reduced; recreational areas may be closed; industrial parks may suffer economic losses; historical sites may have to be closed to visitors; and endangered species may move closer to extinction. In the region of the SRS, the natural background level of radiation (excluding radon) is 76 mrem per year. For a hypothetical design basis accidental release, the radiation levels exceeding 76 mrem per year are well within the site boundary. The size of the area in which exposure levels would exceed exposures from natural background radiation is 2.9×10^{7} square meters (7,166 acres).

Tritium Supply Alone. The proposed action at SRS has the potential for accidents that may impact the health and safety of workers and the public. The potential for and associated consequences of reasonably foreseeable accidents have been assessed for each technology at SRS and are summarized in this section and described in more detail in appendix F. The methodology used in the assessment is described in section 4.1.9.

The potential impacts from accidents, ranging from high consequence/low probability to low consequence/high probability events, have been evaluated in terms of the number of cancer fatalities that may result. The risk of cancer fatalities has also been evaluated to provide an overall measure of an accident's impacts and is calculated by multiplying the accident annual frequency (or probability) of occurrence by the consequences (number of cancer fatalities). Analyses of postulated accidents for the tritium supply facilities at SRS indicate that, for the high consequence accident, the estimated risk of cancer fatalities to the public within 50 miles of the site due to the accidental release of radioactive material or chemicals would be 5.1×10^{-5} cancer fatalities per year (table 4.6.3.9–4). This accident risk, which corresponds with the HWR, is low when compared to the risk of cancer fatalities to the same population from all other causes.

Details on the range of accidents for the tritium supply technologies at SRS are presented in appendix

F. Each of the technologies has been analyzed from the standpoint of identifying the consequences of design-basis/operational accidents (using the GENII Code) and beyond design basis, or severe accidents (using the MACCS computer code). The severe accident consequences are shown in table 4.6.3.9–4 for each technology. The table also shows the consequences of each accident for the population and for an individual who may be located at the site boundary. The results of the analysis indicate that the tritium supply technology with the highest severe accident risk is the ALWR.

The technology with the lowest accident risk is the APT with the helium-3 target system. The APT accident risks are much lower than the HWR, MHTGR, and ALWR consequences. Upgraded tritium recycling facilities are common to all tritium supply technologies but, except for the APT, the accident consequences and risks are dominated by reactor accidents. The tritium extraction facility accident dominates the accelerator accidents.

Heavy Water Reactor. A set of five high consequence accident sequences were postulated. In the event any of these accidents were to occur, there would be an estimated 5 cancer fatalities in the population within 50 miles and a cancer fatality risk of $6.6x10^{-4}$ to an individual who may be located at the site boundary, and 0.023 to a collocated worker at 1,000 meters from the accident. The risk to the population, that takes the probability of the accident into account, is less than $5.1x10^{-5}$ cancer fatalities per year (table 4.6.3.9–4).

Modular High Temperature Gas-Cooled Reactor. A set of four high consequence accident sequences were postulated for the MHTGR. In the event that any of these accidents were to occur, there would be an estimated 0.63 cancer fatalities in the population within 50 miles and an increased likelihood of a cancer fatality of $6.3x10^{-5}$ to an individual who may be located at the site boundary, and $3.2x10^{-3}$ to a collocated worker at 1,000 meters from the accident. The risk to the population, that takes the probability of the accident into account, is $1.0x10^{-5}$ cancer fatalities per year (table 4.6.3.9–4).

Advanced Light Water Reactor. A range of accident sequences with various release categories was analyzed for the ALWR. One release category for a Large ALWR and one for a Small ALWR were selected to represent the accident consequences for an ALWR (appendix section F.2.1.3). In the event that such an accident were to occur, there would be an estimated 1.7 cancer fatalities for a Large ALWR and 14 cancer fatalities for a Small ALWR in the population within 50 miles and an increased likelihood of cancer fatality of $1.3x10^{-3}$ for a Large ALWR, and $1.9x10^{-3}$ for a Small ALWR to an individual who may be located at the site boundary, and 0.023 for a Large ALWR to a collocated worker at 1,000 meters from the accident. The risk to the population, that takes the probability of the accident into account, is $2.6x10^{-7}$ cancer fatalities per year for a Large ALWR and $3.2x10^{-7}$ cancer fatalities per year for a Small ALWR (table 4.6.3.9–4).

Accelerator Production of Tritium with Helium-3 Target System. The large break loss of coolant accident with the total loss of the active emergency cooling system and the heat sink with and without confinement were postulated as the high consequence accidents for this APT and target option. In the event that any of these accidents were to occur, there would be an estimated $3.9x10^{-5}$ fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $5.7x10^{-9}$ to an individual located at the site boundary, and $2.7x10^{-7}$ to a collocated worker at 1,000 meters from the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $2.8x10^{-11}$ cancer fatalities per year (table 4.6.3.9–4).

Accelerator Production of Tritium with Spallation-Induced Lithium Conversion Target System. The large break loss of coolant accident with a successful beam trip and the total loss of the active emergency cooling system with and without confinement were postulated as the high consequence accidents for this APT and target option. In the event that this accident were to occur, there would be an estimated $3.8x10^{-4}$ cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $1.0x10^{-7}$ to an individual located at the site boundary, and $3.8x10^{-6}$ to a collocated worker at 1,000 meters from the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $2.7x10^{-10}$ cancer fatalities per year (table 4.6.3.9–4).

Tritium Target Extraction and Recycling Facility Upgrade. The tritium extraction facility is required to support all tritium supply technologies except the APT technology with the helium-3 target system. The tritium recycling facility upgrade at SRS is required to support all tritium supply technologies. The analyses of postulated high consequence

TABLE 4.6.3.9–4.—*Tritium Supply Technologies and Recycling High Consequence/Low Probability Radioactive Release Accidents and Consequences at Savannah River Site*

Parameter	Tritium Supply Technologies						Tritium Target Extraction Facility[d]	Tritium Recycling Facility[e]
	HWR[a]	MHTGR[b]	Large ALWR[c]	Small ALWR	Full/Phased APT	Full APT		
					Helium-3 Target System[e,f]	SILC Target System[g,h]		
Consequence								
Maximally Exposed Individual								
Cancer fatalities[i]	$6.6x10^{-4}$	$6.3x10^{-5}$	$1.3x10^{-3}$	$1.9x10^{-3}$	$5.7x10^{-9}$	$1.0x10^{-7}$	$6.4x10^{-6}$	$2.2x10^{-5}$
Risk (cancer fatalities per year)	$6.0x10^{-9}$	$1.0x10^{-9}$	$2.0x10^{-10}$	$2.9x10^{-10}$	$4.1x10^{-15}$	$7.3x10^{-14}$	$9.0x10^{-10}$	$4.4x10^{-10}$
Population Within 50 Miles								
Cancer fatalities[i]	5.5	0.63	1.7	14	$3.9x10^{-5}$	$3.8x10^{-4}$	0.043	0.15
Risk (cancer fatalities per year)	$5.1x10^{-5}$	$1.0x10^{-5}$	$2.6x10^{-7}$	$2.3x10^{-6}$	$2.8x10^{-11}$	$2.7x10^{-10}$	$6.0x10^{-6}$	$3.0x10^{-6}$
Worker at 1,000 meters								
Cancer fatalities[i]	0.023	$3.2x10^{-3}$	0.023	0.067	$2.7x10^{-7}$	$3.8x10^{-6}$	$3.0x10^{-4}$	$1.0x10^{-3}$
Risk (cancer fatalities per year)	$2.1x10^{-7}$	$5.1x10^{-8}$	$3.4x10^{-9}$	$1.1x10^{-8}$	$1.9x10^{-13}$	$2.7x10^{-12}$	$4.2x10^{-8}$	$2.0x10^{-8}$
Worker at 2,000 meters								
Cancer fatalities[i]	0.01	$1.1x10^{-3}$	0.013	0.03	$1.0x10^{-7}$	$1.6x10^{-6}$	$1.1x10^{-4}$	$3.9x10^{-4}$
Risk (cancer fatalities per year)	$9.5x10^{-8}$	$1.8x10^{-8}$	$2.0x10^{-9}$	$4.6x10^{-9}$	$7.1x10^{-14}$	$1.1x10^{-12}$	$1.5x10^{-8}$	$7.8x10^{-9}$

[a] For detailed HWR accident discussion see appendix section F.2.1.1.

[b] For detailed MHTGR accident discussion see appendix section F.2.1.2.

[c] For detailed ALWR accident discussion see appendix section F.2.1.3.

[d] The tritium target extraction facility is required for the HWR, MHTGR, ALWR, and the APT with spallation-induced lithium conversion target system tritium supply configurations and not required for the APT with helium-3 target system tritium supply configuration. For detailed tritium target extraction facility discussion, see appendix section F.2.1.6.

[e] For detailed APT with helium-3 target system discussion, see appendix section F.2.1.4.2.

[f] Analysis postulated the total failure of the active emergency cooling system and the loss of the heat sink.

[g] For detailed APT with spallation-induced lithium conversion target system discussion, see appendix section F.2.1.4.3.

[h] Analysis postulated successful beam trip with the total failure of the active emergency cooling system.

[i] Increased likelihood of cancer fatality.

Note: SILC - spallation-induced lithium conversion

Source: Appendix F.

accidents for the tritium extraction and recycling facilities at SRS are presented below.

Tritium Target Extraction Facility. An earthquake and release of process vessel tritium inventory was postulated as the high consequence accident. In the event that this accident were to occur, there would be an estimated 0.043 cancer fatalities in the population within 50 miles and a cancer fatality risk of $6.4x10^{-6}$ to an individual who may be located at the site boundary, and $3.0x10^{-4}$ to a collocated worker at 1,000 meters from the accident. The risk to the population, taking the probability of the accident into account, is less than $6.0x10^{-6}$ cancer fatalities per year (table 4.6.3.9–4).

Tritium Recycling Facility. An earthquake induced leak/ignition and fire in the unloading station carousel reservoir was postulated as the high consequence accident for the tritium recycling facility. In the event that this accident were to occur, there would be an estimated 0.15 cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $2.2x10^{-5}$ to an individual located at the site boundary, and $1.0x10^{-3}$ to a collocated worker at 1,000 meters from the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $3.0x10^{-6}$ cancer fatalities per year.

Tritium Recycling Facility Upgrade. Upgrade of the existing tritium recycling facilities at SRS may change the existing risks of accidents. Under upgrade, all tritium recycling facilities would be brought into compliance with DOE orders and other applicable regulations and standards. This may result in a reduction of risk compared to No Action.

For comparison purposes with high consequence tritium supply facility accidents, for the same total population of 773,000 in the year 2050 within 50 miles of the site, there is a risk of 1,550 cancer fatalities per year from all other natural causes.

The analysis of facility accidents for tritium supply technologies at SRS shows that, for high consequence accidents analyzed using MACCS computer code, the ALWR has the highest risk and the APT has the lowest risk. The risk of accidents for any of the tritium supply technologies, tritium extraction, and tritium recycling facilities common to all technologies is low when compared to the human risk of cancer from all other causes.

Design-Basis Accidents. The consequence of the operational basis or design-basis accident for the tritium extraction facility at SRS is shown in table 4.6.3.9–5. The results in table 4.6.3.9–5 should not be compared with the severe accident analysis results in table 4.6.3.9–4 because different computer codes using different calculational approaches were used. More detailed descriptions of design-basis accidents is included in appendix F.2.2.

Less Than Baseline Operations

Facility Accidents. Less than baseline tritium operation would have no significant change to the current accident analyses consequences for the HWR unless the baseline HWR core design was downsized. The baseline HWR configuration would adjust to the reduced target through-put requirements by reducing the time that the reactor is required to operate at 100 percent power. It is not anticipated that the overall risk from operating the reactor in this mode would decrease significantly. Accident analyses have not been performed to address accident sequences and initiating events when the reactor is in the cold shut down mode. In addition, operator error has a significant effect on facility risk and if the reactor is shut down a high percentage of the time, operator error may actually increase when the reactor is at power.

Less than baseline tritium operations would have no significant change to the current accident analyses consequences for the ALWR. The reactor surplus capacity would be used to generate steam for electric power production.

Less than baseline tritium operation would have no change to the MHTGR accident analyses because the analyses assumed that only one of the reactor modules would be involved in the accident.

Less than baseline tritium operation would have no significant change to the APT accident analyses consequences. The accident consequences for Full and Phased APT accidents with low to moderate consequences were negligible. For the beyond design basis accident, there was no difference in the Full and the Phased accident consequences. Review of the source terms for the Full and the Phased APT

TABLE 4.6.3.9–5.—*Tritium Supply Technologies and Recycling Low-to-Moderate Consequence/High Probability Radioactive Release Accidents and Consequences at Savannah River Site*

Parameter	Tritium Supply Technologies						
	HWR[a,b]	MHTGR[b,c]	Large ALWR[b,d]	Small ALWR[b,d]	APT[b,e] SILC Target System	Tritium Target Extraction Facility[b]	Tritium Recycling Facility[f]
Accident							
Description	Fuel assembly failure during charge and discharge operations	Moderate break in primary system piping.	Fuel handling	Fuel handling	Large break loss of coolant accident[g]	Deflagration[h]	Hydride Bed Rupture
Frequency (per year)	$1.0x10^{-3}$	$2.5x10^{-2}$	$1.0x10^{-5}$	$1.0x10^{-5}$	$1.0x10^{-3}$	$2.0x10^{-5}$	$2.0x10^{-4}$
Consequence							
Maximally Exposed Individual							
Cancer fatalities[i]	$2.3x10^{-5}$	$1.2x10^{-8}$	$1.3x10^{-5}$	$2.0x10^{-5}$	negligible	$1.2x10^{-4}$	$4.9x10^{-7}$
Risk (cancer fatalities per year)	$2.3x10^{-8}$	$3.0x10^{-10}$	$1.3x10^{-10}$	$2.0x10^{-10}$	negligible	$2.4x10^{-9}$	$9.8x10^{-11}$
Population Within 50 Miles							
Cancer fatalities	0.73	$2.5x10^{-4}$	0.037	0.6	negligible	6	0.025
Risk (cancer fatalities per year)	$7.3x10^{-4}$	$6.3x10^{-6}$	$3.8x10^{-6}$	$6.0x10^{-6}$	negligible	$1.2x10^{-4}$	$5.0x10^{-6}$
Worker at 1,000 meters							
Cancer fatalities[i]	$2.9x10^{-4}$	$3.4x10^{-7}$	$2.8x10^{-4}$	$3.6x10^{-4}$	negligible	$4.8x10^{-3}$	$2.0x10^{-5}$
Risk (cancer fatalities per year)	$2.9x10^{-7}$	$8.5x10^{-9}$	$2.8x10^{-9}$	$3.6x10^{-9}$	negligible	$9.6x10^{-8}$	$4.0x10^{-9}$
Worker at 2,000 meters							
Cancer fatalities[i]	$9.8x10^{-5}$	$1.2x10^{-7}$	$9.6x10^{-5}$	$1.2x10^{-4}$	negligible	$1.6x10^{-3}$	$6.8x10^{-6}$
Risk (cancer fatalities per year)	$9.8x10^{-8}$	$3.0x10^{-9}$	$9.6x10^{-10}$	$1.2x10^{-9}$	negligible	$3.2x10^{-8}$	$1.4x10^{-9}$

[a] For detailed HWR accident discussion see appendix section F.2.2.1.

[b] The tritium target extraction facility is required for the HWR, MHTGR, ALWR, and the APT with spallation-induced lithium conversion target system tritium supply configurations and not required for the APT with helium-3 target system tritium supply configuration. For detailed tritium target extraction facility discussion, see appendix section F.2.2.6.

[c] For detailed MHTGR accident discussion see appendix section F.2.2.2.

[d] For detailed ALWR accident discussion see appendix section F.2.2.3.

[e] The APT with helium-3 target system bounding low to moderate consequence accident consequences are bounded by the APT with spallation-induced lithium conversion target system, which are negligible. For detailed APT discussion, see appendix section F.2.2.4.

[f] For detailed tritium recycling facility discussion, see appendix section F.2.4.

[g] Analysis postulated all plant protection systems functioned as designed.

[h] Intense rapid burning.

[i] Increased likelihood of cancer fatality.

Note: SILC - spallation-induced lithium conversion target

Source: Appendix F.

indicated that the tritium component of the source term is identical for both accidents. Review of the MACCS computer code output data for each accident analysis indicated that the tritium component of the source term dominated the dose calculation results. The impact of the other source term isotopes on the dose calculation results is negligible.

Potential Mitigation Measures. The accidents postulated for tritium supply technologies and upgraded recycling facilities are based on operation and safety analyses that have been performed at similar facilities. One potential mitigation measure is to transfer certain tritium extraction activities from Building 232-H to the Replacement Tritium Facility, Building 233-H, to take advantage of improved safety and other new technology features in the Replacement Tritium Facility. This transfer would result in additional sources of tritium in the Replacement Tritium Facility and the potential for additional risk of accidents. This additional risk in the Replacement Tritium Facility is offset by the elimination of a higher risk of performing these activities in the older facilities of Building 232-H. If these activities were transferred to the Replacement Tritium Facility, the change would have to be examined from the standpoint of *Unreviewed Safety Questions* in accordance with DOE Order 5480.21 to determine if the authorization basis for the facility has changed. If the authorization basis changes, operational restrictions are placed on the facility until detailed safety evaluations are completed. One of the major design goals for a tritium supply and recycling facilities is to achieve a reduced risk to facility personnel and to public health and safety to as low as reasonably achievable.

Current estimates are that there would be no collocated workers within 1,000 meters from a tritium supply facility accident and 3,516 collocated workers within 1,000 meters of the recycling facility. There would be 500 tritium supply and 545 tritium recycling collocated workers between 1,000 and meters of those facilities. There would be 7,463 collocated workers beyond 2,000 meters of the tritium supply facility and 4,588 collocated workers beyond 2,000 meters of the recycling facility.

Worker exposures that may result from the accidental release of radioactive material will be minimized through design features and administrative procedures that will be defined in conjunction with the facility design process. The radiological impacts to involved workers from accidents could not be quantitatively estimated for this PEIS because the facility design information needed to support the estimate has not yet been developed. The impacts on workers from accidents will be analyzed as part of subsequent project-specific NEPA documentation and in detailed safety analysis documentation that are prepared in conjunction with the facility design process.

The tritium supply and upgraded recycling facilities would be designed to comply with current Federal, state, and local laws, DOE orders, and industrial codes and standards. This would provide facilities that are highly resistant to the effects of severe natural phenomena, including earthquake, flood, tornado, and high wind, as well as credible events as appropriate to the site, such as fire and explosions, and man-made threats to its continuing structural integrity for containing materials.

The tritium supply facility would be designed to resist the effects of severe natural phenomena as well as the effects of man-made threats to its continuing structural integrity. It also would be designed to provide containment of the tritium inventory at all times through the use of multiple, high quality confinement barriers to prevent the accidental release of tritium to the environment. It also would be designed to produce a lower quantity of waste materials as compared to the tritium facilities of the existing weapons complex.

In addition, DOE orders specify the requirements for emergency preparedness at DOE facilities. SRS has comprehensive emergency plans to protect life and property within the facility and the health and welfare of surrounding areas. The emergency plans would be revised to incorporate future DOE requirements and expanded to incorporate the addition of tritium supply facilities to SRS. See section 4.6.2.9 for emergency preparedness and emergency plan details at SRS.

4.6.3.10 *Waste Management*

Construction and operation of tritium supply and upgrading recycling facilities would impact existing SRS waste management operations, increasing the generation of low-level, mixed low-level, hazardous, and nonhazardous wastes, and reintroducing the generation of spent nuclear fuel. There are no high-level or TRU wastes associated with the proposed action. As part of their design, all reactor technologies would provide stabilization and storage of spent fuel for the life of the facility.

The impacts of a decision to use existing facilities would range from filling onsite LLW disposal facilities at the rate of 13 acres per year; utilizing 50 percent of the capacity of the liquid LLW treatment facilities; increasing the generation of mixed LLW to a rate that would fill the storage facilities in half of their planned lifetime; and increasing the quantity of hazardous waste generated by a factor of nine requiring new RCRA-permitted staging facilities. The reactor technologies produce liquid LLW in quantities requiring new treatment facilities, and all technologies require expanded or new treatment facilities for their liquid sanitary wastes. This section provides a description of the waste generation, treatment, storage, and disposal requirements of the tritium supply technologies and upgraded recycling facilities and the potential impact on waste management activities at SRS.

No Action. Under No Action, high-level, TRU, low-level, mixed low-level, hazardous, and nonhazardous wastes and spent nuclear fuel would continue to be managed from the missions outlined in section 3.3.5. Table 4.6.3.10–1 lists the projected waste generation rates as well as treatment, storage, and disposal capacities under No Action. Projections for No Action were derived from 1991 environmental data, with appropriate adjustments made for those changing operational requirements where the volume of wastes generated is identifiable. These wastes could be managed adequately by existing and currently planned facilities. The projection does not include wastes from yet uncharacterized environmental restoration activities.

Spent nuclear fuel from past production reactor operations will have been stabilized and stored onsite awaiting the availability of a Federal repository. Since the K-Reactor is in a cold standby with no provision for restart, there will be no additional spent reactor fuel generated. However, SRS would continue to receive aluminum clad spent nuclear fuel from offsite facilities in accordance with the ROD from the *Department of Energy Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management Programs Final EIS.* This fuel would be stabilized and prepared for long-term storage onsite. As reflected in this ROD, the DOE estimated inventory of spent nuclear fuel in 2035 is 2,742 metric tons. For comparison purposes, the commercial spent nuclear fuel inventory in 2030, assuming no reprocessing or new orders, is projected to be 85,700 metric tons of heavy metal (DOE 1994d:16).

TRU waste previously stored or buried would be repackaged to meet WIPP waste acceptance criteria and stored in the Solid Waste Disposal Facility for eventual shipment to WIPP once it is demonstrated to be in compliance with the requirements of 40 CFR 191 and 40 CFR 268 or to another TRU waste disposal facility should WIPP prove unsatisfactory. If additional treatment is necessary for disposal at WIPP, SRS would develop the appropriate treatment capability. If shipments to WIPP are delayed, additional storage facilities would be designed and constructed as needed.

Liquid LLW would be processed into saltstone and disposed of in engineered facilities onsite. Solid LLW would be compacted and disposed of in engineered trenches. The planned burial ground expansion in the E-Area is expected to accommodate the current waste disposal requirements through 2012. Additional waste disposal facilities would be constructed as needed to ensure compliance. The Consolidated Incineration Facility would also be utilized to reduce the volume of LLW requiring disposal.

SRS plans to incinerate mixed waste in compliance with applicable RCRA Land Disposal Restriction Standards, stabilize it, and dispose of the residue onsite as LLW. These processes are under development in accordance with terms and schedules of the Federal Facility Compliance Agreement on RCRA Land Disposal Restrictions signed by DOE and EPA on March 13, 1991. Details of this agreement are provided in appendix section A.2.5. This agreement is being reviewed in light of the *Federal Facility Compliance Act* which requires DOE to submit a site-specific treatment plan to the State of South Carolina to address compliance with RCRA Land Disposal Restrictions for mixed waste. At the present time, mixed waste is stored in a RCRA-permitted facility in DOT-approved containers until treatment capacity becomes available.

TABLE 4.6.3.10–1.—*Projected Spent Nuclear Fuel and Waste Management for No Action at Savannah River Site* [Page 1 of 2]

Category	Annual Generation Rate (yd^3)	Treatment Method	Treatment Capacity (yd^3/yr)	Storage Method	Storage Capacity (yd^3)	Disposal Method	Disposal Capacity (yd^3)
Spent Nuclear Fuel	None (offsite receipts of aluminum-clad spent fuel)	Stabilization	Under development[a]	Fuel pools and dry storage	Planned[a]	To repository	Not designed
High-level							
Liquid	5,079 (1,026,000 gal)	Adsorption, evaporation, vitrification	135,362 (27,343,000 GPY)	Tank farm	307,714 (62,158,074 gal)	NA	NA
Solid	None	None	None	Shielded vault	5,562	To repository	NA
Transuranic							
Liquid	None	Grout	Not designed	None	None	NA	NA
Solid	431[b]	Sort, shred	Not designed	Trupact II Containers	Expandable as required	None-WIPP in the future	NA
Low-Level							
Liquid	None	Chemical, filtration, saltstone	520,158 (105,072,000 GPY)	Ponds, tanks-awaiting processing	NA	NA	NA
Solid	5,100	Compact	32,781 yd^3/yr	Not stored	Not stored	Burial vaults	1,400,000
Mixed Low-Level							
Liquid	1,336 (275,900 gal)	Chemical, filtration, saltstone	520,158 (105,072,000 GPY)	Tanks, containers in buildings	326,380 (65,928,760 gal)	NA	NA
Solid	151	Incineration, stabilize	Planned	DOT containers (solid), facility	1,521	To solid LLW burial onsite	9,679
Hazardous							
Liquid	Included in solid	Incineration, stabilize	Planned	Planned RCRA facility	Planned	NA	NA
Solid	13	Incineration, stabilize	Planned	Planned RCRA facility	Planned	Onsite RCRA facility	Planned

TABLE 4.6.3.10–1.—*Projected Spent Nuclear Fuel and Waste Management for No Action at Savannah River Site* [Page 2 of 2]

Category	Annual Generation Rate (yd^3)	Treatment Method	Treatment Capacity (yd^3/yr)	Storage Method	Storage Capacity (yd^3)	Disposal Method	Disposal Capacity (yd^3)
Nonhazardous (Sanitary)							
Liquid	920,000 (186,000,000 gal)	Filter, strip, settle	1,900,000 yd^3/day (383,000,000 GPY)	Flowing ponds	NA	NPDES discharge	Planned
Solid	80,000	Incinerate, compact	Expandable as required	None	None	Onsite lined pit	Planned
Nonhazardous (Other)							
Liquid	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary
Solid	6,800	NA	NA	NA	NA	Recycled	

[a] Treatment and storage were evaluated in the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final EIS*. Further evaluation will be done in site-specific tiered document.

[b] Retrieval and packaging, not new waste.

Note: NA - not applicable.

Source: SR DOE 1993b; SRS 1993a:3.

SRS also plans to incinerate hazardous waste in compliance with applicable RCRA incinerator permit and RCRA Land Disposal Restriction Standards, and NESHAPs (hazardous air pollutants) and New Source Performance Standards of the CAA onsite (in the Consolidated Incineration Facility), stabilize it, and dispose of the residue onsite. A RCRA-permitted hazardous waste storage and disposal facility is currently being designed to handle projected wastes from current operations. Specific areas are being reserved for future expansion. Offsite disposal (current practice) would remain an option. Specifics of this hazardous waste incineration and/or shipment to offsite commercial, RCRA-permitted facilities would be addressed in site-specific tiered NEPA documents.

Sanitary and nonhazardous process waste liquids are treated by various means to remove water and must comply with two CWA settlement agreements discussed in appendix section A.1.5. Disposal of the treated sanitary and process water is addressed in section 4.6.3.4. The resultant solids are disposed of with solid nonhazardous waste in a permitted landfill sized to handle projected future waste volumes. The current sanitary waste landfill is nearing design capacity. Disposal offsite in a permitted commercial facility is being considered for the future.

Tritium Supply and Recycling. Tritium supply and upgraded recycling facilities would treat and package all waste generated in support of the nuclear weapons stockpile into forms that would enable long-term storage and/or disposal in accordance with the *Atomic Energy Act*, RCRA and other relevant statutes as outlined in chapter 5 and in appendix section H.1.2. The resultant waste effluents are shown in section 3.4. Since tritium recycling is a mission already performed at SRS, the incremental waste volumes would come from the new tritium supply facility. Waste generated during construction of any tritium supply technology would consist of wastewater, solid nonhazardous, and hazardous waste. The nonhazardous wastes would be disposed of as part of the construction project by the contractor, and the hazardous wastes would be shipped to a RCRA-permitted treatment and disposal facility. Operation of the three reactor-based tritium supply technologies would generate spent fuel, and all four technologies and the upgraded tritium recycling facilities would generate low-level, mixed low-level, hazardous, and nonhazardous wastes. The volume of the waste streams from tritium supply would vary according to the tritium supply technology chosen. Table 4.6.3.10–2 lists the total estimated waste volumes projected to be generated at SRS as a result of various tritium supply technologies and upgraded recycling facilities. The incremental waste volumes from the tritium supply technologies that were added to the tritium recycling phaseout projection can be found in appendix section A.2. The phaseout projection was derived by subtracting the unconsolidated recycling upgrade volumes from No Action.

Table 4.6.3.10–3 lists potential waste management impacts at SRS at the time of initial operation of the tritium facilities. Spent nuclear fuel storage for the life of the reactors is provided for in the reactor designs (appendix section A.2.1). Because spent nuclear fuel reprocessing is not planned, no HLW would be generated. Without plutonium production, no TRU waste would be generated. The treatment, storage, and disposal of mixed LLW would be in accordance with the *SRS Site Treatment Plan* which is currently being developed pursuant to the *Federal Facility Compliance Act*.

Heavy Water Reactor. Spent nuclear fuel would be generated at the rate of 7 yd^3 per year. This would add 0.3 metric tons of heavy metal per year to the DOE spent nuclear fuel inventory. The HWR would be designed to provide the necessary stabilization and storage for the spent nuclear fuel while awaiting final disposition. The liquid LLW generated by the HWR would require treatment facilities to reduce LLW volume and stabilize the remaining concentrated radionuclides to prepare it for disposal onsite. The solid LLW generated would double the No Action volume, and require 0.4 acres per year of additional onsite LLW disposal area (assuming a 4,500 yd^3 per acre disposal usage factor). There would be no increase in liquid mixed LLW generated, but the solid mixed LLW volume would increase by 79 percent over No Action. Expansion of existing or planned, or new treatment facilities may be required. The HWR would generate hazardous waste at a rate that is 4 times that of No Action. Thus, appropriate RCRA-permitted staging facilities would be planned for the HWR. A factor of 14 increase in liquid sanitary wastes generation would require new treatment facilities. The 10 percent increase in solid sanitary wastes

TABLE 4.6.3.10–2.—*Estimated Annual Generated Spent Nuclear Fuel and Waste Volumes for Tritium Supply Technologies and Recycling at Savannah River Site*

		Tritium Supply Technologies and Recycling Upgrade						
Category	No Action[a] (yd^3)	HWR (yd^3)	MHTGR (yd^3)	Large ALWR (yd^3)	Small ALWR (yd^3)	APT[b] (yd^3)	Tritium Recycling Upgrade[c] (yd^3)	Tritium Recycling Phaseout (yd^3)
Spent Nuclear Fuel	None	7[d]	80[e]	55[f]	36[g]	None	None	None
Low-level								
Liquid	None	10,400 (2,100,000 gal)	2,600 (525,000 gal)	24,800 (5,000,000 gal)	3,910 (790,000 gal)	None	None	None
Solid	5,100	10,300	6,400	5,810	5,760	5,640	5,100	4,750
Mixed Low-Level								
Liquid	1,370 (276,000 gal)	1,370 (276,000 gal)	1,370 (276,000 gal)	1,370 (276,000 gal)	1,370 (276,000 gal)	1,370 (276,000 gal)	1,370 (276,000 gal)	1,370 (276,000 gal)
Solid	151	271	152	157	157	158	151	149
Hazardous								
Liquid	Included in solid	Included in solid	Included in solid	Included in solid	Included in solid	Included in solid	Included in solid	Included in solid
Solid	13	53	113	48	48	16	13	12
Nonhazardous (Sanitary)								
Liquid	920,000 (186,000,000 gal)	12,500,000 (2,530,000,000 gal)	8,990,000 (1,820,000,000 gal)	32,100,000 (6,480,000,000 gal)	15,000,000 (3,040,000,000 gal)	2,130,000 (431,000,000 gal)	920,000 (186,000,000 gal)	767,000 (154,000,000 gal)
Solid	80,000	87,600	87,400	86,900	84,200	81,200	80,000	72,200
Nonhazardous (Other)								
Liquid	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary
Solid	6,800[h]	13,300[h]	13,200[h]	12,600[h]	10,300[h]	6,800[h]	6,800[h]	Included in sanitary

[a] The No Action waste volumes are from table 4.6.3.10–1. Waste volumes for tritium technologies were derived by adding the waste volumes of the various technologies found in appendix section A.2 (tables A.2.1.1–4, A.2.1.2–4, A.2.1.3–4, A.2.1.3–5, A.2.1.4–3, and A.2.2.2–4) to the phaseout volumes. The phaseout volumes are derived by subtracting the Recycling Upgrade unconsolidated waste volumes in table A.2.2.2–4 from No Action. Waste volumes have been rounded to three significant figures.

[b] The APT and Recycling waste volumes are based on the spallation-induced lithium conversion target. The helium-3 target volumes are approximately the same with the exception of solid LLW which is 5,170 yd^3.

[c] The Tritium Recycling waste volumes are based on the unconsolidated upgrade as presented in appendix section A.2.2.2.

[d] Residual heavy metal content is 660 lb (0.3 metric tons)

[e] Residual heavy metal content is 230,000 lb (0.24 metric tons)

[f] Residual heavy metal content is 150,000 lb (105 metric tons)

[g] Residual heavy metal content is 150,000 lb (68 metric tons)

[h] Recyclable wastes.

TABLE 4.6.3.10–3.—*Potential Spent Nuclear Fuel and Waste Management Impacts from Tritium Supply Technologies and Recycling at Savannah River Site* [Page 1 of 2]

	Tritium Supply Technologies and Recycling													
	HWR		MHTGR		Large ALWR		Small ALWR		APT		Tritium Recycling Upgrade		Tritium Recycling Phaseout	
Category	Change from No Action[a] (percent)	Impact	Change from No Action[a] (percent)	Impact	Change from No Action[a] (percent)	Impact	Change from No Action[a] (percent)	Impact	Change from No Action[a] (percent)	Impact	Change from No Action[a] (percent)	Impact	Change from No Action[a] (percent)	Impact
Spent Nuclear Fuel	New[b]	New storage facility	New[b]	New storage facility	New[b]	New storage facility	New[b]	New storage facility	None	None	None	None	None	None
Low-Level														
Liquid	New[c]	New treatment facility	New[c]	New treatment facility	New[c]	New treatment facility	New[c]	New treatment facility	None	None	None	None	None	None
Solid	+102	0.4 acres per yr of additional LLW disposal area	+25	0.1 acres per yr of additional LLW disposal area	+14	0.1 acres per yr of additional LLW disposal area	+13	0.06 acres per yr of additional LLW disposal area	+11	0.05 acres per year of additional LLW disposal area	None	None	-7	Extend LLW disposal facility life
Mixed Low-Level														
Liquid	None	None	None	None	None	None	None	None	None	None	None	None	-<1	None
Solid	+79	Additional facilities	<1	None	+4	Expansions of treatment capacity	+4	Expansions of treatment capacity	+5	Expansions of treatment capacity	None	None	-1	None
Hazardous														
Liquid	Included in solid		Included in solid		Included in solid		Included in solid		Included in solid		Included in solid		Included in solid	
Solid	+308	Additional storage facilities	+769	Additional storage facilities	+269	Additional storage facilities	+269	Additional storage facilities	+19	Expand storage facilities	None	None	-8	None

TABLE 4.6.3.10–3.—*Potential Spent Nuclear Fuel and Waste Management Impacts from Tritium Supply Technologies and Recycling at Savannah River Site* [Page 2 of 2]

	Tritium Supply Technologies and Recycling													
	HWR		MHTGR		Large ALWR		Small ALWR		APT		Tritium Recycling Upgrade		Tritium Recycling Phaseout	
Category	Change from No Action[a] (percent)	Impact	Change from No Action[a] (percent)	Impact	Change from No Action[a] (percent)	Impact	Change from No Action[a] (percent)	Impact	Change from No Action[a] (percent)	Impact	Change from No Action[a] (percent)	Impact	Change from No Action[a] (percent)	Impact
Nonhazardous (Sanitary)														
Liquid	+1,260	Additional treatment facilities	+877	Additional treatment facilities	+3,380	Additional treatment facilities	+1,530	Additional treatment facilities	+132	Additional treatment facilities	None	None	-17	None
Solid	+10	Reduce landfill life or expansion required	+9	Reduce landfill life or expansion required	+9	Reduce landfill life or expansion required	+5	Reduce landfill life or expansion required	+2	Negligible	None	None	-10	Extend life of landfill
Nonhazardous (Other)														
Liquid	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Solid	+96	None-Project wastes are recyclable	+94	None-Project wastes are recyclable	+85	None-Project wastes are recyclable	+51	None-Project wastes are recyclable	None	None - Project waste are recyclable	None	None - Project wastes are recyclable	Included in sanitary	Included in sanitary

[a] Reflects a percentage change in generation rate over No Action. Percentage change was calculated using waste volumes prior to rounding. Do not use rounded numbers in Table 4.6.3.10–2 to calculate percentage change.

[b] Although No Action shows no generation of spent fuel, it has been generated in the past, and receipt of fuel from offsite will continue.

[c] No Action shows no generation, but there is in-process treatment of liquid LLW.

Source: Tables 4.6.3.10–1; 4.6.3.10–2.

would reduce the life of the landfill or require its expansion.

Modular High Temperature Gas-Cooled Reactor. Spent nuclear fuel would be generated at the rate of 80 yd^3 per year. This would add 0.24 metric tons of heavy metal per year to the DOE spent nuclear fuel inventory. The MHTGR would be designed to provide the necessary stabilization and storage for the spent nuclear fuel while awaiting final disposition. The liquid LLW generation would require treatment facilities to concentrate and stabilize the radionuclides for disposal onsite. Solid LLW generation would increase by 25 percent over No Action, requiring 0.1 acres per year of additional new disposal area. There would be no increase in liquid mixed LLW generation, and the solid mixed LLW generation would be less than 1 percent more than No Action; therefore no impacts are expected. The MHTGR does generate solid hazardous waste at a rate that is eight times that of No Action. Additional facilities would be required where this waste could be accumulated and prepared for shipment to a RCRA-permitted disposal facility. A factor of 10 increase in liquid sanitary wastes would require new treatment facilities. Solid sanitary waste generation would increase by 9 percent, reducing the life of the landfill or requiring its expansion.

Advanced Light Water Reactor (Large). Spent nuclear fuel would be generated at the rate of 55 yd^3 per year. This would add 105 metric tons of heavy metal per year to the DOE spent nuclear fuel inventory. The Large ALWR would be designed to provide the necessary stabilization and storage for the spent fuel while awaiting final disposition. The liquid LLW generated by the ALWR would require treatment facilities to concentrate and stabilize the radionuclides for disposal onsite. The solid LLW generated would be 14 percent more than the No Action volume. This would require 0.1 acres of additional LLW disposal area per year. There would be no increase in liquid mixed LLW generated by the ALWR; however, the solid mixed LLW volume would be 4 percent more than No Action. Some expansion of planned treatment facilities may be required. The ALWR would cause hazardous waste generation to increase by a factor of four. Additional RCRA-permitted facilities may be required to prepare the waste for shipment to a RCRA-permitted disposal facility. Liquid sanitary wastes generated by the ALWR would increase 35 times the No Action volumes. This would require expansion of existing facilities, or the construction of new facilities. Solid sanitary wastes increase the No Action volumes by 9 percent, reducing the life of the landfill or requiring its expansion.

Advanced Light Water Reactor (Small). Spent nuclear fuel would be generated at the rate of 36 yd^3 per year. This would add 68 metric tons of heavy metal per year to the DOE spent nuclear fuel inventory. The Small ALWR would be designed to provide the necessary stabilization and storage for the spent nuclear fuel while awaiting final disposition. The liquid LLW generated by the ALWR would require treatment facilities to reduce its volume and stabilize the remaining concentrated radionuclides to prepare the waste for disposal onsite. The solid LLW volume would increase by 13 percent from the No Action volume, requiring 0.06 acres of additional LLW disposal area per year. There would be no increase in liquid mixed LLW generated by the ALWR. The ALWR solid mixed LLW generation would cause the rate at SRS to increase by 4 percent above No Action, and therefore would have a minor impact. The ALWR would generate a factor of four increase in hazardous waste; additional RCRA-permitted facilities may be required to prepare the waste for shipment to a RCRA-permitted disposal facility. Liquid sanitary wastes generated by the Small ALWR would require new treatment facilities since the volume is 16 times the projected No Action volume to be treated in the SRS centralized facilities. The solid sanitary wastes generated by the Small ALWR would increase the generation at SRS by 5 percent more than No Action. This would reduce the life of the landfill or require its expansion.

Accelerator Production of Tritium. The APT does not generate spent nuclear fuel. Any liquid LLW generated can be solidified at the point of generation. Solid LLW generation would increase at SRS by 11 percent from No Action, requiring 0.05 acre per year of additional LLW disposal area. There would be no increase in mixed liquid LLW by the APT. Solid mixed LLW would increase by 5 percent and may require some expansion of planned treatment facilities. Hazardous waste generation would increase 19 percent over No Action, requiring possible expansion or new RCRA-permitted staging facilities. The liquid sanitary wastes generated would be three times the No Action volume and would require additional treatment facilities. The volume of solid sanitary wastes is less than 2 percent of that generated under No Action, and would have a negligible impact to the design life of the existing landfill.

Less Than Baseline Operations. In the event of a reduced tritium requirement, the waste volumes shown in table 4.6.3.10–2 would not appreciably change as a result of the HWR operating at less power and the MHTGR and ALWR irradiating fewer target rods. In the case of a Phased APT using the helium-3 target, the waste volumes with the exception of cooling tower blowdown, which decreases by 36 percent (86 MGY), are approximately the same as the Full APT using the helium-3 target.

Tritium Recycling Upgrade. As described in appendix section A.2.2.2, the unconsolidated tritium recycling upgrade at SRS involves only structural upgrades and other modifications that would have no affect on the operational waste volumes from the recycling mission; thus, there are no waste management impacts for the unconsolidated upgrade. A consolidated upgrade is described in the potential mitigation section.

Tritium Recycling Phaseout. The phasing out of tritium recycling facilities would decrease the generation of solid low-level, mixed low-level, hazardous, and sanitary wastes. The 7-percent decrease in solid LLW generation would extend the planned life of the onsite LLW disposal facility. The less than 1-percent decrease in mixed LLW generation would have negligible impact. An 8-percent decrease in hazardous waste generation would decrease the number of offsite hazardous waste shipments. The 17-percent decrease in liquid nonhazardous sanitary waste and 10-percent decrease in solid nonhazardous sanitary waste would occur over time as the facilities are transitioned to EM.

Multipurpose Reactor

Multipurpose Modular High Temperature Gas-Cooled Reactor. The volume of spent nuclear fuel generated by the six-reactor module multipurpose MHTGR would be approximately double the spent nuclear fuel from the three-reactor module tritium supply MHTGR. Similar to the mixed-oxide fuel assemblies, the plutonium-oxide fuel assemblies would have greater decay heat. Because the increased decay heat reduces storage density in the pool area and increases the fuel pool dwell time before dry storage, the spent nuclear fuel storage requirement would more than double that required for the three-reactor module tritium supply MHTGR. No increases in waste generation rates or characteristics are expected due to the change from uranium-oxide reactor fuel to plutonium-oxide reactor fuel. However, there would be increases in waste generation for all waste categories due to operation of the Pit Disassembly/Conversion Facility to include the introduction of mixed TRU and TRU wastes from both the Pit Disassembly/Conversion Facility and the fabrication of plutonium-oxide fuel. These increases are in addition to those listed in table 4.6.3.10–2 for the tritium supply MHTGR. Table 4.8.3.1–8 provides the quantity of waste effluents from the Pit Disassembly/Conversion Facility. In addition, approximately 385 yd^3 of mixed TRU and TRU wastes would result from the fabrication of plutonium-oxide fuel. The 399 yd^3 of mixed TRU and TRU wastes would require transport to a geologic repository (assuming one is available) after they have been processed to meet the WIPP waste acceptance criteria. SRS has existing and planned TRU waste handling facilities that could be used.

The transport of the mixed TRU and TRU wastes to WIPP would require 35 truck shipments per year, 18 regular train shipments per year, or six dedicated train shipments per year. One hundred gallons of liquid and 0.2 yd^3 of solid mixed LLW would require treatment in accordance with the SRS Site Treatment Plan. Approximately 0.003 acres per year of LLW disposal area would be required to dispose of the 10 yd^3 of solid LLW. Sufficient staging capacity exists to accumulate the 1,000 gallons of liquid and 1 yd^3 of solid hazardous wastes while awaiting shipment to a RCRA-permitted treatment and disposal facility. An additional 87 yd^3 of solid nonhazardous wastes would require disposal in the sanitary landfill. Additional liquid sanitary and industrial wastewater treatment facilities may be required if the Pit Disassembly/Conversion Facility is not collocated with the multipurpose reactor.

<u>Multipurpose Advanced Light Water Reactor</u>. Spent fuel would be generated at the same rate with approximately the same amount of residual heavy metal content as the tritium supply ALWR. The decay heat in the mixed-oxide fuel assemblies could be 10 to 20 percent greater than the heat in spent uranium-oxide fuel assemblies. The increased decay heat load could reduce the fuel assembly storage density in the fuel pool and dry storage casks or increase fuel pool dwell time before dry storage. No increases in waste generation rates or characteristics are expected due to the change from uranium-oxide reactor fuel to mixed-oxide reactor fuel. However, there would be increases in waste generation for all waste categories due to operation of the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility to include the introduction of mixed TRU and TRU wastes. These increases are in addition to those listed in table 4.6.3.10–2 for the Large and Small tritium supply ALWR. As shown in table 4.8.3.1–4, approximately 399 yd^3 of mixed TRU and TRU wastes would require transport to a geologic repository (assuming one is available) after they have been processed to meet the WIPP waste acceptance criteria. SRS has existing and planned TRU waste handling facilities that could be used.

The transport of the mixed TRU and TRU wastes to WIPP would require 35 truck shipments per year, 18 regular train shipments per year, or six dedicated train shipments per year. Two hundred gallons of liquid and 13 yd^3 of solid mixed LLW would require treatment in accordance with the SRS Site Treatment Plan. Approximately 0.12 acres per year of LLW disposal area would be required to dispose of the 524 yd^3 of solid LLW. Sufficient staging capacity exists to accumulate the 200 gallons of liquid and 13 yd^3 of solid hazardous wastes while awaiting shipment to a RCRA-permitted treatment and disposal facility. An additional 3,920 yd^3 of solid nonhazardous wastes would require disposal in the sanitary landfill. Additional liquid sanitary and industrial wastewater treatment facilities may be required if the Pit Disassembly/Conversion/Mixed Oxide Fuel Fabrication Facility is not collocated with the multipurpose reactor.

Potential Mitigation Measures. Each tritium supply technology and the upgraded recycling facilities would be designed to process its own waste into forms suitable for storage or disposal and would use proven waste minimization and pollution prevention technologies to the extent possible. A consolidated recycling facility upgrade could further reduce and minimize waste management. The consolidated upgrade is described in appendix section A.2.2.2 and includes the transferring of functions from Building 232-H. This would result in a 400 yd^3 per year decrease in the generation of solid sanitary waste. All other waste volumes would be unchanged. Some facility designs would produce waste quantities or waste forms that could undergo additional reductions by utilizing emerging technologies, thereby further reducing or mitigating impacts. Pollution prevention and waste minimization would be considered in determining the final design of any facility constructed as part of the proposed action at SRS. Pollution prevention and waste minimization would also be evaluated as part of site-specific analyses and tiered NEPA documents.

Utilization of existing treatment, storage and disposal facilities could further reduce impacts. For example, the liquid LLW processing facilities at SRS have capacity exceeding the generation rates of any of the technology options and may be able to process those wastes. The saltstone process in the defense waste processing facility could be utilized for these wastes. Similarly, the Consolidated Incineration Facility is scheduled to complete its mission of treating existing LLW, mixed LLW and hazardous wastes by the time the new tritium supply facility would be constructed. It therefore could be utilized to process LLW, mixed LLW and hazardous wastes from the tritium supply facility. The use of existing incineration at SRS could reduce the volume of solid LLW to be disposed by a factor of up to 20. The new central sanitary waste treatment plant could also be utilized. Utilization of these facilities would require site-specific engineering studies and NEPA analysis.

4.7 Intersite Transport of Tritium Supply and Recycling Materials

This PEIS examines alternatives to accomplish the future mission for tritium supply and recycling: to retain and upgrade the existing tritium recycling facility at SRS or to locate one of the tritium supply technologies with or without recycling facilities at one of five candidate sites. All of these would require transporting quantities of hazardous materials, including tritium, between sites. All hazardous materials, except tritium and highly enriched uranium, would be transported by commercial carrier in compliance with DOT regulations. Tritium and highly enriched uranium would be transported by authorized government means. Under all alternatives, tritium reserves would remain in place at SRS; therefore, there would be no impacts for relocating tritium inventory.

Transportation impacts could result from normal operation of the tritium supply and recycling facility. With the tritium supply and recycling facility, there are two types of DOE tritium shipments for normal operation: those between DOE facilities and those between a DOE facility and a military first destination. Impacts could also result from the transport of highly enriched uranium for fuel feed materials under the HWR and MHTGR alternatives. Multipurpose reactor impacts are addressed separately in section 4.8.3.

DOE has extensively studied the risk of accidental dispersal of radioactive materials, including tritium transported by Ross Aviation, Inc., DOE's air cargo contractor. The assessment showed that the probability of an accident by Ross Aviation was 2.7×10^{-4} per year. The annual tritium release probability was 1.0×10^{-5} and the consequences from the accidental release of tritium is estimated to be 9.0×10^{-8} latent cancer fatalities per year.

4.7.1 Affected Environment

Although DOE has experienced traffic accidents related to the intersite transport of Complex materials, historically there has never been a traffic accident involving the release of radioactive materials. Therefore, risk impacts were determined using standard analysis criteria and universally accepted computer models.

The Complex's hazardous material (radioactive and nonradioactive) transport requirements are minor compared to the large shipment volume from non-DOE hazardous material transport activities. DOT estimates that approximately 4 billion tons of regulated hazardous materials are transported each year and that approximately 500,000 movements of materials occur each day (PL 101-615, Section 2(1)). There are approximately 2 million annual shipments of radioactive materials involving approximately 2.8 million packages. This is about 2 percent of the Nation's annual hazardous materials shipments. Most radioactive shipments involve small or intermediate quantities of material in relatively small packages. During 1991, the most recent year for which complete data are available, the Complex shipped about 6,200 radioactive packages (commercial and classified) between its sites. This represents less than 0.3 percent of all radioactive shipments in the United States and about 2 percent of all Complex intersite shipments.

The Complex's unclassified radioactive and other hazardous materials are transported by commercial vehicles (truck, rail, and air carriers). Special nuclear material and radioactive weapons components, representing approximately 3 percent of DOE's total hazardous materials shipments, are transported by DOE's safe secure trailers and the Ross Aviation, Inc., air contract carrier. Typically, these special nuclear materials and weapon components require continual surveillance and accountability by DOE's Transportation Safeguards Division located in Albuquerque, NM.

Tritium shipments between sites are made almost exclusively by air by Ross Aviation, Inc. A small number of tritium shipments and most highly enriched uranium shipments are made by DOE-owned and -operated safe secure trailers. The safe secure trailers are vehicles designed specifically for the safety and security of the cargo. Shipments by safe secure trailers are accompanied by armed guards and are monitored by a tracking system. Regulatory authority is discussed further in appendix G.

For the analysis of intersite shipments of tritium, the baseline used is the number of limited-life components (tritium reservoir) needed per year to meet all stockpile requirements, including limited-life components needed for replacement in existing weapons.

This baseline represents DOE's anticipated tritium workload. The historical and projected data for tritium shipments are classified information.

4.7.1.1 *Site Transportation Interfaces for Hazardous Materials*

The existing transportation modes that serve each of the five candidate sites and the links to those modes for the intersite transport of hazardous materials are summarized in table 4.7.1.1–1.

