3 AFFECTED ENVIRONMENT

This EIS considers the proposed action of building and operating a conversion facility at the Paducah site for conversion of the Paducah DUF_6 cylinder inventory. Section 3.1 presents a detailed description of the affected environment for the Paducah site. The option of shipping cylinders from the ETTP site in Oak Ridge, Tennessee, to the Paducah site for conversion is also considered in this EIS. Therefore, information on the affected environment for the ETTP site is provided in Section 3.2.

3.1 PADUCAH SITE

The Paducah site is located in rural McCracken County, Kentucky, approximately 10 mi (16 km) west of the City of Paducah and 3.6 mi (6 km) south of the Ohio River (Figure 3.1-1). The Paducah site consists of 3,556 acres (1,439 ha) currently held by DOE (DOE 2001b). The site is surrounded by the West Kentucky Wildlife Management Area, an additional 2,781 acres (1,125 ha) conveyed by DOE to the Commonwealth of Kentucky for use in wildlife conservation and for recreational purposes. The City of Paducah is the largest urban area in the six counties surrounding the site. The six-county area is primarily rural, with industrial uses accounting for less than 5% of land use.

The Paducah GDP occupies a 750-acre (303-ha) complex within the Paducah site and is surrounded by a security fence (Figure 3.1-1). The Paducah GDP, previously operated by DOE and now operated by USEC, includes about 115 buildings with a combined floor space of approximately 8.2 million ft^2 (0.76 million m^2). The Paducah GDP has operated since 1955.

In 1994, the Paducah site was placed on the EPA National Priorities List (NPL), a list of sites across the nation that the EPA has designated as high priority for site remediation. The NPL designation was assigned primarily because of groundwater contamination with trichloroethylene (TCE) and Tc-99, first detected in 1988. Being placed on the NPL meant that the cleanup requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) would be met in conducting remediation efforts at the Paducah site. Hazardous waste and mixed waste management at the Paducah site must comply with RCRA regulations, which are administered by the Commonwealth of Kentucky (Division of Waste Management). The RCRA regulations also address implementation of corrective actions for SWMUs. Thus, both CERCLA and RCRA have requirements for remedial actions for contaminated environmental media. A Federal Facilities Agreement (FFA) has been developed to coordinate CERCLA/RCRA requirements into a single remediation procedure for the Paducah site.

The northern part of Location A and the southern part of Location B for the proposed conversion facility are located in an area that has been designated as SWMU 194 under the ongoing CERCLA/RCRA investigation. SWMU 194 previously was the site of several support facilities (e.g., administration building, hospital, boiler house, two leach fields) during the construction of the gaseous diffusion plant. These facilities are no longer present. In 2000, preferred Location A was characterized by using surface and subsurface soils samples, surface

water and sediment samples, and groundwater data (Tetra Tech, Inc. 2000). Although several metals and radionuclides were detected above background levels in these environmental media, the study concluded that the site was suitable for constructing industrial facilities.

3.1.1 Cylinder Yards

The Paducah site has a total of 36,191 DOE-managed DUF_6 cylinders (Table 3.1-1). The cylinders are located in about 15 storage yards (Figure 3.1-2). Most of the cylinders are in yards managed by DOE, but a small number of cylinders are still stored in USEC-managed yards. Over several years, most of the storage yards that previously had gravel bases have been reconstructed with concrete bases for control of infiltration and runoff. Currently, only three DOE-managed yards have not been reconstructed: C-745-F (which is located on a former building foundation) and C-745-N and C-745-P (which both have gravel bases). The C-745-F yard has an area of about 247,000 ft^2 (23,000 m^2); the C-745-N and C-745-P yards have a combined area of about 164,000 ft^2 (15,000 m^2).

TABLE 3.1-1 DOE-Managed DUF_6 Cylinders at the Paducah Site

Cylinder Type	No. of Cylinders
Full	35,908
Partially full	136
Heel	147
Total	36,191

Source: Hartman (2003).

3.1.2 Site Infrastructure

The Paducah site is located in an area with an established transportation network. The area is served by two interstate highways, several U.S. and state highways, several rail lines, and a regional airport.

All water used by the site is obtained from the Ohio River through an intake at the steam plant near the Shawnee Power Plant north of the site. Before use, the water is treated on site. Water usage is approximately 15 million gal/d (57 million L/d). The maximum site capacity is 30 million gal/d (115 million L/d) (DOE 1996).

Electric Energy, Inc., supplies electric power to the Paducah site. The electrical need is about 1,600 MW, with a maximum capacity of 3,040 MW. The coal system uses 82 tons (74 t) per day, with a maximum capacity of 180 to 200 tons (160 to 180 t) (DOE 1996).

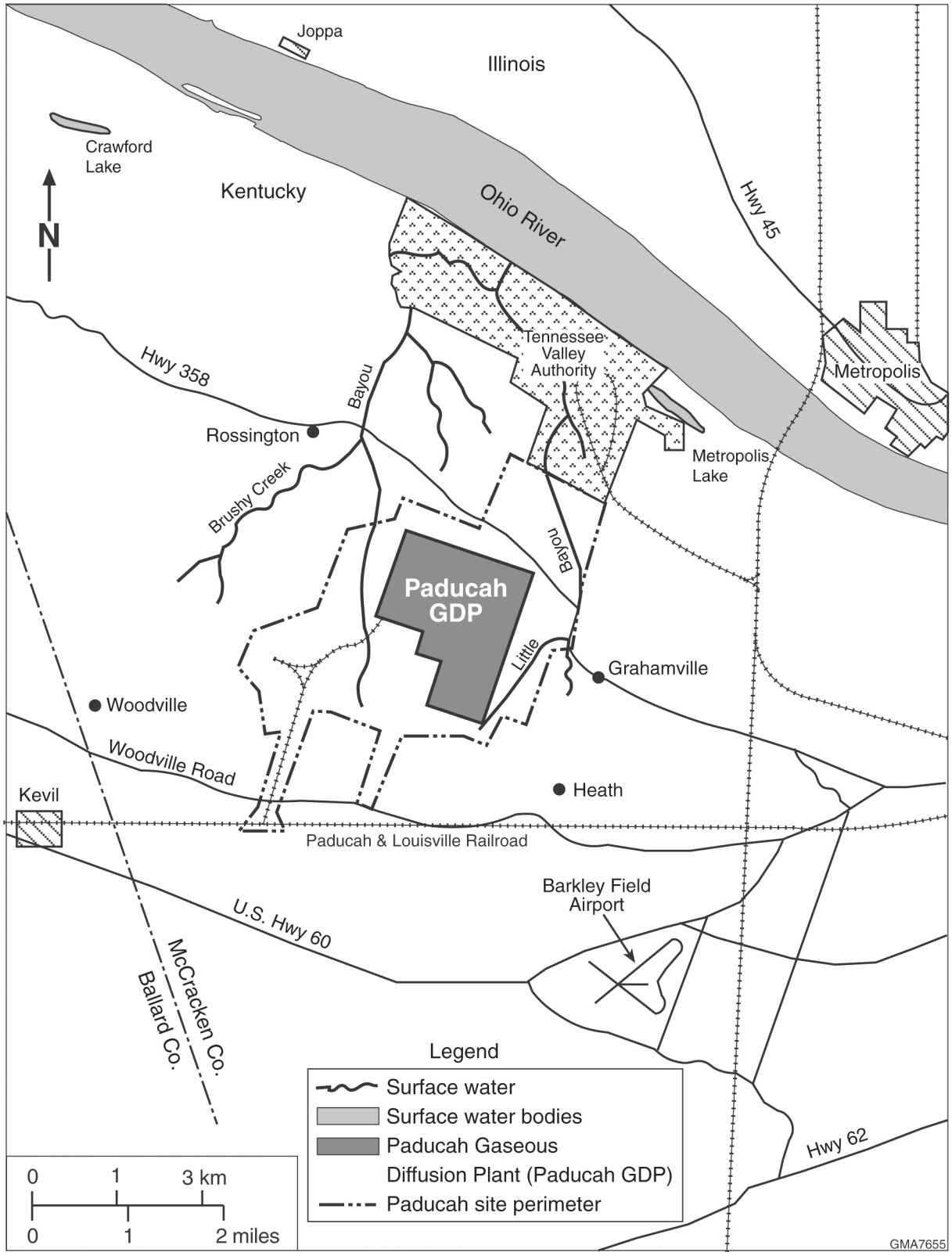

FIGURE 3.1-1 Regional Map of the Paducah Site Vicinity (Source: Adapted from LMES 1996a)

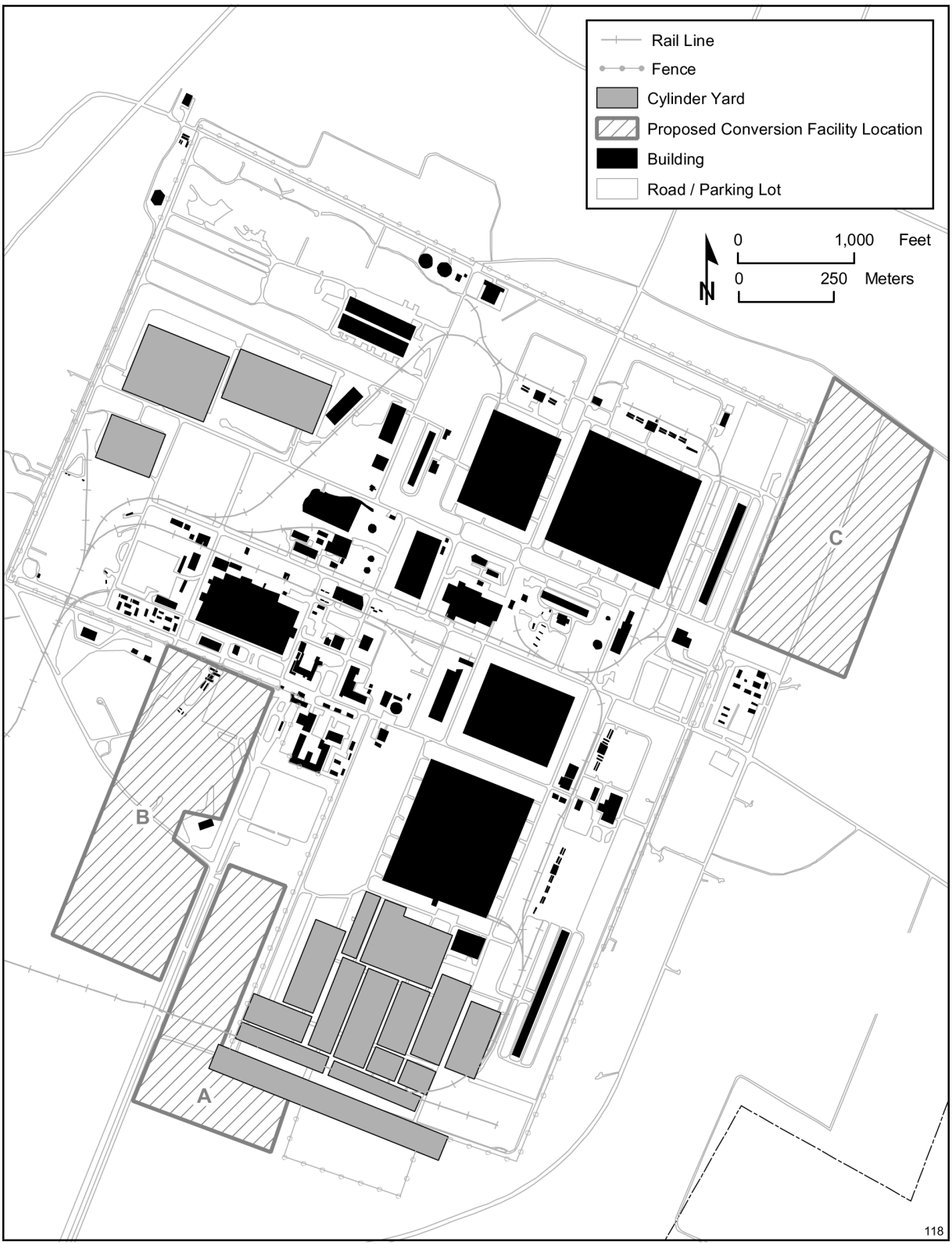

FIGURE 3.1-2 Locations of Cylinder Yards at the Paducah Site That Are Used to Store DOE-Managed Cylinders (Source: Adapted from DOE 1999a)

3.1.3 Climate, Air Quality, and Noise

3.1.3.1 Climate

The Paducah site is located in the humid continental zone, characterized by warm summers and moderately cold winters (DOE 2001b). For the period 1961 through 1990, the annual average temperature was 14.0°C (57.2°F), with the highest monthly average temperature of 26.0°C (78.8°F) in July and the lowest of 0.3°C (32.6°F) in January (Wood 1996). Annual precipitation averages about 125 cm (49.3 in.), mostly occurring as rain. Precipitation is relatively evenly distributed throughout the seasons, but the highest occurs in spring. For the period 1985 through 1993, average annual relative humidity was about 73%, ranging from 82% to 86% at midnight and 6 a.m. and from 58% to 64% at noon and 6 p.m.

Wind data collected at Barkley Regional Airport about 8 km (5 mi) to the southeast of the Paducah site were evaluated. For the period 1990 through 1994, the average wind speed at the 10-m (33-ft) level was about 3.8 m/s (8.6 mph), as shown in Figure 3.1-3 (National Climatic Data Center undated). The dominant wind direction was from the south, with a secondary peak from the south-southwest. Directional wind speeds ranged from 3.1 m/s (6.9 mph) from the east to 4.7 m/s (10.5 mph) from the north-northwest, and the wind speed from the dominant wind direction was also high, at about 4.6 m/s (10.3 mph).

Tornadoes are rare in the area surrounding the Paducah site, and the ones that do occur are less frequent and destructive than those occurring in the Midwest. For the period 1950 through 1995, 402 tornadoes were reported in Kentucky, with an average of 9 tornadoes per year (Storm Prediction Center 2002). For the same period, 6 tornadoes were reported in McCracken County, but most of those tornadoes were relatively weak — at most, F2 of the Fujita tornado scale.

3.1.3.2 Existing Air Emissions

Major air pollution sources around the Paducah site in Kentucky include USEC and the TVA's coal-fired Shawnee Power Plant, about 5 km (3 mi) northeast of the Paducah site (EPA 2003). In Illinois, the Joppa Power Plant and Lafarge Corporation, located about 11 km (7 mi) north-northwest of the Paducah site, are major sources across the Ohio River. Table 3.1-2 lists the annual emissions from the four plants and total criteria pollutant and volatile organic compound (VOC) emissions for the respective counties. As a result of the transfer of the production part of the Paducah GDP to USEC, major air emission sources were transferred to USEC. Accordingly, air emissions from the DOE facilities at Paducah are negligible, and DOE does not currently hold any air quality permits (Knaus 2002). USEC is classified as a major source with a Title V Permit, but its emissions account for less than 1% of areawide emission totals.

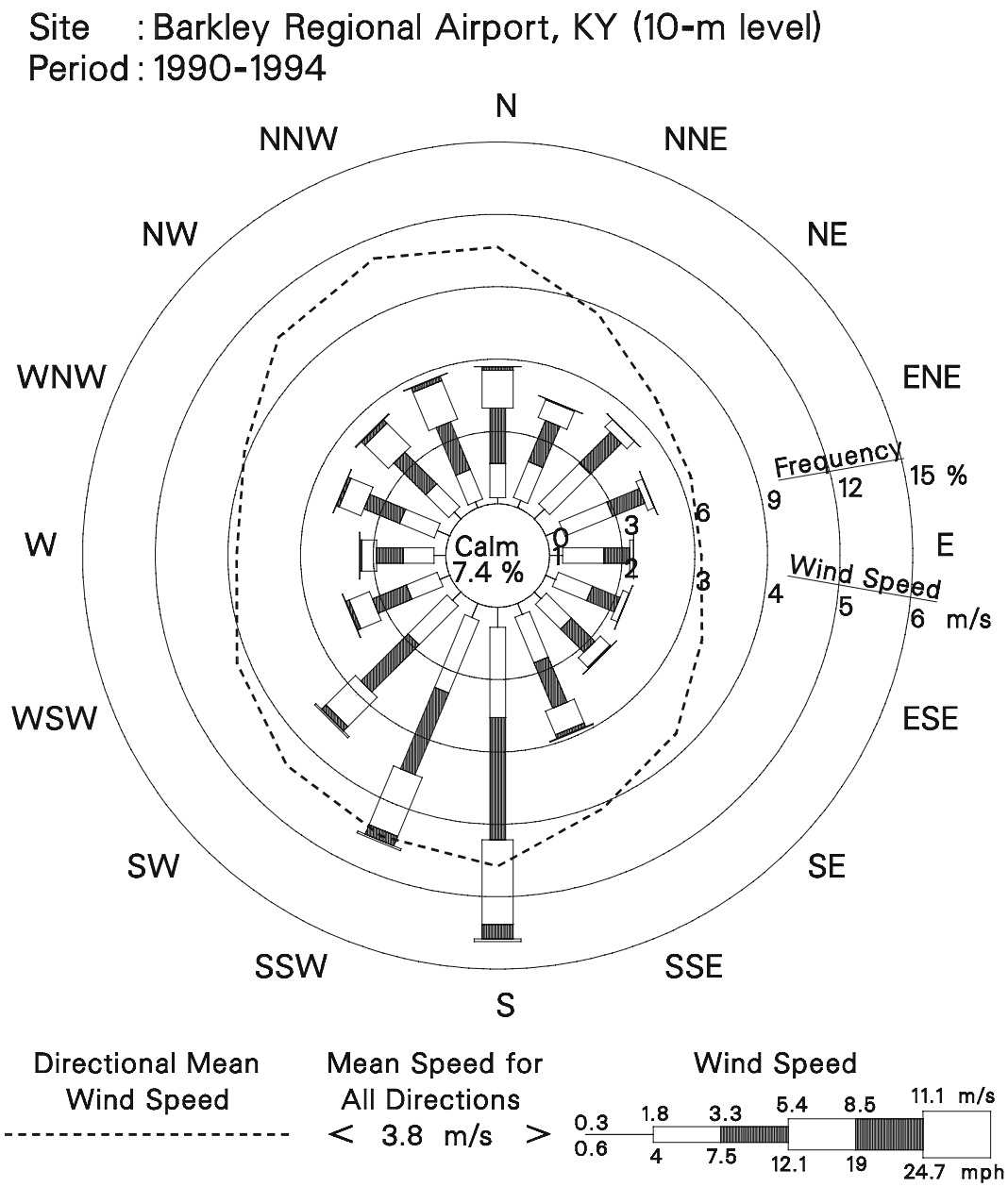

FIGURE 3.1-3 Wind Rose for the Barkley Regional Airport (10-m level), 1990–1994 (Source: National Climatic Data Center undated)

The Commonwealth of Kentucky and the EPA regulate airborne emissions of radionuclides from DOE facilities under 40 CFR Part 61, Subpart H, the National Emission Standards for Hazardous Air Pollutants (NESHAPs) regulations (DOE 2001b). Potential radionuclide sources from the Paducah site in 2000 were the Drum Mountain Removal Project, Northwest Plume Groundwater System, and fugitive emission sources.

TABLE 3.1-2 Annual Criteria Pollutant and Volatile Organic Compound Emissions from Selected Major Point Sources around the Paducah Site in 1999

	Emission Rate (tons/yr)					
Major Emission Source	SO_2	NO_x	CO	VOCs	PM_{10}	$PM_{2.5}$
TVA Shawnee Plant	35,874	23,956	3,699	112	75	46
USEC	427	320	8	1	9	5
McCracken County, Ky., total	36,317	24,283	3,713	352	126	74
Electric Energy, Inc., Joppa	23,744	8,447	1,250	152	927	680
Lafarge Corporation	11,466	1,516	0	0	204	113
Massac County, Ill., total	35,597	10,174	1,316	484	1,383	922

Source: EPA (2003).

3.1.3.3 Air Quality

The Kentucky State Ambient Air Quality Standards (SAAQS) for six criteria pollutants — SO_2, nitrogen dioxide (NO_2), CO, ozone (O_3), PM (PM_{10} and $PM_{2.5}$), and lead (Pb) — are the same as the National Ambient Air Quality Standards (NAAQS)[1] (Kentucky Division for Air Quality 2002), as shown in Table 3.1-3. In addition, the state has adopted standards for hydrogen sulfide (H_2S), gaseous fluorides (expressed as HF), total fluorides, and odors, as presented in Table 3.1-4.

The Paducah site is located in the Paducah-Cairo Interstate Air Quality Control Region (AQCR), which covers the westernmost parts of Kentucky. McCracken County currently is designated as being in attainment for all criteria pollutants (40 CFR 81.318). Current ambient monitoring data for criteria pollutants, H_2S, and HF immediately around the site are not available (Knaus 2002). However, on the basis of 1997 through 2002 monitoring data, the highest concentration levels for SO_2, NO_2, CO, PM_{10}, 24-hour $PM_{2.5}$, and Pb around the Paducah site are less than or equal to 53% of their respective NAAQS, as given in Table 3.1-3 (EPA 2003). The highest O_3 and annual $PM_{2.5}$ concentrations, however, are near to or somewhat higher than the applicable NAAQS. The high ozone concentrations of regional concern are associated with high precursor emissions from the Ohio Valley region and long-range transport from southern states.

Ambient air monitoring stations in and around the site mainly collect data on radionuclides released from the site. These data were used to assess whether air emissions from the Paducah GDP would affect air quality in the surrounding area. Monitoring results showed that all airborne radionuclide concentrations in the surrounding area were at or below background levels (DOE 2001b).

[1] The EPA promulgated new O_3 8-hour and $PM_{2.5}$ standards in July 1997.

TABLE 3.1-3 National Ambient Air Quality Standards, Kentucky State Ambient Air Quality Standards, Maximum Allowable Increments for Prevention of Significant Deterioration, and Highest Background Levels Representative of the Paducah Gaseous Diffusion Plant

		NAAQS/SAAQS[b]		PSD Increment[d] ($\mu g/m^3$)		Highest Background Level	
Pollutant[a]	Averaging Time	Value	Type[c]	Class I	Class II	Concentration[e]	Location (Year)
SO_2	3 hours	0.50 ppm (1,300 $\mu g/m^3$)	S	25	512	0.065 ppm (13%)	Grahamville (1999)
	24 hours	0.14 ppm (365 $\mu g/m^3$)	P	5	91	0.033 ppm (24%)	Grahamville (1997)
	Annual	0.03 ppm (80 $\mu g/m^3$)	P	2	20	0.005 ppm (17%)	Grahamville (1999)
NO_2	Annual	0.053 ppm (100 $\mu g/m^3$)	P, S	2.5	25	0.012 ppm (23%)	Paducah (1998)
CO[f]	1 hour	35 ppm (40 mg/m^3)	P, S	–[g]	–	6.1 ppm (17%)	Paducah (1997)
	8 hours	9 ppm (10 mg/m^3)	P, S	–	–	2.9 ppm (32%)	Paducah (1997)
O_3	1 hour	0.12 ppm (235 $\mu g/m^3$)	P, S	–	–	0.110 ppm (92%)[h]	Paducah (1999)
	8 hours	0.08 ppm (157 $\mu g/m^3$)	P, S	–	–	0.093 ppm (116%)[i]	Paducah (1999)
PM_{10}	24 hours	150 $\mu g/m^3$	P, S	8	30	79 $\mu g/m^3$ (53%)[h]	Paducah (2002)
	Annual	50 $\mu g/m^3$	P, S	4	17	25 $\mu g/m^3$ (50%)	Paducah (1999)
$PM_{2.5}$	24 hours	65 $\mu g/m^3$	P, S	–	–	31.1 $\mu g/m^3$ (48%)[h]	Paducah (2002)
	Annual	15 $\mu g/m^3$	P, S	–	–	14.7 $\mu g/m^3$ (98%)	Paducah (2000)
Pb	Calendar quarter	1.5 $\mu g/m^3$	P, S	–	–	0.02 $\mu g/m^3$ (3%)	Louisville (1997)

Footnotes on next page.

TABLE 3.1-3 (Cont.)

[a] CO = carbon monoxide; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; $PM_{2.5}$ = particulate matter ≤2.5 μm; PM_{10} = particulate matter ≤10 μm; and SO_2 = sulfur dioxide.

[b] The SO_2 (3-hour and 24-hour) and CO standards are attained when the stated value is not exceeded more than once per year. The SO_2 (annual), NO_2, and Pb standards are attained when the stated value is not exceeded. The O_3 (1-hour) standard is attained when the stated value is not exceeded more than three times in 3 years. The O_3 (8-hour) standard is attained when the 3-year average of the annual fourth-highest daily maximum 8-hour average concentration does not exceed the stated value. The PM_{10} (annual) and $PM_{2.5}$ (annual) standards are attained when the 3-year average of the annual arithmetic means does not exceed the stated value. The PM_{10} (24-hour) standard is attained when the 3-year average of the 99th percentile values does not exceed the stated value. The $PM_{2.5}$ (24-hour) standard is attained when the 3-year average of the annual 98th percentile values does not exceed the stated value.

[c] P = primary standard whose limits were set to protect public health; S = secondary standard whose limits were set to protect public welfare.

[d] Class I areas are specifically designated areas in which degradation of air quality is severely restricted under the Clean Air Act; Class II areas have a somewhat less stringent set of allowable emissions.

[e] Values in parentheses are monitored concentrations as a percentage of NAAQS or SAAQS.

[f] The NAAQS have a primary standard only; the Kentucky SAAQS, however, have a secondary standard as well.

[g] A dash indicates that no standard exists.

[h] Second-highest value.

[i] Fourth-highest value.

Sources: 40 CFR Part 50; Kentucky Division for Air Quality (2002); 40 CFR 52.21; EPA (2003).

