1. Introduction to the Oak Ridge Reservation

The Oak Ridge Reservation (ORR) is a 13,563 ha (33,515-acre) federally owned site located in the counties of Anderson and Roane in eastern Tennessee. ORR is home to two major US Department of Energy (DOE) operating components, the Oak Ridge National Laboratory (ORNL) and the Y-12 National Security Complex (Y-12 Complex). A number of other facilities are located on ORR, including the East Tennessee Technology Park (ETTP), site of a former gaseous diffusion plant that is undergoing environmental restoration and transition to a private sector business/industrial park; the Oak Ridge Institute for Science and Education (ORISE) South Campus, which includes training facilities, laboratories, and support facilities; a variety of smaller government-owned, contractor-operated facilities involved in environmental restoration; and the government-owned, government-operated Agent Operations Eastern Command (AOEC) of the National Nuclear Security Administration (NNSA) Office of Secure Transportation (OST).

ORR was established in the early 1940s as part of the Manhattan Project for the purposes of enriching uranium and pioneering methods for producing and separating plutonium. ORR missions are continuing to evolve as it adapts to meet the changing basic and applied research and national security needs of the United States.

The *Oak Ridge Reservation Annual Site Environmental Report* is available at http://www.ornl.gov/sci/env_rpt.

Due to differing permit reporting requirements and instrument capabilities, various units of measurement are used in this report. The list of units of measure and conversion factors provided on pages xxvii and xxviii is intended to help readers convert numeric values presented here as needed for specific calculations and comparisons.

1.1 Background

The *Oak Ridge Reservation Annual Site Environmental Report* is prepared annually and presents summary environmental data to (1) characterize environmental performance, (2) summarize environmental occurrences reported during the year, (3) confirm compliance with environmental standards and requirements, and (4) highlight significant program activities. The report fulfills the requirement contained in DOE O 231.1b, *Environment, Safety and Health Reporting*, (DOE 2011) that an integrated annual site environmental report be prepared.

The results summarized in this report are based on data collected before and continuing through 2011. This report is not intended to, nor does it, present the results of all environmental monitoring associated with ORR. Data collected for other site and regulatory purposes, such as environmental restoration/remedial investigation reports, waste management characterization sampling data, and environmental permit compliance data, are presented in other documents that have been prepared in accordance with applicable DOE guidance and/or laws and are referenced here as appropriate. Appendix A contains a glossary of technical terms that may be useful for understanding the terminology used in this report.

Environmental monitoring on ORR consists primarily of two major activities: effluent monitoring and environmental surveillance. Effluent monitoring involves the collection and analysis of samples or measurements of liquid and gaseous effluents at the points of release to the environment; these measurements allow the quantification and official reporting of contaminant levels, assessment of public exposures to radiation and chemicals, and demonstration of compliance with applicable standards and permit requirements. Environmental surveillance consists of direct measurements and collection and analysis of samples taken from the site and its environs exclusive of effluents; these activities provide information on contaminant concentrations in air, water, groundwater, soil, foods, biota, and other media.

Environmental surveillance data support determinations regarding environmental compliance and, when combined with data from effluent monitoring, support chemical and radiation dose and exposure assessments of the potential effects of ORR operations, if any, on the local environment.

1.2 History of the Oak Ridge Reservation

The ORR area was first occupied by Native Americans more than 10,000 years ago, and members of the Overhill Cherokee tribe still lived in the East Tennessee region when European settlers arrived in the late 1700s. These settlers lived on farms or in four small communities called Elza, Robertsville, Scarboro, and Wheat. All but Elza were founded shortly after the Revolutionary War. In the early 1940s about 1,000 families inhabited the area.

In 1942, the area that was to become ORR was selected for use in the Manhattan Project because the Clinch River provided ample supplies of water, nearby Knoxville was a good source of labor, and the Tennessee Valley Authority (TVA) could supply the huge amounts of electricity needed. About 3,000 residents received court orders to vacate within weeks the homes and farms that their families had occupied for generations. The site's wartime name was "Clinton Engineering Works."