In *A Report by the Nuclear Weapons Complex Reconfiguration Site Evaluation Panel* (October 1991), four sites (INEL, ORR, Pantex, and SRS) were given a comparative rating based on the strengths and weaknesses of their transportation services. For consistency, the rating methodology and evaluation procedures established by the Nuclear Weapons Complex Reconfiguration Site Evaluation Panel were also applied to NTS. A more detailed discussion of transportation issues is included in appendix G.

4.7.1.2 *Packaging*

Packaging refers to a container and all accompanying components or materials necessary to perform its containment function. Packagings used by DOE for hazardous materials shipments are either certified to meet specific performance requirements or built to specifications described in DOT hazardous materials regulations (49 CFR). For relatively harmless radioactive materials, DOT Specification Type A packaging is used. Type A packaging is designed to retain its contents under normal transportation conditions. More sensitive radioactive materials shipments, including limited-life components (tritium reservoirs) and highly enriched uranium, require the use of highly sophisticated Type B packaging, designed to prevent the release of contents under all credible transportation accident conditions.

Tritium, a low-energy beta emitter, is shielded in its packaging to prevent radiation of detectable levels outside the packaging. Tritium is shipped in packaging specifically designed for containment should an accident occur. Thus, during normal operation, tritium-related transportation poses no significant risk to transportation workers or the public.

Highly enriched uranium for fuel feed material would be placed in DOT-specification, Type B packaging and transported by DOE safe secure trailer.

4.7.1.3 *Reactor Vessel Transport*

The reactor vessel is the largest component shipped to a site for installation. The vessel size and weight will vary, depending on the reactor technology and manufacturer selected. Based on past experience, it is possible to transport a reactor vessel to any of the candidate sites. Transport of this type of equipment would require specific routing, special transport vehicles, and assurance that the transportation infrastructure, from origin to destination, is compatible to accept the size and weight of the load. Barge is a preferred mode of transport, when available. Transport of the reactor vessel is typically the

TABLE 4.7.1.1–1.—*Transportation Modes and Comparison Ratings for the Candidate Sites*

Candidate Site	Onsite Railroad Service	Nearest Inter-State Highway (miles)	Distance to Airport for Cargo Shipments (miles)	Barge Service	Possible Weather Delays[a]	Overall Level of Transport Service
Idaho National Engineering Laboratory	Yes	46	40	No	Yes	Good
Nevada Test Site	No	60	65[b]	No	No	Good
Oak Ridge Reservation	Yes	4	31	Yes	Minimal	Good
Pantex Plant	Yes	7	20	No	Minimal	Outstanding
Savannah River Site	Yes	30	20	Yes	Minimal	Good

[a] DOE Transportation Safeguards System shipments.

[b] A closer onsite or nearby airfield could be used for DOE Transportation Safeguards System air cargo shipments only.

Source: Source: DOE 1991j; NTS 1992a:3.

vendor's responsibility. Any potential impacts for reactor vessel transport would be included in site-specific tiered NEPA documentation.

4.7.2 Environmental Impacts

Transportation-related impacts result from the movement of materials between sites. The analysis of transportation impacts focused on the movement of tritium because of its greater potential for impacts. The transportation impact assessment on tritium is presented in a qualitative manner because of a lack of historical accident data.

Because there will be no relocation of existing tritium inventory, regardless of the tritium supply technology selected, the only type of tritium transportation impact that could result from alternatives analyzed in this PEIS are yearly impacts associated with the transport of limited-life components during normal operation. Yearly operational transportation impacts could occur regardless of the site selected for tritium supply and recycling. However, if the tritium supply and recycling functions are collocated with the assembly and disassembly function at Pantex, tritium transportation risk would be reduced between DOE sites.

Radiological impacts could result from the transport of highly enriched uranium fuel material under the HWR and MHTGR alternatives. These risks are assessed.

4.7.2.1 *No Action*

Under No Action, tritium functions would remain at SRS. There would be no new tritium supply and no one-time tritium relocation impacts. The only impacts for No Action would be from minimum operational activity. Hence, tritium-related transportation impacts would decrease under No Action, as the tritium inventory is reduced through component replacement or decay.

Under No Action, DOE would have the capability to perform stockpile surveillance and weapons disassembly activities. These activities would necessitate some transportation of tritium. For both stockpile surveillance and weapons disassembly activities, the weapons would be dismantled at Pantex and tritium components shipped to SRS. The amount of tritium to be transported under stockpile surveillance activities is determined by quality assurance factors (i.e., random selection of weapons for testing and type and number of weapons). Tritium components from stockpile surveillance activities would be shipped at a low level of activity, based on specific requirements of the stockpile. The annual number of nuclear weapons being dismantled would decrease as goals of the current disarmament treaties are reached. By 2005, weapons disassembly under No Action would be performed primarily to meet weapons inventory replacement needs and is expected to involve approximately 5 percent of the stockpile annually.

The No Action impacts for the transportation of tritium can be summarized as follows:

- Normal (Incident-Free) Operation—The risk of transporting limited-life components to/from SRS is negligible because there are no detectable levels of radiation outside the package.

- Accident Condition—The estimated consequences of transporting limited-life components to/from SRS and Pantex is 9.0×10^{-8} latent cancer fatalities per year.

Without a new source of tritium, DOE is projected to eventually run out of tritium reserves. Transportation risks would decrease thereafter until the tritium inventory was depleted.

4.7.2.2 *Tritium Supply and Recycling Alternatives*

With each of the tritium supply technologies and recycling facilities, radiological risk could be incurred from transporting limited-life components between Complex sites in the course of normal operations. The impacts from transporting limited-life components would vary depending on where the tritium supply technologies and recycling facilities are located in relation to Pantex or military first destinations. Factors affecting impacts include air mileage, exposed populations, ground support facilities, and road miles travelled to and from airfields.

All possible transportation route combinations were evaluated. Although differences exist, such as air miles traveled, the consequences of an accidental tritium release during transport is estimated to be

9.0×10^{-8} latent cancer fatalities per year, regardless of the site selected, because takeoffs and landings will remain the same.

A simplified method of estimating the changes in transportation risk for tritium is to compare with No Action the relative changes in the distance that limited-life components might be transported to or from the assembly/disassembly plant at Pantex. Using this approach, transportation risk increases or decreases, depending on miles traveled, can be expressed as a relative mileage factor. The changes in relative transportation risk for the five candidate sites are presented in table 4.7.2.2–1. Compared to the current transportation risk of tritium, the relative transportation risk would be 29 percent lower if tritium supply and recycling is located at INEL, 30 percent lower at NTS, and 13 percent lower at ORR. There would be no transportation risk if tritium supply and recycling is collocated with assembly/disassembly functions at Pantex. For a comparison of air mileage distances between sites, see appendix table G.6–3.

An alternative to collocating tritium supply and new recycling facilities at INEL, NTS, ORR, or Pantex would be to place only tritium supply at these sites and upgrade and continue to use the recycling function at SRS. In this case, the following tritium-related transportation would occur:

- Virgin tritium would be shipped from the tritium supply facilities at INEL, NTS, ORR, or Pantex to SRS for processing in the tritium recycling facilities;
- Tritium limited-life components would continue to be shipped from SRS to Pantex for weapons production;
- Excess tritium limited-life components from disassembled weapons would continue to be shipped from Pantex to SRS for recycling; and
- Tritium limited-life component exchanges would continue to be shipped between SRS and military locations for replenishment.

This option could result in additional impact for transporting virgin tritium from the tritium supply facility to SRS. Two additional trips are estimated per year, or approximately 2 percent of the total distance travelled. Using the relative risk criteria described above, the cumulative risk of this option would vary slightly depending on the location of the selected tritium supply site, but would not exceed a relative risk factor of 1.02. This option poses the highest risk because of the greater distances tritium would be transported.

To estimate radiological impacts from transportation, the probability of an accident occurring was derived from DOE and DOT empirical data bases, and the upper bound additional exposures (50-year committed effective dose equivalent) that might be experienced were used. Factors considered in the analysis include historical accident rates, population densities along the route, and national atmospheric dispersion parameters. These factors were incorporated in the RADTRAN transportation risk computer code used for the calculations.

Based on transporting two truckloads of highly enriched uranium per year over the highest risk route (from Y-12 to INEL), the estimated population dose risk from radiological accidents during transportation is 3.9×10^{-11} person-rem per year.

TABLE 4.7.2.2–1.—*Comparison of Relative Mileage Risk*

Assembly and Disassembly Site	Tritium Supply and Recycling Site				
	INEL	NTS	ORR	Pantex	SRS
Pantex	0.71	0.7	0.87	0[a]	1.0

[a] Zero indicates that the tritium supply and recycling facilities are collocated with the assembly/disassembly function.
The current baseline route for tritium is from SRS to Pantex, 1,010 miles. The baseline mileage risk is 1.0.
Source: DOE 1994b:1.

Nonradiological impacts are fatalities that could result from traffic accidents. Standard risk factors (fatalities per miles) for transport by truck in the U.S. are: 6.8×10^{-8} for rural, 1.7×10^{-8} for suburban, and 9.6×10^{-9} for urban population zones. Using the highest risk route (from Y-12 to INEL), the nonradiological accident impact would not exceed 4.9×10^{-4} fatalities per year.

Modular High Temperature Gas-Cooled Reactor Alternative

For this analysis, highly enriched uranium-oxide would be shipped in DOT-specification, Type B packaging approved for this purpose. Each truckload would contain twenty packages. Based on an annual usage of 2,200 lb of highly enriched uranium (DOE 1995a) and a limit of 40 pounds of highly enriched uranium per package (FDI 1995b), approximately three truckloads per year would be required to transport the material.

The estimated population dose risks from radiological accidents during transportation are 5.8×10^{-11} person-rem per year for the highest risk route (from Y-12 to INEL). The estimated nonradiological accident risks are 7.3×10^{-4} fatalities per year for the highest risk route (from Y-12 to INEL).

The maximum number of fatalities that would occur within 1 year from both radiological and nonradiological accidents involving the transportation of highly enriched uranium-oxide for both HWR and MHTGR would not exceed 0.00051 (DOE 1995a:3).

LLW results from industrial processes and includes radioactively contaminated paper, protective clothing, cleaning materials, metal and glass equipment, tools, and construction items. The Complex's LLW is disposed of at permitted onsite locations with the exception of Pantex, which ships its LLW to NTS. If the tritium supply and recycling facilities are located at Pantex, the additional transportation risk of shipping LLW to NTS for normal operation would be negligible, regardless of the reactor technology, for the reasons described in appendix G. Table 4.7.2.2–2 presents the health impacts from transportation accidents due to siting of tritium supply and recycling facilities at Pantex and shipment of LLW to NTS.

The number of fatal cancers per year by radiological release from all credible accidents ranges from a high of 3.0×10^{-8} to a low of 3.3×10^{-9}. For traffic accidents not involving radiological releases, the number of fatalities ranges from a high of 4.0×10^{-4} to a low of 4.3×10^{-5}. Regardless of the tritium supply and recycling alternative, health impacts from transporting additional LLW shipments from Pantex to NTS are small.

Regardless of the tritium supply technology selected, locating the tritium supply and recycling facilities at Pantex would not appreciably increase impacts should an accident from the transport of LLW to NTS occur.

The impacts for the transportation of tritium, highly enriched uranium, and LLW under tritium supply and recycling alternatives can be summarized as follows: Normal (Incident-Free) Operation—The risk of transporting limited-life components is negligible because no detectable levels of radiation outside the package are expected.

- Accident Conditions—The estimated latent cancer fatalities per year from radiological effects due to an accident involving the transport of limited-life components is 9.0×10^{-8}. If the transport of highly enriched uranium is required (HWR and MHTGR alternatives), the estimated number of fatalities is 5.1×10^{-4}. The worst-case values for transporting LLW between Pantex and NTS are not expected to exceed 3.0×10^{-8} fatalities per year from radiological effects and 4.0×10^{-4} traffic fatalities per year from traffic accidents not involving radiological releases.

4.8 Potential Impacts From Tritium Supply Options

In addition to the impacts described in section 4.2 through 4.7 for the proposed tritium supply technologies and recycling facilities, impacts due to various options are qualitatively described in this section. Where possible, a quantitative analysis is presented. The options identified relate to additional reactor capabilities (electrical production) which have been included in the designs evaluated in this PEIS, an

TABLE 4.7.2.2–2.—*Accident Impacts from Transporting Low-Level Waste from Pantex Plant to Nevada Test Site*

		With a Radiological Release		Without a Radiological Release	
Alternative	**Additional Shipments of Low-Level Waste to NTS (per year)**	**Fatal Cancers from Additional Shipments (per year)**	**Fatal Cancer Frequency (years)**	**Traffic Fatalities (per year)**	**Traffic Fatality Frequency (years)**
Heavy Water Reactor	86	$2.8x10^{-8}$	$3.6x10^{7}$	$3.7x10^{-4}$	2,703
Heavy Water Reactor and Recycling Facility[a]	92	$3.0x10^{-8}$	$3.3x10^{7}$	$4.0x10^{-4}$	2,525
Modular High Temperature Gas- Cooled Reactor	22	$7.2x10^{-9}$	$1.4x10^{8}$	$9.5x10^{-5}$	10,571
Modular High Temperature Gas- Cooled Reactor and Recycling Facility	27	$8.8x10^{-9}$	$1.1x10^{8}$	$1.2x10^{-4}$	8,621
Large Advanced Light Water Reactor	26	$8.5x10^{-9}$	$1.2x10^{8}$	$1.1x10^{-4}$	8,929
Large Advanced Light Water Reactor and Recycling Facility	32	$1.0x10^{-8}$	$9.6x10^{7}$	$1.4x10^{-4}$	7,246
Small Advanced Light Water Reactor	13	$4.2x10^{-9}$	$2.4x10^{8}$	$5.6x10^{-5}$	17,889
Small Advanced Light Water Reactor and Recycling Facility	18	$5.9x10^{-9}$	$1.7x10^{8}$	$7.7x10^{-5}$	12,920
Accelerator Production of Tritium[b]	10	$3.3x10^{-9}$	$3.1x10^{8}$	$4.3x10^{-5}$	23,256
Accelerator Production of Tritium and Recycling Facility	16	$5.2x10^{-9}$	$1.9x10^{8}$	$6.9x10^{-5}$	14,535

[a] High transportation risk alternative.
[b] Low transportation risk alternative.
PX DOE 1993a:1.

option for providing a dedicated power plant for the APT, and a plutonium or mixed-oxide fueled reactor.

4.8.1 Sale of Steam from Tritium Supply Technologies

Two of the tritium supply reactor technologies, the MHTGR and the ALWR, operate at temperatures high enough to produce electricity by a power conversion facility. Heat transferred to the secondary cooling system could be used to generate steam that would drive turbine generator units. The MHTGR and the ALWR reactor technologies, as described and analyzed in this PEIS, include a power conversion facility. Thus, this PEIS includes the consequences of the production of electricity. Impacts to air, water, land, and human health from energy production are included in section 4.2 through 4.7 for the MHGTR and ALWR; however, distribution and transmission of generated power by the reactors are not assessed. The offsite impacts of the distribution and transmission of electrical power to operate a reactor or an accelerator are also not addressed. Because the conditions associated with the sale of steam for power, or the generation and sale of electricity, are uncertain, it is not possible to assess any specific offsite environmental impacts. However, it is clear that it would be necessary to construct electrical distribution or transmission lines and that electricity would be transmitted across the lines. Thus, the following section discusses the general impacts from the sale of steam or electricity. Similar impacts would also be expected from the construction of transmission and distribution lines to operate the reactor and accelerator technologies. A separate tiered site-specific NEPA review would be required to support a decision to sell steam for power production or to generate electricity.

Because it is not known where or how much new offsite transmission capacity would be required for any of the sites, no site-specific impacts can be assessed. However, the general impacts of transmission lines are discussed below.

Construction of an electric distribution or transmission line would result in land use and visual impacts. The level of impact would depend on the existing land uses and the surrounding visual environment. Transmission lines could create strong vertical line and moderate texture contrasts with surrounding landscape, particularly where they run parallel to regional highways. These contrasts would draw attention to the transmission line. Visual impacts may occur along the segments of transmission lines where they cross ridgelines or lands with high visual qualities. The location of towers would likely introduce impacts to the skyline along ridgeline segments and draw strong visual attention from viewers traveling on highways or using regional recreational resources.

Construction of an electric distribution or transmission line would also disturb terrestrial habitats. For example, any crossed wetlands or riparian areas might be disturbed by activities to clear vegetation, place transmission towers, construct maintenance road access, and string cables. With time, disturbed areas in the right-of-ways would undergo some degree of natural succession; however, continued maintenance by the utility would limit the succession stage. The transmission lines could open previously inaccessible areas to human presence through the introduction of roads for construction and maintenance. Workers as well as trespassers using the access roads could increase road kills and general harassment of wildlife in the area of the transmission corridor.

Birds could also be affected by transmission lines. During periods of decreased visibility due to fogging or adverse weather, it is not unusual for birds to collide with lines or transmission towers. The most frequent victims of such collisions are large migratory water birds and raptors in areas where lines are located adjacent to raptor concentration areas, waterfowl wintering staging areas, or other areas with avifauna concentrations. The placement of lines near to where birds congregate (e.g., roosting areas, lakes, and wetlands) could increase the risk and frequency of bird collisions.

Transmission lines produce a corona, which is a physical manifestation of energy loss. This phenomenon results in audible noise, radio and television interference, and the production of ozone in the immediate area of the lines. The effects of corona production decrease dramatically as distance from the line increases.

There is limited scientific understanding of the potential health risks from electromagnetic fields exposure. Electric fields associated with transmission lines are a function of the voltage of the line, while magnetic field levels are a function of the current carried by the conductors. Both field magnitudes are affected by the size of the conductor, conductor separation distance, and distance from the conductor. Electromagnetic field exposure typically is attenuated with distance from the conductors. Therefore, electromagnetic field exposure would vary along a transmission line right-of-way.

Currently it is not known whether certain magnitudes of electromagnetic field exposure are safer or less safe than other levels. For example, with most chemicals, it is assumed that exposure to higher concentrations is worse than exposures at lower concentrations. This may or may not be true in the case of electromagnetic field exposure. The basic nature of the interaction between electromagnetic field exposure and biological processes is still not understood and, because of this, it is inappropriate to make generalizations about the exposure-response relationships and cancer effects. Also, other health effects have not been studied as extensively as cancer effects, so it is even more uncertain if there are any noncarcinogenic health risks associated with electromagnetic field exposure.

4.8.2 Dedicated Power Plant for Accelerator Production of Tritium

As indicated in section 3.4, an option to collocate a dedicated power plant (500 to 600 MWe) at a DOE site or in the site region by a utility to support an APT may be considered a potential but unknown cost saving measure at some sites.

To identify potential site-specific impacts at the five candidate sites from a dedicated power plant, a typical 500 to 600 MWe gas-fired power plant was evaluated. The gas-fired plant was selected for site-specific analysis based on utility trends in power plant new construction and requirements to meet environmental regulatory standards and guidelines. Potential site-specific impacts on site infrastructure, biotics, air quality, and waste management are included in each site's environmental analysis for these issues in section 4.2-4.6.

Because it is not known if the power plant option is viable or even reasonable for any of the candidate sites, where such a plant would be located (onsite or offsite), or what type of power plant would be designed, more detailed site specific impacts can not be assessed. However, the general impacts that may potentially be expected from construction and operation of such a power plant whether it be coal or natural-gas, are discussed below in a qualitative manner. These impacts would be in addition to those described in section 4.8.1 for transmission lines from the regional power pool because the APT would still require this power source as a backup.

4.8.2.1 *Coal-Fired Power Plant*

The design of a 500 to 600 MWe coal-fired, steam-electric generating power plant would vary greatly depending on the site characteristics. However, the major components which could be common to any design can be used to assess general environmental impacts.

The major components of the power plant would include the following: a steam generator (boiler); turbine-generator; air emissions control system (dry scrubber and baghouse); stack; circulating water (cooling water) system; water supply, storage, and treatment facilities; waste management and disposal facilities; and fuel receiving, storage, and handling facilities. In addition to the above components, ancillary facilities for the plant as a whole would typically include access roads, parking areas, a railroad spur, a switchyard, warehouses, and maintenance facilities.

Construction Activities and Potential Impacts. Construction activities for the plant site would typically include road access construction and site preparation; construction of plant facilities (fire pumphouse, wells, power lines, an electric substation, etc.); concrete and structural steel erection for main building and support facilities; and construction of a coal receiving and unloading siding. The construction period of a plant of this size is estimated to be approximately 3 years. An estimated average construction workforce for this period would be approximately 500 persons, with a peak workforce of approximately 800 persons.

Based on power plants of similar size (500 to 600 MWe), approximately 300 acres would be disturbed by construction activities. The area disturbed could increase substantially when ancillary facilities are constructed, such as new railroad spurs. For example, at NTS a new 60-mile-long railroad spur would be required if the plant is collocated with the APT. Land clearing, grading, and general construction activities would impact land use, soils, air quality, and biotic resources at the site. The land use and biotic resources impacts would be long-term. The air quality and soil impacts would be short-term and minor with appropriate standard construction methods. Cultural resources may be potentially affected by clearing, grading, and excavation activities depending on the site. The construction workforce could benefit the revenues of local communities, but could also have adverse impacts on local traffic. Housing and community services in the areas probably would not be affected by a construction project of this size.

Operation and Potential Impacts. The power plant is assumed to operate 24 hours a day, 365 days per year, using three 8-hour workshifts. Based on similar sized plants, an estimated operational workforce of approximately 145 persons would be needed. Operation of the plant would typically involve four major activities on a continuous basis: fuel receiving, storage, and handling; power generating system; plant water supply; and plant water treatment.

Fuel Receiving, Storage, and Handling. The power plant is assumed to burn coal delivered to the plant site by unit trains. A unit train is defined as a train with 55 coal cars, each with the capacity of 104 tons. Depending on the site, the source of coal could be in another state.

Coal to supply Western power plants is generally extracted from the earth by stripmining. Coal in the East is both stripmined and extracted from below ground mines. Below surface mining has fewer and less adverse environmental effects than stripmining. Most below ground mine impacts are the result of spoils storage and water runoff from the mine area. With proper controls and treatment of contaminated runoff, the environmental effects to surface, groundwater, and terrestrial resources are expected to be minor.

Stripmining disturbs a considerable amount of land and affects vegetation and wildlife; it also affects air and water quality. In the stripmining process, surface soil and vegetation are removed, to a depth of 30 feet or more, and piled nearby ("spoils"). The coal is then dug and stored. The stripmining process is then repeated except that the spoils are placed in the preceding pit. The landscape becomes a series of uneven piles. Eventually surface soil is returned and the land is reclaimed.

Potential impacts resulting from stripmining include land disturbance, vegetation removal, runoff, erosion, and increased stream sedimentation. Increased surface water turbidity would affect inhabitants and potentially result in changes in water temperature and loss of habitat. The land reclamation and revegetation process would result in competition among species (including invasive species), soil compaction, and displacement by nonnative plant species. Although coal companies are required to undertake reclamation of mined lands, mining imposes at least a short-term change in land use, with longer-term changes depending on the success of reclamation efforts.

After extraction, coal is transported to generating plants by large trucks and/or unit trains. These methods of transport produce diesel engine emissions, some release of dust to the atmosphere, and consumption of nonrenewable resources (e.g., diesel fuel). Coal would be received from the mine(s) in unit trains that would operate continuously between the mines and the plant. Assuming a 500 to 600 MWe plant operating at a 100-percent capacity factor, approximately 6,000 tons per day of coal would be consumed. Based on an average annual load factor of 85 percent, the demand would be somewhat lower. Average total annual coal consumption thus would be approximately 1,853,000 tons. To support this average firing rate would require 324 unit trains to be delivered every year.

Once the coal is unloaded it is transferred by conveyor to storage silos that feed boilers or to a coal storage yard. Storage silos for the assumed plant size would typically have a capacity of 12,000 tons and be approximately 70 feet in diameter by 210 feet high. The size of a coal storage yard would typically be based on a 45-day supply at an average annual load of 85 percent of nominal generation capacity. The coal storage yard provides a reserve from which the station can be supplied during coal shortages or emergency situations (e.g., mine strikes and rail strikes).

The potential impacts of fuel receiving, storage, and handling are principally associated with fugitive dust (approximately 16 tons per year) generated by the handling and processing of coal and groundwater quality degradation from the potential releases of constituents leached from coal. However, with current technologies for dust control and coal stockpile management, these potential impacts would be minor.

Power Generating System. The power generating system typically includes boilers, turbine-generators, lime spray dry scrubbers, fabric filters, stacks, and mechanical draft cooling towers.

Coal-fired power plants are designed to ensure that coal combustion is complete. Air emissions would include substantial amounts of sulfur dioxide, nitrogen oxides, carbon monoxide, and hydrogen chloride on an annual basis. The estimated controlled annual average emissions from a typical 500 MWe plant would be: sulfur dioxide (3,440 tons); nitrogen oxides (8,600 tons); particulate matter (293 tons); and carbon monoxide (2,219 tons). These products of coal (and to a lesser extent gas) combustion contribute to the regional acid rain problem in the eastern United States, adverse health effects, and potentially the unsolved issue of global warming. Excluding flue gas, the principal products of burned coal would be bottom ash and fly ash carried through to the scrubber and baghouse. An air emission control system designed with best available control technology would minimize air quality impacts and meet applicable state and Federal air quality standards.

A lime spray dry scrubber would require approximately 100 tons per day of lime, and assuming 25-ton capacity pneumatic transfer trailers, 4 additional truck trips per day would be added to site traffic. The air emission control system would also be expected to generate considerable waste products that when added to bottom ash and mill rejects (pyrites) would generate additional truck traffic and land disposal area impacts. An estimated 22 tons per hour of fly ash and scrubber byproduct and an estimated 3 tons per hour of bottom ash and mill rejects would require disposal in a landfill. Assuming the landfill is permitted and meets regulatory requirements, no impacts, outside of developing the landfill if one does not exist, would be expected. Truck traffic impacts would vary depending on the site and the locations of the landfill (onsite or offsite).

The turbine-generators and associated cooling towers would not be expected to have adverse environmental impacts since no discharges to the environment (except for cooling tower water mist) would occur. In best available control technology designed coal-fired power plants, cooling tower blowdown water is typically used for the scrubber, coal dust suppression, bottom ash transport, and other uses; therefore, minimal discharge or potential impacts to surface waters would be expected.

Plant Water Supply. Water, for use in generating steam and for transferring plant-generated waste heat to the atmosphere, would be obtained from either groundwater or surface water depending on the resources available to the site. The estimated water requirement for a 500 to 600 MWe plant is approximately 2.6 BGY. If surface water is used, impacts to land use, soils, and biotic resources and possible wetlands from construction of a pipeline could occur. Operation of the pipeline could also affect the surface water source. Where groundwater was used, new well fields may need to be established along with pumphouses and pipeline. Impacts may potentially occur to groundwater resources (due to drawdown), land use, cultural resources, and biotic resources due to construction of well fields, pipelines, and powerlines.

Plant Water Treatment. A number of chemicals would also be expected to be used to treat cooling systems water and boiler feedwater. The use of such chemicals would not have direct environmental impacts in a properly designed plant; however, the storage of these chemicals in large quantities could increase the risk of environmental impacts in accident situations. Typical chemicals for treating cooling system waters include sulfuric acid, lime soda, and chlorine. Boiler feedwater treatment would depend on the quality of the water available for use at the site. Typical treatment chemicals would include lime, sulfuric acid, caustic soda, hydrazine, and ammonia.

4.8.2.2 *Natural Gas-Fired Power Plant*

A natural gas-fueled combustion turbine electric generating power plant design would also vary greatly depending on the site characteristics. Typically, the natural gas combustion turbine facility requires less land, support facilities, water resources, and waste management than coal-fired plants. The following major components would typically be expected in a 500 to 600 MWe generating facility: five or six combustion turbine generator units (approximately 90 MWe rated capacity each); a natural gas supply system; a fuel oil delivery and storage system; a water supply system (wells or surface water); a water demineralization system; and transmission and distribution equipment. In addition to the major components, ancillary facilities for the plant could typically include access roads, parking areas, warehouses, and maintenance facilities.

Construction Activities and Potential Impacts. Construction activities would be similar to those described for the coal-fired plant but at a much reduced level. The construction period is estimated to be approximately 2 years and the estimated average construction workforce for this period would be approximately 150 persons (approximately 225 peak workforce). Based on similar facilities, approximately 25 acres would be required for this size combustion turbine facility. Ancillary facilities could increase the land requirement and disturbance area substantially. Construction impacts would affect the same resources as those described for the coal power plant but at a substantially reduced level because of the smaller plant size and land disturbance area. Socioeconomic effects would be negligible with this size project.

Operation and Potential Impacts. Operation of a natural gas electric generating facility would require a very small workforce compared to a coal power plant. Approximately 50 to 75 workers would be needed. If constructed at an existing utility site, additional workforce requirements could be less since the turbine units could be designed for unattended operation and remotely operated from the utility dispatch center.

Natural gas, the primary fuel for the combustion turbine, would be directly supplied to the units by pipeline. Assuming an average heat rate of 14,500 Btu per kWh and 1,000 Btu per ft^3 (DOE 1993y), approximately 14.5 ft^3 of natural gas per kWh would be consumed. Thus, for the Full APT electrical requirement of 3,740,000 MWh per year, 54,200 million ft^3 of natural gas would be needed. The Phased APT electrical requirement of 2.4 million MWh per year would consume 34,800 million ft^3 of natural gas. No additional gas handling or storage facilities would be needed. However, most natural gas combustion plants have the backup capability to burn No. 2 fuel oil in the event of gas supply interruption. This auxiliary fuel would require construction and maintenance of storage facilities. Typically, these are 625,000-gallon above-ground steel tanks approximately 50 feet in diameter and 45 feet in height. Approximately 8 to 10 tanks would be needed for 5 turbine units. To contain accidental spills and prevent potential soil, groundwater, and surface water contamination, a dike system with low permeability floors is typically constructed around the tanks. Fuel oil deliveries to the plant are typically by truck; however, other means such as barge transport may be used depending on the site. Potential impacts to groundwater, surface water resources, air quality, and soils would be minimal with standard industry control measures.

The plant would generate no visible emissions during normal operation; however, the plant could generate and contribute substantial sulfur dioxide (5 tons), particulate matter (179 tons), nitrogen oxide (314 tons), carbon monoxide (75 tons), and volatile organic compounds (215 tons) emissions on an annual basis. Using a plant design with best available control technology to minimize emissions and comply with applicable air quality standards and permits would minimize impacts to local and regional air quality.

Approximately 80 MGY of water would be needed to operate the plant. A majority of the water requirement (approximately 83 percent) would be for NO_x emission control. Approximately 15 percent of the total water requirement would be used for backwashing deionizer resins and carbon filters used to demineralize the NO_x injection water. The natural gas turbine plant would typically use approximately 3.5 percent of the water needed for the same size coal power plant. The potential environmental impacts would be anticipated to be similar to those described for the coal power plant; however, the impacts on groundwater and surface water resources may be smaller because of the reduced water requirement.

The demineralized backwash could potentially degrade groundwater and surface water resources if not treated before discharge. Typically, backwash would contain dilute concentrations of trace metals and low-to-moderate concentrations of calcium, sodium, and sulfate. With appropriate wastewater treatment, no impacts to surface water or groundwater resources would be expected.

4.8.3 Multipurpose Reactor

This PEIS for Tritium Supply and Recycling evaluates alternative technologies and sites for long-term, assured tritium supply and recycling. Another DOE program office, the Office of Fissile Materials Disposition, is preparing a PEIS addressing the issue of how to dispose of plutonium that is excess to the Nuclear Weapons Complex (section 1.5.3). Among the alternatives expected to be analyzed in *Long-Term Storage and Disposition of Weapons-Usable Fissile Materials PEIS* is the use of plutonium as a fuel in existing, modified, or new nuclear reactors. Using plutonium in reactor fuel would burn up a portion of the excess plutonium and embed any remaining plutonium in highly radioactive spent fuel, thus reducing the proliferation risks of the material.

The nuclear reactors evaluated for tritium production in this PEIS utilize uranium as the fuel source in their cores, and the analysis is based on that design. Nonetheless, it is conceivable and technically feasible to also use a plutonium or plutonium-uranium oxide (mixed-oxide) fuel for a tritium production reactor. Appendix section A.3 discusses this technical feasibility for each of the tritium supply technologies analyzed in this PEIS. Thus, a tritium production reactor could be utilized by DOE to also dispose of excess plutonium.

Congress and commercial entities have expressed interest in developing a multipurpose reactor that could meet both DOE's tritium supply requirements and dispose of the excess plutonium. A multipurpose reactor is defined as one capable of producing tritium, "burning" plutonium, and generating revenues through the sale of electric power.

Of the four tritium supply technologies evaluated in this PEIS, only the MHTGR and ALWR meet the above definition of a multipurpose reactor. The HWR and APT were not recommended by the Materials Disposition Office Screening Committee for plutonium disposition. Thus, the HWR and APT are not considered for impact analysis in this section.

However, the MHTGR and ALWR can with minor or moderate design changes produce tritium, burn plutonium, and generate revenues through the sale of electric power. This section analyzes the potential environmental impacts if the MHTGR or ALWR were used as a multipurpose reactor. As noted in section 3.2.3, tritium production is the only need addressed in this PEIS. However, if the MHTGR or ALWR were used to produce tritium they could also be used to dispose of plutonium. Therefore, the environmental impacts of a plutonium-burning MHTGR and ALWR are qualitatively presented in this section. These impacts are not analyzed to the same level of detail as those presented for the tritium supply technology alternatives. Furthermore, most of the information required for detailed analysis does not currently exist. Where data does exist, more detailed analysis is presented.

While this section describes a new ALWR operating in a multipurpose mode, the discussion is also applicable to the Commercial Reactor alternative. A commercial reactor could be used to make tritium, produce electricity, and burn plutonium as fuel. The environmental impacts associated with performing those missions would be similar to those described for the multipurpose ALWR. Throughout the document, references to and discussion of impacts for the multipurpose ALWR can be applied to a multipurpose commercial reactor alternative.

The environmental impacts from tritium and steam production using the MHTGR and ALWR technologies at each of the five candidate sites are described in sections 4.2 through 4.6. The generic impacts from the sale of steam or electricity, including construction of electric transmission lines, are analyzed in section 4.8.1. This section describes the impacts resulting from plutonium burning, the third function that could be performed by a multipurpose reactor.

The ALWR multipurpose reactor would require the construction of a new Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility described in section 4.8.3.1. The reactor changes and potential impacts from using mixed-oxide fuel in an ALWR are discussed in section 4.8.3.2.

For a modular gas-cooled multipurpose reactor, twice as many reactor modules would be needed both to meet tritium requirements and to burn plutonium. The additional reactor modules are needed to compensate for the loss in tritium production due to the introduction of plutonium fuel in such a reactor (appendix A.3.2.2). This is true regardless of whether a 350 MWt MHTGR or a 600 MWt Modular Helium

Reactor is used for tritium production (see A.3.1.1 for a description of the helium reactor). Substantial technical uncertainty exists for the use of a gas-cooled reactor for plutonium disposition. The 600 MWt Modular Helium Reactor would be the most likely gas-cooled reactor for multipurpose use.

The environmental impacts associated with tritium production in this PEIS are based upon the 350 MWt MHTGR and not the 600 MWt Modular Helium Reactor. The design information for a 350 MWt MHTGR represents the best available information for a tritium producing gas-cooled reactor. The impacts of three 350 MWt MHTGR reactors are representative of impacts expected from two 600 MWt modular helium reactors for tritium production (see section A.3.1.1). This correlation is expected to remain true for the environmental impacts of a multipurpose reactor. Thus, the environmental impacts discussed in this section for a gas-cooled multipurpose reactor are based upon the 350 MWt MHTGR design.

In addition to twice as many reactor modules, a new Pit Disassembly/Conversion Facility would also be needed for a multipurpose gas-cooled reactor. While such a facility has not been designed it is expected to be similar to the facility described in section 4.8.3.1.

The impacts of the MHTGR Pit Disassembly/Conversion Facility would be minor in comparison to the construction and operation of three more reactor modules. The impacts from construction and operation of three additional MHTGR reactor modules are discussed in section 4.8.3.3.

The discussion of impacts for the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility includes both construction and operation. Impacts are described for a collocated facility with the multipurpose reactor and alone at a separate DOE site. Construction impacts of the ALWR multipurpose reactor would not differ from those described for the tritium production ALWR and therefore are not discussed in this section. Construction of the multipurpose MHTGR would require three additional reactor modules, and therefore construction impacts are discussed.

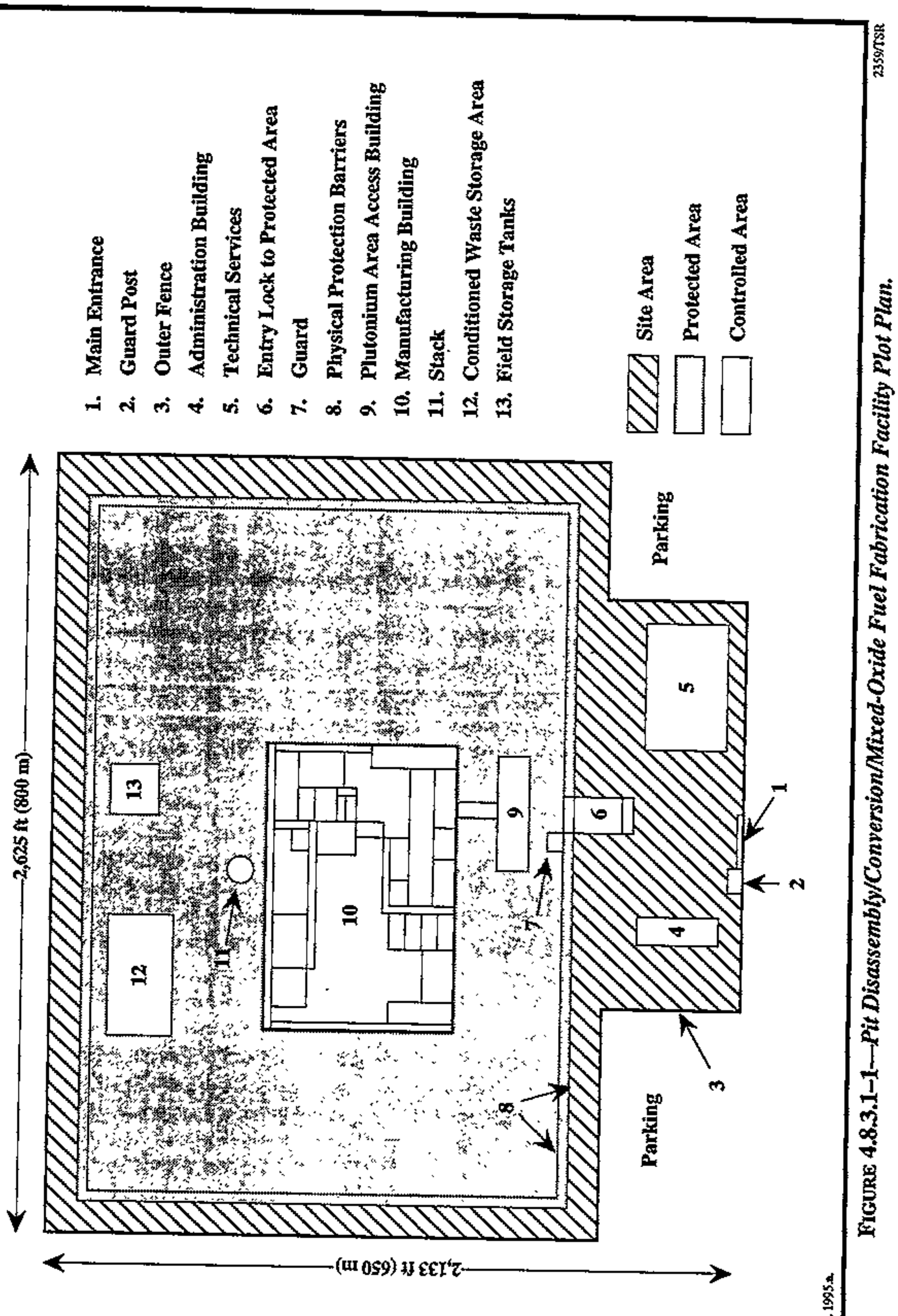
4.8.3.1 *Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility*

The primary purpose of the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would be to combine the functions of pit disassembly, conversion, and mixed-oxide fuel fabrication to produce fuel elements for use in a multipurpose reactor.

The facility would accept surplus plutonium in pit form and produce plutonium-oxide which would then be combined with uranium-oxide received from offsite commercial sources and fabricated into mixed-oxide fuel. This fuel would be assembled into appropriate fuel rods for use in a multipurpose reactor. This process would take plutonium pits, convert them into plutonium-oxide, blend with uranium-oxide, and form into fuel rods. For any plutonium disposition alternative, the pit disassembly/conversion portion of such a facility would be required. For a multipurpose reactor the fuel fabrication portion would also be required. However, in the case of the multipurpose MHTGR, a fuel fabrication facility is already integrated in the tritium supply MHTGR reactor design which, with minor modifications, could be used for plutonium-oxide fuel fabricating. Therefore, only a new Pit Disassembly/Conversion Facility would be required to accept surplus plutonium in pit form and produce plutonium-oxide for the fuel fabrication facility.

Facility Description. A new Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would be housed in four buildings: (1) the manufacturing building; (2) the plutonium area access building; (3) the administration building; and (4) the technical services building. Figure 4.8.3.1–1 presents the facility plot plan and figure 4.8.3.1–2 presents the manufacturing building layout plan. The manufacturing building would be a hardened facility designed to contain the release of radioactive materials should such a release occur. The plutonium area access, administrative, and technical services buildings would not contain radioactive material production or storage facilities.

Similarly, for a new Pit Disassembly/Conversion Facility, primary buildings would include the plutonium processing building and the plutonium operations support building. Nuclear materials would be handled only in the concrete plutonium



Source: LANL 1995a.

FIGURE 4.8.3.1-1—*Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility Plot Plan.*

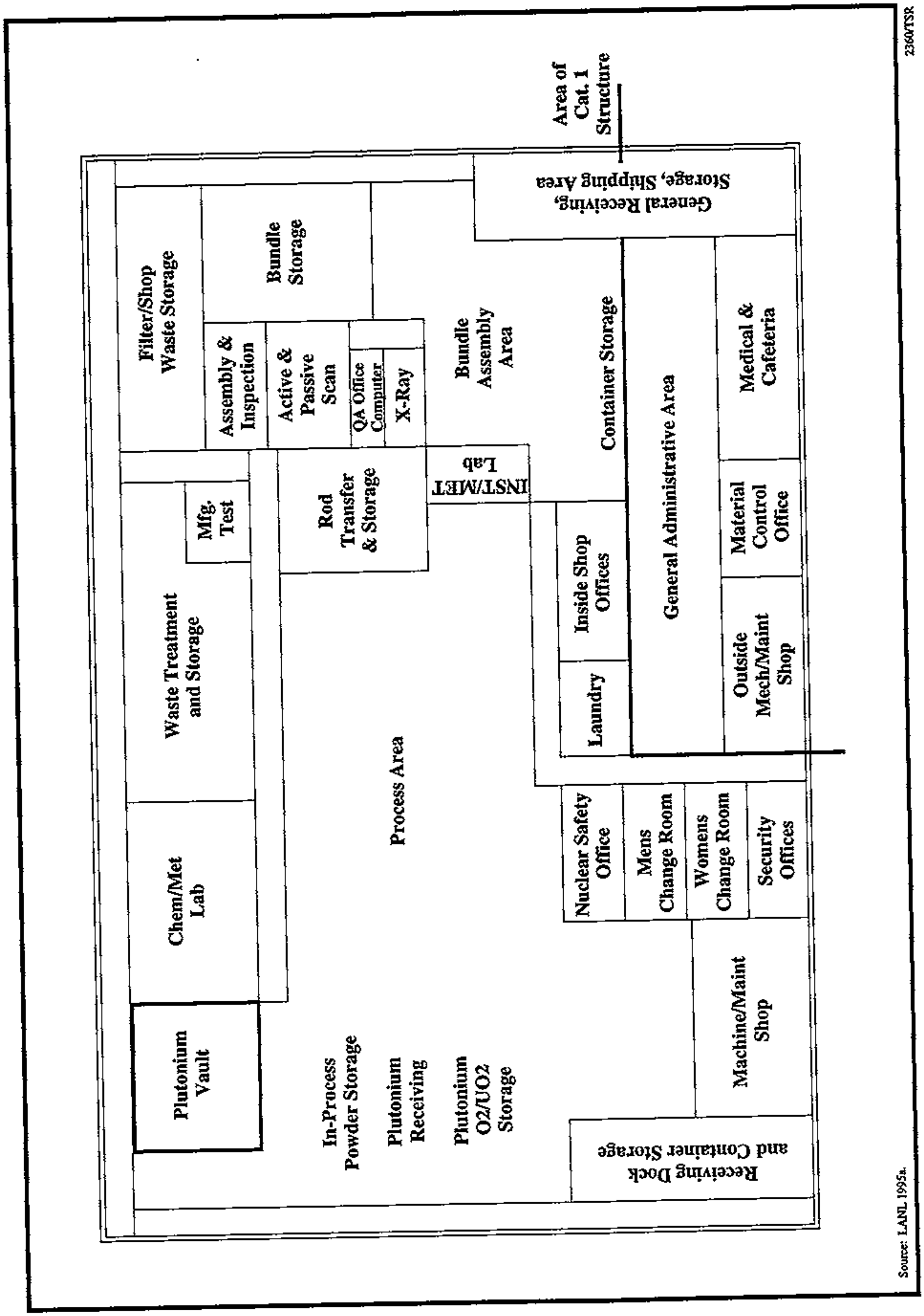


FIGURE 4.8.3.1–2—*Manufacturing Building Layout Plan.*

processing building. Figure 4.8.3.1–1 indicates the conceptual locations of these buildings along with other ancillary facilities.

Table 4.8.3.1–1 presents select key design parameters for the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility. Construction, operation, and waste generation data for the facility are presented in tables 4.8.3.1–2, 4.8.3.1–3, and 4.8.3.1–4.

For comparison purposes, tables 4.8.3.1–5 through 4.8.3.1–8 show the design parameters, construction, operation, and waste management data for the Pit Disassembly/Conversion Facility only.

TABLE 4.8.3.1–1.—*Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility Key Design Parameters*

Design Parameter	Value
Primary fuel to boilers and other miscellaneous energy users	Natural gas
Buffer zone between operations and site boundary	1 mile
Storage capacity for mixed LLW	3 year capacity
Source of raw water (dry site)	Ground wells or reclaimed sanitary wastewater
Manufacturing building footprint	115,000 ft^2
Total manufacturing building ventilation rate	75,000 cfm
Manufacturing building HEPA filters (minimum)	3 stages
Mixed-oxide fabrication capacity (metric tons per year)	100
Public exposure to radiation at site boundary (mrem effective dose equivalent per year)	100
Worker maximum exposure to radiation (mrem effective dose equivalent per year	1,000
Maximum allowable	5,000
Goal	500

Source: LANL 1995b.

TABLE 4.8.3.1–2.—*Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility Construction Requirements*

Requirement	Consumption
Material/Resources	
Electrical power (MW peak)	1
Concrete (yd^3)	40,000
Steel (tons)	4,000
Fuel (gal)	200,000
Industrial gases (scf)	550,000
Water (gal)	3,000,000
Water (GPD peak)	5,000
Land Disturbance (acres)	129
Employment	
Total employment (worker years)	3,155
Peak employment (workers)	745
Construction period (years)	6

Source: LANL 1995b.

TABLE 4.8.3.1–3.—*Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility Operation Requirements*

Requirement	Consumption
Utility	
Electrical power (MWh per year)	20,000
Electrical energy (MW peak)	4
Water (gal/yr)	<10,000,000
Natural gas (scf)	125,000,000
Diesel Fuel (gal per year)	8,000
Plant Footprint	
Plant (acres)	129
Employment	
Total employment	650

Source: LANL 1995b.

TABLE 4.8.3.1–4.—*Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility Waste Volumes*

Category	Annual Average Volume Generated During Construction (yd^3)	Annual Volume Effluent During Operation (yd^3)
Transuranic		
Liquid	None	None
Solid	None	392
Mixed TRU		
Liquid	None	None
Solid	None	6.5
Low-Level		
Liquid	None	None
Solid	None	524
Mixed Low-Level		
Liquid	None	1 (200 gal)
Solid	None	13
Hazardous		
Liquid	None	1 (200 gal)
Solid	None	13
Nonhazardous (Sanitary)		
Liquid	<16,500 (<3,330,000 gal)	495 (10,000,000 gal)
Solid	< 674	3,920
Nonhazardous (Other)		
Liquid	None	Included in sanitary
Solid	Included in sanitary	Included in sanitary

Source: LANL 1995b.

TABLE 4.8.3.1–5.—*Pit Disassembly/Conversion Facility Key Design Parameters*

Design Parameters	Values
Primary fuel to boilers and other miscellaneous energy users	Natural gas
Buffer zone between operations and site boundary	1 mile
Storage capacity for mixed LLW	Shipped offsite
Source of raw water (dry site)	Underground wells
Manufacturing building footprint	82,800
Plutonium-oxide production capacity (metric tons per year)	2
Public exposure to radiation at site boundary (mrem effective dose equivalent per year)	100
Worker maximum exposure to radiation (mrem effective dose equivalent per year)	1,000
Maximum allowable	5,000
Goal	500

Source: LANL 1995b.

TABLE 4.8.3.1–6.—*Pit Disassembly/Conversion Facility Construction Requirements*

Requirement	Consumption
Material/Resources	
Electrical power (MW peak)	5
Concrete (yd^3)	25,000
Steel (tons)	2,500
Fuel (gal)	125,000
Industrial gases (scf)	500,000
Water (gal)	2,000,000
Water (GPD peak)	10,000
Land Disturbance (acres)	5
Employment	
Total employment (worker years)	530
Peak employment (workers)	125
Construction period (years)	6

Source: LANL 1995b.

TABLE 4.8.3.1–7.—*Pit Disassembly/Conversion Facility Operation Requirements*

Requirement	Consumption
Utility	
Electrical energy (MWh per year)	13,000
Electrical power (MW peak)	5
Water (GPY)	10,000,000
Natural gas (scf)	80,000,000
Diesel fuel (GPY)	5,000
Plant Footprint	
Plant (acres)	30
Employment	
Total employment	520

Source: LANL 1995a.

Operation impacts are expected to be less for a Pit Disassembly/Conversion Facility than for a Pit Disassembly/Conversion/Fuel Fabrication Facility due to the difference in annual plutonium product output of 2 metric tons of plutonium-oxide versus 100 metric tons of fabricated fuel, respectively. The decrease is expected for construction impacts as well; the smaller Pit Disassembly/Conversion Facility would require fewer construction personnel, would consume less materials and resources, and would generate fewer construction emissions and wastes.

Construction Impacts. The Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would be constructed in conjunction with a multipurpose ALWR and could be collocated with the reactor or be sited at another DOE site. The stand-alone option would require the transport of the finished fuel rods to the multipurpose reactor site.

For the multipurpose MHTGR, the Pit Disassembly/Conversion Facility could either be collocated with the MHTGR or remain as a stand-alone facility. In the case of the latter, stable plutonium-oxide produced from pits would be transported to the MHTGR fuel fabrication facility.

The discussion of potential impacts associated with the two facilities are addressed in relation to a tritium production MHTGR or ALWR and generally are addressed on a non site-specific basis. Areas addressed include land resources, air emissions, and socioeconomics.

