CHAPTER 4: AFFECTED ENVIRONMENT

The descriptions of the affected environment provide a basis for understanding the direct, indirect, and cumulative effects of the Y-12 proposed actions and alternatives. The scope of the discussion varies by resource to ensure that all relevant issues are included.

For land resources, geology and soils, biological resources, and cultural and paleontological resources, discussions of the Y-12 Site and ORR are included along with descriptions of the potential areas within the Y-12 Site that could be affected by the Y-12 SWEIS alternatives. This information provides a basis for understanding both direct effects and the overall resource base that could be affected by ancillary activities that may be defined in later stages of the Y-12 SIM Program (LMES 1999c).

Ambient conditions are described for air/noise and water resources. Discussions focus on air/noise conditions at the ORR and Y-12 Site boundary and the surface water bodies and groundwater aquifers that could be affected. This information serves as a basis for analyzing important air/noise and water quality parameters to obtain results that can be compared to regulatory standards.

Socioeconomic conditions are described for the counties and communities that could be affected by regional population changes associated with the Y-12 SWEIS proposed actions. The affected environment discussions include projections of regional growth and related socioeconomic indicators. The described region is large enough to account for growth related to direct project employment as well as secondary jobs that may be created by the proposed actions.

In addition to those natural and human environmental resources discussed above, the affected environment sections include a number of issues related to ongoing DOE activities at ORR and Y-12. These issues involve facility operations and site support infrastructure, intersite transportation of nuclear materials, waste management, and radiological and hazardous chemicals impacts during normal operation and from accidents. Where reasonably foreseeable changes to any of these factors can be predicted, they are discussed.

4.1 LAND USE

4.1.1 Land-Use Designations

Oak Ridge Reservation. The ORR consists of 13,943 ha (34,513 acres) and is located mostly within the corporate limits of the city of Oak Ridge, approximately 24 km (15 mi) west of the city of Knoxville. Approximately one-third of ORR is occupied by the facilities of Y-12, ORNL, and ETTP. All of this land is titled to the United States of America and under the jurisdictional control of DOE for administration and management. Figure 4.1.1–1 shows the location of ORR.

Ownership of ORR. Originally, the Federal Government acquired 23,664 ha (58,575 acres) of land between 1942 and 1947. However, 9,721 ha (24,062 acres) were transferred over the years with 25 percent (almost 2,408 ha [5,960 acres]) going to the city of Oak Ridge for developmental purposes. The transferred land included 109 ha (270 acres) for schools; 438 ha (1,083 acres) for utilities, drainage, and roads and streets; 596 ha (1,475 acres) for municipal properties; and 12 ha (29 acres) for public housing. Most of the remaining land tracts were conveyed to the State of Tennessee for health, forestry, agricultural research, and a biomedical graduate school (935 ha [2,315 acres]), private ownership (5,125 ha [12,686 acres]), and the Tennessee Valley Authority (TVA) (1,209 ha [2,992 acres]). Anderson County (11 ha [28 acres]), the town of Oliver Springs (4 ha [9 acres]), and Federal agencies (25 ha [63 acres]) also received land tracts (LMER 1999a, Hartman 1999). Land conveyed for private entities and homeowners totals 5,136 ha (12,692 acres). The reservation's boundaries, both past and present, are shown in Figure 4.1.1–2.

Source: DOE 1996e.

FIGURE 4.1.1–1.—*Oak Ridge Reservation, Tennessee, and Region.*

Source LMER1999a.

FIGURE 4.1.1–2.—*Original U.S. Department of Energy Land Purchase and Current Reservation Boundaries*.

As a result of a decision by the Secretary of Energy in 1979 allowing DOE to make financial assistance payments to the city of Oak Ridge for a 5-year period under the *Atomic Energy Community Act* of 1955, the city submitted a self-sufficiency plan which proposed that DOE sell land to the city for industrial/commercial development. This allowed direct transfer of excess land to the city at fair market price rather than turning it over to the General Services Administration for disposal. The self-sufficiency program ended; however, those parcels that were under review at the time were "grandfathered," thus permitting DOE to still consider transfer of land to the city of Oak Ridge should it become excess to the needs of DOE (LMER 1999a).

Current Land Use at ORR. DOE classifies land use on the ORR according to five categories: Institutional/Research, Industrial, Mixed Industrial, Institutional/Environmental Laboratory, and Mixed Research/Future Initiatives (LMER 1999b). Development on the ORR accounts for about 35 percent of the total acreage leaving approximately 65 percent of the Reservation undeveloped (DOE 1999b).

Land bordering ORR is predominantly rural, with agricultural and forest land dominating. The city of Oak Ridge has residential areas primarily along the northern and eastern boundaries. There are four residential areas along the northern boundary that have several houses within approximately 30 m (98 ft) of the ORR boundary. There are a few residences within Roane County that border the ORR to the west. The Clinch River, which confines the ORR to the south and southeast, forms a boundary between Knox County, Loudon County, and portions of Roane County.

Remote sensing data from 1994 showed 70 percent of the ORR in forest cover while 20 percent was transitional, consisting of old fields, agricultural areas, cutover forest lands, roadsides, and utility corridors (LMER 1999a). Less than 2 percent of ORR remains as open agricultural fields. Currently 234 ha (580 acres) of wetlands on the ORR provide water quality benefits, storm water control, wildlife and rare species habitats, and landscape and biological diversity. About 1,414 ha (3,500 acres) are used as waste sites or are remediation areas (LMER 1999a).

Most of the ORR is designated a Tennessee Wildlife Management Area through a cooperative agreement between DOE and the Tennessee Wildlife Resources Agency (TWRA). The agreement provides protection of wildlife habitat and species as well as restoration of other wildlife habitat and species. Wildlife management is carried out under these agreements by TWRA in cooperation with ORNL's Environmental Sciences Division.

In 1980, DOE established the Oak Ridge National Environmental Research Park (NERP) which includes approximately 8,000 ha (20,000 acres) of ORR (LMER 1998b). The Research Park is an ORNL user facility which serves as an outdoor laboratory for the study of present and future impacts on the environment stemming from the various missions at ORR. Major environmental field research areas within the Research Park include (LMER 1999a):

- Walker Branch Watershed
- Free-Air CO_2 Enrichment Facility
- Global Change Field Research Facility
- Bear Creek Valley Hydrology Field Sites
- Melton Branch Watershed Field Sites
- National Oceanic and Atmospheric Administration Field Research Facility
- Natural and Accelerated Bioremediation Field Research Center

In 1986, seven State Natural Areas were registered on the ORR through an agreement between DOE and TDEC (LMER 1999a). Qualification for this designation requires meeting specific criteria which may include existence of rare plant species, animal species, or community types on the premises. Figure 4.1.1–3 shows the research and forested areas within the ORR.

Source: LMER 1999a.

FIGURE 4.1.1–3.—*Research Areas and Forested Areas.*

On June 23, 1999, Secretary of Energy Bill Richardson set aside 1,214 ha (3,000 acres) of ORR as a conservation and wildlife management area, in an agreement between DOE and TWRA. The proclamation calls for the land to be cooperatively managed for preservation purposes under a use permit. This area, called the Three Bend Scenic and Wildlife Management Refuge Area, is located in the ORR buffer zone on Freels, Gallaher, and Solway bends on the north shore of Melton Hill Lake in Anderson County. TWRA, in consultation with DOE, will prepare a cooperative agreement to serve as a natural resources management plan to establish guidelines for managing this area in the hopes to preserve and enhance its natural attributes.

Two major firearms ranges, along with their surface danger zones or buffer areas, encompass approximately 1,010 ha (2,500 acres) on ORR. The range areas, which are located at the south side of Bear Creek Road about 8 km (5 mi) west of Y-12, extend from the DOE ORR boundary on the west to Highway 95 on the east and from Bear Creek Road on the north to the Clinch River on the south. The eastern portion of the site is operated by DOE's Transportation Safeguards Division Southeastern Courier Section and consists of four individual live-fire ranges and associated support facilities. The western portion of the range site, formerly operated by LMES, is now operated for DOE by Wackenhut Services International (effective January 10, 2000) as a Central Training Facility and consists of an indoor range, five outdoor ranges, a shooting tower, three live-fire facilities, and assorted tactical facilities.

Federal statutes require each state, tribal, or local government to protect its citizens from releases of hazardous materials (40 CFR 301, 302, 304, and 355). Emergency planning zones spanning 8 km (5 mi) are defined around ORNL, ETTP, and Y-12. Each zone is then subdivided into emergency planning sectors, with each defined by easily recognizable terrain features (LMER 1999a).

Under an agreement with DOE and the State of Tennessee, the city of Oak Ridge transports municipal biosolids to approved sites on ORR and applies the material as a soil conditioner and fertilizer. The city of Oak Ridge has been applying biosolids at selected sites on ORR since 1983. Municipal biosolids are not considered RCRA waste but are regulated by EPA under 40 CFR 503 of the *Clean Water Act* regarding disposal, including risk-based, metal-loading criteria for the receiving soil. Since the application process is occurring on Federally owned land, DOE provides oversight of the process. However, daily operations, including permitting, disposal, sampling, and monitoring at each site, are the responsibility of the city of Oak Ridge. The application program currently utilizes a total of 65 ha (160 acres); approximately 20 ha (50 acres) have been closed due to self-imposed solids loading limits rather than exceeding metal or radionuclide limits (Bechtel Jacobs 1999). Table 4.1.1–1 shows all previously identified and approved sites on ORR along with the status of each.

Although ORR is not open to the public, opportunities for public use of numerous facilities and land areas do exist. The following are examples of land/facilities open to public use (LMER 1999a):

- New Bethel Church Interpretive Center (historical site)
- Walks and tours including Community Day, which allows public access to ORNL facilities and land areas such as Freels Bend/Solway Bend (bird-watching, wildflower walks, etc.)
- Ecological and Physical Sciences Study Center
- ORNL Graphite Reactor (National Historic Landmark)
- Clark Center Park (or Clark Center Recreation Area)
- George Jones Memorial Church
- ETTP Visitors Overlook and Y-12 Visitors Center

TABLE 4.1.1–1.—*Biosolids Application Sites*[a]

Site Name	Site No.	Total Acres On-site	Tons Allowed per Year	Total Tons[b] Life of Site	Total Tons to Date	Remaining Capacity in Tons	Years Remaining On-site
McCoy	1	20	Closed	Closed	Closed	Closed	Closed
Pine Plantation	2	20	Closed	Closed	Closed	Closed	Closed
High Pasture	2	25	94	1,250	483	767	8.2
Rogers	2	30	142	1,500	765	735	5.2
Scarboro	3	45	167	2,250	960	1,290	7.7
Upper Hayfield #1	3	25	93	1,250	540	710	7.6
Upper Hayfield #2	3	20	69	1,000	505	495	7.7
Future Site	4	N/A	N/A	N/A	N/A	N/A	N/A
Future Site	5	N/A	N/A	N/A	N/A	N/A	N/A
Future Site	6	N/A	N/A	N/A	N/A	N/A	N/A
Future Site	7	N/A	N/A	N/A	N/A	N/A	N/A
Site #8	8	12	Closed	Closed	Closed	Closed	Closed
Watson Road	9	60	134	3,000	929	2,071	15.4
Future Site	10	N/A	N/A	N/A	N/A	N/A	N/A
Cottonwoods	11	17	Closed	Closed	Closed	Closed	Closed
Future Site	12	N/A	N/A	N/A	N/A	N/A	N/A
Future Site	13	N/A	N/A	N/A	N/A	N/A	N/A
Future Site	14A	N/A	N/A	N/A	N/A	N/A	N/A
Future Site	14B	N/A	N/A	N/A	N/A	N/A	N/A
				Active Site Total Tonnage to Date: **4,182**			

[a] Information is based on COR *Sludge Application Site Monitoring Report in Appendix I.*
[b] Calculations are based on a maximum of 50 tons (dry wt) applied x the number of acres on the site.
Source: Bechtel Jacobs 1999.

Source: LMER 1999a.

FIGURE 4.1.1–4.—*Public, Educational, and Recreational Opportunities.*

DOE has also granted a license for TWRA to sponsor and manage hunting on the ORR. Figure 4.1.1–4 shows the locations of some of the public, educational, and recreational opportunities on ORR.

4.1.2 Future Land Use and Leasing Agreements

Future land use of ORR will continue to incorporate the principles associated with ecosystem management. For the most part, these land uses will expand and build on current uses, not replace them. New future land uses include research facilities, environmental research and partnership areas, waste management facilities, future initiatives, transportation improvements, education and recreation, and land transfers and lease areas (LMER 1999a).

Future research facilities include:

- *Spallation Neutron Source* (SNS). Location will require approximately 45 ha (110 acres) which will encompass a new linear accelerator facility, user facilities, central utility building, support laboratories and shops, and a central office building as well as a 132,500-L (35,000-gal) fire water reservoir, electric service switchyard, and storm water retention pond required to service the facility. As a result of the *Final Environmental Impact Statement for the Construction and Operation of the Spallation Neutron Source*, a ROD was issued for construction and operation where ORR, more specifically Chestnut Ridge, was selected as the site. Funding has been approved and construction is underway.

- *Joint Institute for Neutron Sciences*. Joint venture with the University of Tennessee, the State of Tennessee (the institute providing funding for the facility), and DOE for a user facility which will serve both the High Flux Isotope Reactor and the proposed SNS. The site will be integrated into the SNS campus. Funding has been approved and construction is underway.

- *Laboratory for Comparative and Functional Genomics*. Facility to house 50,000 mice in support of ORNL's mouse genetics mutagenesis. The laboratory will be adjacent to Life Sciences Division Building 1062 at the west end of ORR. The facility is currently in the President's budget for FY2001.

- *Oak Ridge Institute for Sciences and Education*. Future development and expansion for the Institute at Scarboro Operations Site, currently covering approximately 100 ha (247 acres).