The workers' city, named Oak Ridge, was established on the reservation's northern edge. The city grew to a population of 75,000 and was the fifth largest in Tennessee; however, it was not shown on any map. At the Y-12 Complex, south of the city, an electromagnetic separation method was used to separate ^{235}U from natural uranium. A gaseous diffusion plant, later known as K-25, was built on the reservation's western edge. Near the reservation's southwest corner, about 16 km (10 miles) from the Y-12 Complex, was a third facility, known as X-10 or Clinton Laboratories, where the Graphite Reactor was built. The X-10 facility was a pilot plant for the larger plutonium production facilities built at Hanford, Washington. Two years after World War II ended, Oak Ridge was shifted to civilian control, under the authority of the US Atomic Energy Commission. In 1959, the city was incorporated and a city manager and city council form of government was adopted by the community.

Since that time, the missions of these three major installations have continued to evolve and operations have adapted to meet the changing defense, energy, and research needs of the United States. Their current missions, as well as the missions of several smaller DOE facilities/activities on ORR, are described in Sect. 1.4 of this document.

1.3 Site Description

1.3.1 Location and Population

ORR lies within the Great Valley of East Tennessee between the Cumberland and Great Smoky Mountains and is bordered by the Clinch River (Fig. 1.1). The Cumberland Mountains are 16 km (10 miles) to the northwest; the Great Smoky Mountains are 51 km (31.6 miles) to the southeast. ORR encompasses about 13,563 ha (33,515 acres) of mostly contiguous land owned by the federal government and under the management of DOE (Fig. 1.2). Most of it lies within the corporate limits of the city of Oak Ridge; some of the area west of ETTP lies outside the city limits. About 4,667 ha (11,533 acres) of ORR is situated in Anderson County, and about 8,906 ha (22,008 acres) is in Roane County. The population of the 10-county region surrounding ORR is about 946,830 with less than 2% of its labor force employed on ORR. Other municipalities within about 30 km (18.6 miles) of the reservation include Oliver Springs, Clinton, Lake City, Lenoir City, Farragut, Kingston, and Harriman.

Knoxville, the major metropolitan area nearest Oak Ridge, is located about 40 km (25 miles) to the east and has a population of about 185,100. Except for the city of Oak Ridge, the land within 8 km (5 miles) of ORR is semirural and is used primarily for residences, small farms, and cattle pasture. Fishing, hunting, boating, water skiing, and swimming are popular recreational activities in the area.

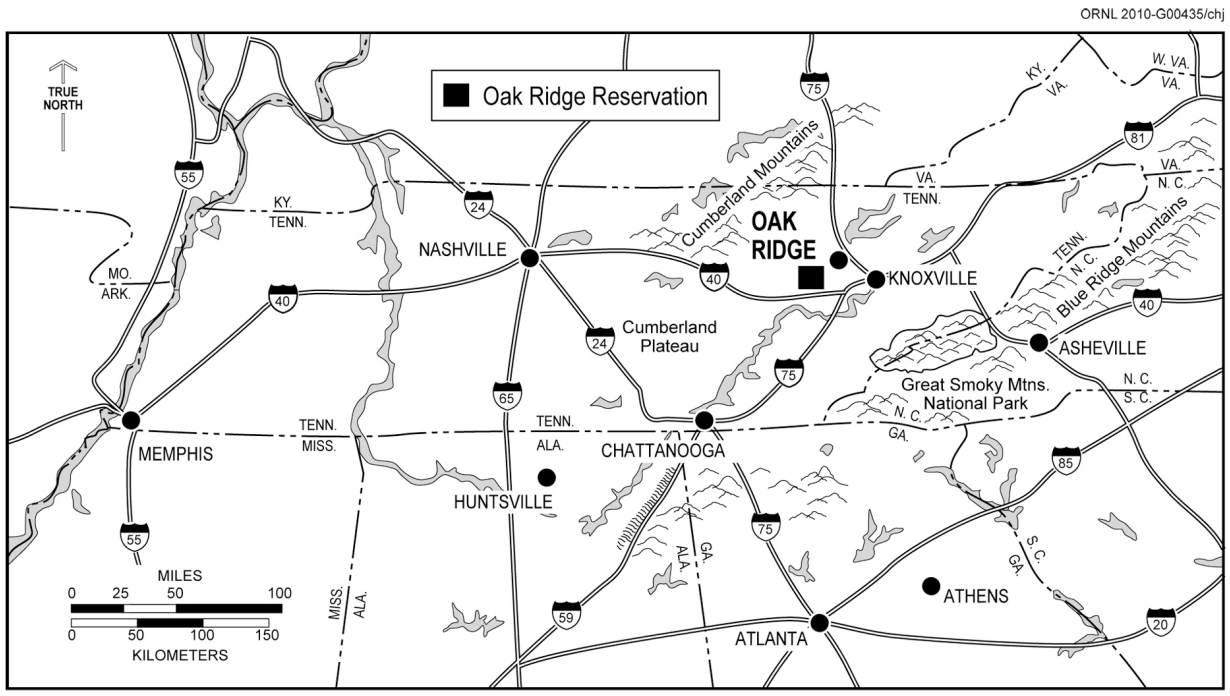

Fig. 1.1. Location of the city of Oak Ridge.