TABLE 3.1-4 Additional Commonwealth of Kentucky Ambient Air Quality Standards[a]

Pollutant	Averaging Time	Primary Standard	Secondary Standard
Hydrogen sulfide	1 hour	–[b]	14 μg/m^3 (0.01 ppm)[c]
Gaseous fluorides (expressed as HF)	12 hours	–	3.68 μg/m^3 (4.50 ppb)[c]
	24 hours	800 μg/m^3 (1.0 ppm)[c]	2.86 μg/m^3 (3.50 ppb)[c]
	1 week	–	1.64 μg/m^3 (2.00 ppb)[c]
	1 month	–	0.82 μg/m^3 (1.00 ppb)[c]
	Annual	400 μg/m^3 (0.5 ppm)	–
Total fluorides[d]	1 month	–	80 ppm (w/w)[e]
	2 months	–	60 ppm (w/w)
	Growing season[f]	–	40 ppm (w/w)
Odors			At any time when 1 volume unit of ambient air is mixed with 7 volume units of odorless air, the mixture must have no detectable odor

[a] These standards are in addition to the Kentucky SAAQS for criteria pollutants listed in Table 3.1-3.

[b] A dash indicates that no standard exists.

[c] This average is not to be exceeded more than once per year.

[d] Dry weight basis (as fluoride ion) in and on forage for consumption by grazing ruminants. The listed concentrations are not to be exceeded.

[e] w/w = weight of fluoride ion per weight of forage unit.

[f] Average concentration of monthly samples over the growing season (not to exceed six consecutive months).

Source: Appendix A of 401 *Kentucky Administrative Regulations* (KAR) 53:010.

Prevention of significant deterioration (PSD) regulations (40 CFR 52.21) limit the maximum allowable incremental increases in ambient concentrations of SO_2, NO_2, and PM_{10} above established baseline levels, as shown in Table 3.1-3. The PSD regulations, which are designed to protect ambient air quality in Class I and Class II attainment areas, apply to major new sources and major modifications to existing sources. The nearest Class I PSD areas are Mingo National Wildlife Refuge in Missouri, about 113 km (70 mi) west of the Paducah site, and Mammoth Cave National Park, about 225 km (140 mi) east of the Paducah site. These Class I areas are not located downwind of prevailing winds at the Paducah GDP (Figure 3.1-3).

3.1.3.4 Existing Noise Environment

The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978; 42 USC 4901–4918), delegates authority to the states to regulate environmental noise and directs government agencies to comply with local community noise statutes and regulations. The Commonwealth of Kentucky and McCracken County, where the Paducah site is located, have no quantitative noise-limit regulations.

The EPA has recommended a maximum noise level of 55 dB(A) as the DNL to protect against outdoor activity interference and annoyance (EPA 1974). This is not a regulatory goal, but it is "intentionally conservative to protect the most sensitive portion of the American population" with "an additional margin of safety." For protection against hearing loss in the general population from nonimpulsive noise, the EPA guideline recommends an L_{eq}(24 h) of 70 dB(A) or less.[2]

The noise-producing activities within the Paducah site are associated with processing and construction activities and local traffic, similar to those at any other industrial site. During site operations, noise levels near the cooling towers are relatively high, but most noise sources are enclosed in the buildings. Another noise source is associated with rail traffic in and out of the Paducah site. In particular, train whistle noise, at a typical noise level of 95 to 115 dB(A), is high at public grade crossings. Currently, rail traffic noise is not a factor in the local noise environment because of infrequent traffic (one train per week).

The Paducah site is in a rural setting, and no residences or other sensitive receptor locations (e.g., schools, hospitals) are located in the immediate vicinity of any noisy on-site operations. (The nearest sensitive receptor is located about 1 mi (2 km) from the proposed conversion facility.) Ambient noise levels around the site are relatively low. Measurements taken at the nearest residence ranged from 44 to 47 dB(A) when the site was in full operation (Pennington 2001; Argonne National Laboratory [ANL] 1991a). At nearby residences, noise emissions from the plant were reported as undetectable from background noise.

3.1.4 Geology and Soil

3.1.4.1 Topography, Structure, and Seismic Risk

The topography of the Paducah site is relatively flat. Western Kentucky has gently rolling terrain between 330 and 500 ft (101 and 152 m) above mean sea level (DOE 1999h). Within the boundaries of the Paducah GDP security fence, the maximum variation in elevation is about 10 ft (3 m) (ERC/EDGe 1989). The site is underlain by bedrock composed of limestone and shale. Several zones of faulting, including the New Madrid Seismic Zone, occur in the vicinity of the site (ANL 1991a).

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[2] L_{eq} is the equivalent steady sound level that, if continuous during a specific time period, would contain the same total energy as the actual time-varying sound. For example, L_{eq}(24 h) is the 24-hour equivalent sound level.

The Paducah site is located near the northern end of the Mississippian Embayment, which is characterized by unconsolidated Cretaceous, Tertiary, and Quaternary sediments overlying indurated Paleozoic bedrock that dip gently to the south. The Mississippian Embayment was a large sedimentary trough oriented nearly north to south that existed during Cretaceous and Tertiary time and received sediments from the central portion of the North American continent (Early et al. 1989).

The sedimentary sequence found in the vicinity of the Paducah site consists mainly of fine- to medium-grained clastic materials (sedimentary rocks formed from particles that were mechanically transported), including (from youngest to oldest) a basal gravel (Tuscaloosa Formation), the McNairy Formation (clay interlaminated with silt and fine-grained sand), the Porters Creek Clay (clay facies and variable thicknesses of sand and silt), and undifferentiated Eocene sands (fine sand with variable amounts of interbedded and interlensing silt and clay). The Eocene sands are thought to be thin and discontinuous beneath the northern portion of the Paducah site. At depth, the site is underlain by dense bedrock of Mississippian limestone and shale.

In the vicinity of the site, a unit designated as Continental Deposits lies immediately beneath variable thicknesses of Pleistocene Loess, which is typically an unstratified, silty clay-clayey silt (EDGe 1987). The loess originated as windblown material generated by glacial activity to the north. The Continental Deposits lie directly on an ancient unconformity (erosional surface) that truncates several formations. The angular nature of the unconformity — coupled with the fact that the Eocene sands, Porters Creek Clay and McNairy Formation lie unconformably on each other — creates a complex stratigraphy. The Continental Deposits resemble a large low-gradient alluvial fan deposited at the confluence of the ancestral Ohio and Tennessee Rivers.

Erosion and reworking of alluvial fan deposits modified the thickness and distribution of the Continental Deposits (DOE 1999h). The Continental Deposits can be subdivided into two components or facies: a lower gravel or sandy gravel unit that varies in thickness from 0 to 106 ft (0 to 32 m) and an upper clay-sand unit that has a comparable thickness (Early et al. 1989). Deposition of the gravel probably occurred in a high-energy braided stream environment closely associated with alluvial fans. Of particular interest is the presence of a prominent channel that passes in a northerly direction through the site and a second, less-prominent channel that occurs near the eastern side of the site boundary. The upper clay-sand unit represents sediments deposited in a fluvial and lacustrine (lake) environment (DOE 1999h).

Several zones of faulting occur in the vicinity of the site. These zones include the St. Genevieve, Rough Creek, Cottage Grove, Wabash Valley, and Shawneetown fault zones. In addition, there is a northeast-trending rift zone (ERC/EDGe 1989). A rift zone is a fault through a divergence zone (i.e., an area in which tectonic plates are moving away from each other) or other area of tension. These features are overlain by younger Cretaceous, Tertiary, and Quaternary sediments. The rift zone is inferred from seismic reflection profiling.

The New Madrid Seismic Zone lies within the central Mississippi Valley and extends from northeast Arkansas, through southeast Missouri, western Tennessee, and western Kentucky

to southern Illinois (Saint Louis University Earthquake Center 2002). The area near the site has been the location of some of the largest earthquakes that have occurred in North America. The largest recorded earthquakes that occurred in the vicinity of the site happened between 1811 and 1812. Four of the earthquakes had Modified Mercalli intensities that ranged from IX to XI (Nuttli 1973). (The Modified Mercalli intensity scale relates an earthquake's intensity to a series of key responses of surface structures and people, such as people awakening, movement of furniture, damage to chimneys, and, finally, total destruction.) In an earthquake with a Modified Mercalli intensity of XI, few, if any, masonry structures remain standing, bridges are destroyed, and rails are greatly bent.

The series of 1811 to 1812 earthquakes completely destroyed the town of New Madrid. The epicenter of the largest 1812 earthquakes was about 60 mi (96 km) southwest of what is now the Paducah site (LMES 1997b). Hundreds of aftershocks occurred over a period of several years. The largest earthquakes that have occurred since then were on January 4, 1843, and October 31, 1895, with body wave magnitude estimates of 6.0 and 6.2, respectively. In addition to these events, seven events of magnitude greater than 5.0 have occurred in the area. Since 1895, more than 4,000 earthquakes have been located in the zone. Most of them were too small to be felt. On average, one earthquake per year is large enough to be felt in the area (Saint Louis University Earthquake Center 2002). On June 18, 2002, a moderate earthquake with a preliminary estimated magnitude of 5.0 occurred in southern Indiana with an epicenter near Evansville (CNN 2002). This earthquake occurred on the northern arm of the New Madrid Seismic Zone. There were no immediate reports of damage.

The seismic hazards at the Paducah site have been extensively studied. The safety analysis report (SAR) completed for this site in March 1997 provided comprehensive analyses and discussions of seismic hazards at the site (see Sections 1.5 and 3.3 of the SAR; LMES 1997b). The analyses considered the possibility of large-magnitude earthquakes similar to the New Madrid earthquakes of 1811 to 1812. The analyses performed by DOE were independently reviewed by the U.S. Geological Survey (USGS). The independent review indicated that the seismic sources, recurrence rates, maximum magnitudes, and attenuation functions used in the SAR analyses were representative of a wide range of professional opinion and were suitable for obtaining probabilistically based seismic hazard estimates. Because of the proximity of the site to the New Madrid Seismic Zone, special deterministic analyses were also performed to estimate the ground motions at the site in the case of recurrence of an earthquake of the same magnitude as the 1811 to 1812 New Madrid earthquakes. The results of the deterministic analyses were similar to the probabilistic seismic hazard results for the probabilities associated with the recurrence of the New Madrid earthquakes of 1811 to 1812.

For the Paducah site, the evaluation basis earthquake (EBE) was designated by DOE to have a return period of 250 years. A detailed analysis indicated that the peak ground motion for the EBE was 0.15 times the acceleration of gravity (LMES 1997b). An earthquake of this size would have an equal probability of occurring any time during a 250-year period.

3.1.4.2 Soils

Soils of the Calloway-Henry Association cover most of the Paducah site; soils of the Grenada-Calloway Association cover the remainder. Soils of the Calloway-Henry Association, which are nearly level and somewhat poorly drained soils of medium texture, occur on uplands. Soils of the Grenada-Calloway Association, which are nearly level to sloping and moderately well-drained, medium-textured soils, also occur on uplands. Calloway, Henry, and Granada soils have a slight potential for erosion, a low shrink-swell potential, and permeabilities ranging from 0.51 to 5.1 cm/h (0.20 to 2.0 in./h) (Humphrey 1976).

Undisturbed soils typically contain a low-permeability layer (fragipan) that occurs at a depth from 1 to 4 ft (0.30 to 1.22 m). Site development has destroyed much of this layer. In areas in which the fragipan is present, perched water may occur (ANL 1991a). Substances in soil possibly associated with past and present cylinder management activities would be uranium and fluoride compounds, which could be released in cases of breached cylinders or faulty valves. For the evaluation of ongoing activities at the Paducah site, soil sampling has been conducted to identify the accumulation of any airborne pollutants deposited on the ground. Annual soil samples have been collected from 10 off-site locations — 4 at the site boundary, 4 at distances of 5 mi (8 km) beyond the boundary, and 2 at more remote locations — to characterize background levels (LMES 1996a; Martin Marietta Energy Systems, Inc. [MMES] 1994a). In 1994, uranium concentrations for the 10 sampling locations ranged from 2.0 to 5.8 μg/g; plant boundary concentrations ranged from 2.3 to 4.9 μg/g (LMES 1996a).

Since the transfer of responsibility for air point sources from DOE to USEC, concentrations of nonradiological parameters in soil at these sampling locations are no longer monitored; however, analytical results for PCBs and metals are available. In 1993, no detectable concentrations of PCBs were found in any of the samples; however, elevated concentrations of bismuth, lead, manganese, thallium, and thorium were detected in several samples (MMES 1994a). Fluoride was not analyzed in soil samples, but it occurs naturally in soils and is of low toxicity.

As part of ongoing CERCLA/RCRA investigations of Paducah site operable units, soils in several areas have been identified as contaminated with radionuclides and chemicals, such as PCBs and metals. This contamination is not associated with the DUF_6 cylinder yards.

An investigation of Location A soils was conducted in 2000 (Tetra Tech, Inc. 2000). The results of several limited soil investigations for SWMU 194, incorporating parts of both Locations A and B, are also summarized in a subsequent risk assessment (DOE 2001a). These reports indicate a limited number of samples in both locations with elevated concentrations of uranium, polycyclic aromatic hydrocarbons (PAHs), and metals in comparison with human-health based guidelines. No characterization of soils in Location C has been conducted. There is no known past or current source of contamination at Location C.

3.1.5 Water Resources

The affected environment for water resources consists of surface water within and in the vicinity of the site boundary and groundwater beneath the site. Analyses of surface water, stream sediment, and groundwater samples have indicated the presence of some contamination resulting from previous site operations.

3.1.5.1 Surface Water

The Paducah site is located in the western part of the Ohio River drainage basin. Surface water from the site drains into tributaries of the Ohio River (Rogers et al. 1988). Bayou Creek (formerly Big Bayou Creek) is located on the western side of the site, and Little Bayou Creek is located on the eastern side (Figure 3.1-1). These two streams join north of the site and discharge to the Ohio River at about River Kilometer 1,524, which is about 34 mi (55 km) upstream from the confluence of the Ohio and Mississippi Rivers. The site is located about 3.5 mi (5.6 km) south of the Ohio River. The historical mean flow for this section of the river is about 200 million gal/min (757 million L/min) (DOE 2001b). All water used by the Paducah site is obtained from the Ohio River through an intake at the steam plant near the Shawnee Power Plant (ANL 1991a), which is located adjacent to the Ohio River north of the facility. Current water use is approximately 15 million gal/d (57 million L/d). Flow in Bayou Creek and Little Bayou Creek fluctuates greatly as a result of precipitation; however, during most of the year, most of the flow in both streams is derived from plant effluents. Bayou Creek has a mean flow of about 67,300 gal/min (254,758 L/min), with a stage (depth) of about 2 ft (0.6 m). The average annual low flow for this stream is about 22,400 gal/min (84,793 L/min) (Pennington 2001). The mean flow rate for Little Bayou Creek is approximately 44,900 gal/min (169,965 L/min), with a depth of about 1 to 2 ft (0.3 to 0.6 m). The average annual low flow for Little Bayou Creek is generally too low to be monitored or sampled. Annual precipitation in the vicinity of the site is about 49.3 in. (125 cm).

A number of wetlands and drainage ditches occur on the three sites identified as potential DUF_6 conversion facility locations. The Paducah site is not located in a 100-year floodplain (elevation of 333 ft [102 m]), nor would it be affected by the historical high-water elevation of 342 ft (104 m).

Most of the liquid effluents from the Paducah site consist of once-through non-contact cooling water, although a variety of the liquid wastes (contaminated with uranium and noncontaminated) are produced by activities such as metal finishing, uranium recovery, and facility cleaning (Rogers et al. 1988). In addition to these discharges, a large variety of conventional liquid wastes, including treated domestic sewage, steam plant wastewater, and coal pile runoff, enter the surface water system.

All effluent discharges are regulated under permits from the KPDES. Currently, there are a total of 15 outfalls — 10 outfalls authorized to USEC (KY0102083) and 5 outfalls authorized to DOE (KY000409). Three of the DOE outfalls are to Bayou Creek and one is to an unnamed tributary of Little Bayou Creek. The average discharge of wastewater to Bayou Creek is approximately 4 million gal/d (15 million L/d). The average discharge to the Ohio River through

Bayou and Little Bayou Creeks is about 4.1 million gal/d (16 million L/d). The average flow in the Ohio River is 1.7×10^{11} gal/d (6.5×10^{11} L/d).

Results of surface water monitoring in 2000 indicated that the maximum concentration of uranium from 20 surface water sampling locations monitored 3 to 5 times annually was 0.017 mg/L in the downstream portion of Little Bayou Creek (DOE 2001b). The maximum average concentration of fluoride was less than 0.224 mg/L in the north/south diversion ditch within the Paducah GDP grounds (MMES 1994b). Comparable data on fluoride were not reported for 1994, 1995, or 1996 (LMES 1996a, 1997a,c).

The KPDES-permitted outfalls are monitored for inorganic substances and about 45 organic substances, including PCBs. The monitoring frequency for most substances is two to four times per year; several substances are monitored monthly or quarterly to comply with KPDES Permit requirements. The maximum average uranium concentration in effluents from the DOE outfalls from 1994 through 1996 was 0.037 mg/L (LMES 1996a, 1997a,c). In 2000, the maximum uranium concentration from DOE outfalls was 0.09 mg/L (DOE 2001b). This value is below the derived concentration guide (DCG) of 600 pCi/L.

KPDES Outfall 017 is located at the central-western edge of alternative Location B. This outfall receives runoff from the cylinder storage yards and from the cylinder painting facility area. Starting in 1998, and again in 2000 and 2001, acute toxicity tests at this outfall exceeded specified limits (DOE 2001b, 2002e). Zinc in runoff from painting activities was suspected of being the leading contributor to the toxicity exceedances (DOE 2001b), but the cause has not been established (DOE 2002e).

Sediment samples are also collected annually from six locations and analyzed for uranium, PCBs, and metals. In 1993, concentrations of uranium and PCBs were detected at levels substantially higher than background levels in Little Bayou Creek (Sampling Location SS2). The uranium concentration of 200 mg/kg at the measuring location was two times higher than it was in 1992. However, levels decreased in 1994 (22 mg/kg maximum uranium concentration, 1.4 mg/kg maximum PCB concentration) (LMES 1996a) and again in 1995 (13 mg/kg maximum uranium concentration, <0.1 mg/kg maximum PCB concentration) (LMES 1997a). In 1996, the uranium concentration in sediment at Location SS2 was 44 mg/kg; the PCB concentration was 1.3 mg/kg. A new sampling location (SS29) was added on Little Bayou Creek closer to the Paducah GDP. The uranium concentration at this location was 360 mg/kg; no PCB value was reported (LMES 1997c). In 2000, the maximum uranium concentration measured for all sediment sampling locations was 60 mg/kg (DOE 2001b).

3.1.5.2 Groundwater

Two near-surface aquifers are important at the Paducah site. The upper aquifer is a shallow, perched-water aquifer composed of upper continental deposits of sand and of sand and clay mixtures that are discontinuous. Water yields from this aquifer are very low, and the hydraulic gradient (change in water elevation with distance) is difficult to detect. Water movement is generally considered to be vertically downward (DOE 2001a).

The lower aquifer is a good-yielding gravel aquifer that has an upper surface at a depth of about 39 ft (12 m) and a thickness that ranges from about 20 to 59 ft (6 to 18 m). This aquifer appears to be continuous beneath the site. Hydraulic conductivity is estimated to be 0.0001 to 1 cm/s for the regional gravel aquifer and 0.00001 to 0.01 cm/s for the upper Continental Deposits (sands). Water movement is 2 to 5 ft/yr (0.6 to 1.5 m/yr) and toward the north-northeast (DOE 2001a).

Groundwater is sampled from about 200 monitoring wells, residential wells, and TVA wells on and off the Paducah site. Off-site sampling is performed to monitor three separate TCE and Tc plumes first detected in 1988 (LMES 1996a). Paducah has provided a municipal water supply to all residents whose wells are within the area of groundwater contamination from the site; wells that are no longer sampled are locked and capped.

Although the magnitude of groundwater contamination originating from the Paducah site is greatest for TCE and Tc, the primary drinking water standards or DCGs for several other inorganic, volatile organic, and radionuclide substances were also exceeded in one or more of the monitoring wells on or near the Paducah site in sampling conducted from 1993 through 1996 (MMES 1994b; LMES 1996a, 1997a,c). The DCG is equivalent to the maximum concentration limit (MCL); it is the concentration of a radionuclide that under conditions of continuous exposure for 1 year would result in an effective dose equivalent of 4 mrem (EPA 1996; DOE 1990). The uranium guideline of 20 μg/L in 1996 was exceeded in four wells, and the fluoride guideline of 4 mg/L was exceeded in two wells. The wells with uranium and fluoride exceedances are not located near the cylinder yards. Alternative Location C lies within the area of the northeastern groundwater plume that is contaminated with TCE.

Data from the 2000 annual groundwater monitoring program (DOE 2001b) showed that three pollutants exceeded primary drinking water regulation levels in groundwater at the Paducah site; chromium was present in all wells, nitrogen as nitrate in one well, and TCE in two wells. Beta activity was found in seven wells.

3.1.6 Biotic Resources

3.1.6.1 Vegetation

The Paducah site includes the highly developed Paducah GDP, which has few natural vegetation communities. The DOE property between the Paducah GDP and the surrounding West Kentucky Wildlife Management Area consists primarily of open, frequently mowed grassy areas. The DOE property also includes several small upland areas of mature forest, old-field, and transitional habitats. The banks of Bayou Creek and Little Bayou Creek support mature riparian forest with river birch, black willow, and cottonwood (ANL 1991a). The West Kentucky Wildlife Management Area contains wooded areas, from early and mid-successional stages to mature forest communities, as well as restored prairie. Nonforested areas are managed by controlled burns, mowing, and planting to promote the development of native prairie species.

Location A, one of the three potential facility locations for DUF_6 conversion at the Paducah site, is approximately 35 acres (14 ha) in size and includes previously disturbed and undisturbed areas. The northern portion of Location A is relatively level and previously contained facilities during the initial construction of the Paducah GDP. It now supports an open vegetation cover of grasses maintained as mowed lawn. The southern portion of Location A is relatively undisturbed and primarily supports a mature deciduous hardwood forest community of about 10 acres (4 ha). The dominant species in the forested area are red maple, sweet gum, cherry bark oak, and pin oak; swamp chestnut oak, swamp white oak, and hickories are also present (Pennington 2001). Saplings of red maple, American elm, green ash, white ash, and sweet gum are the primary species of the shrub layer. Vines are primarily Virginia creeper and poison ivy, while the dominant species of the herbaceous layer are stiff marsh bedstraw, blunt broom sedge, narrow-leaved cat tail sedge, Japanese chess, swamp rose, and water parsnip. An open grassland lies immediately south of the forested area within the electric power line right-of-way. A small area of shrubs is located adjacent to the forest and extends into the grassland.

Location B covers about 59 acres (24 ha) and consists of a previously disturbed open area in the northern half and mature deciduous hardwood forest in the southern half of the location. The northern portion of Location B (north of Curlee Road), as well as the northeastern area of the southern portion, is flat to gently sloping and is vegetated primarily with grasses maintained as mowed lawn. Two open woodland groves occur in the northern portion and are also mowed. A number of drainage channels within this portion are bordered by steep banks supporting a mosaic of upland herbaceous and immature woodland communities, which include willows, maples, sycamore, sweet gum, tulip tree, milkweed, dogbane, poison ivy, and fleabane. A large mature deciduous hardwood forest is located south of Curlee Road and extends south and west of Location B. Dominant species in the forested area are oaks and hickories, with sassafras and sweet gum also common. Virginia creeper and honeysuckle are common vines within the forested area.

Location C is approximately 53 acres (21 ha) in size and is relatively level throughout. The western half has been previously disturbed and supports a deciduous hardwood forest that includes many young trees and saplings. The dominant species are oaks and hickories. The western margin of this area is located under the electric power lines and consists of an open grassland area that is periodically mowed. A margin of shrubs and saplings borders the western edge of the forested area. The eastern half of Location C consists primarily of an open old-field community with scattered groves of mature deciduous trees, primarily oaks. The vegetation of the open field is predominantly herbaceous and consists primarily of grasses such as fescue and broom-sedge.

3.1.6.2 Wildlife

The habitats at the Paducah site support a relatively high diversity of wildlife species. Common species of the surrounding West Kentucky Wildlife Management Area and undeveloped areas of the Paducah site outside the Paducah GDP fence line include white-tailed deer, red fox, raccoon, opossum, coyote, turkey, and bobwhite quail. Ground-nesting species

include the white-footed mouse, bobwhite, and eastern box turtle. Bayou Creek, upstream of the Paducah site, supports aquatic fauna indicative of oxygen-rich, clean water, including 14 fish species. Aquatic species just downstream of the Paducah site discharge points include 11 fish species (LMES 1997c). The abundance and diversity of aquatic organisms are generally lower near the outfalls than in upstream areas for both Little Bayou and Bayou Creeks (DOE 1994b).

The habitats within Locations A, B, and C support wildlife species typical of similar habitats in the vicinity. Species common to forested areas include slimy salamander, red-bellied woodpecker, Kentucky warbler, red-eyed vireo, white-footed mouse, eastern gray squirrel, and eastern fox squirrel. The forest and woodland communities within the three candidate locations provide foraging habitat for neotropical migratory songbirds during spring and fall migrations. Open areas and old-field habitats support bobwhite, indigo bunting, common grackle, and southeastern shrew. Species found in or near wetlands include American toad, Woodhouse's toad, green frog, red-eared turtle, snapping turtle, beaver, mink, and muskrat. Southern leopard frogs occur near the forested area of Location A.

3.1.6.3 Wetlands

Although no wetlands are identified on the Paducah GDP by the National Wetlands Inventory, approximately 5 acres (2 ha) of jurisdictional wetlands have been identified in drainage ditches scattered throughout the Paducah GDP (ANL 1991a; CDM Federal Programs Corporation 1994; Sadri 1995). Outside the Paducah GDP, a large number of wetlands are scattered throughout the Paducah site. These include forested wetlands, ponds, wet meadows, vernal pools, and wetlands converted to agriculture (U.S. Department of the Army 1994c). Palustrine forested wetlands occur extensively along the banks of Bayou and Little Bayou Creeks. The National Wetlands Inventory identifies many wetlands on the Paducah site, primarily ponds and forested wetlands. A forested wetland dominated by tupelo trees in the West Kentucky Wildlife Management Area has been designated by the Kentucky Nature Preserves Commission and Kentucky Department of Fish and Wildlife as an area of ecological concern (DOE 1996).