- *ORNL Expansion*. Bethel Valley areas east and west of the central ORNL site are identified for future R&D use to include support and service facilities and will cover a total of 283 ha (700 acres).

- *Engineering Technology Complex*. Planned for the main Bethel Valley campus; more specifically, a parking lot between the 4000 and 6000 areas. This is planned to be a privately funded, leased facility to be constructed in the 2001-2002 time frame.

- *Fusion Materials Irradiation Facility*. Proposed to house a linear accelerator, a supply system for lithium targets, and an experimental complex for irradiation and handling test specimen assemblies. It will be used to address the technological problems associated with the development of fusion reactor materials. This project is still in the early planning stages without funding as of yet. However, plans to relocate the Fusion Energy Division to the 7600 area in the next 3-4 years will open up construction of a GPP funded office building in the 7600 area and modifications/additions to other facilities for preparation of relocation.

Source: LMER 1999a.

FIGURE 4.1.2–1.—*New Future Use at Oak Ridge Reservation.*

- *Melton Valley R&D Facilities (Ramsey Drive Site).* Approximately 16 ha (39 acres) adjoining the proposed Fusion Materials Irradiation Facility have been identified for future use. Specific facility designations are not yet determined (LMER 1999a).

New field research areas, in addition to that previously mentioned within the Research Park, include Bull Bluff Watersheds, watershed manipulation experiments; Copper Ridge Research Area, forest nutrient dynamics; Freels Bend Research Area, agricultural research; Raccoon Creek Research Area, global change research; White Wing Research Area, biodiversity, global change, and fundamental ecological process research; Pine Ridge Experimental Catchments, expansion to Walker Branch Watershed research; Unexploded Ordnance Research and Demonstration Area, testing and validation methodology of locating unexploded ordnance (LMER 1999a).

Proposed waste management facilities including the Environmental Management Waste Management Facility at East Bear Creek and the Transuranic Waste Packaging Facility at ORNL and are in various stages of planning (LMER 1999a).

The following proposed transportation improvements have been identified by the Tennessee Department of Transportation (DOT): I-75/I-40 connector, Highway 58 widening, and Bethel Valley Road/Illinois Avenue interchange (LMER 1999a). Figure 4.1.2–1 shows some of the proposed land uses for the ORR.

Also, the following are areas that have been identified by DOE that have recently been, or will soon be, leased or re-leased (LMER 1999b):

Public Areas:

- 3.5 ha (8.5-acre) parcel of Federal land near Wisconsin Avenue in Oak Ridge to the city of Oak Ridge for a park

Industrial Development:

- Parcel ED-1, located near the former K-25 Site (Horizon Center),was leased in April of 1998 to the Community Reuse Organization of East Tennessee, a private sector organization established by DOE to lease underutilized facilities on ORR, for industrial development. The parcel is now known as the Horizon Center.

- Parcel ED-2, 6 ha (15 acres) leased to the Community Reuse Organization of East Tennessee in September of 1997

- 40 ha (100 acres) of Parcel 8, pending

- Tower Shielding Facility (10.5 ha [26 acres] leased in 1998 to BioNeutrics, Inc.)

- Boeing Property. Oak Ridge Properties is interested in purchasing approximately 492 ha (1,216 acres) from the Boeing Company at the former K-25 Site (Horizon Center) and has proposed a mixed-use development plan which would include approximately 1,500 residential units including houses, apartments/condominiums, about 187 ha (450 acres) of industrial zoned property, and a shopping area (*Oak Ridge* 12/10/99, 12/17/99, and 01/04/00). The Boeing Property was rezoned from industrial to mixed-use in February 2000. The Oak Ridge Land Company is also pursuing the acquisition of a 74-ha (182-acre) floodplain strip abutting the Boeing Property for use a s a buffer zone and green space. DOE controls the floodplain strip and is currently preparing an EA on the transfer of the property to the abutting landowner.

- DOE is considering leasing Parcel ED-3, an 187-ha (450-acre) piece of land located south of the former K-25 Site, to be developed for mixed use purposes. A buffer zone of approximately 615 ha (1,520 acres) would surround the site. The land would be transferred to the Community Reuse Organization of East Tennessee and leased to private companies. Currently, DOE is preparing an EA to evaluate the impacts of this action.

Mobile Service Antenna Sites:

- Commercial service antennas proposed for three appropriate sites at ORR (attachment to existing structures when possible). BellSouth has erected a tower in the ETTP area while SprintCom has requested use of the Chestnut Ridge site (LMER 1999a).

Y-12. The Y-12 Area of Responsibility on the ORR covers a total of 2,197 ha (5,428 acres). The main area of Y-12 is largely developed and encompasses 328 ha (811 acres), with 255 ha (630 acres) fenced, (4 km [3 mi] long and 2 km [1 mi] wide), with approximately 580 buildings that house about 1 million m^2 (7.6 million ft^2) of laboratory, machining, dismantlement, and R&D areas (LMER 1999b). For the purposes of this SWEIS, the boundary of analysis includes a total of approximately 1,472 ha (3,638 acres). As a result of the site's defense support, manufacturing, and storage facilities, the land in the Y-12 area is classified in DOE's industrial category.

The Research Park surrounds the Y-12 SWEIS area. Areas outside the main plant site but within its area of responsibility are used primarily for a buffer area as well as for environmental restoration and waste management activities. There are limited forested areas within the Y-12 boundary. There are no wetlands located within the Y-12 fenced boundaries. Land outside the SWEIS area includes buffer for the Walker Branch watershed long-term research area and other environmental research sites.

There are a number of active waste management facilities within the Y-12 SWEIS area of analysis. These include the following:

- Disposal Area Remedial Action (liquid storage) facility. Collection of contaminated groundwater as a result of cleanup efforts in Bear Creek Valley

- Above-Ground Low-Level Waste Storage Facility

- Industrial Landfill V. Nonhazardous, nonradioactive industrial solid waste

- Construction/Demolition Landfill VI. Construction and demolition debris

- Construction/Demolition Landfill VII. Additional storage of construction and demolition debris (SPAS 1988)

These areas are discussed in detail in Appendix A.5, Waste Management Activities.

Source: LMER 1999a.

FIGURE 4.1.2–2.—*Watershed Areas on Oak Ridge Reservation.*

The environmental restoration Y-12 Project includes two areas that are located within the Y-12 SWEIS physical study area of analysis: the Bear Creek and UEFPC watersheds. The boundaries of the Bear Creek watershed extend west from a topographic high near the west end of the plant to the point where Bear Creek exits the valley near Highway 95. Release points within the Y-12 SWEIS area of analysis include the (former) S-3 Pond Site, Sanitary Landfill I, Boneyard/Burnyard, the Oil Landfarm, the Bear Creek Burial Grounds, and the Rust Spoil Area. These units were used in the past as the primary area for disposal of various types of hazardous and nonhazardous wastes generated at Y-12. The UEFPC watershed is bounded by the base of Pine Ridge to the north and by Chestnut Ridge to the south and extends westward, abutting the Bear Creek watershed, and eastward to the DOE property line (LMER 1999a). These watersheds are shown in Figure 4.1.2–2.

Some sludge land farming activity is conducted to the south of the Y-12 Plant. Figures 4.1.2–3 and 4.1.2–4 present the locations of the sludge land farming sites and environmental restoration activities, respectively.

The ORR End Use Working Group has recommended the following land use for Y-12: "the western area of the Y-12 Plant is expected to remain controlled industrial property. As opportunity arises, national security activities should be concentrated in the western area to allow for the broadest possible use of the rest of the plant (PEC 1998)."

Source: Tetra Tech, Inc./SPAS 1998.

FIGURE 4.1.2–3.—*Sludge Land Application Sites.*

Source: Tetra Tech Inc./SPAS 1998.

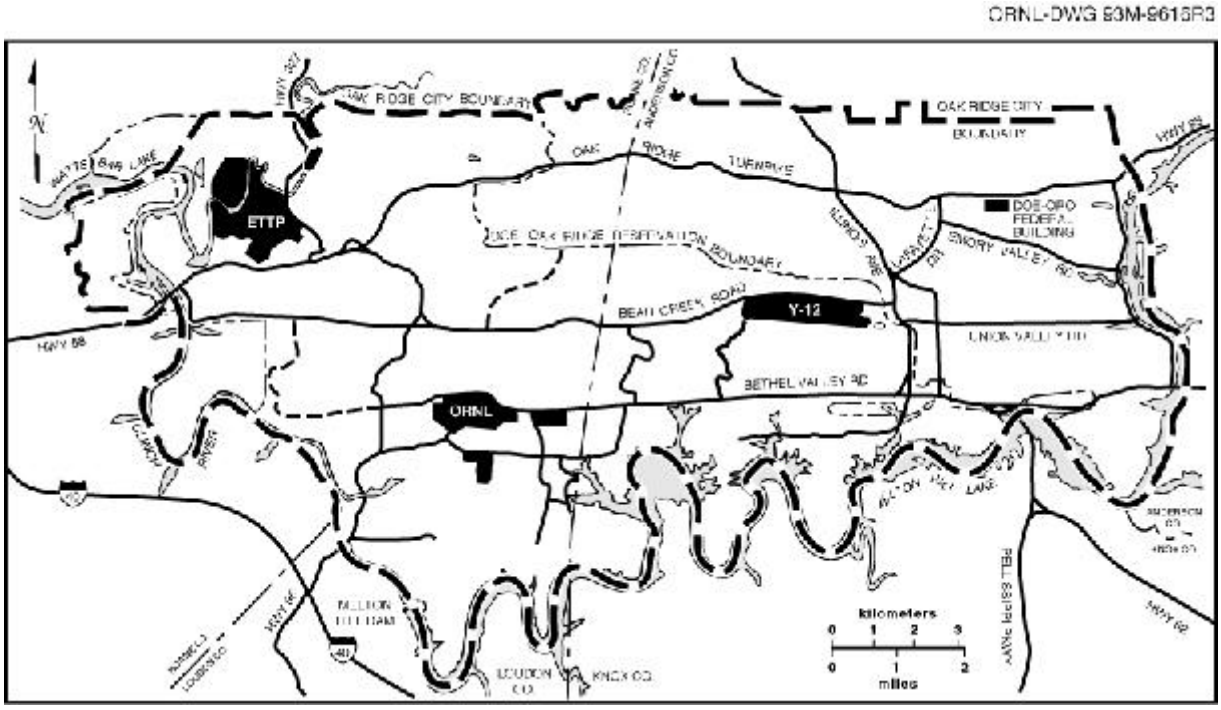
FIGURE 4.1.2–4.—*Active Waste Management Facilities and Environmental Restoration Projects.*

4.2 TRANSPORTATION

4.2.1 On-site Traffic

Primary roads on the ORR serving Y-12 include Tennessee State Routes (TSRs) 95, 58, 62, and 170 (Bethel Valley Road), and Bear Creek Road. Except for Bear Creek Road, all are public roads. Figure 4.2.1–1 schematically presents the on-site routes on the ORR serving the Y-12 Site.

Existing traffic on these on-site roads is presented in Table 4.2.1–1 along with designation of Level of Service (LOS).



Source: DOE 1999k.

FIGURE 4.2.1–1.—*Road Network at Y-12 Site.*

4.2.2 Off-site Traffic

Y-12 is located within 80 km (50 mi) of three interstate highways: I-40, I-75, and I-81. Interstate 40, an east-west highway, extends from North Carolina to California. Interstate 75 is a north-south highway extending from Michigan to Florida. Interstate 81 is a north-south interstate extending from New York to Tennessee. Interstate 81 connects with I-40 east of Knoxville while I-40 and I-75 connect west of Knoxville near the city of Oak Ridge. In addition, TSR 61, TSR 162, and U.S. 25W at Clinton also serve Y-12 transportation needs off-site.

4.2.3 Transportation of Materials and Waste

Various chemicals and other materials being used for Y-12 operations are transported by truck using the above-addressed roads (TSRs 58, 62, 95, and 170; I-40, I-75, and I-81). LLW, hazardous waste, and municipaland solid wastes are being generated by Y-12 operations. LLW is being stored on-site in temporary storage facilities and would eventually be disposed off-site at a DOE Site. A detailed description of Y-12 waste treatment and storage capabilities can be reviewed in Appendix A.5.

4.2.4 Other Transportation

Rail transport is available to Y-12 but is not currently being used.

TABLE 4.2.1–1.—*Existing Average Daily Traffic Flows (Vehicles per Day) on Oak Ridge Reservation Serving Y-12*

Road	To	From	Average Daily Traffic Vehicles/Day	Level of Service[a]
TSR 58	TSR 95	I-40	11,600	B
TSR 95	TSR 62	TSR 58	16,440	D
TSR 95	TSR 58	I-40	8,058	A
TSR 62	TSR 95	TSR	28,320	E
East Bear Creek Rd.	Eastbound	-	12,490	C
West Bear Creek Rd.	Westbound	-	3,200	A
East Bethel Valley Rd.	Eastbound	-	10,000	C
West Bethel Valley Rd.	Westbound	-	6,440	A

[a] LOS designations: A(Free Flow); B (Free Flow with maneuverability slightly impeded); C (Stable Flow maneuverability noticeably restricted); D (Stable Flow, reduced speed, maneuverability limited); E (Near capacity, speeds are low but relatively uniform).
Source: TDOT 1998.

4.3 SOCIOECONOMICS

This section describes current socioeconomic conditions within a region of influence (ROI) where more than 90 percent of the ORR workforce resides. The ROI is a four-county area in Tennessee comprised of Anderson, Knox, Loudon, and Roane Counties. Figure 4.3–1 shows the surrounding counties influenced by ORR. In 1997, almost 40 percent of the ORR workforce resided in Knox County, 29 percent in Anderson County, 16 percent in Roane County, and 6 percent in Loudon County. The remaining 9 percent of the workforce resides in other counties across Tennessee, none of which are home to more than 3 percent of the workforce (DOE 1999f).