TABLE 4.8.3.1–8.—*Pit Disassembly/Conversion Facility Waste Volumes*

Waste Category	Annual Average Volume Generated During Construction (yd^3)	Annual Volume Effluent During Operation (yd^3)
Transuranic		
Liquid	None	None
Solid	None	13[a]
Mixed TRU		
Liquid	None	None
Solid	None	1[a]
Low-Level		
Liquid	None	None
Solid	None	10[a]
Mixed Low-Level		
Liquid	None	0.5 (100 gal)
Solid	None	0.2[a]
Hazardous		
Liquid	None	5 (1,000 gal)
Solid	None	1[a]
Nonhazardous (Sanitary)		
Liquid	1,650[b] (333,300 gal)	74,270 (15,000,000 gal)
Solid	None	87[a]
Nonhazardous (Other)		
Liquid	None	None
Solid (concrete/steel)	84[c]	None

[a] Solid waste volumes are estimated using the conversion factor of 2,530 lb/yd^3 (1,500kg/m^3).
[b] Does not include dewatering, if required.
[c] Includes 7 tons of steel.
Source: LANL 1995b.

Land Resources. The Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would require approximately 129 acres of land for a stand-alone facility. The Pit Disassembly/Conversion Facility would require approximately 30 acres. For a collocated facility, the land requirement would be less because some of the land developed for the reactor complex would be shared. This additional acreage would not result in a large increase in the percentage of the total land area disturbed by construction at a tritium production site. The loss of an additional 30 to 129 acres for a stand-alone facility could lead to increased soil erosion, impacts to biotic resources, and disturbance to cultural and paleontological resources.

Air Emissions. Air pollutants generated during construction of the facility would principally be fugitive dust associated with land disturbance and exhaust emissions from equipment and vehicles. These pollutants would represent an incremental increase in those generated during construction of a tritium production MHTGR or ALWR, and would increase the potential for the 24-hour ambient standard for PM_{10} and TSP to be exceeded during the peak construction period. Construction emissions would be expected to be approximately one-half that of constructing a tritium recycling facility. Impacts could be reduced by the implementation of mitigation measures such as using water sprays on gravel roads, applying soil stabilizers to inactive construction areas, suspending excavation and grading operations when wind speeds warrant, paving heavily used construction roads, and using electricity from power poles rather than gasoline and diesel power generators.

Water. Construction water demand would be approximately 0.5 MGY, with a peak demand of about 5,000 GPD. This would represent a less than 1 percent increase of the total construction demand for either an MHTGR or ALWR tritium production facility. The increase would not be expected to impact either groundwater or surface water supplies if the facility were sited alone at another location.

Sources of wastewater during construction include storm water runoff and nonhazardous and/or sanitary discharge. For a stand-alone facility, storm water runoff would result from disturbance of additional land. A collocated facility would potentially disturb less acreage since it would be within the tritium supply complex perimeter. Standard erosion and sediment control measures would minimize adverse impacts from this source. Discharges of nonhazardous and/or sanitary wastewater would meet NPDES permit requirements. The combined discharge would not be expected to result in a substantial increase in the flow of receiving water courses.

Socioeconomics. Construction of the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would require about 550 workers (approximately 530 for a Pit Disassembly/Conversion Facility) over a 6-year construction period. This would be an approximate 3 to 16 percent increase in the work force needed to build either the MHTGR or ALWR tritium production facility. The number of peak construction workers would be somewhat less if collocated with a tritium production facility. The increase would have some additional impact on local traffic and economies, including increased secondary employment, decreased unemployment, and increased demand for housing and other services.

Operation. The discussion of potential impacts resulting from facility operations includes atmospheric and liquid emissions, water requirements, socioeconomics, human health during normal operation and accidents, waste, and intersite transportation.

Atmospheric Emissions. Operation of the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would generate criteria and toxic/hazardous pollutants regulated by Federal and state ambient air quality standards and guidelines. Engineering controls or mitigations would be used to minimize air quality impacts from operation with respect to the concentrations of criteria and toxic/hazardous air pollutants, and achieve compliance with all applicable Federal, state, and local air quality regulations or guidelines. Air pollutant emission sources associated with the operation of the facility include power generators, heating boilers, vehicle exhaust and fugitive dust, and other facility emissions. Criteria pollutant emissions are expected to be approximately one-half those expected from a tritium recycling facility. The only likely facility emissions of concern may potentially include trace amounts of volatile organic compounds, hydrogen cleaning solvents, and plutonium-oxide (15 µCi per year, which is equivalent to one-millionth of a pound per year).

Prevention of Significant Deterioration regulations, which are designed to protect ambient air quality in attainment areas, apply to new sources and major modifications to existing sources. Prevention of Significant Deterioration permits may be required for the facility if constructed at a separate site from the multipurpose reactor. This may require reductions of existing emissions for the facility to receive permits.

Liquid Emissions. Operation of the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would generate approximately 10 MGY of sanitary wastewater. This wastewater would not have radioactive or hazardous constituents. Sanitary effluents would be treated and discharged in accordance with NPDES permit requirements. Wastewater would be sampled and analyzed for radioactive materials, tritium, and heavy metals to determine permit compliance. Storm water would be collected and treated, if necessary, before discharge.

Water Requirements. Operation of the facility would require approximately 10 million gallons of water per year, which is approximately 10 percent of the water requirements of a large ALWR at a dry site. This water would be withdrawn from existing surface water and groundwater sources. The increase in water requirements may only cause an impact at Pantex.

Socioeconomics. Operation of the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would require an additional 650 workers including management and operating contractor, support, and DOE employees. This workforce would represent an approximate 70- to 130-percent increase in operation workers compared to that required for an MHTGR or ALWR tritium supply facility. However, this increase may be somewhat less if the facility were collocated because of shared support facilities and personnel. Additional indirect impacts may also be felt. The in-migrating population could increase the demand for housing units. Revenues of local governments could increase along with expenditures due to an increased burden on community infrastructure.

Human Health. The Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility design would comply with all applicable Federal, state, and local laws and regulations. Additional industry consensus codes and standards would be applied to the design as appropriate.

Normal Operation. As low as reasonably achievable radiological exposure principles would be incorporated appropriately throughout the design of the facility. Worker exposure to radiation would not exceed an annual dose of 1,000 mrem effective dose equivalent. The goal for facility workers is 500 mrem effective dose equivalent per year. Based on historical records at DOE fuel fabrication facilities from 1989 to 1992, a conservative estimated dose of 50 mrem per year would be expected. If all 650 workers were exposed to such a dose, a highly conservative assumption, 32.5 person-rem per year and 0.52 latent cancer fatality (less than one) would be expected over the 40 year operation life of the facility.

The facility design would ensure worker exposure to toxic agents would not exceed 80 percent of the regulatory standard. Any potential use of carcinogens would be minimized or eliminated.

Public exposure to radiation at the site boundary from routine operations would not exceed 100 mrem per year per DOE Order 5400.5, *Radiological Protection of the Public and Environment*, and the *Radiological Control Manual*. The goal for the facility for public radiation exposure would be not to exceed 1.0 mrem effective dose equivalent per year. The facilities would be designed so that radiation exposure to the public would be as low as reasonably achievable.

Accidents. The Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would be designed to comply with all applicable Federal, state, and local laws, DOE orders, and industrial codes and standards. This would provide a plant that is highly resistant to the effects of severe natural phenomena, including earthquake, flood, tornado, and high wind, as well as credible events appropriate to the site, such as fire and explosions, and man-made threats to its continuing structural integrity.

The facility would be designed and operated to reduce accumulation of plutonium-bearing scrap, plutonium feed stock processed components, and contaminated wastes during manufacturing operations. This would reduce the potential for an accident and the material available for dispersal during accident scenarios.

Safety analysis reports have not been prepared for the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility. However, for analysis purposes selected bounding accident scenarios have been identified from safety analysis reports and Defense Production safety surveys for similar plants of the existing Complex.

High Consequence Accidents. A set of four beyond design-basis accidents have been analyzed to represent the consequences and risks of operating the mixed-oxide fuel fabrication facility. The four accidents were a criticality, beyond design-basis fire, beyond design-basis explosion, and beyond design-basis earthquake. The consequences and risks to workers and the public at each site for the composite set of four accidents are summarized in table 4.8.3.1–9. The number of population cancer fatalities ranges from $4.6x10^{-3}$ at NTS to 0.44 at ORR, and the corresponding population risk of cancer fatalities ranges from $1.8x10^{-9}$ per year to $1.8x10^{-7}$ per year. The increased likelihood of cancer fatality to the maximum offsite individual located at the site boundary ranges from $2.6x10^{-5}$ at SRS to $6.0x10^{-4}$ at ORR and the corresponding risk of cancer fatality ranges from $1.0x10^{-11}$ per year to $2.4x10^{-10}$ per year. For the maximum collocated worker located at 1,000 meters from the accident, the increased likelihood of cancer fatality are similar at all sites ranging from $1.2x10^{-3}$ to $3.2x10^{-3}$ and the corresponding risk of cancer fatality ranges from $4.9x10^{-10}$ per year to $1.3x10^{-9}$ per year. Additional details on high consequence accidents are provided in section F.2.1.5.

Low Consequence/High Probability Accidents. The impacts on workers and the population of low consequence/high probability accidents also have been assessed and are summarized in table 4.8.3.1–10. Impacts are shown for the loading dock fire accident which has the highest consequences of the four accidents selected for evaluation. The other three accidents that were evaluated were a process cell fire, a plutonium spill, and a glovebox explosion. Additional details for these accidents are provided in section F.2.2.5.

Accident Mitigation. The Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility design would meet the appropriate level of public health and safety goals. DOE has adopted two quantitative safety goals to limit the risks of fatalities associated with its nuclear operations. These goals are:

- The risk to an average individual in the vicinity of a DOE nuclear facility for immediate fatalities that might result from an accident should not exceed 0.1 percent of the sum of immediate fatalities resulting from other accidents to which members of the affected population are generally exposed. For evaluation purposes, individuals are assumed to be located within 1 mile of the site boundary.
- The risk to the general population in the area of a DOE nuclear facility for latent cancer fatalities that might result from normal operations should not exceed 0.1 percent of the sum of all cancer fatality risks resulting from all other causes. For evaluation purposes, individuals are assumed to be located within 10 miles of the site boundary (LANL 1995a:41).

Waste Management. Construction and operation of the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would impact existing waste management operations at a site by increasing the generation of TRU, mixed TRU, low-level, mixed low-level, hazardous, and nonhazardous wastes. Tables 4.8.3.1–4 and 4.8.3.1–8 list the projected waste volumes generated from construction and the waste effluent volumes from operations of these facilities. If the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility was collocated with the multipurpose reactor, the waste volumes in table 4.8.3.1–8 would be added to twice those in table 3.4.2.2–3 (MHTGR) or those in table 4.8.3.1–4 added to those in table 3.4.2.3–3 (Large ALWR). If the multipurpose reactor and the tritium recycling facility are collocated at any site other than SRS, the waste volumes in table 3.4.3.1–3 (New Tritium Recycling Facility) would also have to be added. Wastes from the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would be treated and packaged into forms that would enable long-term storage and/or disposal in accordance with the *Atomic Energy Act*, RCRA, and other relevant statutes as outlined in chapter 5 and in appendix section H.1.2.

Waste generated during construction would consist of wastewater and nonhazardous solid wastes. The nonhazardous wastes would be disposed of as

TABLE 4.8.3.1–9.—*Mixed-Oxide Fuel Fabrication Worker and Population Impacts of High Consequence Accidents*

Site	Worker at 1,000 meters		Maximum Offsite Individual		Population to 50 Miles	
	Cancer Fatality[a]	Risk of Cancer Fatality	Cancer Fatality[a]	Risk of Cancer Fatality	Cancer Fatality[b]	Risk of Cancer Fatality
Idaho National Engineering Laboratory	$3.2x10^{-3}$	$1.3x10^{-9}$	$2.8x10^{-5}$	$1.1x10^{-11}$	0.048	$1.9x10^{-8}$
Nevada Test Site	$2.2x10^{-3}$	$8.9x10^{-10}$	$7.5x10^{-5}$	$3.0x10^{-11}$	$4.6x10^{-3}$	$1.8x10^{-9}$
Oak Ridge Reservation	$3.0x10^{-3}$	$1.2x10^{-9}$	$6.0x10^{-4}$	$2.4x10^{-10}$	0.44	$1.8x10^{-7}$
Pantex Plant	$1.2x10^{-3}$	$4.9x10^{-10}$	$4.0x10^{-4}$	$1.6x10^{-10}$	0.057	$2.3x10^{-8}$
Savannah River Site	$1.3x10^{-3}$	$5.0x10^{-10}$	$2.6x10^{-5}$	$1.0x10^{-11}$	0.18	$7.2x10^{-8}$

[a] Increased likelihood of cancer fatality to an individual.
[b] Number of cancer fatalities to the population within 50 miles.
Note: The impacts shown are for a composite set of four accidents. Additional details on the accidents are given in appendix section F.2.1.5.
Source: Appendix section F.2.1.5.2.

TABLE 4.8.3.1–10.—*Mixed-Oxide Fuel Fabrication Worker and Population Impacts of Low Consequence/High Probability Accidents*

Site	Worker at 1,000 meters		Maximum Offsite Individual		Population to 50 miles	
	Cancer Fatality[a]	Risk of Cancer Fatality	Cancer Fatality[a]	Risk of Cancer Fatality	Cancer Fatality[b]	Risk of Cancer Fatality
Idaho National Engineering Laboratory						
Loading dock fire	$3.3x10^{-5}$	$1.7x10^{-8}$	$9.5x10^{-7}$	$4.8x10^{-10}$	$9.0x10^{-3}$	$4.5x10^{-6}$
Nevada Test Site						
Loading dock fire	$9.6x10^{-6}$	$4.8x10^{-9}$	$4.2x10^{-7}$	$2.1x10^{-10}$	$1.5x10^{-4}$	$7.5x10^{-8}$
Oak Ridge Reservation						
Loading dock fire	$5.2x10^{-5}$	$2.6x10^{-8}$	$8.0x10^{-6}$	$4.0x10^{-9}$	0.09	$4.5x10^{-5}$
Pantex Plant						
Loading dock fire	$3.9x10^{-6}$	$2.0x10^{-8}$	$7.5x10^{-7}$	$3.8x10^{-10}$	$3.0x10^{-3}$	$1.5x10^{-6}$
Savannah River Site						
Loading dock fire	$8.8x10^{-5}$	$4.4x10^{-8}$	$2.7x10^{-6}$	$1.4x10^{-9}$	0.085	$4.3x10^{-5}$

[a] Increased likelihood of cancer fatality to an individual.
[b] Number of cancer fatalities to the population within 50 miles.
Note: The impacts shown are for the bounding low consequence/high probability accident out of four evaluated. Additional details on low consequence/high probability accidents are given in appendix section F.2.2.5.
Source: Appendix section F.2.2.5.2.

part of the construction project by the contractor. For operations, the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would be the only generator of TRU and mixed TRU wastes. Such wastes would result primarily from plutonium processing operations and are expected to be contact-handled TRU waste. Solvents, lead, and scintillation vials would comprise the hazardous constituent of mixed TRU waste. TRU and mixed TRU wastes would be treated and packaged according to the Waste Isolation Pilot Plant waste acceptance criteria. These wastes would be stored at the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility or an existing site facility, if available, until WIPP is determined to be a suitable disposal facility pursuant to the requirements of 40 CFR 191 and 40 CFR 268, or another suitable repository is found. Assuming 11.4 yd^3 per truck shipment, 22.8 yd^3 per regular train shipment, or 68.6 yd^3 per dedicated train shipment, approximately 35 truck, 18 regular train, or 6 dedicated train shipments per year of TRU waste would be required. TRU waste management options would be determined by decisions resulting from the Waste Management PEIS now being prepared by DOE.

The liquid LLW generated by the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would use the multipurpose reactor treatment facilities if collocated. If not collocated and depending on the site, a liquid radioactive waste treatment facility may need to be constructed. The concentrated radionuclides would be solidified and disposed of in an approved LLW disposal facility. Other solid LLW such as contaminated clothing, shoes, wipes, and HEPA filters would be compacted as appropriate and disposed of in an approved LLW disposal facility. Liquid and solid mixed LLW would be stabilized and staged in a RCRA-permitted storage facility until treatment could be accomplished in accordance with the site treatment plan that was developed pursuant to the *Federal Facility Compliance Act*. Liquid and solid hazardous wastes would be stabilized and compacted if appropriate, and packaged in DOT-approved containers for transport to RCRA-permitted treatment and disposal facilities using DOT-certified transporters. Depending on the site, additional hazardous waste accumulation facilities may be required if not collocated with the multipurpose reactor. Liquid and solid sanitary wastes would be managed in accordance with current site practices. Additional liquid sanitary and industrial wastewater treatment facilities may be required if not collocated with the multipurpose reactor.

Intersite Transportation. The Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would receive pits and send out completed fuel assembly bundles and associated waste products. The destination of the completed fuel assembly bundles and associated waste products would depend on the location of the multipurpose reactor and the final disposition option selected for plutonium. Transportation of pits, completed fuel assembly bundles, and associated waste products would be subject to government regulations and DOE orders. Transportation issues include criticality control, shielding, and containment of nuclear material. The composition and form of the radioactive materials to be transported would determine the applicable portions of the regulations as well as the packaging design.

Locating a multipurpose reactor at one of the alternative sites would require the transportation of weapons–grade plutonium pits by safe secure trailer from Pantex to INEL, NTS, ORR, or SRS for fabrication into reactor fuel. Intersite transportation would not be required if Pantex is selected as the reactor site.

For this analysis, the plutonium pits were assumed to be fully encased in a covering of stainless steel or similar material and placed in a DOT–specification, Type B packaging designed for this purpose. Eight packages, each containing one primary containment vessel (an inner container designed to hold a pit) would be placed in a cargo restraint transporter and six cargo restraint transporters would be placed in a truckload. Each truck would transport 48 packages. Based on plutonium usage of 110,000 pounds for the 40–year life of the project and a limit of 9.9 pounds of plutonium per package, approximately six truckloads per year would be required.

To estimate the radiological impacts from transporting the plutonium pits, the probability of an accident occurring was derived from DOE and DOT empirical databases, and the upper bound additional exposures (50–year committed effective dose equivalent) that might be experienced were used. Factors considered in the analysis include historical accident rates, population densities along the route, and national atmospheric dispersion parameters. These factors were incorporated in the RADTRAN transportation risk computer code used for the calculations.

Based on transporting six truckloads of plutonium per year over the highest risk route (from Pantex to SRS), the maximum potential impact from radiological accidents during transportation is 1.3×10^{-7} person–rem per year for the general population.

Nonradiological impacts are fatalities that could result from traffic accidents. Standard risk factors (fatalities per kilometer) for transport by truck are: 6.8×10^{-8} for rural, 1.7×10^{-8} for suburban, and 9.6×10^{-9} for urban population zones. Using the highest risk route (Pantex to SRS), the nonradiological accident impact would not exceed 8.7×10^{-4} per year.

The maximum number of fatalities that would occur within 1 year from both radiological and nonradiological accidents involving the transportation of plutonium would not exceed 0.00066 (DOE 1995a:3).

The risks associated with the transport of radioactive material by various transport modes have been assessed in a number of NEPA related documents such as: the *Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes*, NUREG-0170; the *Final Environmental Impact Statement, Special Isotope Separation Project*, DOE/EIS-0136, 1988; the *Environmental Assessment of the Risks of the Taiwan Research Reactor Spent Fuel Project*, DOE/EA-0515, 1991; and the *Environmental and Other Evaluations of Alternatives for Siting, Constructing, and Operating New Production Reactor Capacity*, DOE/NP-0014, September 1992. Based on the analyses in these documents, it can be concluded that the transportation risks are very small even for large quantities of special nuclear materials, including plutonium pits, by safe-secure trailers over extended time periods. In NUREG-0170, the U.S. Nuclear Regulatory Commission (NRC) concluded that "the risks attendant to accidents involving radioactive material shipments are sufficiently small to allow continued shipments by all modes." Therefore, the potential public health risks and environmental consequences resulting from normal transportation and postulated severe accidents are expected to be low.

4.8.3.2 *Mixed-Oxide Fueled Advanced Light Water Reactors*

The ALWR tritium-producing reactor technology previously described in section 3.4 and appendix section A.2.1.3 offers the possibility of transforming excess weapons plutonium into spent nuclear fuel within a few decades. This section discusses this concept for the ALWR technology. Commercial light water reactors operating in the United States are similar to the ALWR described in this PEIS and also can perform this plutonium consumption function. The NRC has already evaluated mixed-oxide burning light water reactors in the *Final Generic Environmental Statement on the Use of Recycled Plutonium in Mixed-Oxide Fuel in Light Water Cooled Reactors* August 1976 (NUREG-0002), and presented extensive information on the changes and impacts in the overall fuel and plant that may occur. This document was used as the basis for analyzing the impacts of the tritium production ALWR, analyzed in this PEIS, when operating as a mixed-oxide fueled multipurpose reactor.

For the purpose of plutonium consumption, excess weapons plutonium could be mixed with natural or depleted uranium to produce a mixed-oxide fuel that could be used in typical commercial light water reactors. The tritium production ALWR cores are similar to the commercial light water reactors. Current designs and analyses support using mixed-oxide fuel in the core without major modifications. The tritium production ALWR reactors are described in section 3.4.2.3 and appendix section A.2.1.3. This section describes the potential impacts of using the tritium production ALWR with a mixed-oxide fueled core derived from weapons surplus plutonium.

Construction Impacts. Construction impacts associated with a multipurpose ALWR would not be different from those expected from the tritium production ALWR. Impacts from constructing and operating the new Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility necessary to support the multipurpose ALWR are addressed in section 4.8.3.1.

Operation. For operation impact analysis, changes in the operating characteristics of the tritium production ALWR were compared with the analysis presented in the *Final Generic Environmental*

Statement on the Use of Recycled Plutonium in Mixed-Oxide Fuel in Light Water Cooled Reactors. The identified changes for operating baseline and potential impacts are addressed for the following categories: emissions; personnel; radiological and human health (normal operations and accidents); waste; and spent fuel. The other resource issues would not be expected to change from those described for the tritium production ALWR and are not analyzed further in this section.

Emissions. The NRC report indicated that chemical discharges released to the air and to water bodies do not change for the mixed-oxide fueled light water reactor. Similar findings are anticipated for the ALWR (NRC 1976a). The NRC report also indicated that there is an increase of tritium in the radioactive gaseous and liquid effluent releases when light water reactor fuel is changed from uranium oxide fuel to mixed-oxide fuel. Comparison of comparable reactor systems using different fuels shows that in no case are emissions significantly altered by changes in fuel types. Therefore, emissions from normal operations are expected to be changed very slightly by the introduction of mixed-oxide fuel into reactor systems originally fueled with uranium-oxide (NRC 1976a). Table 4.8.3.2–1 presents a summary of the findings.

Personnel Requirements. The use of mixed-oxide fuel in the ALWR will cause an increase in personnel requirements for unloading and receipt inspection of the fuel assemblies; safeguards and security of the nonirradiated fuel assemblies on the reactor site; wet and dry storage of spent nuclear fuel; unloading, inspection, and storage of empty and decontaminated spent nuclear fuel storage casks; handling and packaging of spent fuel for shipment; and loading spent nuclear fuel casks on trucks and/or railroad cars for shipment offsite. The number of personnel cannot be quantified at this time but is not expected to increase substantially. The number of additional workers and related impacts would be addressed in project specific analysis.

TABLE 4.8.3.2–1.—*Increase of Radioactive Materials for the Mixed-Oxide Fueled Light Water Reactor*

Release of Radioactive Materials	Percent Increase Over Uranium Fueled Reactor[a]
Radioactive Materials Released in Liquid Effluents	
All releases except tritium	0
Tritium only	8.3 to 9.3
Radioactive Materials Released in Gaseous Effluents:	
All releases except tritium	-2.8 to 0
Tritium only	9.1 to 9.3

[a] Releases would vary depending upon the type of light water reactor.

Source: NRC 1976a.

Radiological and Human Health Impacts During Normal Operation and Accidents. During normal operations of reactors small quantities of fission products and induced activities are released to the environment. The exposure pathways for radiation doses that might be delivered to individuals at locations on and beyond the boundaries of the multipurpose reactor site include liquid effluents, gaseous effluents, and direct radiation. Based on measurements made at operating commercial light water reactors, direct radiation doses are negligible (< 5 mrem per year) and in the case of both boiling water and pressurized light water reactors, the type of fuel would have virtually no effect on direct radiation dose rates (NRC 1976a). The analysis performed by the NRC on commercial light water reactors burning mixed-oxide fuel, which would be expected to be similar for the multipurpose ALWR analyzed here, showed that in no case is dose significantly altered by changes in fuel types. The NRC report concluded that the calculated dose to individuals from normal operations is perturbed very slightly by the introduction of mixed-oxide fuel into reactor systems originally fueled with uranium-oxide. The total dose to workers, however, would be expected to increase in relation to the number of additional workers at the facility.

Workers handling irradiated mixed-oxide fuel assemblies could potentially be exposed to higher doses since these assemblies would have neutron radiation levels that are about two orders of magnitude higher than the neutron radiation levels for irradiated uranium oxide fuel assemblies (NRC 1976a). To minimize this increased exposure, irradiated mixed-oxide fuel handling at the multipurpose ALWR site would be performed remotely as is done for uranium fuel.

The use of plutonium in an ALWR will not significantly affect the consequences of radioactivity releases from severe accidents though there will be some small changes in the source term release spectrum and frequency. This is because plutonium is in the fuel in the form of an oxide which is not a volatile substance. The transport processes in the severe accidents result in these nonvolatile substances being retained in the core debris on the reactor containment floor. It is possible to design mixed-oxide reactors with up to one-third of the fissile loading being provided by plutonium that retain all the performance and safety characteristics of the UO_2 reactors. With higher plutonium loadings, the lower flux and the effect of the Pu-239 thermal fission resonance, the control design, and the accident response may differ. This could lead to changes in accident frequencies or characteristics, but these are not expected to be significant. As a result, the expected consequences and risks of accidents for an ALWR with plutonium in the fuel are expected to be within the envelop of accident consequences and risk for the tritium supply ALWR described in sections 4.2.3.9 through 4.6.3.9.

Waste. Since waste generation is not a function of reactor fuel type, no increases in waste generation rates or characteristics are expected due to the change from uranium oxide reactor fuel to mixed-oxide reactor fuel.

Spent Nuclear Fuel. The NRC report indicated that decay heat in spent mixed-oxide fuel assemblies could be 10 to 20 percent greater than decay heat in spent uranium oxide fuel assemblies. Higher decay heat loads may require changes to reactor operational procedures. The reactor power level may have to be derated and/or the reactor Emergency Core Cooling System performance requirements may have to be upgraded based on the safety analysis results for the mixed-oxide-fueled reactor. The increased decay heat load in the mixed-oxide fuel assemblies could also impact the following: (1) extend refueling outage reactor cooldown time and (2) reduce the fuel assembly storage density in the fuel pool and dry storage casks or increase fuel pool cooling requirements and increase the fuel pool dwell time prior to dry storage.

Transportation/Handling. The use of mixed-oxide fuel would have a significant impact on transportation and handling of the spent nuclear fuel. The handling of the spent nuclear fuel would most likely require remote operations (GA 1994a). Due to the higher radiation levels of the spent mixed-oxide fuel, the weight of the shipping casks would increase because of the additional shielding. Due to the higher decay heat of the spent fuel, fewer spent fuel assemblies could be loaded into each shipping cask (NRC 1976a). Thus handling (i.e., packaging), loading, unloading, and transportation requirements would be increased for spent mixed-oxide fuel.

4.8.3.3 *Plutonium-Oxide Fueled Modular High Temperature Gas-Cooled Reactor*

A plutonium fueled MHTGR, unlike the ALWR, would result in a decrease in tritium production efficiency. The decrease in tritium production is due to the design which restricts the tritium target placement to only core reflectors. In order to meet the steady state tritium requirement, six 350 MWt reactor modules would be needed (appendix A.3.2.2). Therefore, the predominant environmental impact of burning plutonium in MHTGRs would be the construction of three additional reactor modules. The in-core changes of individual reactors would be minor contributors to environmental impacts of a multipurpose MHTGR compared to the construction of three additional modules.

Unlike the light water reactor, which has had significant environmental analysis prepared for using mixed-oxide fuel, no detailed environmental studies have been prepared for an MHTGR. Nonetheless, many of the principals in the *Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed-Oxide Fuel in Light Water Cooled Reactor* would apply. Therefore, the impacts discussed in this section are directed to the construction and operation of three additional MHTGR 350 MWt reactor modules. The Pit Disassembly/Conversion Facility needed to support the MHTGR, although conceptually slightly different than the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility described in section 4.8.3.1, would be expected to have similar impacts.

Construction Impacts. Adding three additional 350 MWt reactor modules would increase construction resource requirements by approximately two as shown in table 4.8.3.3–1. The construction period

TABLE 4.8.3.3–1.—*Multipurpose Modular High Temperature Gas-Cooled Reactor Estimated Construction Material/Resource Requirements*

Material/Resources	Six Reactors Consumption
Electrical energy (MWh)	131,400
Concrete (yd^3)	396,000
Steel (tons)	108,000
Fuel (gal)	5,760,000
Water (gal)	288,000,000

Source: Modified from table 3.4.2.2-1.

would also be somewhat longer, approximately 3 to 4 years, to accommodate the three new reactor module construction. The resource and issues areas most affected by the expanded module construction would be land resources, water resources, geology and soils, and paleontological resources.

Land Resources. The addition of 3 reactor modules would require more land. Assuming economics of scale and shared support infrastructure, approximately 240 additional acres would be needed. The larger land siting requirements may pose a problem at sites with limited available land. If the multipurpose MHTGR and Pit Disassembly/Conversion Facility were collocated with a new tritium recycling facility, land requirements could approach approximately 900 acres. Impacts to current and proposed site land use plans and development would need to be addressed in site-specific analysis.

Water Resources. The estimated total water requirement needed for construction of a six reactor module MHTGR would be approximately 288 million gallons. This represents an average annual water requirement increase of approximately 33 percent over a tritium production MHTGR. At sites where available water supplies were limited or already experiencing adverse water withdrawal impacts, the additional water requirements would cumulatively add to existing adverse impacts. Depending on the site, groundwater dewatering effluent volume and activities might increase due to the additional excavation required for the three added reactor modules. Site-specific analysis would be needed to identify the extent and severity of water resource impacts.

Geology and Soils. Adding three additional reactor modules would substantially increase the soil disturbance and excavation requirement at a site. Soil erosion control measures would minimize impacts to surface water and would not be expected to increase the affects expected from the tritium production MHTGR with three reactor modules. The additional excavation required for three more reactor modules would also substantially increase the volume of soil needing storage and/or disposal. Groundwater flow direction may be influenced by the extent of excavation depending on the site. Appropriate engineering measures are available to minimize groundwater infiltration into the excavation.

Paleontological Resource. Depending on the site, the increased excavation required for the additional reactors may add to the potential for affecting paleontological resources. Site-specific analysis and studies would be needed to evaluate the extent and severity of potential impacts.

Operation Impacts. The changes in the operating baseline of the tritium production MHTGR to accommodate plutonium fuel by adding three additional 350 MWt reactors are addressed for the following resource and issue areas: site infrastructure, water resources, socioeconomics, radiological impacts during normal operation and accidents, and waste management.

Site Infrastructure. Modifications to site infrastructure would be required to accommodate a six-reactor multipurpose MHTGR. Additional electrical power and other fuel requirements would increase substantially over the tritium production MHTGR (table 4.8.3.3–2). Water requirements for the multipurpose MHTGR would increase over the tritium production MHTGR. Additional wells, pumps, pipelines, and water treatment facilities may need to be constructed to support the multipurpose six-reactor MHTGR.

Water Resources. Depending on the site, surface water and/or groundwater requirements for operations would increase by 80 percent by the addition of three more reactor modules. Water use would be approximately 7,200 MGY at a wet site and 54 MGY at a dry site. Adverse impacts to groundwater and/or surface water resources may occur depending on the site. Where water resources are allotted or are currently being adversely impacted due to existing water use, the additional water requirements for the multipurpose MHTGR would exacerbate the impact.

TABLE 4.8.3.3–2.—*Multipurpose Modular High Temperature Gas-Cooled Reactor Estimated Operation Utility Requirements*

Utility	Six Reactors Consumption
Electrical Energy (MWh per year)	
Wet site	468,000
Dry site	648,000
Electrical Load (MWe)	
Wet site	65
Dry site	83
Fuel	
Gas (ft^{3}per year)	10,800,000
Liquid (GPY)	146,000
Water (MGY)	
Wet site	7,200
Dry site	54

Source: Modified from table 3.4.2.2-2.

Discharges due to cooling water discharge (at wet sites) or cooling systems blowdown could potentially impact receiving water bodies. Potential impacts, such as stream flow increases, stream bed scouring, and sediment transport, may increase due to the increase in discharge volume. Engineering measures such as plunge or stilling basins, retention basins, or lined conveyance channels to minimize impacts of such discharges may require additional land or new support site infrastructure. Treatment of all wastewater discharges would minimize potential impacts to water quality. Therefore impacts from the additional water discharges would not be substantially different than that expected from the tritium production MHTGR analyzed in this PEIS.

Socioeconomics. Construction and operation of a multipurpose MHTGR would require more personnel. Therefore, more direct and indirect socioeconomic affects would occur in the region. Approximately 15,860 worker-years would be needed to construct the six-reactor multipurpose MHTGR, an increase of 7,050 worker-years over the three-reactor tritium production MHTGR. Operation of the multipurpose MHTGR would require 1,640 workers, an increase of 730. The specific ffects would need to be determined in site-specific nalysis. However, in general the effects would be an crease in housing demand and benefits to local government public finances. An increase in employment and population would also be expected once constructed but impacts would not be substantially different from that expected from a tritium production MHTGR with three reactors. The effects would be influenced by the specific site region and would need to be addressed in a site assessment to determine the magnitude of the impacts.

Radiological and Human Health Impacts During Normal Operation and Accidents. Radiological impacts to the public and site workforce resulting from normal operations cannot be determined without source term data for a plutonium fueled multipurpose MHTGR. However, with the addition of three reactor modules total doses to the maximally exposed member of the public, population doses, and the annual dose to the site workforce would increase. Worker doses may potentially double from the those expected from a three-reactor tritium production MHTGR because of the additional three-reactor modules. Site-specific analysis would need to be performed to determine the estimated radiological impacts to these potential receptors. Engineering design measures would be required to be incorporated into any multipurpose MHTGR design to meet applicable standards for the protection of the public and site workers.

The multipurpose MHTGR with six reactor modules would have a potential for accidents that may impact the health and safety of workers and the public. The assumption can be made and supported that with more reactors the potential for accidents to occur may increase. Studies show that for both the 350 MWt and 600 MWt module designs the most severe accidents are calculated to result in fuel temperatures that peak below the 1,600 °C fuel design criteria, so that any radioactivity release is restricted to a small fraction of fuel particles whose coatings may have failed during normal operations. Based on these studies, it can be concluded that the use of plutonium in an MHTGR will not significantly affect severe accident radioactivity releases and associated consequences because no fuel failures are expected. Even if there was a small release it would not be significant because plutonium releases have been shown to not contribute significantly in light water reactors where higher releases occur. As a result, the expected consequences and risks of accidents for an MHTGR with plutonium in the fuel are expected to be within the envelope of accident consequences and risk for the tritium supply MHTGR described in sections 4.2.3.9 through 4.6.3.9.

Waste Management. The operational waste volumes for the six reactor module multipurpose MHTGR would almost double those presented in table 3.4.2.2–3. Depending on the site, additional treatment and storage facilities may be required. Waste management options would be determined by decisions resulting from the Waste Management PEIS now being prepared by DOE. New facilities may potentially have adverse impacts on site land use, air quality, biotic resources, and worker health and safety. Those new facilities already identified for the three-reactor module tritium production MHTGR would have to be designed to handle the additional waste volumes associated with a six-reactor module multipurpose MHTGR.

Spent Nuclear Fuel. The volume of spent nuclear fuel generated in the six-reactor module multipurpose MHTGR would approximately double the spent nuclear fuel from the three-reactor module tritium production MHTGR. However, as observed in section 4.8.3.2 for the light water reactor the spent plutonium-oxide fuel assemblies would have greater decay heat. Because the increased decay heat reduces storage density in the pool area and increases the fuel pool dwell time prior to dry storage, the spent fuel storage requirement would more than double that required for the three-reactor module tritium production MHTGR. Additional impacts to worker health and safety from the increased spent fuel handling may also occur.

4.9 CUMULATIVE IMPACTS

Impacts from the siting, construction, and operation of a new tritium supply and recycling facility would be cumulative with impacts from existing and planned facilities and actions at the five DOE candidate sites. The consequences section for each resource and issue area identifies, as appropriate, the cumulative effect of tritium supply and recycling impacts to impacts from existing and planned operations.

A cumulative impact is defined as the "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7). This section discusses potential impacts from other facilities, operations, and activities that in combination with potential impacts from the Tritium Supply and Recycling Proposal may contribute to cumulative impacts within the 2010 to 2050 time frame.

Implementing the Tritium Supply and Recycling Proposal would contribute to cumulative impacts. Depending on the alternative selected, changes in regional employment, population, housing, local government finances, and local transportation would …ur. For the tritium supply alternatives at the DOE …idate sites, construction and operation employ- …nd the cumulative indirect land use impacts …ed with housing and employment would be …to increase. If a tritium supply facility were …ly site other than SRS and new recycling …ere constructed at INEL, NTS, ORR, or … adverse cumulative socioeconomic …ning from the phaseout of existing …ing facilities at SRS would be negligi- …3.8). The phaseout would occur over …rs and the impacts would be offset by …er DOE sites.

…sonably foreseeable near-term …didate sites are included in the …010) environmental conditions. …RS, the impacts of No Action … activities other than tritium …ities. Information on EM's potential future waste management activities at DOE sites was included as appropriate in the assessment of waste management impacts. Project-related impacts are added to the future baseline predicted for air quality, socioeconomics, human health, and waste management at each site. The sum of the baseline and the predicted impacts represent the cumulative impacts for each of these resource and issue areas. Discussion of these impacts can be found in each of the site environmental consequences sections. Other more long-range impacts associated with the proposed Environmental Management Program and the Storage and Disposition of Weapons-Usable Fissile Materials Program are speculative at this time, but could increase cumulative impacts, depending on the decisions resulting from the PEIS being prepared for these programs and the time frame of site-specific projects. Because of the budget requirements that would be necessary to implement any of the proposed tritium supply alternatives, other major future defense program projects at DOE candidate sites would be unlikely or phased in over an extended period. The potential for programmatic cumulative impacts for the other resources and issues was analyzed but was determined to be negligible.

Because of the preconceptual design and non-site-specific location of the technologies and proposed facilities at candidate DOE sites, cumulative impacts are discussed qualitatively. More detailed cumulative analysis would occur in site-specific tiered NEPA documents resulting from decisions stemming from this PEIS and the ROD.

Because it is not known for any of the sites where or how much new offsite electrical transmission capacity would be required, no site specific cumulative impacts of transmission lines can be assessed. However, the general cumulative impacts of transmission lines are identified in the following appropriate resource and issue area discussions. The same approach is used to address potential cumulative impacts from a dedicated power plant (section 4.8.2) to support the APT and multipurpose reactor option discussed in section 4.8.3.

Construction and operation of any tritium supply and recycling facility would have a minimal cumulative impact on the available land at candidate sites or the continued/expanded missions at the sites. Land requirements for tritium supply and rec…

facilities would be approximately 3.5 percent or less of the total site area at all sites. Additional onsite cumulative land use impacts at INEL, NTS, and Pantex associated with new rights-of-way for electric transmission power lines are expected. Power plant operation within the regional power pool to supply the 500 MW of power for the APT and 50 to 70 MW for the HWR would result in adverse cumulative impacts from air emissions, liquid emissions, fossil fuel consumption, and waste generation. The MHTGR and ALWR in comparison would provide approximately 1,300 MW of electricity and have a beneficial cumulative impact (approximately 1,800 MW total compared to the APT) on the power pool.

A decision resulting from the *Long-Term Storage and Disposition of Weapons-Usable Fissile Material PEIS* to locate a consolidated storage facility at one of the candidate sites would have a minimal cumulative impact on the available land with the largest impact being with the MHTGR at Pantex. The land requirement for a consolidated plutonium and highly-enriched uranium storage facility is approximately one-fourth that required for any tritium supply and recycling facility.

The environmental management program would have minor land use requirements (less than 170 acres) at INEL, NTS, ORR, Pantex, and SRS. The largest land use for waste management combined alternatives would be at ORR (approximately 166 acres) which would have a minor cumulative land use impact at the site with the MHTGR.

Construction of offsite electrical transmission lines would have cumulative land use, visual, and biotic resource impacts. Where possible these impacts can be minimized by upgrading or constructing new lines parallel to existing lines. Constructing and operating a dedicated power plant for the APT would require an estimated additional 25 to 300 acres, depending on the type of plant, and have a cumulative impact on site land use, biotic resources, and visual character. Additional acreage would be required for ancillary infrastructure to support such a facility. If the power plant were constructed offsite by a utility adjacent to or within an existing power station complex, the potential cumulative impacts may be reduced.

The MHTGR multipurpose reactor with tritium ...g and Pit Disassembly/Conversion Facility would require approximately 400 acres of additional land at each site. Cumulative impacts on each site's land use, biotic resources, and visual character would occur. At Pantex, the additional acres would represent a 58 percent increase in use of available land over a tritium supply MHTGR. Constructing the multipurpose MHTGR facilities at Pantex would require approximately 7 percent of the undeveloped land. Potential cumulative impacts on land use, biotic resources, and visual character would be greatest at Pantex.

Environmental restoration activities at INEL, ORR, and SRS are expected to coincide with construction and operation activities of proposed tritium supply and recycling facilities, thereby increasing impacts to air quality from incineration of contaminated soil and hazardous waste. The environmental management activities at these sites are expected to last approximately 30 years while construction and operation of the tritium facilities would continue for a 40-year period. The net impact to air quality at these sites would be an increase in emissions during the period of concurrent construction followed by operation o[f] the tritium supply and recycling facilities a[nd] environmental management activities. In the lo[ng] term, air quality at all sites is expected to improve[e as] environmental management and waste minim[ization] facilities are decommissioned and waste minimiza- tion programs are instituted. No exceedanc[e of] ambient air quality standards is expected from c[umu]lative impacts.

Operation of a power plant for the APT or a P... assembly/Conversion/Mixed-Oxide Fuel Fa... Facility to support a multipurpose reactor ...ar cumulatively to the expected criteria ...on emissions at a site. The expected emis... e sh year) from a natural gas-fired power ... inc in appendix table B.1.3.1–1. A su... vo in all criteria and other pollutan... nia, organic compounds, methan... de w methane hydrocarbons, and f... No Ac occur. The percent incre... pact se emissions are shown in the a... in add for each site. These emiss... ould ex to the APT emissions. O... pact fr ence the least cumulativ... ion of a dedicated gas-fired pow... ll increa tipurpose reactor wo... xpected radiological air emi... the tritium product...

TABLE 4.8.3.3–2.—*Multipurpose Modular High Temperature Gas-Cooled Reactor Estimated Operation Utility Requirements*

Utility	Six Reactors Consumption
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Wet site	65
Dry site	83
Fuel	
Gas (ft^3 per year)	10,800,000
Liquid (GPY)	146,000
Water (MGY)	
Wet site	7,200
Dry site	54

Source: Modified from table 3.4.2.2-2.

Discharges due to cooling water discharge (at wet sites) or cooling systems blowdown could potentially impact receiving water bodies. Potential impacts, such as stream flow increases, stream bed scouring, and sediment transport, may increase due to the increase in discharge volume. Engineering measures such as plunge or stilling basins, retention basins, or lined conveyance channels to minimize impacts of such discharges may require additional land or new support site infrastructure. Treatment of all wastewater discharges would minimize potential impacts to water quality. Therefore impacts from the additional water discharges would not be substantially different than that expected from the tritium production MHTGR analyzed in this PEIS.

Socioeconomics. Construction and operation of a multipurpose MHTGR would require more personnel. Therefore, more direct and indirect socioeconomic affects would occur in the region. Approximately 15,860 worker-years would be needed to construct the six-reactor multipurpose MHTGR, an increase of 7,050 worker-years over the three-reactor tritium production MHTGR. Operation of the multipurpose MHTGR would require 1,640 workers, an increase of 730. The specific effects would need to be determined in site-specific analysis. However, in general the effects would be an increase in housing demand and benefits to local government public finances. An increase in employment and population would also be expected once constructed but impacts would not be substantially different from that expected from a tritium production MHTGR with three reactors. The effects would be influenced by the specific site region and would need to be addressed in a site assessment to determine the magnitude of the impacts.

Radiological and Human Health Impacts During Normal Operation and Accidents. Radiological impacts to the public and site workforce resulting from normal operations cannot be determined without source term data for a plutonium fueled multipurpose MHTGR. However, with the addition of three reactor modules total doses to the maximally exposed member of the public, population doses, and the annual dose to the site workforce would increase. Worker doses may potentially double from the those expected from a three-reactor tritium production MHTGR because of the additional three-reactor modules. Site-specific analysis would need to be performed to determine the estimated radiological impacts to these potential receptors. Engineering design measures would be required to be incorporated into any multipurpose MHTGR design to meet applicable standards for the protection of the public and site workers.

The multipurpose MHTGR with six reactor modules would have a potential for accidents that may impact the health and safety of workers and the public. The assumption can be made and supported that with more reactors the potential for accidents to occur may increase. Studies show that for both the 350 MWt and 600 MWt module designs the most severe accidents are calculated to result in fuel temperatures that peak below the 1,600 °C fuel design criteria, so that any radioactivity release is restricted to a small fraction of fuel particles whose coatings may have failed during normal operations. Based on these studies, it can be concluded that the use of plutonium in an MHTGR will not significantly affect severe accident radioactivity releases and associated consequences because no fuel failures are expected. Even if there was a small release it would not be significant because plutonium releases have been shown to not contribute significantly in light water reactors where higher releases occur. As a result, the expected consequences and risks of accidents for an MHTGR with plutonium in the fuel are expected to be within the envelope of accident consequences and risk for the tritium supply MHTGR described in sections 4.2.3.9 through 4.6.3.9.

Waste Management. The operational waste volumes for the six reactor module multipurpose MHTGR would almost double those presented in table 3.4.2.2–3. Depending on the site, additional treatment and storage facilities may be required. Waste management options would be determined by decisions resulting from the Waste Management PEIS now being prepared by DOE. New facilities may potentially have adverse impacts on site land use, air quality, biotic resources, and worker health and safety. Those new facilities already identified for the three-reactor module tritium production MHTGR would have to be designed to handle the additional waste volumes associated with a six-reactor module multipurpose MHTGR.

Spent Nuclear Fuel. The volume of spent nuclear fuel generated in the six-reactor module multipurpose MHTGR would approximately double the spent nuclear fuel from the three-reactor module tritium production MHTGR. However, as observed in section 4.8.3.2 for the light water reactor the spent plutonium-oxide fuel assemblies would have greater decay heat. Because the increased decay heat reduces storage density in the pool area and increases the fuel pool dwell time prior to dry storage, the spent fuel storage requirement would more than double that required for the three-reactor module tritium production MHTGR. Additional impacts to worker health and safety from the increased spent fuel handling may also occur.

4.9 Cumulative Impacts

Impacts from the siting, construction, and operation of a new tritium supply and recycling facility would be cumulative with impacts from existing and planned facilities and actions at the five DOE candidate sites. The consequences section for each resource and issue area identifies, as appropriate, the cumulative effect of tritium supply and recycling impacts to impacts from existing and planned operations.

A cumulative impact is defined as the "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7). This section discusses potential impacts from other facilities, operations, and activities that in combination with potential impacts from the Tritium Supply and Recycling Proposal may contribute to cumulative impacts within the 2010 to 2050 time frame.

Implementing the Tritium Supply and Recycling Proposal would contribute to cumulative impacts. Depending on the alternative selected, changes in regional employment, population, housing, local government finances, and local transportation would occur. For the tritium supply alternatives at the DOE candidate sites, construction and operation employment and the cumulative indirect land use impacts associated with housing and employment would be expected to increase. If a tritium supply facility were sited at any site other than SRS and new recycling facilities were constructed at INEL, NTS, ORR, or Pantex, the adverse cumulative socioeconomic impacts resulting from the phaseout of existing tritium recycling facilities at SRS would be negligible (section 4.6.3.8). The phaseout would occur over a number of years and the impacts would be offset by the actions at other DOE sites.

Impacts from reasonably foreseeable near-term projects at DOE candidate sites are included in the No Action baseline (2010) environmental conditions. For each site except SRS, the impacts of No Action include the effects of site activities other than tritium supply and recycling facilities. Information on EM's potential future waste management activities at DOE sites was included as appropriate in the assessment of waste management impacts. Project-related impacts are added to the future baseline predicted for air quality, socioeconomics, human health, and waste management at each site. The sum of the baseline and the predicted impacts represent the cumulative impacts for each of these resource and issue areas. Discussion of these impacts can be found in each of the site environmental consequences sections. Other more long-range impacts associated with the proposed Environmental Management Program and the Storage and Disposition of Weapons-Usable Fissile Materials Program are speculative at this time, but could increase cumulative impacts, depending on the decisions resulting from the PEIS being prepared for these programs and the time frame of site-specific projects. Because of the budget requirements that would be necessary to implement any of the proposed tritium supply alternatives, other major future defense program projects at DOE candidate sites would be unlikely or phased in over an extended period. The potential for programmatic cumulative impacts for the other resources and issues was analyzed but was determined to be negligible.

Because of the preconceptual design and non-site-specific location of the technologies and proposed facilities at candidate DOE sites, cumulative impacts are discussed qualitatively. More detailed cumulative analysis would occur in site-specific tiered NEPA documents resulting from decisions stemming from this PEIS and the ROD.

Because it is not known for any of the sites where or how much new offsite electrical transmission capacity would be required, no site specific cumulative impacts of transmission lines can be assessed. However, the general cumulative impacts of transmission lines are identified in the following appropriate resource and issue area discussions. The same approach is used to address potential cumulative impacts from a dedicated power plant (section 4.8.2) to support the APT and multipurpose reactor option discussed in section 4.8.3.

Construction and operation of any tritium supply and recycling facility would have a minimal cumulative impact on the available land at candidate sites or the continued/expanded missions at the sites. Land requirements for tritium supply and recycling facilities would be approximately 3.5 percent or less of the total site area at all sites. Additional onsite cumulative land use impacts at INEL, NTS, and Pantex associated with new rights-of-way for electric transmission power lines are expected. Power plant operation within the regional power pool to supply the 500 MW of power for the APT and 50 to 70 MW for the HWR would result in adverse cumulative impacts from air emissions, liquid emissions, fossil fuel consumption, and waste generation. The MHTGR and ALWR in comparison would provide approximately 1,300 MW of electricity and have a beneficial cumulative impact (approximately 1,800 MW total compared to the APT) on the power pool.

A decision resulting from the *Long-Term Storage and Disposition of Weapons-Usable Fissile Material PEIS* to locate a consolidated storage facility at one of the candidate sites would have a minimal cumulative impact on the available land with the largest impact being with the MHTGR at Pantex. The land requirement for a consolidated plutonium and highly-enriched uranium storage facility is approximately one-fourth that required for any tritium supply and recycling facility.

The environmental management program would have minor land use requirements (less than 170 acres) at INEL, NTS, ORR, Pantex, and SRS. The largest land use for waste management combined alternatives would be at ORR (approximately 166 acres) which would have a minor cumulative land use impact at the site with the MHTGR.