Several wetland areas occur at Location A (Figure 3.1-4) and total approximately 7.2 acres (2.9 ha) (Tetra Tech, Inc. 2000). The open area in the northern portion of this location is crossed by several drainage ditches and swales that contain wetlands. The northernmost of these drainages conveys storm water from the cylinder storage yard to KPDES Outfall 017, located west of the Paducah GDP entrance road. Two small isolated wetland areas occur about 300 ft (90 m) south of this drainage. Wetlands also occur in drainage ditches that border the gaseous diffusion plant entrance road and the service road that passes through this area. These areas support palustrine emergent wetlands, which are characterized by herbaceous vegetation in saturated or shallowly inundated soils. The dominant vegetation species in these wetlands are spikerush, green bulrush, needle-pod rush, fowl manna grass, field paspalum, twig-rush, and blunt broom sedge. These wetlands are seasonally flooded. They receive surface water runoff from adjacent areas and possibly groundwater discharge, and they generally drain through

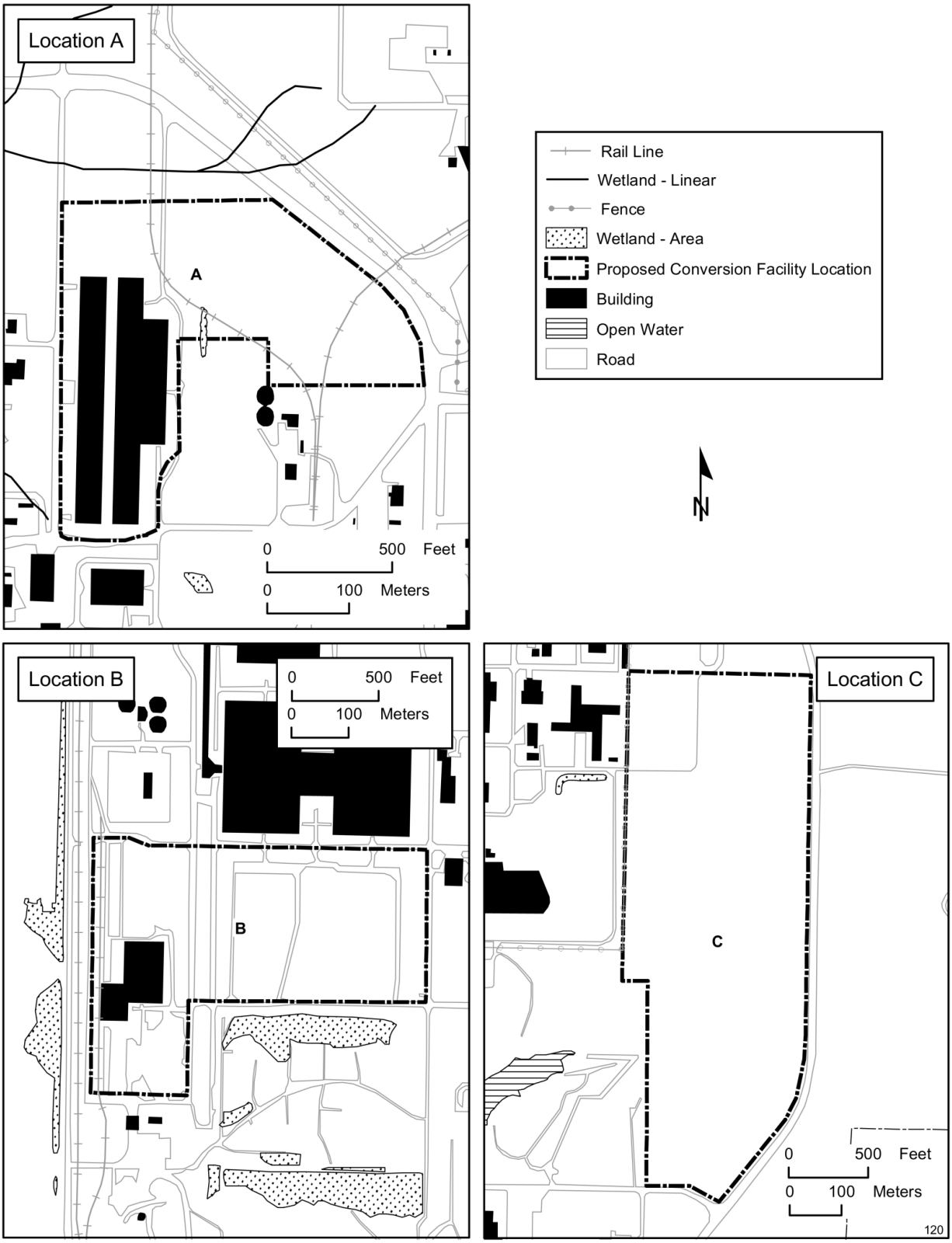

FIGURE 3.1-4 Wetlands in the Vicinity of the Three Candidate Locations for the Paducah Conversion Facility

culverts into drainage channels west of the entrance road. The two isolated wetlands lack a surface outflow. Surface water also remains in the drainages except during periods of high water levels, when excess water is conveyed through the culvert system.

Two small isolated wetlands, as well as a drainage from the adjacent storage yard, also occur immediately east of the forested area. The drainage flows to the west and provides surface water input to a large wetland within the forested area. This area supports palustrine forested wetland, which is characterized by woody vegetation (over 20 ft [60 m] tall) in saturated or shallowly inundated soils. This wetland, approximately 6.3 acres (2.6 ha) in size, lacks a surface outflow and is seasonally flooded. Surface water is present early in the growing season but is absent by mid-summer. The dominant species are similar to those listed above for the forest community. The dominant canopy trees are red maple, sweet gum, cherry bark oak, and pin oak, with swamp chestnut oak, and swamp white oak also present. Saplings of red maple, American elm, green ash, white ash, and sweet gum are the primary species of the shrub layer. Vines are primarily Virginia creeper and poison ivy. The dominant species of the herbaceous layer are stiff marsh bedstraw, blunt broom sedge, narrow-leaved cat tail sedge, swamp rose, and water parsnip, with sensitive fern and fox sedge also present.

Location B contains a series of drainage channels that support riverine and palustrine emergent wetland and flow into Bayou Creek (Figure 3.1-4) (DOE 1994b). In the forested areas of the southern portion of Location B, trees and shrubs overhang these drainages. Two small palustrine emergent wetlands are also located immediately south of Curlee Road. The forested areas support a number of palustrine forested wetlands totaling approximately 1.8 acres [0.7 ha] in area. The dominant canopy species in two of these wetlands are silver maple and cherry bark oak, with green ash present in the shrub layer. Birch is the dominant species in three small forested wetlands; two wetlands are dominated by black willow and buttonbush; and one wetland is dominated by maple. Two wetlands are open water. The predominant forested wetland types are maple/oak, willow/buttonbush, and maple. The total area of wetlands within Location B is approximately 2.9 acres (1.2 ha).

The western portion of Location C contains several palustrine forested wetlands. Pin oak and cherry bark oak are the dominant canopy species in a large wetland area (3.3 acres [1.3 ha]); black gum and red maple are also present. Other forested wetlands in this area are also dominated by cherry bark oak. Small palustrine emergent wetlands along an open pathway support bulrush. Drainage ditches along both sides of Dyke Road contain wetlands with bulrush, sedge, and willow. The eastern portion of Location C contains four small wetlands. Birch is the dominant species of one forested wetland. A small palustrine emergent wetland is located in the southeast corner, and open water wetlands occur to the north. The total area of wetlands within Location C is approximately 5.6 acres (2.3 ha), with 5.3 acres (2.2 ha) in the western portion and 0.3 acre (0.1 ha) in the eastern portion.

3.1.6.4 Threatened and Endangered Species

Federal- and state-listed species in the vicinity of the Paducah site are identified in Table 3.1-5. Although no occurrence of federal-listed plant or animal species on the Paducah site itself has been documented, the Indiana bat (federal- and state-listed as endangered) has been found near the confluence of Bayou Creek and the Ohio River 3 mi (5 km) north of the Paducah GDP. Indiana bats use trees with loose bark (such as shagbark hickory or standing dead trees) in forested areas as roosting sites during spring or summer. Potential roosting habitat for this species occurs on the Paducah site outside the gaseous diffusion plant (U.S. Department of the Army 1994d) and in adjacent wooded areas (Figure 3.1-5). Good-quality habitat contains large trees, provides a dense canopy cover, and is located within 0.25 mi (0.4 km) of potential foraging areas (water bodies). Poor-quality habitat contains less mature trees, provides minimal amounts of canopy cover, and is greater than 0.25 mi (0.4 km) from potential foraging areas. Fair-quality habitat meets some of the requirements for good-quality habitat. Areas within 1,640 ft (500 m) of paved roads are not considered potential Indiana bat habitat.

TABLE 3.1-5 Federal- and State-Listed Endangered, Threatened, and Special Concern Species near the Paducah Site

Category and Scientific Name	Common Name	Status[a]	
		Federal	State
Mammals			
Myotis sodalis	Indiana bat	E	E
Birds			
Ardea herodias	Great blue heron		S
Vireo bellii	Bell's vireo		S
Amphibians			
Rana areolata circulosa	Northern crawfish frog		S
Fish			
Erimyzon sucetta	Lake chubsucker		T
Plants			
Baptisia bracteata leucophaea	Cream wild indigo		S
Silphium laciniatum	Compass plant		T

[a] E = endangered; S = special concern; T = threatened.

Source: U.S. Department of the Army (1994d).

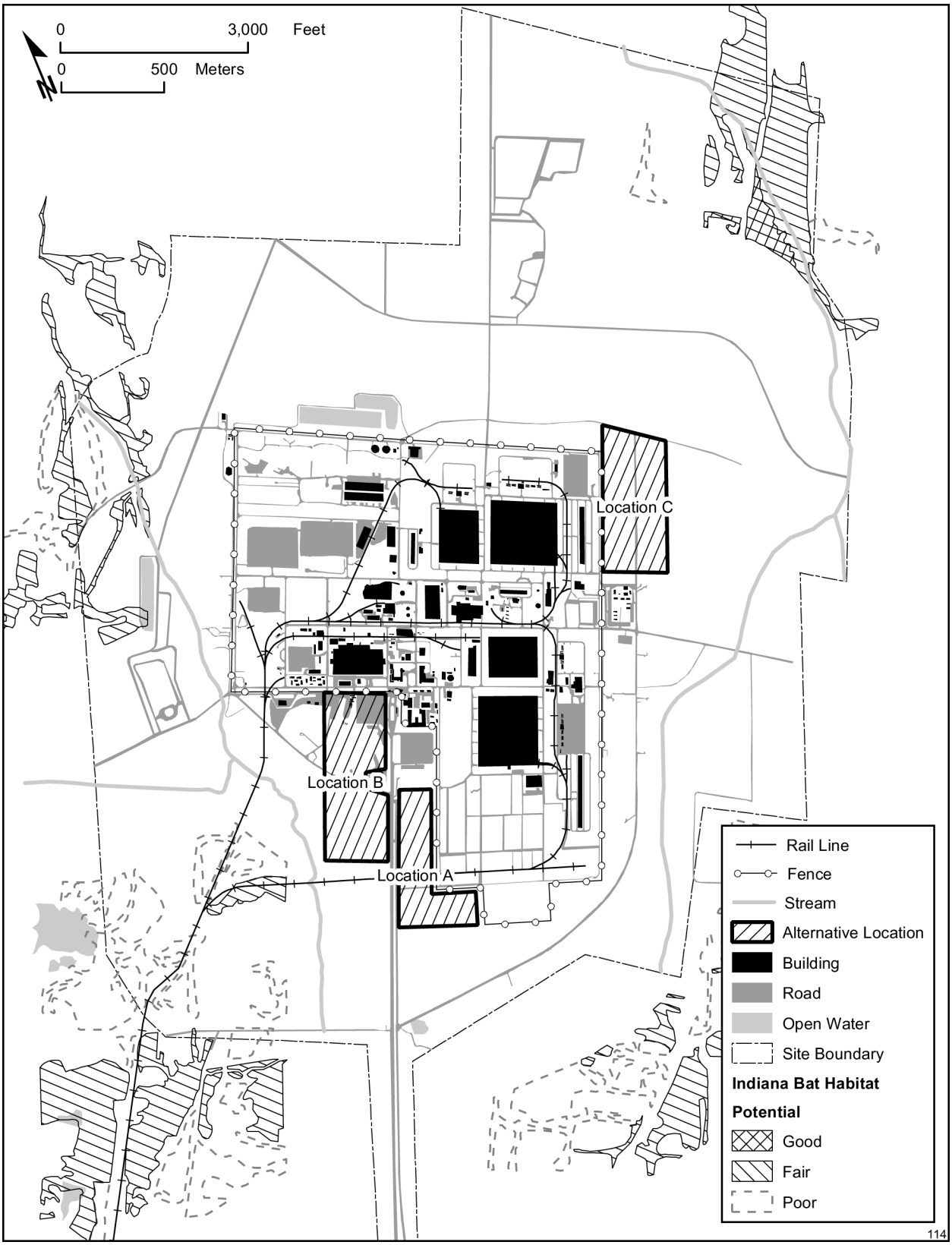

FIGURE 3.1-5 Areas of Potential Indiana Bat Habitat at the Paducah Site

The compass plant, listed by the Commonwealth of Kentucky as threatened, and cream wild indigo, listed by Kentucky as a species of special concern, are prairie species known to occur in several locations on the Paducah site. State-listed species of special concern that occur on or near the Paducah site include Bell's vireo, great blue heron, and Northern crawfish frog. The lake chubsucker, listed by the state as threatened, is known from early, but not recent, surveys of Bayou Creek and Little Bayou Creek.

No federal- or state-listed species have been found to occur on Location A, B, or C (U.S. Department of the Army 1994d). Potential habitat for the Indiana bat has not been identified at any of the candidate locations (see Figure 3.1-5). The mature forest areas of Location B, near Bayou Creek, may provide good-quality summer roosting sites; however, their proximity to roads reduces their suitability. Trees in other wooded areas of the locations have the potential to be used by Indiana bats; however, their proximity to roads, their distance from foraging areas, and the presence of higher-quality habitat in the vicinity reduce their potential for being used. The nearest potential Indiana bat habitat is west of Bayou Creek, about 0.15 mi (0.24 km) from Location B and 0.35 mi (0.56 km) from Location A. It is rated as having poor potential habitat quality. Another area slightly farther south is rated as having fair potential habitat quality. The nearest location at which a state-listed species has been found is about 0.2 mi (0.3 km) west of Location A and southwest of Location B, where a population of cream wild indigo occurs.

Foraging habitat for the great blue heron includes ponds and other open water areas. Open water wetlands occur in the northeast portion of Location C. The Northern crawfish frog occurs approximately 0.35 mi (0.56 km) northeast of Location C and 0.6 mi (1 km) west of Location B. Habitat for the Northern crawfish frog is native prairie, particularly near fishless ponds or similar surface waters. Compass plant occurs about 0.3 mi (0.5 km) north of Location C. Although Location C supports an herbaceous old-field vegetation community, native prairie species are generally lacking. Prairie restoration and management activities in the vicinity of Location C, however, may increase the occurrence of prairie species in that area. These activities may also increase the potential for occurrence of cream wild indigo in or near Location C. Foraging habitat for the great blue heron includes ponds and other open water areas.

3.1.7 Public and Occupational Safety and Health

3.1.7.1 Radiation Environment

Operations at the Paducah site result in radiation exposure of both on-site workers and off-site members of the general public (Table 3.1-6). Exposures of on-site workers generally are associated with the handling of radioactive materials used in the on-site facilities and with the inhalation of radionuclides released from processes conducted on site. Off-site members of the public are exposed to radionuclides discharged from on-site facilities with airborne and/or waterborne emissions and, in some cases, to radiation emanated from radioactive materials handled in the on-site facilities.

TABLE 3.1-6 Estimated Radiation Doses to Members of the General Public and Cylinder Yard Workers at the Paducah Gaseous Diffusion Plant

Receptor	Radiation Source	Dose to Individual (mrem/yr)
Member of the general public (MEI)[a]	Routine site operations	
	Airborne radionuclides	0.0088[b]
	Waterborne radionuclides	0.032[c]
	Direct gamma radiation	0.17[d]
	Ingestion of drinking water	0.00055[e]
	Ingestion of wildlife	1.7[f]
Cylinder yard worker	External radiation	170–427[g]
Member of the public or worker	Natural background radiation around the Paducah site	95[h]
DOE worker limit		2,000[i]

[a] The MEI is assumed to reside at an off-site location that would yield the largest dose. An average person would receive a radiation dose much less than the values shown in this table.

[b] Radiation doses from airborne releases were estimated by using an air dispersion model and took into account exposure from external radiation, inhalation, and ingestion of foodstuffs. The MEI was assumed to be located approximately 4,003 ft (1,220 m) north of the plant site (DOE 2001b).

[c] Radiation doses would result from incidental ingestion of contaminated sediment in Little Bayou Creek every other day during the hunting season (DOE 2001b).

[d] Radiation exposure would result from frequently traveling along Dykes Road in the vicinity of the cylinder storage yards (DOE 2001b).

[e] The radiation dose was estimated on the basis of the assumption that the MEI consumes water supplied by the public water system at Cairo, Illinois, the closest water supply system that uses water downstream of Paducah GDP effluents (DOE 2001b).

[f] Radiation doses could result from ingestion of the edible portion of two average-weight deer containing the maximum detected concentrations of radionuclides (DOE 2001b).

[g] Range of annual dose in 2001 (Hicks 2002a).

[h] Average dose from natural background radiation is 105 mR/yr (DOE 2001b), which can be converted to 95 mrem/yr.

[i] DOE administrative procedures limit DOE workers to 2,000 mrem/yr (DOE 1992), whereas the regulatory dose limit for radiation workers is 5,000 mrem/yr (10 CFR Part 835).

The total radiation dose to a MEI of the general public is estimated to be 1.9 mrem/yr, which is much lower than the maximum radiation dose limit set for the general public of 100 mrem/yr (DOE 1990). The MEI dose is also a small fraction of the 95 mrem/yr dose received by an average individual living close to Paducah from natural background and medical sources. In 2001, the measured external radiation doses for cylinder yard workers ranged from 170 to 427 mrem, with an average of 254 mrem (Hicks 2002a). The measured doses are well below the maximum dose limit of 5,000 mrem/yr set for radiation workers (10 CFR Part 835).

3.1.7.2 Chemical Environment

Table 3.1-7 gives the estimated hazard quotients from chemical exposures for members of the general public under existing environmental conditions near the Paducah site. The hazard quotient represents a comparison of the estimated human intake level of a contaminant with an intake level below which adverse effects are very unlikely to occur (see Appendix F for further details). The estimated hazard quotients indicate that exposures to DUF_6-related contaminants in environmental media near the Paducah site are generally only a small fraction of those that might be associated with adverse health effects. An exception is groundwater, for which the hazard quotients for uranium and several other substances could exceed the threshold of 1. However, because this groundwater is not a drinking water source, there is no exposure. The residents near the Paducah site whose wells have been contaminated have been provided with alternative water sources.

The Occupational Safety and Health Administration (OSHA) has proposed permissible exposure limits (PELs) for uranium compounds and HF in the workplace (29 CFR Part 1910, Subpart Z, as of February 2003) as follows: 0.05 mg/m^3 for soluble uranium compounds, 0.25 mg/m^3 for insoluble uranium compounds, and 2.5 mg/m^3 for HF. Paducah worker exposures are kept below these limits.

3.1.8 Socioeconomics

Socioeconomic data for the Paducah site focus on a ROI surrounding the site consisting of six counties: Ballard, Carlisle, Graves, Marshall, and McCracken Counties in Kentucky, and Massac County in Illinois. The ROI is defined on the basis of the current residential locations of government workers directly connected to Paducah site activities and includes the area in which these workers spend much of their wages. More than 92% of Paducah workers currently reside in these counties (Sheppard 2002). Data are presented in the following sections for each of the counties in the ROI. However, the majority of Paducah site workers live in McCracken County and in the City of Paducah, and it is expected that the majority of impacts from the Paducah site would occur in these locations. Therefore, more emphasis is placed on these two areas.

TABLE 3.1-7 Estimated Hazard Quotients for Members of the General Public near the Paducah Site under Existing Environmental Conditions[a]

Environmental Medium	Parameter	Assumed Exposure Concentration	Estimated Chronic Intake (mg/kg-d)	Reference Level[b] (mg/kg-d)	Hazard Quotient[c]
Air[d,e]	Uranium	0.02 μg/m^3	5.7×10^{-6}	0.0003	0.019
	HF	0.096 μg/m^3	2.7×10^{-5}	0.02	0.0014
Soil[f]	Uranium	5.8 μg/g	7.7×10^{-5}	0.003	0.026
Surface water[e,g]	Uranium	17 μg/L	9.3×10^{-6}	0.003	0.003
	Fluoride	< 224 μg/L	1.2×10^{-4}	0.06	0.002
Sediment[e,h]	Uranium	360 μg/g	6.2×10^{-6}	0.003	0.033
	Aroclor® 1254	1.4 μg/g	3.8×10^{-7}	0.00002	0.019
	Aroclor 1254[i]	1.4 μg/g	5.5×10^{-8}	2 (slope factor)	1.1×10^{-7} (cancer risk)
Groundwater[j]	Uranium	600 μg/L	1.7×10^{-2}	0.003	5.7
	Fluoride	520 μg/L	1.5×10^{-2}	0.06	0.25

[a] The receptor is assumed to be a long-term resident near the site boundary or another off-site monitoring location that would have the highest concentration of the contaminant being addressed; reasonable maximum exposure conditions were assumed. Only the exposure pathway contributing the most to intake levels was considered (i.e., inhalation for air and ingestion for soil, sediment, surface water, and groundwater). Residential exposure scenarios were assumed for air, soil, and groundwater analyses; recreational exposure scenarios were assumed for surface water and sediment analyses.

[b] The reference level is an estimate of the daily human exposure level that is likely to be without an appreciable risk of deleterious effects. The reference levels used in this assessment are defined in Appendix F. For the carcinogen Aroclor 1254, the slope factor is also given. Slope factors in units of $(mg/kg\text{-}d)^{-1}$ are multiplied by lifetime average intake to estimate excess cancer risk.

[c] The hazard quotient is the ratio of the intake of the human receptor to the reference level. A hazard quotient of less than 1 indicates that adverse health effects resulting from exposure to that chemical alone are unlikely. For carcinogens, the cancer risk (intake × slope factor) is also given. Increased cancer risks of between 10^{-6} and 10^{-4} are considered tolerable at hazardous waste sites; risks of less than 10^{-6} are considered negligible.

[d] For the uranium air concentration, the reported concentration for uranium-238 and thorium-234 combined was used (DOE 2001b). No new HF air concentration data were available; the concentration reported in MMES (1994a,b) was used.

[e] Exposure concentrations are the maximum annual averages for all monitoring locations.

[f] Maximum uranium concentration from 10 facility boundary and off-site soil monitoring locations (LMES 1996a).

[g] The uranium value is the maximum average surface water concentration from 20 sampling locations (DOE 2001b). No new fluoride concentration data were available; the concentration reported in MMES (1994a,b) was used.

[h] Uranium sediment concentration is from LMES (1997a); PCB data are from LMES (1996a). Values reported in the 2000 environmental report are lower.

[i] Parameter analyzed for carcinogenic effects; all other parameters were analyzed for noncarcinogenic effects.

[j] Data are maximum detected values for monitoring and residential wells located on or near DOE property at the Paducah site (none of the wells are currently used for drinking water). The maximum uranium concentration was observed in the upper continental recharge system; the maximum fluoride concentration was from the northwest plume, MW 237 (DOE 2001b). Several additional substances (most notably TCE and Tc-99) exceeded reference levels between 1993 and 1996; listed here are only substances of particular interest for this EIS.

3.1.8.1 Population

The population of the ROI in 2000 was 161,465 people (U.S. Bureau of the Census 2002a) and was projected to reach 165,000 by 2003 (Table 3.1-8). In 2000, 65,514 people (41% of the ROI total) resided in McCracken County, with 26,307 of them residing in the City of Paducah (U.S. Bureau of the Census 2002a). During the 1990s, each of the counties in the ROI experienced a small increase in population, with an ROI average of 0.6%. The City of Paducah experienced a decline of –0.4% in its population during that period. Over the same period, the population grew at a rate of 0.9% in Kentucky and 0.8% in Illinois.

3.1.8.2 Employment

Total employment in McCracken County in 2000 was 37,426, and it was projected to reach 40,500 by 2003. The economy of the county is dominated by the trade and service industries, with employment in these activities currently contributing almost 71% of all employment in the county (see Table 3.1-9). Excluding mining, which grew from a very small base, employment growth in the highest growth sector (services) was 6.7% during the 1990s, compared with 2.7% in the county for all sectors as a whole (U.S. Bureau of the Census 1992, 2002b).

In 2000, total employment in the ROI was 67,866, and it was projected to reach 69,300 by 2003. The economy of the ROI is dominated by the trade and service industries, with employment in these activities currently contributing 60% of all employment in the ROI

TABLE 3.1-8 Population in the Paducah Region of Influence, Kentucky, and Illinois in 1990, 2000, and 2003

Location	1990	2000	Growth Rate (%), 1990–2000[a]	2003 (Projected)[b]
City of Paducah	27,256	26,307	-0.4	26,000
McCracken County	62,879	65,514	0.4	66,300
Ballard County	7,902	8,286	0.5	8,400
Carlisle County	5,238	5,351	0.2	5,400
Graves County	33,550	37,028	1.0	38,100
Marshall County	27,205	30,125	1.1	31,100
Massac County	14,752	15,161	0.3	15,300
ROI total	151,526	161,465	0.6	164,600
Kentucky	3,685,296	4,041,769	0.9	4,155,000
Illinois	11,430,602	12,419,293	0.8	12,732,000

[a] Average annual rate.

[b] ANL projections, as detailed in Appendix F.

Source: U.S. Bureau of the Census (2002a), except as noted.