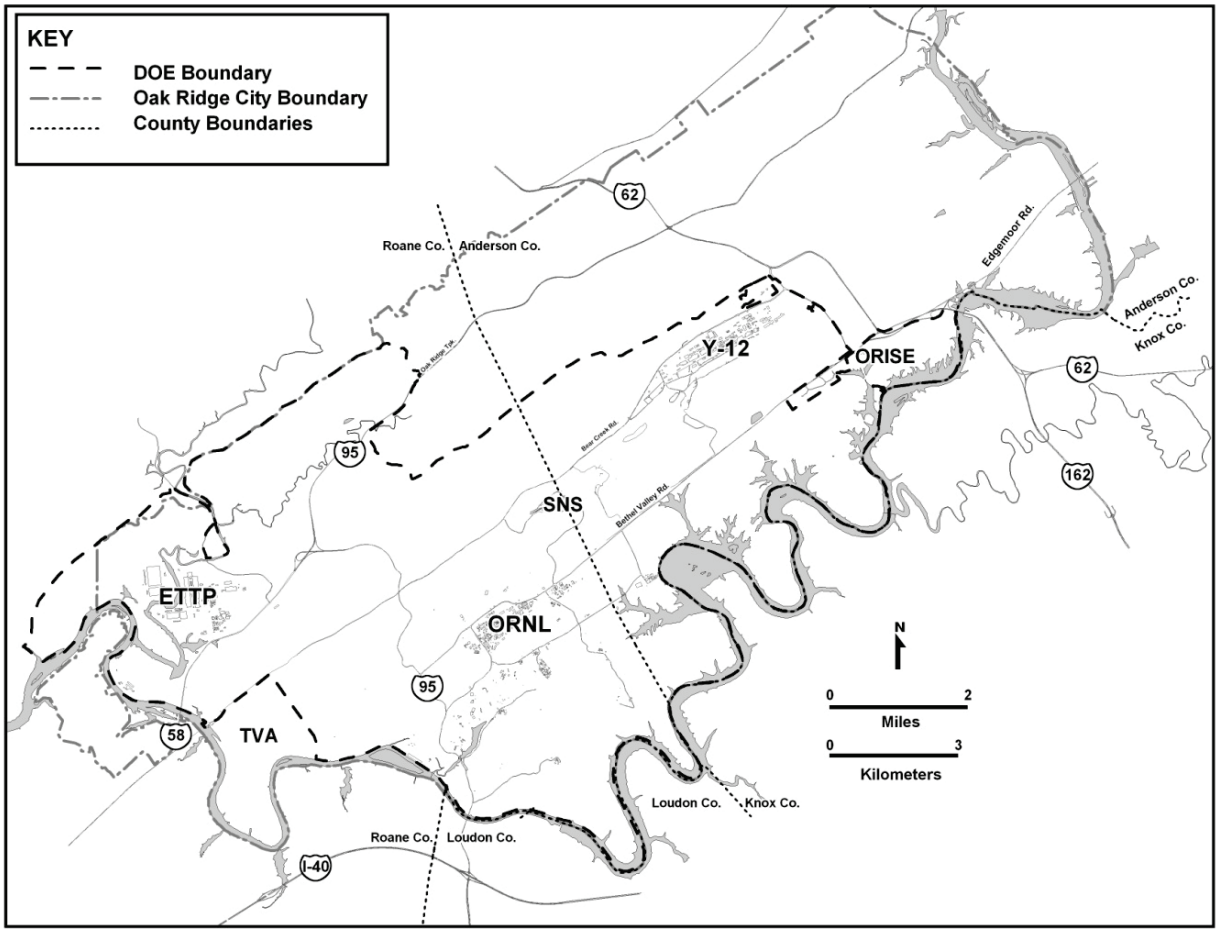

Fig. 1.2. The Oak Ridge Reservation.