Construction of offsite electrical transmission lines would have cumulative land use, visual, and biotic resource impacts. Where possible these impacts can be minimized by upgrading or constructing new lines parallel to existing lines. Constructing and operating a dedicated power plant for the APT would require an estimated additional 25 to 300 acres, depending on the type of plant, and have a cumulative impact on site land use, biotic resources, and visual character. Additional acreage would be required for ancillary infrastructure to support such a facility. If the power plant were constructed offsite by a utility adjacent to or within an existing power station complex, the potential cumulative impacts may be reduced.

The MHTGR multipurpose reactor with tritium recycling and Pit Disassembly/Conversion Facility would require approximately 400 acres of additional land at each site. Cumulative impacts on each site's land use, biotic resources, and visual character would occur. At Pantex, the additional acres would represent a 58 percent increase in use of available land over a tritium supply MHTGR. Constructing the multipurpose MHTGR facilities at Pantex would require approximately 7 percent of the undeveloped land. Potential cumulative impacts on land use, biotic resources, and visual character would be greatest at Pantex.

Environmental restoration activities at INEL, ORR, and SRS are expected to coincide with construction and operation activities of proposed tritium supply and recycling facilities, thereby increasing impacts to air quality from incineration of contaminated soil and hazardous waste. The environmental management activities at these sites are expected to last approximately 30 years while construction and operation of the tritium facilities would continue for a 40-year period. The net impact to air quality at these sites would be an increase in emissions during the periods of concurrent construction followed by operation of the tritium supply and recycling facilities and environmental management activities. In the long term, air quality at all sites is expected to improve as facilities are decommissioned and waste minimization programs are instituted. No exceedance of ambient air quality standards is expected from cumulative impacts.

Operation of a power plant for the APT or a Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility to support a multipurpose reactor would add cumulatively to the expected criteria pollutant air emissions at a site. The expected emissions (tons per year) from a natural gas-fired power plant are shown in appendix table B.1.3.1–1. A substantial increase in all criteria and other pollutants such as volatile organic compounds, methane, ammonia, non-methane hydrocarbons, and formaldehyde would occur. The percent increase over No Action emissions are shown in the air quality impact section for each site. These emissions would be in addition to the APT emissions. Overall, SRS would experience the least cumulative air quality impact from a dedicated gas-fired power plant. Operation of a multipurpose reactor would result in a small increase in radiological air emissions over those expected from the tritium production reactors.

The cumulative impacts of constructing and operating a tritium supply and recycling facility at any of the DOE candidate sites on the regional economies, population, housing, local government finances, and local transportation would be minor. Generally, the regional economies and local government finances would improve without burdening the housing market, but increased traffic would further aggravate congestion on local roads. Future environmental restoration management activities and fissile materials program activities could create additional jobs (both direct and indirect) at potential candidate sites. For example, the Spent Nuclear Fuel Management Program maximum employment would reach about 1,700 workers for implementation. The Storage and Disposition Program could add between 1,385 new jobs to the sites under consideration for the Tritium Supply and Recycling Proposal. The Environmental Management Program could add up to 4,925 new jobs at INEL, 3,272 jobs at NTS, 3,581 jobs at ORR, 654 at Pantex, and 5,667 jobs at SRS. The cumulative socioeconomic impact of the three programs would be the primary stimulation of regional economic growth. The adverse cumulative impact of these programs would be transportation congestion as well as the increased demand for new housing and other public services. However, these needs could be offset by additional tax revenues generated by new residents.

If the APT alternative is selected and a dedicated power plant is constructed, additional socioeconomic impacts would result. The size of the construction and operation workforce would depend on the type of fuel used to power the plant. For example, a coal-fired plant generating 500 to 600 MWe would require a construction workforce of 500 (peaking at 800) and operation workforce of approximately 145. A natural gas-fired plant would require a construction workforce of 150 (peaking at 225) and an operation workforce of 50 to 75.

Cumulative human health impacts in the form of additional cancer risk to workers and the public from the environmental management program and fissile materials program activities at INEL, NTS, ORR, and SRS are expected to be minor. The cumulative impacts are attributed to more onsite workers and increased exposure to radioactivity due to waste management activities at the sites. Cumulative radiological health impacts from the Environmental Management Program alternatives from the expected maximum radiological releases would result in a large increase in the risk to the offsite population at INEL and SRS. The increase would primarily result from the treatment of TRU waste. At all five tritium supply candidate sites however, the maximum cumulative radioactive releases from the Environmental Management Program, including INEL and SRS, would be below the EPA standard of 10 mrem per year to the maximally exposed individual.

The potential cumulative health impacts from the Spent Nuclear Fuel Management program under the Regionalization Alternative at INEL, NTS, ORR, and SRS are minimal. Over a 40-year period, the estimated number of additional fatal cancers resulting from Regionalization by Fuel Type would range from zero to about one. Applicable regulations, standards, and monitoring would pertain to all environmental management program activities. The annual radiation dose to workers and to individual members of the public from the tritium supply and recycling activities would remain constant. However, the collective dose to and numbers of cancers in the population would increase due to the projected increase in the population within 50 miles of the site.

The expected increase in radiological air emissions from a multipurpose reactor would also contribute to the cumulative human health impacts at a site. Small increases in site worker doses would also be expected from the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility. The cumulative human health impacts to workers and the public are expected to be within applicable regulations and standards.

The cumulative impact on waste management activities that would result from siting new tritium supply and recycling facilities would be affected by future decisions resulting from the *Waste Management PEIS* and the *Long-Term Storage and Disposition of Weapons-Usable Fissile Materials PEIS*. The largest cumulative impacts from the *Waste Management PEIS* for INEL, ORR, Pantex, and SRS would arise if they were selected to be a regional treatment and disposal site for LLW and mixed LLW. The largest impact for NTS would occur if it were selected as a central disposal site for LLW and mixed LLW. If INEL, NTS, ORR, Pantex, or SRS were selected as a result of the ROD from the *Waste Man-*

agement PEIS, the waste volumes for the proposed tritium supply and recycling facilities would be a less significant contributor to the waste management at these sites.

No cumulative impacts on waste management from the *Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management EIS* are expected at Pantex. Under the Regionalization by Fuel Type alternative, the largest cumulative impacts from tritium supply and recycling would occur at INEL and SRS. These sites are expected to receive inventories of spent nuclear fuel (in metric tons of heavy metal) of 165 and 7, respectively. Cumulative waste management impacts at ORR would also result from the stabilization processing of existing spent nuclear fuel inventories at ORR for shipment to INEL and SRS. The stabilization and redistribution of spent nuclear fuel would occur over the period from 1996 to 2035. The Tritium Supply Program alternatives would potentially increase the spent nuclear fuel inventories at INEL and SRS from 0 (APT) to 105 metric tons of heavy metal spent fuel per year (approximately 4,200 metric tons over the projected 40-year life of the program).

In the *Long-Term Storage and Disposition of Weapons-Usable Fissile Material PEIS* INEL, NTS, ORR, Pantex, and SRS are being considered for the possible consolidated storage of plutonium and highly-enriched uranium. Site selection for the Storage and Disposition PEIS analysis for the other alternatives such as mixed-oxide fuel fabrication have not been completed. Wastes generated from a consolidated storage facility are small; therefore, cumulative impacts on waste management from a consolidated storage facility are minimal when added to the tritium supply and recycling projected impacts.

4.10 Commercial Light Water Reactor Alternative and/or Contingency

The purchase by DOE of an existing operating or partially completed commercial power reactor is a reasonable alternative being evaluated to meet the stockpile tritium requirement mission. Production of tritium using irradiation services contracted from commercial power reactors is also being evaluated as a reasonable alternative and as a potential contingency measure to meet the projected tritium requirements for the Nation's nuclear weapons stockpile in the event of a national emergency. The reactors employed for domestic electric power generation in the United States are conventional light water reactors, which use ordinary water as moderator and coolant. Commercial light water reactors use both pressurized water and boiling water technologies. Feasibility studies show that of the two types of commercial reactors, pressurized water reactors are more readily adaptable than boiling water reactors to the requirements of tritium production by DOE tritium target rod irradiation (FDI 1994i).

The commercial light water reactor alternative does not include a specific site for analysis in the PEIS. Any one of the existing operating commercial nuclear reactors or partially completed reactors are potential candidates for the tritium supply mission. Currently, 109 commercial nuclear power plants are located at 71 sites in 32 of the contiguous states (figure 4.10–1). Of these, 53 sites are located east of the Mississippi River. No commercial nuclear power plants are located in Alaska or Hawaii. Approximately half of these 71 sites contain two or three nuclear units per site.

Figure 4.10–2 shows the commercial nuclear power plants with electric ratings of 1,100 MWe or more which would be representative of the generic commercial light water reactor described and analyzed for the commercial reactor purchase alternatives and the contingency option in this section.

The following discussion in sections 4.10.1 and 4.10.2 is summarized from the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, August 1991.

4.10.1 Commercial Light Water Reactor Plant Description

Commercial pressurized water reactors are high-temperature, high-pressure reactors that use ordinary light water as the coolant and moderator and are capable of generating large amounts of electricity through a steam turbine generator. The range of electrical production for these plants is approximately 390 million kWh per year to 6,900 million kWh per year using an assumed annual capacity factor of 62 percent.

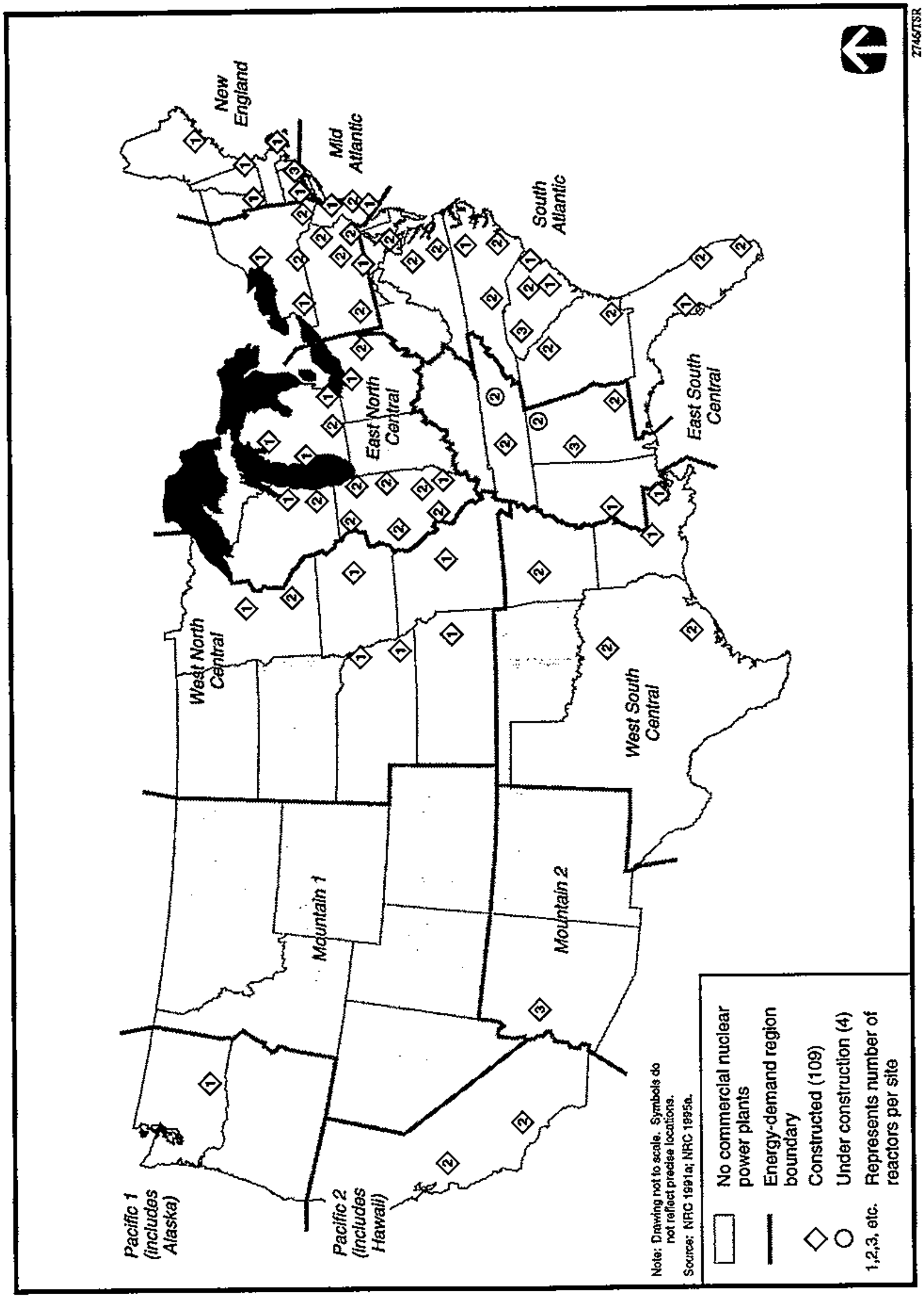

FIGURE 4.10–1.—*Commercial Nuclear Power Plants Within Eleven Energy-Demand Regions of the United States.*

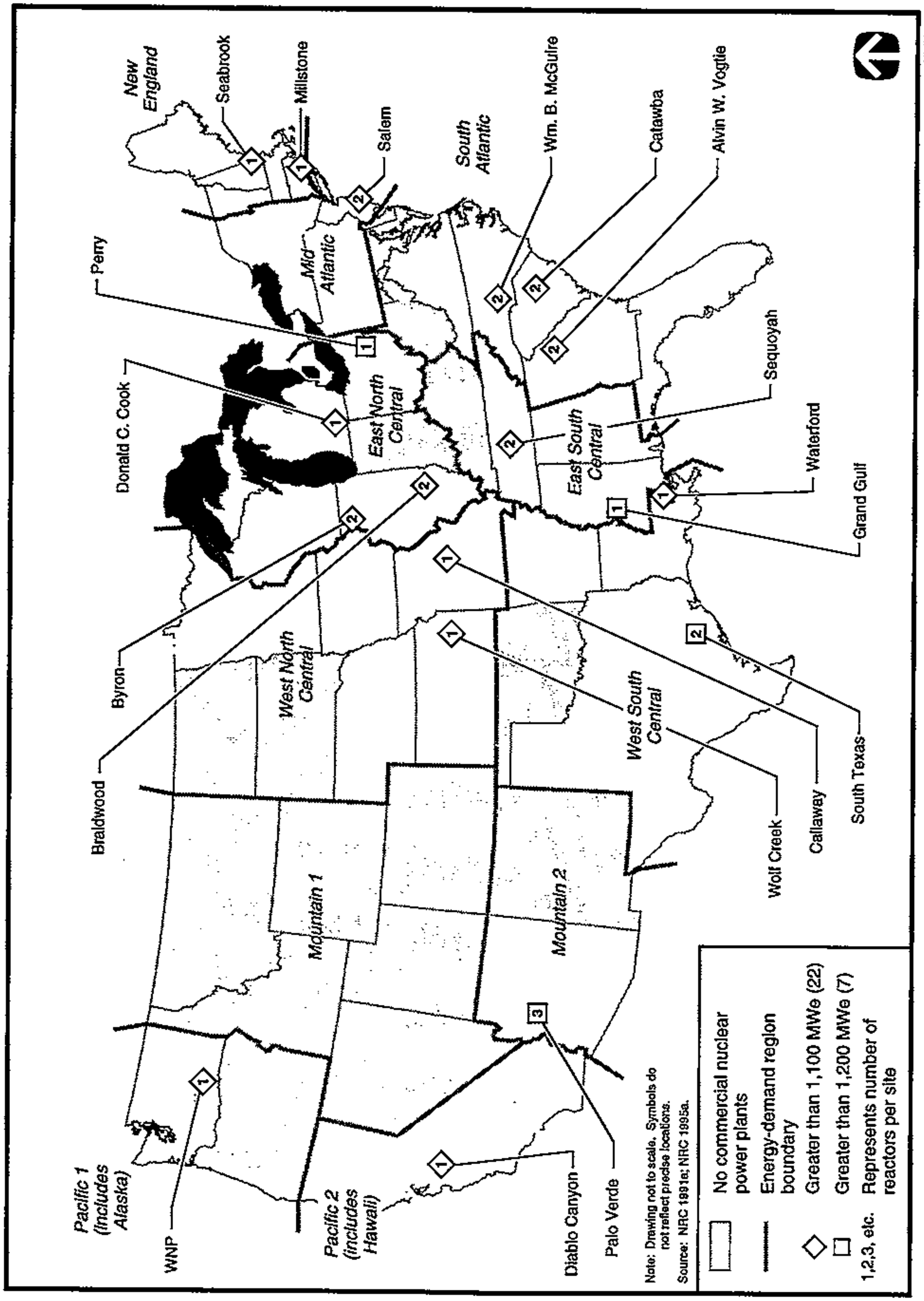

FIGURE 4.10–2.—*Commercial Nuclear Power Plants with Design Electric Rating Greater than 1,100 Megawatts Electric Within Eleven Energy-Demand Regions of the United States.*

Commercial pressurized light water reactor nuclear power plants generally contain four main buildings or structures:

- Containment or Reactor Building—A massive containment structure that houses the reactor vessel, steam generators, pressurizer, pumps, and associated piping. The building is generally designed to withstand such disasters as hurricanes, earthquakes, and aircraft collision, and is the final deterrent to prevent the release of radioactive materials.

- Turbine Building—Plant structures that house the steam turbine and generator, condenser, waste heat rejection system, pumps, and equipment that supports these systems.

- Auxiliary Buildings—Buildings that house such support systems as the ventilation systems, emergency core cooling system, water treatment system, and waste treatment system, along with fuel storage facilities and the plant control room.

- Cooling Towers—Cooling structures designed to remove excess heat from the condenser without dumping such heat directly into water bodies.

The plant site also contains a large switchyard, where the electric voltage is stepped up and fed into the regional power distribution system. A plant complex may also include various administrative and security buildings. During the operating life of a plant, its basic appearance remains unchanged.

Typically, nuclear power plant sites and the surrounding area are flat-to-rolling countryside in wooded or agricultural areas. More than 50 percent of the sites have 50-mile population densities of less than 200 persons per square mile, and over 80 percent have 50-mile densities of less than 500 persons per square mile.

Site areas range from 84 acres to 30,000 acres. Almost 60 percent of the plant sites encompass 500 to 2,000 acres. Larger land-use areas are associated with plant cooling systems that include reservoirs and artificial lakes and buffer areas.

United States reactors employed for domestic electric power generation are conventional (thermal) light water reactors using water as moderator and coolant. The two types of light water reactors are pressurized water reactors and boiling water reactors. Of the 109 power reactors in the United States, 72 are pressurized water reactors and 37 are boiling water reactors.

In the pressurized water reactor, reactor heat is transferred from the primary coolant to a secondary coolant loop that is at a lower pressure, allowing steam to be generated in the steam generator. The steam then flows to a turbine for power production. All domestic power reactors employ a containment structure that is a major safety feature to prevent release of radionuclides in the event of an accident. Pressurized water reactors employ three types of containments, namely: large, dry containments; subatmospheric containments; and ice condenser containments. Of the 80 U.S. pressurized water reactors, 65 have large, dry containments, seven have subatmospheric containments, and eight have ice condenser containments.

4.10.1.1 *Cooling and Auxiliary Water Systems*

The predominant water use at a nuclear power plant is for removing excess heat generated in the reactor by condenser cooling. The quantity of water used for condenser cooling is a function of several factors, including the capacity rating of the plant capacity and the increase in cooling water temperature from the intake to the discharge. The larger the plant, the greater the quantity of waste heat to be dissipated, and the greater the quantity of cooling water required.

In addition to removing heat from the reactor, cooling is also provided to the service water system and to the auxiliary cooling water system. The volume of water required for these systems for once-through cooling is usually less than 15 percent of the volume required for condenser cooling. In closed-cycle cooling, the additional water needed is usually less than 5 percent of that needed for condenser cooling.

Of the 109 nuclear reactors, 42 use closed-cycle cooling systems. Most closed-cycle systems use cooling towers. Some closed-cycle systems units use a cooling lake or canals for transferring heat to the atmosphere. Of the 42 plants with closed-cycle cooling systems, 15 use mechanical draft cooling towers, 19 use natural draft cooling towers, 4 use a canal system, and 4 use a cooling lake. Once-through cooling systems are used at 67 units. A few of these systems are augmented with helper cooling towers to reduce the temperature of the effluent released to the adjacent body of water. Of the 67 plants with once-through cooling systems, 24 discharge to a river, 11 discharge to the Great Lakes, 17 discharge to the ocean or an estuary, and 15 discharge to a reservoir or lake. Five of the once-through plants can also switch to cooling towers.

In closed-cycle systems, the cooling water is recirculated through the condenser after the waste heat is removed by dissipation to the atmosphere, usually by circulating the water through large cooling towers constructed for that purpose. Several types of closed-cycle cooling systems are currently used by the nuclear power industry. Recirculating cooling systems consist of either natural draft or mechanical draft cooling towers, cooling ponds, cooling lakes, or cooling canals. Because the predominant cooling mechanism associated with closed-cycle systems is evaporation, most of the water used for cooling is consumed and is not returned to a water source.

In a once-through cooling system, circulating water for condenser cooling is drawn from an adjacent body of water, such as a lake or river, passed through the condenser tubes, and returned at a higher temperature to the adjacent body of water. The waste heat is dissipated to the atmosphere mainly by evaporation from the water body and, to a much smaller extent, by radiation loss.

For both once-through and closed-cycle cooling systems, the water intake and discharge structures are of various configurations to accommodate the source water body and to minimize impact to the aquatic ecosystem. The intake structures are generally located along the shoreline of the body of water and are equipped with fish protection devices. The discharge structures are generally the jet or diffuser outfall type and are designed to promote rapid mixing of the effluent stream with the receiving body of water. Biocides and other chemicals used for corrosion control and for other water treatment purposes are mixed with the condenser cooling water and discharged from the system.

In addition to surface water sources, some nuclear power plants use groundwater as a source for service water, makeup water, or potable water. Other plants operate dewatering systems to intentionally lower the groundwater table, either by pumping or by a system of drains, in the vicinity of building foundations.

4.10.1.2 *Radioactive Waste Treatment Systems*

During the fission process, a large inventory of radioactive fission products builds up within the fuel. A small fraction of these fission products escape the fuel and contaminates the reactor coolant. The primary system coolant also has radioactive contaminants as a result of neutron activation. These contaminants are removed from the coolant by an elaborate radioactive waste treatment system. The following sections describe the basic design and operation of pressurized water reactor radioactive-waste-treatment systems.

Gaseous Radioactive Waste. Pressurized water reactors have three primary sources of gaseous radioactive emissions:

- Discharges from the gaseous waste management system;
- Discharges associated with the exhaust of noncondensable gases at the main condenser if a primary-to-secondary system leak exists; and
- Radioactive gaseous discharges from the building ventilation exhaust, including the reactor building, reactor auxiliary building, and fuel-handling building.

The gaseous waste management system collects fission products, mainly noble gases, that accumulate in the primary coolant. A small portion of the primary coolant flow is continually diverted to the primary coolant purification, volume, and chemical control system to remove contaminants and adjust the coolant chemistry and volume. During this process, noncondensable gases are stripped and routed to the gaseous waste management system, which consists of a series of gas storage tanks. The storage tanks allow the short-half-life radioactive gases to decay, leaving only relatively small quantities of long-half-life radionuclides to be released to the atmosphere. In addition, some pressurized water reactors are using charcoal delay systems rather than gas holdup tanks.

Liquid Radioactive Waste. Radionuclide contaminants in the primary coolant are the source of liquid radioactive waste in commercial light water reactors. Liquid wastes resulting from commercial light water reactor plant operation may be classified into the following categories: clean wastes, dirty wastes, detergent wastes, turbine building floor drain water, and steam generator blowdown. Clean wastes include all liquid wastes with a normally low conductivity and variable radioactivity content. They consist of reactor grade water, which is amenable to processing for reuse as reactor coolant makeup water. Clean wastes are collected from equipment leaks and drains, certain valve and pump seal leakoffs not collected in the reactor coolant drain tank, and other aerated leakage sources. In addition, these wastes include primary coolant. Dirty wastes include all liquid wastes with a moderate conductivity and variable radioactivity content that, after processing, may be used as reactor coolant makeup water. Dirty wastes consist of liquid wastes collected in the containment building sump, auxiliary building sumps and drains, laboratory drains, sample station drains, and other miscellaneous floor drains. Detergent wastes consist principally of laundry wastes and personnel and equipment decontamination wastes and normally have a low radioactivity content. Turbine building floor-drain wastes usually have a high conductivity and low radionuclide content. Steam generator blowdown can have relatively high concentrations of radionuclides depending on the amount of primary-to-secondary leakage. Following processing, the water may be reused or discharged.

Each of these sources of liquid wastes receives varying degrees and types of treatment before storage for reuse or discharge to the environment under the site National Pollutant Discharge Elimination System (NPDES) permit. The extent and types of treatment depend on the chemical radionuclide content of the waste. To increase the efficiency of waste processing, wastes of similar characteristics are batched before treatment.

The degree of processing, storing, and recycling of liquid radioactive waste has steadily increased among operating plants. For example, extensive recycling of steam generator blowdown is now the typical mode of operation, and secondary side wastewater is routinely treated. In addition, the plant systems used to process wastes are often augmented with the use of commercial mobile processing systems. As a result, radionuclide releases in liquid effluent from commercial light water reactor plants have generally declined or remained the same.

Low-Level Waste. Solid LLW from commercial nuclear power plants is generated by removal of radionuclides from liquid waste streams, the filtration of airborne gaseous emissions, and the removal of contaminated material from various reactor areas. Liquid contaminated with radionuclides comes from primary and secondary coolant systems, spent-fuel pools, decontaminated wastewater, and laboratory operations. 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, slurried into 55-gal steel drums, and stored onsite in shielded Butler-style buildings or other facilities until suitable for offsite disposal. These buildings usually contain volume reduction and solidification facilities to prepare LLW for disposal at a certified LLW disposal facility.

High-efficiency particulate filters are used to remove radioactive material from gaseous plant effluents. These filters are compacted and are disposed of as solid wastes.

Solid LLW consists of contaminated protective clothing, paper, rags, glassware, compactible and noncompactible trash, and nonirradiated reactor components and equipment. Most of this waste comes from plant modifications and routine maintenance activities. Additional sources include tools and other material exposed to the reactor environment. Before disposal, compactible trash is usually taken to onsite or offsite volume reduction facilities. Compacted dry active waste is the largest single form of LLW disposed from commercial nuclear plants, comprising one-half of the total average annual volumes from pressurized water reactors.

Volume reduction efforts have been undertaken in response to increased disposal costs and the passage of the *Low Level Radioactive Waste Policy Act* of 1980 and the *Low Level Radioactive Waste Policy Amendments Act* of 1985 (PL 96-573; PL 99-240), which require LLW disposal allocation systems for nuclear plants. Volume reduction is performed both on- and offsite. The most common on-site volume reduction techniques are ultra-high-pressure compaction of waste drums, monitoring waste streams to segregate wastes, minimizing the exposure of routine equipment to contamination, and decontamination and sorting of radioactive or nonradioactive batches before offsite shipment. Offsite waste management vendors incinerate dry activated waste; separate and incinerate oily, organic wastes, solidify the ash; and occasionally undertake supercompaction, waste crystallization, and asphalt solidification of resins and sludges.

Spent Fuel. Spent fuel is produced by the formation of fission products and actinides when nuclear fuel is irradiated in reactors. After spent fuel is removed from reactors, it is stored in racks placed in storage pools to isolate it from the environment. Delays in siting an interim Monitored Retrievable Storage facility or permanent repository, coupled with rapidly filling spent-fuel pools, have led utilities to seek other storage solutions, including expansion of existing pools, aboveground dry storage, longer fuel burnup, and shipment of spent fuel to other plants.

Pool storage has been increased through enlarging the capacity of spent-fuel racks, adding racks to existing pool arrays ("dense-racking"), reconfiguring spent fuel with neutron-absorbing racks, and employing double-tiered storage (installing a second tier of racks above those on the pool floor).

Efforts under way to further develop dry storage technologies include casks, silos, dry wells, and vaults. Dry storage facilities are simpler and more readily maintained than fuel pools. They are growing in favor because they offer a more stable means of storage and take up relatively little land area (less than half an acre in most cases). Dry storage is currently in use at about 5 percent of the sites.

Transportation of Radioactive Materials. There are four types of radioactive material shipments to and from nuclear plants: routine and refurbishment-generated LLW transported from plants to disposal facilities; routine LLW shipped to offsite facilities for volume reduction; nuclear fuel shipments from fuel fabrication facilities to plants for loading into reactors (generally occurring on a 12- to 18-month cycle); and, spent-fuel shipments to other nuclear power plants with available storage space (an infrequent occurrence usually limited to plants owned by the same utility).

For commercial reactors to be used to produce tritium, the commercial reactor sites would have to obtain new fuel assemblies with the DOE target rods included or target rods to replace burnable poison rods from an offsite source. Additionally, irradiated target rods would have to be shipped offsite to SRS for tritium extraction and recycling.

Workers and others are protected from exposure during radioactive material transport by the waste packaging. Operational restrictions on transport vehicles, ambient radiation monitoring, imposition of licensing standards (which ensure proper waste certification by testing and analysis of packages), waste solidification, and training of emergency personnel to respond to mishaps are also used. Additional regulations may be imposed by states and communities along transportation corridors.

A typical commercial pressurized light water reactor makes approximately 40 to 50 shipments of LLW per year. The majority of this LLW is Class A waste packaged in 55-gal drums or other Type A containers and shipped to disposal facilities by flatbed truck. (A Type A container is a NRC-certified and DOT-approved container which has been tested extensively and certified as able to allow for no release of radioactive material under normal transportation conditions and able to limit radiation exposure to handling personnel). LLW shipments require manifests that describe the contents of the packages to permit inspection by state, local, and facility personnel and to ensure that the waste is suitable for a particular disposal facility.

Currently, the only spent-fuel shipments from nuclear plants are to other plants. A few spent-fuel shipments have, in the past, been made to fuel reprocessing plants. These shipments are packaged in Type B casks designed to retain the highly radioactive contents under normal and accident conditions.

These containers range from 25 to 40 tons for truck shipment (each cask is capable of holding 7 fuel assemblies) to 120 tons for rail transport (with a capacity for 36 assemblies). The casks are resistant to both small-arms fire and high-explosive detonation.

The transportation of "cold" (unirradiated) nuclear fuel to the reactor, of spent irradiated fuel from the reactor, and of solid radioactive wastes from the reactor to a waste burial ground represents a source of exposure considered in 10 CFR 51:52. The contribution of the environmental effects of such transportation to workers and the exposed population is summarized in 10 CFR 51.52 Table 5-4.

4.10.1.3 *Nonradioactive Waste Systems*

Nonradioactive wastes from commercial nuclear power plants include boiler blowdown (continual or periodic purging of impurities from plant boilers), water treatment wastes (sludges and high saline streams whose residues are disposed of as solid wastes and biocides), boiler metal cleaning, floor and yard drains, and stormwater runoff. Principal chemical and biocide waste sources include the following:

- Boric acid used to control reactor power and lithium hydroxide used for controlling pH in the coolant (These chemicals could be inadvertently released due to pipe or steam generator leakage.);
- Sulfuric acid, which is added to the circulating water system to control scale;
- Hydrazine, which is used for corrosion control (It is released in steam generator blowdown.);
- Sodium hydroxide and sulfuric acid, which are used to regenerate resins (These are discharged after neutralization.);
- Phosphate in cleaning solutions; and
- Biocides used for condenser defouling.

Other small volumes of wastewater are released from other plant systems depending on the design of each plant. These are discharged from such sources as the service water and auxiliary cooling systems, water treatment plant, laboratory and sampling wastes, boiler blowdown, floor drains, stormwater runoff, and metal treatment wastes. These waste streams are discharged as separate point sources or are combined with the cooling water discharges.

4.10.1.4 *Power-Transmission Systems*

Power-transmission systems associated with commercial nuclear power plants consist of switching stations (or substations) located on the plant sites and of transmission lines located primarily offsite. These systems are required to transfer power from the generating station to the utility's network of power lines in its service area.

Switching stations transfer power from generating sources to power lines and regulate the operation of the power system. Transformers in switching stations convert the generated voltage to voltage levels appropriate for the power lines. Equipment for regulating system operation includes switches, power circuit breakers, meters, relays, microwave communication equipment, capacitors, and a variety of other electrical equipment. This equipment meters and controls power flow; improves performance characteristics of the generated power; and protects generating equipment from short circuits, lightening strikes, and switching surges that may occur along the power lines. Switching stations occupy onsite areas generally two to four times as large as areas occupied by reactor and generator buildings but are not as tall or as visible as the plant buildings.

4.10.2 Commercial Light Water Reactor Plant Environment

This section describes commercial nuclear power plants' interaction with the environment. Commercial nuclear power plants are sited, designed, and operated to minimize impacts to the environment, including plant workers. Land that could be used for other purposes is dedicated to electric power production for the life of the plant. The aesthetics of the landscape are altered because of the new plant structures; the surface and groundwater hydrology and terrestrial and aquatic ecology may be affected; the air quality may be affected; and, finally, the community infrastructure and services are altered to accommodate the influx of workers into the area. The environmental impact from plant operation is determined largely by waste effluent streams (gaseous, liquid, and solid); the plant cooling systems; the exposure of plant workers to radiation; and plant expenditures, taxes, and jobs.

4.10.2.1 *Land Use*

Nuclear power plants are large physical entities. Land requirements generally amount to several hundred acres for the plant site, of which 50 to 100 acres may actually be disturbed during plant construction. Other land commitments can amount to many thousands of acres for transmission line rights-of-way and cooling lakes, when such a cooling option is used.

4.10.2.2 *Water Use*

Commercial nuclear power plants withdraw large amounts of mainly surface water to meet a variety of plant needs. Water withdrawal rates from adjacent bodies of water for plants with once-through cooling systems are large. Flow through the condenser for a 1,000 MWe plant may be 700,000 to 1 million gpm. Water lost by evaporation from the heated discharge is about 60 percent of that which is lost through cooling towers. Additional water needs for service water, auxiliary systems, and radioactive waste systems account for 1 to 15 percent of that needed for condenser cooling.

Water withdrawal from adjacent bodies of water for plants with closed-cycle cooling systems is 5 to 10 percent of that with once-through cooling systems, with much of this water being used for makeup of water by evaporation. With once-through cooling systems, evaporative losses are about 40 percent less but occur externally in the adjacent body of water instead of in the closed-cycle system. The average makeup water withdrawals for several recently constructed plants having closed-cycle cooling, normalized to 1,000 MWe, are about 14,000 to 18,000 gpm. Variation is due to cooling tower design, concentration factor of recirculated water, climate at the site, plant operating conditions, and other plant-specific factors. Consumptive loss normalized to 1,000 MWe is about 11,200 gpm, which is about 80 percent of the water volume taken in.

Consumptive water losses remove surface water from other uses downstream. In those areas experiencing water availability problems, nuclear power plant consumption may conflict with other existing or potential closed-cycle uses (e.g., municipal and agricultural water withdrawals) and in-stream uses (e.g., adequate in-stream flows to protect aquatic biota, recreation, and riparian communities).

As discussed previously, some commercial nuclear power plants use groundwater as an additional source of water. The rate of usage varies greatly among users. Many plants use groundwater only for the potable water system and require less than 100 gpm; however, withdrawals at other sites can range from 400 to 3,000 gpm.

4.10.2.3 *Water Quality*

Water quality is impacted by the liquid effluents discharged from commercial nuclear power plants. Discharges from the heat dissipation system account for the largest volumes of water and usually the greatest potential impacts to water quality and aquatic systems, although other systems may contribute heat and toxic chemical contaminants to the effluent. The relatively small volumes of water required for the service water and auxiliary cooling water systems do not generally raise concerns about thermal or chemical impacts to the receiving body of water. However, because effluents from these systems contain contaminants that could be toxic to aquatic biota, their concentrations are regulated under the power plant's NPDES discharge permit. The quality of groundwater may also be diminished by water from cooling ponds seeping into the underlying groundwater table.

Sewage wastes and cleaning solvents, including phosphate cleaning solutions, are treated as sanitary wastes. They are treated prior to their release to the environment to minimize environmental impacts. In cases where nonradioactive sanitary or other wastes cannot be processed by onsite water treatment systems, the wastes are collected by independent contractors and trucked to offsite treatment facilities. Water quality issues relate to the following: NPDES permit system for regulating low-volume wastewater, adequate wastewater treatment capacity to handle increased flow and loading associated with operational changes to the plant and discharges of wastes through emission of phosphates from utility laundries, suspended solids and coliforms from sewage treatment discharges, and other effluents that cause excessive biological oxygen demand.

All effluent discharges are regulated under the provisions of the *Clean Water Act* and the implementing effluent guidelines, limitations, and standards established by EPA and the states. Conditions of discharge from each plant are specified in its NPDES permit issued by the state or EPA.

4.10.2.4 *Air Quality*

Overall, commercial nuclear power plants have a minimal effect on air quality. Transmission lines have been associated with the production of minute amounts of ozone and nitrogen oxides. These issues are associated with corona, the breakdown of air very near the high-voltage conductors. Corona is most noticeable for the higher-voltage lines and during foul weather. Through the years, line designs have been developed that greatly reduce corona effects. Diesel generators used as backup emergency power source contribute to air quality impacts.

4.10.2.5 *Aquatic Resources*

Operation of the once-through (condenser cooling) system requires large amounts of water withdrawn directly from surface waters. These surface waters contain aquatic organisms that may be injured or killed through their interactions with the power plant. Aquatic organisms that are too large to pass through the intake debris screens, which commonly have a 0.4-inch mesh, and cannot move away from the intake, may be impinged against the screens. If the organisms are held against the screen for long periods, they will suffocate; if they receive severe abrasions, they may die. Impingement can harm large numbers of fish and large invertebrates (e.g., crabs, shrimp, and jellyfish).

Aquatic organisms that are small enough to pass through the debris screens will travel through the entire condenser cooling system and be exposed to heat, mechanical, and pressure stresses, and possibly biocidal chemicals before being discharged back to the body of water. This process, called entrainment, may affect a wide variety of small plants (phytoplankton), invertebrates (zooplankton), and fish eggs and larvae (ichthyoplankton). Entrainment mortality is variable; conditions at some plants with once-through cooling may result in relatively low levels of mortality, although at such plants the volumes of water (and numbers of entrained organisms) are often high. Generally no aquatic organisms survive at plants with closed-cycle cooling that recirculate water though cooling towers, although the volumes of water withdrawn are relatively low.

Discharges from the plant heat rejection system may affect the receiving body of water through heat loading and chemical containments, most notably chlorine or other biocides. Heated effluents can kill aquatic organisms directly by either heat shock or cold shock. In addition, a number of indirect or sublethal stresses are associated with thermal discharges that have the potential to alter aquatic communities (e.g., increased incidence of disease, predation, or parasitism, as well as changes in dissolved gas concentrations).

4.10.2.6 *Terrestrial Resources*

A number of ongoing issues associated with terrestrial resources can arise in the immediate area around the plant or its power transmission lines. Most power lines are located on easements (or rights-of-way) that the utility purchased from the landowner. Land uses on the easements are limited to activities compatible with power-line operation. In areas with rapidly growing vegetation, utilities must periodically cut or spray the vegetation to prevent it from growing so close to the conductors that it causes short circuits and endangers power line operation. Other terrestrial resource issues can result from changes in local hydrology. Such changes can occur from altered contouring of the land, reduced tree cover, and increased paving. These changes can reduce the value of land and contribute to local erosion and flooding. Additional impacts can include the effect of cooling tower drift, reduced habitat for plants and animals, disruption of animal transit routes, and bird collisions with cooling towers and transmission lines.

4.10.2.7 *Radiological Impacts*

Operational Exposures. Plant workers conducting activities involving radioactively contaminated systems or working in radiation areas can be exposed to radiation. Most of the occupational radiation dose to commercial nuclear plant workers results from external radiation exposure rather than from internal exposure from inhaled or ingested radioactive materials. Experience has shown that the dose to nuclear plant workers varies from reactor to reactor and from year to year. Since the early 1980s, when NRC regulatory requirements and guidance placed increased emphasis on maintaining nuclear power plant occupational radiation exposures as low as reasonably achievable, there has been a decreasing trend in the average annual dose per nuclear plant worker. The average total annual whole body dose to workers at commercial nuclear power plants is approximately 200 person-rem.

Public Radiation Exposures. Commercial nuclear power reactors, under controlled conditions, release small amounts of radioactive materials to the environment during normal operation. These releases result in radiation doses to humans of approximately 0.003 mrem per year that are small relative to the U.S. average dose from natural radioactivity of 300 mrem per year. Nuclear power plant licensees must comply with NRC regulations (e.g., 10 CFR 20, 10 CFR 50 Appendix I, 10 CFR 50.36a, and 40 CFR 190) and conditions specified in the operating license.

Potential environmental pathways through which persons may be exposed to radiation originating in a nuclear power reactor include atmospheric and aquatic pathways. Radioactive materials released under controlled conditions include fission products and activation products. Fission product releases consists primarily of the noble gases and some of the more volatile materials like iodines, cesiums, and tritium. These materials are monitored carefully before release to determine whether the limits on releases can be met. Releases to the aquatic pathways are similarly monitored. Radioactive materials in the liquid effluents are processed in radioactive waste treatment systems. The major radionuclides released to the aquatic systems are cobalts, cesiums, and tritium. When an individual is exposed through one of these pathways, the dose is determined, in part, by the exposure time and, in part, by the amount of time that the radioactivity inhaled or ingested is retained in the individual's body.

Solid Waste. Both nonradioactive and radioactive wastes are generated at commercial nuclear power plants. The nonradioactive waste is generally not of concern unless it is classified as *Resource Conservation and Recovery Act* (RCRA) waste. Such hazardous waste is handled, packaged, and disposed of in a licensed landfill in accordance with the provisions of RCRA.

Solid radioactive waste consists of LLW, mixed waste, and spent fuel. LLW is generated by removal of radionuclides from liquid waste streams, the filtration of airborne gaseous emissions, and the removal of contaminated material from the reactor environment. Mixed waste is LLW that also contains chemically hazardous components as defined under RCRA. Mixed waste consists primarily of decontamination wastes and ion exchange resins. Under the *Low Level Radioactive Waste Policy Act* of 1980 and the *Low Level Radioactive Waste Policy Amendments Act* of 1985, states must secure their own disposal capacity for LLW generated within their boundaries after 1992 by forming waste compacts or siting their own disposal facilities.

Workers receive radiation exposure during the storage and handling of LLW; however, this source of exposure is small compared with other sources of exposure at operating commercial nuclear plants. Members of the general public are also exposed when the LLW is shipped to a disposal site. The public radiation exposures from radioactive material transportation have been addressed generically in 10 CFR 51 Table S-4.

Spent Fuel. Spent fuel is produced during reactor operations. The buildup of fission products and actinides, during normal operation, prevents the continued use of the fuel assembly. Spent fuel is stored at the reactor site. The average commercial pressurized water reactor generates approximately 17 yd^3 of spent fuel per year. A monitored-retrievable storage or permanent spent-fuel repository may become available in the near future. However, NRC has examined this issue and determined that licensees may, without significant impact on the environment, store spent fuel on-site for 30 years after ceasing reactor operation (55 FR 38474).

4.10.2.8 *Chemical Impacts*

Many power plants are periodically treated with biocidal chemicals (most notably some form of chlorine) to control fouling and bacterial slimes. Discharge of these chemicals to the receiving body of water can have toxic effects on aquatic organisms.

Chlorine is used widely as a biocide at commercial nuclear power plants and represents the largest potential source of chemically toxic release to the aquatic environment. Chlorine application as a cooling system biocide is typically by injection in one of several different forms, including chlorine gas or sodium hypochlorite. It may be injected at the intake or targeted at various points (such as the condensers) on an intermittent or continuous basis. Such treatments control certain pest organisms such as the Asiatic clams or the growth of bacterial or fungal slime. The control of biological pests or growth is critical to maintaining optimum system performance and minimizing operating costs.

Because of the evolution of the guidelines pertaining to chlorine and changes in biocide technologies over the past 15 years, the potential for any adverse impacts of chlorine has been decreasing. Improvements in dechlorination technologies are likely to significantly reduce the level of chlorine in the aquatic environment. Given the critical need for controlling biofouling in the cooling system, both alternative and chlorine treatment technologies are expected to keep pace with regulatory requirements.

Hazardous chemicals do not present a major health risk to personnel at commercial nuclear power plants, but they must be understood and treated carefully. Hazardous chemicals may be encountered in the work environment during adjustments to the chemistry of the primary and secondary coolant systems, during biocide application for fouling of heat removal equipment, during repair and replacement of equipment containing hazardous oils or other chemicals, insolvent cleaning, and in the repair of equipment. Exposures to hazardous chemicals are minimized by observing good industrial hygiene practices. Disposal of essentially all of the hazardous chemicals used at commercial nuclear power plants is regulated by RCRA or NPDES permits.

4.10.2.9 *Socioeconomic Factors*

Work Force. Each nuclear power plant is part of a utility that may own several nuclear power plants. An on-site staff is responsible for the actual operation of each plant and an offsite staff may be headquartered at the plant site or some other location.

In most cases, the permanent work force required to operate a nuclear power plant has been substantially smaller than the work force required to build the plant. However, there are considerable differences among U.S. nuclear power plants in terms of the size of their permanent operations-period work forces. One-unit plants average 832 workers, two-unit plants average 1,247 workers, and three-unit plants average 2,404 workers.

Commercial nuclear plants also differ in the number of nonpermanent personnel required for various types of outages during normal operating periods. The mean number of additional workers required per unit of a typical planned outage (for refueling and other routine tasks) is 783, an in-service inspection outage 734, and the largest single outage (e.g., steam generator replacement) 122. These numbers are higher (and quite possibly much higher) than the peak number of workers on-site during a single day or week. Replacement of major components, such as steam generators, can involve between 200,000 and 900,000 work hours. The duration of these shutdowns has lasted from about 8 months to almost 1 year. Less complex modifications [e.g., replacing reactor pressure vessel internal, safe ends, or recirculation pipes] require between 10,000 and 200,000 work hours. During such activities, plants have been shut down for periods of 2 to 10 months.

A substantial portion of the regular plant work force is normally involved in many of the efforts listed above, supplemented as needed by contractor personnel for support during specialized projects. Peak crew sizes are greatly affected by the specific requirements at each plant, utility decisions to make major repairs to systems and components to improve or sustain plant performance, and the relative phasing (schedule overlap) of these activities. Exact crew sizes can therefore vary widely from plant to plant.

Community. Typically, the immediate environment in which a nuclear power plant is located is rural, but the population density of the larger area surrounding the plant and the distance from a medium- or large-sized metropolitan center varies substantially across sites. Most sites, however, are not extremely remote (i.e., not more than 20 miles from a community of 25,000 or 50 miles from a community of 100,000). The significance of any given commercial nuclear power plant to its host area will depend to a large degree on its remoteness, with the effects generally being most concentrated in those communities closest to the plant. Major influences on the local communities include the plant's effects on employment, taxes, housing, offsite land use, economic structure, and public services.

The average nuclear power plant directly employs from 800 to 2,400 people, depending on the number of operating reactors, and many hundreds of additional jobs are provided through plant subcontractors and service industries in the area. In rural communities, industries that provide this number of jobs at relatively high wages are major contributors to the local economy. In addition to the beneficial effect of the jobs that are created, local plant purchasing and worker spending can generate considerable income for local businesses.

Nuclear power plants represent an investment of several billion dollars. Such an asset on the tax rolls is extraordinary for rural communities and can constitute the major source of local revenues for small or remote taxing jurisdictions. Often, this revenue can allow local communities to provide higher quality and more extensive public services with lower tax rates. In general, capital expenditures and large changes in public services are seldom necessitated by the presence of the plant and its operating workers, particularly after local communities have adapted to greater and more dynamic changes experienced earlier during plant construction.

4.10.3 Potential Impacts

The option to purchase an operating commercial power reactor or finish construction of a nearly complete commercial reactor to support the stockpile tritium requirement would have similar impacts as described in the following discussion. The reactor technologies and characteristics would be the same. However, some additional land use impacts may occur to incorporate security infrastructure and other requirements which would be needed for a DOE owned and operated tritium production facility. The potential land use impacts would result from new buffer zone requirements, new fencing, security buildings, and road access restrictions or construction of new roads. The NEPA documents prepared for the commercial reactors by the NRC would need to be supplemented under the "purchase option" to address the additional impacts expected with conversion to a DOE site dedicated to a tritium production mission.

4.10.3.1 *Completing Construction of a Commercial Reactor*

The environmental impacts of completing construction of an unfinished commercial nuclear power plant would be relative to the extent that the potential power plant has been completed by the utility. The degree of completion (percent complete) would principally affect the amount of construction materials and resources needed to finish the project, the number of construction workers, the length of construction activities, and the amount of construction waste and emissions.

Land, construction site infrastructure, and project related offsite supporting infrastructure would not be affected. Since these resources and support facilities are the first part of a major construction project they would already be in place. There would be only minor upgrades to these facilities and infrastructure to support renewed construction activities. Environmental impacts from these upgrade activities would be minor.

The following discussion of construction impacts covers a range of reactor completion (45 percent to 85 percent) based on a review of incomplete nuclear power plants in the country. The impact analysis is also generic since no specific reactor(s) has been identified as a potential candidate for this alternative. The construction period for completion is assumed to be 5 years in both scenarios.

Construction impacts would primarily be expected to result from the activities associated with finishing the permanent concreting of power plant structures and final construction of all site buildings. All remaining temporary construction facilities would be dismantled as appropriate during the completion phase and the impacted area landscaped.

The estimated construction materials and resources to finish a 45 percent and 85 percent completed nuclear power plant are shown in table 4.10.3.1–1.

The amount of materials actually used would depend on the type of reactor design, site construction conditions, and methods of construction used at a particular site.

TABLE 4.10.3.1–1.—*Estimated Total Construction Materials/Resources Consumption to Complete a Nuclear Power Plant*

Material/ Resource	85 percent complete	45 percent complete
Utilities		
Electricity (MWh)	575,000	950,000
Water (gal)	74,000,000	105,500,000
Solids		
Concrete (yd^3)	2,860	4,620
Steel (tons)	390	470
Liquids		
Fuel (gal)	2,550,000	3,300,000
Gases		
Industrial gases[a] (ft^3)	17,700	52,100

[a] Standard cubic feet measured at 1 atmosphere and 15.55 °C.
Source: TVA 1995a..

TABLE 4.10.3.1–2.—*Estimated Peak Year Construction Air Emissions From Activities to Complete a Nuclear Power Plant*

Criteria and Hazardous Air Pollutants	Quantity (tons)	
	85 percent complete	45 percent complete
Carbon dioxide (CO_2)	27.5	31.7
Hazardous air pollutants (HAP)	0.06	0.07
Nitrogen oxides (NO_x)	105.3	121.3
Particulate matter (PM_{10})	4.1	5.6
Sulfur dioxide (SO_2)	21.0	24.9
Volatile organic compounds (VOC)	3.5	4.0

Source: TVA 1995a

Construction activities would be expected to result in impacts that primarily affect air resources, socioeconomics, and waste management.

Air Resources. Completing construction of a nuclear power plant would result in air emissions from construction equipment, support facilities, and general construction activities. These emissions sources generally include diesel generators, concrete batch plants, boilers, fuel oil tanks, lube oil systems, and onsite construction vehicle traffic. Table 4.10.3.1–2 shows the estimated construction emissions during the peak construction year for the two construction scenarios. These emissions would be temporary and would not be expected to significantly affect air quality in the project site area.