TABLE 4.3.1–1.—*Employment by Sector (%)*

Sector	1980	1990	1998
Services	19.1	27.5[a]	30.2[a]
Wholesale and Retail	21.1	25.3[a]	24.7[a]
Government (including Federal, State, local, and military)	20.3	15.6	13.7
Manufacturing	21.9	15.9	13.0
Farm	2.0	1.6	1.2
Construction	4.9	5.4	6.1
Finance, Insurance, and Real Estate	6.0	5.2	6.5
Transportation and Public Utilities	3.7	4.0	4.5
Agricultural Service, Forestry, and Other	0.3	0.6	0.9
Mining	0.7	0.4	0.2

[a] Percentage only includes Knox and Loudon Counties. Data for Roane and Anderson Counties not available.
Source: BEA 1999.

4.3.1 Employment and Income

The ORR ROI has historically been dependent on manufacturing and government employment. More recent trends show growth in the service and wholesale and retail trade sectors and a decline in manufacturing and government employment. Table 4.3.1–1 presents current and historical employment for the major sectors of the ROI economy.

The ROI labor force grew by almost 15 percent in the first half of this decade from 243,209 in 1990 to 279,275 in 1995. There was a slight decline in the labor force between 1995 and 1998 when it totaled 278,866. ROI employment grew from 231,822 in 1990 to 268,748 in 1995 and continued to grow despite the decline in the labor force and totaled 269,466 in 1998 (BLS 1999).

The ROI unemployment rate was 3.4 percent in 1998, the lowest level in over a decade, as shown in Table 4.3.1–2. Unemployment rates within the ROI ranged from a low of 3.1 percent in Knox County to a high of 5 percent in Roane County. The unemployment rate in Tennessee was 4.2 percent in 1998 (BLS 1999).

Source: LMER 1999a.

FIGURE 4.3–1.—*Location of Oak Ridge Reservation and Surrounding Counties.*

Per capita income in the ROI was $23,520 in 1997, a 35 percent increase from the 1990 level of $17,407. Per capita income in 1997 in the ROI ranged from a low of $19,564 in Roane County to a high of $24,688 in Knox County. The per capita income in Tennessee was $22,699 in 1997 (BEA 1999).

TABLE 4.3.1–2.—*Region of Influence Unemployment Rates (%)*

County	1990	1991	1992	1993	1994	1995	1996	1997	1998
Anderson	4.8	5.1	5.4	4.9	3.9	3.9	4.8	5.5	3.6
Knox	4.1	4.5	4.5	3.9	3.3	3.4	3.4	3.6	3.1
Loudon	5.7	7.0	5.6	4.6	3.9	4.0	3.9	4.6	3.2
Roane	8.3	8.2	8.5	5.7	4.4	5.8	5.3	7.3	5.0
ROI Total	4.7	5.0	5.0	4.3	3.6	3.6	3.6	4.3	3.4
Tennessee	5.3	6.7	6.4	5.7	4.8	5.2	5.2	5.4	4.2

Source: BLS 1999.

Y-12 employs approximately 8,900 workers, including DOE employees and contractors. DOE has a significant impact on the economy of the ROI and Tennessee. As a whole, DOE employees and contractors number more than 13,700 individuals in Tennessee, primarily in the ROI. These jobs have a higher average salary than the statewide average, $40,000 compared to $25,695 (BEA 1999). DOE employment and spending generate additional benefits to the ROI and state economies through the creation of additional jobs in sectors providing support to DOE and its workers.

4.3.2 Population and Housing

Between 1960 and 1990, population growth in the ROI was slower than population growth in Tennessee as a whole. The ROI population increased at an average annual rate of 1 percent while the state population increased 1.2 percent annually. Between 1990 and 1998, ROI population growth increased 1.1 percent annually while the state population increased 1.4 percent annually. Loudon County experienced the fastest rate of population growth, averaging 3.1 percent annually between 1990 and 1998, while Anderson County population has increased an average of 0.5 percent annually (Census 1995, Census 1999). Population in all counties in the ROI is projected to continue to grow at a somewhat slower rate between 1998 and 2020, as shown in Table 4.3.2–1.

Knox County is the largest county in the ROI with a 1998 population of 366,846. Knox County includes the city of Knoxville, the largest city in the ROI. Loudon County is the smallest county in the ROI with a total population of 39,052. The city of Oak Ridge and the ORR are located in both Anderson and Roane Counties with 1998 populations of 71,116 and 50,026, respectively (Census 1999).

TABLE 4.3.2–1.—*Historic and Projected Population in the Region of Influence*

County	1960	1970	1980	1990	1998	2000	2010	2020
Anderson	60,032	60,300	67,346	68,250	71,116	72,502	76,000	79,275
Knox	250,523	276,293	319,694	335,749	366,846	374,616	404,666	432,866
Loudon	23,757	24,266	28,553	31,255	39,052	39,761	44,941	50,238
Roane	39,133	38,881	48,425	47,227	50,026	50,829	54,433	58,113
ROI	373,445	399,740	464,018	482,481	527,040	537,708	580,040	620,492
Tennessee	3,567,089	3,923,687	4,591,120	4,877,203	5,430,621	5,533,762	6,062,695	6,593,194

Source: Census 1995, Census 1999, BEA 1999.

TABLE 4.3.2–2.—*Region of Influence Housing Characteristics (1990)*

County	Total Number of Housing Units	Number of Owner-Occupied Units	Owner-Occupied Vacancy Rates (percent)	Median Value	Number of Occupied Rental Units	Rental Vacancy Rates (percent)	Median Monthly Contract Rent
Anderson	29,323	19,401	1.1	$55,100	7,983	9.3	$262
Knox	143,582	85,369	1.9	$63,900	48,270	8.4	$272
Loudon	12,995	9,428	1.7	$51,000	2,727	7.2	$190
Roane	20,334	14,102	1.4	$48,700	4,351	9.9	$194
ROI	206,234	128,300	NA	NA	63,331	NA	NA

Note: NA - Not applicable.
Source: Census 1992.

There were a total of 206,234 housing units in the ROI in 1990. A summary of ROI housing characteristics is shown in Table 4.3.2–2. Approximately 67 percent of these units were single family homes, 24 percent were multifamily units, and 8 percent were mobile homes. Approximately 7 percent of the housing units were vacant, although some vacant units were used for seasonal, recreational, or other occasional purposes. Rental vacancy rates ranged from 7.2 percent in Loudon County to 9.9 percent in Roane County while homeowner vacancy rates ranged from 1.1 percent in Anderson County to 1.9 percent in Knox County.

Owner-occupied housing units accounted for 62 percent of the total housing units while renter-occupied units accounted for approximately 31 percent (Census 1992).

In 1990, the median value of owner-occupied housing units ranged from $48,700 in Roane County to $63,900 in Knox County, while the median contract rent ranged from $190 in Loudon County to $272 in Knox County.

4.3.3 Community Services

Community services in the ROI include public schools, law enforcement, and medical services.

Eight public school districts with a total of 144 schools provide educational services for the approximately 78,000 students in the ROI. Higher education opportunities in the ROI include the University of Tennessee as well as several private colleges and two community colleges (HPI 1999a).

Law enforcement is provided by 20 municipal, county, and local police departments that employ over 1,500 officers and civilians. Security at Y-12 was provided by LMES employees until January 10, 2000, when the protective force and selected security work was contracted to Wackenhut Services, Inc. (HPI 199b).

There are 13 hospitals in the ROI with a total of 2,833 beds. These hospitals operate at an average of 67 percent occupancy (AHA 1995). There are 1,525 doctors in the ROI with the majority (1,279) in Knox County (AMA 1996).

4.4 GEOLOGY AND SOILS

4.4.1 Physiography

ORR lies in the Valley and Ridge Physiographic Province of eastern Tennessee. The topography consists of alternating valleys and ridges that have a northeast-southwest trend, with most ORR facilities occupying the valleys. In general, the ridges consist of resistant siltstone, sandstone, and dolomite units, and the valleys, which resulted from stream erosion, consist of the less-resistant shales and shale-rich carbonates (DOE 1991b).

The topography within the ORR ranges from a low of 229 m (750 ft) above mean sea level (MSL) along the Clinch River to a high of 384 m (1,260 ft above) MSL along Pine Ridge. Within the ORR, the topographic relief between the valley floors and ridge crests is generally about 91 to 107 m (300 to 350 ft) (LMER 1999a).

4.4.2 Geology

ORR Geology. Several geologic formations are present in the ORR area. A geologic map and stratigraphic column of the area are shown in Figures 4.4.2–1 and 4.4.2–2, respectively. The Rome Formation, which is present north of Y-12 and forms Pine Ridge, consists of massive to thinly bedded sandstones interbedded with minor amounts of thinly bedded, silty mudstones, shales, and dolomites. In the ORR area, the stratigraphic thickness of the Rome Formation is uncertain because of the displacement caused by the White Oak Mountain Thrust Fault. The Conasauga Group, which underlies Bear Creek Valley, consists primarily of calcareous shales, siltstone, and limestone. The Knox Group, which is present immediately south of Y-12, can be divided into five formations of dolomite and limestone. All five formations have been identified at the ORR. The Knox Group, which underlies Chestnut Ridge, is estimated to be approximately 732 m (2,400 ft) thick. The Knox Group weathers to a thick, orange-red, clay residuum that consists of abundant chert and contains karst features (DOE 1991b).

Carbonate bedrock displaying karst features are dissolutional features occurring in carbonate bedrock. Karst features represent a spectrum ranging from minor solutional enlargement of fractures to conduit flowpaths to caves large enough for a person to walk into. Numerous surface indications of karst development have been identified at ORR (Figure 4.4.2–3). Surface evidence of karst development includes sinking streams (swallets) and overflow swallets, karst springs and overflow springs, accessible caves, and numerous sinkholes of varying size. In general, karst appears most developed in association with the Knox Group carbonate bedrock, as the highest density of sinkholes occurs in this group (LMER 1999a).

ORR Seismology. The Oak Ridge area lies at the boundary between seismic Zones 1 and 2 of the Uniform Building Code, indicating that minor to moderate damage could typically be expected from an earthquake (Table 4.4.2–1). Since the New Madrid earthquakes of 1811 to 1812, at least 26 other earthquakes with a Modified Mercalli intensity, herein referred to as intensity, of III to VI have been felt in the Oak Ridge area, the majority of these having occurred in the Valley and Ridge Province. The Charleston, South Carolina, earthquake of 1886 had an intensity of VI at Oak Ridge, and an earthquake centered in Giles County, Virginia, in 1886 produced an intensity of IV to V at Oak Ridge. One of the closest seismic events to ORR occurred in 1930; its epicenter was 8 km (5 mi) from ORR (DOE 1996e). This earthquake had an estimated intensity of VII at the epicenter and an approximate intensity of V to VI in the Oak Ridge area. Maximum horizontal ground surface accelerations of 0.06 to 0.30 of acceleration due to gravity at ORR are estimated to result from an earthquake that could occur once every 500 to 2,000 years.

Source: Sutton and Field (1995).

FIGURE 4.4.2–1.—*Generalized Geological Map of the Oak Ridge Reservation.*

Source: DOE 1998b.

FIGURE 4.4.2–2.—*Stratigraphic Section in the Vicinity of the Upper East Fork Poplar Creek Characterization Area.*

An earthquake occurred in 1973 in Maryville, TN, 34 km (21 mi) southeast of ORR, and had an estimated intensity of V to VI in the Oak Ridge area (DOE 1996b). In 1987, a significant earthquake occurred approximately 48 km (30 mi) from ORR with an intensity of VI. In addition, since 1995, two earthquakes with an intensity of III and two earthquakes with an intensity of V occurred within 160 km (100 mi) of the ORR (NEIC 1999). In 1998, one earthquake that had an intensity of III occurred approximately 3 km (1.9 mi) from the ORR. There have been 13 earthquakes in the last 155 years that at their epicenter produced an intensity of VI and one of intensity VII within 166 km (100 mi) of ORR (NEIC 1999).

There is no volcanic hazard at ORR. The area has not experienced volcanism within the last 230 million years. Therefore, no present or future volcanic activity is expected (DOE 1996e).

Y-12 Seismology. Y-12 is cut by many inactive faults formed during the late Paleozoic Era (DOE 1996e). There is no evidence of capable faults in the immediate area of Oak Ridge, as defined by 10 CFR 100 (surface movement within the past 35,000 years or movement of a recurring nature within the past 500,000 years). The nearest capable faults are approximately 480 km (300 mi) west of ORR in the New Madrid Fault zone.

Y-12 Geology. Y-12 is located within Bear Creek Valley, which is underlain by Middle to Late Cambrian strata of the Conasauga Group (see Figure 4.4.2–1). The Conasauga Group consists primarily of highly fractured and jointed shale, siltstone, calcareous siltstone, and limestone in the site area. The upper part of the group is mainly limestone, while the lower part consists of mostly shale (LMER 1999a). This group can be divided into six discrete formations, which are, in ascending order, the Pumpkin Valley Shale, the Rutledge Limestone, the Rogersville Shale, the Maryville Limestone, the Nolichucky Shale, and the Maynardville Limestone. The thickness of each of these formations varies throughout the Conasauga Group. The bedrock at the Y-12 Site is adequate to support structures using standard construction techniques.

Bedrock in the Y-12 area is overlain by alluvium, colluvium, man-made fill, fine-grained residuum from the weathering of the bedrock, saprolite, and weathered bedrock. The overall thickness of these materials in the Y-12 area is typically less than 12 m (40 ft). In undeveloped areas of the Y-12, the saprolite (a transitional mixture of fine-grained residuum and bedrock remains) retains primary textural features of the unweathered bedrock, including fractures (HSW 1994).