1.3.2 Climate

The climate of the Oak Ridge region may be broadly classified as humid subtropical and is characterized by significant temperature changes between summer and winter. The 30-year mean temperature for the period of 1981–2010 is 14.9°C (58.8°F). The average temperature for the Oak Ridge area during 2011 was 15.7°C (60.3°F). The coldest month is usually January, with temperatures averaging about 3.2°C (37.7°F). During 2011, January temperatures averaged below normal at 2.8°C (35.8°F). July tends to be the warmest month, with average temperatures of 25.8°C (78.5°F). July 2011 temperatures averaged 27.3°C (81.1°F), above the 30-year average.

Average annual precipitation in the Oak Ridge area for the 30-year period from 1981 to 2010 was 1,293.5 mm (50.91 in.), including about 21.3 cm (8.4 in.) of snowfall annually (NOAA 2011). Total precipitation during 2011 (measured at the Oak Ridge National Weather Service meteorological tower) was 1,805 mm (71.05 in.), and total 2011 snowfall was 10.9 cm (4.3 in.). Precipitation during 2011 was about 40% above the 30-year average, but snowfall was below average. Monthly summaries of precipitation averages, extremes, and 2011 values are provided in Appendix B, Table B.1.

In 2011, wind speeds at ORNL Tower C (MT2) measured at 10 m (32.8 ft) above ground level (AGL) averaged 1.2 m/s (2.7 mph). This value increased to about 3.0 m/s (6.7 mph) for winds at 100 m (328 ft) AGL (about the height of local ridgetops). The local ridge-and-valley terrain reduces average wind speeds at valley bottoms, resulting in frequent periods of nearly calm conditions, particularly during clear early morning hours. Wind direction frequencies with respect to 2011 nonprecipitation and precipitation hours for the ORR towers may be reviewed at http://www.ornl.gov/~das/web/page7.cfm.

More detailed information on the climate of the Oak Ridge area is available in *Oak Ridge Reservation Physical Characteristics and Natural Resources* (Parr and Hughes 2006) and in Appendix B of this document. A detailed analysis of wind patterns for the Oak Ridge Reservation was conducted from 2009 to 2011 and may be reviewed online at http://www.ornl.gov/~das/met/MT/KRB_ORNL.pdf (Birdwell 2011).

1.3.3 Regional Air Quality

The US Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards has set National Ambient Air Quality Standards (NAAQS) for key principal pollutants, which are called "criteria" pollutants. These pollutants are sulfur dioxide (SO_2), carbon monoxide (CO), carbon dioxide (CO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), particulate matter (PM) with an aerodynamic diameter less than or equal to 10 μm (PM_{10}), and fine PM with an aerodynamic diameter less than or equal to 2.5 μm ($PM_{2.5}$). EPA evaluates NAAQS based on ambient (outdoor) levels of the criteria pollutants. Areas that satisfy NAAQS are classified as attainment areas, whereas areas that exceed the NAAQS for a particular pollutant are classified as nonattainment areas for that pollutant.

ORR is located in Anderson and Roane counties. EPA has designated Anderson County as a basic nonattainment area for the 8-hour (h) O_3 standard as part of the larger Knoxville 8 h basic O_3 nonattainment area, which encompasses several counties. In addition, EPA has designated Anderson, Knox, and Blount counties as a nonattainment area for the $PM_{2.5}$ air quality standard. EPA also designated the portion of Roane County surrounding the Kingston Steam Plant as a nonattainment area for $PM_{2.5}$. The greater Knoxville and Oak Ridge area is classified as an attainment area with the NAAQS for all other criteria pollutants for which EPA has made attainment designations.

1.3.4 Surface Water

ORR lies within the Valley and Ridge Physiographic Province, which is composed of a series of drainage basins or troughs containing many small streams feeding the Clinch River. Surface water on ORR drains into a tributary or series of tributaries, streams, or creeks within different watersheds. Each of these watersheds drains into the Clinch River that, in turn, flows into the Tennessee River.

The largest of the drainage basins is Poplar Creek, which receives drainage from a 352 km^2 (136 $mile^2$) area, including the northwestern sector of ORR. It flows from northeast to southwest, roughly through the center of ETTP, and discharges directly into the Clinch River.