Employment. Construction workforce numbers and peak workforce numbers would be dependent on the percent of completion of a nuclear power plant site. The estimated number of workers needed to complete a 45 percent or an 85 percent partially completed reactor power plant in 7 or 5 years, respectively are shown in table 4.10.3.1–3. The 45 percent reactor scenario would require more workers and higher peak number workforce than the 85 percent reactor scenario. Impacts to the local economy and area population, housing, and local services would be expected, however, the significance of these impacts can not be determined since they are site-specific. These socioeconomic impacts would be evaluated in project and site-specific NEPA documents if this alternative is selected.

In general, the direct and indirect employment resulting from the 45 percent reactor scenario would be expected to have a larger socioeconomic effect in the local area because of the overall larger worker numbers.

Because a majority of the nuclear power plant infrastructure and the power plant itself have already been completed using a much larger overall workforce and peak workforce, even the 45 percent reactor scenario socioeconomic impacts are expected to be minor.

Waste Management. Construction activities are expected to generate construction debris and other hazardous and nonhazardous wastes. Table 4.10.3.1–4 shows the estimated total waste generated during the construction phase for each reactor scenario. Typical hazardous wastes generated during the completion construction phase would include paints, solvents, acids, oils, and degreasers. All hazardous wastes would be collected and stored onsite for transport to a licensed and permitted storage treatment and disposal facility. Adverse environmental impacts from hazardous waste management would not be expected. Typical nonhazardous waste generated during the completion construction phase are shown in table 4.10.3.1–4.

Construction projects of this nature generally recover materials that can be used on other projects. Scrap treated lumber and inert construction and demolition waste (concrete, block, brick, gravel, asphalt, and gypsum board) would be collected and disposed of at an offsite permitted landfill. Construction and permanent (once installed) sanitary wastewater would be disposed of in an approved and permitted sewage treatment system. At some plants this may be an onsite facility and at others it may be the local community system. Portable toilets would be utilized as appropriate until the permanent facilities were operable. Portable toilet wastes would be disposed of by commercial vendors in an environmentally acceptable manner.

In summary, construction impacts associated with completing a commercial reactor for production of tritium would be short-term and minor with appropriate construction mitigation measures. Further site-specific analysis would be required to determine the impacts and significance of construction employment on the local community, population, housing, and local services.Purchase a Reactor or Irradiation Services

TABLE 4.10.3.1–4.—*Estimated Construction Waste Generated to Complete a Nuclear Power Plant*

Waste Category	85 percent complete	45 percent complete
Hazardous		
Solids (tons)	6.9	9.7
Liquids (tons)	62.5	87.8
Nonhazardous Solids		
Concrete (yd^3)	513	720
Steel (tons)	229	272
Other (yd^3)	27,500	75,600
Nonhazardous Liquids		
Sanitary (gal)	81,600,000	114,525,000
Flushing (gal)	1,600,000	13,000,000
Other (gal)	17,200	24,100

Source: TVA 1995a.

The following discussion of impacts applies to the commercial light water reactor alternative where DOE would purchase an existing operating or partially completed reactor and convert it to the tritium production defense mission. The discussion of impacts also applies to the commercial reactor alternative and/or contingency option where DOE would purchase irradiation services from one or more operating commercial light water reactors. Since the contingency option covers one to several reactors

TABLE 4.10.3.1–3.—*Estimated Construction Workers Needed by Year to Complete a Nuclear Power Plant*

Worker Type	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Total Craft Workers							
85 percent complete	–	375	1,035	590	60	–	–
45 percent complete	–	260	750	1,305	1505	770	30
Construction Management and Support Staff							
85 percent complete	40	325	490	445	170	–	–
45 percent complete	30	220	425	675	560	310	25
Total Employment							
85 percent complete	40	700	1,525	1,035	230	–	–
45 percent complete	30	480	1,175	1,980	2,065	1,080	55

Source: TVA 1995a.

which would encompass the purchase of a single reactor alternative, most of the discussion refers to the single reactor contingency scenario. However, the operation impacts of a DOE-owned commercial reactor would be the same.

The discussion of impacts is based on the pressurized water reactor technology and two production scenario options. The first option is the single reactor scenario in which one reactor would be loaded with sufficient DOE targets to meet weapons stockpile tritium requirements. Under this scenario, some fuel rods may be replaced with DOE target rods. The second option is the multiple reactor scenario in which several reactors (2 or more, but fewer than 10) are used in order to minimize power plant operational impacts. This scenario entails replacement of burnable poison rods (neutron-absorbing rods designed to control reactivity and power distribution in the core) with the appropriate number of DOE tritium target rods, which would have nominally the same effect on core reactivity and core power distribution over the life of the fuel cycle as the burnable poison rods, thus enabling each reactor to maintain its current power production.

Operating Baseline. Characteristics for a generic commercial light water reactor are listed in table 4.10.3.1–1. Data for each reactor characteristic is empirical and taken from individual site operation reports covering a representative calendar year (1990). Data for 12 operational reactors were used to determine a nominal average for each listed characteristic except shipped LLW and stored mixed waste per 1,000 MWe. The waste values presented are averages for all pressurized water reactors in operation in 1990 and, as such, are more representative of the reactor type as a group. The characteristics listed in table 4.10.3.1–1 were considered adequate for describing a generic commercial light water reactor.

A neutron-absorbing material called a burnable poison (typically boron-10) is used in some commercial light water reactor core designs to reduce local power density and even power distribution across the core, thereby extending the life of the fuel. Burnable poison is added to the reactor core design, either in a distributed form mixed with the uranium oxide fuel or as a discrete rod.

TABLE 4.10.3.1–1.—*Generic Commercial Light Water Reactor Operational Parameters*

Operational Parameter	Nominal Average Value
Thermal rating (MWt)	3,500
Thermal generation (MWhr)	21,000,000
Electric rating (MWe)	1,200
Electric generation (MWhr)	7,000,000
Unit availability factor (percent)	76
Water uptake (ft^3/sec)	770
Site size (acres)	6,000
Estimated population (2010) within 50-mile radius	2,000,000
Airborne tritium (Ci/yr)	1,100
All other gaseous radioactive effluent (Ci/yr)	9,200
Liquid tritium (Ci/yr)	280
All other liquid radioactive effluent (Ci/yr)	0.25
Shipped LLW (yd^3/yr)	330
Number of shipments per year	20
Stored mixed LLW/1000 MWe (yd^3/yr)	130
Total annual whole body personnel dose (person-rem)	200
Total refueling personnel annual whole body dose (person-rem)	20
Assemblies discharged	170[a]
Licensed spent fuel pool storage capacity (assemblies)	1,500
Projected date for last refueling discharge to spent nuclear fuel pool storage	2006

[a] Heavy metal content is approximately 0.43 metric tons per assembly.

Source: Tt 1994a; NRC 1985a.

The use of commercial light water reactors to irradiate DOE tritium target rods is based on the concept of replacing the boron-10 burnable poison rods with lithium-6 target rods configured to have a similar effect on power density and which, upon neutron interaction, also results in tritium production. While burnup characteristic of lithium-6 target rods may not match exactly, the substitution can be accommodated with little impact on the reactor operations. For the purpose of evaluating commercial light water reactor feasibility, targets are assumed to be of a single uniform design and lithium-6 enrichment. Symmetry to previous core designs has also been assumed. To produce current stockpile tritium requirements, about 6,000 target rods would be needed.

The commercial light water reactor would operate at its currently licensed full power for the generation of electricity while performing a secondary mission of tritium production. The rate of producing tritium is a function of power level, lithium-6 enrichment, time of operation, and target-loading density, and therefore would vary based on the specific reactor and the alternative commercial reactor production scenario option selected.

The following operational characteristics are associated with the single reactor scenario:

- One reactor loaded with sufficient DOE targets to meet current stockpile tritium requirements;
- Some fuel rods may be replaced with target rods which would require fuel disassembly to remove the target rods for tritium extraction;
- Full core refueling required, with a major reduction in attainable fuel burnup;
- Significant increases in spent nuclear fuel storage requirements are included, and may result in requirement for onsite dry storage of spent nuclear fuel;
- No effect expected on ability to attain full power, but the reactor may be limited to baseload operation with restricted rate of load change;
- Changes to plant support systems may be required; and
- Target handling tools and fixtures must be added to the complement of spent nuclear fuel pit equipment, and target packaging and transportation are added to the scope of normal utility activities.

The following operational characteristics are associated with the multiple reactor scenario:

- For analysis purposes, consists of eight reactors deployed to the tritium supply mission;
- Replacement of burnable poison rods with the appropriate number of DOE target rods to yield approximately the same effect on core reactivity and core power distribution over the life of the fuel cycle;
- No effect on core design, refueling cycle durations, or spent fuel storage requirement; however, some tradeoffs involving fuel enrichment and cycle burnup may arise in optimizing the fuel management strategy;
- No effect on normal operation, including plant maneuvering capability or mode change restrictions;
- Few or no changes to plant support systems would be required; and
- Target-handling tools and fixtures must be added to the complement of spent fuel pit equipment, and target packaging and transportation are added to the scope of normal utility activities.

In the multiple reactor scenario the number of fuel rods and the performance requirements imposed on the fuel would not be changed. However, to minimize fuel cycle impacts in the multiple reactor scenario, it would be desirable to extend the design life and qualification of the DOE target rod to envelope the longest fuel cycle commonly used in a commercial light water reactor. Qualification for extended use is not a necessary condition to the feasibility of the concept, since the single reactor scenario does not require it.

The single reactor scenario represents the largest number of DOE target rods inserted into a reactor, the highest tritium content, and the largest perturbation to the existing safety analysis of the plant. Insertion of the necessary number of DOE target rods to produce current tritium requirements in a single reactor results in the replacement of approximately 15 percent of the fuel rods in a large reactor with a 17x17 matrix of rods per assembly. It is technically feasible to increase the average heat generation in the remaining fuel rods to compensate for this amount of replacement of fuel rods by DOE target rods without jeopardizing the plant's ability to operate at full-power.

The use of a commercial reactor or multiple reactors for producing tritium would result in additional environmental impacts from the changes in the reactor operational characteristics (table 4.10.3.2–1) due to the introduction of DOE target rods. Impacts would most likely result from core changes, personnel requirements, effluent, waste, spent fuel, operational variances (radiation exposure), and transportation/handling. Impacts from these seven factors are discussed in general terms based on a "typical" nonsite-specific commercial light water reactor. Table 4.10.3.2–2 shows the incremental changes. Impacts on all other environmental resources from the commercial reactor alternative were negligible or not expected, and therefore are not discussed in detail.

Core Changes. Production of tritium in a commercial light water reactor would require physical changes to the reactor core, which could range from replacement of burnable poison elements with DOE target elements to the replacement of fuel rods with DOE target assemblies. Core changes could alter the accident basis and would modify the source term. The estimated additional core tritium content in curies per reactor at the end of the irradiation period would be 3.2×10^7 for a single reactor. Because of the reduced burn up in the reactor core, the total fission products in each fuel rod would decrease. Using multiple reactors to produce the same quantity would reduce the curies of tritium per reactor.

Personnel Requirements. The added requirements to execute DOE target handling and shipping activities would be expected to create new job tasks and require that additional personnel be hired at the commercial reactor site. An estimated 72 additional personnel would be needed for a typical commercial nuclear power facility. The additional personnel would represent an increase of approximately 9 percent for a single reactor. The number of personnel would be smaller for each commercial reactor site if multiple reactors were used. In the case of a single reactor, it is assumed that one work crew would handle 12 DOE tritium target shipments per year, with each shipment containing about 500 target rods. The work crew would include fuel pool workers to remove and package the target tritium rods from the fuel assemblies. Assuming multiple reactors, no manpower increases would be anticipated during refueling. The preparation of the DOE targets for shipment would require a single crew at one work station for each reactor. Shipments would include 500 targets each and would be handled by a single crew covering all reactors. Three crews of fuel pool workers could handle all reactors.

Effluent. Because of the addition of DOE target rods, airborne and water-borne effluent would be expected to change (particularly for tritium). Estimates for expected increases of gaseous tritium effluent range from 5,740 Ci per year for a single reactor to 3,680 Ci per year in the multiple reactor scenario. Estimated increases of liquid tritium effluent ranges from 1,460 Ci per year for a single reactor to 935 Ci per year per reactor in the multiple reactor scenario. For a single reactor, the release of fission products to the reactor coolant could be expected to significantly decrease because the fission product inventory is lower due to the lower average fuel assembly burn up, and the fuel element failure rate is lower due to the shorter residence time in the core (FDI 1994i). However, there would be a net 5-percent increase in rod surface areas that would come into contact with the coolant. This would proportionately increase the reactor "crud" that accumulates on rod surfaces and could lead to a 5-percent increase in the neutron activation products that enter into the coolant.

Waste. Additional activities associated with the handling, processing, and shipping of DOE target assemblies would be expected to increase waste generation rates at the commercial reactor site. Of the 330 yd^3 of LLW shown in table 4.10.3.1–2, 159 yd^3 is dry compacted and 93 yd^3 is dry noncompacted. It is assumed that 50 percent of the dry waste is considered to be related to refueling outages and maintenance and that this waste quantity (126 yd^3) would increase proportionately with the increase in refueling activities. An estimated 164 yd^3 per year of LLW per reactor would be expected. This would be approximately a 50-percent increase for a typical plant. No increase in mixed waste generation would be anticipated.

TABLE 4.10.3.1–2.—*Commercial Light Water Reactor Operational Parameter Changes From Tritium Production* [Page 1 of 2]

Parameter	No Action				Alternative Scenarios	
	Typical Plant	Average Value	Low Value	High Value	Single Reactor Case	Multiple (2) Reactor Case
Core Changes[a]						
Nuclide (curies per reactor)						
H-3	NA	NA	NA	NA	$3.2x10^7$	$1.6x10^7$
Fission products	NA	NA	NA	NA	-50 percent[b]	-50 percent[b]
Personnel[c]						
Reactors (per utility site)						
1 unit	832	NA	NA	NA	72	127
2 units	1,247	NA	NA	NA	NA	100
3 units	2,404	NA	NA	NA	NA	100
Expected refueling cycle	NA	NA	NA	NA	12 months	12 months
Effluent						
Isotope (curies/year/reactor)[d]						
Tritium (gaseous)	NA	1,100	NA	NA	5,740	3,680
Tritium (liquid)	NA	280	NA	NA	1,460	935
Waste						
Waste type (yd^3/year/reactor)						
Low-level waste	330	NA	NA	NA	160	160
Mixed	130	NA	NA	NA	0	0
Operational Variances - Refueling Personnel						
Job Category (person-rem/reactor)						
Maintenance	NA	14.7	0	76.5	19.1	19.1
Operations	NA	1.3	0	5.3	1.7	1.7
Health physics	NA	4.7	0	16.7	6.1	6.1
Supervisory personnel	NA	0.6	0	1.2	0.8	0.8
Engineering	NA	2.1	0	8.7	2.7	2.7
Total	NA	23.4	0	107.0	30.4	30.4
Operational Variances - All Personnel						
Job Category (person-rem/reactor)						
Maintenance	NA	127.1	39.4	459.2	24	12
Operations	NA	11.4	2.1	39.4	9.1	4.6

TABLE 4.10.3.1–2.—*Commercial Light Water Reactor Operational Parameter Changes From Tritium Production* [Page 2 of 2]

Parameter	No Action				Alternative Scenarios	
	Typical Plant	Average Value	Low Value	High Value	Single Reactor Case	Multiple (2) Reactor Case
Health physics	NA	29.4	11.5	58.5	9	4.5
Supervisory personnel	NA	6.0	0.3	19.7	1	2.7
Engineering	NA	17.6	3.3	51.2	5.4	24.2
Total	NA	191.5	69.8	541.4	48.3	48
Spent Fuel						
Spent Fuel (fuel assemblies/yr/reactor)						
Total assemblies	56[e]	NA	NA	NA	137	137
Dry storage assemblies	56	NA	NA	NA	137	137
Wet storage assemblies	0	NA	NA	NA	0	0

[a] This data represents the total radioactive material at risk and not the source term. The source term is calculated by applying a release fraction to the material at risk.

[b] The single reactor case involves reduced cycle length and full core discharge at the end of each cycle. Therefore, the equilibrium burnup for the average fuel assembly would decrease by more than 50 percent.

[c] Personnel requirements are given in total numbers for all units participating in the option.

[d] Design-basis values from NRC 1985a.

[e] Heavy metal content is approximately 0.43 metric tons per assembly.

Note: NA - not applicable.

Source: DOE 1995y.

The amount of LLW requiring disposal would increase by approximately 160 yd^3. LLW treatment and storage facilities may not be adequate to accommodate the 50 percent increase over the 330 yd^3 per year handled by a typical commercial pressurized light water reactor. Thus, depending on the selected site, expansion of existing or construction of new facilities may be required. The LLW due to DOE activities could be shipped to an approved LLW disposal facility such as NTS or through a memorandum of agreement it could be shipped using the existing shipment practices of the site selected. The small increases in hazardous and nonhazardous wastes could be accommodated within existing facilities.

In the multiple reactor scenario, there would be a smaller increase in the generation of spent nuclear fuel, LLW, or mixed LLW. However, since LLW generated by burnable poison rod assemblies is being replaced by LLW generated by DOE target rod assemblies, the amount of LLW going to a commercial LLW disposal site could even decrease. The LLW generated by the DOE target rod assemblies could be shipped to an approved LLW disposal facilities such as NTS, or through a Memorandum of Agreement it could be shipped using the existing shipment practices of the site selected. The small increases in hazardous and nonhazardous wastes could likely be accommodated within existing facilities.

Spent Nuclear Fuel. More frequent refueling operations and the segmenting of fuel assemblies could result in an increase in spent nuclear fuel volumes. This increase could result in additional requirements for wet and dry storage space at the reactor site. With the single reactor case, 137 additional spent fuel assemblies (40 yd^3, assuming 8 ft^3/assembly) would be generated each year. This amounts to approximately 58 metric tons of heavy metal. This represents more than a 3-fold increase over the average of 56 assemblies (24 metric tons of heavy metal) for a typical pressurized commercial light water reactor. Because existing spent nuclear fuel storage capacities are limited, additional spent nuclear fuel storage might be required. The additional storage space needed for 40 years of storage at this rate of accumulation is estimated to be 2.6 acres. If dry storage facilities were constructed, there is adequate capacity for an 8-year wet storage. No increase in spent nuclear fuel is expected with the multiple reactor scenario. The change to 12-month refueling cycles with full core discharge would accelerate the consumption of available spent nuclear fuel pool storage and would require earlier use of additional storage alternatives such as dry storage at some commercial reactor sites.

Operational Variances. New DOE target assembly process activities and, in some cases, more frequent refueling-type operations would be expected to increase radiation exposure for some categories of workers. Estimates for expected increases of exposure for refueling personnel range from 19 person-rem per reactor for maintenance workers to less than 1 person-rem for supervisory personnel. In addition to refueling operations, three other areas of exposure would be anticipated to be associated with the DOE tritium targets. These areas are waste operations, fuel pool work, and target shipments. The increase in person-rem per reactor for all personnel ranges from 24 for maintenance workers to 1 for supervisory personnel. The more reactors used to produce the tritium, the smaller the increase in person-rem per reactor.

Transportation/Handling. All commercial reactors in the United States are of the light water reactor design, thus the same criteria for assessing transportation risk can be used. Irradiated target rods would be removed from fuel assembly bundles and shipped in NRC-approved, Type B fuel assembly shipping casks by truck, via a routing that conforms with 49 CFR to SRS where the tritium would be extracted. Some additional risk would be expected to be incurred due to the transport of these elements.

Shipping tritium-bearing targets from the commercially designed N-Reactor at the Hanford site to SRS was routinely carried out in the 1960s. Historically, DOE has shipped more than 50,000 1-foot tritium targets from Hanford to SRS in casks without a radiological release accident. Approximately 18,000 irradiated targets could be transported yearly from the commercial reactor site to the DOE extraction facility.

A tritium target, called a "pencil", is a unit that is less than 1 inch in diameter and approximately 1 foot (0.3 meters) long. The target is made of ceramic (lithium aluminate) to trap the tritium within the boundaries of the ceramic. There is usually free gas present; therefore, the ceramic is either encased in an aluminum can, or is surrounded by a nickel-plated zircaloy-4 "getter" (barrier) to absorb and retain tritium during irradiation. Of the two designs, the "getter-barrier" target design was recommended by the Light Water Reactor Tritium Target Development Project as the most practical for use in a light water reactor.

A tritium target rod is an assembly of up to 12 target pencils placed in a stainless steel sleeve (cylindrical column) 150 inches (3.8 meters) long. The number of rods in a reactor depends on the neutronics of the reactor. The target rods would be removed from the reactor approximately every 12 months. In the past, only the pencils were shipped during N-Reactor tritium production at Hanford. However, for assessing risk in this PEIS, it is assumed that full-length target rods would be transported in order to eliminate the need for additional facilities and handling at the commercial reactor site and to move extraneous radioactive target rod material to a DOE site.

Assuming that an inventory of 500 target rods would be accumulated for shipment at one time in NRC-approved fuel assembly shipping casks, and one cask per transport truck, approximately 12 shipments per year would occur. The curie content per truck would be approximately $2.7x10^6$. No additional loading, unloading, or handling facilities would be required at the commercial reactor site because provision for shipment of spent fuel is already within the design of these facilities.

Radiological Impacts

Normal Operations. The impact from adding tritium targets to a commercial reactor would vary depending on the reactor type, reactor site location, and the number of sites involved in the tritium production mission. The maximum impacts at a given site would occur if all of the tritium were produced at that site. The impacts would lessen at a given site if multiple sites are used.

Considering that the arithmetic mean annual radiation dose to people who lived within a 50-mile radius of a commercial nuclear power plant in 1991 was about 1.2 person-rem (0.25 and 0.95 person-rem from airborne and liquid releases, respectively) and the median was less than 0.2 person-rem (NUREG/CR-2850), impacts of normal operation from tritium production are expected to be less than the NESHAPS 10 mrem limit for atmospheric releases and less than the drinking water limit of 4 mrem. It is estimated that the changes in radioactive releases associated with the production of tritium in a single reactor would result in an annual dose increase of 0.51 person-rem to the 50-mile population. This would result in a calculated increase of 0.010 fatal cancer in this population as the result of 40 years of reactor operation. There would be a slightly larger increase in the total number of fatal cancers in the several population groups for the multiple reactor scenario compared with the single reactor, but the risk to an individual member of the public would be less because of the larger number of people exposed.

The estimated probability of accidents occurring during transportation, derived from DOE and DOT empirical data bases, and the upper bound additional exposures (50-year committed effective dose equivalent) that might be experienced as a result of transporting target rods, were used to estimate radiological consequences of a transportation accident. Factors considered in the analysis included historical accident rates; optimum routes via interstate highways; rural, suburban, and urban population densities along the route; and national meteorological atmospheric dispersion parameters incorporated in DOE's RADTRAN transportation risk computer code (FDI 1994i:16).

Table 4.10.3.2–3 shows the estimated population dose risk in person-rem/yr from radiological accidents during transportation from a single site to SRS. The values are based upon 12 shipments of irradiated target assemblies being transported per year and conservatively assumes that in any truck accident 100 percent of the irradiated target assemblies would be released into the environment as tritiated water with no plume drop-out. Shipments from geographically diverse locations could incur some smaller average of the values shown.

TABLE 4.10.3.2–3.—*Radiological Consequences of Transportation Accidents Shipping Tritium Target Rods*

Reactor Site Origin	Total Shipping Distance (miles)	Population Dose Risk (person-rem per year) Total
Eastern	1,110	0.061
Midwest	895	0.049
Western	2,750	0.15

Source: DOE 1995y.

Facility Accidents. Based upon the tests and analyses that have been performed for WNP-1, it is unlikely that there is any target-related design-basis accident or anticipated abnormal occurrence that significantly impacts or adds significant uncertainties to safety issues involved with the use of tritium target rods in commercial light water reactors (FDI 1994j). Although a complete safety evaluation remains to be accomplished, it appears that no new significant safety hazard is introduced as a result of a decision to produce tritium in a commercial light water reactor core (FDI 1994i). The accident consequences for the commercial light water reactor tritium target extraction facility highest consequence accident are bounded by the accident consequences for the tritium recycling facility at SRS.

4.10.4 Institutional Issues

Because commercial reactors are highly regulated, civilian, non-defense related facilities, the potential use of a commercial reactor for tritium production raises several issues unique to the commercial reactor alternative. Before a commercial reactor could be used to produce tritium, these "institutional" issues would need to be fully explored. Generally, institutional issues can be grouped under four major categories: Statutory, Policy, Licensing, and Economic Regulation. A brief description of each category follows:

Statutory Issues. A comprehensive statutory review would address the issue of whether there are any statutory prohibitions to the use of commercial reactors for tritium production. Initial reviews indicate that there are none.

Policy. The United States has traditionally separated defense nuclear activities from commercial nuclear activities, and civilian reactors have never before been given roles that directly support nuclear weapon needs. A comprehensive review would address the issue of whether the use of commercial reactors for tritium production would violate national policy, treaties, and weapons non-proliferation initiatives.

Licensing. Commercial reactors are regulated by the Nuclear Regulatory Commission. Changes to specific conditions of a commercial reactor's license or technical specifications including potential transfer or termination of an existing license, would require Nuclear Regulatory Commission (NRC) review and approval prior to implementing the changes. A comprehensive review would address the issue of NRC regulation and licensing.

Economic Regulation. Commercial reactors are also regulated by economic regulators such as State Public Utility Commissions (PUC) or the Federal Energy Regulatory Commission (FERC) regarding economic factors. A comprehensive review would address the issue of economic and financial considerations associated with the production of tritium in commercial reactors.

The Draft PEIS contained a brief discussion of specific issues in each of these areas associated with the potential use of commercial reactors to make tritium. However, the Department believes that it is premature to reach any conclusions regarding these issues without additional investigation. If the preferred alternative identified in Section 3.7 were selected in the Record of Decision, the Department would, in addition to other technical work, resolve these institutional issues for the commercial reactor alternative over the next two to three years before selection of the primary option.

4.11 Producing Tritium at an Earlier Date

This PEIS evaluates alternative tritium supply technologies against the baseline tritium requirement to support the 1994 *Nuclear Weapons Stockpile Plan*, which is based on a stockpile level consistent with START II of approximately 3,500 accountable weapons. Based on this requirement, a new tritium supply facility would be needed by 2011, and the amount of tritium produced would support both the steady-state requirement to make up for the tritium lost through natural decay while also allowing for a surge capability to replace any tritium that might be used in the event the Nation ever dipped into, or lost, its tritium reserve. Potential environmental impacts of locating tritium supply and recycling facilities at the five candidate sites are discussed in sections 4.2 through 4.6 of the PEIS for the START II stockpile level. For these analyses, construction periods range from 5 to 9 years, peak construction occurs in the year 2005, and full operations begin in the year 2010. In these sections, the environmental impacts of producing both the steady-state and surge tritium requirements are analyzed.

While a START II stockpile level represents a reasonable basis against which to evaluate tritium supply alternatives, it is possible that the START II Treaty may not be ratified. If that were to occur, a larger stockpile level could represent the future baseline. To support a stockpile level consistent with START I, new tritium would be needed in approximately 2005. The amount of tritium needed to make up for the natural decay of a stockpile level consistent with START I would be approximately equal to the amount of tritium needed to make up for the natural decay of a START II level stockpile plus the START II surge capability. This section addresses the environmental impacts of providing a new tritium supply facility to support a larger stockpile.

Because operations to support a START II level stockpile and make up for any lost tritium reserves essentially equals the steady-state tritium requirements for a stockpile level consistent with START I, the environmental impacts of operating tritium supply facilities to support the larger stockpile level have already been addressed in sections 4.2 through 4.6 of the PEIS. The only difference in environmental impacts would result from changing the period of operation from 2010-2050, to 2005-2045. While there would be greater technical risks associated with bringing a new tritium supply facility on line by 2005, this issue is addressed in the technical risk studies, not the PEIS. Additionally, the fact that tritium supply facilities would be limited in their ability to provide a surge supply of tritium for a larger stockpile level is also addressed in the technical risk studies.

For the most part, the construction impacts to meet an earlier tritium requirement date would be similar to those discussed in sections 4.2 through 4.6 of this PEIS. Because of the need to compress the construction schedule to meet a 2005 operation date, short-term increases in air emissions and construction vehicle traffic over those discussed in sections 4.2 through 4.6 would be expected. All other construction related impacts would be similar to those described in the PEIS except for the socioeconomic impacts associated with the increase in peak workforce due to the compressed schedule. The remainder of this section discusses the potential impacts on socioeconomics for the compressed construction period at each of the candidate sites.

In order to meet tritium requirements for a larger stockpile level, a new tritium supply technology and recycling would have to be constructed in 4 years, tested for 1 year, and at full operation by the year 2005. Under this scenario, construction would begin in the year 2000, peak in 2002, and end in the year 2003. Operations personnel would begin testing in the year 2004 and full operation would begin in 2005. Although the operation of the tritium supply and recycling facility would begin earlier than under START II protocol, the same operation workforce would be needed and the total employment (direct and indirect) created at each of the sites would be the same as under START II. Consequently, the effects that any of the tritium supply technologies and recycling would have on the socioeconomic environment during operation at each of the sites would be the same as those described in sections 4.2.3.8 through 4.6.3.8. The effects of an accelerated construction schedule to meet a larger stockpile level tritium requirements would, however, be different.

Under the accelerated construction schedule, the number of direct and indirect jobs (total employment) created by a tritium supply technology and recycling would be the same as under START II construction requirements. However, the rate at which these jobs would be created would be faster than under the longer START II construction schedules. The rate of growth for total employment, in-migration, housing demand, and the effects on public finance vary depending upon the socioeconomic environment surrounding each of the candidate sites and are discussed in the following sections. Locating a tritium supply technology alone would have fewer effects than if collocated with recycling at any one of the candidate sites.

Idaho National Engineering Laboratory

Siting a tritium supply technology and recycling to meet a 2005 operation date would increase total employment at an annual average rate of 3 to 4 percent until the peak year of 2002. Between peak construction (2002) and full operation (2005) total employment would decline at an annual average of 1 or 2 percent. Population and housing would exhibit similar trends. Local governments could experience annual growth in revenues and expenditures ranging from 2 to 8 percent between 2000 and 2002, and then decline annually by 1 to 2 percent from peak construction to operation. The ALWR would have the greatest effects on socioeconomics in the region surrounding the site. The other tritium supply technologies would have similar effects on the ROI, but these would be less than the ALWR.

Nevada Test Site

Siting a tritium supply technology and recycling to meet a 2005 operation date would increase total employment at an annual average rate of 1 to 1.5 percent until the peak year of 2002. Between peak construction (2002) and full operation (2005) total employment would decline at an annual average of 1 to less than 1 percent. Population and housing would exhibit similar trends. Local governments could experience annual growth in revenues and expenditures ranging from 1 to 1.5 percent between 2000 and 2002, and then decline annually by 1 to less than 1 percent from peak construction to operation. The ALWR would have the greatest effects on socioeconomics in the region surrounding the site. The other tritium supply technologies would have similar effects on the ROI, but these would be less than the ALWR.

Oak Ridge Reservation

Siting a tritium supply technology and recycling to meet a 2005 operation date would increase total employment at an annual average rate of 1 to 1.5 percent until the peak year of 2002. Between peak construction (2002) and full operation (2005, total employment would decline at an annual average of 1 to less than 1 percent. Population and housing would exhibit similar trends. Local governments could experience annual growth in revenues and expenditures ranging from 1 to 1.5 percent between 2000 and 2002, and then decline annually by 1 to less than 1 percent from peak construction to operation. The ALWR would have the greatest effects on socioeconomics in the region surrounding the site. The other tritium supply technologies would have similar effects on the ROI, but these would be less than the ALWR.

Pantex

Siting a tritium supply technology and recycling to meet a 2005 operation date would increase total employment at an annual average rate of 2 to 3.5 percent until the peak year of 2002. Between peak construction (2002) and full operation (2005) total employment would decline at an annual average of 1 to 2 percent. Population and housing would exhibit similar trends. Local governments could experience annual growth in revenues and expenditures ranging from 2 to 6 percent between 2000 and 2002, and then decline annually by 12 to 2 percent from peak construction to operation. The ALWR would have the greatest effects on socioeconomics in the region surrounding the site. The other tritium supply technologies would have similar effects on the ROI, but these would be less than the ALWR.

Savannah River Site

Siting a tritium supply technology and recycling to meet a 2005 operation date would increase total employment at an annual average rate of 1 percent until the peak year of 2002. Between peak construction (2002) and full operation (2005) total employment would decline at an annual average of less than 1 percent. Population and housing would exhibit similar trends. Local governments could experience annual growth in revenues and expenditures ranging from 2 to 8 percent between 2000 and 2002, and then decline annually by 1 to 2 percent from peak construction to operation. The ALWR would have the greatest effects on socioeconomics in the region surrounding the site. The other tritium supply technologies would have similar effects on the ROI, but these would be less than the ALWR.

4.12 Unavoidable Adverse Environmental Impacts

Siting, construction, and operation of tritium supply and recycling facilities at INEL, NTS, ORR, Pantex, or SRS would result in adverse environmental impacts. The impact assessment conducted in this PEIS has identified these potential adverse impacts along with mitigative measures that could be implemented to either avoid or minimize these impacts. The residual adverse impacts remaining following mitigation are unavoidable and the worst case impacts of all alternatives at all candidate sites are discussed below.

At each of the candidate sites, up to 562 acres of land could be disturbed to construct and operate the new tritium supply and recycling facilities and additional supporting infrastructure and access roads. Loss of habitat in the disturbed area would be unavoidable.

Land requirements would represent 2 percent or less than the total area of all sites except for Pantex, which represents approximately 4 percent. Soil erosion in the disturbed area due to wind and stormwater runoff would be minor. Small areas of potential wetlands could be unavoidably impacted, but mitigation measures approved by the U.S. Corps of Engineers would be implemented. Construction of both the MHTGR and APT would require deep excavations resulting in removal of a large volume of soil and dewatering operations. Reuse of this soil as fill and treatment of dewatering effluent would mitigate much of this adverse impact.

Cooling towers associated with evaporative cooling systems for the HWR, MHTGR, and ALWR at ORR and SRS would impact visual resources through their physical structure and vapor plumes which are visible during certain atmospheric conditions. Construction of tritium supply and recycling facilities would affect the visual character near the proposed TSS at NTS, ORR, or SRS. Generally there would be no change in the overall appearance from key viewpoints with high sensitivity levels, except at ORR. Modifications to the electrical power infrastructure may be required for certain alternatives to provide the additional electric load capability required to support the tritium missions.

Construction and operation of tritium supply and recycling facilities would generate criteria and toxic/hazardous pollutants that have the potential to exceed Federal and state ambient air quality standards and guidelines. Concentrations of PM_{10} and total suspended particulates are expected to be close to or exceed the 24-hour ambient PM_{10} and TSP standards during peak construction periods under dry and windy conditions. Such exceedances are not uncommon for large construction projects. Air pollutant concentrations during operation would be greater than No Action concentrations, but are expected to remain within Federal and state ambient air quality standards.

For each of the technologies considered, use of water for cooling system requirements is unavoidable and could represent an adverse impact depending on the site. The maximum amount of surface water required for tritium facility operation would be about 16,014 MGY at ORR; and the maximum total site groundwater requirement at SRS would be 90 MGY. Cooling system water used at ORR and SRS would be taken from the Clinch River and Savannah River, respectively. There would be some unavoidable impact to aquatic biota from the loss of fish, larvae, and fish eggs due to entrainment and impingement at water intakes. Increased turbidity during construction activities could impact some fish spawning and feeding habitat. It is expected that this loss would be small in comparison with resident fish populations and reproductive capabilities. At sites where cooling water comes from groundwater, the maximum amount of water withdrawn for tritium supply and recycling operation is about 1,214 MGY for the APT alternative.

Cooling system blowdown activities discharge great quantities of water to surface waters over short-duration periods (e.g., 26 million gallons over a one hour period, once a day). This blowdown without mitigation would increase stream velocity, causing scouring of stream beds, erosion of stream channels, increased turbidity, resuspension and deposition of contaminated sediments in downstream areas, and potential flooding of areas at either ORR or SRS. Without mitigation, blowdown discharges could (1) alter the aquatic ecosystem by displacing existing plant and animal communities, (2) exceed water quality standards or NPDES discharge requirements, or (3) result in thermal impacts.

Federal-listed threatened or endangered species, such as the desert tortoise, bald eagle, short-nosed sturgeon and wood stork, could be affected directly or by disruptions to benthic and foraging habitats during construction and operation of tritium supply and recycling facilities. Several candidate or state-listed animal species and special status plant species may also be affected at different sites. Where potential conflicts occur, mitigation measures would be developed in consultation with the USFWS. While such disruptions may be unavoidable, appropriate measures would be implemented and monitored to ensure that any impacts are not irreversible. Construction of new facilities would have some adverse unavoidable effects on animal populations. Larger mammals and birds would move to similar habitats nearby, while less mobile animals within the project areas, such as amphibians, reptiles and small mammals, would be destroyed during land-clearing activities. Drift from cooling towers for reactors at ORR and SRS may cause some unavoidable salt deposition on surrounding land areas and vegetation at or near the tritium supply site at a rate at which salt stress symptoms could become evident on sensitive plants.

Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area at each candidate site. The appropriate State Historical Preservation Officers would be consulted to minimize unavoidable adverse impacts. Native American resources may be unavoidably affected by land disturbance and audio or visual intrusions on Native American sacred sites or due to reduced access to traditional use areas. DOE would consult with the affected tribes to minimize any impacts.

With the onset of construction and operation of tritium supply and recycling facilities, the site and regional population would increase by as much as 13,700 during construction of an ALWR at NTS or 5,500 during full HWR and MHTGR operation at NTS. Population and housing could increase in the NTS total ROI by 2 percent during construction and less than 1 percent during operation. There would be an associated increased burden on community infrastructure while subsequent effects on the public finances of local governments in the region of influence would be for the most part positive. An increase in vehicle traffic associated with construction and operation of tritium supply and recycling facilities would affect the roads and transportation network surrounding some of the candidate sites. The resulting impacts in traffic, congestion, and road accidents resulting from socioeconomic growth is unavoidable, but can be reversed. For example, site access roads which are degraded during construction can be upgraded beyond their original condition to accommodate increased worker traffic.

Some amount of radiation would be released unavoidably by normal tritium supply and recycling operations. The greatest radiation dose to the maximally exposed member of the public would be 8.8 mrem per year from atmospheric releases and 14 mrem from liquid releases at ORR. The associated risk of fatal cancers from 40 years of operations with these doses is $4.6x10^{-4}$. The greatest annual population dose from total site operations through the year 2030 is 340 person-rem which occurs at SRS; such a total dose would result in 6.8 fatal cancers over the entire 40 years of operations. The largest average annual dose to a site worker is 140 mrem at NTS and would result in an associated risk of fatal cancer of $2.3x10^{-3}$ from 40 years of operations. The greatest annual dose to the total site workforce is 650 person-rem occurring at SRS and would result in 10 fatal cancers over 40 years of operations.

Since hazardous and toxic chemicals are present during construction and operation of tritium facilities, worker exposure to these chemicals is unavoidable. The maximum hazard to site workers, based solely on emissions of hazardous chemicals, is represented by a HI of 1.8 at SRS, which exceeds the OSHA action level of 1.0. Cancer risks to the public and site workers are $3.3x10^{-5}$ and $5.9x10^{-3}$ respectively; both values exceed the typical acceptable standard of $1.0x10^{-6}$. The use of remote, automated, and robotic production methods are being developed to reduce this worker exposure. Substitution of less toxic solvents would also result in reductions of the hazard index and possible complete elimination of the cancer risk. Other mitigative and protective measures would minimize this expected exposure to hazardous and toxic chemicals.

Spent nuclear fuel would be generated as an unavoidable result of reactor operations to produce tritium. Each of the candidate sites would require construction of a new spent fuel storage facility. Although each site would implement waste minimization techniques, generation of additional low-level, hazardous and nonhazardous wastes is unavoidable. Any introduction of new waste types could be an adverse impact since treatment, storage, and disposal facilities may have to be developed and permitted to deal with certain new types of wastes. In addition, the generation of additional LLW would require a new treatment facility for liquid waste at Pantex and a new staging facility for solid LLW, prior to offsite shipments to NTS. Generation of additional hazardous or mixed wastes could require expansion of existing or planned treatment, storage, and disposal facilities for these wastes at some sites. Generation of additional nonhazardous wastes may also require expansion of existing, or construction of new, liquid and solid waste treatment facilities or reduce the lifetimes of current solid waste landfills.

4.13 Relationship Between Local Short-Term Uses of the Environment and the

Maintenance and Enhancement of Long-Term Productivity

The use of land on any of the five candidate sites being considered for tritium supply and recycling facilities would enhance the long-term productivity of each site in two ways. First, tritium missions represent a long-term production function compatible with historic nuclear weapons support and requires a skilled and stable workforce. Second, since existing facilities do not have the capability to produce the required amounts of tritium, construction of new, modern tritium supply facilities would enhance the long-term productivity of the selected site.

Each alternative requires the use of additional land for additional disposal of radiological and hazardous materials. Such short-term usage would remove this land from other beneficial uses indefinitely because of the presence of long-lived hazards. Disposal of solid nonhazardous waste generated from tritium supply and recycling facilities construction and operations would require additional land at onsite sanitary landfills. Solid nonhazardous waste generated from these facilities would continuously require additional land at a sanitary landfill site which would be unavailable for other uses in the long term. LLW would require additional space for onsite storage and waste processing and would involve the commitment of associated land, transportation, processing facilities, and other disposal resources. Creation of waste disposal facilities allows the site to be productive for the long-term by protecting the overall environment and complying with Federal and state environmental requirements.

Construction of a tritium supply and recycling facility at NTS would require short-term resource uses which could compromise long-term productivity. The range of the endangered desert tortoise lies in the southern one-third of NTS. The proposed TSS is located near one of the areas on NTS having a relatively high number of desert tortoises compared to the rest of the site. Construction and operation of tritium facilities could pose a threat to both individual tortoises and their habitat. Measures designed to avoid impacts to the desert tortoise from previous projects at NTS have been implemented with mitigation measures developed in consultation with USFWS.

Losses of other terrestrial and aquatic habitats from natural productivity to accommodate new facilities and temporary disturbances required during construction of these facilities are possible. Land clearing and construction activities resulting in large numbers of personnel and equipment moving about an area would disperse wildlife and temporarily eliminate habitats. Although some destruction would be inevitable during and after construction, these losses would be minimized by site selection and thorough environmental reviews at the project-specific level. In addition, short-term disturbances of previously undisturbed biological habitats from the construction of new facilities could cause long-term reductions in the biological productivity of an area. These long-term reductions could occur, for example, at facilities located in arid areas of the western United States such as at INEL and NTS, where biological communities recover very slowly from disturbances. Additional nuclear operations at SRS and ORR could affect wetlands habitat and aquatic biota because of cooling water withdrawals and thermal effluent discharges. These impacts could be mitigated by avoiding sensitive areas, reducing water withdrawals, and reducing the temperature of thermal discharges through the use of cooling towers.

Phasing out the tritium recycling activities at SRS offers the possibility of restoring existing facilities at that site to another purpose. Environmental restoration activities could have minor or short-term impacts similar to those normally associated with construction activities, such as habitat disturbance and soil erosion. If contaminated structures were removed and site areas restored to a natural state, these areas could provide improved conditions for the long term.

4.14 Irreversible and Irretrievable Commitments of Resources

This section describes the major irreversible and irretrievable commitments of resources that can be identified at this programmatic level of analysis. A commitment of resources is irreversible when its primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources neither renewable nor recoverable for later use by future generations.

The tritium supply and recycling facility proposal was initiated to ensure a continuing and secure supply of tritium for the Complex. As such, the programmatic decisions resulting from this PEIS will ensure the commitment of resources to new construction and renovation of tritium facilities at locations in line with the future workloads and long-range nuclear weapons production strategy. This section discusses three major resource categories that are committed irreversibly or irretrievably to the proposed action: land, materials, and energy.

Land Use. The land that is currently occupied by, or designated for, future tritium supply and recycling facilities, could ultimately be returned to open space uses if buildings, roads, and other structures were removed, areas cleaned up, and the land revegetated. Alternatively, the facilities could be modified for use in other nuclear programs. Therefore, the commitment of this land is not necessarily irreversible.

However, land rendered unfit for other purposes, such as that set aside for radiological and hazardous chemical waste disposal facilities, represents an irreversible commitment because wastes in below-ground disposal areas may not be completely removed at the end of the project. The land could not be restored to its original condition or to minimum cleanup standards, nor could the site feasibly be used for any other purposes following closure of the disposal facility. This land would be perpetually unusable because the substrata would not be available for other potential intrusive uses such as mining, utilities, or foundations for other buildings. However, the surface area appearance and biological habitat lost during construction and operation of the facilities could to a large extent be restored.

Material. The irreversible and irretrievable commitment of material resources during the entire life-cycle of tritium facilities includes construction materials that cannot be recovered or recycled, materials that are rendered radioactive but cannot be decontaminated, and materials consumed or reduced to unrecoverable forms of waste. Where construction is necessary, materials required include wood, concrete, sand, gravel, plastics, steel, aluminum, and other metals. At this time, no unusual construction material requirements have been identified either as to type or quantity. The construction resources, except for those that can be recovered and recycled with present technology, would be irretrievably lost. However, none of these identified construction resources is in short supply and all are readily available in the vicinity of locations being considered for new facilities. The commitment of materials to be manufactured into new equipment that cannot be recycled at the end of the project's useful lifetime is irretrievable. Consumption of operating supplies, miscellaneous chemicals, and gases, while irretrievable, would not constitute a permanent drain on local sources or involve any material in critically short supply in the United States as a whole. Materials consumed or reduced to unrecoverable forms of waste, such as uranium, are also irretrievably lost. However, strategic and critical materials, or resources having small natural reserves, are of such value that economics promotes recycling. Plans to recover and recycle as much of these valuable, depletable resources as is practical should depend on need and each item would be considered individually at the time a recovery decision is required.

Energy. The irretrievable commitment of resources during construction and operations of the facilities would include the consumption of fossil fuels used to generate heat and electricity for the sites. Energy would also be expended in the form of diesel fuel, gasoline, and oil for construction equipment and transportation vehicles. The amount of energy required to operate the tritium facilities is estimated in section 3.4.2 and would be irretrievable. These estimates are roughly comparable to past energy requirements except for the APT, which represents a significant increase over amounts historically consumed for operation of tritium supply facilities.

4.15 Facility Transition

The final disposition of all Complex facilities is the responsibility of EM. DOE is committed to remediate these sites, to comply with all applicable environmental requirements, and to protect public and worker health and safety. DOE is currently considering many technologies for the treatment of contaminated materials and equipment, and for the long-term management of sites. DOE has prepared a PEIS to identify configurations for selected waste management facilities. The term "configurations" as used in this context means the arrangement of facilities and related activities at one or more DOE sites for a specific waste type. The selected waste management facilities for each of these waste types are: interim storage facilities for treated HLW; treatment and storage facilities for TRU waste in the event that treatment is required before disposal; treatment and disposal facilities for LLW and interim storage facilities for commercial Greater-Than-Class C LLW; treatment and disposal facilities for mixed LLW; and treatment facilities for hazardous waste.

At the end of their useful life, all facilities (new ones and those phased out as a result of mission changes) would undergo transition to EM. Facility transition begins when the Program Secretarial Office or the Secretary of Energy determines that there is no further need for a facility. The transition process involves developing a transition plan, the deactivation and preliminary characterization of the facility against turnover requirements, preparation of budget requests, and other necessary planning and information exchange activities. Each transition plan would incorporate site-specific details and define actions necessary to bring identified facilities into a condition acceptable for transfer to EM. The facility would be accepted by EM after the acceptance criteria are met. Deactivation of the facility could include the removal of usable equipment and material, classified documents, and parts of other activities in order to reduce the long-term surveillance and maintenance costs. Ideally, deactivation would be completed prior to turnover to EM. However, turnover to EM may occur at any time between formal acceptance and completion of deactivation activities, including the possibility of turnover occurring at the time of acceptance. Timing of acceptance, deactivation, and turnover to EM is controlled by funding, political, and departmental workload considerations. Facility transition ends when the facility has been turned over to EM for final disposition, including any decontamination and decommissioning (D&D).

It is important to recognize that the decisions to conduct near-term cleanup and D&D activities at the potential phaseout site do not depend on whether the proposals for tritium supply and recycling are implemented. Regardless of whether tritium recycling is phased out at SRS, substantial cleanup of both soil and groundwater contamination and substantial D&D of buildings already determined to be unnecessary for future operations are either occurring or planned. These cleanup and D&D activities represent a substantial percentage of the total scope of activities that must occur at the potential phaseout site. When specific proposals are completed for the D&D of facilities that would be phased out as a result of the implementation of the proposed tritium supply and recycling action, the appropriate NEPA documentation would be prepared. Depending on the level and type of contamination, D&D may involve: (1) decontamination and return of an area to its original condition without restrictions on use or occupancy or (2) partial decontamination and isolation of remaining residues with continued surveillance and restrictions on use or occupancy.

In making any final disposition decisions, DOE will face many complex issues, including: human resources; cost; future site use; public involvement; and health, safety, and environmental issues. Public involvement in facility transition activities would be considered in making the DOE facility transition and the associated environmental restoration program a success. DOE has established and will continue to establish transition working groups at the affected site to work with the public throughout the transition process.

In planning the transition of facilities and sites from a production mission to an environmental restoration mission, the following guidelines would be followed (DOE 1993e):

- Laws, regulations, formal agreements, and DOE orders will form the basis for transition planning and execution.
- Transition planning will be coordinated with the appropriate regulatory agencies, host state, and other affected stakeholders.
- All vital safety and utility systems within the affected facility will be fully functional upon transfer.
- Facilities will have a current safety analysis report and other technical safety requirements that address the change in facility mission and condition of the facility at the time of turnover.
- Facilities used in waste management operations or other support functions will remain operational as required to support future environmental restoration activities, including facility decontamination and dismantlement.

- Management of waste streams during the transition period will be in accordance with existing regulations.

- A systems engineering risk assessment approach will be used to determine future site and facility uses and possible directions for achieving them.

The required level of effort to complete D&D of facilities would be a function of the types of chemical and radiological materials utilized when the facility was operational, and the extent to which radioactive and hazardous/toxic materials have been deposited on the internal and external surfaces of components, systems, and structures.

In sequence, the steps to accomplish D&D of a facility associated with weapons reconfiguration are: (1) deactivation—DP characterizes the facility waste; (2) facility is transferred to EM; (3) facility is decontaminated; and (4) final disposition.

Because designs are preconceptual, it is impossible to analyze potential impacts at this time. However, a relative comparison of D&D activities and potential impacts between the tritium supply technologies can be made. It is expected that the APT would have the smallest impact from D&D activities. Although extensive excavation may be required to remove the tunnel, the amount and level of activity for radioactively contaminated waste volumes would be considerably less than the reactor technologies. Because of multiple reactor vessels and the fact that its reactor vessels are below grade, the MHTGR would probably have the largest impact from D&D activities. Because of fuel and target fabrication being done offsite, the impacts from D&D for the ALWR and HWR would be similar. Radiological impacts from D&D activities to the general population are expected to be negligible. All D&D activities would be regulated by DOE orders. Exposure limits to the general population would be similar to exposure limits for facility operations.

4.16 Environmental Justice in Minority and Low-Income Populations

DOE is committed, to the greatest extent practicable and permitted by law, to achieving environmental justice as part of its tritium supply and recycling mission. Previous section of chapter 4 describes the employment, population, income, housing, public finance, and regional economics surrounding each candidate site. Impacts to these socioeconomic issue areas due to the implementation of the proposed action at these sites are also discussed. Selected demographic characteristics of the region-of-influence (ROI) for each of the five candidate sites is presented in tables 4.16–1 through 4.16–5 and figures 4.16–1 through 4.16–10. DOE has attempted in this PEIS, and will continue in subsequent tiered NEPA documents, to identify and to mitigate when so identified, any disproportionately high and adverse human health or environmental effects on minority and low-income populations resulting from decisions based on this PEIS for Tritium Supply and Recycling.