Numerous dissolution and karst features are the primary geological features influencing Y-12 (see Figure 4.4.2–3). Y-12 is situated on carbonate bedrock such that groundwater flow and contaminant transport are controlled by solution conduits in the bedrock. These karst features, including large fractures, cavities, and conduits, are most widespread in the Maynardville Limestone, a formation underlying Y-12, and the Knox Group. These cavities and conduits are often connected and typically found at depths greater than approximately 33 m (100 ft) (DOE 1998b).

FIGURE 4.4.2–3.—*Geology and Karst Features.*

TABLE 4.4.2–1.—*The Modified Mercalli Intensity Scale of 1931, With Approximate Correlations to Richter Scale and Maximum Ground Acceleration*[a]

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

[a] This table illustrates the approximate correlation between the Modified Mercalli intensity scale, the Richter scale, and maximum ground acceleration.

[b] Intensity is a unitless expression of observed effects.

[c] Magnitude is an exponential function of seismic wave amplitude, related to the energy released.

[d] Acceleration is expressed in relation to the earth's acceleration due to earth's gravity (g).

Source: NEIC 1999.

4.4.3 Soils

ORR Soils. Bear Creek Valley lies on well to moderately well-drained soils underlain by shale, siltstone, and silty limestone. Developed portions of the valley are designated as urban land. Soil erosion from past land uses has ranged from slight to severe. Erosion potential is very high in those areas that have been eroded in the past with slopes greater than 25 percent. Erosion potential is lowest in the nearly flat-lying permeable soils that have a loamy texture. Additionally, wind erosion is slight, shrink-swell potential is low to moderate, and the soils are acceptable for standard construction techniques (DOE 1996e).

Y-12 Soils. Y-12 lies on soils of the Armuchee-Montevallo-Hamblen, the Fullerton-Claiborne-Bodine, and the Lewhew-Armuchee-Muskinghum associations. Soil erosion due to past land use has ranged from slight to severe. Wind erosion is slight and shrink-swell potential is low to moderate. Finer textured soils of the Armuchee-Montevallo-Hamblen association have been designated as prime farmland when drained (DOE 1993). The soils at the Y-12 Site are generally stable and acceptable for standard construction techniques

4.5 HYDROLOGY

This section describes the surface and groundwater resources on the ORR in general and Y-12 specifically. Much of the information for the Y-12 water resources, particularly surface water and groundwater quality, are based on the results of recent CERCLA Remedial Investigations conducted in Bear Creek Valley (DOE 1997a) and UEFPC (DOE 1998b).

4.5.1 Surface Hydrology

ORR Surface Drainage Systems. The major surface water body in the immediate vicinity of the ORR is the Clinch River, which borders the site to the south and west. There are four major subdrainage basins on the ORR that flow into the Clinch River and are affected by site operations: Poplar Creek, East Fork Poplar Creek, Bear Creek, and White Oak Creek. Drainage from Y-12 enters both Bear Creek and EFPC; ETTP drains predominantly into Poplar Creek and Mitchell Branch; and ORNL drains into the White Oak Creek drainage basin (DOE 1992). Several smaller drainage basins, including Ish Creek, Grassy Creek, Bearden Creek, McCoy Branch, Kerr Hollow Branch, and Raccoon Creek, drain directly in to the Clinch River. Each drainage basin takes the name of the major stream flowing through the area. Within each basin are a number of small tributaries. The natural surface water bodies in the vicinity of ORR are shown in Figure 4.5.1–1.

Y-12 Surface Drainage Systems. Within the Y-12 area the two major surface water drainage basins are those of Bear Creek and EFPC. The upper reaches of EFPC drain the majority of the industrial facilities of Y-12. The in-plant portion of EFPC has been designated as UEFPC.

The natural drainage pattern of UEFPC has been radically altered by the construction of Y-12. The western portion of the creek flows underground through pipes and the remaining portion flows in a modified and straightened channel lined with riprap and concrete. Flow in UEFPC is derived partially from groundwater captured by the buried channels and funneled to the creek. In addition, outfalls into UEFPC add a combination of groundwater, storm water, and water generated by plant operations (e.g., basement sumps, treatment plant discharges). As a result of reduced operations and elimination of inadvertent direct discharges of contaminated water to UEFPC, flow in UEFPC decreased from 38 - 57 MLD (10-15 MGD) in the mid-1980s to about 9 MLD (2.5 MGD) in the mid-1990s. To improve downstream water quality (e.g., toxicity requirements, temperature), Y-12's 1995 National Pollutant Discharge Elimination System (NPDES) permit

required supplementing flow in UEFPC by the addition of raw water from the Clinch River. Since mid-1996, water has been added to the western portion of the open channel in order to maintain flow of 26 MLD (7 MGD) at Station 17.

Bear Creek Valley west of Y-12 is drained by Bear Creek. Bear Creek begins near the westernmost portion of Y-12 and flows west for approximately 8.3 km (5 mi). When Bear Creek reaches U.S. Highway 95, it turns north and flows through a water gap in Pine Ridge to its confluence with Lower EFPC just above its confluence with Poplar Creek. Bear Creek flow is maintained by inputs from tributary streams flowing in from the north (mostly) from Pine Ridge. Flow in Bear Creek is further supplemented by discharges from several springs at the base of Chestnut Ridge (entering Bear Creek from the south). The channel of Bear Creek is less modified than that of UEFPC but several short reaches have been relocated to accommodate construction (e.g., Bear Creek Road) at the west end of Y-12.

The Clinch River and connected waterways supply all raw water for ORR and provide potable water for Y-12, ORNL, and the city of Oak Ridge. The Clinch River has an average flow of 132 m^3/s (4,647 ft^3/s) as measured at the downstream side of Melton Hill Dam at mile 23.1. The average flow of Bear Creek near Y-12 is 0.11 m^3/s (3.9 ft^3/s). Prior to flow augmentation in UEFPC, the average flow in EFPC measured downstream of Y-12 was 1.3 m^3/s (45 ft^3/s). The average flow in EFPC has increased as flow augmentation raised the minimum flow rate to 0.3 m^3/s (11 ft^3/s) in the headwaters of UEFPC. Y-12 uses approximately 7,530 MLY (1,989 MGY) of water while ORR uses approximately twice as much (14,760 MLY [3,900 MGY]). The ORR water supply system, which includes the city of Oak Ridge treatment facility and the ETTP treatment facility, has a capacity of 44,347 MLY (11,716 MGY).

Clinch River water levels in the vicinity of ORR are regulated by a system of dams operated by TVA. Melton Hill Dam controls the flow of the Clinch River along the northeast and southeast sides of ORR. Watts Bar Dam, located on the Tennessee River downstream of the lower end of the Clinch River, controls the flow of the Clinch River along the southeast side of ORR.

Source: Tetra Tech, Inc.

FIGURE 4.5.1–1.—*Y-12 Plant Area Surface Water Features.*

TVA has conducted floodplain studies along Clinch River, Bear Creek, and EFPC (TVA 1991). Portions of Y-12 lie within the 100- and 500-year floodplains of EFPC; however, proposed SWEIS facilities are located outside the 500-year floodplain (Figure 4.5.1–2).

Surface Water Quality. The streams and creeks of Tennessee are classified by TDEC and defined in the State of Tennessee Water Quality Standards. Classifications are based on water quality, designated uses, and resident aquatic biota. The Clinch River is the only surface water body on ORR classified for domestic water supply. Most of the streams at ORR are classified for fish and aquatic life, livestock watering, wildlife, and recreation. White Oak Creek and Melton Branch are the only streams not classified for irrigation. Portions of Poplar Creek and Melton Branch are not classified for recreation.

At Y-12, there are six treatment facilities with NPDES-permitted discharge points to UEFPC. Y-12 is also permitted to discharge wastewater to the city of Oak Ridge Wastewater Treatment Facility. The water quality of surface streams in the vicinity of Y-12 is affected by current and past operations. Despite efforts to reroute discharge pipes and to treat all wastewater from the plant processes, wastewater discharges from Y-12 are a major influence on water quality and flow in UEFPC. Storm water discharges, groundwater discharges (either directly to the stream channel or collected in building sumps and discharged to UEFPC) and wastewater discharges contribute specific contaminants to UEFPC. Surface water contaminants in UEFPC are summarized in Table 4.5.1–1 and include metals (particularly mercury and uranium), chlorinated solvents, and radionuclides (especially isotopes of uranium) (DOE 1998b). Water quality in Bear Creek is influenced significantly by a groundwater hydraulic connection either directly to Bear Creek or to tributaries to Bear Creek. Contaminants in Bear Creek, from multiple formerly used waste burial trenches and pits, include nitrate, metals (e.g., uranium), radionuclides (e.g., uranium isotopes, ^{99}Tc), and chlorinated organics and are summarized in Table 4.5.1–1 (DOE 1997a and LMES 1997b).

FIGURE 4.5.1–2.—*100- and 500-year Floodplains for Y-12.*

Surface Water Rights and Permits. In Tennessee, the state's water rights laws are codified in the *Water Quality Control Act.* In effect, the water rights are similar to riparian rights in that the designated usages of a water body cannot be impaired. The only requirement to withdraw water from available supplies would be a U.S. Army Corps of Engineers (USACE) permit to construct intake structures.

TABLE 4.5.1–1.—*Surface Water Quality, Upper East Fork Poplar Creek (Station 8 to Station 17) During Flow Augmentation, and Lower Bear Creek (BCK-0.63)*

			Tennessee Water Quality Criteria			
					Recreation	
Parameter	UEFPC (mean concentration)	Bear Creek	Domestic Use	Fish and Aquatic Life	Organisms	Water and Organisms
Metals (mg/L)						
Mercury	0.00091	!	0.002	0.00169	0.00005	0.00005[b]
Uranium	0.015	0.031	!	!	!	!
Lithium	0.041	!	!	!	!	!
Copper	0.007	!	!	0.0177[c]	!	!
Zinc	0.045	0.003	!	0.117[c]	!	!
Nickel	0.021	!	0.1	1.418[c]	4.6	0.61
Organics (Fg/L)						
Chloroform	2.8	!	!	!	4700	57
Tetrachloroethene	3.9	!	5	!	88.5	8
Carbon Tetrachloride	4[a]	!	5	!	44	2.5
Radionuclides (pCi/L)						
Gross Alpha	6.8	12.5	!	!	!	!
Gross Beta	3.7	8.62	!	!	!	!
Gamma	28	!	!	!	!	!

[a] One sample.
[b] Based on consumption of water and organisms. Applied to waters designated for domestic and recreational uses.
[c] Based on total hardness of 100 mg/L.
Note: BCK - Bear Creek kilometer.
Source: DOE 1997a, DOE 1998b, LMES 1997b, TDEC 1999b.

4.5.2 Groundwater

ORR Hydrogeology. ORR is located in an area of sedimentary rocks of widely varying hydrological characteristics. Two geologic units on the ORR, designated as the Knox Group and the Maynardville Limestone of the Conasauga Group, both consisting of dolostone and limestone, constitute the Knox Aquifer. A combination of fractures and solution conduits in this aquifer control flow over substantial areas and relatively large quantities of water may move rapidly over relatively long distances. Active groundwater flow can occur at substantial depths in the Knox Aquifer (92 to 122 m [300 to 400 ft] deep). The Knox Aquifer is the primary source of groundwater to many streams (base-flow), and most large springs on the ORR

receive discharge from the Knox Aquifer. Yields of some wells penetrating larger solution conduits are reported to exceed 3,784 LPM (1,000 GPM).

The remaining geologic units on the ORR (the Rome Formation, the Conasauga Group below the Maynardville Limestone, and the Chickamauga Group) are aquitards, which consist mainly of siltstone, shale, sandstone, and interbedded limestone and dolostone of low to very low permeability. Nearly all groundwater flow in the aquitards occurs through fractures similar to the flow mechanism dominant in the aquifers. However, the absence of solution-enlarged fractures in the aquitards limits flow to a system of smaller and less connected fractures. The typical yield of a well in the aquitards is less than 4 LPM (1 GPM) and the base flows of streams draining areas underlain by the aquitards are poorly sustained because of such low flow rates. In areas underlain by aquitards, the combination of topographic relief and a decrease in bedrock fracture density with depth, restrict groundwater flow to shallow depths of the saturated zone and groundwater discharges primarily to nearby surface waters within the ORR (DOE 1999k).

The Knox Aquifer and ORR Aquitards can each be divided into a shallow soil and regolith unit and a deeper bedrock unit. The shallow unit consists of manmade fill, alluvium, colluvium, residuum, and weathered bedrock. In undisturbed areas an active storm flow zone, roughly equivalent to the zone of plant roots, carries a large percentage of infiltrating precipitation toward surface water streams. The influence of manmade fill on groundwater flow within the shallow unit is particularly important in Y-12 where pre-existing UEFPC stream channels have been filled and act as preferential groundwater flow paths (DOE 1998b). The bedrock unit consists of sandstones, siltstones, shales, and carbonates where groundwater flow occurs in fracture and/or conduit systems.

Y-12 Hydrogeology. Y-12, bound on the north by Pine Ridge and on the south by Chestnut Ridge, is located near the boundary between the Knox Aquifer and the ORR Aquitards. ORR Aquitards underlie Pine Ridge and Bear Creek Valley, which contains the main plant area of Y-12 and the disposal facilities of western Bear Creek Valley. The Knox Aquifer underlies Chestnut Ridge and the stream channels of Bear Creek and UEFPC. Bedrock formations comprising the Aquitards are hydraulically upgradient of the Aquifer, which functions as a hydrologic drain in Bear Creek Valley. Fractures provide the principal groundwater flowpaths in both the Aquifer and Aquitards. Dissolution of carbonates in the Aquifer has enlarged fractures and produced solution cavities and conduits that greatly enhance its hydraulic conductivity relative to the Aquitards.