TABLE 3.1-9 Employment in McCracken County by Industry in 1990 and 2000

Sector	No. of People Employed in 1990[a]	Percentage of County Total	No. of People Employed in 2000[b]	Percentage of County Total	Growth Rate (%), 1990–2000
Agriculture	785[c]	2.7	489[d]	1.3	-4.62[e]
Mining	10	0.0	175	0.5	33.1
Construction	1,604	5.6	1,786	4.8	1.1
Manufacturing	3,965	13.8	4,210	11.2	0.6
Transportation and public utilities	2,316	8.0	3,400	9.1	3.9
Trade	9,951	34.6	9,258	24.7	-0.7
Finance, insurance, and real estate	1,042	3.6	914	2.4	-1.3
Services	9,022	31.3	17,174	45.9	6.7
Total	28,791		37,426		2.7

[a] U.S. Bureau of the Census (1992).

[b] U.S. Bureau of the Census (2002b).

[c] These agricultural data are for 1992 and are taken from USDA (1994).

[d] These agricultural data are for 1999 and are taken from USDA (1999).

[e] Agricultural data are for 1992 and 1997.

(see Table 3.1-10). Employment growth in the highest growth sector, services, was 6.4% during the 1990s, compared with 0.7% in the ROI for all sectors as a whole (U.S. Bureau of the Census 1992, 2002b). Employment at the Paducah site currently stands at 1,799 (Sheppard 2002).

Unemployment in McCracken County steadily declined during the late 1990s from a peak rate of 6.2% in 1990 to the current rate of 5.4% (Table 3.1-11) (Bureau of Labor Statistics [BLS] 2002). Unemployment in the ROI in December 2002 was 6.0% compared with 5.4% for the state.

3.1.8.3 Personal Income

Personal income in McCracken County was about $1.9 billion (in 2002 dollars) in 2000, and it was projected to reach $2.2 billion in 2003, with an annual average rate of growth of 2.1% over the period 1990 through 2000 (Table 3.1-12). County per capita income also rose in the 1990s, and it was projected to reach $33,200 in 2003, compared with $24,771 at the beginning of the period. In the ROI, total personal income grew at an annual rate of 2.1% over the period 1990 through 2000, and it was expected to reach $4.8 billion by 2003. ROI per capita income was expected to grow from $22,054 in 1990 to $29,000 in 2003, an average annual growth rate of 1.5%.

TABLE 3.1-10 Employment in the Paducah Region of Influence by Industry in 1990 and 2000

Sector	No. of People Employed in 1990[a]	Percentage of ROI Total	No. of People Employed in 2000[b]	Percentage of ROI Total	Growth Rate (%), 1990–2000
Agriculture	5,758[c]	9.1	4,652[d]	6.9	-2.1[e]
Mining	245	0.4	175	0.3	-3.3
Construction	3,730	5.9	3,651	5.4	-0.2
Manufacturing	14,748	23.3	11,866	17.5	-2.2
Transportation and public utilities	4,335	6.8	4,795	7.1	1.0
Trade	17,803	28.1	13,639	20.1	-2.6
Finance, insurance, and real estate	2,356	3.7	1,842	2.7	-2.4
Services	14,578	23.0	27,170	40.0	6.4
Total	63,410		67,866		0.7

[a] U.S. Bureau of the Census (1992).

[b] U.S. Bureau of the Census (2002b).

[c] These agricultural data are for 1992 and are taken from U.S. Department of Agriculture (USDA) (1994).

[d] These agricultural data are for 1999 and are taken from USDA (1999).

[e] Agricultural data are for 1992 and 1997.

3.1.8.4 Housing

Housing stock in McCracken County grew at an annual rate of 1.0% over the period 1990 through 2000 (Table 3.1-13) (U.S. Bureau of the Census 2002a), with total housing units projected to reach 30,900 in 2003, reflecting the relatively slow growth in county population. Growth in the City of Paducah was slight at 0.1% per year, with total housing units projected to reach 13,100 in 2003.

Almost 2,800 new units were added to the existing housing stock in the county during the 1990s; fewer than 100 of those units were constructed in Paducah. Vacancy rates in 2000 stood at 10.6% in the city and 8.6% in the county as a whole for all types of housing. On the basis of annual population growth rates, 2,700 vacant housing units were expected in the county in 2003. About 850 of these were expected to be rental units available to incoming construction workers at the proposed facility.

In the ROI as a whole, housing grew at a higher rate than in McCracken County or Paducah during the 1990s, with an overall growth rate of 1.1% per year. Total housing units were expected to reach 76,600 by 2003, with more than 7,800 housing units added in the 1990s. On the basis of vacancy rates in 2000, which stood at 10.5%, more than 2,000 rental units were expected to be available for incoming construction workers at the proposed facility.

TABLE 3.1-11 Unemployment Rates in McCracken County, the Paducah Region of Influence, and Kentucky

Location and Period	Rate (%)
McCracken County	
1992–2002 average	4.6
Dec. 2002 (current rate)	5.4
ROI	
1992–2002 average	5.8
Dec. 2002 (current rate)	6.0
Kentucky	
1992–2002 average	5.4
Dec. 2002 (current rate)	5.4

Source: BLS (2002).

3.1.8.5 Community Resources

3.1.8.5.1 Community Fiscal Conditions. Revenues and expenditures for local government jurisdictions, including counties, cities, and school districts constitute community fiscal conditions. Revenues would come primarily from state and local sales tax revenues associated with employee spending during construction and operation and would be used to support additional local community services currently provided by each jurisdiction. Tables 1 and 2 in Allison (2002) present information on revenues and expenditures by the various local government jurisdictions in the ROI.

TABLE 3.1-12 Personal Income in McCracken County and the Paducah Region of Influence in 1990, 2000, and 2003

Location and Type of Income	1990	2000	Growth Rate (%), 1990–1997	2003 (Projected)[a]
McCracken County				
Total personal income (millions of 2002 $)	1,558	1,910	2.1	2,200
Personal per capita income (2002 $)	24,771	29,147	1.6	33,200
Total ROI				
Total personal income (millions of 2002 $)	3,342	4,125	2.1	4,800
Personal per capita income (2002 $)	22,054	25,548	1.5	29,000

[a] ANL projections, as detailed in Appendix F.

Source: U.S. Department of Commerce (2002).

3.1.8.5.2 Community Public Services. Construction and operation of the proposed facility would increase demand for community services in the counties, cities, and school districts likely to host relocating construction workers and operations employees. Additional demands would also be placed on local medical facilities and physician services. Tables 3.1-14 and 3.1-15 present data on employment and levels of service (number of employees per 1,000 population) for public safety, general local government services, and physicians. Tables 3.1-16 and 3.1-17 provide staffing data for school districts and hospitals.

TABLE 3.1-13 Housing Characteristics in the City of Paducah, McCracken County, and the Paducah Region of Influence in 1990 and 2000

Location and Type of Unit	No. of Units 1990	No. of Units 2000
City of Paducah		
Owner-occupied	6,501	6,254
Rental	5,454	5,571
Total unoccupied	1,195	1,396
Total	13,150	13,221
McCracken County		
Owner-occupied	17,470	19,054
Rental	8,155	8,682
Total unoccupied	1,956	2,625
Total	27,581	30,361
ROI Total		
Owner-occupied	45,815	50,412
Rental	15,181	16,441
Total unoccupied	5,935	7,856
Total	66,931	74,709

Source: U.S. Bureau of the Census (2002a).

3.1.9 Waste Management

The Paducah site generates wastewater, solid LLW, solid and liquid LLMW, nonradioactive hazardous waste, and nonradioactive nonhazardous solid waste. Wastes generated from site operations and environmental restoration are managed by DOE. USEC manages the disposal of waste generated from ongoing management of the DOE-generated DUF_6 cylinders currently in storage. The cylinder storage yards at Paducah currently generate only a very small amount of waste compared with the volume of waste generated from ongoing gaseous diffusion plant operations and environmental restoration. Cylinder yard waste consists of small amounts of metal, scrapings from cylinder maintenance operations, potentially contaminated soil, and miscellaneous items.

The site has an active program to minimize the generation of solid LLW, hazardous waste, and LLMW. Waste minimization efforts for radioactive waste include preventing packaging material from entering radiological areas and replacing wood pallets used in radiological areas. Hazardous waste and LLMW minimization actions include using chlorinated solvents less, recycling paint waste, and compacting PCB wastes. Solid waste minimization actions include recycling of paper and cardboard and off-site recycling of fluorescent bulbs and used batteries.

Table 3.1-18 lists the Paducah site waste loads assumed for the analysis of impacts of projected activities.

TABLE 3.1-14 Public Service Employment in the City of Paducah, McCracken County, and Kentucky in 2002

	City of Paducah		McCracken County		Kentucky[b]
Employment Category	No. of Workers	Level of Service[a]	No. of Workers	Level of Service[a]	Level of Service[a]
Police	74	2.8	41	1.0	1.5
Fire[c]	77	2.9	0	0	1.3
General	174	6.6	180	4.5	34.1
Total	325	12.4	221	5.6	36.9

[a] Level of service represents the number of employees per 1,000 persons in each jurisdiction.

[b] 2000 data.

[c] Does not include volunteers.

Sources: City of Paducah: Moriarty (2002); McCracken County: Brown (2002); Kentucky: U.S. Bureau of the Census (2002d).

TABLE 3.1-15 Number of Physicians in McCracken County and Kentucky in 1997

	McCracken County		Kentucky
Employment Category	No.	Level of Service[a]	Level of Service[a]
Physicians	205	3.1	2.2

[a] Level of service represents the number of physicians per 1,000 persons in each jurisdiction.

Source: American Medical Association (1999).

TABLE 3.1-16 School District Data for McCracken County and Kentucky in 2001

	McCracken County		Kentucky
Employment Category	No.	Student-to-Teacher Ratio[a]	Student-to-Teacher Ratio[a]
Teachers	510	12.6	12.4

[a] The number of students per teacher in each school district.

Source: Kentucky Department of Education (2002).

TABLE 3.1-17 Medical Facility Data for McCracken County in 1998

Hospital	No. of Staffed Beds	Occupancy Rate (%)[a]
Carter Behavioral Health System	56	NA[b]
Lourdes Hospital	290	55
Western Baptist Hospital	325	57
McCracken County total	671	NA

[a] Percentage of staffed beds occupied.

[b] NA = not available.

Source: Healthcare InfoSource, Inc. (1998).

3.1.9.1 Wastewater

Wastewater at the Paducah site consists of nonradioactive sanitary and process-related wastewater streams, cooling water blowdown, and radioactive process-related liquid effluents. Wastewater is processed at on-site treatment facilities and is discharged to Bayou Creek or Little Bayou Creek through eight permitted outfalls. The total capacity of the site wastewater control facilities is approximately 1.75 million gal/d (6.6 million L/d).

3.1.9.2 Solid Nonhazardous, Nonradioactive Waste

Solid waste — including sanitary refuse, cafeteria waste, industrial waste, and construction and demolition waste — is collected and disposed of at the on-site landfill, which consists of three cells. The landfill is permitted for 1 million yd^3 (764,600 m^3) per Permit KY073-00045.

TABLE 3.1-18 Projected Waste Generation Volumes for the Paducah Site[a]

Waste Category	Waste Treatment Volume (m^3/yr)
LLW	7,200
LLMW	7,600
TRU	0.6
Hazardous waste	370
Nonhazardous waste[b]	
Solids	18,900
Wastewater	72

[a] Volumes include operational and environmental restoration wastes projected from FY 2002 to FY 2025.

[b] Volumes include sanitary and industrial wastes.

Source: Cain (2002c).

3.1.9.3 Nonradioactive Hazardous and Toxic Waste

Nonradioactive waste that is considered hazardous waste according to RCRA or contains PCBs as defined under the TSCA requires special handling, storage, and disposal. The Paducah site generates hazardous waste, including spent solvents, heavy-metal-contaminated waste, and PCB-contaminated toxic waste. The site has a permit that authorizes it to treat and store hazardous waste in 10 treatment units, 16 tanks, and 4 container storage areas at the site. Several additional 90-day storage areas for temporary storage of hazardous waste are located on the site.

Certain hazardous/toxic wastes are sent to permitted off-site contractors for final treatment and/or disposal. Much of the hazardous/toxic waste load consists of PCB-contaminated waste. Some liquid hazardous and/or mixed waste streams are shipped to the ETTP site for incineration in a TSCA incinerator with a capacity of 1,800 yd^3/yr (1,400 m^3/yr).

3.1.9.4 Low-Level Radioactive Waste

LLW generated at the Paducah site is stored on site pending shipment to a commercial facility in Tennessee for volume reduction. Solid LLW generated at the Paducah site includes refuse, sludge, and debris contaminated with radionuclides, primarily uranium and technetium. Site wastewater treatment facilities can process up to 1,480 yd^3 (1,140 m^3) per year of aqueous LLW.

3.1.9.5 Low-Level Radioactive Mixed Waste

LLW that contains PCBs or RCRA hazardous components is considered to be LLMW. On-site capacity for storing LLMW containers at the Paducah site is 3,600 yd^3 (2,800 m^3). The site can treat up to 204 ft^3/yr (156 m^3/yr) of aqueous LLMW (DOE 1996).

3.1.10 Land Use

The Paducah site is located in western Kentucky, in the northwestern portion of rural McCracken County about 10 mi (16 km) west of the City of Paducah. On the basis of an analysis of Landsat satellite imagery from 1992, dominant land cover categories in McCracken County include pasture/hay (27.8%), row crops (27.0%), and deciduous forest (17.8%) (Figure 3.1-6). The most recent agricultural census recorded 457 farms in McCracken County in 1997, covering more than 66,500 acres (26,900 ha) (U.S. Department of Agriculture [USDA] 1999). Residential land use occurs throughout much of McCracken County; most of it occurs in the eastern half of the county in the communities of Concord, Hendron, Lone Oak, Massac, Paducah, Reidland, and Woodlawn-Oakdale. The western half of the county, where the site lies, consists primarily of pasture/hay and row crops.

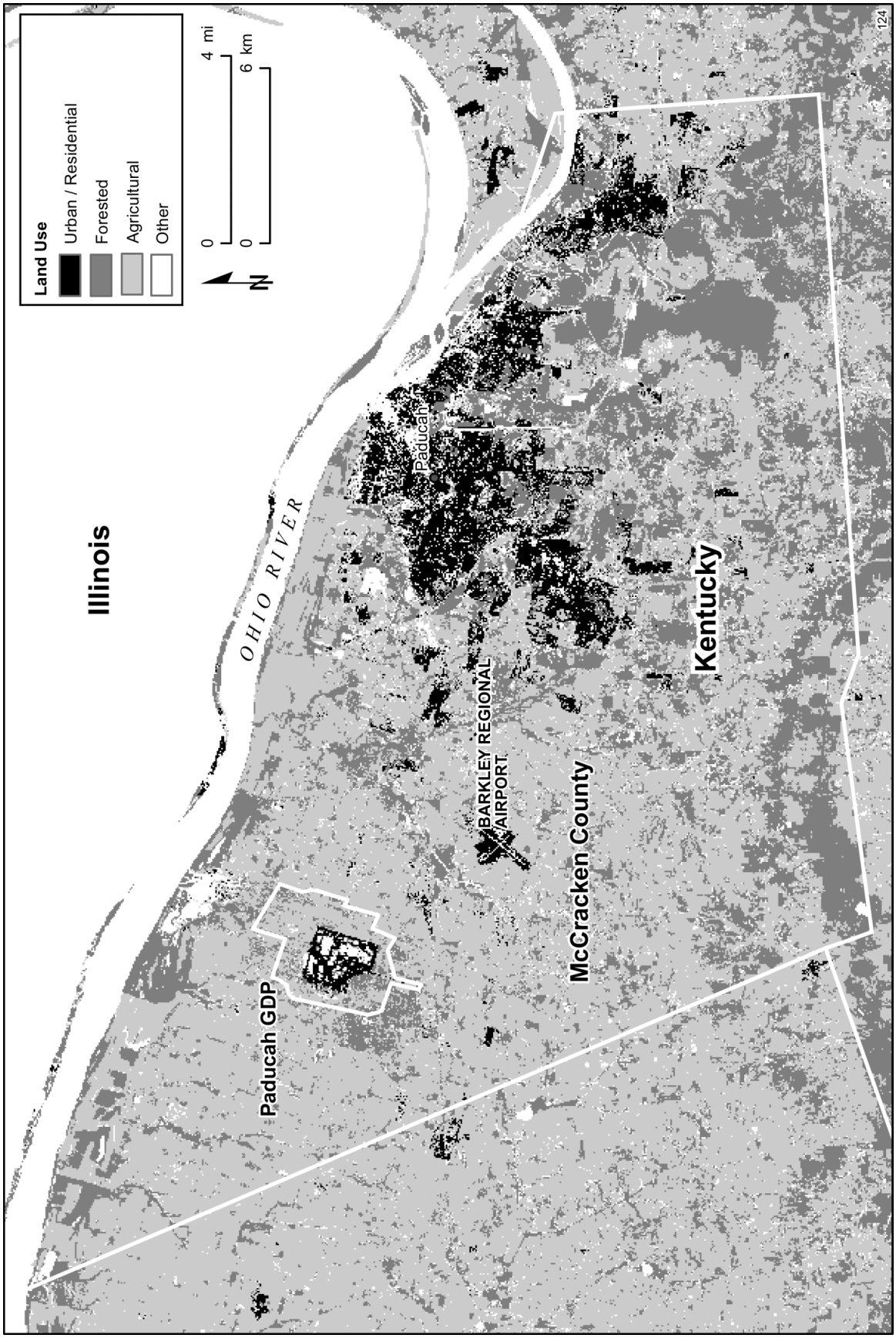

FIGURE 3.1-6 Land Cover in McCracken County, Kentucky (Data Source: USGS 2002)

The Paducah site encompasses 3,556 acres (1,439 ha) currently held by DOE (DOE 2001b). It is surrounded by the West Kentucky Wildlife Management Area, an additional 2,781 acres (1,125 ha) conveyed by DOE to the Commonwealth of Kentucky for use in wildlife conservation and for recreational purposes. According to a 1953 agreement granting the land to the Kentucky Department of Fish and Wildlife Resources, DOE can use any or all of this surrounding land whenever the need arises (MMES 1990). The Paducah GDP occupies a 750-acre (303-ha) complex within the Paducah site and is surrounded by a security fence (see Figure 3.1-1). The site is heavily developed and includes about 115 buildings with a combined floor space of about 8.2 million ft^2 (0.76 million m^2). The areas between buildings consist primarily of mowed grassy areas, while the area immediately surrounding the Paducah site generally features a combination of pasture, row crops, and deciduous forest.

3.1.11 Cultural Resources

Prehistoric and historic cultural resources are present at the Paducah site and within its immediate surroundings. Prehistoric archaeological sites at the Paducah site, found chiefly on floodplains, include remains from the Archaic (8000–1000 B.C.), Woodland (1000 B.C.–A.D. 1000), and Mississippian (A.D. 1000–1700) periods. The Paducah GDP is located in what were once traditional Chickasaw hunting grounds, and Chickasaw were reported in the Paducah area as late as 1827. In addition, the Peoria of Oklahoma have land claims in McCracken County. Consultation with these groups as well as the Kentucky State Historic Preservation Officer (SHPO) has been initiated (see Appendix G for consultation letters). No religious or sacred sites, burial sites, or resources significant to Native Americans have been identified at the Paducah site to date.

Historically, what is now the Paducah GDP site was included in the Jackson Purchase — land purchased from the Chickasaw in 1818. Uplands included dispersed 19th century farmsteads, settlements, and three associated cemeteries. The Paducah site was initially acquired in 1942 for the construction of the Kentucky Ordnance Works (KOW). Some KOW structures still remain. The AEC acquired KOW for the construction of a gaseous diffusion plant in 1950 as part of the nation's Cold War nuclear armament program. Construction began in 1951 (U.S. Department of the Army 1994a). The plant was completed in 1954, with enriched uranium production beginning in 1955. The plant's mission has continued unchanged, and the upgraded and refurbished original enrichment facilities remain in operation under lease to USEC (DOE 2001b).

Although the Paducah GDP has not undergone a complete archaeological survey, 32 archaeological sites have been recorded. Of these, at least three prehistoric sites and one historic site are potentially eligible for the *National Register of Historic Places* (NRHP) (U.S. Department of the Army 1994a,b). In 1994, a 20% stratified random sample archaeological survey was conducted at the Paducah GDP. Results of a sensitivity analysis based on this survey indicate that, for the most part, the candidate DUF_6 construction locations have a "low" to "very low" sensitivity index (low to very low probability of containing significant archaeological resources) (U.S. Department of the Army 1994a,b).

No archaeological sites are known from Location A, which was not included in the 1994 survey of the site. Several temporary buildings were located at this site during the construction of the Paducah GDP. These buildings have since been removed, but their foundations may remain. The southern end of the location includes old growth forest and appears to be relatively undisturbed. Only this southern portion of Location A appears to have been considered in the archaeological sensitivity analysis. It has a "low" to "very low" sensitivity index (U.S. Department of the Army 1994b).

The undeveloped portion of Location B includes rolling fields and the margins of the Bayou Creek floodplain. The rolling fields appear to have been created by the dumping of spoil during the construction or operation of the Paducah GDP. The portions of the site directly overlooking Bayou Creek appear to be undisturbed and have a "high" archaeological sensitivity. The remaining undeveloped sections vary in archaeological sensitivity from "low" to "very low" (U.S. Department of the Army 1994b).

Location C is a flat, densely wooded area outside the eastern fences of the Paducah GDP main compound. About half the location was included in the 1994 survey, but no archaeological sites were identified. The location has a "low" to "very low" sensitivity index (U.S. Department of the Army 1994b).

A pending programmatic agreement (PA) among DOE, the Kentucky SHPO, and the Advisory Council on Historic Preservation calls for a complete cultural resource survey of the Paducah GDP, including an architectural survey of Cold War era scientific facilities. That survey will be undertaken once the agreement is finalized. The PA also stipulates the development and implementation of a cultural resource management plan (CRMP).

3.1.12 Environmental Justice

3.1.12.1 Minority Populations

This EIS uses data from the most recent decennial census in 2000 to evaluate environmental justice implications of the proposed action and the no action alternative with respect to minority populations. The CEQ guidelines on environmental justice recommend that "minority" be defined as members of American Indian or Alaska Native, Asian or Pacific Islander, Black non-Hispanic, and Hispanic populations (CEQ 1997). The earliest release of 2000 census data that included information necessary to identify minority populations identified individuals both according to race and Hispanic origin (U.S. Bureau of the Census 2001). It also identified individuals claiming multiple racial identities (up to six races). To remain consistent with the CEQ guidelines, the phrase "minority populations" in this document refers to persons who identified themselves as partially or totally Black (including Black or Negro, African American, Afro-American, Black Puerto Rican, Jamaican, Nigerian, West Indian, or Haitian), American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, or "Other Race." The minority category also includes White individuals of Hispanic origin, although the latter is technically an ethnic category. To avoid double counting, tabulations included only

White Hispanics; the above racial groups already account for non-White Hispanics. In sum, then, the minority population considered under environmental justice consisted of all non-White persons (including those of multiple racial affiliations) plus White persons of Hispanic origin.

To identify census tracts with disproportionately high minority populations, this EIS uses the percentage of minorities in each state containing a given tract as a reference point. Using the individual states to identify disproportionality acknowledges that minority distributions in the state can differ from those found in the nation as a whole. In 2000, of the 173 census tracts within 50 mi (80 km) of the proposed conversion facility at Paducah, 42 had minority populations in excess of state-specific thresholds — a total of 47,093 minority persons in all (Figure 3.1-7). In McCracken County, 13.2% of the population in 2000 was minority (U.S. Bureau of the Census 2002c).

3.1.12.2 Low-Income Populations

As recommended by the CEQ guidelines, the environmental justice analysis identifies low-income populations as those falling below the statistical poverty level identified annually by the U.S. Bureau of the Census in its Series P-60 documents on income and poverty. The Census Bureau defines poverty levels on the basis of a statistical threshold that considers for each family both overall family size and the number of related children younger than 18 years old. For example, in 1999, the poverty threshold annual income for a family of three with one related child younger than 18 was $13,410, while the poverty threshold for a family of five with one related child younger than 18 was $21,024 (U.S. Bureau of the Census 2000). The 2000 census used 1999 thresholds, because 1999 was the most recent year for which annual income data were available when the census was conducted. If a family fell below the poverty line for its particular composition, the census considered all individuals in that family to be below the poverty line.

To identify census tracts with disproportionately high low-income populations, this EIS uses the percentage of low-income persons living in each state containing a given tract as a reference point. In 1999, of the 204 census tracts within 50 mi (80 km) of the proposed conversion facility at Paducah, 109 had low-income populations in excess of state-specific thresholds — a total of 118,029 low-income persons in all (Figure 3.1-8). In McCracken County in 1999, 15.1% of the individuals for whom poverty status was known were low-income (U.S. Bureau of the Census 2002c).