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, directs Federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. Executive Order 12898 also directs the Administrator of EPA to convene an interagency Federal Working Group on Environmental Justice. The Working Group is directed to provide guidance to federal agencies on criteria for identifying disproportionately high and adverse human health or environmental effects on minority and low-income populations. The Working Group has not yet issued the guidance directed by Executive Order 12898. In coordination with the Working Group, the Department is in the process of developing internal guidance on implementing the Executive order. Because both the Working Group and the Department are still in the process of developing guidance, the approach taken in this analysis may depart somewhat from whatever guidance is eventually issued.

This PEIS analyzes the demographic information presented in the tables and figures contained in this section. For analysis, the shaded areas in figures 4.16–1, 4.16–3, 4.16–5, 4.16–7, and 4.16–9 show census tracts where people of color comprise 50 percent or (simple majority) of the total population in the census tract, or where people of color comprise less than 50 percent but greater than 25 percent of the total population in the census tract. Figures 4.16–3, 4.16–3, 4.16–6, 4.16–8, and 4.16–10 show low-income communities generally defined as those where 25 percent or more of the population is characterized as living in poverty (income of less than $8,076 for a family of two). No minority or low-income populations live within a 50-mile radius of NTS. This analysis considers any disproportionately high and adverse human health or environmental effects on minority populations and low-income populations which could result from the alternatives being considered.

As shown in section 4.12, unavoidable adverse environmental impacts, impacts, if any, to surrounding communities would most likely result from toxic/hazardous air pollutants and radiological emissions. As further shown in sections 4.2.3.9, 4.3.3.9, 4.4.3.9, 4.5.3.9, and 4.6.3.9 on radiological and hazardous chemical impacts during normal operation and accidents, these emissions are expected to be lower than regulatory limits. While these releases and emissions are within regulatory limits, the cumulative effect of continuous (or intermittent over time) very low level exposures could have some impact on human health or the environment. Therefore, whatever adverse human health or environmental impacts to any offsite populations, would most likely occur to people living within communities located near the five candidate sites. The analysis of the demographics data presented in figures 4.16–1 through 4.16–10, tables 4.16–1 through 4.16–5 and for the communities surrounding the five candidate sites indicates that even if there were any health impacts to these communities, these impacts would not appear to disproportionately affect minority or low-income populations.

A review of the impact analysis presented in the Site-Wide EIS for NTS was also performed to identify any potential disproportionately high and adverse human health or environmental effects even though no minority or low income populations live within a 50-mile radius of the proposed project site at NTS. The analysis indicates that offsite impacts from normal operation air pollutants and radiological emissions would be negligible and below regulatory limits. The radiological release from a design-basis reactor accident would not go beyond the NTS boundary (appendix figure F.3.2-1). Therefore, no disproportionate health effects to the offsite public would be expected. Groundwater withdrawals to support the reactor and APT technologies at NTS would not affect aquifer levels beyond the site boundary (section 4.3.3.4). Therefore, no disproportionately adverse effects to public wells near NTS would be expected.

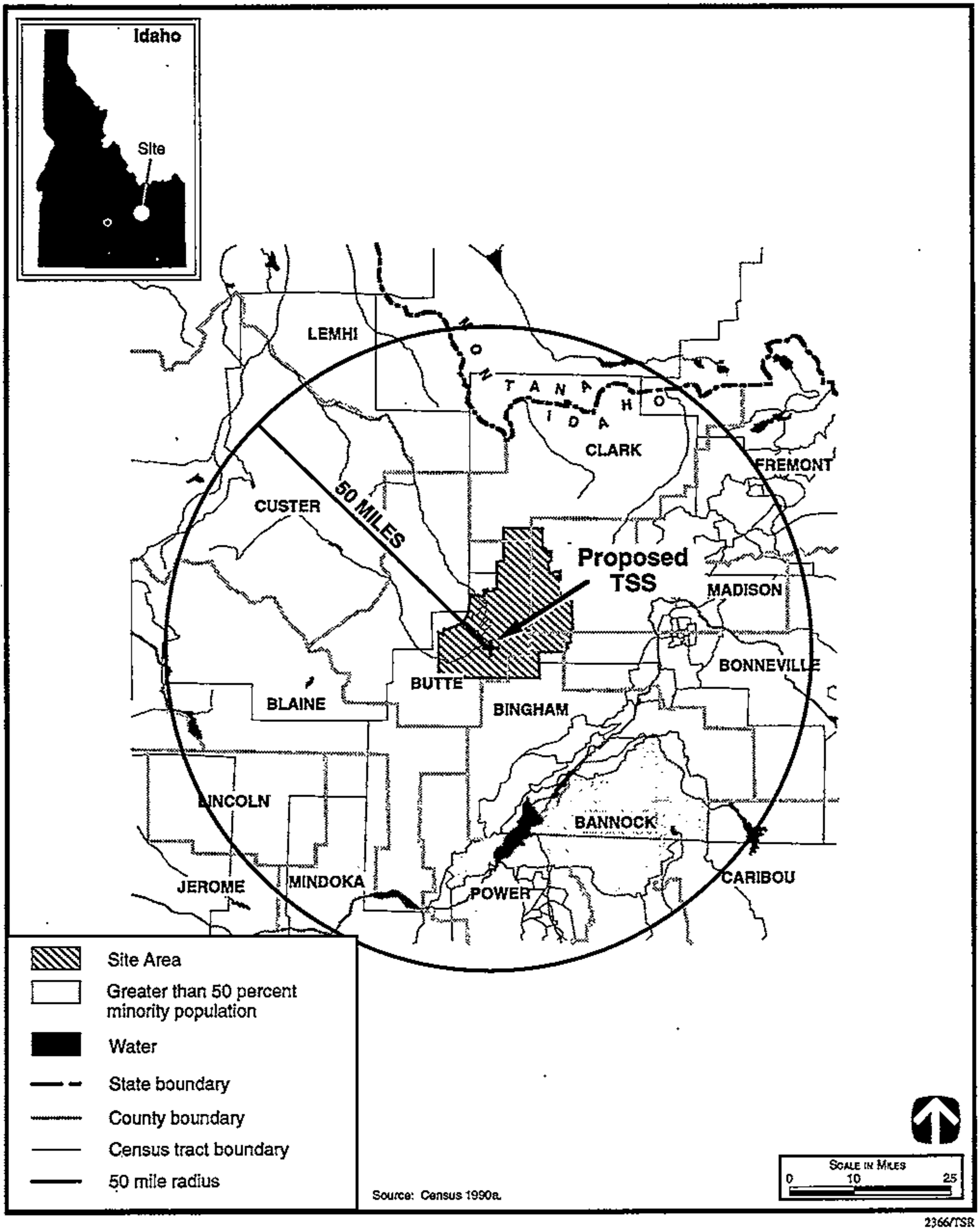

FIGURE 4.16–1.—*Minority Population Distribution for Idaho National Engineering Laboratory and Surrounding Area.*

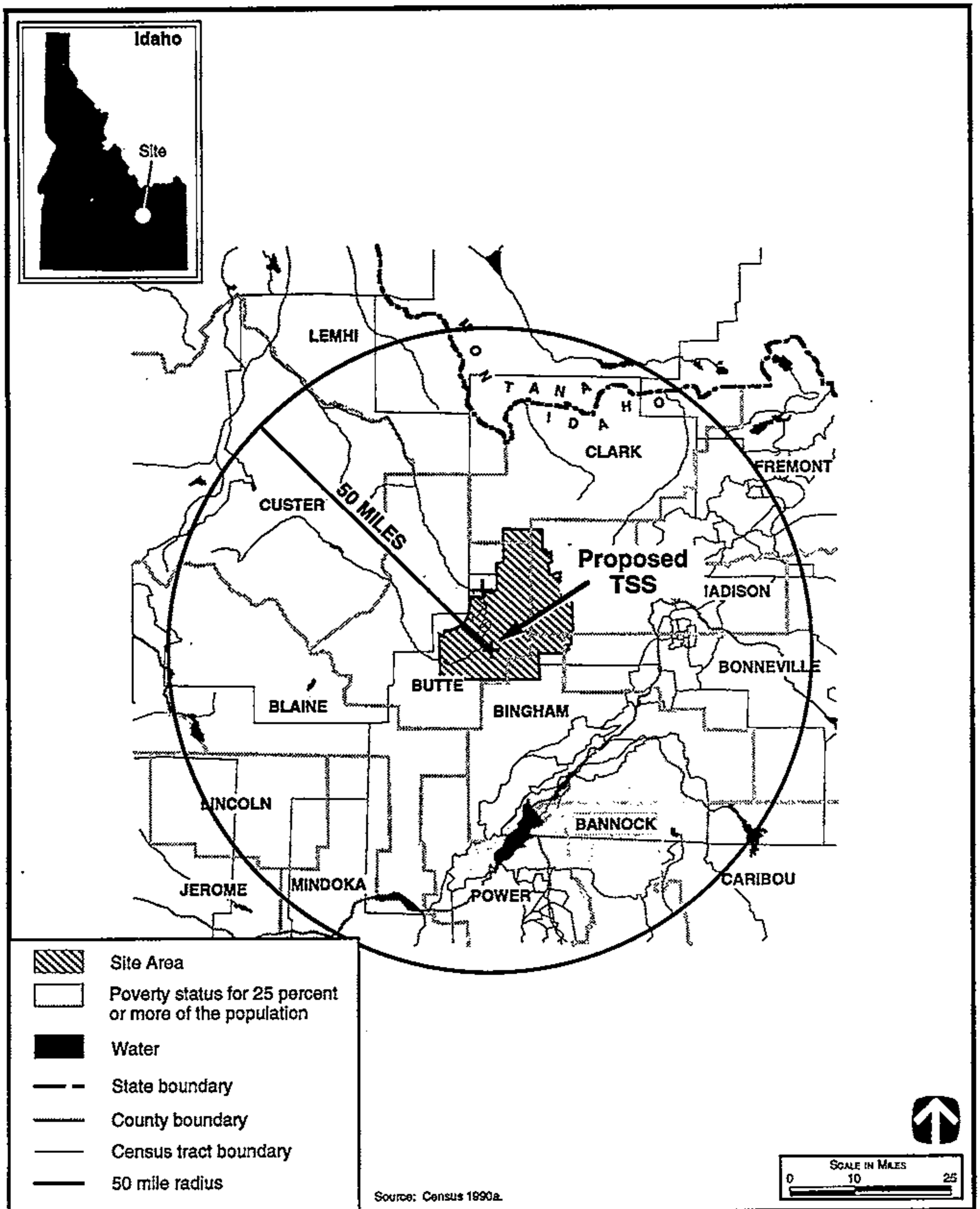

FIGURE 4.16–2.—*Low-Income Distribution by Poverty Status for Idaho National Engineering Laboratory and Surrounding Area.*

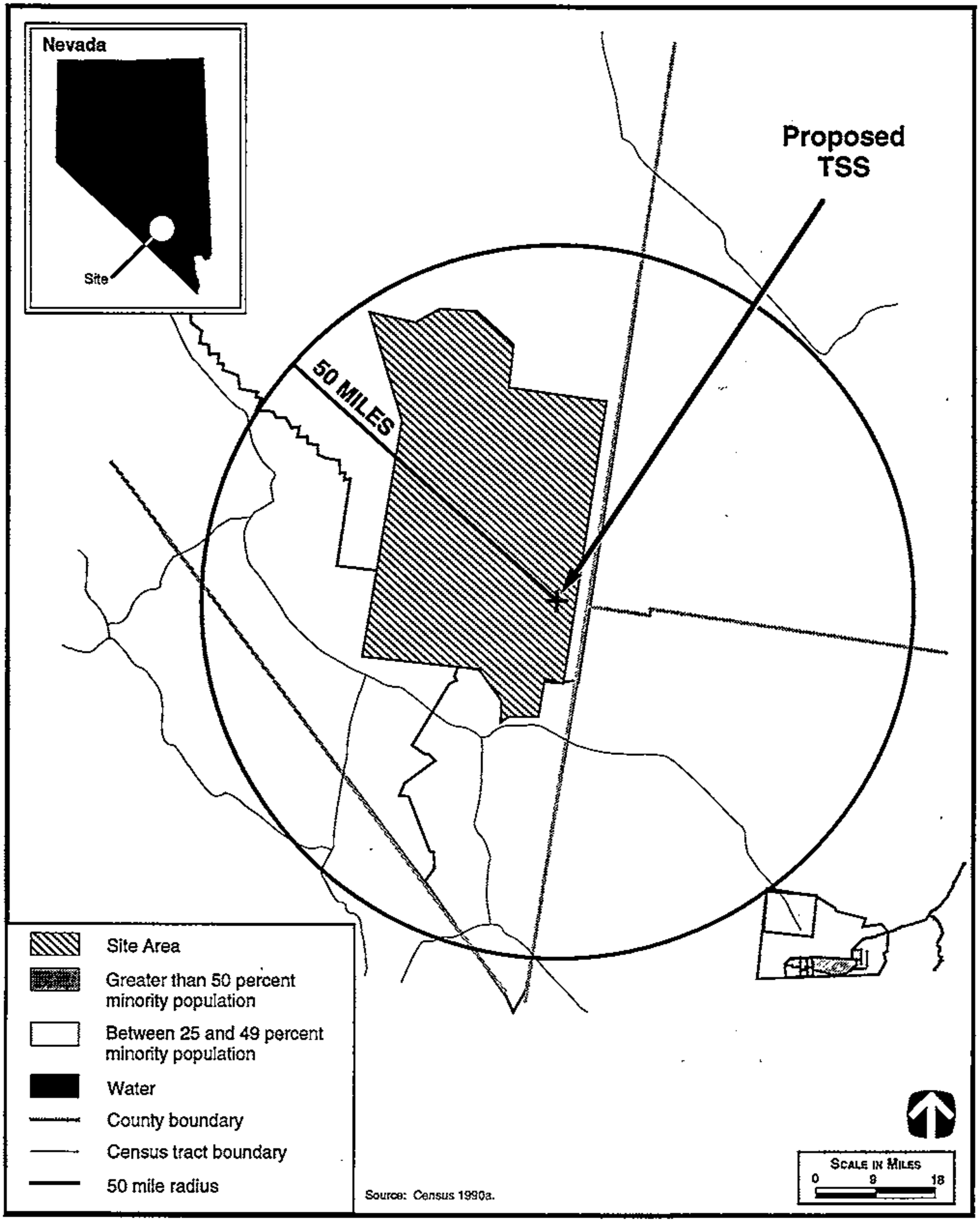

FIGURE 4.16–3.—*Minority Population Distribution for Nevada Test Site and Surrounding Area.*

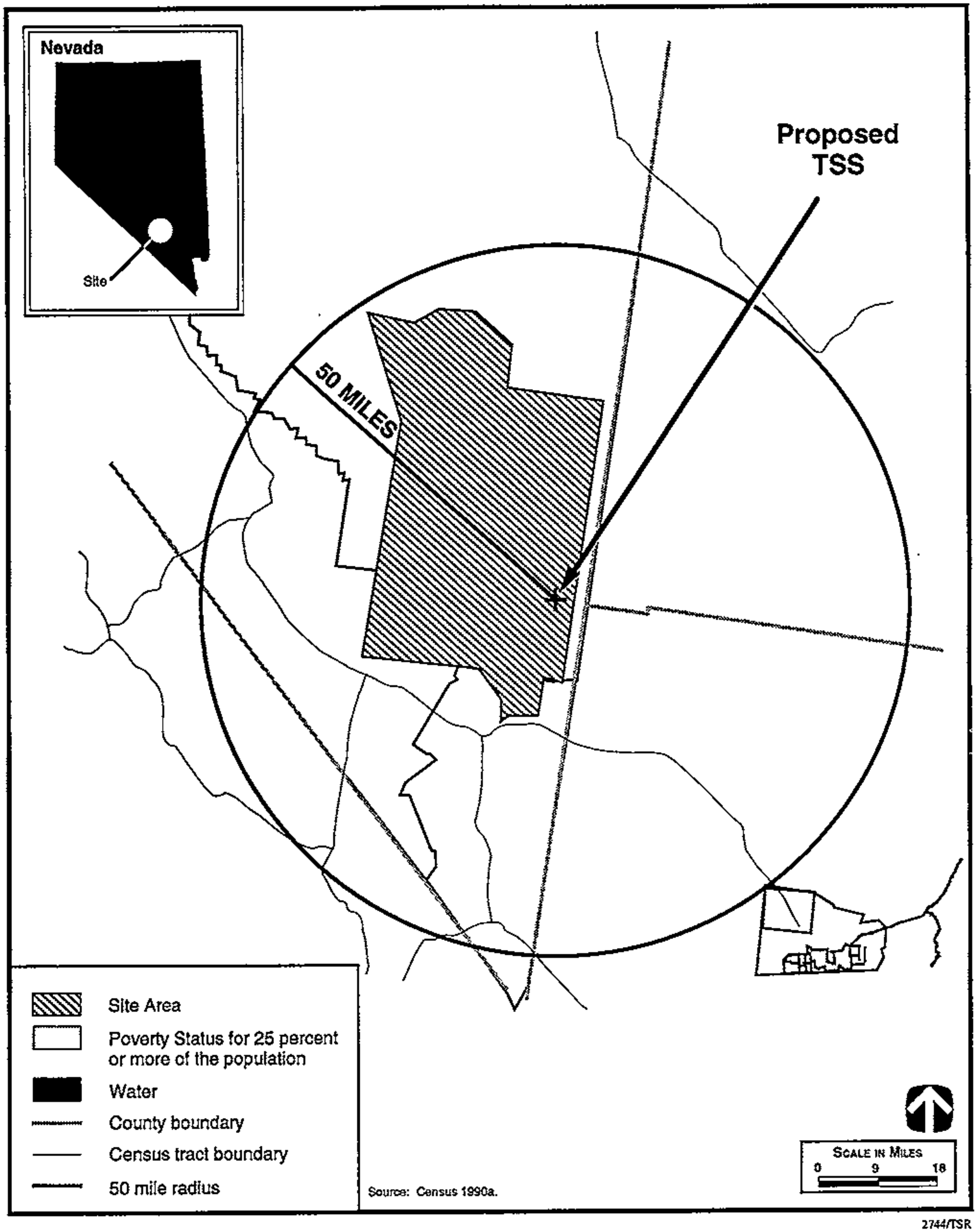

FIGURE 4.16–4.—*Low-Income Distribution by Poverty Status for Nevada Test Site and Surrounding Area.*

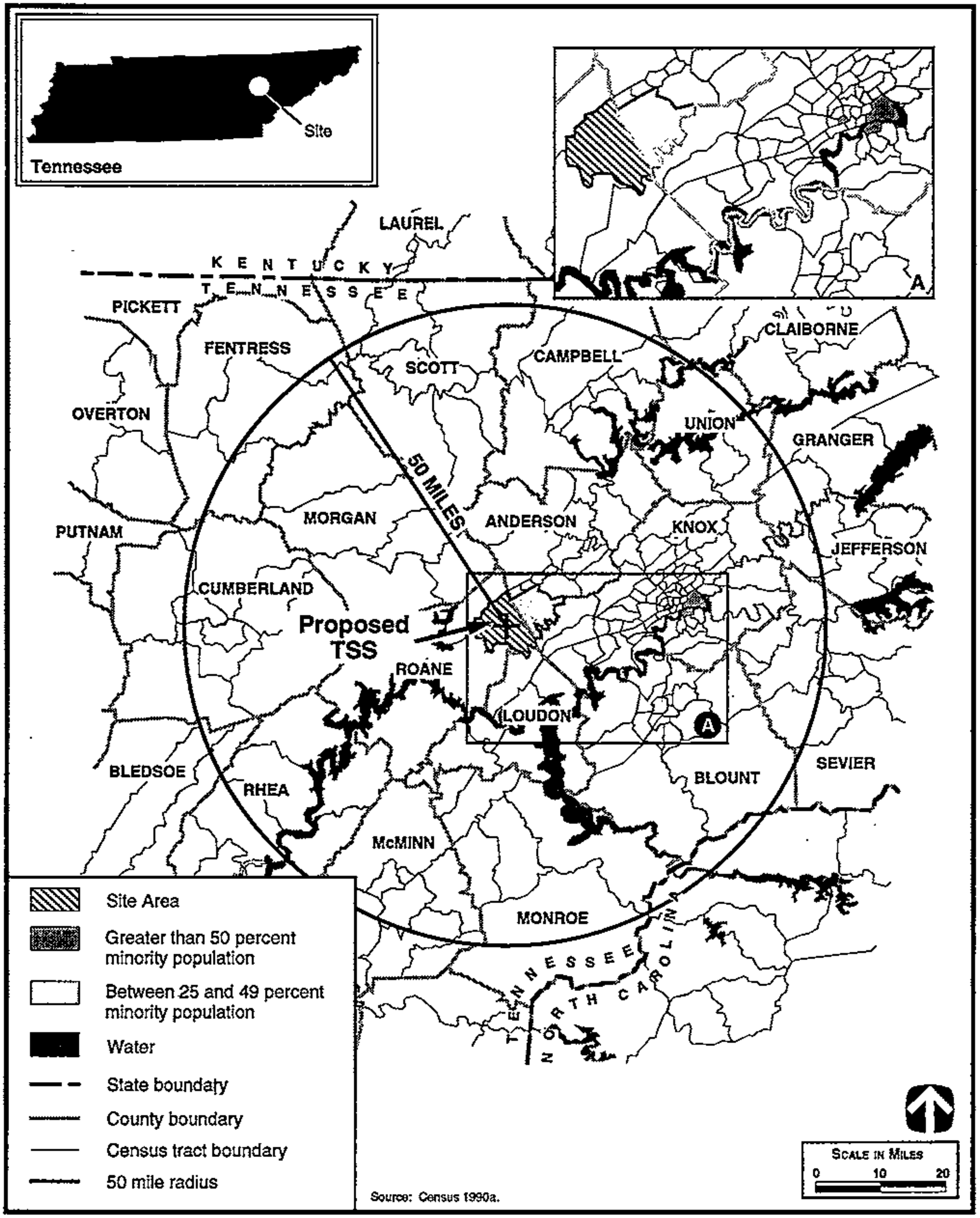

FIGURE 4.16–5.—*Minority Population Distribution for Oak Ridge Reservation and Surrounding Area.*

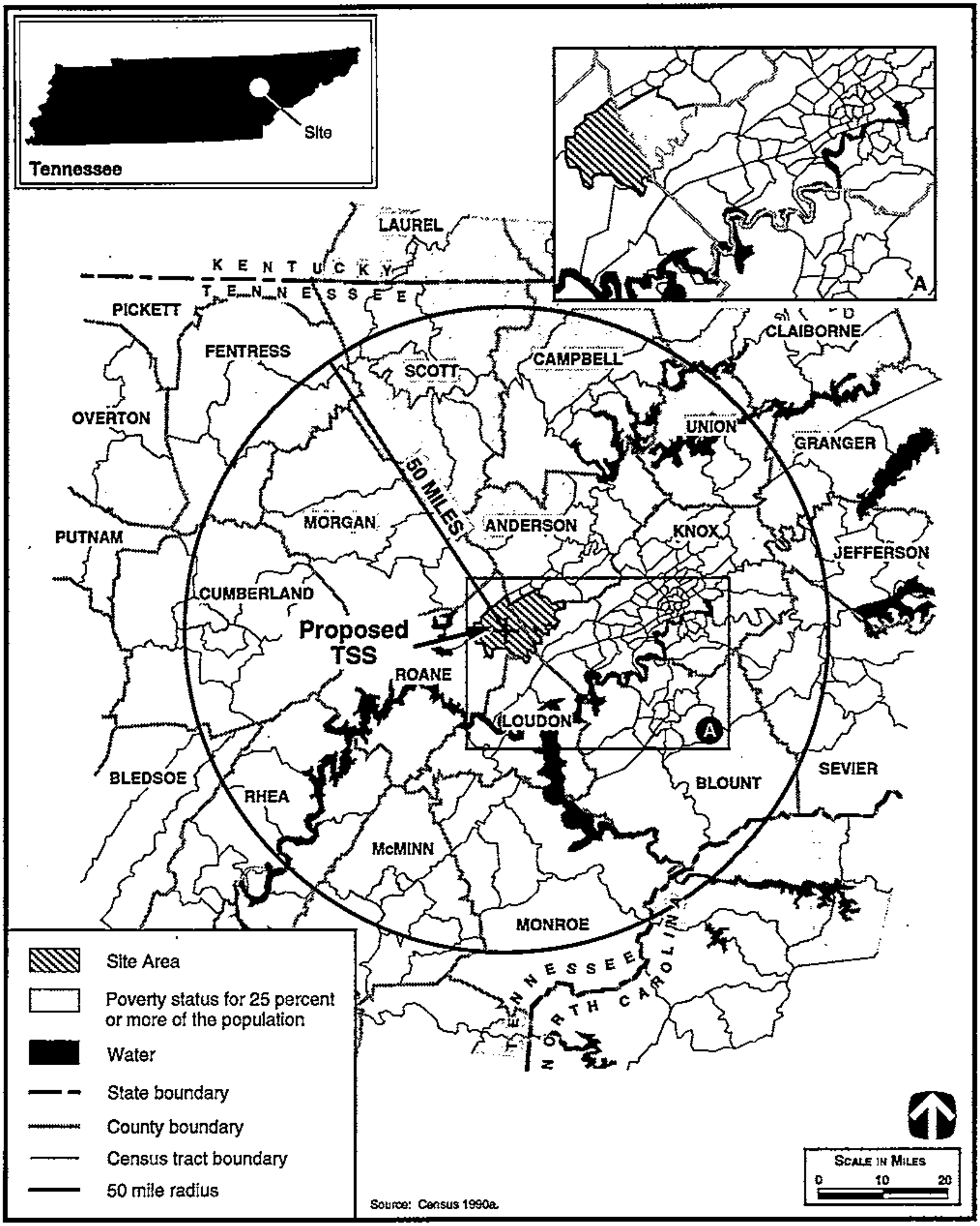

FIGURE 4.16–6.—*Low-Income Distribution by Poverty Status for Oak Ridge Reservation and Surrounding Area.*

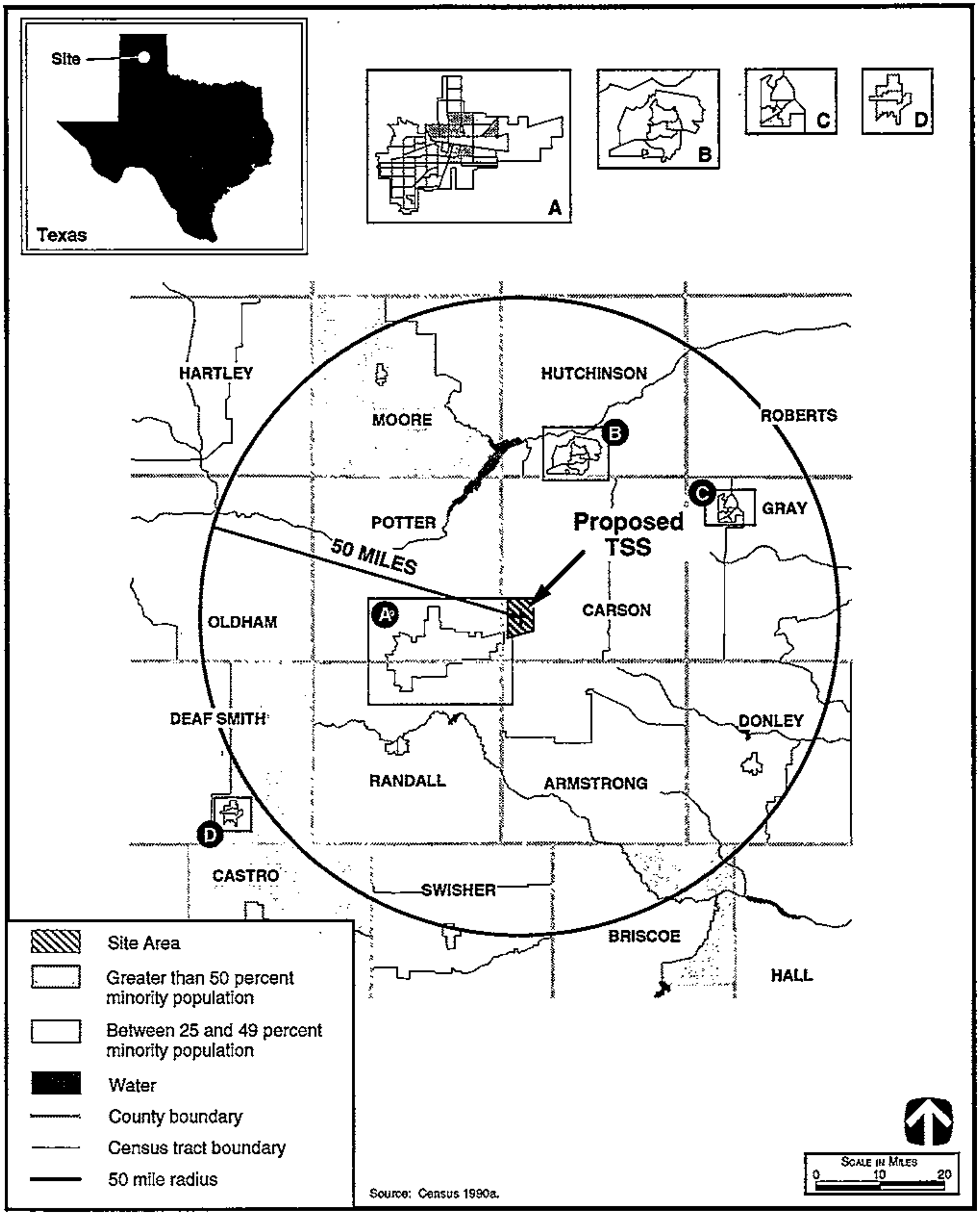

FIGURE 4.16–7.—*Minority Population Distribution for Pantex Plant and Surrounding Area.*

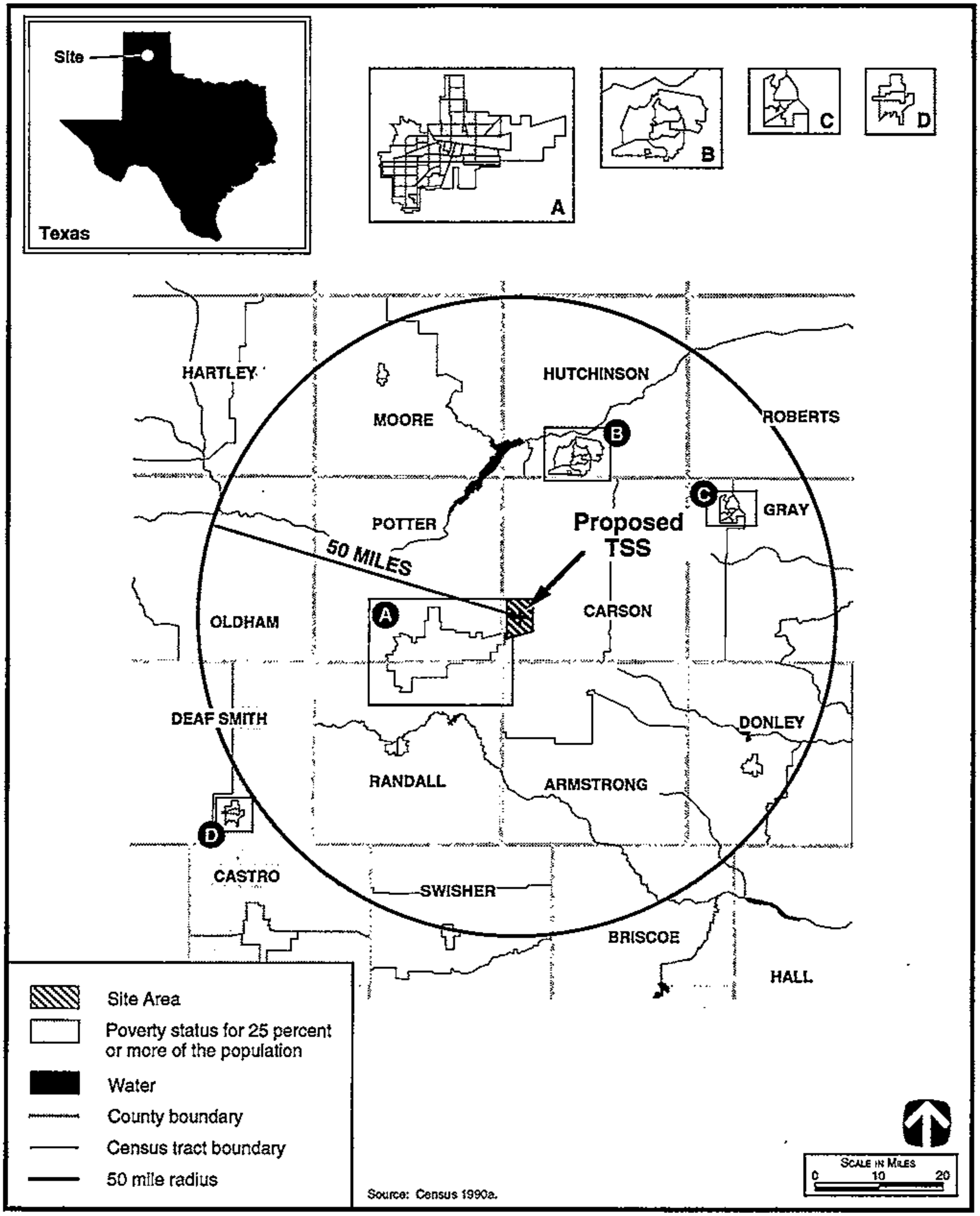

FIGURE 4.16–8.—*Low-Income Distribution by Poverty Status for Pantex Plant and Surrounding Area.*

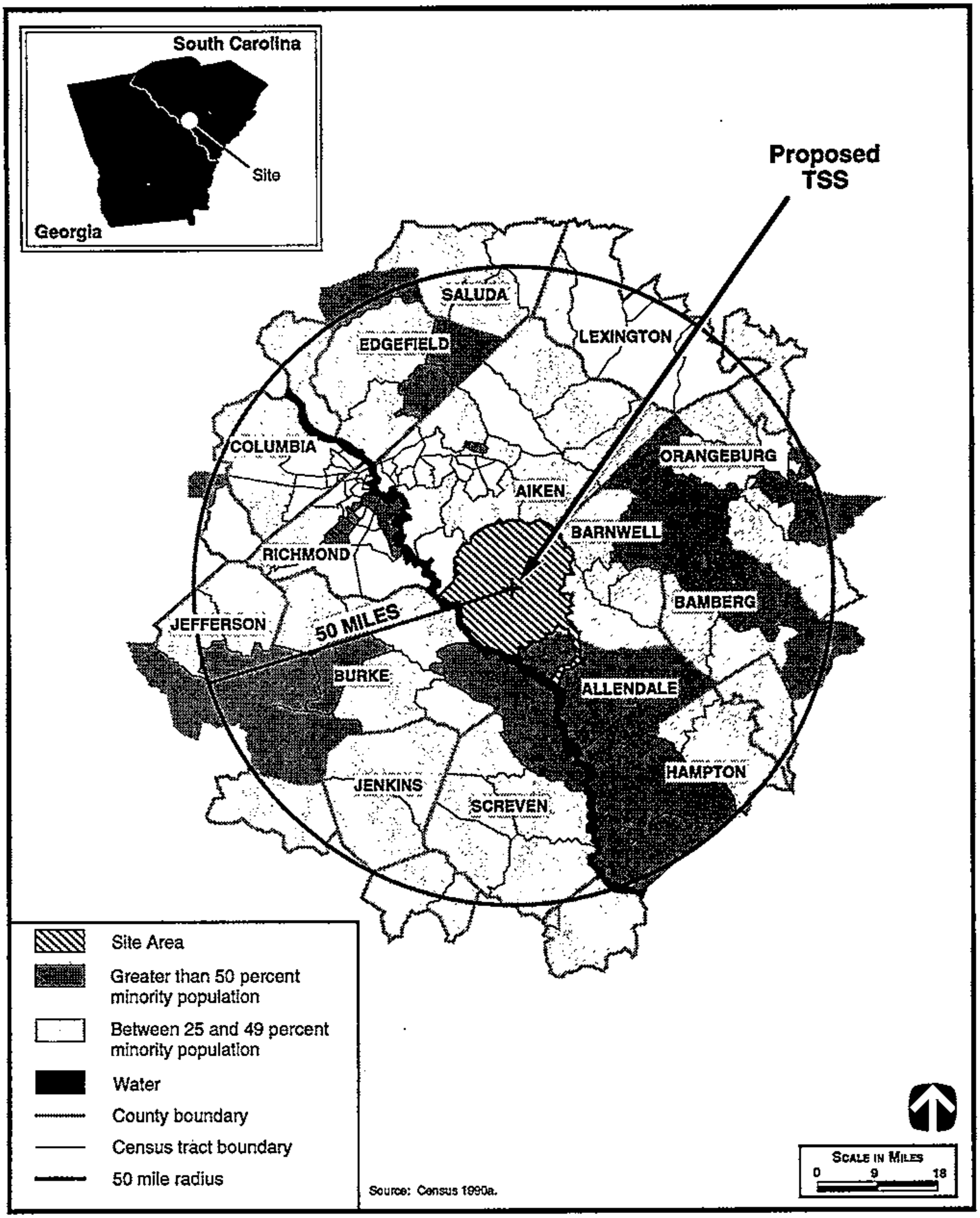

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FIGURE 4.16–9.—*Minority Population Distribution for Savannah River Site and Surrounding Area.*

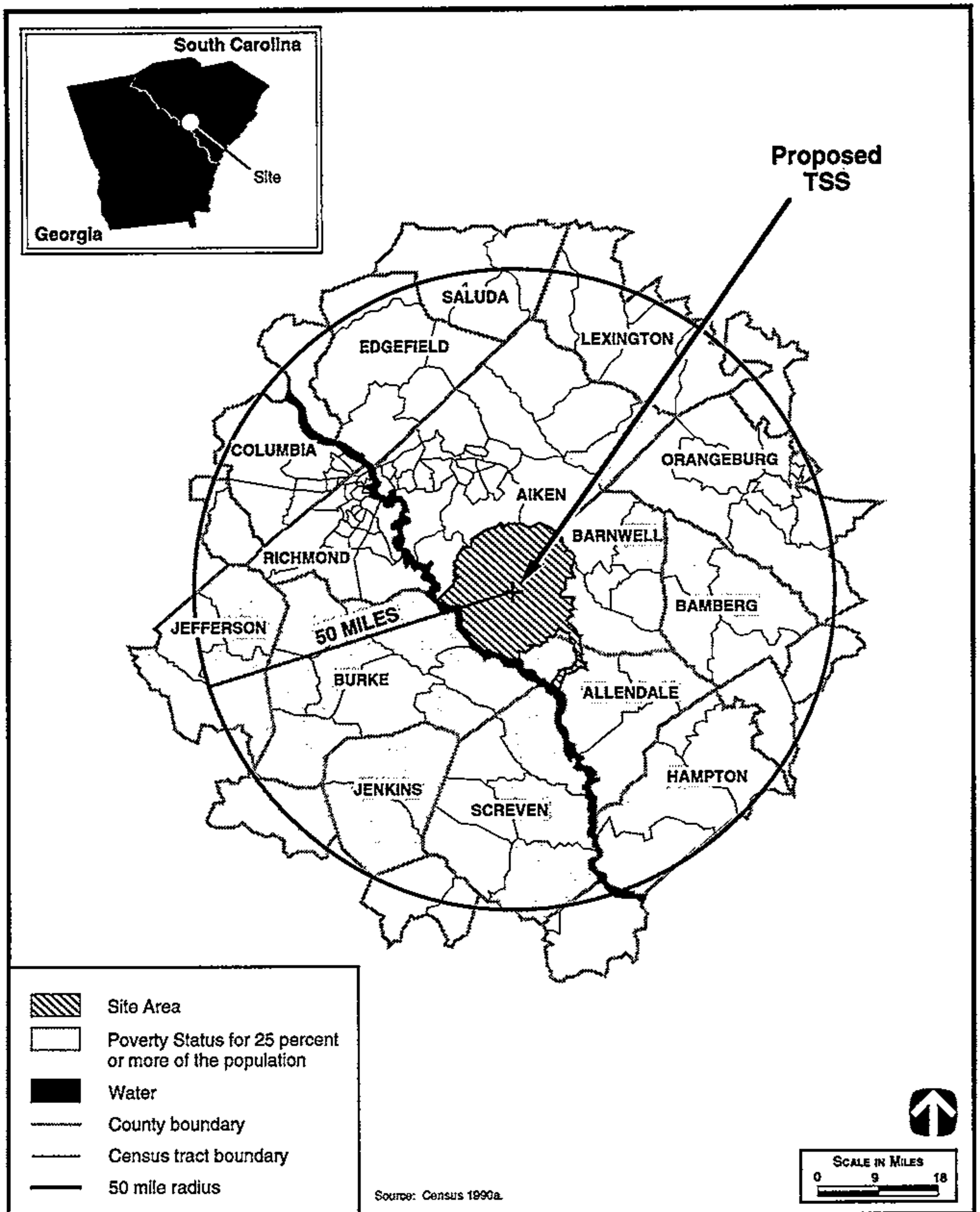

FIGURE 4.16–10.—*Low-Income Distribution by Poverty Status for Savannah River Site and Surrounding Area.*

TABLE 4.16–1.—*Selected Demographic Characteristics for Idaho National Engineering Laboratory Region-of-Influence*

Characteristic/Area	Bannock County (number)	Bingham County (number)	Bonneville County (number)	Butte County (number)	Jefferson County (number)	Total Region-of-Influence (number)	Total Region-of-Influence (percent)
Persons by Race/Ethnicity							
Non-Hispanic, White	60,626	31,432	67,879	2,791	15,219		
Hispanic	2,740	3,614	3,010	101	1,155		
Non-Hispanic, American Indian	1,509	2,209	343	21	109		
Non-Hispanic, Black	415	31	286	0	3		
Non-Hispanic, Asian/Pacific Islander	697	284	663	5	40		
Non-Hispanic, Other	39	33	26	0	17		
Total 1990 Population	66,026	37,583	72,207	2,918	16,543		
Total Number of Households	23,412	11,513	24,289	997	4,871		
1989 Low Income							
Persons Below Poverty							
Number	8,944	5,804	7,056	392	2,353		
Percent	13.8	15.6	9.9	13.5	14.3		

Source: Census 1990a.

TABLE 4.16–2.—*Selected Demographic Characteristics for Nevada Test Site Region-of-Influence*

Characteristic/Area	Clark County (number)	Nye County (number)	Total Region-of-Influence (number)	Total Region-of-Influence (percent)
Persons by Race/Ethnicity				
Non-Hispanic, White	558,875	15,635	574,510	75.7
Hispanic	82,904	1,237	84,141	11.1
Non-Hispanic, American Indian	5,514	475	5,989	0.8
Non-Hispanic, Black	68,858	274	69,132	9.1
Non-Hispanic, Asian/Pacific Islander	24,483	148	24,631	3.2
Non-Hispanic, Other	825	12	837	0.1
Total 1990 Population	741,459	17,781	759,240	100.0
Total Number of Households	287,025	6,664	293,689	
1989 Low Income *Persons Below Poverty*				
Number	76,737	1,840	78,577	
Percent	10.3	10.3	10.3	

Source: Census 1990a.

TABLE 4.16–3.—*Selected Demographic Characteristics for Oak Ridge Reservation Region-of-Influence*

Characteristic/Area	Anderson County (number)	Knox County (number)	Loudon County (number)	Roane County (number)	Total Region-of-Influence (number)	Total Region-of-Influence (percent)
Persons by Race/Ethnicity						
Non-Hispanic, White	64,320	300,040	30,668	45,274	440,302	91.2
Hispanic	381	2,067	83	212	2,743	0.6
Non-Hispanic, American Indian	236	775	52	95	1,158	0.2
Non-Hispanic, Black	2,753	29,483	400	1,456	34,092	7.1
Non-Hispanic, Asian/Pacific Islander	537	3,263	49	186	4,035	0.8
Non-Hispanic, Other	23	121	3	4	151	0.0
Total 1990 Population	68,250	335,749	31,255	47,227	482,481	99.9
Total Number of Households	27,384	133,639	12,155	18,453	191,631	
1989 Low Income						
Persons Below Poverty						
Number	9,664	45,608	4,192	7,467	66,931	
Percent	14.2	13.6	13.4	15.8	13.9	

Source: Census 1990a.

TABLE 4.16–4.—*Selected Demographic Characteristics for Pantex Plant Region-of-Influence*

Characteristic/Area	Armstrong County (number)	Carson County (number)	Potter County (number)	Randall County (number)	Total Region-of-Influence (number)	Total Region-of-Influence (percent)
Persons by Race/Ethnicity						
Non-Hispanic, White	1,951	6,158	66,877	81,364	156,350	79.7
Hispanic	55	354	19,246	6,144	25,799	13.1
Non-Hispanic, American Indian	9	41	709	414	1,173	0.6
Non-Hispanic, Black	0	11	8,460	1,082	9,553	4.9
Non-Hispanic, Asian/ Pacific Islander	5	9	2,431	626	3,071	1.6
Non-Hispanic, Other	1	3	151	43	198	0.1
Total 1990 Population	2.021	6,576	97,874	89,673	196,144	100.0
Total Number of Households	768	2,402	37,344	34,553	75,067	
1989 Low Income						
Persons Below Poverty						
Number	232	583	21,619	7,819	30,253	
Percent	11.5	8.9	22.1	8.7	15.4	

Source: Census 1990a.

TABLE 4.16–5.—*Selected Demographic Characteristics for Savannah River Site Region-of-Influence*

	South Carolina				Georgia			
Characteristic/Area	Aiken County (number)	Allendale County (number)	Bamberg County (number)	Barnwell County (number)	Columbia County (number)	Richmond County (number)	Total Region-of-Influence (number)	Total Region-of-Influence (percent)
Persons by Race/Ethnicity								
Non-Hispanic, White	90,130	3,598	6,428	11,421	56,141	103,009	270,727	63.6
Hispanic	867	161	75	146	962	3,707	5,918	1.4
Non-Hispanic, American Indian	213	11	22	31	150	491	918	0.2
Non-Hispanic, Black	29,176	7,939	10,356	8,677	7,239	79,221	142,608	33.5
Non-Hispanic, Asian/Pacific Islander	528	7	20	17	1,518	3,186	5,276	1.2
Non-Hispanic, Other	26	6	1	1	21	105	160	0.0
Total 1990 Population	120,940	11,722	16,902	20,293	66,031	189,719	425,607	99.9
Total Number of Households	44,883	3,791	5,587	7,100	21,841	68,675	151,877	
1989 Low Income								
Persons Below Poverty								
Number	16,671	3,837	4,547	4,367	4,255	32,590	66,267	
Percent	13.8	32.7	26.9	21.5	6.4	17.2	15.6	

Source: Census 1990a.

CHAPTER 5

Chapter 5

CHAPTER 5: ENVIRONMENTAL, OCCUPATIONAL SAFETY & HEALTH PERMITS AND COMPLIANCE REQUIREMENTS

Chapter 5 identifies the environmental, occupational safety and health, permits, and compliance requirements associated with the proposed action as specified by the major Federal and state statutes, regulations, orders, and agreements.

5.1 Introduction and Purpose

Chapter 5 provides information concerning the environmental standards and statutory requirements that impact on the various tritium supply technologies and recycling facilities to the extent necessary to assist in making programmatic-level decisions. It presents some of the more important regulatory requirements associated with the proposed action by identifying the applicable environmental statutes, regulations, and approval requirements. These requirements are found in Federal and state statutes, regulations, permits, approvals, and consultations, as well as in Executive and Department of Energy (DOE) orders, Consent Orders, Federal Facility Agreements, Federal Facility Compliance Agreements, and Agreements In Principle. These documents provide the standard for evaluating the ability of candidate sites to meet the environment, safety, and health (ES&H) requirements and obtaining required Federal and state permits and licenses necessary to implement programmatic decisions. The remainder of the chapter provides historical background on environmental protection at nuclear weapons production facilities, explains the concept of shared Federal and state enforcement, and summarizes compliance with occupational safety and health and environmental justice requirements.

Compliance with the applicable requirements of each of the major environmental statutes, regulations, or orders identified in the tables would allow DOE to construct and operate the tritium supply and recycling facilities to meet existing ES&H requirements. To be environmentally sound, programmatic decisions must also address the ES&H planning considerations described in section 3.3 of the *Nuclear Weapons Complex Reconfiguration Study* (DOE/DP-0083) in order for the tritium supply and recycling facilities to meet ES&H requirements which would exist in the future and to accomplish the mission in a timely and cost-effective manner.

5.2 Background

Since the majority of the Nuclear Weapons Complex (Complex) facilities were constructed in the 1940s and 1950s before the advent of today's environmental and worker health requirements, safety and the ability to satisfy national security requirements played the dominant roles in the design and operation of these major industrial plants. With the emergence of an awareness of environmental and health-related issues and the enactment of environmental and worker health programs, however, DOE shifted a great deal of its resources into programs designed to achieve compliance with all applicable Federal, state, and local ES&H requirements. Today, many government agencies at the Federal, state, and local levels have regulatory authority over DOE facility operations. DOE has entered into enforceable compliance agreements with the regulators at most of its facilities. These agreements detail specific programs, funding levels, and schedules for achieving compliance with applicable ES&H statutory and regulatory requirements.

All newly constructed and modified facilities must comply with the increasing number and complexity of environmental regulations. The application of constantly changing requirements to facilities that are more than 40 years old makes it difficult to achieve compliance quickly. These older facilities generally do not meet all current standards for seismic design, fire protection, and environmental protection (air emissions, liquid effluents, and the management of solid and hazardous wastes). However, modernization of facilities to meet all applicable ES&H requirements now and into the 21st century and the development of a system to adequately manage the wastes generated by these facilities would take place regardless of the proposed action addressed in this PEIS.

5.3 Environmental Statutes, Orders, and Agreements

The *Atomic Energy Act* of 1954 authorizes DOE to establish standards to protect health and minimize dangers to life or property with respect to activities under its jurisdiction. The Nuclear Regulatory Commission (NRC) is charged under the *Atomic Energy Act* and the *Energy Reorganization Act* of 1974 with jurisdiction over commercial reactor construction and operation. NRC also licenses and regulates the possession, use, transportation, and disposal of radioactive materials, including wastes. The Environmental Protection Agency (EPA), under authority of the *Atomic Energy Act*, has set radiation protection standards such as "Environmental Radiation Protection Standards for Nuclear Power Operations" (40 CFR 190). EPA has also promulgated Federal environmental statutes and regulations to protect the environment and to control the generation, handling, treatment, storage, and disposal of hazardous materials and waste substances.

Because of their length, and for ease of reading, all tables in this chapter are presented consecutively at the end of the text. Table 5.3–1 lists the applicable Federal environmental statutes, regulations, and Executive orders, and also identifies the associated permit, approval, and consultation requirements generally required to site, construct, or operate a tritium supply technology and recycling facility. Except for limited Presidential exemptions, Federal agencies must comply with all applicable provisions of Federal environmental statutes and regulations, in addition to all applicable state and local requirements. DOE is committed to fully complying with all applicable environmental statutes, regulatory requirements, and Executive and internal orders. Table 5.3–2 lists selected DOE ES&H orders which apply to all sites, but which may affect each site differently.