Groundwater at Y-12 has been divided into three hydrogeologic regimes: UEFPC, Bear Creek, and Chestnut Ridge. A surface water divide at the west end of Y-12 effectively separates the UEFPC and Bear Creek hydrogeologic regimes with groundwater flow directions generally to the west in the Bear Creek regime and toward the east in the UEFPC regime. Bedrock beneath these two regimes is predominantly the ORR Aquitards. The Chestnut Ridge hydrogeologic regime, although hydraulically connected to the other two regimes, is distinctive in being developed on the underlying Knox Aquifer. In Bear Creek Valley, depth to groundwater is generally 6 to 9 m (20 to 30 ft) but is as little as 2 m (7 ft) in the area of Bear Creek near Highway 95. On Chestnut Ridge, the depth to the water table is greatest (>30 m [100 ft] below ground surface) along the crest of the ridge, which is a groundwater flow divide and recharge area. Groundwater in the Chestnut Ridge hydrogeologic regime tends to flow from west to east with elements of radial flow from the ridge crest north into Bear Creek Valley and south toward the headwaters of tributaries draining into Bethel Valley.

Recharge occurs over most of the area but is most effective where overburden soils are thin or permeable. Groundwater flow in the Aquitard and the Aquifer is primarily parallel to bedding, which in the Aquitard may or may not coincide with the direction of maximum hydraulic gradient calculated from field measurements.

Cross bedding flows occur along permeable zones formed by fractures. The northern tributaries to Bear Creek (those exposed in western Bear Creek Valley and buried beneath Y-12) are possibly surficial expressions of the cross-cutting features.

In the Aquitard, most groundwater flow occurs in a highly conductive interval near the bedrock/residuum interface (water table interval). Flow occurs above the water table in response to precipitation when flowpaths in the residual soils become saturated and rapidly transmit water laterally (stormflow) down slope toward springs and seeps in drainage features, and vertically (recharge) to the water table interval. Recharge to the water table interval promotes bedding-parallel groundwater flow toward discharge areas in nearby cross-cutting streams. Although most active groundwater flow occurs at depth less than 30 m (100 ft) below ground surface, contaminants in groundwater more than 61 m (200 ft) below ground surface in the Aquitard indicate permeable flowpaths at depth.

In the Aquifer, most groundwater flow occurs at shallow depths (i.e., <30 m [100 ft] below ground surface) in an extensively interconnected maze of solution conduits and cavities. Below the shallow karst network, fractures provide the primary flowpaths. Flow in the shallow karst network in the Aquifer is relatively rapid and during rainfall results in rapid discharge to surface streams. Groundwater from the deeper flow system (>30 m [100 ft] below ground surface) discharges along major gaining reaches of Bear Creek. In the main plant area of Y-12, the surface water drainage system has been drastically altered by construction. Despite the alterations, groundwater discharges continue to the buried tributaries and to pre-existing spring locations. Actively pumping basement sumps in several buildings within Y-12 locally influence groundwater flow directions by drawing water toward the pump and lowering the water table. Basement sumps also contribute discharge to UEFPC.

There are no Class I sole-source aquifers that lie beneath ORR. All aquifers are considered Class II aquifers (current potential sources of drinking water). Because of the abundance of surface water and its proximity to the points of use, very little groundwater is used at ORR. Only one water supply well exists on ORR; it provides a supplemental water supply to an aquatics laboratory during extended droughts.

Groundwater Quality. Groundwater samples are collected semiannually or annually from a representative number of the monitoring wells throughout ORR. Groundwater samples collected from the monitoring wells are analyzed for a standard suite of parameters and constituents, including trace metals, VOCs, radionuclides, inorganics, and field parameters. Background groundwater quality at ORR is generally good in the near surface aquifer zones and poor in the bedrock aquifer at depths greater than 300 m (984 ft) due to high total dissolved solids.

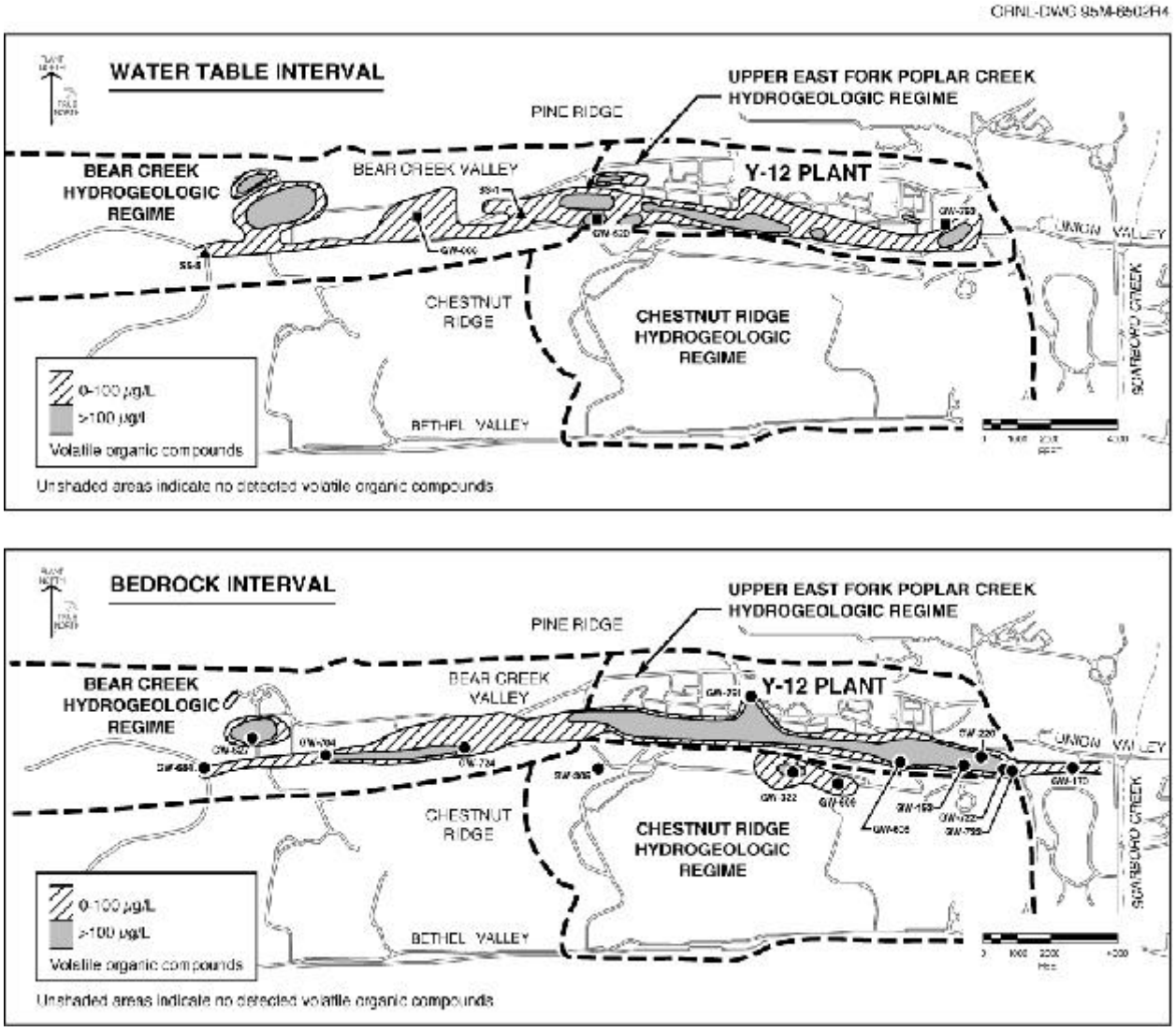
Groundwater in Bear Creek Valley west of Y-12 has been contaminated by hazardous chemicals and radionuclides (mostly uranium) from past weapons production waste disposal activities (DOE 1997a). The contaminant sources include past waste disposal facilities sited on Aquitard bedrock north of Bear Creek. Former disposal facilities include the S-3 Ponds, the Oil Landfarm, the Boneyard/Burnyard site, and the Bear Creek Burial Grounds, all closed since 1988. Each site was used for the disposal of waste chemicals including acids, solvents, oils, radioactive material (e.g., uranium), and wastewater containing dissolved metals and radionuclides. As a result, the aquifers below disposal sites often contain accumulations of the organic solvents (dense nonaqueous phase liquids) and the groundwater beneath and downgradient of the disposal facilities is contaminated with nitrate, solvents (e.g., PCE, TCE, DCE), radionuclides (e.g., uranium isotopes and ^{99}Tc), and metals (e.g., uranium, cadmium, strontium). The distribution of groundwater contamination in the Bear Creek hydrogeologic regime is illustrated in Figures 4.5.2–1 through 4.5.2–3.

Historical monitoring of groundwater in the UEFPC Y-12 area has been used to define an area of contamination that extends throughout Y-12 and off-site to the east into Union Valley. The groundwater contamination is the result of a comingling of releases from multiple sources within Y-12. The most widespread contaminant types are VOCs such as the solvents PCE, TCE, DCE, carbon tetrachloride, and chloroform; and fuel components such as benzene, toluene, ethylbenzene, and xylenes (BTEX). Other groundwater contaminants include nitrate, gross alpha activity (primarily uranium isotopes), gross beta activity (primarily uranium isotopes and ^{99}Tc). The most frequently detected metals are boron, beryllium, cobalt, copper, chromium, lead, lithium, mercury, manganese, nickel, and total uranium (DOE 1998b). The distribution of groundwater contamination in the UEFPC hydrogeologic regime is illustrated in Figures 4.5.2–1 through 4.5.2–3.

The Chestnut Ridge hydrogeologic area is dominated by several closed and operating disposal facilities including the closed Chestnut Ridge Security Pits, Chestnut Ridge Sediment Disposal Basin, United Nuclear Corporation Site, and five nonhazardous waste landfills. Groundwater monitoring data collected since the mid-1980s indicate limited groundwater contamination. Contaminants consist primarily of VOCs detected in scattered monitoring wells. The only definable VOC contaminant plume in groundwater is associated with the Chestnut Ridge Security Pits and extends approximately 792 m (2,600 ft) east of that facility. The distribution of groundwater contamination in the Chestnut Ridge hydrogeologic regime is illustrated in Figures 4.5.2–1 through 4.5.2–3.

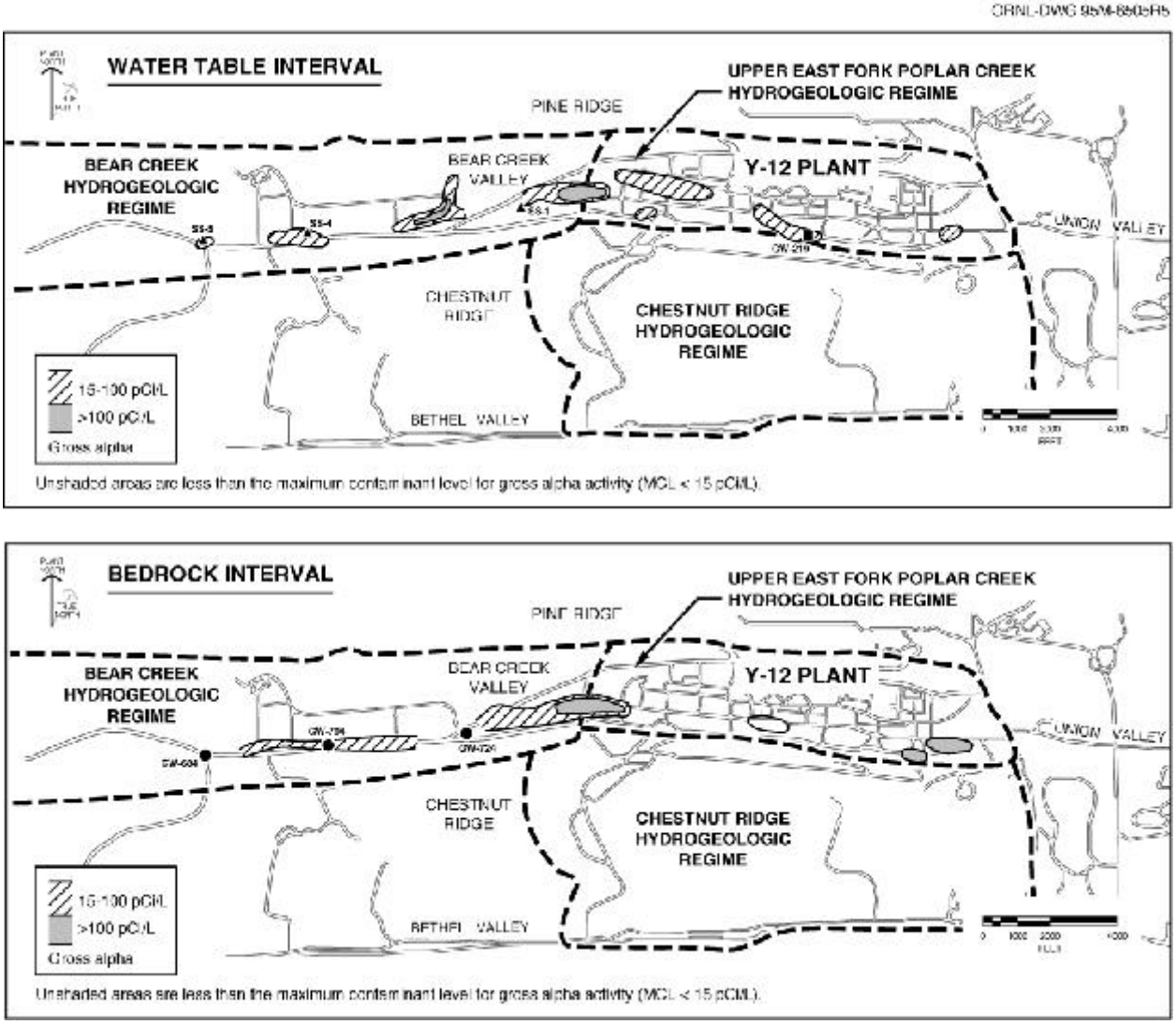
Groundwater Availability, Use, and Rights. Industrial and drinking water supplies in the area are primarily taken from surface water sources. However, single-family wells are common in adjacent rural areas not served by the public water supply system. Most of the residential supply wells in the immediate area of ORR are south of the Clinch River. Most wells used for potable water are located in the deeper principal carbonate aquifer (305 m [1,000 ft]), while the groundwater contamination at Y-12 is primarily found above a depth of approximately 84 m (276 ft), with the exception of VOC contamination at the east end of Y-12 which has been found to extend to 171 m (560 ft) below ground surface.