3.2 EAST TENNESSEE TECHNOLOGY PARK

ETTP is located in eastern Roane County about 25 mi (40 km) west of Knoxville, Tennessee (Figure 3.2-1). ETTP is part of the ORR in the City of Oak Ridge, Tennessee. The site was established in 1940 with initiation of construction of the Oak Ridge Gaseous Diffusion Plant. Uranium enrichment was the site's mission until the mid-1980s, when gaseous diffusion operations ceased. In 1990, the site was renamed as the K-25 Site, and it was renamed again in 1997 as the ETTP. Previous missions were waste management and restoration; the current

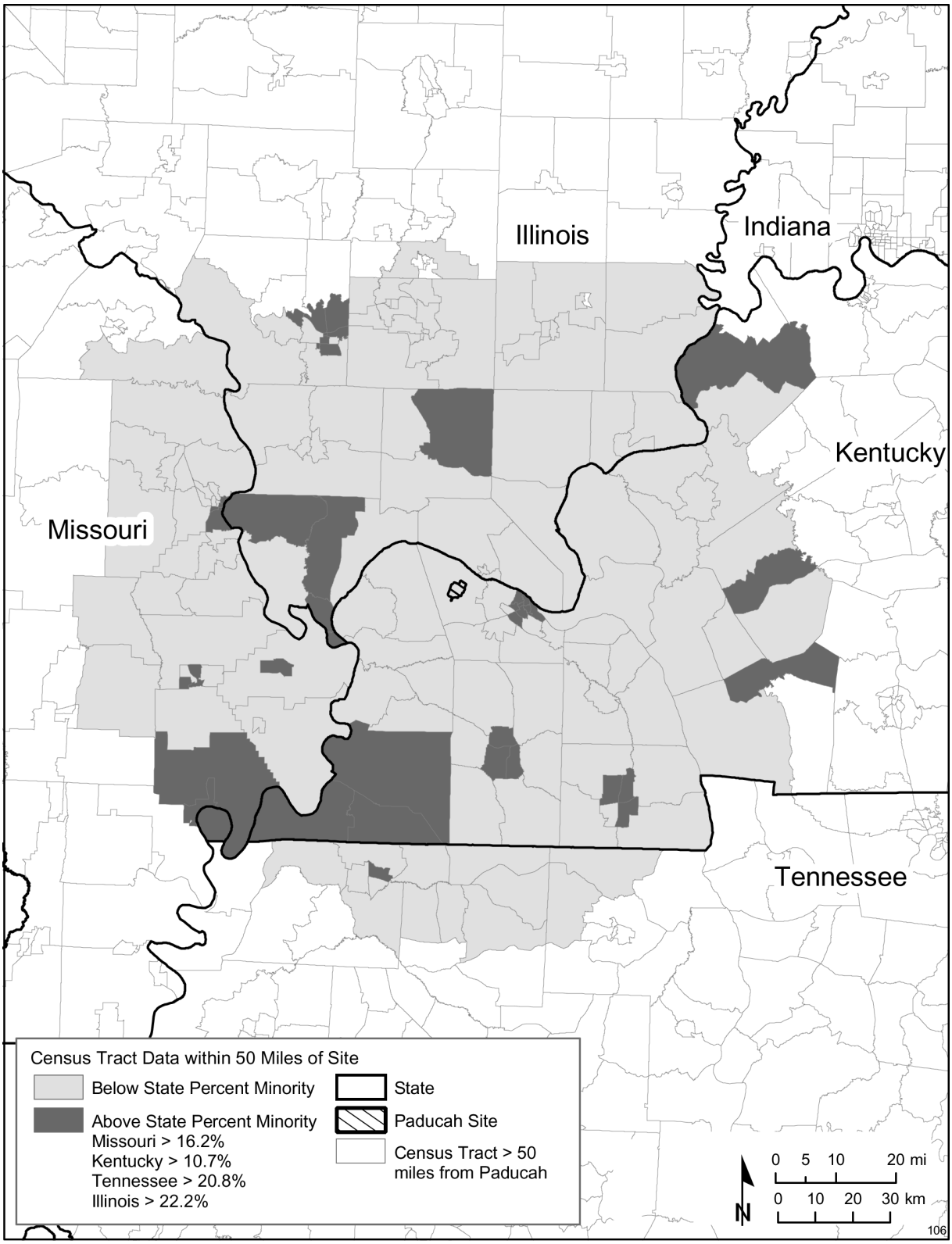

FIGURE 3.1-7 Census Tracts within 50 mi (80 km) of the Conversion Facility at the Paducah Site with Minority Populations in Excess of State-Specific Thresholds (Source: Based on data from U.S. Bureau of the Census 2002c)

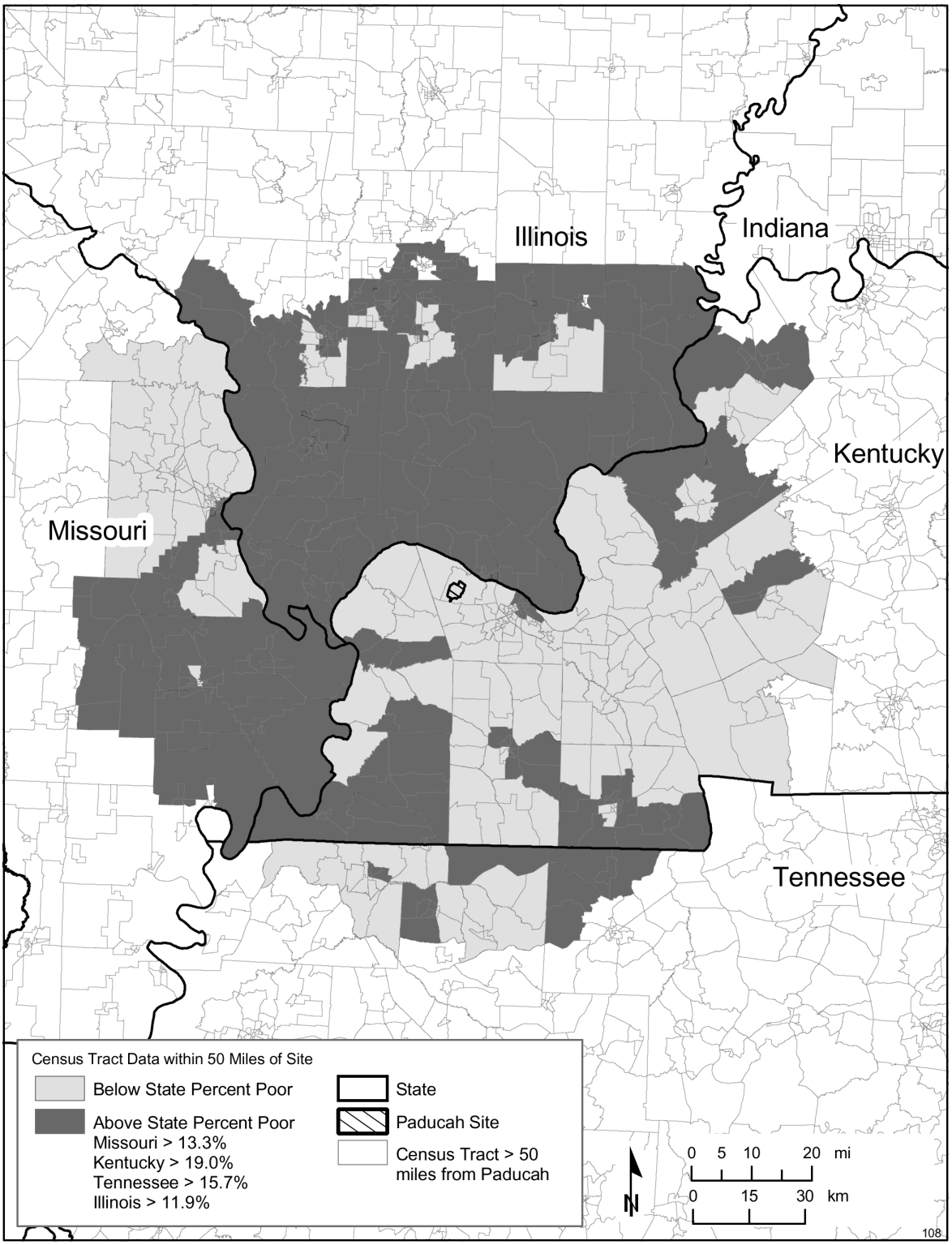

FIGURE 3.1-8 Census Tracts within 50 mi (80 km) of the Conversion Facility at the Paducah Site with Low-Income Populations in Excess of State-Specific Thresholds (Source: Based on data from U.S. Bureau of the Census 2002c)

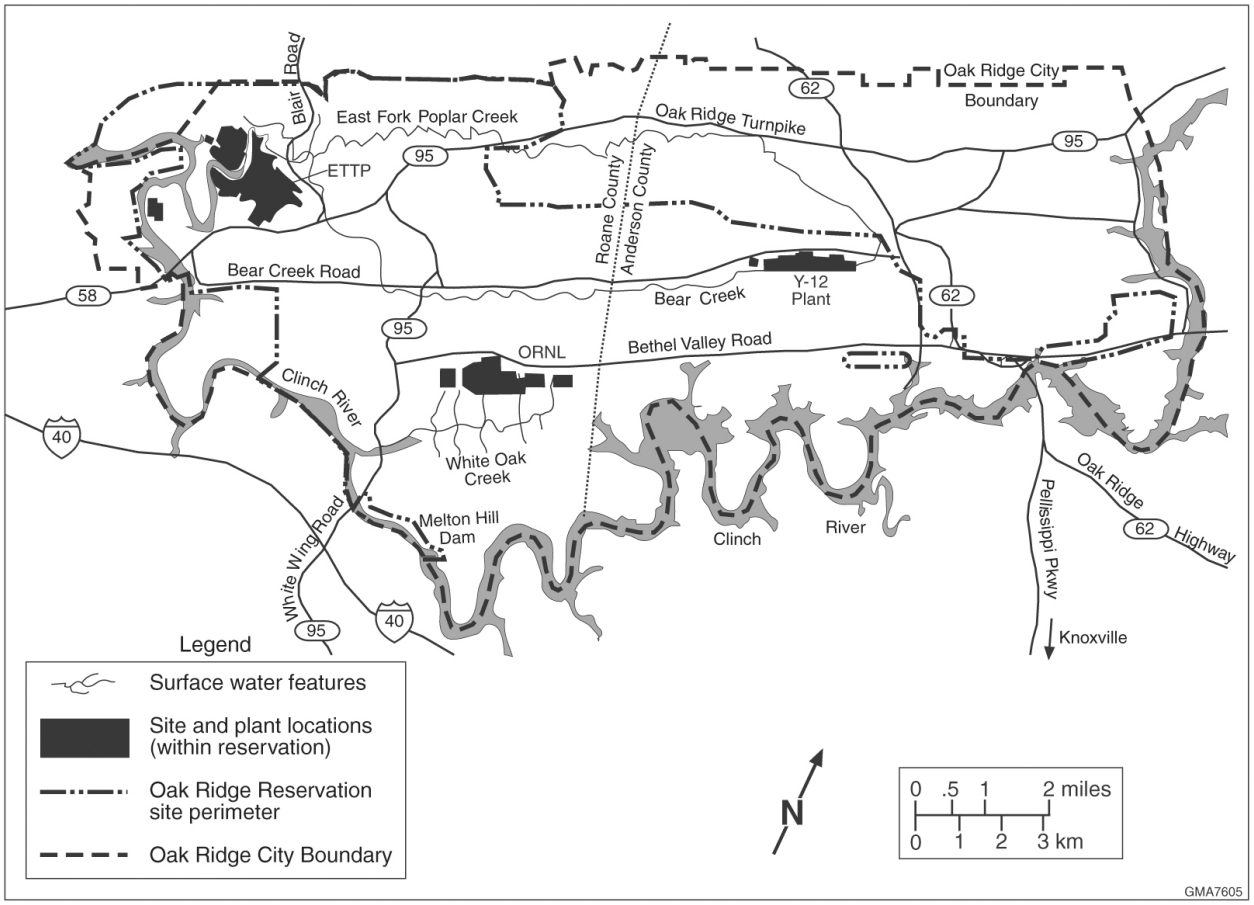

FIGURE 3.2-1 Regional Map of the ETTP Vicinity

mission is to "reindustrialize and reuse site assets through leasing of vacated facilities and incorporation of commercial industrial organizations as partners in the ongoing environmental restoration (ER), D&D, waste treatment and disposal, and diffusion technology development activities" (DOE 2001b).

3.2.1 Cylinder Yards

There are 4,817 DUF_6 storage cylinders located in ETTP site cylinder yards (Table 3.2-1, Figure 3.2-2). Cylinders are stacked two high to conserve space. About 30% of the cylinders are stored in yard K-1066-E (constructed with a concrete base), and 30% are stored in yard K-1066-K (constructed with a gravel base). The other cylinders are stored in four smaller yards.

TABLE 3.2-1 DOE-Managed DUF_6 Cylinders at the ETTP Site

Cylinder Type	No. of Cylinders
Full	4,719
Partially full	85
Heel	13
Total	4,817

Source: Hartman (2003).

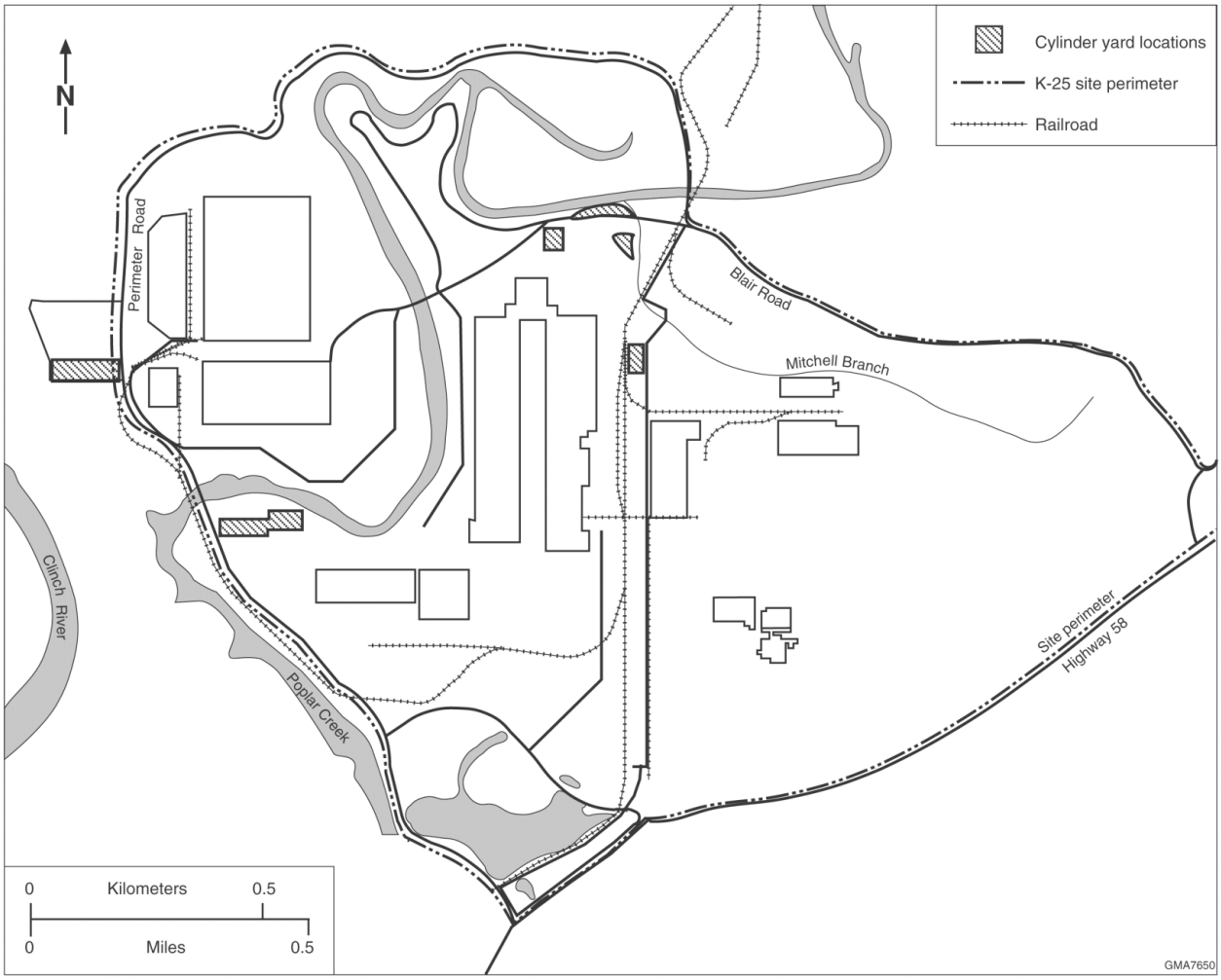

FIGURE 3.2-2 Locations of Storage Yards at ETTP That Are Used to Store DOE-Managed Cylinders

In storage at ETTP, in addition to the cylinders that contain DUF_6, are a number of cylinders in various sizes that contain LEU-UF_6 or normal UF_6 or are empty. These non-DUF_6 cylinders total 1,547, and they contain a total of about 25 t (28 tons) of UF_6 (6 t [7 tons] of LEU-UF_6 plus 19 t [21 tons] of normal UF_6) (Hartman 2003). About 600 of these non-DUF_6 cylinders are empty. Of the 738 non-DUF_6 cylinders that contain enriched uranium, fewer than 30 contain uranium enriched to greater than 5% uranium-235, and all of these are small, sample cylinders containing less than 3 lb (1.4 kg) of UF_6 each. In general, the enriched uranium in cylinders at ETTP contains less than 5% uranium-235. It is assumed that the natural and LEU-UF_6 would be put to beneficial uses; therefore, conversion of the contents of the non-DUF_6 cylinders is not considered in this EIS. This EIS does, however, include these cylinders in its evaluation of an alternative that considers the transportation of cylinders from ETTP to Paducah for conversion.

It is expected that many of the full DUF_6 cylinders at the ETTP site would not meet DOT transportation requirements because of damage and corrosion from poor historical storage conditions. It is estimated that a range of one-half to all of the full DUF_6 cylinders would not meet DOT transportation requirements (DOE 1999a). No similar estimate of the condition of the non-DUF_6 cylinders at ETTP is available.

3.2.2 Site Infrastructure

The ETTP site is located in an area with a well-established transportation network. The site is near two interstate highways, several U.S. and state highways, two major rail lines, and a regional airport (Figure 3.2-1).

The ETTP water supply is pumped from Clinch River. The water is treated and stored in two storage tanks. This system, with a capacity of 4 million gal/d (15 million L/d), provides water to the Transportation Safeguards Facility and the ETTP site.

Electric power is supplied by the TVA. The distribution of power is managed through the ETTP Power Operations Department. The average demand for electricity by all of the DOE facilities at Oak Ridge, including the ETTP site, is approximately 100 MVA. The maximum capacity of the system is 920 MVA (DOE 1995). Natural gas is supplied by the East Tennessee Natural Gas Company; the daily capacity of 7,600 decatherms can be increased, if necessary. The average daily usage in 1994 was 3,600 decatherms (DOE 1995).

3.2.3 Climate, Air Quality, and Noise

3.2.3.1 Climate

The climate of the region, including the ETTP site, may be broadly classified as humid continental. The region is located in a broad valley between the Cumberland Mountains to the northwest and the Great Smoky Mountains to the southeast, which influence meteorological patterns over the region (Wood 1996). During the summer, tropical air masses from the south provide warm and humid conditions that often produce thunderstorms. In winter, the Cumberland Mountains have a moderating influence on local climate by shielding the region from cold air masses from the north and west.

For the period 1961 through 1990, the annual average temperature was 13.7°C (56.6°F), with the highest monthly average temperature of 24.3°C (75.8°F) occurring in July and the lowest of 1.7°C (35.0°F) occurring in January (Wood 1996). Annual precipitation averages about 137 cm (53.8 in.), including about 25 cm (9.8 in.) of snowfall. Precipitation is evenly distributed throughout the season, with the highest occurring in spring.

Winds in the region are controlled in large part by the valley-and-ridge topography. Prevailing wind directions are from the northeast and southwest, reflecting the channeling of

winds parallel to the ridges and valleys in the area. The average wind speed at Oak Ridge is about 2.0 m/s (4.4 mph); the dominant wind direction is from the southwest (Wood 1996). For 2001, the average wind speed at the 10-m (33-ft) level of the ETTP K1209 meteorological tower was 1.5 m/s (3.4 mph), as shown in Figure 3.2-3 (ORNL 2002). The lower wind speed in the region reflects the air stagnation relatively common in eastern Tennessee. The dominant wind direction is southwest, with secondary peaks from the south-southwest and the east.

Tornadoes rarely occur in the valley surrounding the ETTP site between the Cumberlands and the Great Smokies, and they historically have been less destructive than those in the Midwest. For the period 1950 through 1995, 541 tornadoes were reported in Tennessee, with an average of 12 tornadoes per year (Storm Prediction Center 2002). For the same period, 3 tornadoes were reported in Anderson and Roane Counties each, but these tornadoes were relatively weak, being F3 of the Fujita tornado scale, at most.

3.2.3.2 Existing Air Emissions

At the end of calendar year 2001, there were 88 active air emission sources under DOE control at ETTP (DOE 2002c). Of these 88 sources, ETTP operated 30; these were covered under 8 major air emission sources subject to rules in the Tennessee Title V Major Source Operating Permit Program under an application shield granted by the TDEC Division of Air Pollution Control. All remaining active air emission sources are exempt from permitting requirements.

Major sources for criteria pollutants and VOCs in Anderson and Roane Counties in Tennessee include TVA steam plants and DOE operations, including the Y-12, ORNL, and ETTP sites. Annual emissions from major sources and total county emissions are presented in Table 3.2-2. The SO_2 and NO_x emissions from ETTP operations are negligible compared with those from the two TVA steam plants in Anderson and Roane Counties. However, VOC emissions account for about 39% of the Roane County emission total, and PM (PM_{10} and $PM_{2.5}$) emissions account for about 8% of the Roane County emission total. The amount of actual emissions from the ETTP site is much less than the amount of allowable emissions presented in Table 3.2-2 (DOE 2002c).

The State of Tennessee and the EPA regulate airborne emissions of radionuclides from DOE facilities under 40 CFR Part 61, Subpart H, NESHAPs regulations (DOE 2002c). The three ETTP major sources that operated during 2000 were the TSCA incinerator and the two stacks in the K-33 building operated by British Nuclear Fuels, Ltd. Emissions from these exhaust stacks are controlled by a particulate filtration system, and continuous sampling for radionuclides emissions is conducted at these stacks to assess the dose to the public.

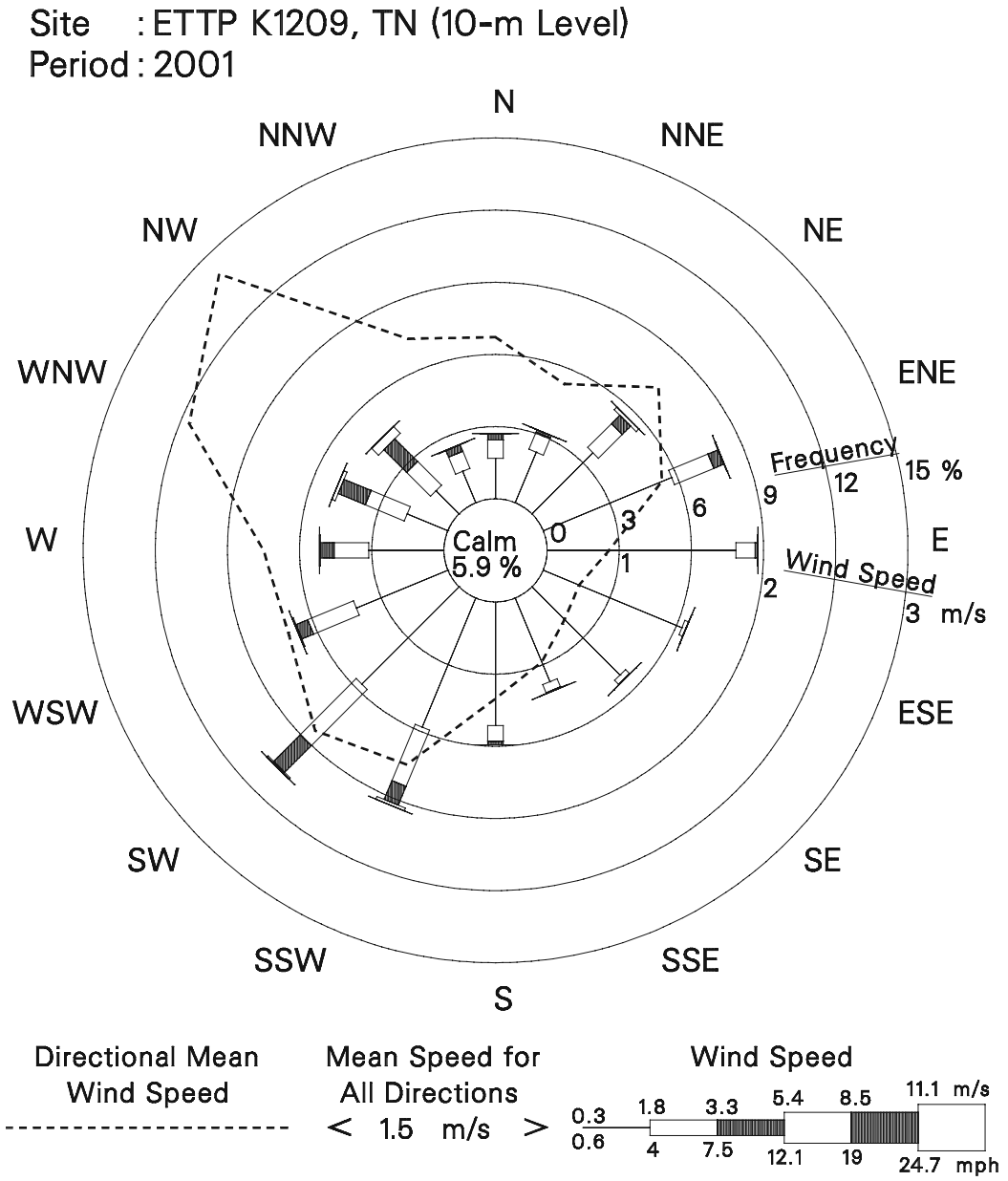

FIGURE 3.2-3 Wind Rose for the ETTP K1209 Meteorological Tower (10-m [33-ft] level), 2001 (Source: ORNL 2002)

TABLE 3.2-2 Annual Criteria Pollutant and Volatile Organic Compound Emissions from Selected Major Point Sources around the ETTP Site in 1999

	Emission Rate (tons/yr)					
Major Emission Source	SO_2	NO_x	CO	VOC	PM_{10}	$PM_{2.5}$
TVA Bull Run Steam Plant, Clinton	38,179	13,528	420	50	529	267
Y-12 Plant (DOE)	13,375	1,672	38	19	61	21
Anderson County, Tenn., total	51,555	15,237	460	405	731	365
TVA Kingston Steam Plant, Kingston	109,194	26,055	995	122	95	98
ORNL (DOE)	361	25	53	14	363	267
ETTP (formerly K-25) (DOE)	222 (0.20%, 0.14%)[a]	60 (0.23%, 0.14%)	29 (2.5%, 1.8%)	86 (39%, 14%)	41 (8.2%, 3.2%)	34 (8.5%, 4.5%)
Roane County, Tenn., total	109,777	26,149	1,157	222	498	399

[a] First and second values in parentheses are ETTP emissions as percentages of Roane County emissions total and combined Anderson and Roane Counties emissions total, respectively.