DOE has entered into agreements with regulatory agencies on behalf of all of the DOE facilities being considered in this Programmatic Environmental Impact Statement (PEIS). These agreements normally establish a schedule for achieving full compliance at these DOE facilities. Table 5.3–3 lists those DOE environmental agreements with Federal and state regulatory agencies that have substantive provisions in effect. Appendix section A.1 summarizes the applicability and provides more detail on the environmental regulatory compliance agreements and consent orders still in effect at each of the nuclear facilities. These agreements and consent orders are generally available from the regulatory agency that is a party to the agreement, normally the state environmental department or EPA region, and also at the local DOE information resource center or reading room. Table 5.3–4 lists the potential requirements imposed by the major state environmental statutes and regulations applicable to this PEIS. These requirements apply to Federal activities within the jurisdiction of the enforcing authority. Just as table 5.3–1 identifies requirements based on Federal laws, table 5.3–4 identifies the permits, approvals, and consultations generally required to site, construct, or operate tritium supply and recycling facilities in accordance with state statutes and regulations.

5.4 Federal and State Environmental Enforcement

Under various Federal environmental statutes (table 5.3–1), the EPA may delegate the implementation and execution of the laws' various provisions to states with approved programs that are at least as stringent as the minimum Federal requirements contained in the laws and EPA regulations. Table 5.3–4 lists many of the states' laws and regulations, including provisions that are more stringent than the minimum requirements. In addition, the *Federal Facility Compliance Act* of 1992 waives sovereign immunity from the enforcement of *Resource Conservation and Recovery Act* (RCRA) at Federal facilities and thereby gives states the authority to assess fines and penalties under certain conditions. It further requires DOE to develop plans and enter into agreements with states as to specific management actions for particular mixed waste streams. Such agreements could have a direct effect on the wastes generated as a result of the implementation of the proposed action, yet such an effect cannot be determined until such time as these agreements are approved according to the terms of the *Federal Facility Compliance Act.*

Some environmental regulatory programs are enforced through review, approval, and permitting requirements that attempt to minimize the negative impacts from releases to the environment from potential pollution sources by limiting activities to established standards. Federal and state agencies share environmental regulatory authority over DOE facility operations when Federal legislation delegates permitting or review authority to qualifying states. Some examples are: the National Emission Standards for Hazardous Air Pollutants (NESHAP) and the Prevention of Significant Deterioration under the *Clean Air Act* (CAA); the Water Quality Standards and the National Pollutant Discharge Elimination System (NPDES) under the *Clean Water Act* (CWA); the Hazardous Waste Programs under RCRA; and the Drinking Water and Underground Injection Control Programs under the *Safe Drinking Water Act* (SDWA). When Federal legislation allows delegation of enforcement authority, states must set standards equal to or more stringent than those required by Federal law to obtain such authority. Where the Federal regulatory agency has delegated its authority, the state or local regulations set the governing standards. However, when Federal legislation does not provide for delegation of enforcement authority to the states, e.g., the *Toxic Substances Control Act* (TSCA), the standards are administered and enforced solely by the Federal government.

5.5 Compliance with Occupational Safety and Health Requirements

The health and safety of all workers associated with the tritium supply and recycling facilities is a primary consideration in the programmatic decision resulting from this PEIS. A comprehensive nuclear and occupational safety and health initiative was announced by the Secretary on May 5, 1993 entailing closer consultation with the Occupational Safety and Health Administration (OSHA) regarding regulation of worker safety and health at DOE contractor-operated facilities. Regulation of worker health and safety at DOE contractor-operated facilities will gradually shift from DOE to OSHA. The *Occupational Safety and Health Act* of 1970, (Public Law 91-596) establishes Federal requirements for assuring occupational safety and health protection for employees.

DOE facilities also comply with the *Emergency Planning and Community Right-To-Know Act,* (42 USC §11001) which requires facilities to report the release of extremely hazardous substances and other specified chemicals; provide material safety data sheets or lists thereof; and provide estimates of the amounts of hazardous chemicals on-site. The reporting and emergency preparedness requirements are designed to protect both individuals and communities.

Workplace Safety and Accidents. Operations at all DOE sites expose workers to occupational hazards during the normal conduct of their work activities. Occupational safety and health training is provided for all employees at DOE facilities and includes specialized job safety and health training appropriate to the work performed. Such training also includes informing employees of their rights and responsibilities under the *Occupational Safety and Health Act* of 1970, Executive Order 12196, which established OSHA Federal Agency Standards, 29 CFR 1960- *The OSHA Federal Agency Standards*-which describes the safety and health programs that Federal agencies must establish and implement under Executive Order 12196, and DOE Order 3790.1B (*Federal Employee Occupational Safety and Health Program).* DOE provides implementation guidance in DOE Order 3790.1B, including the requirements and guidelines for the DOE Federal Employee Industrial Hygiene Program. DOE policy is to:

- Provide places and conditions of employment that are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm.
- Assure that employees and employee representatives shall have the opportunity to participate in the Federal Employee Occupational Safety and Health Program.
- Establish programs in safety and health training for all levels of Federal employees.
- Consider the 29 CFR 1960 (*OSHA Standards For Federal Agencies*) requirements to be the minimum standards for DOE employees.

DOE contractor operations at each site expose workers to hazardous constituents. DOE orders require that site operations have programs for protection of workers. DOE Orders 5480.11, *Radiation Protection for Occupational Workers,* and 5483.1A, *Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities,* establish procedures for protection of workers against radiological and hazardous materials, respectively. DOE Order 5000.3B, *Occurrence Reporting and Processing of Operations Information,* provides for reporting and guides appropriate corrective action(s) and follow-up should an exposure occur.

DOE Order 5440.1E, *National Environmental Policy Act Compliance Program;* DOE Order 5480.1B, *Environment Safety and Health Program for Department of Energy Operations;* DOE Order 5480.23, *Nuclear Safety Analysis Reports;* DOE Order 5481.1B, *Safety Analysis and Review System;* and DOE Order 6430.1A, *General Design Criteria,* provide the basis for review of all planned and existing construction and operation for the potential for accidents and the assessment of the associated human health and environmental consequences, should an accident occur. The results of these reviews are used as the basis for determining the need for controls or other mitigative actions to eliminate or greatly reduce the potential for, and consequences of, an accident. These reviews are required before authorization of construction or start of operation. These reviews also involve the identification of hazards and an analysis of normal, abnormal, and accident conditions. This analysis includes consideration of natural and man-made external events including fires, floods, tornadoes, earthquakes, other severe weather events, human errors, and explosions. The sites associated with the tritium supply and recycling proposal have complied with applicable DOE orders.

In accordance with DOE Order 5500.1B, *Emergency Management System*, emergency response planning and training are provided to mitigate the consequences of potential accidents. Additionally, should an accident occur, the incident would be reported in accordance with DOE Orders 5000.3B, *Occurrence Reporting and Processing of Operations Information*, and 5400.4, *Comprehensive Environmental Response, Compensation, and Liability Act Requirements*. The reports would also include appropriate corrective action(s) and followup.

Consequences of the Tritium Supply and Recycling Proposal on Candidate Site Workplace Safety and Accidents. Construction and operation of tritium supply and recycling facilities at potential candidate sites would result in increased exposure of site workers to industrial-type work hazards and accidents. In addition, levels of risk to workers in new construction increases in relation to the amount of new construction required for the tritium supply and recycling facilities. Based on the length of construction periods for the candidate tritium supply technologies, the Modular High Temperature Gas-Cooled Reactor (MHTGR) (9 years) and the Heavy Water Reactor (HWR) (8 years) would have the largest risk and the Accelerator Production of Tritium (APT) (5 years) the least construction accident risk. Based on technology designs, the MHTGR and APT would be expected to have increased worker safety and accident risks during construction because of the deep below ground excavation required for reactor vessel and accelerator tunnel construction. Table 5.5–1 shows the relative risk of fatalities due to construction by technology. Before implementation of the tritium supply and recycling proposal at any site, however, notification would be made to the site's environmental, safety, and health staff that a new process or facility is being planned, or that an existing process is being considered for change or modification to allow the impact of the anticipated change on the work environment to be evaluated.

Appropriate measures would be implemented to minimize work hazards and accidents based on this early evaluation. Once operational, as part of the Occupational Safety and Health Program at each site, ongoing surveillance of the new or modified processes or activities would be performed to identify potential health hazards. If potential health hazards are identified, a hazard evaluation would be conducted to determine the extent of the hazard and if required, the recommended control measures. Where feasible, engineering controls would be used to protect worker health and safety. Administrative controls and personal protective equipment would supplement engineering controls as appropriate.

TABLE 5.3–1.—*Federal Environmental Statutes, Regulations, and Orders* [Page 1 of 5]

Resource Category	Statute/Regulation/Order	Citation	Responsible Agency	PEIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications
Air Resources	Clean Air Act (CAA), as amended	42 USC §§7401 et seq.	EPA	Requires sources to meet standards and obtain permits to satisfy: National Ambient Air Quality Standards (NAAQS), State Implementation Plans, Standards of Performance for New Stationary Sources, National Emission Standards for Hazardous Air Pollutants (NESHAP), and Prevention of Significant Deterioration.
	National Ambient Air Quality Standards/State Implementation Plans	42 USC §§7409 et seq.	EPA	Requires compliance with primary and secondary ambient air quality standards governing SO_2, NO_x, CO, O_3, Pb, and PM_{10} and emission limits/reduction measures as designated in each state's State Implementation Plan.
	Standards of Performance for New Stationary Sources	42 USC §7411	EPA	Establishes control/emission standards and recordkeeping requirements for new or modified sources specifically addressed by a standard.
	National Emission Standards for Hazardous Air Pollutants	42 USC §7412	EPA	Requires sources to comply with emission levels of carcinogenic or mutagenic pollutants; may require a preconstruction approval, depending on the process being considered and the level of emissions that will result from the new or modified source.
	Prevention of Significant Deterioration	42 USC §§7470 et seq.	EPA	Applies to areas that are in compliance with NAAQS. Requires comprehensive preconstruction review and the application of Best Available Control Technology to major stationary sources (emissions of 100 tons/year) and major modifications; requires a preconstruction review of air quality impacts and the issuance of a construction permit from the responsible state agency setting forth emission limitations to protect the Prevention of Significant Deterioration increment.
	Noise Control Act of 1972	42 USC §§4901 et seq.	EPA	Requires facilities to maintain noise levels that do not jeopardize the health and safety of the public.
Water Resources	Clean Water Act (CWA)	33 USC §§1251 et seq.	EPA	Requires EPA or state-issued permits and compliance with provisions of permits regarding discharge of effluents to surface waters.
	National Pollutant Discharge Elimination System (NPDES) (section 402 of CWA)	33 USC §1342	EPA	Requires permit to discharge effluents (pollutants) to surface waters and stormwaters; permit modifications are required if discharge effluents are altered.
	Dredged or Fill Material - (section 404 of CWA)/Rivers and Harbors Appropriations Act of 1899	33 USC §1344/ 33 USC §§401 et seq.	U.S. Army Corps of Engineers	Requires permits to authorize the discharge of dredged or fill material into navigable waters or wetlands and to authorize certain structures or work in or affecting navigable waters.

TABLE 5.3–1.—*Federal Environmental Statutes, Regulations, and Orders* [Page 2 of 5]

Resource Category	Statute/Regulation/Order	Citation	Responsible Agency	PEIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications
Water Resources (continued)	Wild and Scenic Rivers Act	16 USC §§1271 et seq.	Fish and Wildlife Service (USFWS), Bureau of Land Management, Forest Service, National Park Service	Consultation required before construction of any new Federal project associated with a river designated as wild and scenic or under study in order to minimize and mitigate any adverse effects on the physical and biological properties of the river.
	Safe Drinking Water Act (SDWA)	42 USC §§300f et seq.	EPA	Requires permits for construction/operation of underground injection wells and subsequent discharging of effluents to ground aquifers.
	Executive Order 11988: Floodplain Management	3 CFR, 1977 Comp., p. 117	Water Resources Council, Federal Emergency Management Agency, Council on Environmental Quality (CEQ)	Requires consultation if project impacts a floodplain.
	Executive Order 11990: Protection of Wetlands	3 CFR, 1977 Comp., p. 121	U.S. Army Corps of Engineers/USFWS	Requires Federal agencies to avoid the long and short term adverse impacts associated with the destruction or modification of wetlands.
	Compliance with Floodplain/Wetlands Environmental Review Requirements	10 CFR 1022	DOE	Requires DOE to comply with all applicable floodplain/wetlands environmental review requirements.
Hazardous Wastes and Soil Resources	Resource Conservation and Recovery Act (RCRA)/Hazardous and Solid Waste Amendments of 1984	42 USC §§6901 et seq./PL 98-616	EPA	Requires notification and permits for operations involving hazardous waste treatment, storage, or disposal facilities; changes to site hazardous waste operations could require amendments to RCRA hazardous waste permits involving public hearings.
	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)/Superfund Amendments and Reauthorization Act of 1986 (SARA)	42 USC §§9601 et seq./PL 99-499	EPA	Requires cleanup and notification if there is a release or threatened release of a hazardous substance; requires DOE to enter into Interagency Agreements with EPA and state to control the cleanup of each DOE site on the National Priorities List (NPL).
	Executive Order 12580: Superfund Implementation	3 CFR, 1987 Comp., p. 193	EPA	DOE shall comply with the National Contingency Plan (NCP) in addition to the other requirements of the order, as amended.

TABLE 5.3–1.—*Federal Environmental Statutes, Regulations, and Orders* [Page 3 of 5]

Resource Category	Statute/Regulation/Order	Citation	Responsible Agency	PEIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications
Hazardous Wastes and Soil Resources (continued)	Community Environmental Response Facilitation Act	PL 102-426	EPA	Amends CERCLA (40 CFR 300) to establish a process for identifying, prior to the termination of Federal activities, property that does not contain contamination. Requires prompt identification of parcels that will not require remediation to facilitate the transfer of such property for economic redevelopment purposes.
	Farmland Protection Policy Act of 1981	7 USC §§4201 et seq.	Soil Conservation Service	DOE shall avoid any adverse effects to prime and unique farmlands.
	Federal Facility Compliance Act of 1992	42 USC §6961	States	Waivers of sovereign immunity for Federal facilities under RCRA and requires DOE to develop plans and enter into agreements with states as to specific management actions for specific mixed waste streams.
Biotic Resources	Fish and Wildlife Coordination Act	16 USC §§661 et seq.	USFWS	Requires consultation on the possible effects on wildlife if there is construction, modification, or control of bodies of water in excess of 10 acres in surface area.
	Bald and Golden Eagle Protection Act	16 USC §§668 et seq.	USFWS	Consultations should be conducted to determine if any protected birds are found to inhabit the area.. If so, DOE must obtain a permit prior to moving any nests due to construction or operation of project facilities. .
	Migratory Bird Treaty Act	16 USC §§703 et seq.	USFWS	Requires consultation to determine if there are any impacts on migrating bird populations due to construction or operation of project facilities. If so, DOE will develop mitigation measures to avoid adverse effects.
	Wilderness Act of 1964	16 USC §§1131 et seq.	Department of Commerce and DOI	DOE shall consult with the Department of Commerce and DOI and minimize impact.
	Wild Free-Roaming Horses and Burros Act of 1971	16 USC §§1331 et seq.	DOI	DOE shall consult with DOI and minimize impact.
	Endangered Species Act of 1973	16 USC §§1531 et seq.	USFWS/National Marine Fisheries Service	Requires consultation to identify endangered or threatened species and their habitats, assess DOE impacts thereon, obtain necessary biological opinions and, if necessary, develop mitigation measures to reduce or eliminate adverse effects of construction or operation.
Cultural Resources	National Historic Preservation Act of 1966, as amended	16 USC §§470 et seq.	President's Advisory Council on Historic Preservation	DOE shall consult with the State Historic Preservation Office (SHPO) prior to construction to ensure that no historical properties will be affected.
	Archaeological and Historical Preservation Act of 1974	16 USC §§469 et seq.	DOI	DOE shall obtain authorization for any disturbance of archaeological resources.
	Archaeological Resources Protection Act of 1979	16 USC §§470aa et seq.	DOI	DOE shall obtain authorization for any excavation or removal of archaeological resources.
	Antiquities Act	16 USC §§431-33	DOI	DOE shall comply with all applicable sections of the Act.

TABLE 5.3–1.—*Federal Environmental Statutes, Regulations, and Orders* [Page 4 of 5]

Resource Category	Statute/Regulation/Order	Citation	Responsible Agency	PEIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications
Cultural Resources (continued)	American Indian Religious Freedom Act of 1978	42 USC §1996	DOI	DOE shall consult with local Native American Indian tribes prior to construction to ensure that their religious customs, traditions, and freedoms are preserved.
	Native American Graves Protection and Repatriation Act of 1990	25 USC §3001	DOI	DOE shall consult with local Native American Indian tribes prior to construction to guarantee that no Native American graves are disturbed.
	Executive Order 11593: Protection and Enhancement of the Cultural Environment	3 CFR 154, 1971-1975 Comp., p. 559	DOI	DOE shall aid in the preservation of historic and archaeological data that may be lost during construction activities.
Worker Safety and Health	Occupational Safety and Health Act (OSHA)	5 USC §5108	OSHA	Agencies shall comply with all applicable worker safety and health legislation (including guidelines of 29 CFR 1960) and prepare, or have available, Material Safety Data Sheets.
	Hazard Communication Standard	29 CFR 1910.1200	OSHA	DOE shall ensure that workers are informed of, and trained to handle, all chemical hazards in the DOE workplace.
Other	Atomic Energy Act of 1954	42 USC §2011	DOE	DOE shall follow its own standards and procedures to ensure the safe operation of its facilities.
	National Environmental Policy Act (NEPA)	42 USC §§4321 et seq.	CEQ	DOE shall comply with NEPA implementing procedures in accordance with 10 CFR 1021.
	Uranium Mill Tailings Radiation Control Act of 1978	42 USC §§7901 et seq.	EPA	DOE shall enforce and implement health and environmental standards and acquire licenses when required.
	Toxic Substances Control Act (TSCA)	15 USC §§2601 et seq.	EPA	DOE shall comply with inventory reporting requirements and chemical control provisions of TSCA to protect the public from the risks of exposure to chemicals; TSCA imposes strict limitations on use and disposal of PCB-contaminated equipment.
	Hazardous Materials Transport Action Act	49 USC §§1801 et seq.	DOT	DOE shall comply with the requirements governing hazardous materials and waste transportation.
	Hazardous Materials Transportation Uniform Safety Act of 1990	49 USC §1801	DOT	Restricts shippers of highway route-controlled quantities of radioactive materials to use only permitted carriers.
	Emergency Planning and Community Right-To-Know Act of 1986	42 USC §§11001 et seq.	EPA	Requires the development of emergency response plans and reporting requirements for chemical spills and other emergency releases, and imposes right-to-know reporting requirements covering storage and use of chemicals which are reported in toxic chemical release forms.

TABLE 5.3–1.—*Federal Environmental Statutes, Regulations, and Orders* [Page 5 of 5]

Resource Category	Statute/Regulation/Order	Citation	Responsible Agency	PEIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications
Other (continued)	Pollution Prevention Act of 1990	42 USC 11001-11050	EPA	Establishes a national policy that pollution should be reduced at the source and requires a toxic chemical source reduction and recycling report for an owner or operator of a facility required to file an annual toxic chemical release form under section 313 of SARA.
	Executive Order 12843: Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances	April 21, 1993	EPA	Requires Federal agencies to minimize procurement of ozone depleting substances and conform their practices to comply with Title VI of CAA Amendments reference stratospheric ozone protection and to recognize the increasingly limited availability of Class I substances until final phaseout.
	Executive Order 12856: Federal Compliance with Right-To-Know Laws and Pollution Prevention Requirements	August 3, 1993	EPA	Requires Federal agencies to achieve 50 percent reduction of agency's total releases of toxic chemicals to the environment and offsite transfers, to prepare a written facility pollution prevention plan not later than 1995, and to publicly report toxic chemicals entering any waste stream from Federal facilities, including any releases to the environment, and to improve local emergency planning, response and accident notification.
	Executive Order 12873: Federal Acquisition, Recycling, and Waste Prevention	October 20, 1993	EPA	Requires Federal agencies to develop affirmative procurement policies and establishes a shared responsibility between the system program manager and the recycling community to effect use of recycled items for procurement.
	Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	February 11, 1994	EPA	Requires Federal agencies to identify and address as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.
	Executive Order 12088: Federal Compliance with Pollution Control Standards	3 CFR, 1978 Comp., p. 243	Office of Management and Budget	Requires Federal agency landlords to submit to OMB an annual plan for the control of environmental pollution and to consult with EPA and state agencies regarding the best techniques and methods.
	Executive Order 11514: Protection and Enhancement of Environmental Quality	3 CFR, 1966-1970 Comp., p. 902	CEQ	Requires Federal agencies to demonstrate leadership in achieving the environmental quality goals of NEPA; provides for DOE consultation with appropriate Federal, state, and local agencies in carrying out their activities as they affect the environment.
	Nuclear Waste Policy Act of 1982	42 USC §§10101 et seq.	EPA	DOE shall dispose of radioactive waste per standards of 40 CFR 191.
	Low-Level Radioactive Waste Policy Act	42 USC §§2021b-2021d	NRC	DOE shall dispose of LLW per compacts of the states in which it operates.

TABLE 5.3–2.—*Selected Department of Energy Environment, Safety, and Health Orders*

DOE Order	Order Title
1540.2	Hazardous Material Packaging for Transport-Administrative Procedures
1540.3A	Base Technology for Radioactive Material Transportation Packaging Systems
3790.1B	Federal Employee Occupational Safety and Health Program
5000.3B	Occurrence Reporting and Processing of Operations Information
5400.1	General Environmental Protection Program
5400.2A	Environmental Compliance Issue Coordination
5400.4	Comprehensive Environmental Response, Compensation, and Liability Act Requirements
5400.5	Radiation Protection of the Public and the Environment
5440.1E	National Environmental Policy Act Compliance Program
5480.1B	Environment, Safety, and Health Program for Department of Energy Operations
5480.3	Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Waste
5480.4	Environmental Protection, Safety, and Health Protection Standards
5480.6	Safety of Department of Energy-Owned Nuclear Reactors
5480.7A	Fire Protection
5480.9A	Construction Project Safety and Health Management
5480.10	Contractor Industrial Hygiene Program
5480.11	Radiation Protection for Occupational Workers
5480.19	Conduct of Operations Requirements for DOE Facilities
5480.21	Unreviewed Safety Questions
5480.22	Technical Safety Requirements
5480.23	Nuclear Safety Analysis Reports
5480.24	Nuclear Criticality Safety
5481.1B	Safety Analysis and Review System
5482.1B	Environment, Safety, and Health Appraisal Program
5483.1A	Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities
5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements
5500.1B	Emergency Management System
5500.3A	Planning and Preparedness for Operational Emergencies
5530.1A	Accident Response Group
5530.4	Aerial Measuring System
5630.11B	Safeguards and Security Program
5630.12A	Safeguards and Security Inspection and Assessment Program
5632.1C	Protection and Control of Safeguards and Security Interests
5700.6C	Quality Assurance
5820.2A	Radioactive Waste Management
6430.1A	General Design Criteria

TABLE 5.3–3.—*Department of Energy Agreements with Federal and State Environmental Regulatory Agencies*

Facility	Resource Category	Parties (Agency/State)	Scope of Agreement	Effective Date
Idaho National Engineering Laboratory	Air	DOE/ID	CAA-Consent Order (Permit to construct)	02/11/92
	Water	DOE/ID	RCRA-Consent Order on percolation ponds	10/07/92
	Soil	DOE/EPA/ID	CERCLA/RCRA-Federal Facility Agreement & Consent Order	12/09/91
	Soil	DOE/ID/EPA	RCRA-Consent Order	04/03/92
Nevada Test Site	Soil	DOE/NV	RCRA-Settlement Agreement-TRU mixed waste	07/23/92
	Cultural	DOE/NV	Programmatic Agreement-Archaeological and Historic Preservation activities	05/08/93
Oak Ridge Reservation	Air	DOE/EPA	CAA-Federal Facility Compliance Agreement, Radionuclide NESHAP	05/26/92
	Soil	DOE/EPA/TN	CERCLA-Federal Facility Agreement	01/01/92
	Soil	DOE/EPA	RCRA-Federal Facility Compliance Agreement for storage of mixed waste subject to Land Disposal Restrictions	06/12/92
Pantex Plant	Soil	DOE/EPA	RCRA-Section 3008 (h) Administrative Order on Consent	12/10/90
Savannah River Site	Air	DOE/EPA	CAA-Federal Facility Compliance Agreement for Radionuclide NESHAP	10/31/91
	Water	DOE/SC	CWA-Consent Order 84-4-W, Thermal discharge limitations, with amendment	01/03/84, 08/31/87
	Water	DOE/SC	CWA-Settlement Agreement 90-13-W, Construction of a wastewater treatment facility	02/27/90, 01/16/91
	Water	DOE/SC	CWA-Settlement Agreement 90-25-W, Thermal mitigation of minor discharges	06/05/90
	Water	DOE/SC	CWA-Settlement Agreement 90-26-W, Fish kill mitigation	06/05/90
	Water	DOE/SC	CWA-Settlement Agreement 91-44-W, NPDES	07/31/91
	Soil	DOE/SC	RCRA-Settlement Agreement 87-52-SW with amendment, Part B application deficiencies; groundwater monitoring	11/12/87, 05/10/91
	Soil	DOE/SC	RCRA/SC Hazardous Waste Management Act-Consent Decree - Civil Action	05/26/88, 08/03/89
	Soil	DOE/EPA	RCRA-Federal Facility Compliance Agreement for Land Disposal Restrictions, with amendment 1, Docket No. 91-01-FFR	03/13/91, 04/24/92
	Soil	DOE/SC	RCRA-Settlement Agreement 91-51-SW, Solvent rag violations	08/26/91
	Soil	DOE/EPA/SC	CERCLA/RCRA-Federal Facility Agreement	01/15/93
	Cultural	DOE/SHPO ACHP	Programmatic Memorandum of Agreement-Management of archaeological sites	08/24/90

TABLE 5.3–4.—*State Environmental Statutes, Regulations, and Orders* [Page 1 of 5]

Resource Category	Legislation	Citation	Responsible Agency	Potential Applicability/Permits
Idaho National Engineering Laboratory, Idaho				
Air Resources	Idaho Environmental Protection and Health Act	ID Code, Title 39, Chapter 101	ID Department of Health and Welfare	Permit required prior to construction or modification of an air contaminant source.
	Idaho Department of Health and Welfare Rules	ID Code, Title 39, Chapter 1	ID Department of Health and Welfare	Permit required prior to construction or modification of an air contaminant source.
Water Resources	Idaho Wastewater-Land Application Permit Regulations	ID Rules/Regs., Title 1, Chapter 17	ID Department of Health and Welfare	Permit required prior to construction or modification of a water discharge source.
	Idaho Water Pollution Control Act	ID Code, Title 39, Chapter 36	ID Department of Health and Welfare	Permit required prior to construction or modification of a water discharge source.
	Idaho Water Quality Standards	ID Rules/Regs., Title 1, Chapter 2	ID Department of Water Resources, Resource Administration Division	Permit required prior to the construction or operation of a wastewater injection well.
	Idaho Stream Channel Protection Act	ID Code, Title 42, Chapter 38	ID Department of Water Resources	Permit required prior to dredge or fill of any stream.
	Idaho Lake Protection Act	ID Code, Section 58-142 et seq.	ID Department of Lands	Permit required prior to dredge or fill of any lake.
Hazardous Wastes and Soil Resources	Idaho Hazardous Waste Management Act	ID Code, Title 39, Chapter 44	ID Department of Health and Welfare	Permit required prior to construction or modification of a hazardous waste disposal facility.
	Idaho Hazardous Waste Management Regulations	ID Rules/Regs., Title 1, Chapter 5	ID Department of Health and Welfare	Permit required prior to construction or modification of a hazardous waste disposal facility.
Biotic Resources	No state-level legislation identified			
Cultural Resources	Idaho Historic Preservation Act	ID Code, Title 67, Chapter 46	ID Historic Preservation Commission	Consult with responsible local governing body.
Worker Safety and Health	No state-level legislation identified			
Nevada Test Site, Nevada				
Air Resources	Nevada Air Pollution Control Law	NV Statutes, Title 40	NV State Environmental Commission	Permit required prior to construction or modification of an air contaminant source.
	Nevada Air Quality Regulations	NV Admin. Code, Chapter 445	NV State Environmental Commission	Permit required prior to construction or modification of an air contaminant source.

TABLE 5.3–4.—*State Environmental Statutes, Regulations, and Orders* [Page 2 of 5]

Resource Category	Legislation	Citation	Responsible Agency	Potential Applicability/Permits
Water Resources	Nevada Water Pollution Control Law	NV Statutes, Title 40, Chapter 445	NV Department of Environmental Protection	Permit required prior to construction or modification of a water discharge source.
	Nevada Water Pollution Control Regulations	NV Admin. Code, Chapter 445	NV Department of Environmental Protection	Permit required prior to construction or modification of a water discharge source.
Hazardous Wastes and Soil Resources	Nevada Underground Storage Tank Rules	NV Admin. Code, Chapter 459	NV Department of Environmental Protection	Permit required prior to construction or modification of an underground storage tank.
	Nevada Solid Waste Disposal Law	NV Statutes, Title 40, Chapter 444	NV Department of Environmental Protection	Permit required prior to construction or modification of a solid waste disposal facility.
	Nevada Solid Waste Disposal Regulations	NV Admin. Code, Chapter 44	NV Department of Environmental Protection	Permit required prior to construction or modification of a solid waste disposal facility; permit for septage hauling may be required.
	Nevada Hazardous Waste Disposal Law	NV Statutes, Title 40, Chapter 459	NV Department of Environmental Protection	Permit required prior to construction or modification of a hazardous waste disposal facility.
	Nevada Hazardous Waste Facility Regulations	NV Admin. Code, Chapter 444	NV Department of Environmental Protection	Permit required prior to construction or modification of a hazardous waste disposal facility.
Biotic Resources	Nevada Non-Game Species Act	NV Admin. Code, Title 45, Chapter 503	NV Department of Wildlife	Consult with NV Department of Wildlife and minimize impact.
Cultural Resources	Historic Preservation and Archaeology Regulations	NV Statutes, Title 26, Chapter 381-383	NV Advisory Board for Historic Preservation and Archaeology	Permit required prior to the investigation, exploration, or excavation of an historic or prehistoric site.
Worker Safety and Health	No state-level legislation identified			
		Oak Ridge Reservation, Tennessee		
Air Resources	Tennessee Air Pollution Control Regulations	TN Rules, Division of Air Pollution	TN Air Pollution Control Board	Permit required to construct, modify, or operate an air contaminant source; sets fugitive dust requirements.
Water Resources	Tennessee Water Quality Control Act	TN Code, Title 69, Chapter 3	TN Water Quality Control Board	Authority to issue new or modify existing NPDES permits required for a water discharge source.

TABLE 5.3–4.—*State Environmental Statutes, Regulations, and Orders* [Page 3 of 5]

Resource Category	Legislation	Citation	Responsible Agency	Potential Applicability/Permits
Hazardous Wastes and Soil Resources	Tennessee Underground Storage Tank Program Regulations	TN Rules, Chapter 1200-1-15	TN Division of UST Programs	Permit required prior to construction or modification of an underground storage tank.
	Tennessee Hazardous Waste Management Act	TN Code, Title 68, Chapter 46	TN Division of Solid Waste Management	Permit required to construct, modify, or operate a hazardous waste treatment, storage, or disposal facility.
	Tennessee Solid Waste Processing and Disposal Regulations	TN Rules, Chapter 1200-1-7	TN Division of Solid Waste Management	Permit required to construct or operate a solid waste processing or disposal facility.
Biotic Resources	Tennessee State Executive Order on Wetlands	TN State Executive Order	TN Division of Water Quality Control	Consultation with responsible agency.
	Tennessee Threatened Wildlife Species Conservation Act of 1974	TN Code, Title 70, Chapter 8	TN Wildlife Resources Agency	Consultation with responsible agency.
	Tennessee Rare Plant Protection and Conservation Act of 1985	TN Code, Title 70, Chapter 8-301 et seq.	TN Wildlife Resources Agency	Consultation with responsible agency.
	Tennessee Water Quality Control Act	TN Code, Title 69, Chapter 3	TN Division of Water Quality Control	Permit required prior to alteration of a wetland.
Cultural Resources	Tennessee Desecration of Venerated Objects	TN Code, Title 39, Chapter 17-311	TN Historical Commission	Forbids a person to offend or intentionally desecrate venerated objects including a place of worship or burial.
	Tennessee Abuse of Corpse	TN Code, Title 39, Chapter 17-312	TN Historical Commission	Forbids a person from disinterring a corpse that has been buried or otherwise interred.
	Native American Indian Cemetery Removal and Reburial	TN Comp. Rules and Regulations, Chapter 400-9-1	TN Historical Commission	Requires notification if Native American Indian remains are uncovered.
	Tennessee Protective Easements	TN Code, Title 11, Chapter 15-101	TN State Government	Grants power to the state to restrict construction on land deemed as a "protective" easement.
Worker Safety and Health	No state-level legislation identified			
Pantex Plant, Texas				
Air Resources	Texas Air Pollution Control Regulations	TX Admin. Code, Title 30, Chapter 101-125, 305	TX Natural Resource Conservation Commission (effective 9/1/93)	Permit required prior to construction or modification of an air contaminant source.

TABLE 5.3–4.—*State Environmental Statutes, Regulations, and Orders* [Page 4 of 5]

Resource Category	Legislation	Citation	Responsible Agency	Potential Applicability/Permits
Water Resources	Texas Water Quality Standards	TX Admin. Code, Title 30, Chapter 305, 308-325	TX Natural Resource Conservation Commission (effective 9/1/93)	A permit may be required prior to any modification of Waters of the United States including stream alteration for the construction of intakes, discharges, bridges, submarine utility crossings, etc.
	Texas Consolidated Permit Rules	TX Admin. Code, Title 30	TX Natural Resource Conservation Commission (effective 9/1/93)	A permit may be required prior to any modification of waters of the State including stream alteration for the construction of intakes, discharges, bridges, submarine utility crossings, etc.
	Texas Water Quality Acts	TX Code, Title 30, Chapter 290	TX Natural Resource Conservation Commission (effective 9/1/93)	A permit may be required prior to any modification of waters of the State including stream alteration for the construction of intakes, discharges, bridges, submarine utility crossings, etc.
Hazardous Wastes and Soil Resources	Texas Underground Storage Tanks Rules	TX Admin. Code, Title 30, Chapter 334	TX Natural Resource Conservation Commission (effective 9/1/93)	Permit required prior to construction or modification of an underground storage tank.
	Texas Solid Waste Management Regulations	TX Admin. Code, Title 30, Chapter 305, 335	TX Natural Resource Conservation Commission (effective 9/1/93)	Permit required prior to construction or modification of a solid waste disposal facility.
	Texas Solid Waste Disposal Act	TX Statutes, Article 4477-7	TX Natural Resource Conservation Commission (effective 9/1/93)	Permit required prior to construction or modification of a solid waste disposal facility.
Biotic Resources	Texas Parks and Wildlife Regulations	TX Parks and Wildlife Code, Chapters 67, 68, & 88	TX Parks and Wildlife Department	Permit required by anyone who possesses, takes, or transports endangered, threatened, or protected plants or animals.
Cultural Resources	Antiquities Code of Texas	TX Statutes, Volume 17, Article 6145	TX State Historical Survey Committee	Permit required for the examination or excavation of sites and the collection or removal of objects of antiquity.
Worker Safety and Health	No state-level legislation identified			

TABLE 5.3–4.—*State Environmental Statutes, Regulations, and Orders* [Page 5 of 5]

Resource Category	Legislation	Citation	Responsible Agency	Potential Applicability/Permits
		Savannah River Site, South Carolina		
Air Resources	South Carolina Pollution Control Act/South Carolina Air Pollution Control Regulations and Standards	SC Code, Title 48, Chapter 1	SC Dept. of Health and Environmental Control	Permit required prior to construction or modification of an air contaminant source.
	Augusta-Aiken Air Quality Control Region	40 CFR 81.114	SC and GA	Requires SRS and surrounding communities in the 2-state region to attain NAAQS.
	South Carolina Atomic Energy & Radiation Control Act	SC Code, Title 13, Chapter 7	SCDHEC	Establishes standards for radioactive air emissions.
Water Resources	South Carolina Pollution Control Act	SC Code, Title 48, Chapter 1	SCDHEC	Permit required prior to construction or modification of a water discharge source.
	South Carolina Water Quality Standards	SC Code, Title 61, Chapter 68	SCDHEC	Permit required prior to construction or modification of a water discharge source.
	South Carolina Safe Drinking Water Act	SC Code, Title 44, Chapter 55	SCDHEC	Establishes drinking water standards.
Hazardous Wastes and Soil Resources	South Carolina Underground Storage Tanks Act	SC Code, Title 44, Chapter 2	SCDHEC	Permit required prior to construction or modification of an underground storage tank.
	South Carolina Solid Waste Regulations	SC Code, Title 61, Chapter 60	SCDHEC	Permit required to store, collect, dispose, or transport solid wastes.
	South Carolina Industrial Solid Waste Disposal Site Regulations	SC Code, Title 61, Chapter 66	SC Pollution Control Authority	Permit required for industrial solid waste disposal systems.
	South Carolina Hazardous Waste Management Act	SC Code, Title 44, Chapter 56	SCDHEC	Permit required to operate, construct, or modify a hazardous waste treatment, storage, or disposal facility.
	South Carolina Solid Waste Management Act	SC Code, Title 44, Chapter 96	SCDHEC	Establishes standards to treat, store, or dispose of solid waste.
Biotic Resources	South Carolina Nongame and Endangered Species Conservation Act	SC Code, Title 50, Chapter 15	SC Wildlife and Marine Resources Department	Consult with SC Wildlife and Marine Resources Department and minimize impact.
Cultural Resources	South Carolina Institute of Archaeology and Anthropology	SC Code, Title 60, Chapter 13-210	SC State Historic Preservation Office	Consult with SC State Historic Preservation Office and minimize impact.
Worker Safety and Health	No state-level legislation identified			

TABLE 5.5–1.—*Estimated Number of Construction Worker Fatalities by Technology*

	HWR	MHTGR	ALWR/Large	ALWR/Small	APT	Tritium Recycling
Potential accidental worker deaths[a]	2.1	1.9	2.8	1.6	.8	.2

[a] Results are based on the death rates experienced for construction workers in 1993. For the construction industry in general in 1993, the death rate was 22 deaths per 100,000 worker-years.

Source: NSC 1994a.

REFERENCES

References

CHAPTER 6: REFERENCES

REGULATION, ORDER, LAW

10 CFR 20 — Nuclear Regulatory Commission (NRC), "Energy: Standards for Protection Against Radiation," *Code of Federal Regulations,* Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, January 1, 1992.

10 CFR 71 — NRC, "Energy: Packaging and Transportation of Radioactive Material," *Code of Federal Regulations,* Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, January 1, 1992.

10 CFR 1022 — Department of Energy (DOE), "Energy: Compliance with Floodplains/Wetlands Environmental Review Requirements," *Code of Federal Regulations*, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, January 1, 1992.

29 CFR 1910.106 — Occupational Safety and Health Administration Labor, "Flammable and Combustible Liquids,", Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, January 1, 1992.

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Mills, Thomas M., Nuclear Materials Lead, SRA Technologies, Inc.
M.S., Physics, 1971, U.S. Naval Postgraduate School, Monterey, CA
B.S., Chemical Engineering, 1962, Brooklyn Polytechnic Institute, Brooklyn, NY
Years of Experience: 32

Minnoch, John K., Jr., Intersite Transportation Task Leader, SRA Technologies, Inc.
M.B.A., Finance, 1972, University of Utah, Salt Lake City, UT
B.S., Air Science, 1960, Oklahoma State University, Stillwater, OK
Years of Experience: 32

Olson, David G., PEIS QA Representative, Halliburton NUS Corp.
B.S., Chemistry, 1963, Duquesne University, Pittsburgh, PA
Years of Experience: 29

Rench, Jerry D., Chemical Health Risk Assessment Task Leader, SRA Technologies, Inc.
Ph.D., Environmental Health, 1979, Colorado State University, Fort Collins, CO
M.S., Environmental Health, 1976, Colorado State University, Fort Collins, CO
A.B., Zoology, 1972, Indiana University, Bloomington, IN
Years of Experience: 18

Rikhoff, Jeffrey J., Technical Coordinator for Air Quality and Acoustics, Biotic Resources, Human Health: Normal Operations and Accidents, Halliburton NUS Corp.
M.R.P., Regional Planning, 1988, University of Pennsylvania, Philadelphia, PA
M.S., Development Economics, 1987, University of Pennsylvania, Philadelphia, PA
B.A., English, 1980, Depauw University, Greencastle, IN
Years of Experience: 11

Roed, Carl J., Project Definition Site Task Leader, Lamb Associates, Inc.
M.B.A., Management, 1986, Salve Regina College, Newport, RI
B.A., Public Administration, 1969, San Diego State College, San Diego, CA
Years of Experience: 26

Rose, James J., PEIS Document Manager, DP-25, DOE
J.D., 1994, Columbus School of Law, Catholic University, Washington, DC
B.S., Ocean Engineering, 1983, U.S. Naval Academy, Annapolis, MD
Years of Experience: 12

Schinner, James R., Biotic Resources Discipline Leader, Halliburton NUS Corp.
Ph.D., Wildlife Management, 1974, Michigan State University, East Lansing, MI
B.S., Zoology, 1967, University of Cincinnati, Cincinnati, OH
Years of Experience: 22

Schlegel, Robert L., Radiological Health Risk Assessment Task Leader, Halliburton NUS Corp.
M.S., Nuclear Engineering, 1961, Columbia University, New York, NY
B.S., Chemical Engineering, 1959, Massachusetts Institute of Technology, Cambridge, MA
Years of Experience: 30

Schweitzer, Eric A., Deputy Director, Office of Reconfiguration, DP-25, DOE
M.U.R.P., Urban and Regional Planning, 1971, University of Pittsburgh, Pittsburgh, PA
B.A., Geography, 1969, Indiana University, Bloomington, IN
Years of Experience: 24

Silhanek, Jay S., Waste Management Task Leader, Lamb Associates, Inc.
M.P.H., Health Physics, 1961, University of Michigan, Ann Arbor, MI
M.S., Sanitary Engineering, 1957, University of Wisconsin, Madison, WI
B.S., Civil Engineering, 1956, Case Western Reserve, Cleveland, OH
Years of Experience: 37

Smith, Mark E., Deputy Project Task Manager, Tetra Tech, Inc.
B.S., Civil Engineering, 1987, Carnegie Mellon University, Pittsburgh, PA
Years of Experience: 8

Sohinki, Stephen M., Director, Office of Reconfiguration, DP-25, DOE
J.D., 1974, Georgetown University Law Center, Washington, DC
B.A., Political Science, 1971, University of Pittsburgh, Pittsburgh, PA
Years of Experience: 17

Steibel, John, Waste Management Technical Lead, SRA Technologies, Inc.
B.S., Industrial Engineering, Management Systems, 1958, General Motors Institute, Flint, MI
Years of Experience: 36

Sullivan, Barry D., Facility Accidents, Halliburton NUS Corp.
M.B.A., Management, 1964, Hofstra University, Hempstead, NY
B.S., Electrical Engineering, 1960, Rutgers University, New Brunswick, NJ
Years of Experience: 34

Swedock, Robert D., Project Definition Team Leader, Lamb Associates, Inc.
M.S., Civil Engineering, 1975, Stanford University, Stanford, CA
B.S., Military Science, 1968, U.S. Military Academy, West Point, NY
Years of Experience: 26

Toblin, Alan L., Health Physics Member, Halliburton NUS Corp.
M.S., Chemical Engineering, 1970, University of Maryland, College Park, MD
B.E., Engineering, 1968, The Cooper Union, New York, NY
Years of Experience: 24

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Currently enrolled, University of Virginia, Falls Church, VA
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Varner, Steven M., Local Transportation Task Leader, Halliburton NUS Corp.
M. Arch., Architecture, 1991, Virginia Polytechnic Institute and State University, Blacksburg, VA
B.S., Civil Engineering, 1987, Virginia Polytechnic Institute and State University, Blacksburg, VA
Years of Experience: 2

West, Terri S., Groundwater Task Leader, Tetra Tech, Inc.
B.S., Geology, 1985, Texas A&M University, College Station, TX
Years of Experience: 9

Westbrook, Chris R., Project Definition Site Task Leader, Lamb Associates, Inc.
M.S., Nuclear Engineering, 1980, Air Force Institute of Technology, Dayton, OH
M.A., Business Administration, 1976, Webster University, St. Louis, MO
B.S., Nuclear Engineering, 1973, University of Tennessee, Knoxville, TN
Years of Experience: 24

List of Agencies

List of Agencies

CHAPTER 8: LIST OF AGENCIES, ORGANIZATIONS, AND PERSONSTO WHOM COPIES OF THIS STATEMENT WERE SENT

This chapter lists agencies, organizations, and persons who requested Volumes I and II, and the Executive Summary of the *Draft Programmatic Environmental Impact Statement* (PEIS) for *Tritium Supply and Recycling*. Not listed are the many agencies, organizations, and persons who requested the Executive Summary or Volume II appendices.

Federal-Elected Officials Representing Affected Areas

States: Georgia
Idaho
Nevada
South Carolina
Tennessee
Texas

Governors Representing Affected Areas

States: Georgia
Idaho
Nevada
South Carolina
Tennessee
Texas

State Elected Officials Representing

States: Georgia
Idaho
Nevada
South Carolina
Tennessee
Texas

NEPA State Single Points of Contact

States: Georgia
Idaho
Nevada
South Carolina
Tennessee
Texas

Federal-Recognized Indian Tribes

Battle Mountain Band Council, NV
Bureau of Indain Affairs
Carson Community Council, NV
Cawtawba Indian Nation, SC
Coeur d'Alene Tribal Council, ID
Council of the Te-Moak, NV
Dresslerville Community Council, NV
Duckwater Shoshone Indian Tribe, NV
Elko Band Council, NV
Ely Colony Tribal Council, NV
Fallon Business Council, NV
Fort Hall Business Council Sho Ban Tribes, ID
Fort McDermitt Paiute-Shoshone Tribes, NV
Kootenai Tribal Council, ID
Las Vegas Indian Colony, NV
Moapa Paiute Indian Tribe, NV
National Congress of American Indians, DC
Nez Perce Tribal Executive Committee, ID
Northwestern Band of Shoshoni Nation
Pahrump Paiute Indian Tribe, NV
Pascua Yagui Tribal Council, NV
Reno/Sparks Tribal Council, NV
Shoshone Bannock Tribe, NV
Shoshone Paiute Business Council, NV
South Fork Band Council, NV
Stewart Community Council, NV
Summit Lake Paiute Council, NV
Walker River Paiute Tribal Council, NV
Wells Indian Colony Band Council, NV
Western Shoshone Elders Council, NV
Western Shoshone National Council, NV
Winnemucca Indian Colony, NV
Yerington Paiute Tribal Council, NV
Yomba Shoshone Indian Tribe, NV

Mayors Representing Affected Areas

Georgia	Idaho (Continued)	Nevada (Continued)	South Carolina (Continued)	Tennessee (Continued)	Tennessee (Continued)	Tennessee (Continued)	Texas
City	*City*	*City*	Salley	Fairfield Glade	New Tazwell	Vonore	*City*
Atlanta	Dubious	Warm Spring	Saluda	Fairview	Niota	Walland	Panhandle
Augusta	Firth	**South Carolina**	Springfield	Friendsville	Norris	Wartburg	Pullman
Bath	Fort Hall	*City*	Sycamore	Gatlinburg	Oakdale	Wildwood	Philips
Blyth	Hailey	Allendale	Trenton	Grandview	Oak Ridge	**Texas**	Sanford
Evans	Idaho Falls	Augusta	Vanville	Greenback	Old Washington	*City*	Skelleytown
Girard	Iona	Bamberg	Wagener	Harriman	Oliver Springs	Amarillo	Spearman
Harlem	Ketchum	Barnwell	Windsor	Halls Crossroads	Oneida	Ashota	Silverton
Hephzibah	Lewisville	Batesburg	Williston	Huntsville	Petros	Borger	Stinnett
Keysville	Menan	Blackville	**Tennessee**	Jacksonboro	Philadelphia	Bushland	Tulia
Martinez	Mud Lake	Beech Island	*City*	Jamestown	Pigeon Forge	Canyon	Vega
Millen	Pocatello	Columbia	Andersonville	Jefferson City	Pomona	Channing	Washburn
Sardis	Richfield	Denmark	Alcoa	Jellico	Powell	Clarendon	Wildorado
Savannah	Rigby	Edgefield	Allardt	Karns	Rockford	Claude	
Statesboro	Rupert	Estill	Athens	Kingston	Rockwood	Cliffside	
Thomson	Shelley	Gaston	Bethel	Knoxville	Rutledge	Conway	
Waynesboro	SunValley	Gloverville	Blaine	Kodak	Sevierville	Dial	
Wrens	Ucon	Graniteville	Briceville	La Follette	Sharps Chapel	Dawn	
Idaho	**Nevada**	Hampton	Caryville	Lake City	Solway	Dumas	
City	*City*	Jackson	Clarkrange	Lancing	Speedwell	Electric City	
Aberdeen	Alamo	Johston	Clinton	Lenoir City	Spring City	Fritch	
American Falls	Amargosa Valley	Leesville	Coalfield	Loudon	Strawberry Plains	Goodnight	
Ammon	Ash Springs	Monmorenci	Corrytown	Louisville	Sunbright	Groom	
Arco	Beatty	New Ellenton	Crossville	Luttrell	Sweetwater	Happy	
Atomic	Blue Diamond	North	Dandridge	Madisonville	Talbot	Hereford	
Basalt	Henderson	Norway	Decatur	Maryville	Tellico Plains	Lake Tanglewood	
Bellevue	Hiko	Orangeburg	Deer Lodge	Mascot	Ten Mile	Paloduro	
Blackfoot	Indian Springs	Owdoms	Elgin	Maynardville	Townsend	Pampa	
Butte	Las Vegas	Pelion	Etowah	Midtown	Washington		
Carey	Pahrump	Perry	Town of Farragut	New Market	Vonore		

Federal Agencies

Commission on Economic Development, NV
Council on Environmental Quality
Defense Contract Administration
Defense Nuclear Facilities Safety Board
Department of Archives & History, SC
Department of Conservation and Natural Resources, NV
Department of Conservation, TN
Department of Natural Resources
Defense Nuclear Facilities Safety Board
Defense Contract Administration
Environmental Protection Agency
Environmental Protection Agency, Region IV
Environmental Protection Agency, Region VI
Environmental Protection Agency, Region IX
Environmental Protection Agency, Region X
Federal Energy Regulatory Commission
Food and Drug Administration
General Accounting Office
General Services Administration
Georgia State Clearinghouse
Housing and Urban Development
Interstate Commerce Commission
Legislative and Intergoverment Affairs
Management Support Systems
Marine Mammal Commission
National Academy of Sciences
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
National Parks and Conservation
National Science Foundation
Office of Environmental Policy
Office of Management and Budget
Office of Regulatory Analysis
Office of Solid Waste and Emergency Response
Office of Technology Assessment
Small Business Administration
State and Local Federal Emergency Management Agency
U.S. Arms Control and Disarmament Agency
U.S. Army Corps of Engineers, GA
U.S. Army Corps of Engineers, ID
U.S. Army Corps of Engineers, NV
U.S. Army Corps of Engineers, SC
U.S. Army Corps of Engineers, TN
U.S. Army Corps of Engineers, TX
U.S. Bureau of Land Management
U.S. Department of Justice
U.S. Department of Labor
U.S. Department of the Interior, Region III
U.S. Department of the Interior, Region V
U.S. Department of the Interior, Region VII
U.S. Department of the Interior, Region VIII
U.S. Department of Housing and Urban Development Region II, V, VIII, and XI
U.S. Dept. of Transportation Environmental Division
U.S. General Accounting Office
U.S. Geological Survey
U.S. National Park Service
U.S. Nuclear Regulatory Commission

State Historical Preservation Officers

Idaho State Historic Society, ID
Department of Conservation and Natural Resources, NV
Department of Archives & History, SC
Department of Conservation, TN
Texas Historical Commission, TX

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Boyd, Susan
Burnfield, Dan L.
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Dunn, Loretta L.
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District of Columbia (Continued)
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Geddes, Richard
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Idaho
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Anderson, Clarence
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Beal, Seth E.
Beck, Rod
Beital, GA
Bennett, George A.
Bjornsen, Fritz
Black, Pete
Boatright, Clyde
Bodnar, Louis Z.
Bowman, A.L.
Breen, Micheal
Bridges,George
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Chang, Gray

Organizations and Individuals Requesting Copies to Date [Page 2 of 5]

Idaho (Continued)
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Wilcox, Debra
Worley, Tal

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McCord, Catherine
Zeyher, Allen

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New Jersey
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New Mexico
Armijo, Alan
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Carmichael, Jeff
Chanin, David I.
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Wolff, Louis

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Tennessee
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Dowbiggin
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Tennessee (Continued)
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Leuthke, James S.
Lindstrom, William
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Lough, David
Ludwig, Scott
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Organizations and Individuals Requesting Copies to Date [Page 4 of 5]

Tennessee (Continued)
Marine, Mayford W.
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Tennessee (Continued)
Stevens, John
Thomas, Mary
Thomas, Steven
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Organizations and Individuals Requesting Copies to Date [Page 5 of 5]

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GLOSSARY

Glossary

CHAPTER 9: GLOSSARY

Absorbed dose: The energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest in that material. Expressed in units of radiation absorbed dose or grays, where 1 radiation absorbed dose equals 0.01 gray. Also, see "radiation absorbed dose."