Groundwater rights in the State of Tennessee are traditionally associated with the Reasonable Use Doctrine (Van der Leeden 1990). Under this doctrine, landowners can withdraw groundwater to the extent that they must exercise their rights reasonably in relation to the similar rights of others.



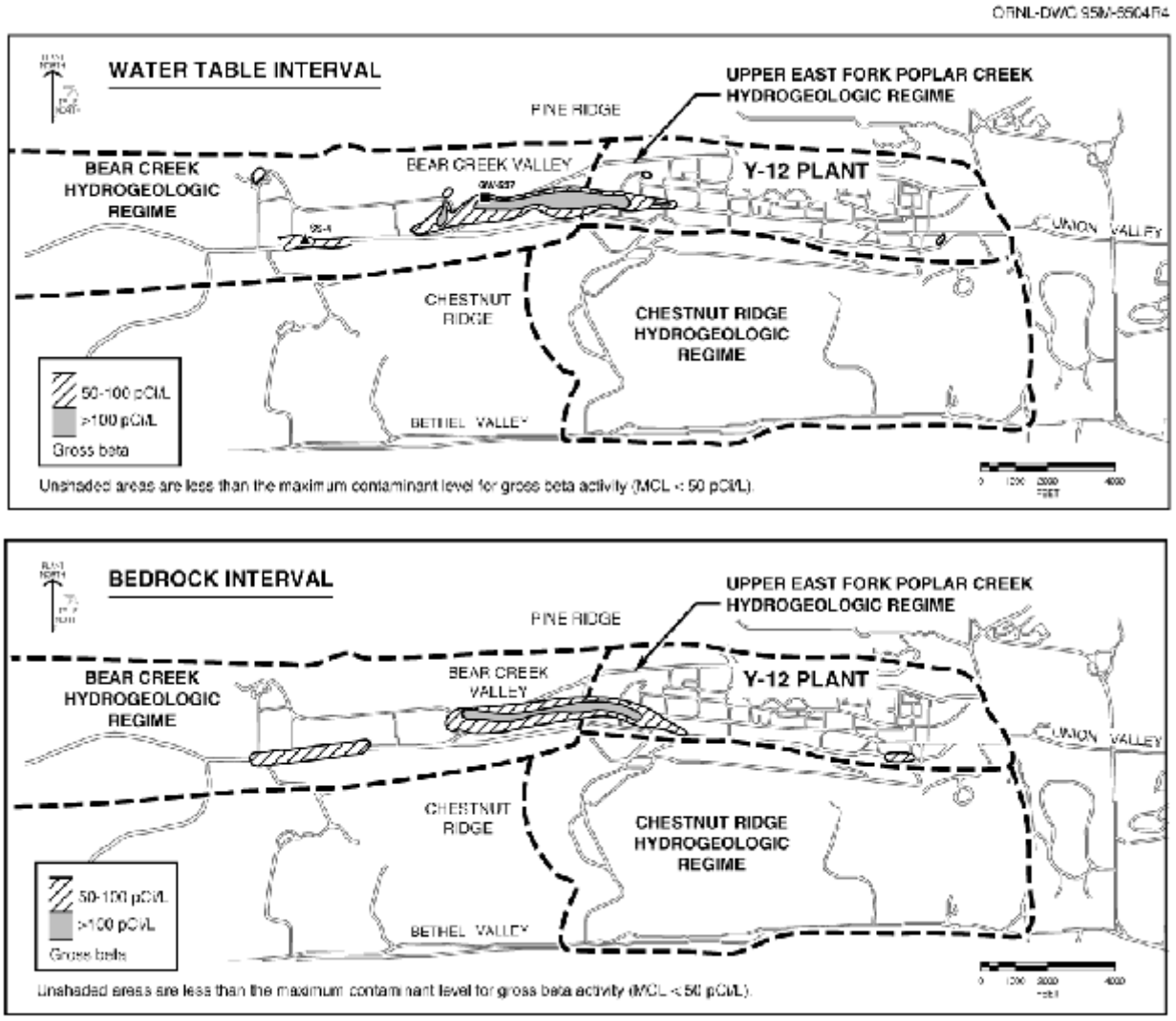
Source: DOE 1999k.

FIGURE 4.5.2–1.—*Summed Volatile Organic Compounds in Groundwater*.



Source: DOE 1999k.

FIGURE 4.5.2–2.—*Gross Alpha Activity in Groundwater at Y-12.*



Source: DOE 1999k.

FIGURE 4.5.2–3.—*Gross Beta Activity in Groundwater at Y-12.*

4.5.3 Y-12 Liquid Release

Nonradiological Liquid Discharges. The *Clean Water Act* requires that EPA establish limits on the amounts of specific pollutants that may be discharged to surface waters. The standards, called effluent limitations, are written into NPDES permits issued to all municipal and industrial dischargers. The Y-12 Plant, ORNL, and the ETTP are each required to monitor discharges at frequencies specified in their permits to ensure compliance with the NPDES effluent limitations.

The current Y-12 Plant NPDES permit, issued on April 28, 1995, and effective on July 1, 1995, requires sampling, analysis and reporting at approximately 100 outfalls. Discharges to surface water allowed under the permit include storm drainage, cooling water, cooling tower blowdown, andtreated process wastewaters, including effluents from wastewater treatment facilities. The effluent limitations contained in the permit are based on the protection of water quality in the receiving streams.

The permit emphasizes monitoring storm water runoff as well as biological, toxicological, and radiological monitoring. Currently, the Y-12 Plant has outfalls and monitoring points in the following water drainage areas: EFPC, Bear Creek, and several unnamed tributatries on the south side of Chestnut Ridge. These creeks and tributatries eventually drain to the Clinch River (DOE 1999k). At Y-12, there are six treatment facilities with NPDES-permitted discharge points to UEFPC. Y-12 is also permitted to discharge wastewater to the city of Oak Ridge Wastewater Treatment Facility.

Radiological Liquid Discharges. At the Y-12 Plant, a Radiological Monitoring Plan is in place to address compliance with DOE Orders and the NPDES permit. No discharge limits for radionuclides are set by the NPDES permit; however, the permit does require monitoring and reporting of results. Under the monitoring program, effluent monitoring is performed at three types of locations: (1) treatment facilities, (2) other point and area source discharges, and (3) instream locations. Radiological parameters monitored at the Y-12 Plant in 1998 include the following:

- Uranium isotopes (^{238}U, ^{235}U, and ^{234}U, total uranium, and weight % of uranium ^{235}U)
- Fission and activation products (^{90}Sr, tritium, ^{99}Tc, and ^{137}Cs)
- Transuranic isotopes (^{241}Am, ^{237}Np, ^{238}Pu, and $^{239/240}Pu$)
- Other isotopes of interest (^{232}Th, ^{230}Th, ^{288}Th, ^{226}Ra and ^{228}Ra)

In 1998, the highest summed percentage of Derived Concentration Guidelines (DCGs) was from the total 8.6 percent. The total mass of uranium and associated curies released from the Y-12 Plant at the easternmost monitoring station, Station 17 on UEFPC, and the westernmost monitoring station, at Bear Creek Kilometer 4.55, was 375 kg or 0.167 Ci.

The Radiological Monitoring Plan also addresses monitoring of the sanitary sewer. The Y-12 Plant is permitted to discharge domestic wastewater to the city of Oak Ridge publicly owned treatment works. Studies of the potential sources of radionuclides discharging to the sanitary sewer have shown that levels of radionuclides are orders of magnitude below levels established in DOE Orders and are not thought to pose a safety or health risk. No single radionuclide in the Y-12 Plant contribution to the sanitary sewer exceeded 1 percent of the DCG listed in DOE Order 5400.5. Summed percentages of DCGs calculated from the Y-12 Plant contribution to the sewer are essentially zero.

Radiological monitoring of storm water also is required by the NPDES permit. Uranium is the dominant constituent and increases during storm flow, probably due to surface sources and increase groundwater flow (DOE 1999k).

4.6 BIOLOGICAL RESOURCES

This section describes the biological resources at ORR including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Information for Y-12 is also provided.

4.6.1 Terrestrial Resources

Plant communities on the ORR are characteristic of the intermountain regions of central and southern Appalachia. Approximately 35 percent of the ORR has been developed since it was withdrawn from public access; the remainder of the site has reverted to or been planted with natural vegetation (LMER 1999a). Over 1,100 vascular plant species have been found on ORR (LMER 1999a). The vegetation of ORR has been categorized into seven plant communities (Figure 4.6.1–1). Pine and pine-hardwood forest and oak-hickory forest are the most extensive plant communities on ORR, while northern hardwood forest and hemlock-white pine-hardwood forest are the least common forest community types. Important conifers on the ORR include loblolly pine (*Pinus taeda*), shortleaf pine (*Pinus echinata*), Virginia pine (*Pinus virginiana*), and white pine (*Pinus strobus*). Important deciduous trees include white oak (*Quercus alba*), black oak (*Quercus velutina*), northern red oak (*Quercus rubra*), shagbark hickory (*Carya ovata*), pignut hickory (*Carya glabra*), sweetgum (*Liquidambar styraciflua*), tulip poplar (*Liriodendron tulipifera*), and American beech (*Fagus grandifolia*). Some additional representative plants are provided in Table 4.6.1–1.

Animal species found on the ORR include about 63 species of fish; 59 species of amphibians and reptiles; up to 260 species of migratory, transient, and resident birds; and 38 species of mammals (LMER 1999a). Representative amphibians and reptiles include American toad (*Bufo americanus),* eastern tiger salamander (*Ambystoma tigrinum),* five-lined skink (*Eumeces fasciatus),* eastern garter snake (*Thamnophis sirtalis),* rat snake (*Elaphe obsoleta),* and eastern box turtle (*Terrapene carolina).*

Some representative mammals on the ORR, particularly in less developed areas, include deer mouse (*Peromyscus maniculatus*), eastern chipmunk (*Tamias striatus*), eastern cottontail (*Sylvilagus floridanus),* eastern gray squirrel (*Sciurus carolinensis*), southern flying squirrel (*Glaucomys volans),* gray fox (*Urocyon cinereoargenteus*), hispid cotton rat (*Sigmodon hispidus),* Meadow vole (*Microtus pennsylvanicus),* opposum (*Didelphis virginiana),* raccoon (*Procyon lotor),* striped skunk (*Mephitis mephitis),* and white-tailed deer (*Odocoileus virginianus)* (Mitchell 1996). The white-tailed deer is a game species hunted on the ORR.

Some of the more common birds on the ORR, particularly in less developed areas, include mourning dove (*Zenaida macroura*), chimney swift (*Chaetura pelagica*), barn swallow (*Hirundo rustica*), blue jay (*Polioptila caerulea*), Carolina chickadee (*Parus carolinesis*), American crow (*Corvus brachyrhunchos*), Carolina wren (*Thryothus Iudovicianus*), American robin (*Turdus migratorius*), northern mockingbird (*Mimus polyglottos*), European starling (*Sturnis vulgaris*), red-eyed vireo (*Vireo olivaceus*), northern cardinal (*Cardinalis cardinalis*), indigo bunting (*Passerina cyanea*), eastern meadowlark (*Sturnella magna*), common grackle (*Quiscalus quiscula*), and house sparrow (*Passer domesticus*) (Mitchell, 1996; Sauer, 1997). The wild turkey (*Meleagris gallopavo)* is a game species hunted on the ORR. A variety of migratory birds has been found at ORR. Migrating birds present on site, as well as their nests and eggs, are protected by the *Migratory Bird Treaty Act.* The ORR has more species of breeding birds documented than any other single tract of land in Tennessee (Mitchell 1998). Table 4.6.1-2 contains a partial list of some of the potential breeding birds and their relative abundance on the ORR. A more detailed list is provided by Sauer et al. (1997).