Source: EPA (2003).

3.2.3.3 Air Quality

The Tennessee SAAQS for six criteria pollutants — SO_2, NO_2, CO, O_3, PM (PM_{10} and $PM_{2.5}$), and Pb — are almost the same as the NAAQS (Waynick 2002), as shown in Table 3.2-3. In addition, the state has adopted standards for gaseous fluorides (expressed as HF), as presented in Table 3.2-4.

The ETTP site in Roane County is located in the Eastern Tennessee-Southwestern Virginia Interstate AQCR. Currently, the county is designated as being in attainment for all criteria pollutants (40 CFR 81.343).

Although uranium enrichment activities at ETTP were discontinued in 1985, ambient air monitoring for radionuclides, criteria pollutants (PM_{10} and Pb),[3] and several metals has continued at on-site and off-site locations (DOE 2002c). Monitoring indicates that no standards were exceeded, and there was no statistically significant elevation of pollutant concentrations associated with site operations. On the basis of modeling radionuclide emissions from all major and minor point sources, the effective dose equivalent to the most exposed member of the public was 0.8 mrem/yr in 2001, well below the NESHAPs dose limit of 10 mrem/yr (DOE 2002c).

[3] At the end of 2001, all PM_{10} sampling was discontinued after a review of PM_{10} data over a 10-year period (1991 through 2000) in which all concentrations were below the ambient air quality standards.

TABLE 3.2-3 National Ambient Air Quality Standards, Tennessee State Ambient Air Quality Standards, Maximum Allowable Increments for Prevention of Significant Deterioration, and Highest Background Levels Representative of the ETTP Site

		NAAQS/SAAQS[b]		PSD Increments[d] ($\mu g/m^3$)		Highest Background Level	
Pollutant[a]	Averaging Time	Value	Type[c]	Class I	Class II	Concentration[e]	Location (Year)
SO_2	3 hours	0.50 ppm (1,300 $\mu g/m^3$)	S	25	512	0.109 ppm (22%)	Rockwood (1998)
	24 hours	0.14 ppm (365 $\mu g/m^3$)	P	5	91	0.031 ppm (22%)	Rockwood (2001)
	Annual	0.03 ppm (80 $\mu g/m^3$)	P	2	20	0.003 ppm (10%)	Oak Ridge (2000)
NO_2	Annual	0.053 ppm (100 $\mu g/m^3$)	P, S	2.5	25	0.008 ppm (15%)	Oak Ridge (2000)
CO[f]	1 hour	35 ppm (40 mg/m^3)	P,S	–[g]	–	11.1 ppm (32%)	Knoxville (1999)
	8 hours	9 ppm (10 mg/m^3)	P, S	–	–	4.9 ppm (54%)	Knoxville (1997)
O_3	1 hour	0.12 ppm (235 $\mu g/m^3$)	P, S	–	–	0.116 ppm (97%)[h]	Oak Ridge (1999)
	8 hours	0.08 ppm (157 $\mu g/m^3$)	P, S	–	–	0.099 ppm (124%)[i]	Anderson County (2002)
PM_{10}	24 hours	150 $\mu g/m^3$	P, S	8	30	69.9 $\mu g/m^3$ (47%)	ETTP (2000)
	Annual	50 $\mu g/m^3$	P, S	4	17	23.2 $\mu g/m^3$ (46%)	ETTP (2000)
$PM_{2.5}$	24 hours	65 $\mu g/m^3$	P, S	–	–	50.4 $\mu g/m^3$ (78%)[h]	Harriman (2000)
	Annual	15 $\mu g/m^3$	P, S	–	–	18.4 $\mu g/m^3$ (123%)	Harriman (2000)
Pb	Calendar quarter	1.5 $\mu g/m^3$	P, S	–	–	0.0063 $\mu g/m^3$ (0.4%)	ETTP (2000)

Footnotes on next page.

TABLE 3.2-3 (Cont.)

[a] CO = carbon monoxide; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; $PM_{2.5}$ = particulate matter ≤2.5 µm; PM_{10} = particulate matter ≤10 µm; and SO_2 = sulfur dioxide.

[b] The SO_2 (3-hour and 24-hour) and CO standards are attained when the stated value is not exceeded more than once per year. The SO_2 (annual), NO_2, and Pb standards are attained when the stated value is not exceeded. The O_3 (1-hour) standard is attained when the stated value is not exceeded more than three times in three years. The O_3 (8-hour) standard is attained when the 3-year average of the annual fourth-highest daily maximum 8-hour average concentration does not exceed the stated value. The PM_{10} (annual) and $PM_{2.5}$ (annual) standards are attained when the 3-year average of the annual arithmetic means does not exceed the stated value. The PM_{10} (24-hour) standard is attained when the 3-year average of the 99th percentile values does not exceed the stated value. The $PM_{2.5}$ (24-hour) standard is attained when the 3-year average of the annual 98th percentile values does not exceed the stated value.

[c] P = primary standard whose limits were set to protect public health; S = secondary standard whose limits were set to protect public welfare.

[d] Class I areas are specifically designated areas in which the degradation of air quality is severely restricted under the Clean Air Act; Class II areas have a somewhat less stringent set of allowable emissions.

[e] Values in parentheses are monitored concentrations as a percentage of NAAQS or SAAQS.

[f] The NAAQS have a primary standard only; the Tennessee SAAQS, however, have a secondary standard as well.

[g] A dash indicates that no standard exists.

[h] Second-highest value.

[i] Fourth-highest value.

Sources: 40 CFR 50; TDEC (1999); 40 CFR 52.21; DOE (2002c); EPA (2003).

TABLE 3.2-4 Additional Tennessee Ambient Air Quality Standards[a]

Pollutant	Averaging Time	Primary Standard	Secondary Standard
Gaseous fluorides (as HF)	12 hours	–[b]	3.7 μg/m^3(4.5 ppb)[c]
	24 hours	–	2.9 μg/m^3 (3.5 ppb)[c]
	7 days	–	1.6 μg/m^3 (2.0 ppb)[c]
	30 days	–	1.2 μg/m^3 (1.5 ppb)[c]
Gaseous fluorides (as HF)[d]	30 days	–	0.5 μg/m^3 (0.6 ppb)[c]

[a] These standards are in addition to the Tennessee SAAQS listed in Table 3.2-3.

[b] A dash indicates that no standard exists.

[c] This average is not to be exceeded more than once per year.

[d] Applied in the vicinity of primary aluminum reduction plants in operation on or before December 31, 1973.

Source: TDEC (1999).

Also, the airborne dose from all ETTP radionuclide emissions was still less than the ORR maximum. The highest concentration levels for SO_2, NO_2, CO, PM_{10}, 24-hour $PM_{2.5}$, and Pb around and within the ETTP site are less than or equal to 78% of their respective NAAQS in Table 3.2-3 (EPA 2003; DOE 2002c). However, the highest O_3 and annual $PM_{2.5}$ concentrations that are of regional concern are approaching or somewhat higher than the applicable NAAQS.

PSD regulations (40 CFR 52.21) limit the maximum allowable incremental increases in ambient concentrations of SO_2, NO_2, and PM_{10} above established baseline levels, as shown in Table 3.2-3. The PSD regulations, which are designed to protect ambient air quality in Class I and Class II attainment areas, apply to major new sources and major modifications to existing sources. The nearest Class I PSD is the Great Smoky Mountains National Park, about 55 km (34 mi) southeast of ETTP. The Joyce Kilmer-Slickrock Wilderness Area just south of the western end of Great Smoky Mountains National Park is also a Class I area. These Class I areas are not located downwind of prevailing winds at the ETTP (see Figure 3.2-3).

3.2.3.4 Existing Noise Environment

The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978, 42 USC Parts 4901–4918), delegates to the states the authority to regulate environmental noise and directs government agencies to comply with local community noise statutes and regulations. Anderson County has quantitative noise-limit regulations, as

shown in Table 3.2-5 (Anderson County 2002), although the State of Tennessee and Roane County do not.

The EPA has recommended a maximum noise level of 55 dB(A) as DNL to protect against outdoor activity interference and annoyance (EPA 1974). This level is not a regulatory goal but is "intentionally conservative to protect the most sensitive portion of the American population," with "an additional margin of safety." For protection against hearing loss in the general population from nonimpulsive noise, the EPA guideline recommends an L_{eq}(24 h) of 70 dB(A) or less over a 40-year period.

The noise-producing activities within the ETTP site are associated with the DUF_6 cylinder project and local traffic, similar to that at any other industrial site. Major noise sources within the ETTP site consist of heavy equipment, forklift, and crane operations associated with cylinder handling, steel grit blasting operations, welding/burning/hotwork activities during breach repairs, etc. (Cain 2002a).

ETTP is in a rural setting, and no residences and sensitive receptors (e.g., schools, hospitals) are located in the immediate vicinity. As part of hearing protection for workers, industrial hygiene measurements of noise associated with the DUF_6 cylinder project have been made since 1998. Ambient noise levels around the site are relatively low. Measurements taken at the nearby residence along Poplar Creek Road (off Blair Road) to the north of the site on June 1991 at 8:30 a.m. was about 39 dB(A), typical of a rural environment (ANL 1991b). At three residences on Blair Road nearest the site, noises from the K-25 activities were not distinguishable from background noise. To date, there have been no complaints about noise from neighboring communities.

TABLE 3.2-5 Allowable Noise Level by Zoning District in Anderson County, Tennessee

Zoning		Allowable Noise Level (dBA)	
District	Abbreviation	7 a.m.–10 p.m.	10 p.m.–7 a.m.
Suburban-residential	R-1	60	55
Rural-residential	A-2	65	60
Agriculture-forest	A-1	65	60
General commercial	C-1	70	65
Light industrial	I-1	70	70
Heavy industrial	I-2	80	80
Floodway	F-1	80	80

Source: Anderson County (2002).

3.2.4 Geology and Soil

3.2.4.1 Topography, Structure, and Seismic Risk

The topography of the Oak Ridge site is varied; the maximum change in elevation across the site is about 420 ft (130 m). The site is underlain by sedimentary rocks composed of limestone and dolomite. Sinkholes, large springs, and other karst features can occur in the limestone formations adjacent to the site (DOE 1995).

The ETTP site is situated in the Valley and Ridge Subregion of the Appalachian Highlands Province near the boundary with the Cumberland Plateau (DOE 1995). This subregion consists of a series of northeast-southwest trending ridges bounded by the Cumberland Escarpment on the west and by the Blue Ridge Front on the east.

The major stratigraphic units underlying the site and its confining ridges are the Rome Formation (silty shale and shale), the Conasauga Group (calcareous shale interbedded with limestone and siltstone), the Knox Group (silty dolomite), and the Chickamauga Limestone (interbedded with layers of bentonite). These units range in age from Lower Cambrian (Rome Formation) to Middle Ordovician (Chickamauga Limestone). Contacts between the members are gradational and discontinuous. Sinkholes, large springs, and other karst features are common in the Knox Group, and areas underlain with limestone or dolomites are, for the most part, classified as karst terrains (DOE 1995).

The most important structural feature near the site is a fault system consisting of the Whiteoak Mountain Fault, which runs through the southeastern corner of the Oak Ridge facility; the Kingston Fault, a parallel fault that occurs north of Poplar Creek; and the Copper Creek Fault, located in Melton Valley. A branch of the Whiteoak Mountain Fault originates just south of the facility and runs due north through its center. None of these faults appear to have any topographic expression, and it is assumed that displacement took place prior to the development of the present surface of erosion (DOE 1979). These faults can probably be considered inactive; no seismic events have been associated with these faults near the site, and no surface movement has been reported along the faults.

3.2.4.2 Soils

The typical soil types of the Valley and Ridge Province at ETTP are red-yellow podsols, reddish-brown laterites, or lithosols (DOE 1979). They are usually strongly leached and acidic and have a low organic content. The thickness of alluvium beneath the site ranges from nearly 0 to 60 ft (0 to 18 m). Soils developed on the Chickamauga Formation, which underlies most of the site, are typically yellow to yellow-brown montmorillonites. The Conasauga Shale, which underlies the southeastern corner of the site, develops a silty brown, tan, greenish, and maroon clay that is micaceous and contains fragments of unweathered parent rock. In upland areas around the site, the Fullerton Soil Series is dominant. This soil has moderate infiltration rates and is moderately drained to well drained. The Nolichucky and Talbott Series soils are the most

abundant valley and terrace soils within the site proper. The Nolichucky and Talbott Series soils are similar to the Fullerton Series soils (Geraghty & Miller, Inc. 1989).

Soil and groundwater data have been collected to determine whether contamination is associated with the Oak Ridge cylinder yards (DOE 1994a). Substances in soil possibly associated with cylinder management activities are uranium and fluoride compounds, which could be released to soil if breached cylinders or faulty valves were present. In 1991, 122 systematic soil samples were collected at the K-yard; these samples had maximum concentrations of 0.14 mg/kg of uranium-235 and 13 mg/kg of uranium-238. Soil samples collected in March 1992 at the K-yard had a maximum uranium concentration of 36 ±2 mg/kg.

In 1994, 200 systematic and 28 biased soil samples were collected in areas surrounding the cylinder yards; the maximum concentrations detected in these samples were 0.83 mg/kg of uranium-235 at the K-1066-F yard (F-yard) and 75 mg/kg of uranium-238 at the E-yard. Groundwater concentrations of total uranium (measured as gross alpha and gross beta) for upgradient and downgradient wells indicate that although some elevated levels of uranium have been detected in cylinder yard soil, no migration to groundwater has occurred (DOE 1994a).

Soil samples collected as part of general site monitoring in the immediate surrounding area in 1994 had the following maximum concentrations: uranium, 6.7 mg/kg; Aroclor® 1254 (a PCB), 0.16 mg/kg; cadmium, 0.34 mg/kg; mercury, 0.15 mg/kg; and nickel, 33 mg/kg (LMES 1996c). Fluoride was not analyzed in the soil samples, but it is naturally occurring and of low toxicity. Concentrations of uranium in 1995 and 1996 soil monitoring were lower than the previous results (LMES 1996b, 1997b).

As part of ongoing CERCLA/RCRA investigations, several areas of soil at the ETTP site have been identified as contaminated with radionuclides and/or chemicals. Remediation of this contamination is being implemented as a part of ongoing CERCLA/RCRA activities at the site.

3.2.5 Water Resources

The affected environment for water resources consists of surface water within and in the vicinity of the site boundary and groundwater beneath the site. Analyses of surface water, stream sediment, and groundwater samples have indicated the presence of some contamination resulting from previous gaseous diffusion plant operations. Although several contaminants are present in the water, only small amounts of uranium and fluoride compounds are related to releases from the cylinders.

3.2.5.1 Surface Water

The ETTP site is located near the confluence of the Clinch River (a tributary of the Tennessee River) and Poplar Creek (Figure 3.2-4). Effluent discharge points are located on both Poplar Creek and the Clinch River, and two water withdrawal points are on the Clinch River (DOE 1979).

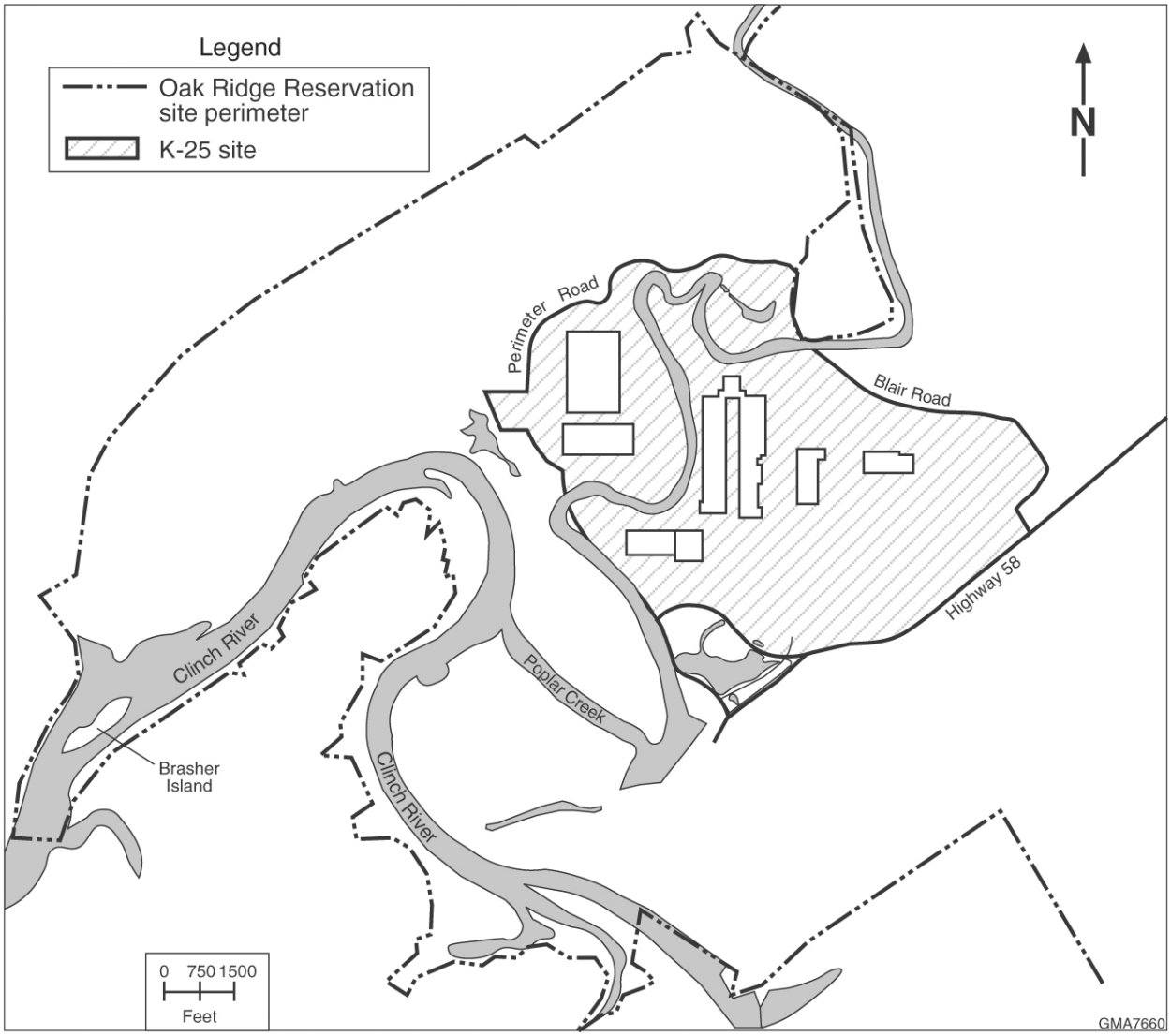

FIGURE 3.2-4 Surface Water Features in the Vicinity of ETTP

All waters that drain the ETTP site eventually reach the Tennessee-Ohio-Mississippi river system. The Clinch River provides the most immediate destination for waters discharged from the site and flows southwest into the Tennessee River near Kingston, Tennessee (Geraghty & Miller, Inc. 1989). A dam constructed in 1963 at River Mile 23.1 created the Melton Hill Reservoir, which establishes the eastern and southeastern boundaries of the Oak Ridge facility. Before this dam was constructed, flows were regulated by Watts Bar Dam, which is located about 38 mi [61 km] downstream from the mouth of the Clinch River. Because of the presence of Melton Hill and Watts Bar dams, the hydrology of the Clinch River-Poplar Creek system is very complex. Average flows in Melton Branch, Whiteoak Creek, and the East Fork of Poplar Creek were 1,120, 4,320, and 21,680 gal/min (4,240, 16,350, and 82,060 L/min), respectively, for a period of record circa 1960. The average daily discharge below Melton Hill Dam was 2 million gal/min (128.5 m^3/s) for a 39-year period of record (Geraghty & Miller, Inc. 1989).

The ETTP site contains a series of limited drainage basins through which small streams traverse and ultimately join with the Clinch River (DOE 1979). Poplar Creek (Figure 3.2-4) is one such stream; it receives drainage from an area of 136 mi^2 (352 km^2), including the northwestern sector of the site. The headwaters of the East Fork are collected in the vicinity of Y-12, where they receive treated wastewater in the form of cooling tower blowdown, waste stream condensate, and process cooling water. In the uplands around the site, surface runoff is largely controlled by soil cover. Within the site, runoff is largely controlled by subsurface drains and diversion ditches. Annual precipitation is 54.8 in. (139 cm). In the vicinity of ETTP, most of the facilities are free from flood hazards for both the 100-year and 500-year maximum probable floods in Poplar Creek (Rothschild et al. 1984).

The ORR site takes water from the Clinch River for makeup cooling water for its reactors at a rate of approximately 20 million gal/d (76 million L/d). An additional 4 million gal/d (15 million L/d) is withdrawn for other process water. These withdrawals occur at Clinch River Miles 11.5 and 14.4. About 25% of this water is returned to the river as treated effluent or blowdown water. As of 1979, no withdrawals were reported from Poplar Creek (DOE 1979). Average water consumption for ETTP in 1994 was 1,324 gal/min (5,011 L/min), equaling about 700 million gal (2.6 billion L) per year.

As of 2000, surface water was being monitored at seven locations at ETTP (DOE 2002c). In the last quarter of 1999, sampling at most monitoring stations was scaled back to a semiannual frequency. Uranium levels were well within permitted levels based on radiological standards. In most instances, results for nonradiological parameters were also well within their applicable Tennessee water quality standards. Heavy metals were detected, but they were always well within applicable standards. In general, analytical results for samples collected upstream of ETTP were chemically similar to those collected downstream of the site, indicating that the site has little effect on chemical concentrations in surface water.

Sediment samples have also been collected at points that coincided with the ORR water sampling locations. The sediment samples were analyzed for uranium and other parameters. For 1994, the following maximum concentrations were measured: uranium, 43 mg/kg; mercury, 6 mg/kg; nickel, 89 mg/kg; and Aroclor 1254, 10 mg/kg (LMES 1996c).

3.2.5.2 Groundwater

Groundwater occurs in a surficial aquifer and in bedrock aquifers in the vicinity of ETTP. The surficial aquifer consists of man-made fill, alluvium, and the residuum of weathered bedrock (Geraghty & Miller, Inc. 1989). The depth to unweathered bedrock varies from less than 10 to more than 50 ft (<3 to >15 m), depending on the characteristics of the underlying rocks.

Bedrock aquifers in the area are composed of Cambrian to Ordovician sandstones, siltstones, shales, dolostones, and limestones. The uppermost bedrock aquifer occurs in the Chickamauga Group. This formation disconformably overlies the Knox Dolostone and is the most extensive bedrock unit underlying the site. Shale beds restrict groundwater flow in the

aquifer, resulting in concentrated flow along the limestone-shale contact, with resultant solution cavities.

The next-lower aquifer occurs in the Knox Group. It is composed of dolostone with interbeds of limestone. Solution features such as sinkholes and caverns are common and are an important route for groundwater flow. This unit is the principal aquifer on the site (Rothschild et al. 1984); the mean yield of wells and springs is about 268 gal/min (1,014 L/min).

As in the Knox Group, solution cavities in the Conasauga Group are an important controlling influence for groundwater flow. Because shale beds within the group are generally less transmissive, groundwater flow is concentrated in the limestone strata. In addition to solution features, folds and faults can also control flow in this unit (Rothschild et al. 1984). The oldest units in the area are the Shady Dolomite and the Rome Formation. Groundwater in these units is largely controlled by fractures and vugs (Geraghty & Miller, Inc. 1989).

During the late spring and summer of 1981, a series of tests to determine properties of the bedrock aquifers directly across the Clinch River from site K-770 were conducted (Geraghty & Miller, Inc. 1989). Transmissivity values for the bedrock aquifers (Upper Rome Formation, Chickamauga and Knox Groups) ranged from 22 to 15,000 gal/d per foot (270 to 185,000 L/d per meter), with most values ranging from 22 to 6,000 gal/d per foot (270 to 73,600 L/d per meter). Slug tests performed in the unconsolidated surficial aquifer indicated that the hydraulic conductivity ranged from 1×10^{-7} to 0.01 cm/s. Bedrock values ranged from 1×10^{-6} to 1×10^{-3} cm/s.

On May 29 and 30, 1991 water-level measurements were collected from 185 of 191 monitoring wells at the ETTP site (Geraghty & Miller, Inc. 1991). Inferred directions of groundwater flow are to the south and southwest toward Poplar Creek. Recharge to the groundwater system occurs from surface water bodies and infiltrating precipitation.

Groundwater contamination is a significant problem on the site (Rothschild et al. 1984). The problem is compounded by use of land underlain by shallow groundwater (found in most of the valleys on the reservation) and by the presence of direct conduits to groundwater (e.g., solution features and fractures), which are common. Contamination is associated with waste disposal activities, buried pipelines, and accidental spills.

In 1994 and 1995, groundwater samples were collected from a network of between 200 and 225 monitoring wells at the site (LMES 1996b,c). The number of wells monitored was greatly decreased in 1996 as a result of the reorganization of the site into six watersheds and reduced monitoring requirements (LMES 1997b). In the 1994 and 1995 sampling conducted for the larger network of monitoring wells, the following substances were detected at levels exceeding their associated primary drinking water standards: antimony, arsenic, barium, cadmium, chromium (up to 0.741 mg/L), fluoride (only at two wells), lead, nickel (up to 0.626 mg/L), thallium (up to 0.021 mg/L), benzene (up to 6 μg/L), carbon tetrachloride, 1,1-dichloroethene (greater than 1,000 μg/L), chloroform, 1,2 dichloroethene (greater than 1,000 μg/L), methylene chloride, toluene (greater than 1,000 μg/L), 1,1,2-trichloro-1,2,2-trifluoroethane (greater than 1,000 μg/L), TCE (up to 11,000 μg/L), 1,1,1-trichloroethane

(up to 140,000 μg/L), 1,1,2-trichloroethane, tetrachloroethene (up to 17 μg/L), vinyl chloride, gross alpha activity (up to 43 pCi/L), and gross beta activity (up to 6,770 pCi/L) (LMES 1996b,c). Aluminum, iron, and manganese also consistently exceeded secondary, non-health-based standards because of the natural geochemical nature of the groundwater underlying the site (LMES 1996b).