East Fork Poplar Creek, which discharges into Poplar Creek east of ETTP, originates within the Y-12 Complex and flows northeast along the south side of the Y-12 Complex. Bear Creek also originates within the Y-12 Complex but flows southwest. Bear Creek is mostly affected by storm water runoff, groundwater infiltration, and tributaries that drain former waste disposal sites in the Bear Creek Valley Burial Grounds Waste Management Area and the current Environmental Management Waste Management Facility (EMWMF).

Both the Bethel Valley and Melton Valley portions of ORNL are in the White Oak Creek drainage basin, which has an area of 16.5 km^2 (6.4 $mile^2$). White Oak Creek headwaters originate on Chestnut Ridge, north of ORNL, near the Spallation Neutron Source (SNS) site. At the ORNL site, the creek flows west along the southern boundary of the developed area and then flows southwesterly through a gap in Haw Ridge to the western portion of Melton Valley, where it forms a confluence with Melton Branch. The headwaters of Melton Branch originate in Melton Valley east of the High Flux Isotope Reactor (HFIR) Complex. It has a drainage basin area of about 3.8 km^2 (1.47 $mile^2$). The waters of White Oak Creek enter White Oak Lake, which is an impoundment formed by White Oak Dam. Water flowing over White Oak Dam enters the Clinch River after passing through the White Oak Creek embayment area.

1.3.5 Geological Setting

ORR is located in the Tennessee portion of the Valley and Ridge Physiographic Province, which is part of the southern Appalachian fold-and-thrust belt. As a result of thrust faulting and differential erosion rates, a series of parallel valleys and ridges have formed that trend southwest–northeast.

Two geologic units on ORR, designated as the Knox Group and the Maynardville Limestone of the Upper Conasauga Group, consisting of dolostone and limestone, respectively, make up the most significant water-bearing hydrostratigraphic unit in the Valley and Ridge Province (Zurawski 1978) and on ORR. Being composed of fairly soluble minerals, these bedrock formations are prone to dissolution as slightly acidic rainwater and percolating recharge water come in contact with the mineral surfaces. This dissolution increases fracture apertures and can form caverns and extensive solution conduit networks under some circumstances. This hydrostratigraphic unit is referred to locally as the "Knox Aquifer." A combination of fractures and solution conduits in the aquifer control flow over substantial areas, and large quantities of water may move long distances. Active groundwater flow can occur at substantial depths in the Knox Aquifer [91.5 to 122 m (300 to 400 ft) deep]. The Knox Aquifer is the primary source of groundwater for many streams (base flow), and most large springs on ORR receive discharge from the Knox Aquifer. Yields of some wells penetrating larger solution conduits are reported to exceed 3,784 L/min (1,000 gal/min). The high productivity of the Knox Aquifer is attributed to the combination of its abundant and sometimes large solution conduit systems and frequently thick overburden soils that promote recharge and storage of groundwater.

The remaining geologic units on ORR (the Rome Formation, the Conasauga Group below the Maynardville Limestone, and the Chickamauga Group) are composed predominantly of shales, siltstones, and sandstones with a subordinate and locally variable amount of carbonate bedrock. These formations are predominantly composed of insoluble minerals such as clays and quartz that were derived from ancient continental erosion. Groundwater occurs and moves through fractures in those bedrock units. Groundwater availability in such settings is dependent on the abundance and interconnectedness of fractures and the connection of fractures to sources of recharge such as alluvial soils along streams that can provide some sustained infiltration. The shale and sandstone formations are the poorest aquifers in the Valley and Ridge Province (Zurawski 1978). Well yields are generally low in the Rome, Conasauga, and Chickamauga bedrock formations except in very localized areas where carbonate beds may provide greater groundwater storage than adjacent clastic bedrock (Fig. 1.3). Detailed information on ORR groundwater hydrology and flow is available in *Oak Ridge Reservation Physical Characteristics and Natural Resources* (Parr and Hughes 2006).