Accident sequence: An initiating event followed by system failures or operator errors, which can result in significant core damage, confinement system failure, and/or radionuclide releases.

Accountable weapon: The number of weapons associated with each missile or aircraft type limited by this treaty. This does not include non-strategic nuclear forces, Department of Defense spares or spares needed to replace weapons disassembled by Department of Energy surveillance testing.

Activation products: Nuclei, usually radioactive, formed by the bombardment of material with neutrons, protons, or other nuclear particles.

Acute exposure: The exposure incurred during and shortly after a radiological release. Generally, the period of acute exposure ends when long-term interdiction is established, as necessary. For convenience, the period of acute exposure is normally assumed to end 1 week after the inception of a radiological accident.

Air quality standards: The level of pollutants in the air prescribed by regulations that may not be exceeded during a specified time in a defined area.

Alpha activity: The emission of alpha particles by fissionable materials (uranium or plutonium).

Alpha particle: A positively charged particle, consisting of two protons and two neutrons, that is emitted during radioactive decay from the nucleus of certain nuclides. It is the least penetrating of the three common types of radiation (alpha, beta, and gamma).

Alpha wastes: Wastes containing radioactive isotopes which decay by producing alpha particles.

Ambient air: The surrounding atmosphere as it exists around people, plants, and structures.

American Indian Religious Freedom Act of 1978: This Act establishes national policy to protect and preserve for Native Americans their inherent right of freedom to believe, express, and exercise their traditional religions, including the rights of access to religious sites, use and possession of sacred objects, and the freedom to worship through traditional ceremonies and rites.

Anadromous: Fish that migrate from salt to fresh water to spawn.

Aquatic biota: The sum total of living organisms within any designated aquatic area.

Aquifer: A saturated geologic unit through which significant quantities of water can migrate under natural hydraulic gradients.

Aquitard: A less-permeable geologic unit in a stratigraphic sequence. The unit is not permeable enough to transmit significant quantities of water. Aquitards separate aquifers.

Archaeological sites (resources): Any location where humans have altered the terrain or discarded artifacts during either prehistoric or historic times.

Artifact: An object produced or shaped by human workmanship of archaeological or historical interest.

As low as reasonably achievable: A concept applied to the quantity of radioactivity released in routine operation of a nuclear system or facility, including "anticipated operational occurrences." It takes into account the state of technology, economics of improvements in relation to benefits to public health and safety, and other societal and economic considerations in relation to the use of nuclear energy in the public interest.

Atmospheric dispersion: The process of air pollutants being dispersed in the atmosphere. This occurs by the wind that carries the pollutants away from their source and by turbulent air motion that results from solar heating of the Earth's surface and air movement over rough terrain and surfaces.

Atomic Energy Act of 1954: This Act was originally enacted in 1946 and amended in 1954. For the purpose of this Programmatic Environmental Impact Statement "...a program for Government control of the possession, use, and production of atomic energy and special nuclear material whether owned by the Government or others, so directed as to make the maximum contribution to the common defense and security and the national welfare, and to provide continued assurance of the Government's ability to enter into and enforce agreements with nations or groups of nations for the control of special nuclear materials and atomic weapons..." (Section 3(c)).

Atomic Energy Commission: A five-member commission, established by the *Atomic Energy Act* of 1946, to supervise nuclear weapons design, development, manufacturing, maintenance, modification, and dismantlement. In 1974, the Atomic Energy Commission was abolished and all functions were transferred to the Nuclear Regulatory Commission and the Administrator of the Energy Research and Development Administration. The Energy Research and Development Administration was later terminated and its functions vested by law in the Administrator were transferred to the Secretary of Energy.

Background radiation: Ionizing radiation present in the environment from cosmic rays and natural sources in the Earth; background radiation varies considerably with location. Also, see "natural radiation".

Badged worker: A worker equipped with an individual dosimeter who has the potential to be exposed to radiation.

Baseline: A quantitative expression of conditions, costs, schedule, or technical progress to serve as a base or standard for measurement during the performance of an effort; the established plan against which the status of resources and the progress of a project can be measured. For this Programmatic Environmental Impact Statement, the environmental baseline is the site environmental conditions as they are projected to occur in 2010.

BEIR V: Biological Effects of Ionizing Radiation; referring to the fifth in a series of committee reports from the National Research Council.

Beryllium: An extremely lightweight, strong metal used in weapons systems.

Benthic: Plants and animals dwelling at the bottom of oceans, lakes, rivers, and other surface waters.

Biota (biotic): The plant and animal life of a region (pertaining to biota).

Blanket assemblies: In a heavy water reactor, lithium-aluminum alloy clad tubes positioned in a ring surrounding the radial reflector zone. They prevent neutron damage to the reactor vessel's metal wall by absorbing neutrons from the reflector zone, and they produce tritium.

Boiling water reactor: A type of nuclear reactor that uses fission heat to generate steam in the reactor to drive turbines and generate electricity.

Burial ground: A place for burying unwanted (i.e., radioactive) materials in which the earth acts as a receptacle to prevent the dispersion of wastes in the environment and the escape of radiation.

Burnable poison rod: A nuclear reactor rod used to moderate (reduce the energy of) neutrons created in the core by the fission reactions during the early core life.

Calcination: The process of converting high-level waste to unconsolidated granules or powder. Calcined solid wastes are primarily salts and oxides of metals (heavy metals) and components of high level waste (also called calcining).

Caldera: A large crater formed by the collapse of the central part of a volcano.

Cancer: The name given to a group of diseases characterized by uncontrolled cellular growth with cells having invasive characteristics such that the disease can transfer from one organ to another.

Capable fault: A fault that has exhibited one or more of the following characteristics (10 CFR 100, Appendix A):

1. Movement at or near the ground surface at least once within the past 35,000 years or movement of a recurring nature within the past 500,000 years.

2. Macro-seismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault.

3. A structural relationship to a capable fault according to characteristics (1) or (2) of this paragraph such that movement on one could be reasonably expected to be accompanied by movement on the other.

Capacity factor: The ratio of the annual average power load of a power plant to its rated capacity.

Carbon adsorption: A unit physiochemical process in which organic and certain inorganic compounds in a liquid stream are absorbed on a bed of activated carbon; used in water or waste purification and chemical processing.,

Carbon dioxide: A colorless, odorless, nonpoisonous gas that is a normal component of the ambient air; it is an expiration product of normal plant and animal life.

Carbon monoxide: A colorless, odorless gas that is toxic if breathed in high concentration over a period of time.

Carolina bay: Ovate, intermittently flooded depression of a type occurring on the Coastal Plain from New Jersey to Florida.

Cask (radioactive materials): A container that meets all applicable regulatory requirements for shipping spent nuclear fuel or high-level waste.

Cesium: A silver-white alkali metal. A radioactive isotope of cesium, cesium-137, is a common fission product.

Chronic exposure: Low-level radiation exposure incurred over a long time period due to residual contamination.

Cladding: The outer jacket of fuel elements and targets, usually made of aluminum, stainless steel, or zirconium-aluminum alloy, used to prevent fuel corrosion and retain fusion products during reactor operations, or to prevent releases into the environment during storage.

Clean Air Act: This Act mandates and enforces air pollutant emissions standards for stationary sources and motor vehicles.

Clean Air Act Amendments of 1990: Expands the Environmental Protection Agency's enforcement powers and adds restrictions on air toxics, ozone depleting chemicals, stationary and mobile emissions sources, and emissions implicated in rain and global warming.

Clean Water Act of 1972, 1987: This Act regulates the discharge of pollutants from a point source into navigable waters of the United States in compliance with a National Pollution Discharge Elimination System permit as well as regulates discharges to or dredging of wetlands.

Climatology: The science that deals with climates and investigates their phenomena and causes.

Code of Federal Regulations: All Federal regulations in force are published in codified form in the Code of Federal Regulations.

Cold standby: Maintenance of a protected reactor condition in which the fuel is removed, the moderator is stored in tanks, and equipment and system layup is performed to prevent deterioration, such that future refueling and restart are possible.

Collective committed effective dose equivalent: The committed effective dose equivalent of radiation for a population.

Committed dose equivalent: The predicted total dose equivalent to a tissue or organ over a 50-year period after an intake of radionuclide into the body. It does not include external dose contributions. Committed dose equivalent is expressed in units of rem or Sievert. The committed effective dose equivalent is the sum of the committed dose equivalents to various tissues of the body, each multiplied by the appropriate weighting factor.

Community (biotic): All plants and animals occupying a specific area under relatively similar conditions.

Complex: The Nuclear Weapons Complex, which is a set of Federal sites and government-owned/contractor-operated facilities administered by the Department of Energy.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (or Superfund): This Act provides regulatory framework for remediation of past contamination from hazardous waste. If a site meets the Act's requirements for designation, it is ranked along with other "Superfund" sites and is listed on the National Priorities List. This ranking is the Environmental Protection Agency's way of determining which sites have the highest priority for cleanup.

Conceptual design: Efforts to develop a project scope that will satisfy program needs; ensure project feasibility and attainable performance levels of the project for congressional consideration; develop project criteria and design parameters for all engineering disciplines; and identify applicable codes and standards, quality assurance requirements, environmental studies, construction materials, space allowances, energy conservation features, health, safety, safeguards, and security requirements and any other features or requirements necessary to describe the project.

Consumptive water use: The difference in the volume of water withdrawn from a body of water and the amount released back into the body of water.

Container: The metal envelope in the waste package that provides the primary containment function of the waste package and is designed to meet the containment requirements of 10 CFR 60.

Containment design basis: For a nuclear reactor, those bounding conditions for the design of the containment, including temperature, pressure, and leakage rate. Because the containment is provided as an additional barrier to mitigate the consequences of accidents involving the release of radioactive materials, the containment design basis may include an additional specified margin above those conditions expected to result from the plant design-basis accidents to ensure that the containment design can mitigate unlikely or unforeseen events.

Control rods: The elements of a nuclear reactor that absorb slow neutrons and are used to increase, decrease, or maintain the neutron density in the reactor.

Coolant: A substance, either gas or liquid, circulated through a nuclear reactor or processing plant to remove heat.

Credible accident: An accident that has a probability of occurrence greater than or equal to one in a million years.

Cretaceous Period: Geologic time making up the end of the Mesozoic Era, dating from approximately 144 million to 66 million years ago.

Criteria pollutants: Six air pollutants for which national ambient air quality standards are established by the Environmental Protection Agency: sulfur dioxide, nitric oxides, carbon monoxide, ozone, particulate matter (smaller than 10 microns in diameter), and lead.

Critical habitat: Defined in the *Endangered Species Act* of 1973 as "specific areas within the geographical area occupied by [an endangered or threatened] species..., essential to the conservation of the species and which may require special management considerations or protection; and specific areas outside the geographical area occupied by the species... that are essential for the conservation of the species."

Criticality: A reactor state in which a self-sustaining nuclear chain reaction is achieved.

Cultural resources: Archaeological sites, architectural features, traditional use areas, and Native American sacred sites.

Curie: A unit of radioactivity equal to 37 billion disintegrations per second; also a quantity of any nuclide or mixture of nuclides having 1 curie of radioactivity.

Decay heat (radioactivity): The heat produced by the decay of certain radionuclides.

Decay (radioactive): The decrease in the amount of any radioactive material with the passage of time, due to the spontaneous transformation of an unstable nuclide into a different nuclide or into a different energy state of the same nuclide; the emission of nuclear radiation (alpha, beta, or gamma radiation) is part of the process.

Decontamination: The removal of radioactive or chemical contamination from facilities, equipment, or soils by washing, heating, chemical or electrochemical action, mechanical cleaning, or other techniques.

Demilitarization: An irreversible modification or destruction of a weapons component or part of a component to the extent required to prevent use in its original weapon purpose.

Depleted uranium: Uranium whose content of the isotope uranium-235 is less than 0.7 percent, which is the uranium-235 content of naturally occurring uranium.

Deposition: In geology, the laying down of potential rock-forming materials; sedimentation. In atmospheric transport, the settling out on ground and building surfaces of atmospheric aerosols and particles ("dry deposition") or their removal from the air to the ground by precipitation ("wet deposition" or "rainout").

Design basis: For nuclear facilities, information that identifies the specific functions to be performed by a structure, system, or component and the specific values (or ranges of values) chosen for controlling parameters for reference bounds for design. These values may be: (1) restraints derived from generally accepted state-of-the-art practices for achieving functional goals; (2) requirements derived from analysis (based on calculation and/or experiments) of the effects of a postulated accident for which a structure, system, or component must meet its functional goals; or (3) requirements derived from Federal safety objectives, principles, goals, or requirements.

Design-basis accident: For nuclear facilities, a postulated abnormal event that is used to establish the performance requirements of structures, systems, and components that are necessary to (1) maintain them in a safe shutdown condition indefinitely or (2) prevent or mitigate the consequences of the design-basis accident so that the general public and operating staff are not exposed to radiation in excess of appropriate guideline values.

Design-basis events: Postulated disturbances in process variables that can potentially lead to design-basis accidents.

Design laboratory: Department of Energy facilities involved in the design of nuclear weapons.

Deuterium: A nonradioactive isotope of the element hydrogen with one neutron and one proton in the atomic nucleus.

Deuterium oxide: See "heavy water."

Dewatering: Pumping water from the soil to ensure proper soil characteristics for construction of facilities. May be required during operation if the water table impinges on foundations.

Direct economic effects: The initial increases in output from different sectors of the economy resulting from some new activity within a predefined geographic region.

Disposition: The ultimate "fate" or end use of a surplus Department of Energy facility following the transfer of the facility to the Office of the Assistant Secretary for Environmental Waste Management.

Dolomite: Calcium magnesium carbonate, a limestone-like mineral.

Dose: The energy imparted to matter by ionizing radiation. The unit of absorbed dose is the rad.

Dose commitment: The dose an organ or tissue would receive during a specified period of time (e.g., 50 to 100 years) as a result of intake (as by ingestion or inhalation) of one or more radionuclides from a defined release, frequently over a year's time.

Dose equivalent: The product of absorbed dose in rad (or gray) and the effect of this type of radiation in tissue and a quality factor. Dose equivalent is expressed in units of rem or Sievert, where 1 rem equals 0.01 Sievert. The dose equivalent to an organ, tissue, or the whole body will be that received from the direct exposure plus the 50-year committed dose equivalent received from the radionuclides taken into the body during the year.

Drainage basin: An aboveground area that supplies the water to a particular stream.

Drawdown: The height difference between the natural water level in a formation and the reduced water level in the formation caused by the withdrawal of groundwater.

Drift: Effluent mist or spray carried into the atmosphere from cooling towers.

Drinking-water standards: The prescribed level of constituents or characteristics in a drinking water supply that cannot be exceeded legally.

Dry site: For the purpose of this Programmatic Environmental Impact Statement any site where adequate water is not abundantly available for cooling of the tritium supply technologies.

Effective dose equivalent: The summation of the products of the dose equivalent received by specified tissues of the body and a tissue-specific weighting factor. This sum is a risk-equivalent value and can be used to estimate the health effects risk of the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides, and the effective dose equivalent due to penetrating radiation from sources external to the body. Effective dose equivalent is expressed in units of rem (or Sievert).

Effluent: A gas or fluid discharged into the environment.

Emergency condition: For a nuclear facility, occurrences or accidents that might occur infrequently during start-up testing or operation of the facility. Equipment, components, and structures might be deformed by these conditions to the extent that repair is required prior to reuse.

Emission standards: Legally enforceable limits on the quantities and/or kinds of air contaminants that can be emitted into the atmosphere.

Endangered species: Animals, birds, fish, plants, or other living organisms threatened with extinction by man-made or natural changes in their environment. Requirements for declaring species endangered are contained in the *Endangered Species Act* of 1973.

Endangered Species Act of 1973: This Act requires Federal agencies, with the consultation and assistance of the Secretaries of the Interior and Commerce, to ensure that their actions will not likely jeopardize the continued existence of any endangered or threatened species or adversely affect the habitat of such species.

Engineered safety features: For a nuclear facility, features that prevent, limit, or mitigate the release of radioactive material from its primary containment.

Entrainment: The involuntary capture and inclusion of organisms in streams of flowing water, a term often applied to the cooling water systems of power plants/reactors. The organisms involved may include phyto- and zooplankton, fish eggs and larvae (ichthyoplankton), shellfish larvae, and other forms of aquatic life.

Environment, safety, and health program: In the context of the Department of Energy, encompasses those Department of Energy requirements, activities, and functions in the conduct of all Department of Energy and Department of Energy-controlled operations that are concerned with: impacts to the biosphere; compliance with environmental laws, regulations, and standards controlling air, water, and soil pollution; limiting the risks to the well-being of both operating personnel and the general public to acceptably low levels; and protecting property adequately against accidental loss and damage. Typical activities and functions related to this program include, but are not limited to, environmental protection, occupational safety, fire protection, industrial hygiene, health physics, occupational medicine, and process and facilities safety, nuclear safety, emergency preparedness, quality assurance, and radioactive and hazardous waste management.

Environmental assessment: A written environmental analysis that is prepared pursuant to the *National Environmental Policy Act* to determine whether a Federal action would significantly affect the environment and thus require preparation of a more detailed environmental impact statement. If the action does not significantly affect the environment, then a finding of no significant impact is prepared.

Environmental impact statement: A document required of Federal agencies by *National Environmental Policy Act* for major proposals or legislation significantly affecting the environment. A tool for decision-making, it describes the positive and negative effects of the undertaking and alternative actions.

Eocene: A geologic epoch early in the Cenozoic Era, dating from approximately 54 to 38 million years ago.

Epicenter: The point on the Earth's surface directly above the focus of an earthquake.

Epidemiology: The science concerned with the study of events that determine and influence the frequency and distribution of disease, injury, and other health-related events and their causes in a defined human population.

Equivalent sound (pressure) level (L_{eq}): The equivalent steady sound level that, if continuous during a specified time period, would contain the same total energy as the actual time-varying sound. For example, L_{eq} (1-h) and L_{eq} (24-h) are the 1-hour and 24-hour equivalent sound level, respectively.

Exposure limit: The level of exposure to a hazardous chemical (set by law or a standard) at which or below which adverse human health effects are not expected to occur:

- Reference dose is the chronic exposure dose (mg or kg per day) for a given hazardous chemical at which or below which adverse human non-cancer health effects are not expected to occur.

- Reference concentration is the chronic exposure concentration (mg/m^3) for a given hazardous chemical at which or below which adverse human non-cancer health effects are not expected to occur.

Fault: A fracture or a zone of fractures within a rock formation along which vertical, horizontal, or transverse slippage has occurred. A normal fault occurs when the hanging wall has been depressed in relation to the footwall. A reverse fault occurs when the hanging wall has been raised in relation to the footwall.

Finding of No Significant Impact: A document by a Federal agency briefly presenting the reasons why an action, not otherwise excluded, will not have a significant effect on the human environment and will not require an environmental impact statement.

Fissile material: Plutonium-239, uranium-233, uranium-235, or any material containing any of the foregoing.

Fission: The splitting of a heavy atomic nucleus into two nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or be induced by neutron bombardment.

Fission products: Nuclei formed by the fission of heavy elements (primary fission products); also, the nuclei formed by the decay of the primary fission products, many of which are radioactive.

Floodplain: The lowlands adjoining inland and coastal waters and relatively flat areas including at a minimum that area inundated by a 1-percent or greater chance flood in any given year. The base floodplain is defined as the 100-year (1.0 percent) floodplain. The critical action floodplain is defined as the 500-year (0.2 percent) floodplain.

Flux: Rate of flow through a unit area; in reactor operation, the apparent flow of neutrons in a defined energy range (see neutron flux).

Formation: In geology, the primary unit of formal stratigraphic mapping or description. Most formations possess certain distinctive features.

Fossil: Impression or trace of an animal or plant of past geological ages that has been preserved in the earth's crust.

Fossiliferous: Containing a relatively large number of fossils.

Fugitive emissions: Emissions to the atmosphere from pumps, valves, flanges, seals, and other process points not vented through a stack. Also includes emissions from area sources such as ponds, lagoons, landfills, and piles of stored material.

Gamma rays: High-energy, short-wavelength, electromagnetic radiation accompanying fission and emitted from the nucleus of an atom. Gamma rays are very penetrating and can be stopped only by dense materials (such as lead) or a thick layer of shielding materials.

Gaussian plume: The distribution of material (a plume) in the atmosphere resulting from the release of pollutants from a stack or other source. The distribution of concentrations about the centerline of the plume, which is assumed to decrease as a function of its distance from the source and centerline (Gaussian distribution), depends on the mean wind speed and atmospheric stability.

Genetic effects: The outcome resulting from exposure to mutagenic chemicals or radiation which results in genetic changes in germ line or somatic cells.

- Effects on genetic material in germ line (sex cells) cause trait modifications that can be passed from parents to offspring.

- Effects on genetic material in somatic cells result in tissue or organ modifications (e.g. liver tumors) that do not pass from parents to offspring.

Geologic repository (mined geologic repository): A facility for the disposal of nuclear waste; the waste is isolated by placement in a continuous, stable geologic formation at depths greater than 300 meters.

Geology: The science that deals with the Earth: the materials, processes, environments, and history of the planet, including the rocks and their formation and structure.

Glove box: An airtight box used to work with hazardous material, vented to a closed filtering system, having gloves attached inside of the box to protect the worker.

Ground shine: An area on the ground where radioactivity has been deposited by a radioactive plume or cloud.

Groundwater: The supply of water found beneath the Earth's surface, usually in aquifers, which may supply wells and springs.

Half-life (radiological): The time in which half the atoms of a radioactive substance disintegrate to another nuclear form; this varies for specific radioisotopes from millionths of a second to billions of years.

Hazard Index: A summation of the Hazard Quotients for all chemicals now being used at a site and those proposed to be added to yield cumulative levels for a site. A Hazard Index value of 1.0 or less means that no adverse human health effects (non-cancer) are expected to occur.

Hazard Quotient: The value used as an assessment of non-cancer associated toxic effects of chemicals, e.g., kidney or liver dysfunction. It is independent of a cancer risk, which is calculated only for those chemicals identified as carcinogens.

Hazardous material: A material, including a hazardous substance, as defined by 49 CFR 171.8 which poses a risk to health, safety, and property when transported or handled.

Hazardous/toxic waste: Any solid waste (can also be semisolid or liquid, or contain gaseous material) having the characteristics of ignitability, corrosivity, toxicity, or reactivity, defined by the Resource Conservation and Recovery Act and identified or listed in 40 CFR 261 or by the Toxic Substances Control Act.

Heat exchanger: A device that transfers heat from one fluid (liquid or gas) to another.

Heavy metals: Metallic or semimetallic elements of high molecular weight, such as mercury, chromium, cadmium, lead, and arsenic, that are toxic to plants and animals at known concentrations.

Heavy water: A form of water (a molecule with two hydrogen atoms and one oxygen atom) in which the hydrogen atoms consist largely or completely of the deuterium isotope. Heavy water has almost identical chemical properties, but quite different nuclear properties, as light water (common water).

Heavy Water Reactor: A nuclear reactor in which circulating heavy water is used to cool the reactor core and to moderate (reduce the energy of) the neutrons created in the core by the fission reactions.

High efficiency particulate air filter: A filter used to remove particulates from dry gaseous effluent streams.

High-level waste: The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid. High-level waste contains a combination of transuranic waste and fission products in concentrations requiring permanent isolation.

Highly enriched uranium: Uranium in which the abundance of the isotope uranium-235 is increased well above normal (naturally occurring) levels.

Historic resources: Archaeological sites, architectural structures, and objects produced after the advent of written history dating to the time of the first Euro-American contact in an area.

Holocene: The current epoch of geologic time, which began approximately 10,000 years ago.

Hydraulic gradient: The difference in hydraulic head at two points divided by the distance between two points.

Hydrology: The science dealing with the properties, distribution, and circulation of natural water systems.

Impingement: The process by which aquatic organisms too large to pass through the screens of a water intake structure become caught on the screens and are unable to escape.

Incident-free risk: The radiological or chemical impacts resulting from packages aboard vehicles in normal transport. This includes the radiation or hazardous chemical exposure of specific population groups such as crew, passengers, and bystanders.

Indirect economic effects: Indirect effects result from the need to supply industries experiencing direct economic effects with additional outputs to allow them to increase their production. The additional output from each directly affected industry requires inputs from other industries within a region (i.e., purchases of goods and services). This results in a multiplier effect to show the change in total economic activity resulting from a new activity in a region.

Induced economic effects: The spending of households resulting from direct and indirect economic effects. Increases in output from a new economic activity lead to an increase in household spending throughout the economy as firms increase their labor inputs.

Injection wells: A well that takes water from the surface into the ground, either through gravity or by mechanical means.

Interbedded: Occurring between beds or lying in a bed parallel to other beds of a different material.

Interim (permit) status: Period during which treatment, storage, and disposal facilities coming under the Resource Conservation and Recovery Act of 1980 are temporarily permitted to operate while awaiting denial or issuance of a permanent permit.

Ion exchange: A unit physiochemical process that removes anions and cations, including radionuclides, from liquid streams (usually water) for the purpose of purification or decontamination.

Ionizing radiation: Radiation that can displace electrons from atoms or molecules, thereby producing ions.

Isotope: An atom of a chemical element with a specific atomic number and atomic mass. Isotopes of the same element have the same number of protons but different numbers of neutrons and different atomic masses.

Joule: A metric unit of energy, work, or heat, equivalent to 1 watt-second, 0.737 foot-pound, or 0.239 calories.

Klystron: An electron tube used for the generation of ultrahigh-frequency current.

Lacustrine: Found or formed in lakes; also, a type of wetland situated on or near a lake.

Landscape character: The arrangement of a particular landscape as formed by the variety and intensity of the landscape features (land, water, vegetation, and structures) and the four basic elements (form, line, color, and texture). These factors give an area a distinctive quality that distinguishes it from its immediate surroundings.

Large release: A release of radioactive material that would result in doses greater than 25 rem to the whole body or 300 rem to the thyroid at 1.6 kilometer from the control perimeter (security fence) of a reactor facility.

Latent fatalities: Fatalities associated with acute and chronic environmental exposures to chemical or radiation that occur within 30 years of exposure.

Light water: The common form of water (a molecule with two hydrogen atoms and one oxygen atom) in which the hydrogen atom consists largely or completely of the normal hydrogen isotope (one proton).

Light Water Reactor: A nuclear reactor in which circulating light water is used to cool the reactor core and to moderate (reduce the energy of) the neutrons created in the core by the fission reactions.

Lithic: Pertaining to stone or a stone tool.

Long-lived radionuclides: Radioactive isotopes with half-lives greater than about 30 years.

Loss-of-coolant accidents: A postulated accident that results from the loss of reactor coolant (at a rate that exceeds the capability of the reactor coolant makeup system) from breaks in the reactor coolant pressure boundary, up to and including a break equivalent in size to the double-ended rupture of the largest pipe of the reactor coolant system.

Loss-of-pumping accidents: An event that involves a pipe break through which coolant (either primary or secondary) is released.

Low-level waste: Waste that contains radioactivity but is not classified as high-level waste, transuranic waste, spent nuclear fuel, or "11e(2) by-product material" as defined by DOE Order 5820.2A, *Radioactive Waste Management.* Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranic waste is less than 100 nanocuries per gram. Some low-level waste is considered classified because of the nature of the generating process and/or constituents, because the waste would tell too much about the process.

Mastodon: Any of numerous extinct mammals that differ from the related mammoths and existing elephants chiefly in the form of molar teeth.

Maximum contaminant level: The maximum permissible level of a contaminant in water delivered to any user of a public water system. Maximum contaminant levels are enforceable standards.

Maximally exposed individual: A hypothetical person who could potentially receive the maximum dose of radiation or hazardous chemicals.

Megawatt: A unit of power equal to 1 million watts. Megawatt thermal is commonly used to define heat produced, while megawatt electric defines electricity produced.

Meteorology: The science dealing with the atmosphere and its phenomena, especially as relating to weather.

Migration: The natural movement of a material through the air, soil, or groundwater; also, seasonal movement of animals from one area to another.

Miocene Epoch: Geologic time in the Cenozoic Era dating from 26 to 7 million years ago.

Mixed waste: Waste that contains both "hazardous waste" and "radioactive waste" as defined in this glossary.

Moderator: A material used to decelerate neutrons in a reactor from high energies to low energies.

Modified Mercalli intensity: A level on the modified Mercalli scale. A measure of the perceived intensity of earthquake ground shaking with 12 divisions, from I (not felt by people) to XII (damage nearly total).

Modular High Temperature Gas-Cooled Reactor: A relatively small nuclear reactor of standardized design in which graphite (a compound of electrical carbon) is used to moderate (reduce the energy of) the neutrons created in the core by fission reactions, and a gas (helium) is used to cool the reactor core

Mollusks: Unsegmented, invertebrate animals including gastropods, pelecypods, and cephalopods.

National Ambient Air Quality Standards: Air quality standards established by the *Clean Air Act*, as amended. The primary National Ambient Air Quality Standards are intended to protect the public health with an adequate margin of safety, and the secondary National Ambient Air Quality Standards are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Emission Standards for Hazardous Air Pollutants: A set of national emission standards for listed hazardous pollutants emitted from specific classes or categories of new and existing sources. These were implemented in the Clean Air Act Amendments of 1977.

National Environmental Policy Act of 1969: This Act is the basic national charter for the protection of the environment. It requires the preparation of an environmental impact statement for every major Federal action that may significantly affect the quality of the human or natural environment. Its main purpose is to provide environmental information to decision makers so that their actions are based on an understanding of the potential environmental consequences of a proposed action and its reasonable alternatives.

National Environmental Research Park: An outdoor laboratory set aside for ecological research to study the environmental impacts of energy developments. National environmental research parks were established by the Department of Energy to provide protected land areas for research and education in the environmental sciences and to demonstrate the environmental compatibility of energy technology development and use.

National Historic Preservation Act of 1966, as amended: This Act provides that property resources with significant national historic value be placed on the National Register of Historic Places. It does not require any permits but, pursuant to Federal code, if a proposed action might impact an historic property resource, it mandates consultation with the proper agencies.

National Pollutant Discharge Elimination System: Federal permitting system required for hazardous effluents regulated through the *Clean Water Act*, as amended.

National Register of Historic Places: A list maintained by the Secretary of the Interior of districts, sites, buildings, structures, and objects of prehistoric or historic local, state, or national significance. The list is expanded as authorized by Section 2(b) of the *Historic Sites Act* of 1935 (16 U.S.C. 462) and Section 101(a)(1)(A) of the *National Historic Preservation Act* of 1966, as amended.

Neutron: An uncharged elementary particle with a mass slightly greater than that of the proton, found in the nucleus of every atom heavier than hydrogen-1; a free neutron is unstable and decays with a half-life of about 13 minutes into an electron and a proton.

Neutron poison: A chemical solution (e.g., boron or rare earth solution) injected into a nuclear reactor to absorb neutrons and end criticality.

Nonattainment area: An air quality control region (or portion thereof) in which the Environmental Protection Agency has determined that ambient air concentrations exceed national ambient air quality standards for one or more criteria pollutants.

Nitrogen oxides: Refers to the oxides of nitrogen, primarily NO (nitrogen oxide) and NO_2 (nitrogen dioxide). These are produced in the combustion of fossil fuels and can constitute an air pollution problem. When nitrogen dioxide combines with volatile organic compounds, such as ammonia or carbon monoxide, ozone is produced.

Nuclear criticality: (See "criticality.)

Nuclear facility: A facility whose operations involve radioactive materials in such form and quantity that a nuclear hazard potentially exists to the employees or the general public. Included are facilities that: produce, process, or store radioactive liquid or solid waste, fissionable materials, or tritium; conduct separations operations; conduct irradiated materials inspection, fuel fabrication, decontamination, or recovery operations; or conduct fuel enrichment operations. Incidental use of radioactive materials in a facility operation (e.g., check sources, radioactive sources, and x-ray machines) does not necessarily require a facility to be included in this definition.

Nuclear grade: Material of a quality adequate for use in a nuclear application.

Nuclear material: Composite term applied to: (1) special nuclear material; (2) source material such as uranium or thorium or ores containing uranium or thorium; and (3) by-product material, which is any radioactive material that is made radioactive by exposure to the radiation incident to the process of producing or using special nuclear material.

Nuclear power plant: A facility that converts nuclear energy into electrical power. Heat produced in a nuclear reactor is used to make steam which drives a turbine connected to an electric generator.

Nuclear production: Production operations for components of nuclear weapons that are fabricated from nuclear materials, including plutonium and uranium.

Nuclear reaction: A reaction in which an atomic nucleus is transformed into another isotope of that respective nuclide, or into another element altogether; it is always accompanied by the liberation of either particles or energy.

Nuclear reactor: A device in which a fission chain reaction is maintained, and which is used for irradiation of materials or to produce heat for the generation of electricity.

Nuclide: A species of atom characterized by the constitution of its nucleus and hence by the number of protons, the number of neutrons, and the energy content.

Obsidian: A black volcanic glass.

Occupational Safety and Health Administration: Oversees and regulates workplace health and safety, created by the *Occupational Safety and Health Act* of 1970.

Onsite population: Department of Energy and contractor employees who are on duty, and badged onsite visitors.

Operable: For a nuclear facility, a situation wherein a reactor and fuel/target cycle facilities are being operated or have the potential for being operated. A reactor and fuel/target cycle facility that cannot be operated on a day-to-day basis because of refueling, extensive modifications, or technical problems is still considered operable.

Operable unit: A discrete action that comprises an incremental step toward comprehensively addressing site problems. This discrete portion of a remedial response manages migration or eliminates or mitigates a release, threat of release, or pathway of exposure. The cleanup of a site can be divided into a number of operable units.

Outfall: The discharge point of a drain, sewer, or pipe as it empties into a body of water.

Ozone: The triatomic form of oxygen; in the stratosphere, ozone protects the Earth from the sun's ultraviolet rays, but in lower levels of the atmosphere ozone is considered an air pollutant.

Packaging: The assembly of components necessary to ensure compliance with Federal regulations. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle tie-down system and auxiliary equipment may be designated as part of the packaging.

Paleontology: The study of fossils.

Paleozoic Era: Geologic time dating from 570 million to 245 million years ago when seed-bearing plants, amphibians, and reptiles first appeared.

Palustrine: Found or formed in marshes; also, a type of wetland situated in or near a marsh.

Perched groundwater: A body of groundwater of small lateral dimensions lying above a more extensive aquifer.

Permeability: geology, the ability of rock or soil to transmit a fluid.

Person-rem: The unit of collective radiation dose commitment to a given population; the sum of the individual doses received by a population segment.

Physical setting: The land and water form, vegetation, and structures that compose the landscape.

Pit: An assembly at the center of a nuclear device containing a sub-critical mass of fissionable material.

Playa: A dry lake bed in a desert basin or a closed depression that contains water on a seasonal basis.

Pleistocene Epoch: Geologic time that began approximately 3 to 5 million years ago.

Pliocene Epoch: Geologic time between the Miocene and the Pleistocene epochs approximately 2 to 13 million years ago.

Plume: The elongated pattern of contaminated air or water originating at a point source, such as a smokestack or a hazardous waste disposal site.

Plume immersion: Occurs when an individual is enveloped by a cloud of radioactive gaseous effluent and receives an external radiation dose.

Plutonium: A heavy, radioactive, metallic element with the atomic number 94. It is produced artificially in a reactor by bombardment of uranium with neutrons and is used in the production of nuclear weapons.

Potentiometric surface: An imaginary surface defined by the level that water will rise to in a tightly-cased well.

Pounds per square inch: A measure of pressure; atmospheric pressure is about 14.7 pounds per square inch.

Prehistoric: Predating written history. In North America, also predating contact with Europeans.

Pressurized water reactor: A nuclear power reactor that uses water under pressure as a coolant. The water boiled to generate steam is in a separate system.

Prevention of Significant Deterioration: Regulations established by the 1977 Clean Air Act Amendments to limit increases in criteria air pollutant concentrations above baseline.

Primary system: The system that circulates a coolant (e.g., water) through the reactor core to remove the heat of reaction.

Prime farmland: Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oil-seed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor without intolerable soil erosion, as determined by the Secretary of Agriculture (*Farmland Protection Policy Act* of 1981, 7 CFR 7, paragraph 658).

Probabilistic risk assessment: A comprehensive, logical, and structured methodology to identify and quantitatively evaluate significant accident sequences and their consequences. (See "Level-1 probabilistic risk assessment, Level-2 probabilistic risk assessment, and Level-3 probabilistic risk assessment.")

Probable maximum flood: Flood levels predicted for a scenario having hydrological conditions that maximize the flow of surface waters.

Protected area: An area encompassed by physical barriers, subject to access controls, surrounding material access areas, and meeting the standards of DOE Order 5632.1C, *Protection and Control of Safeguards and Security Interests.*

Quality factor: The principal modifying factor that is employed to derive dose equivalent from absorbed dose.

Rad: See "radiation absorbed dose."

Radiation: The emitted particles or photons from the nuclei of radioactive atoms. Some elements are naturally radioactive; others are induced to become radioactive by bombardment in a reactor. Naturally occurring radiation is indistinguishable from induced radiation.

Radiation absorbed dose: The basic unit of absorbed dose equal to the absorption of 0.01 joule per kilogram of absorbing material.

Radioactive waste: Materials from nuclear operations that are radioactive or are contaminated with radioactive materials, and for which use, reuse, or recovery are impractical.

Radioactivity: The spontaneous decay or disintegration of unstable atomic nuclei, accompanied by the emission of radiation.

Radioisotopes: Radioactive nuclides of the same element (same number of protons in their nuclei) that differ in the number of neutrons.

Radionuclide: A radioactive element characterized according to its atomic mass and atomic number which can be man-made or naturally occurring. Radionuclides can have a long life as soil or water pollutants, and are believed to have potentially mutagenic or carcinogenic effects on the human body.

Radon: Gaseous, radioactive element with the atomic number 86 resulting from the radioactive decay of radium. Radon occurs naturally in the environment, and can collect in unventilated enclosed areas, such as basements. Large concentrations of radon can cause lung cancer in humans.

RADTRAN: A computer code combining user-determined meteorological, demographic, transportation, packaging, and material factors with health physics data to calculate the expected radiological consequences and accident risk of transporting radioactive material.

Reactor accident: See "design-basis accident; severe accident."

Reactor charge: The fuel and target assemblies loaded into specific positions in the reactor to produce the desired product; the reactor positions occupied by the assemblies depend on the product and the types of assemblies used.

Reactor core: In a heavy water reactor: the fuel assemblies, including the fuel and target tubes, control assemblies, blanket assemblies, safety rods, and coolant/moderator. In a light-water reactor: the fuel assemblies, including the fuel and target rods, control rods, and coolant/ moderator. In a modular high-temperature gas-cooled reactor: the graphite elements, including the fuel and target elements, control rods, any other reactor shutdown mechanisms, and the graphite reflectors.

Reactor facility: Unless it is modified by words such as containment, vessel, or core, the term reactor facility includes the housing, equipment, and associated areas devoted to the operation and maintenance of one or more reactor cores. Any apparatus that is designed or used to sustain nuclear chain reactions in a controlled manner, including critical and pulsed assemblies and research, test, and power reactors, is defined as a reactor. All assemblies designed to perform subcritical experiments that could potentially reach criticality are also to be considered reactors.

Reactor year: A unit of time by which accident frequency and core damage frequency are measured; it assumes that more than one reactor can operate during the year (a calendar year during which three reactors operated would be the experience equivalent of 3 reactor years) and it assumes that a reactor might not operate continuously for the entire year (a reactor operating only 60 percent of the calendar year would be the equivalent of 0.6 reactor year).

Receiving waters: Rivers, lakes, oceans, or other bodies of water into which wastewaters are discharged.

Recharge: Replenishment of water to an aquifer.

Recycling: The recovery, purification, and reuse of tritium contained in tritium reservoirs within the nuclear weapons stockpile.

Rem: See "roentgen equivalent man."

Remediation: The process, or a phase in the process, of rendering radioactive, hazardous, or mixed waste environmentally safe, whether through processing, entombment, or other methods.

Resource Conservation and Recovery Act, as amended: The Act that provides "cradle to grave" regulatory program for hazardous waste which established, among other things, a system for managing hazardous waste from its generation until its ultimate disposal.

Rhyolite: A volcanic rock rich in silica; the volcanic equivalent of granite.

Riparian wetlands: Wetlands on or around rivers and streams.

Riprap: A loose assemblage of stones used in water or soft ground to prevent erosion.

Risk: A quantitative or qualitative expression of possible loss that considers both the probability that a hazard will cause harm and the consequences of that event.

Risk assessment (chemical or radiological): The qualitative and quantitative evaluation performed in an effort to define the risk posed to human health and/or the environment by the presence or potential presence and/or use of specific chemical or radiological pollutants.

Runoff: The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and eventually enters streams.

Safe Drinking Water Act, as amended: This Act protects the quality of public water supplies, water supply and distribution systems, and all sources of drinking water.

Safe secure trailer: A specially designed semitrailer, pulled by an armored tractor, which is used for the safe, secure transportation of cargo containing nuclear weapons or special nuclear material.

Safety Analysis Report: A safety document providing a concise but complete description and safety evaluation of a site, design, normal and emergency operation, potential accidents, predicted consequences of such accidents, and the means proposed to prevent such accidents or mitigate their consequences. A safety analysis report is designated as final when it is based on final design information. Otherwise, it is designated as preliminary.

Saltstone: Low radioactivity fraction of high-level waste from the in-tank precipitation process mixed with cement, flyash, and slag to form a concrete block.

Sandstone: A sedimentary rock predominantly containing individual mineral grains visible to the unaided eye.

Sanitary wastes: Wastes generated by normal housekeeping activities, liquid or solid (includes sludge), which are not hazardous or radioactive.

Sanitization: An irreversible modification or destruction of a component or part of a component to the extent required to prevent revealing classified or otherwise controlled information.

Scintillation: Minute flash of light caused when alpha, beta, or gamma rays strike certain phosphors.

Scope: In a document prepared pursuant to the *National Environmental Policy Act* of 1969, the range of actions, alternatives, and impacts to be considered.

Secondary system: The system that circulates a coolant (water) through a heat exchanger to remove heat from the primary system.

Sedimentation: The settling out of soil and mineral solids from suspension in water.

Seismic: Pertaining to any earth vibration, especially an earthquake.

Seismic zone: An area defined by the Uniform Building Code (1991), designating the amount of damage to be expected as the result of earthquakes. The United States is divided into six zones: (1) Zone 0 - no damage; (2) Zone 1 - minor damage; corresponds to intensities V and VI of the modified Mercalli intensity scale; (3) Zone 2A - moderate damage; corresponds to intensity VII of the modified Mercalli intensity scale (eastern U.S.); (4) Zone 2B - slightly more damage than 2A (western U.S.); (5)

Zone 3 - major damage; corresponds to intensity VII and higher of the modified Mercalli intensity scale; (6) Zone 4 - areas within Zone 3 determined by proximity to certain major fault systems.

Seismicity: The tendency for the occurrence of earthquakes.

Severe accident: An accident with a frequency rate of less than 10^{-6} per year that would have more severe consequences than a design-basis accident, in terms of damage to the facility, offsite consequences, or both.

Sewage: The total of organic waste and wastewater generated by an industrial establishment or a community.

Short-lived activation products: An element formed from neutron interaction that has a relatively short half-life and which is not produced from the fission reaction (e.g., a cobalt isotope formed from impurities in the metal of the reactor piping).

Short-lived nuclides: Radioactive isotopes with half-lives no greater than about 30 years (e.g., cesium-137 and strontium-90).

Shrink-swell potential: Refers to the potential for soils to contract while drying and expand after wetting.

Shutdown: For a Department of Energy reactor, that condition in which the reactor has ceased operation and the Department has declared officially that it does not intend to operate it further (see DOE Order 5480.6, *Safety of Department of Energy-Owned Nuclear Reactors*).

Silt: A sedimentary material consisting of fine mineral particles intermediate in size between sand and clay.

Siltstone: A sedimentary rock composed of fine textured minerals.

Source term: The estimated quantities of radionuclides or chemical pollutants released to the environment.

Spallation: Any nuclear reaction when several particles result from a collision, e.g., chain-reaction in a nuclear reactor.

Special nuclear materials: As defined in Section 11 of the *Atomic Energy Act* of 1954, special nuclear material means (1) plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Nuclear Regulatory Commission determines to be special nuclear material or (2) any material artificially enriched by any of the foregoing.

Standardization (Epidemiology): Techniques used to control the effects of differences (e.g., age) between populations when comparing disease experience. The two main methods are:

- Direct method, in which specific disease rates in the study population are averaged, using as weights the distribution of the comparison population.
- Indirect method, in which the specific disease rates in the comparison population are averaged, using as weights the distribution of the study population.

Standby: That condition in which a reactor facility is neither operable nor declared excess and in which documentary authorization exists to maintain the reactor for possible future operation (DOE Order 5480.6).

Steppe: An area of grass-covered and generally treeless plains.

Steppe climate (semiarid climate): The type of climate in which precipitation is very slight but sufficient for the growth of short, sparse grass.

Stratigraphy: Division of geology dealing with the definition and description of rocks and soils, especially sedimentary rocks.

Strike: The direction or trend that a structural surface (e.g., a bedding or fault plane) takes as it intersects the horizontal.

Superfund Amendments and Reauthorization Act of 1986: In addition to certain free-standing provisions of law, it includes amendments to *Compensa-*

tion Environmental Response, Compensation, and Liability Act of 1980 and the *Safe Drinking Water Act.*

Surface water: Water on the Earth's surface, as distinguished from water in the ground (groundwater).

Tertiary Period: The first geologic period of the Cenozoic Era, dating from 66 million to about 3 million years ago. During this time, mammals became the dominant life form.

Third Thirds waste: The Environmental Protection Agency proposed the Third Thirds Rule, as required by the Hazardous and Solid Waste Amendments of 1984, to establish treatment standards and effective dates for all wastes (including characteristic wastes) for which treatment standards had not yet been promulgated (40 CFR 268.12), including derived-from wastes (i.e., multi-source leachage), and for mixed radioactive/hazardous wastes.

Threatened species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Threshold limit values: The recommended concentrations of contaminants workers may be exposed to according to the American Council of Governmental Industrial Hygienists.

Toxic Substances Control Act of 1976: This Act authorizes the Environmental Protection Agency to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by the Environmental Protection Agency before they are manufactured for commercial purposes.

Transients: Events that could cause the temporary production of more (or less) heat in the reactor than the cooling system; also called reactivity change or power transients.

Transuranic waste: Waste contaminated with alpha-emitting radionuclides with half-lives greater than 20 years and concentrations greater than 100 nanocuries/gram at time of assay. It is not a mixed waste.

Tritium: A radioactive isotope of the element hydrogen with two neutrons and one proton. Common symbols for the isotope are H-3 and T.

Unconfined aquifer: A permeable geological unit having the following properties: a water-filled pore space (saturated), the capability to transmit significant quantities of water under ordinary differences in pressure, and an upper water boundary that is at atmospheric pressure.

Unsaturated zone (vadose): A region in a porous medium in which the pore space is not filled with water.

Uranium: A heavy, silvery-white metallic element (atomic number 92) with many radioactive isotopes. Uranium-235 is most commonly used as a fuel for nuclear fission. Another isotope, uranium-238, is transformed into fissionable plutonium-239 following its capture of a neutron in a nuclear reactor.

Viewshed: The extent of the area that may be viewed from a particular location. Viewsheds are generally bounded by topographic features such as hills or mountains.

Visual Resource Management Class: A class defines the different degrees of modification allowed to the basic elements of landscape. They are Class 1–applied to wilderness areas, wild and scenic rivers, and other similar situations; Class 2–contrasts are seen but do not attract attention; Class 3–contrasts caused by a cultural activity are evident, but remain subordinate to the existing landscape; Class 4–contrasts that attract attention and are dominant features of the landscape in terms of scale, but repeat the contrast of the characteristic landscape; Class 5–applied to areas where unacceptable cultural modification has lowered scenic quality (where the natural character of the landscape has been disturbed to a point where rehabilitation is needed to bring it up to one of the four other classifications).

Visual sensitivity level: The relative degree of viewer numbers, visibility of the subject landscape and the degree of potential viewer interest, concern, and attitude for existing or proposed changes in the landscape character.

Vitrification: A waste treatment process that uses glass (e.g., borosilicate glass) to encapsulate or immobilize radioactive wastes to prevent them from reacting in disposal sites.

Volatile organic compounds: A broad range of organic compounds, often halogenated, that vaporize at ambient or relatively low temperatures, such as benzene, chloroform, and methyl alcohol.

Waste Isolation Pilot Plant: A facility in southeastern New Mexico being developed as the disposal site for transuranic and transuranic mixed waste, not yet in operation.

Water table: Water under the surface of the ground occurs in two zones, an upper unsaturated zone and the deeper saturated zone. The boundary between the two zones is the water table.

Weapons-grade: Fissionable material in which the abundance of fissionable isotopes is high enough that the material is suitable for use in thermonuclear weapons.

Weighting factor: Represents the fraction of the total health risk resulting from uniform whole-body irradiation that could be contributed to that particular tissue.

Wetland: Land or areas exhibiting hydric soil conditions, saturated or inundated soil during some portion of the year, and plant species tolerant of such conditions.

Wet site: For the purposes of this Programmatic Environmental Impact Statement, any site where adequate water is available for evaporative cooling of tritium supply technologies.

Whole-body dose: Dose resulting from the uniform exposure of all organs and tissues in a human body. (Also, see "effective dose equivalent.")

Wind rose: A depiction of wind speed and direction frequency for a given period of time.

X/Q (Chi/Q): The relative calculated air concentration due to a specific air release; units are (sec/m^3). For example, (Ci/m^3)/(Ci/sec)=(sec/m^3) or (g/m^3)/(g/sec)=(sec/m^3).

Zircaloy-4: An alloy of zirconium metal frequently used in nuclear reactors because of its desirable chemical and nuclear properties.

INDEX

Index

CHAPTER 10: INDEX

Subjects are indexed by page number.