Source: DOE 1996e

FIGURE 4.6.1–1 ***Distribution of Plant Communities on the Oak Ridge Reservation.***

TABLE 4.6.1–1.—*Common and Scientific Names of Some of the Nonthreatened and Nonendangered Plants and Animals Occurring On or In the Vicinity of the ORR* [Page 1 of 2]

Common name	Scientific name	Common name	Scientific name
PLANTS		**FISH (continued)**	
American beech	*Fagus grandifolia*	Largemouth bass	*Micropterus salmonides*
Black oak	*Quercus velutina*	Sauger	*Stizostedion canadense*
Black willow	*Salix nigra*	Sunfish	*Lepomis spa*
Blueberry	*Vaccinium* sp.		
Box elder	*Acer negundo*	**AMPHIBIANS & REPTILES**	
Juneberry	*Aelanchier* sp.	American toad	*Bufo americanus*
Fescue	*Festuca* sp.	Bull frog	*Bufo catesbeiana*
Green ash	*Fraxinus pennsylvanica*	Eastern tiger salamander	*Amblystoma tigrinum*
Hazelnut	*Corylus americana*	Spring peeper	*Pseudacris triseriata*
Hop hornbeam	*Ostrya virginiana*	Five-lined skink	*Eumeces fasciatus*
Japanese honeysuckle	*Lonicera japonica*	Corn snake	*Elaphe guttata*
Jewelweed	*Impatiens capensis*	Eastern garter snake	*Thamnophis sirtalis*
Juneberry	*Amelanchier* sp.	Northern water snake	*Nerodia spiedon*
Loblolly pine	*Pinus taeda*	Rat snake	*Elaphe obsoleta*
Northern red oak	*Quercus rubra*	Eastern box turtle	*Terrapene carolina*
Pignut hickory	*Carya glabra*	Painted turtle	*Chrysemys picta*
Red bud	*Cercis canadensis*	**BIRDS**	
Reed canary grass	*Phalaris arundianaceae*	Wood duck	*Aix sponsa*
Rice cutgrass	*Leersia oryzoides*	Canada goose	*Branta canadensis*
Rusty viburnum	*Viburnum rudifulum*	Mourning dove	*Zenaida macroura*
Sedges	Carex sp.	Yellow-billed cuckoo	*Coccyzus americanus*
Shagbark hickory	*Carya ovata*	Chimney swift	*Chaetura pelagica*
Shortleaf pine	*Pinus echinata*	Barn swallow	*Hirundo rustica*
Silky dogwood	*Cornus amomum*	Blue jay	*Cyanocitta cristata*
Soft rush	*Juncus effusus*	American crow	*Corvus brachyrhynchos*
Sugar maple	*Acer sccharum*	Carolina chickadee	*Parus carolinesis*
Sweetgum	*Liquidambar styraciflua*	Tufted titmouse	*Parus bicolor*
Sycamore	*Platanus occidentalis*	Carolina wren	*Thryothus Iudovicianus*
Tulip poplar	*Liriodendron tulipifera*	Blue-gray gnatcatcher	*Polioptila caerulea*
Turnflower rush	*Juncuc biflorus*	Eastern bluebird	*Sialia sialis*
Virginia pine	*Pinus virginiana*	Wood thrush	*Hylocichla mustelina*
White oak	*Quercus alba*	American robin	*Turdus migratorius*
White pine	*Pinus strobus*	Northern mockingbird	*Mimus polyglottos*
FISH		Brown thrasher	*Toxostoma rufum*
Shad	Clupeidae	European starling	*Sturnus vulgaris*
Herring	*Clupeidae*	Red-eyed vireo	*Vireo olivaceus*
Common carp	*Cyprinus carpio*	Ovenbird	*Seiurus aurocapillus*
Catfish	Ictaluridae	Common yellowthroat	*Geothylpis trichas*
Bluegill	*Lepomis macrochirus*	Yellow-breasted chat	*Icteria virens*
Crappie	Pomoxis spp	Scarlet tanager	*Piranga olivacea*
Drum	*Aplodinotus grunniens*	Northern cardinal	*Cardinalis cardinalis*

TABLE 4.6.1–1.—*Common and Scientific Names of Some of the Nonthreatened and Nonendangered Plants and Animals Occurring On or In the Vicinity of the ORR* [Page 2 of 2]

Common name	Scientific name	Common name	Scientific name
BIRDS (Continued)		**MAMMALS**	
Indigo Bunting	*Passerina cyanea*	Deer mouse	*Peromyscus maniculatus*
Eastern Towhee	*Pipilo erthrophthalmus*	Eastern chipmunk	*Tamias striatus*
Field Sparrow	*Spizella pusilla*	Eastern cottontail	*Sylvilagus floridanus*
Song Sparrow	*Melospiza melodia*	Eastern gray squirrel	*Sciurus carolinensis*
Red-winged Blackbird	*Agelaius phoeniceus*	Eastern harvest mouse	*Reithrodontomys humulis*
Eastern Meadowlark	*Sturnella magna*	Gray fox	*Urocyon cinereoargenteus*
Common Grackle	*Quiscalus quiscula*	Hispid cotton rat	*Sigmodon hspidus*
Brown-headed Cowbird	*Molothrus ater*	Meadow vole	*Microtus pennsylvanicus*
American Goldfinch	*Carduelis tristis*	Mink	*Mustela vison*
House Sparrow	*Passer domesticus*	Norway rat	*Rattus norvegicus*
Wild turkey	*Meleagris gallopavo*	Opposum	*Didelphis virginiana*
Turkey Vulture	*Cathartes aura*	Raccoon	*Procyon lotor*
Red-shouldered hawk	*Buteo lineatus*	Shorttailed shrew	*Blarina brevicauda*
Broad-winged hawk	*Buteo platypterus*	Southern flying squirrel	*Glaucomys volans*
		Striped skunk	*Mephitis mephitis*
		White-footed mouse	*Peromyscus leucopus*
		White-tailed deer	*Odocoileus virginianus*

Sources: Mitchell et al. 1996; ORNL 1994; DOE 2000.

Table 4.6.1–2.—*List of Potential Breeding Birds and Relative Abundance on the Oak Ridge Reservation* [Page 1 of 4]

Common Name	Scientific Name	Relative Abundance
Great Blue Heron	*Ardea herodias*	0.18
Green Heron	*Butorides virescens*	0.46
Black-crowned Night Heron	*Nycticorax nycticorax*	0.11
Yellow-crowed Night Heron	*Nycticorax violacus*	0.01
Canada Goose	*Branta canadensis*	0.94
Wood Duck	*Aix sponsa*	0.28
Mallard	*Anas platyrhynchos*	0.09
Black Vulture	*Coragyps atratus*	0.01
Turkey Vulture	*Cathartes aura*	0.48
Sharp-shinned Hawk	*Accipiter striatus*	0.03
Cooper's Hawk	*Accipiter cooperii*	0.02
Red-shouldered Hawk	*Buteo lineatus*	0.49
Broad-winged Hawk	*Buteo platypterus*	0.19
Red-tailed Hawk	*Buteo jamaicensis*	0.07
American Kestrel	*Falco sparverius*	0.08
Ruffed Grouse	*Bonasa umbellus*	0.00
Northern Bobwhite	*Colinus virginianus*	8.05
Killdeer	*Charadrius vociferus*	3.02
American Woodcock	*Scolopax minor*	0.00
Rock Dove	*Columba livia*	4.78
Mourning Dove	*Zenaida macroura*	26.40
Black-billed Cuckoo	*Coccyzus erythropthalmus*	0.03
Yellow-billed Cuckoo	*Coccyzus americanus*	6.15
Eastern Screech-owl	*Otus asio*	0.04
Great Horned Owl	*Bubo virginianus*	0.07
Barred Owl	*Strix varia*	0.11
Common Nighthawk	*Chordeiles minor*	0.00
Chuck-will's-widow	*Caprimulgus carolinensis*	0.24
Whip-poor-will	*Caprimulgus vociferus*	0.16
Chimney Swift	*Chaetura pelagica*	21.14
Ruby-throated Hummingbird	*Archilochus colubris*	0.51
Belted Kingfisher	*Ceryle alcyon*	0.58

Table 4.6.1–2.—*List of Potential Breeding Birds and Relative Abundance on the Oak Ridge Reservation* [Page 2 of 4]

Common Name	Scientific Name	Relative Abundance
Red-headed Woodpecker	*Melanerpes erythrocephalus*	0.00
Red-bellied Woodpecker	*Melanerpes carolinus*	4.41
Downy Woodpecker	*Picoides pubescens*	3.70
Hairy Woodpecker	*Picoides villosus*	0.40
Yellow-shafted Flicker	*Colaptes auratus*	2.96
Pileated Woodpecker	*Dryocopus pileatus*	3.44
Easter Wood-pewee	*Contopus virens*	4.62
Acadian Flycatcher	*Empidonax virescens*	3.90
Willow Flycatcher	*Empidonax traillii*	0.12
Least Flycatcher	*Empidonax minimus*	0.06
Easter Phoebe	*Sayornis phoebe*	5.41
Great Crested Flycatcher	*Myiarchus crinitus*	2.10
Easter Kingbird	*Tyrannus tyrannus*	2.33
Horned Lark	*Ermophila alpestris*	0.00
Purple Martin	*Progne subis*	4.06
Tree Swallow	*Tachycineta bicolor*	0.01
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	1.42
Bank Swallow	*Riparia riparia*	0.01
Cliff Swallow	*Hirundo pyrrhonota*	0.05
Barn Swallow	*Hirundo rustica*	18.33
Blue Jay	*Cyanocitta cristata*	15.09
American Crow	*Corvus brachyrhynchos*	37.45
Carolina Chickadee	*Parus carolinensis*	17.97
Tufted Titmouse	*Parus bicolor*	12.45
White breasted Nuthatch	*Sitta carolinensis*	2.93
Carolina Wren	*Thryothorus ludovicianus*	1628
Bewick's Wren	*Thryomanes bewickii*	0.00
House Wren	*Troglodytes aedon*	0.14
Winter Wren	*Troglodytes troglodytes*	0.08
Blue-gray Gnatcatcher	*Polioptila caerulea*	6.32
Eastern Bluebird	*Sialia sialis*	6.09
Veery	*Catharus fuscescens*	0.77

Table 4.6.1–2.—*List of Potential Breeding Birds and Relative Abundance on the Oak Ridge Reservation* [Page 3 of 4]

Common Name	Scientific Name	Relative Abundance
Wood Thrush	*Hylocichla mustelina*	14.84
American Robin	*Turdus migratorius*	32.81
Gray Catbird	*Dumetella carolinensis*	2.46
Northern Mockingbird	*Mimus polyglottos*	14.79
Brown Thrasher	*Toxostoma rufum*	3.34
Cedar Waxwing	*Bombycilla cedrorum*	4.48
Loggerhead Shrike	*Lanius ludovicianus*	0.17
European Starling	*Sturnus vulgaris*	69.36
White-eyed Vireo	*Vireo griseus*	3.85
Solitary Vireo	*Vireo solitarius*	0.65
Yellow-throated Vireo	*Vireo flavifrons*	4.25
Red-eyed Vireo	*Vireo olivaceus*	24.68
Blue-winged Warbler	*Vermivora pinus*	0.14
Golden-winged Warbler	*Vermivora chrysoptera*	0.28
Norther Parula	*Parula americana*	1.37
Yellow Warbler	*Dendroica petechia*	1.61
Chestnut-sided Warbler	*Dendroica pensylvanica*	0.20
Black-throated Blue Warbler	*Dendroica caerulescens*	1.46
Black-throated Green Warbler	*Dendroica virens*	3.64
Blackburnian Warbler	*Dendroica fusca*	0.00
Yellow-throated Warbler	*Dendroica dominica*	5.24
Pine Warbler	*Dendroica pinus*	1.51
Prairie Warbler	*Dendrocia discolor*	0.79
Cerulean Warbler	*Dendroica cerulea*	1.29
Black & white Warbler	*Mniotilta varia*	3.37
American Redstart	*Setophaga ruticilla*	1.36
Prothonotary Warbler	*Protonotaria citrea*	0.00
Worm-eating Warbler	*Helmitheros vermivorus*	1.59
Swainson's Warbler	*Limnothlypis swainsonii*	0.09
Ovenbird	*Seiurus aurocapillus*	9.26
Louisiana Waterthrush	*Seiurus motacilla*	1.67
Kentucky Warbler	*Oporornis formosus*	2.86

Table 4.6.1–2.—*List of Potential Breeding Birds and Relative Abundance on the Oak Ridge Reservation* [Page 4 of 4]

Common Name	Scientific Name	Relative Abundance
Common Yellowthroat	*Geothlypis trichas*	8.88
Hooded Warbler	*Wilsonia citrina*	5.87
Yellow-breasted Chat	*Icteria virens*	7.95
Summer Tanager	*Piranga rubra*	1.28
Scarlet Tanager	*Piranga olivacea*	7.41
Northern Cardinal	*Cardinalis cardinalis*	27.19
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	0.10
Blue Grosbeak	*Guiraca caerulea*	2.03
Indigo Bunting	*Passerina cyanea*	35.31
Dickcissel	*Spiza americana*	0.01
Eastern Towhee	*Pipilo erythrophthalmus*	8.50
Chipping Sparrow	*Spizella passerina*	5.78
Field Sparrow	*Spizella pusilla*	7.42
Grasshopper Sparrow	*Ammodramus savannarum*	0.16
Song Sparrow	*Melospiza melodia*	31.21
Slate-colored Junco	*Junco hyemalis*	0.92
Red-winged Blackbird	*Agelaius phoeniceus*	19.57
Eastern Meadowlark	*Sturnella magna*	23.28
Common Grackle	*Quiscalus quiscula*	48.73
Brown-headed Cowbird	*Molothrus ater*	7.72
Orchard Oriole	*Icterus spurius*	2.28
Baltimore Oriole	*Icterus galbula*	0.08
House Finch	*Carpodacus mexicanus*	3.95
American Goldfinch	*Carduelis tristis*	8.25
House Sparrow	*Passer domesticus*	14.68

Source: Mitchell 1996; Sauer 1997.

The Oak Ridge Research Park covers approximately 8,094 ha (20,000 acres) at ORR for the protection of flora and fauna. As an ORNL User Facility, the Research Park is available for environmental research and education by DOE, other Federal agencies, industries, state, and other organizations, individuals, and academic institutions (LMER 1999a). The Walker Branch Watershed located partially within the Y-12 area has been used for long-term studies on hydrology, forest and stream ecology, and watershed biogeochemical studies since 1968 (SPAS 1998).

Within the fenced, developed portion of Y-12, grassy and devegetated areas surround the entire facility (see Figure 4.6.1–1). Buildings and parking lots dominate the landscape in Y-12, with limited vegetation present (ORNL 1992a). Fauna within the Y-12 area is limited by the lack of large areas of natural habitat. The two sites being considered for the proposed HEU Materials Facility are in previously disturbed areas containing a parking lot (Site A) or existing facilities (Site B). Adjacent land has also been previously disturbed to allow the construction of roads, structures, and utilities. As such, neither site is conducive to sustaining plant or animal populations, although birds and more mobile mammals may traverse the sites on a transient basis. Three sites are being considered for the proposed new Special Materials Complex. Site 1 is just north of the perimeter fence in a grassy and wooded area. The lower 50 percent of Site 1 is cleared and contains grass and non-native herbaceous plants (ORNL 1994). Site 2 and Site 3 are in previously disturbed areas of Y-12 containing structures, roads, and parking lots. Site 3 for the Special Materials Complex is the same location as Site B for the HEU Materials Facility. Neither Site 2 nor Site 3 is conducive to sustaining plant or animal populations, although birds and more mobile mammals may traverse the sites on a transient basis.