Data from the 2000 annual groundwater monitoring program showed that aluminum and lead exceeded maximum contaminant levels for groundwater at ETTP (DOE 2002c). Copper, iron, and zinc were also found at elevated concentrations, but MCLs are not available for these analytes.

Exit-pathway groundwater surveillance monitoring was conducted in 1994 and 1995 at convergence points where shallow groundwater flows from relatively large areas of the site and converges before discharging to surface water locations (LMES 1996b,c). The exit-pathway monitoring data are representative of maximum groundwater contamination levels associated with the site at areas to which the general public might possibly have access in the future. For 1994, monitoring indicated that thallium, bis(2-ethylhexyl)phthalate, and TCE were present in at least one exit-pathway well sample at concentrations exceeding primary drinking water standards (LMES 1996c). The following average concentrations of these constituents were measured: thallium, 0.007 mg/L; bis(2-ethylhexyl)phthalate, 0.169 mg/L; and TCE, 0.008 mg/L. Alpha activity and fluoride levels were also measured but did not exceed reference levels (the average concentration was 4.4 pCi/L for alpha activity and 0.4 mg/L for fluoride). For 1995, monitoring indicated that no inorganic or organic substances exceeded primary drinking water standards; however, alpha activity exceeded the reference level in one well during the spring sampling event (level of 17 pCi/L) (LMES 1996b).

3.2.6 Biotic Resources

3.2.6.1 Vegetation

About 65% of the land within a 5-mi (8-km) radius of the ETTP site is forested, although most of the ETTP site consists of mowed grasses. Oak-hickory forest is the predominant community on ridges and dry slopes. Mixed pine forests or pine plantations, many of which are managed, have replaced former agricultural fields. Selective logging occurred over much of the site before 1986. Cedar barrens are small communities, primarily on shallow limestone soils, that support drought-tolerant species such as little bluestem, dropseed, eastern red cedar, and stunted oak. A cedar barrens across the Clinch River from the ETTP site may be the best example of this habitat in the state and has been designated as a State Natural Area.

3.2.6.2 Wildlife

The high diversity of habitats in the area supports many wildlife species. Ground-nesting species commonly occurring on the ETTP site include red fox, ruffed grouse, and eastern box

turtle. Canada geese are also common in the ETTP area, and most are probably residents (ANL 1991b). Waterfowl, wading birds, and shorebirds are numerous along the Clinch River, in its backwaters, and in ponds. Two great blue heron rookeries are located north of the ETTP site on Poplar Creek (ANL 1991b). Species commonly associated with streams and ponds include muskrat, beaver, and several species of turtles and frogs.

The aquatic communities within the Clinch River and Poplar Creek support a high diversity of fish species and other aquatic fauna. Mitchell Branch supports fewer fish species, although the diversity of fish species has increased downstream of most ETTP discharges since 1990 (DOE 2002c; LMES 1996b).

3.2.6.3 Wetlands

Numerous wetlands occur in the vicinity of ETTP, including three small wetlands along Mitchell Branch (ANL 1991b). Extensive forested wetlands occur along Poplar Creek, East Fork Poplar Creek, Bear Creek, and their tributaries. Shallow water embayments of Melton Hill Reservoir and Watts Bar Reservoir support large areas of palustrine emergent wetlands with persistent vegetation. Forested wetlands occur along these marshy areas and extend into tributaries (DOE 1995).

3.2.6.4 Threatened and Endangered Species

No occurrence of federal- or state-listed threatened or endangered species on the ETTP site has been documented. Table 3.2-6 gives the federal- and state-listed species that occur on the ORR. Gray bats, which are federal and state listed as endangered, have been observed on ORR as transient individuals (DOE 2002c). The bald eagle, federal listed as threatened, is a winter visitor on the reservation (DOE 2001c). Bachman's sparrow, state listed as endangered, may be present on ORR, although it has not been observed recently (DOE 2002c). Suitable nesting habitat on the reservation includes open pine woods with shrubs and dense ground cover (ANL 1991b).

3.2.7 Public and Occupational Safety and Health

3.2.7.1 Radiation Environment

Table 3.2-7 gives the radiation doses to the ETTP cylinder yard workers and to off-site members of the general public. Exposure to airborne emissions from ETTP operations is approximately 13% of that from operations of the entire ORR. Radiation exposure of the general public MEI is estimated to be 6.7 mrem/yr. This dose is about 7% of the maximum dose limit of 100 mrem/yr set for the general public (DOE 1990a) and much smaller than the average dose from natural background radiation in the State of Tennessee. The actual radiation exposure of the general public would be much lower than the estimated maximum value.

TABLE 3.2-6 Federal- and State-Listed Endangered, Threatened, and Special Concern Species on ORR

Scientific Name	Common Name	Federal Status	State Status
Mammals			
Myotis grisescens	Gray bat	E	E
Sorex longirostris	Southeastern shrew		NM
Birds			
Accipieter striatus	Sharp-shinned hawk		NM
Aimophila aestivalis	Bachman's sparrow		E
Anhinga anhinga	Anhinga		NM
Casmerodius alba	Great egret		NM
Circus cyaneus	Northern harrier		NM
Contopus borealis	Olive-sided flycatcher		NM
Dendroica cerulea	Cerulean warbler		NM
Egretta caerulea	Little blue heron		NM
Egretta thula	Snowy egret		NM
Falco peregrinus	Peregrine falcon		E
Heliaeetus leucocephalus	Bald eagle	T	NM
Lanius ludovicianus	Loggerhead shrike		NM
Pandion haliaetus	Osprey		E
Sphyrapicus varius	Yellow-bellied sapsucker		NM
Amphibians			
Hemidactylium scutatum	Four-toed salamander		NM
Fish			
Phoxinus tennesseensis	Tennessee dace		NM
Plants			
Aureolaria patula	Spreading false-foxglove		T
Carex gravida	Heavy sedge		S
Carex oxylepis pubescens	Hairy sharp-scaled sedge		S
Cimicifuga rubifolia	Appalachian bugbane		T
Cypripedium acaule	Pink lady's slipper		E
Delphinium exaltatum	Tall larkspur		E
Diervilla lonicera	Northern bush-honeysuckle		T
Draba ramosissima	Branching whitlow-grass		S
Elodea nuttallii	Nuttall waterweed		S
Fothergilla major	Mountain witch-alder		T
Hydrastis canadensis	Golden seal		S
Juglans cinerea	Butternut		T
Juncus brachycephalus	Small-head rush		S
Lilium canadense	Canada lily		T
Lilium michiganense	Michigan lily		T
Liparis loeselii	Fen orchid		E
Panax quinquifolius	Ginseng		S
Platanthera flava herbiola	Tuberculed rein-orchid		T
Ruellia purshiana	Pursh's wild petunia		S
Scirpus fluviatilis	River bulrush		S
Spiranthes lucida	Shining ladies-tresses		T
Thuja occidentalis	Northern white cedar		S
Viola tripartita	Three-parted violet		S

[a] Status codes: E = endangered; T = threatened; NM = in need of management; S = special concern.

Source: DOE (2001c).

TABLE 3.2-7 Estimated Radiation Doses to Members of the General Public and Cylinder Yard Workers at ETTP

Receptor	Radiation Source	Dose to Individual (mrem/yr)
Member of the general public (MEI)[a]	Routine site operations	
	Airborne radionuclides[b]	
	ETTP only	0.1
	Entire ORR	0.8
	Waterborne radionuclides[c]	3.7
	Direct gamma radiation	1.8[d]
	Ingestion of wildlife	0.4[e]
Cylinder yard worker	External radiation	32–92,[f] 107[g]
Member of public or worker	Average natural background radiation in the State of Tennessee	42[h]
DOE worker limit		2,000[i]

[a] The MEI is assumed to reside at an off-site location or undertake the specific activities that would yield the largest dose. An average person would receive a radiation dose much less than the values shown in this table.

[b] Radiation doses from airborne releases were estimated by using an air dispersion model and took into account exposures from external radiation, inhalation, and ingestion of foodstuffs. Doses were estimated on the basis of the emission rate from ETTP only and from the entire ORR (DOE 2002d).

[c] The radiation dose would result from eating 21 kg/yr (46 lb/yr) of the most contaminated accessible fish, drinking 730 L/yr (193 gal/yr) of the most contaminated drinking water, and using the shoreline near the most contaminated stretch of water for 67 h/yr (DOE 2002d).

[d] Radiation doses would result from 250 hours of shoreline activity per year along the banks of Poplar Creek or near the K-1066-E cylinder yard (DOE 2002d).

[e] Radiation doses would result from ingestion of two hypothetical worst-case geese (a combination of the heaviest goose harvested and the highest measured concentrations of cesium-137 and strontium-90 found in released geese (0.3 mrem/yr) and a hypothetical worst-case turkey (0.1 mrem/yr) (DOE 2002d). Deer hunt activities were cancelled because of security concerns during the final quarter of 2001 (DOE 2002d).

[f] The range of annual average doses from 1991 through 1995 (Hodges 1996).

[g] In 1998, the maximum worker exposure from painting cylinders was 107 mrem/yr (Cain 2002b).

[h] Dose from natural background radiation ranges from 19 to 72 mrem/yr in Tennessee (DOE 2002c).

[i] DOE administrative procedures limit DOE workers to 2,000 mrem/yr (DOE 1992), whereas the regulatory dose limit for radiation workers is 5,000 mrem/yr (10 CFR Part 835).

Between 1991 and 1995, the average annual dose to cylinder yard workers ranged from 32 to 92 mrem/yr, which is less than 2% of the maximum radiation dose limit of 5,000 mrem/yr set for radiation workers (10 CFR Part 835). In 1998, 400 cylinders were repainted; the maximum worker exposure was 107 mrem/yr (Cain 2002b).

3.2.7.2 Chemical Environment

Table 3.2-8 gives the estimated hazard quotients for members of the general public under existing environmental conditions near the ETTP site. The hazard quotient represents a comparison of the estimated human intake level of a contaminant with an intake level below which adverse effects are very unlikely to occur. The estimated hazard quotients indicate that exposures to DUF_6-related contaminants in environmental media near the ETTP site are generally a small fraction of those that might be associated with adverse health effects. An exception is groundwater, for which the hazard quotient for fluoride could exceed the threshold of 1. However, it is highly unlikely that this groundwater would be used as a drinking water source.

OSHA has proposed PELs for uranium compounds and HF in the workplace (29 CFR Part 1910, Subpart Z, as of February 2003) as follows: 0.05 mg/m^3 for soluble uranium compounds, 0.25 mg/m^3 for insoluble uranium compounds, and 2.5 mg/m^3 for HF. ETTP worker exposures are kept below these limits.

3.2.8 Socioeconomics

Socioeconomic data for the ETTP site focus on an ROI comprising four Tennessee counties surrounding the site: Anderson, Knox, Loudon, and Roane. The counties included in the ROI were selected on the basis of the current residential locations of government workers directly involved in ETTP activities. The ROI is defined on the basis of the current residential locations of government workers directly connected to ETTP site activities and includes the area in which these workers spend much of their salaries. More than 90% of ETTP workers currently reside in these counties (Cain 2002b). Because the majority of ETTP workers live in Anderson and Knox Counties and the City of Knoxville, the majority of impacts from ETTP would be expected to occur in these locations; therefore, the following discussions emphasize those areas.

3.2.8.1 Population

The population of the ROI in 2000 was 544,358 people (U.S. Bureau of the Census 2002a) and was expected to reach 565,000 by 2003 (Table 3.2-9). In 2000, 382,032 people (70% of the ROI total) resided in Knox County, 71,330 people resided in Anderson County, and 173,890 people resided in the City of Knoxville itself (U.S. Bureau of the Census 2002a). During the 1990s, each of the counties in the ROI and the City of Knoxville experienced moderate

TABLE 3.2-8 Estimated Hazard Quotients for Members of the Public near ETTP under Existing Environmental Conditions[a]

Environmental Medium	Parameter	Assumed Exposure Concentration	Estimated Chronic Intake (mg/kg-d)	Reference Level[b] (mg/kg-d)	Hazard Quotient[c]
Air[d]	Uranium	0.0014 μg/m^3	3.9×10^{-7}	0.0003	0.0013
Soil[e]	Uranium	6.7 μg/g	8.9×10^{-5}	0.003	0.03
Surface water[f]	Uranium	13 μg/L	7.1×10^{-6}	0.003	0.0024
	Fluoride	180 μg/L	9.9×10^{-5}	0.06	0.0016
Sediment[g]	Uranium	43 μg/g	1.2×10^{-5}	0.003	0.0039
Groundwater[h]	Uranium	25 μg/L	1.8×10^{-4}	0.003	0.24
	Fluoride	4,000 μg/L	1.1×10^{-2}	0.06	1.9

[a] The receptor was assumed to be a long-term resident near the site boundary or another off-site monitoring location that would have the highest concentration of the contaminant being addressed; reasonable maximum exposure conditions were assumed. Only the exposure pathway contributing the most to intake levels was considered (i.e., inhalation for air and ingestion for soil, sediment, surface water, and groundwater). Residential exposure scenarios were assumed for air, soil, and groundwater analyses; recreational exposure scenarios were assumed for surface water and sediment analyses. For all environmental media, only uranium and fluoride data (of particular interest for this EIS) are presented, although other substances are also measured.

[b] The reference level is an estimate of the daily human exposure level that is likely to be without an appreciable risk of deleterious effects. The reference levels used in this assessment are defined in Appendix F.

[c] The hazard quotient is the ratio of the intake of the human receptor to the reference level. A hazard quotient of less than 1 indicates that adverse health effects resulting from exposure to that chemical alone are unlikely.

[d] For the uranium air concentration, the maximum average from six monitoring locations was used (DOE 2002d). HF was not measured.

[e] Current soil sampling data were unavailable; data presented are from LMES (LMES 1996c). No data were available for fluoride.

[f] For uranium, the value is the maximum average for downstream locations (DOE 2002d). Current surface water sampling data for fluoride were unavailable; data presented are from LMES (1996c).

[g] Current sediment sampling data were unavailable; data presented are from LMES (1996c).

[h] Groundwater data are not provided in the current annual site environmental report (DOE 2002c). The concentration presented for uranium is from LMES (1996c). The value is the maximum annual average for all exit pathway monitoring locations because these are the locations where the general public could most likely be exposed in the future. Alpha activity was used as a surrogate measure of the uranium concentration. The well-specific concentration for fluoride was not available; the exposure concentration given is the drinking water standard. Several wells were stated to have fluoride levels in excess of the standard (LMES 1996b). The hazard index for fluoride could therefore exceed that presented. Several additional substances exceeded drinking water standards or guidelines in 1994 and 1995 monitoring; only substances of particular interest for this EIS are listed here.

TABLE 3.2-9 Population in the ETTP Region of Influence and Tennessee in 1990, 2000, and 2003

Location	1990	2000	Growth Rate (%), 1990–2000[a]	2003[b] (Projected)
City of Knoxville	165,121	173,890	0.5	176,600
Knox County	335,749	382,032	1.3	397,100
Anderson County	68,250	71,330	0.4	72,300
Loudon County	31,255	39,086	2.3	41,800
Roane County	47,227	51,910	1.0	53,400
ROI total	482,481	544,358	1.2	564,600
Tennessee	4,877,185	5,689,283	1.6	5,958,000

[a] Average annual rate.

[b] ANL projections, as detailed in Appendix F.

Source: U.S. Bureau of the Census (2002a), except as noted.

increases in population, with an ROI average growth of 1.2%. A slightly higher growth rate was experienced in Loudon County (2.3%), which had the smallest population in the ROI. Over the same period, the population in Tennessee grew at a rate of 1.6%.

3.2.8.2 Employment

Total employment in Knox County was 188,114 in 2000; it was projected to reach 199,400 by 2003. The economy of the county is dominated by the trade and service sectors, with employment in those sectors currently contributing more than 75% of all employment in the county (Table 3.2-10). Employment growth in the highest growth sector, the service sector, was 7.1% during the 1990s, compared with 2.0% in the county for all sectors as a whole (U.S. Bureau of the Census 1992, 2002b).

Total employment in Anderson County was 39,797 in 2000; it was projected to reach 42,000 by 2003. The economy of the county is dominated by the manufacturing and service sectors, with employment in those sectors currently contributing more than 82% of all employment in the county (Table 3.2-11). Employment growth in the highest growth sector, services, was 5.5% during the 1990s, compared with 1.8% in the county for all sectors as a whole (U.S. Bureau of the Census 1992, 2002b).

Total employment in the ROI was 248,003 in 2000; it was projected to reach 262,600 by 2003. The economy of the ROI is dominated by the trade and service sectors; combined, they contribute 72% of all employment in the ROI (Table 3.2-12). Employment growth in the highest

TABLE 3.2-10 Employment in Knox County by Industry in 1990 and 2000

Sector	No. of People Employed in 1990[a]	Percentage of County Total	No. of People Employed in 2000[b]	Percentage of County Total	Growth Rate (%), 1990–2000
Agriculture	2,010[c]	1.3	951[d]	0.5	-7.2[e]
Mining	775	0.5	315	0.2	-8.6
Construction	9,817	6.3	12,225	6.5	2.2
Manufacturing	22,720	14.7	16,912	9.0	-2.9
Transportation and public utilities	9,823	6.3	5,272	2.8	-6.0
Trade	52,258	33.7	41,951	22.3	-2.2
Finance, insurance, and real estate	7,228	4.7	10,668	5.7	4.0
Services	50,032	32.3	99,707	53.0	7.1
Total	154,968		188,114		2.0

[a] U.S. Bureau of the Census (1992).

[b] U.S. Bureau of the Census (2002b).

[c] These agricultural data are for 1992 and are taken from USDA (1994).

[d] These agricultural data are for 1997 and are taken from USDA (1999).

[e] Agricultural data are for 1992 and 1997.

growth sector, services, was almost 6.8% during the 1990s, compared with 1.9% in the ROI for all sectors as a whole (U.S. Bureau of the Census 1992, 2002b). Employment at the ETTP site currently stands at 1,740 (Cain 2002b).

Unemployment in the Knoxville Metropolitan Statistical Area was 2.8% in December 2002, slightly lower than the average rate during the 1990s (Table 3.2-13). Unemployment for the state was 4.1% in December 2002, which is also slightly lower than the average rates for the last 10 years.

3.2.8.3 Personal Income

Personal income in Knox County totaled about $11.3 billion in 2000 (in 2002 dollars) and was projected to reach $13.5 billion by 2003. The annual average rate of growth was 2.8% over the period 1990 through 2000 (Table 3.2-14). County per capita income also rose in the 1990s and was expected to reach $34,400 in 2003, compared with $29,600 at the beginning of the period.

TABLE 3.2-11 Employment in Anderson County by Industry in 1990 and 2000

Sector	No. of People Employed in 1990[a]	Percentage of County Total	No. of People Employed in 2000[b]	Percentage of County Total	Growth Rate (%), 1990–2000
Agriculture	577[c]	1.7	243[d]	0.6	-8.3[e]
Mining	293	0.9	60	0.2	-14.7
Construction	857	2.6	1,175	3.0	3.2
Manufacturing	11,634	34.9	10,523	26.4	-1.0
Transportation and public utilities	801	2.4	218	0.5	-12.2
Trade	5,236	15.7	4,200	10.6	-2.2
Finance, insurance, and real estate	829	2.5	1,058	2.7	2.5
Services	13,016	39.1	22,273	56.0	5.5
Total	33,299		39,797		1.8

[a] U.S. Bureau of the Census (1992).

[b] U.S. Bureau of the Census (2002b).

[c] These agricultural data are for 1992 and are taken from USDA (1994).

[d] These agricultural data are for 1997 and are taken from USDA (1999).

[e] Agricultural data are for 1992 and 1997.

TABLE 3.2-12 Employment in the ETTP Region of Influence by Industry in 1990 and 2000

Sector	No. of People Employed in 1990[a]	Percentage of ROI Total	No. of People Employed in 2000[b]	Percentage of ROI Total	Growth Rate (%), 1990–2000
Agriculture	4,528[c]	2.2	2,545[d]	1.0	-5.6[e]
Mining	1,138	0.6	407	0.2	-9.8
Construction	11,185	5.5	14,416	5.8	2.6
Manufacturing	39,633	19.3	32,706	13.2	-1.9
Transportation and public utilities	11,322	5.5	6,682	2.7	-5.1
Trade	61,583	30.1	50,387	20.3	-2.0
Finance, insurance, and real estate	8,851	4.3	12,357	5.0	3.4
Services	66,279	32.3	128,299	51.7	6.8
Total	204,922		248,003		1.9

[a] U.S. Bureau of the Census (1992).

[b] U.S. Bureau of the Census (2002b).

[c] These agricultural data are for 1992 and are taken from USDA (1994).

[d] These agricultural data are for 1997 and are taken from USDA (1999).

[e] Agricultural data are for 1992 and 1997.

Personal income in Anderson County was almost $2 billion in 2000 (in 2002 dollars) and was expected to reach $2.2 billion by 2003. The annual average rate of growth was 1.9% over the period 1990 through 2000 (Table 3.2-14). County per capita income also rose in the 1990s and was expected to reach $31,100 in 2003, compared with about $27,200 at the beginning of the period.

Growth rates in total personal income in the ROI as a whole were the same as those for Knox County and slightly higher than those for Anderson County. Total personal income in the ROI grew at a rate of 2.8% over the period 1990 through 2000 and was expected to reach almost $18.5 billion by 2003. ROI per capita income was expected to grow from about $28,500 in 1990 to $33,000 by 2003, which is an average annual growth rate of 1.4%.

TABLE 3.2-13 Unemployment Rates in the Knoxville Metropolitan Statistical Area and Tennessee

Location and Period	Rate (%)
Knoxville MSA[a]	
1992–2002 average	3.7
Dec. 2002 (current rate)	2.8
Tennessee	
1992–2002 average	4.6
Dec. 2002 (current rate)	4.1

[a] Knoxville Metropolitan Statistical Area (MSA) consists of Anderson, Blount, Knox, Loudon, Sevier, and Union Counties.

Source: BLS (2002).

TABLE 3.2-14 Personal Income in Knox and Anderson Counties and the ETTP Region of Influence in 1990, 2000, and 2003

Location and Type of Income	1990	2000	Growth Rate (%), 1990–2000	2003 (Projected)[a]
Knox County				
Total personal income (millions of 2002 $)	8,790	11,308	2.8	13,500
Personal per capita income (2002 $)	26,180	29,599	1.4	34,400
Anderson County				
Total personal income (millions of 2002 $)	1,643	1,938	1.9	2,200
Personal per capita income (2002 $)	24,074	27,173	1.4	31,100
Total ROI				
Total personal income (millions of 2002 $)	12,118	15,516	2.8	18,500
Personal per capita income (2002 $)	25,115	28,503	1.4	33,000

[a] ANL projections, as detailed in Appendix F.

Source: U.S. Department of Commerce (2002).

3.2.8.4 Housing

Housing stock in Knox County grew at an annual rate of 1.8% over the period 1990 through 2000 (Table 3.2-15) (U.S. Bureau of the Census 2002a), with 178,000 housing units expected by 2002, reflecting the growth in county population. Growth in the City of Knoxville during this period was 1.1%, with total housing units expected to reach 86,300 by 2003. During the 1990s, 27,900 new units were added to the existing housing stock in the county, with 8,528 of these units in the City of Knoxville in 2000. Vacancy rates in 2000 stood at 9.8% in the city and 7.9% in the county as a whole for all types of housing. On the basis of annual population growth rates, 14,900 housing units were expected to be vacant in the county in 2003; 4,800 of these were expected to be rental units.

Housing stock in Anderson County grew at an annual rate of 1.0% over the period 1990 to 2000 (Table 3.2-15) (U.S. Bureau of the Census 2002a), with total housing units expected to reach 33,500 in 2003, reflecting moderate growth in county population. Almost 3,130 new units were added to the existing housing stock in the county during the 1990s. Vacancy rates in 2000 stood at 8.2% in the county for all types of housing. On the basis of annual population growth rates, 2,900 housing units were expected to be vacant in the county in 2003, of which 800 were expected to be rental units.

TABLE 3.2-15 Housing Characteristics in the City of Knoxville, Knox and Anderson Counties, and the ETTP Region of Influence in 1990 and 2000

Location and Type of Unit	No. of Units 1990	No. of Units 2000
City of Knoxville		
Owner-occupied	34,892	39,208
Rental	35,081	37,442
Total unoccupied	6,480	8,331
Total	76,453	84,981
Knox County		
Owner-occupied	85,369	105,562
Rental	48,270	52,310
Total unoccupied	9,943	13,567
Total	143,582	171,439
Anderson County		
Owner-occupied	19,401	21,592
Rental	7,983	8,188
Total unoccupied	1,939	2,671
Total	29,323	32,451
ROI Total		
Owner-occupied	128,300	156,219
Rental	63,331	68,577
Total unoccupied	14,603	19,740
Total	206,234	244,536

Source: U.S. Bureau of the Census (2002a).

Housing stock grew at a slightly slower rate in the ROI as a whole than it did in Knox County during the 1990s, with an overall growth rate of 1.7%. Total housing units were expected to reach 257,400 by 2003, with more than 38,300 housing units added in the 1990s. On the basis of vacancy rates in 2000, which stood at 8.1%, more than 6,400 rental units were expected to be available in 2003.

3.2.8.5 Community Resources

3.2.8.5.1 Community Fiscal Conditions. Construction and operation of the proposed facility might result in increased revenues and expenditures for local government jurisdictions, including counties, cities, and school districts. Revenues would come primarily from state and local sales tax revenues associated with employee spending during construction and operations, and they would be used to support additional local community services currently provided by each jurisdiction. Tables 1 and 2 of Allison (2002) present information on revenues and expenditures by the various local government jurisdictions in the ROI.

3.2.8.5.2 Community Public Services. Construction and operation of the proposed facility would result in increased demand for community services in the counties, cities, and school districts likely to host relocating construction workers and operations employees. Additional demands would also be placed on local medical facilities and physician services. Table 3.2-16 presents data on employment and levels of service (number of employees per 1,000 population) for public safety and general local government services, and Table 3.2-17 covers physicians. Tables 3.2-18 and 3.2-19 provide staffing data for school districts and hospitals.