ORNL scientists monitor trace levels of radionuclides in hay, milk, eggs, and fish. The purpose of the monitoring is to evaluate potential radiation doses and to track trends in long-term accumulation of radionuclides (DOE 1999k). ORR conducts annual deer and turkey hunts, with the carcasses scanned at monitoring stations for radioactivity. Since hunts began in 1985, 2.3 percent of 7,123 deer taken (through 1998) have been retained due to radiological contamination (LMER 1999a).

A Biological Monitoring and Abatement Program was established in conjunction with the NPDES permit issued to Y-12 in 1992. The program includes toxicity monitoring, bioaccumulation studies, biological indicator studies, and ecological surveys. Toxicity testing and bioaccumulation studies indicate that the exposure of aquatic organisms in UEFPC to toxicants has been steadily decreasing as a result of remedial activities such as implementation of flow management and continuing mercury reductions at Y-12 (LMER 1999a).

4.6.2 Wetlands

Approximately 235 ha (580 acres) of wetlands have been identified on ORR, with most classified as forested palustrine, scrub/shrub, and emergent wetlands. Known wetlands range in size from several square yards at small seeps to approximately 10 ha (25 acres) at the White Oak Lake. Only a small percentage of the wetlands on the ORR are greater than 0.4 ha (1 acre) in size, with larger ones typically associated with river embayments, other areas affected by fluctuating levels of the Clinch River reservoirs, or beaver ponds (LMER 1999a). A wetland survey for the Y-12 area has been performed using the USACE methodology (DOE 1987), and wetlands have been classified as palustrine, scrub/shrub, or emergent according to the U.S. Fish and Wildlife Service system (USFWS 1979, ORNL 1994, ORNL 1992a).

An emergent wetland was found at the eastern end of Y-12 at a seep by a small tributary of the EFPC, between New Hope Cemetery and Bear Creek Road. The wetland receives effluent from an NPDES outfall. Cardinal flower (*Lobelia cardinalis*), an obligate species, and jewelweed (*Impatiens capensis*), a facultative species, were observed there (ORNL 1994).

Eleven small wetlands were found north of Bear Creek Road in remnants of the UEFPC. Obligate species observed included black willow (*Salix nigra*) and cattail (*Typha latifolia*); facultative species included elderberry (*Sambuccus canadensis*) and dotted smartweed (*Polygonum punctatum*) (ORNL 1994).

A relatively undisturbed, forested, wetland was identified in the stream bottomland of Bear Creek North Tributary 1 between Bear Creek Road and the powerline right-of-way in the Bear Creek Operable Unit. Common species noted included sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), and hazelnut (*Corylus americana*) (ORNL 1994).

Emergent and scrub/shrub wetlands were identified in the riparian area and in old pastures in the McCoy Branch bottomland in Chestnut Ridge Operable Unit 2 between Bethel Valley Road and the McCoy Embayment west of Y-12. Common species included reed canary grass (*Phalaris arundinaceae*), soft rush (*Juncus effusus*); some green ash, black willow, and sycamore (*Plantanus occidentalis*) were observed along McCoy Branch and in depressions (ORNL 1994).

4.6.3 Aquatic Resources

Aquatic habitat on or adjacent to the ORR ranges from small, free-flowing streams in undisturbed watersheds to larger streams with altered flow patterns due to dam construction. These aquatic habitats include tailwaters, impoundments, reservoir embayments, and large and small perennial streams. Aquatic areas within the ORR also include seasonal and intermittent streams (DOE 1996e).

Sixty-four fish species have been collected on or adjacent to the ORR. The minnow family has the largest number of species and is numerically dominant in most streams (ORNL 1988). Fish species representative of the Clinch River in the vicinity of the ORR include shad and herring (Clupeidae), common carp (*Cyprinus carpio*), catfish and bullheads (Ictaluridae), bluegill (*Lepomis macrochirus*), crappie (*Pomoxis* spp.), and freshwater drum (*Aplodinotus grunniens*) (ORNL 1981b). The most important fish species taken commercially in the ORR area are common carp and catfish. Commercial fishing is permitted on the Clinch River downstream from Melton Hill Dam (TWRA 1995). Recreational species consist of crappie, largemouth bass (*Micropterus salmonides*), sauger (*Stizostedion canadense*), sunfish (*Lepomis* spp.), and catfish. Sport fishing is not permitted within the ORR.

4.6.4 Threatened and Endangered Species

Forty-five Federal- and state-listed threatened, endangered, and other special status species have been identified on the ORR (Table 4.6.4–1) (ORNL 1999). Fifteen of these species are Federal- and/or state-listed as threatened or endangered (DOE 1996; Mitchell 1996; ORNL 1999). A rare plant survey has been performed for the Y-12 area (ORNL 1992a). There are no federally listed threatened or endangered plant species at ORR. Only two Federal-listed animal species have been observed on the ORR. The bald eagle (*Haliaeetus leucocephalus*) forages on Melton Hill and Watts Bar Lakes. On July 6, 1999, the U.S. Fish and Wildlife Service (USFWS) requested public comments concerning a proposal to remove the bald eagle (*Haliaeetus leucocephalus)* from that agency's list of endangered and threatened wildlife (64 FR 36454, July 1999). However, that proposal does not change the current threatened designation provided the bald eagle by the USFWS and the State of Tennessee, nor protection afforded under the *Bald and Golden Eagle Protection Act* and the *Migratory Bird Treaty Act.* The final rule on this proposal has not been issued (64 FR 36454, July 1999). On August 25, 1999, the USFWS removed the American peregrine falcon (*Falco peregrinus anatum*) from that agency's list of endangered and threatened wildlife (64 FR 46542, August 1999). However, that decision does not affect the endangered designation provided by the State of Tennessee. The USFWS is still tracking this raptor as a species of concern.

The only federally threatened or endangered species that has been reported from Y-12 is a single dead federally endangered gray bat (*Myotis grisescens*). The specimen was turned over to USFWS. The USFWS is currently conducting analyses to determine the cause of death and any potential exposure to Y-12 site-related contaminants (USFWS 1999). Two surveys have been conducted, in part, to determine if gray bats are present on ORR. Neither survey detected gray bats, although several species of unprotected bats were collected (Webb 1990, ORNL 1997). USFWS records indicate that the federally endangered Indiana Bat (*Myotis sodalis*) may also be present in the vicinity of Y-12 SWEIS impact area (USFWS 1999c). However, this bat has not been observed at Y-12 or other parts of ORR, during previous surveys for protected and sensitive species (Mitchell 1996). No critical habitat for threatened or endangered species, as

defined in the *Endangered Species Act* (50 CFR 17.11 and 17.12), exists on ORR.

The ORR also has four plant and two animal species that are designated as Federal species of concern: Appalachian bugbane (*Cimicifuga rubifolia*), butternut (*Juglans cinerea*), spreading false foxglove (*Aureolaria patula*), tall larkspur (*Delphinium exaltatum*), paddlefish (*Polyodon spathula*), and loggerhead shrike (*Lanius ludovicianus*). These former C2 species (i.e., species possibly appropriate for listing as protected) no longer receive protection under the *Endangered Species Act.* However, Federal agencies are encouraged to include them in NEPA environmental impact analyses.

State threatened and endangered species observed on the ORR include 11 plant, 1 mammal, and 3 raptor species (ORNL 1999). A number of rare or state-listed animals and plants are present in the vicinity of Y-12. A population of the Tennessee dace (*Phoxinus tennesseensis*) is found in Bear Creek which flows out of Y-12 into the EFPC. This species is classified as "deemed in need of management" by the State of Tennessee.

The only ORR population of mountain witch alder (*Fothergilla major*), a species with Tennessee-threatened status, is on a west-facing slope of the Walker Branch Watershed. Canada lily *(Lilium canadense*) and the tuberculed rein-orchid (*Platanthera flava* var. *herbiola*), two species with Tennessee-threatened status, are found in the Pine Ridge Wetlands. Ginseng (*Panax quinquifolius*), a Tennessee species of special concern, and whorled horsebalm (*Collinsonia verticillata*) considered rare by the Nature Conservancy are found in the Chestnut Ridge area. The tuberculed rein-orchid, ginseng, and whorled horsebalm are found in the Bear Creek Spring area. A recently described quillwort species (*Isoetes carolinia*) is present at the Quillwort Temporary Pond and may be rare enough to be Tennessee listed (LMES 1998).

TABLE 4.6.4–1.—*Federal- or State-Listed Threatened, Endangered, and Other Special Status Species Reported on the Oak Ridge Reservation*

	Common Name	Scientific Name	Status[a] Federal	State
Mammals				
	Gray bat[b]	*Myotis grisescens*	E	E
	Indiana bat[c]	*Myotis sodalis*	E	E
	Southeastern shrew	*Sorex longirostris*	NL	NM
Birds				
	American peregrine falcon[d]	*Falco peregrinus anatum*	NL	E
	Anhinga[d]	*Anhinga anhinga*	NL	NM
	Bald eagle[d]	*Haliaeetus leucocephalus*	T (DL)	T
	Cerulean warbler[e]	*Dendroica cerulea*	C	NL
	Cooper's hawk[e]	*Accipter cooperii*	NL	NM
	Double-crested cormorant[d]	*Phalacrocorax auritus*	NL	NM
	Grasshopper sparrow[e]	*Ammodramus savannarum*	NL	NM
	Great egret[d]	*Casmerodius alba*	NL	NM
	Little blue heron[e]	*Egretta caerulea*	NL	NM
	Loggerhead shrike	*Lanius ludovicianus*	NL	NM
	Northern harrier[d]	*Circus cyaneus*	NL	NM
	Olive-sided flycatcher[d]	*Contopus borealis*	NL	NM
	Osprey	*Pandion haliaetus*	NL	T
	Sandhill crane[d]	*Grus canadensis*	NL	NM
	Sharp-shinned hawk[e]	*Accipiter striatus*	NL	NM
	Snowy egret	*Leucophoyx thula*	NL	NM
	Yellow-bellied sapsucker	*Sphyrapicus varius*	NL	NM
Amphibians				
	Four-toed salamander	*Hemidactylium scutatum*	NL	NM
Fish				
	Paddlefish	*Polyodon spathula*	SC	NL
	Tennessee dace[f]	*Phoxinus tennesseensis*	NL	NM
Plants				
	American ginseng[f]	*Panax quinquefolius*	NL	S-CE
	Appalachian bugbane[d]	*Cimicifuga rubifolia*	SC	T
	Branching whitlow-grass	*Draba ramosissima*	NL	S
	Butternut[f]	*Juglans cinerea*	SC	T
	Canada (wild-yellow) lily[f]	*Lilium canadense*	NL	T
	Carey's saxifrage[f]	*Saxifraga careyana*	NL	S
	Fen orchid[f]	*Liparis loeselii*	NL	E
	Golden seal[f]	*Hydrastis canadensis*	NL	S-CE
	Hairy sharp-scaled sedge	*Carex oxylepis var. pubescense*	NL	S
	Heavy sedge[f]	*Carex gravida*	NL	S
	Howe's sedge	*Carex howei*	NL	E
	Lesser lady's tresses	*Spiranthes ovalis*	NL	S
	Michigan lily[f]	*Lilium michiganense*	NL	T
	Mountain witch alder[f]	*Fothergilla major*	NL	T
	Northern bush honeysuckle[f]	*Diervilla lonicera*	NL	T
	Northern white cedar	*Thuja occidentalis*	NL	S
	Nuttall waterweed[f]	*Elodea nuttallii*	NL	S
	Pink lady's-slipper[f]	*Cypripedium acaule*	NL	E-CE
	Purple fringeless orchid[f]	*Platanthera peramoena*	NL	T
	Pursh's wild-petunia	*Ruellia purshiana*	NL	S
	River bulrush	*Scirpus fluviatilis*	NL	S
	Shining ladies-tresses	*Spiranthes lucida*	NL	T
	Small-headed sedge	*Juncus brachycephalus*	NL	S
	Spreading false foxglove[f]	*Aureolaria patula*	SC	T
	Tall larkspur[f]	*Delphinium exaltatum*	SC	E
	Three-parted violet	*Viola triparta* var. *triparta*	NL	S
	Tubercled rein-orchid[f]	*Platanthera flava var. herbiola*	NL	S
	White-topped sedge	*Rhynchospora colorata*	NL	S
	Whorled mountainmint	*Pycnanthemum verticillatum*	NL	E-P

[a] Status codes: C-Candidate; DL-proposed for delisting; E-endangered; NL-not listed; NM-in need of management; P-possibly extirpated; S-special concern in Tennessee; SC-Federal Species of Concern; T-threatened.

[b] Only one dead gray bat has been reported from the ORR. Not currently known to nest on the ORR.

[c] The Indiana bat has not been reported from the ORR although USFWS records suggest it may be present.

[d] Uncommon visitor or migrant. Not currently known to nest on the ORR.

[e] Summer

[f] Recent record of species occurrence on ORR.

Sources: 50 CFR 17.11; 50 CFR 17.12; DOE 1995a; 64 FR36454; 64 FR 46542; DOE 1990; ORNL 1993b; ORNL 1981b; ORNL 1984a; ORNL 1988; DOE 1999k; LMER 1999a; TDEC 1997; TDEC 1998; TWRC 1991a; TWRC 1991b.