3.2.9 Waste Management

The ETTP site generates industrial and sanitary waste, including wastewater, solid nonhazardous waste, solid and liquid hazardous waste, radioactive waste, and radioactive hazardous mixed waste. The ETTP site is an active participant in the waste minimization and recycling program within the ORR complex. Much of the waste generated at ETTP is from the ongoing environmental remediation efforts at the site. The ETTP site has the capability to treat wastewater and certain radioactive and hazardous wastes. Some of the wastes generated at ETTP can also be processed or disposed of at facilities located at the Y-12 Plant and ORNL. The ETTP facilities also store and process waste generated at Y-12, ORNL, and from other DOE installations at Paducah, Portsmouth, and Fernald. Most radioactive waste at ETTP is contaminated with uranium and uranium decay products, with small amounts of fission products and TRU radionuclides from nuclear fuel recycling programs. Table 3.2-20 lists the ETTP site waste loads assumed for the analysis of impacts of projected activities.

3.2.9.1 Wastewater

Treated wastewater at the ETTP site is discharged under a National Pollution Discharge Elimination System (NPDES) permit. Sanitary wastewater is processed at an on-site sewage treatment plant with a capacity of 0.92 million gal/d (3.5 million L/d).

TABLE 3.2-16 Public Service Employment in the City of Knoxville, ETTP Region-of-Influence Counties, and Tennessee in 2001

	City of Knoxville		Knox County		Clinton	
Employment Category	No. of Workers	Level of Service[a]	No. of Workers	Level of Service[a]	No. of Workers	Level of Service[a]
Police	429	2.5	495	2.3	24	2.5
Fire[b]	334	1.91.91	0	0.0	18	1.9
General	907	5.2	2,505	11.8	58	6.1
Total	1,670	9.6	3,000	14.1	100	10.6

	Lake City		City of Oak Ridge		Anderson County		Tennessee[c]
Employment Category	No. of Workers	Level of Service[a]	No. of Workers	Level of Service[a]	No. of Workers	Level of Service	Level of Service
Police	7	3.8	56	2.0	93	2.8	2.4
Fire[b]	3	1.6	42	1.5	0	0.0	1.1
General	19	10.2	256	9.3	336	10.2	39.1
Total	29	15.6	354	12.9	429	13.0	52.6

[a] Level of service represents the number of employees per 1,000 persons in each jurisdiction (U.S. Bureau of the Census 2002a).

[b] Volunteers not included.

[c] 2000 data.

Sources: City of Knoxville: Hatfield (2002); Knox County: Rodgers (2002), Parolari (2002); Clinton: Shootman (2002); Lake City: Hayden (2002); City of Oak Ridge: McGinnis (2002); Anderson County: Worthington (2002); Tennessee: U.S. Bureau of the Census (2002d).

TABLE 3.2-17 Number of Physicians in Knox and Anderson Counties and Tennessee in 1997

	Knox County		Anderson County		Tennessee
Employment Category	No.	Level of Service[a]	No.	Level of Service[a]	Level of Service[a]
Physicians	1,519	4.1	209	3.0	2.6

[a] Level of service represents the number of physicians per 1,000 persons in each jurisdiction.

Source: American Medical Association (1999).

TABLE 3.2-18 School District Data for Knox and Anderson Counties and Tennessee in 2001

	Knox County		Anderson County		Tennessee
Employment Category	No.	Student-to-Teacher Ratio[a]	No.	Student-to-Teacher Ratio[a]	Student-to-Teacher Ratio[a]
Teachers	3,380	15.4	488	12.5	15.8

[a] The number of students per teacher in each school district.

Source: Tennessee Department of Education (2001).

TABLE 3.2-19 Medical Facility Data for Knox and Anderson Counties in 1998

Hospital	No. of Staffed Beds	Occupancy Rate (%)[a]
Knox County		
Baptist Hospital of East Tennessee	316	66
East Tennessee Children's Hospital	103	67
County total	319	NA[b]
Anderson County		
Methodist Medical Center of Oak Ridge	250	72
Ridgeview Psychiatric Hospital and Center	20	35
County total	270	NA

[a] Percent of staffed beds occupied.

[b] NA = not available.

Source: Healthcare InfoSource, Inc. (1998).

3.2.9.2 Solid Nonhazardous, Nonradioactive Waste

About 35,000 yd^3/yr (27,500 m^3/yr) of solid nonhazardous waste is generated at ORR, which includes waste from the ETTP site. The waste is disposed of at the Y-12 landfill; it is projected that about 50% of the landfill's capacity, or about 920,000 yd^3 (700,000 m^3), would be available in the year 2020.

3.2.9.3 Nonradioactive Hazardous and Toxic Waste

The ETTP site generates both RCRA-hazardous and TSCA-hazardous waste. The site operates several RCRA hazardous waste treatment and storage facilities. The site also operates a permitted TSCA incinerator to treat hazardous and LLMW liquids contaminated with PCBs. The incinerator also processes PCB waste from other facilities at ORR and from off-site DOE installations.

TABLE 3.2-20 Projected Waste Generation Volumes for ETTP[a]

Waste Category	Waste Treatment Volume (m^3/yr)
LLW	41,000
LLMW	2,700
TRU	0
Hazardous waste	350
Nonhazardous waste[b]	
Solids	12,000
Wastewater	47,000

[a] Volumes include operational and environmental restoration waste projected from FY 2002 to FY 2025. However, it is projected that the majority of the waste would be generated by FY 2008.

[b] Volumes include sanitary and industrial wastes.

Source: Cain (2002c).

3.2.9.4 Low-Level Radioactive Waste

Current ORR policy for newly generated LLW is to perform necessary packaging for direct shipment to appropriate on- and off-site treatment, storage, and disposal facilities. LLW that is not treated or disposed of at ORR is placed in storage, pending either treatment or disposal, or both, at off-site facilities.

3.2.9.5 Low-Level Radioactive Mixed Waste

The majority of radioactive waste generated at ETTP is LLMW, which consists of two categories: (1) aqueous RCRA-hazardous radioactive waste contaminated with corrosives or metals and (2) organic liquids contaminated with PCBs.

Aqueous LLMW is treated on site, and resulting wastewaters are discharged to the NPDES-permitted discharges, which have a capacity of 450,000 yd^3/yr (340,000 m^3/yr). Organic LLMW liquids contaminated with PCBs are treated by the ETTP TSCA incinerator, which has a capacity of 1,800 yd^3/yr (1,400 m^3/yr).

ETTP has the capacity to treat approximately 6,500 yd^3/yr (5,000 m^3/yr) of liquid LLMW via grout stabilization. The site has the capacity to store 88,600 yd^3 (67,800 m^3) of LLMW containers.

3.2.10 Land Use

ETTP is located in east-central Tennessee, in the eastern part of Roane County about 25 mi (40 km) west of the City of Knoxville. An analysis of Landsat satellite imagery from 1992 shows that the dominant land cover categories in Roane County include deciduous forest (42.0%), mixed forest (19.7%), evergreen forest (13.6%), and pasture/hay (10.3%) (Figure 3.2-5). The 1997 agricultural census recorded 99 farms in Roane County, covering more than 53,100 acres (21,489 ha) (USDA 1999). Human settlement is sparse throughout much of the county, with most of the population residing in the communities of Harriman, Kingston, Oak Ridge, and Rockwood. The eastern third of Roane County, where ETTP is located, is dominated by deciduous and mixed forest and pasture.

The 1,700-acre (690-ha) ETTP site contains more than 300 buildings with a combined floor space of 13 million ft^2 (1.2 million m^2) (MMES 1994b).

Land use at ETTP focuses on the reuse of facilities, equipment, materials, and utilities previously associated with the gaseous diffusion plant, with an emphasis on reindustrialization (Bechtel Jacobs Company LLC 2002). Activities at the site include a range of operations associated with environmental management at the DOE Oak Ridge Operations facilities, such as management of the TSCA incinerator and the treatment, storage, and disposal of hazardous and radioactive waste (including DUF_6) (Operations Management International, Inc. 2002a). Currently, ETTP is home to two business centers: Heritage Center and Horizon Center. The Heritage Center encompasses 125 of the main buildings of the former gaseous diffusion facility, which are currently leased to more than 40 companies (Operations Management International, Inc. 2002b). The Horizon Center encompasses 1,000 acres (447 ha) of building sites aimed primarily at high-tech companies.

3.2.11 Cultural Resources

The ETTP site falls under the CRMP for ORR. That plan, which contains procedures for managing archaeological sites, historic structures, traditional cultural properties, and Native American sacred sites, was finalized in July 2001 (Souza et al. 2001). Under the plan, ETTP has responsibility for cultural resources at the eastern end of the reservation.

Cultural resource surveys at ORR have provided a considerable body of knowledge regarding the history and prehistory of the area. Archaeological evidence indicates that there has been a human presence at ORR for at least 12,000 years. All the major prehistoric Eastern Woodland archaeological periods are represented there: Paleo-Indian (10,000 B.C.–8,000 B.C.), Archaic (8,000 B.C.–900 B.C.), Woodland (900 B.C.–A.D. 900), and Mississippian

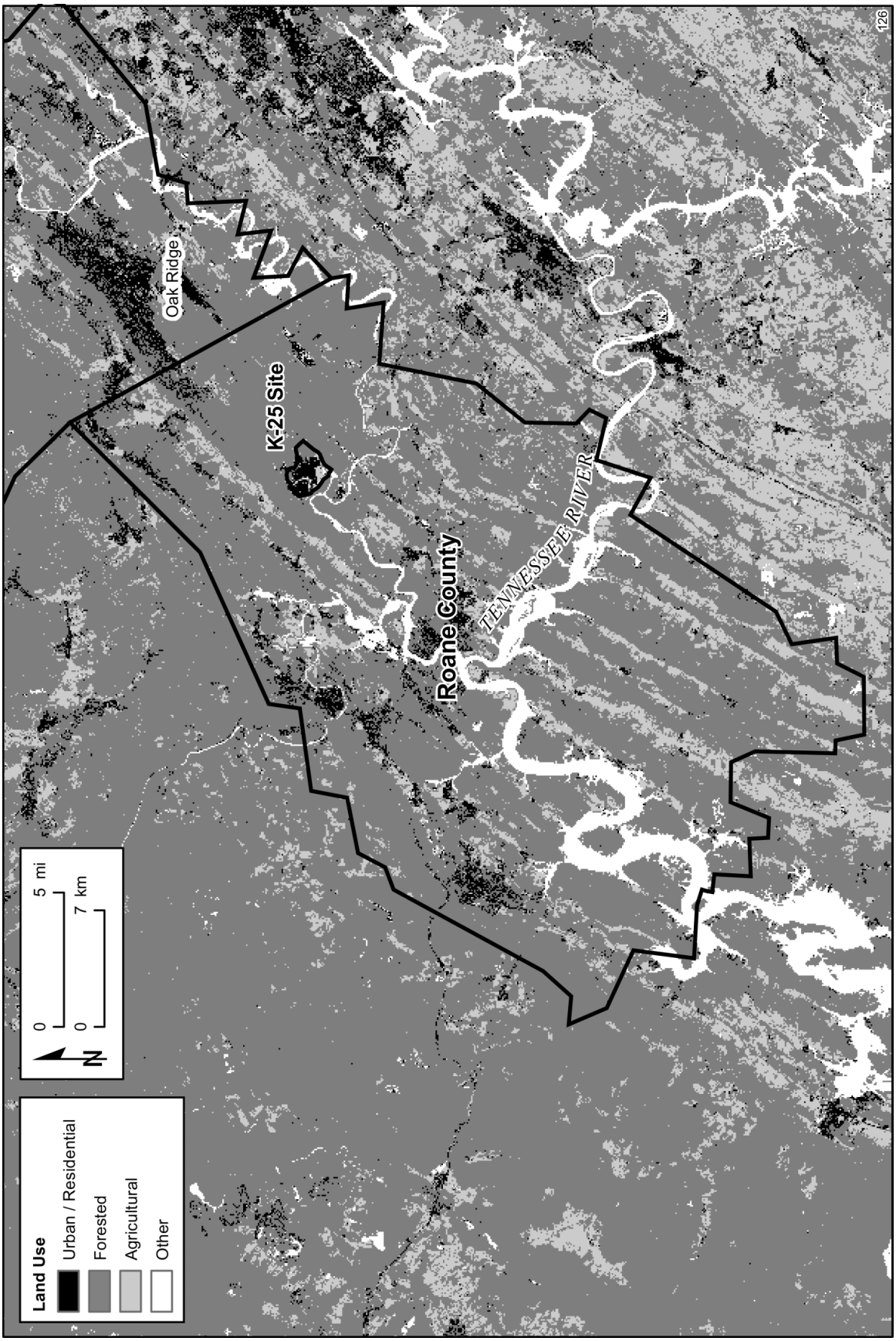

FIGURE 3.2-5 Land Cover in Roane County, Tennessee (Data Source: USGS 2002)

(A.D. 900–A.D. 1600). While the ETTP area has not been completely surveyed, six prehistoric sites were identified there. Three of them were determined to be eligible for the NRHP. Five of the six sites lie outside the ETTP security fences. The area within the ETTP security fences underwent massive earthmoving operations during the construction of the gaseous diffusion plant. It is unlikely that unidentified intact archaeological sites remain within the fences (Morris 1998; Souza et al. 2001).

The Overhill Cherokee occupied part of eastern Tennessee from the 1700s until their relocation to Oklahoma in 1838. DOE Oak Ridge Operations has initiated consultations with the Eastern Band of the Cherokee Indians and the Cherokee Nation of Oklahoma regarding Native American issues related to the DUF_6 conversion project at ORR (see Appendix G). No religious or sacred sites, burial sites, or resources significant to the Cherokee have been identified at ETTP to date. However, there are mounds and other prehistoric sites at ORR thought likely to contain prehistoric burials. Similar resources could exist in the unsurveyed portions of the ETTP area (Souza et al. 2001).

Euro-American settlers began entering eastern Tennessee after 1798, and by 1804, settlement of the area that would become ORR in the 20th century had begun. An economy based on subsistence farming and, later, on coal mining developed. A survey of pre-World War II historic structures at ORR was conducted; 254 structures were evaluated, and 41 were recommended as being eligible for the NRHP, in addition to the 6 that were already listed (DuVall and Souza 1996). Two historic archaeological districts were proposed. Of these, the Wheat Community Historic District lies within the ETTP area. It includes 28 contributing structures; one (the George Jones Memorial Church) is already listed on the NRHP. The ETTP site also includes six historic cemeteries (Morris 1998; Souza et al. 2001).

In 1942, the U.S. Army began to acquire land in eastern Tennessee for the Manhattan Project's "Site X." Renamed the Clinton Engineer Works in 1943, the new facility included a gaseous diffusion plant at the K-25 Site. The K-25 Site played a significant role in the production of highly enriched uranium for weapons manufacture between 1944 and 1964, materially contributing to the development of nuclear weapons during World War II and the Cold War. The K-25 site forms the heart of ETTP. Buildings at the ETTP site were evaluated for their historical significance in 1994. One historic district, the Main Plant Historic District, is eligible for the NRHP. The district consists of 157 buildings, 120 of which contribute to the district (37 do not). Eleven additional buildings not adjacent to the district are also considered eligible by virtue of their supporting roles in the uranium-235 enrichment process (DuVall and Souza 1996; Holcombe-Burdette 1998; Souza et al. 2001).

3.2.12 Environmental Justice

3.2.12.1 Minority Populations

This EIS uses data from the most recent decennial census in 2000 to evaluate environmental justice implications of the proposed action and all alternatives with respect to

minority populations. The CEQ guidelines on environmental justice recommend that "minority" be defined as members of American Indian or Alaska Native, Asian or Pacific Islander, Black non-Hispanic, and Hispanic populations (CEQ 1997). The earliest release of 2000 census data that included information necessary to identify minority populations identified individuals both according to race and Hispanic origin (U.S. Bureau of the Census 2001). It also identified individuals claiming multiple racial identities (up to six races). To remain consistent with the CEQ guidelines, the term "minority population" in this document refers to persons who identified themselves as partially or totally Black (including Black or Negro, African American, Afro-American, Black Puerto Rican, Jamaican, Nigerian, West Indian, or Haitian), American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, or "Other Race." The minority category also includes White individuals of Hispanic origin, although the latter is technically an ethnic category. To avoid double counting, tabulations included only White Hispanics; the above racial groups already account for non-White Hispanics. In sum, then, the minority population considered under environmental justice consisted of all non-White persons (including those of multiple racial affiliations) plus White persons of Hispanic origin.

To identify census tracts with disproportionately high minority populations, this EIS uses the percentage of minorities in each state containing a given tract as the reference point. Using the individual states to identify disproportionality acknowledges that minority distributions in the state can differ from those found in the nation as a whole. In 2000, of the 240 census tracts within 50 mi (80 km) of the storage facility at ETTP, 19 had minority populations in excess of state-specified thresholds — a total of 24,235 minority persons in all (Figure 3.2-6). In 2000, 5.2% of the Roane County population was minority (U.S. Bureau of the Census 2002e).

3.2.12.2 Low-Income Populations

As recommended by the CEQ guidelines, the environmental justice analysis identifies low-income populations as those falling below the statistical poverty level identified annually by the U.S. Bureau of the Census in its Series P-60 documents on income and poverty. The Census Bureau defines poverty levels on the basis of a statistical threshold that considers for each family both overall family size and the number of related children younger than 18 years old. For example, in 1999, the poverty threshold annual income for a family of three with one related child younger than 18 was $13,410, while the poverty threshold for a family of five with one related child younger than 18 was $21,024 (U.S. Bureau of the Census 2000). The 2000 census used 1999 thresholds because 1999 was the most recent year for which annual income data were available when the census was conducted. If a family fell below the poverty line for its particular composition, the census considered all individuals in that family to be below the poverty line.

To identify census tracts with disproportionately high low-income populations, this EIS uses the percentage of low-income persons in each state containing a given tract as a reference point. In 1999, of the 240 census tracts within 50 mi (80 km) of the storage facility at ETTP, 128 had low-income populations in excess of state-specified thresholds — a total of 157,843 low-income persons in all (Figure 3.2-7). In 1999, in Roane County, 13.9% of those individuals for whom poverty status was known were low-income (U.S. Bureau of the Census 2002e).

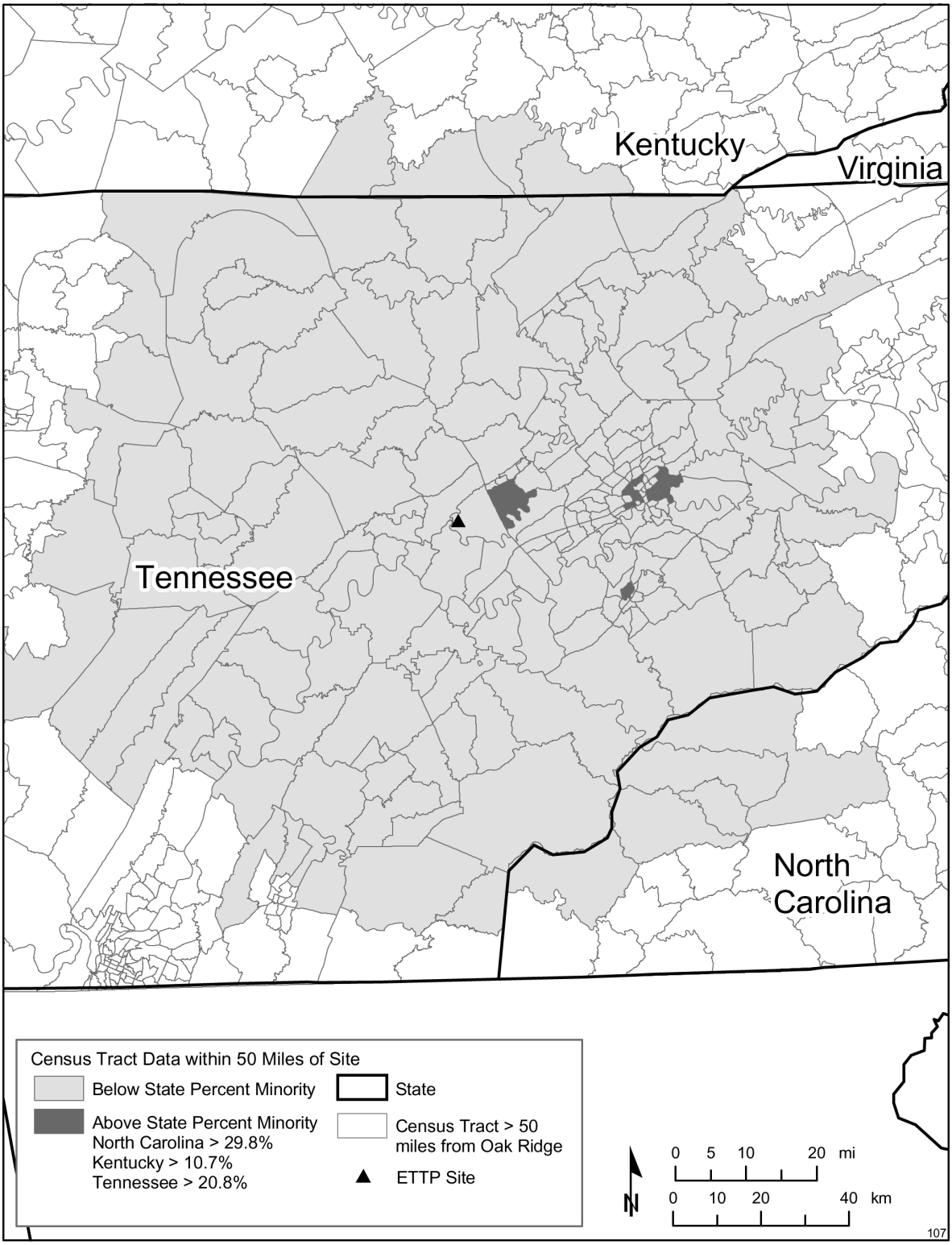

FIGURE 3.2-6 Census Tracts within 50 mi (80 km) of the Storage Facility at ETTP with Minority Populations in Excess of State-Specific Thresholds (Source: Based on data from U.S. Bureau of the Census 2002e)

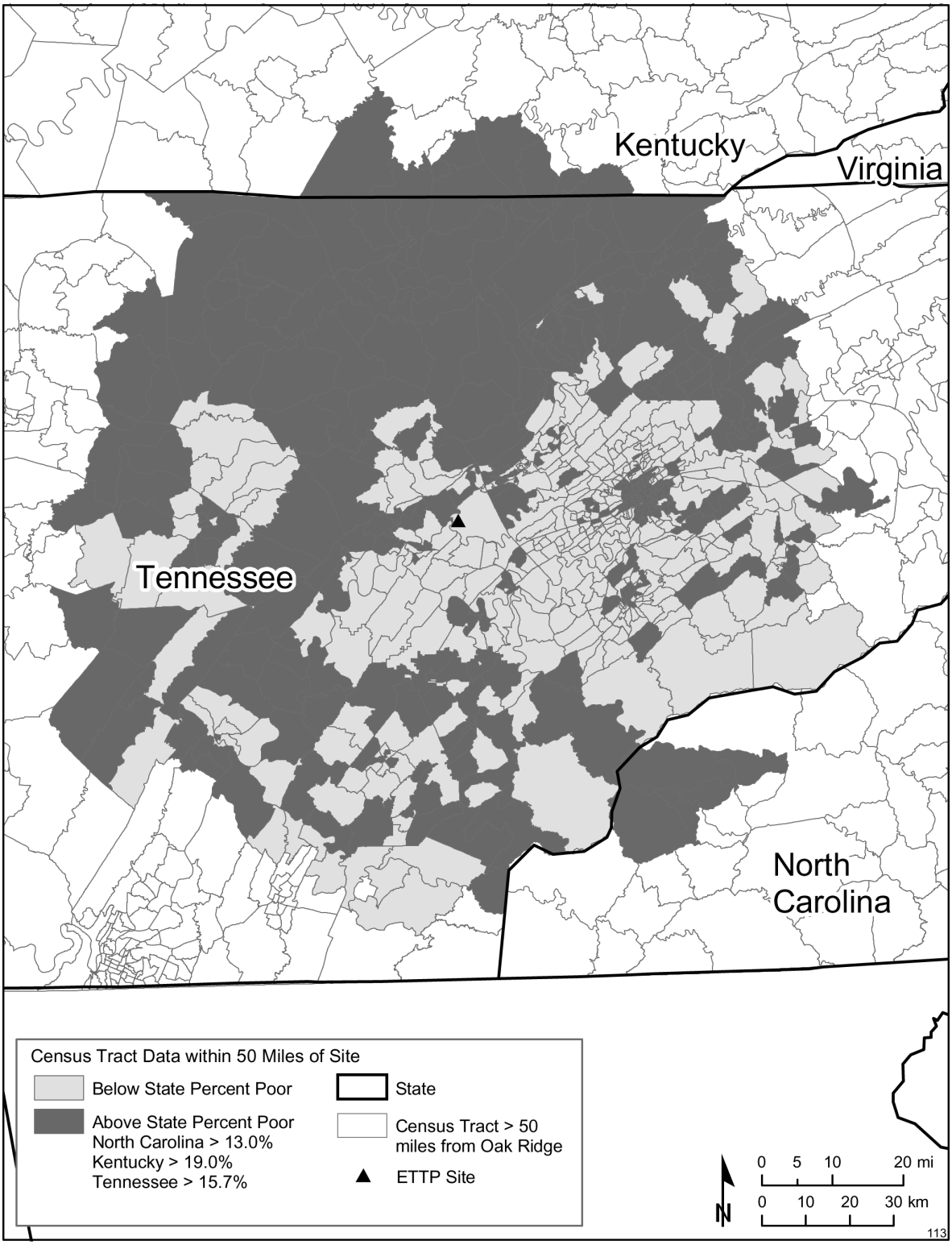

FIGURE 3.2-7 Census Tracts within 50 mi (80 km) of the Storage Facility at ETTP with Low-Income Populations in Excess of State-Specific Thresholds (Source: Based on data from U.S. Bureau of the Census 2002e)