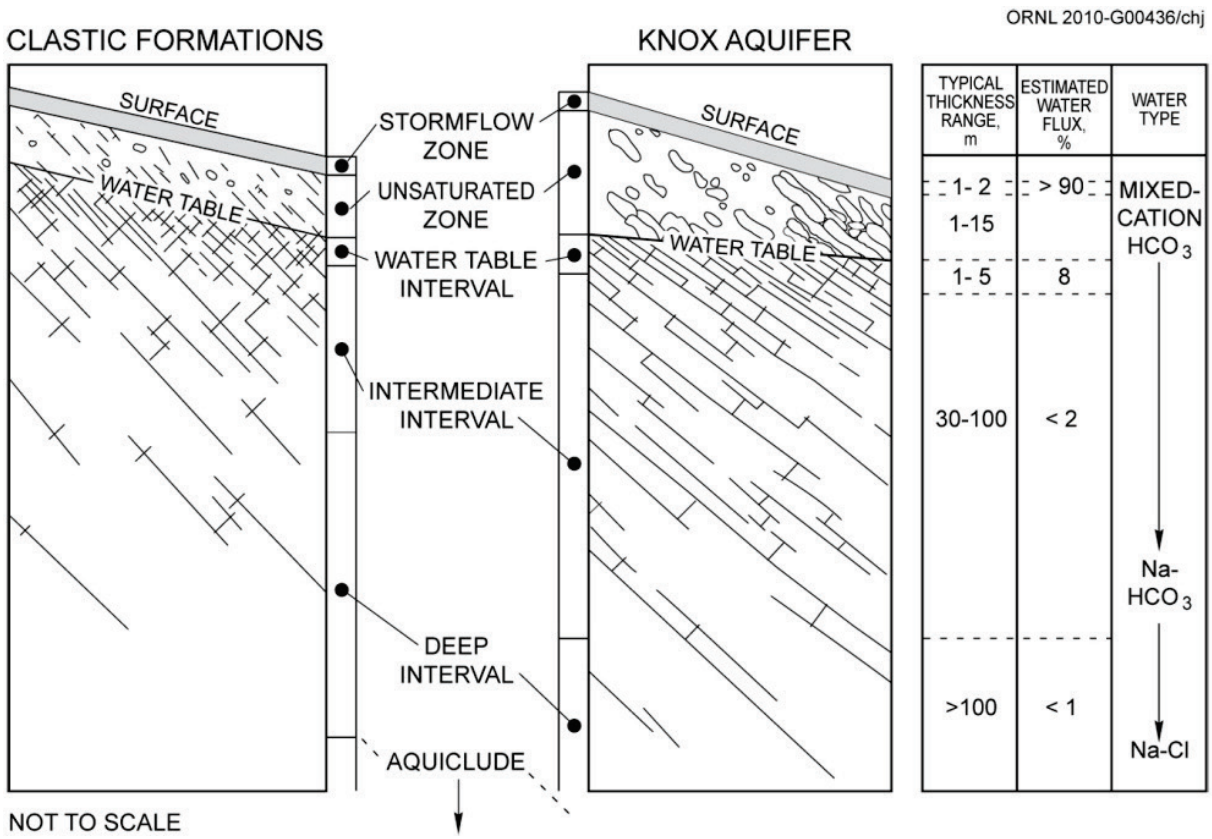

Fig. 1.3. Vertical relationships of flow zones of the Oak Ridge Reservation: estimated thicknesses, water flux, and water types.

1.3.6 Natural, Cultural, and Historic Resources

ORR contains a unique variety of natural, cultural, and historic resources. Ongoing efforts continue to focus on preserving the rich diversity of these resources.

1.3.6.1 Wetlands

About 243 ha (600 acres) of wetlands have been identified on ORR; most are classified as forested palustrine, scrub/shrub, and emergent wetlands. Wetlands occur across ORR at low elevations, primarily in riparian zones of headwater streams and receiving streams and in the Clinch River embayments (Fig. 1.4). Wetlands identified to date range in size from several square meters at small seeps and springs to about 10 ha (25 acres) at White Oak Lake. Surveys of wetlands resources presented in *Identification and Characterization of Wetlands in the Bear Creek Watershed* (Rosensteel and Trettin 1993), *Wetland Survey of the X-10 Bethel Valley and Melton Valley Groundwater Operable Units at Oak Ridge National Laboratory, Oak Ridge, Tennessee* (Rosensteel 1996), and *Wetland Survey of Selected Areas in the Oak Ridge Y-12 Plant Area of Responsibility, Oak Ridge, Tennessee* (Rosensteel 1997) serve as references to support wetlands assessments for upcoming projects and activities. In addition, wetlands maps have been developed for selected areas of ORR in response to project-specific requirements. These are also consulted, and verified by site inspections, when appropriate.

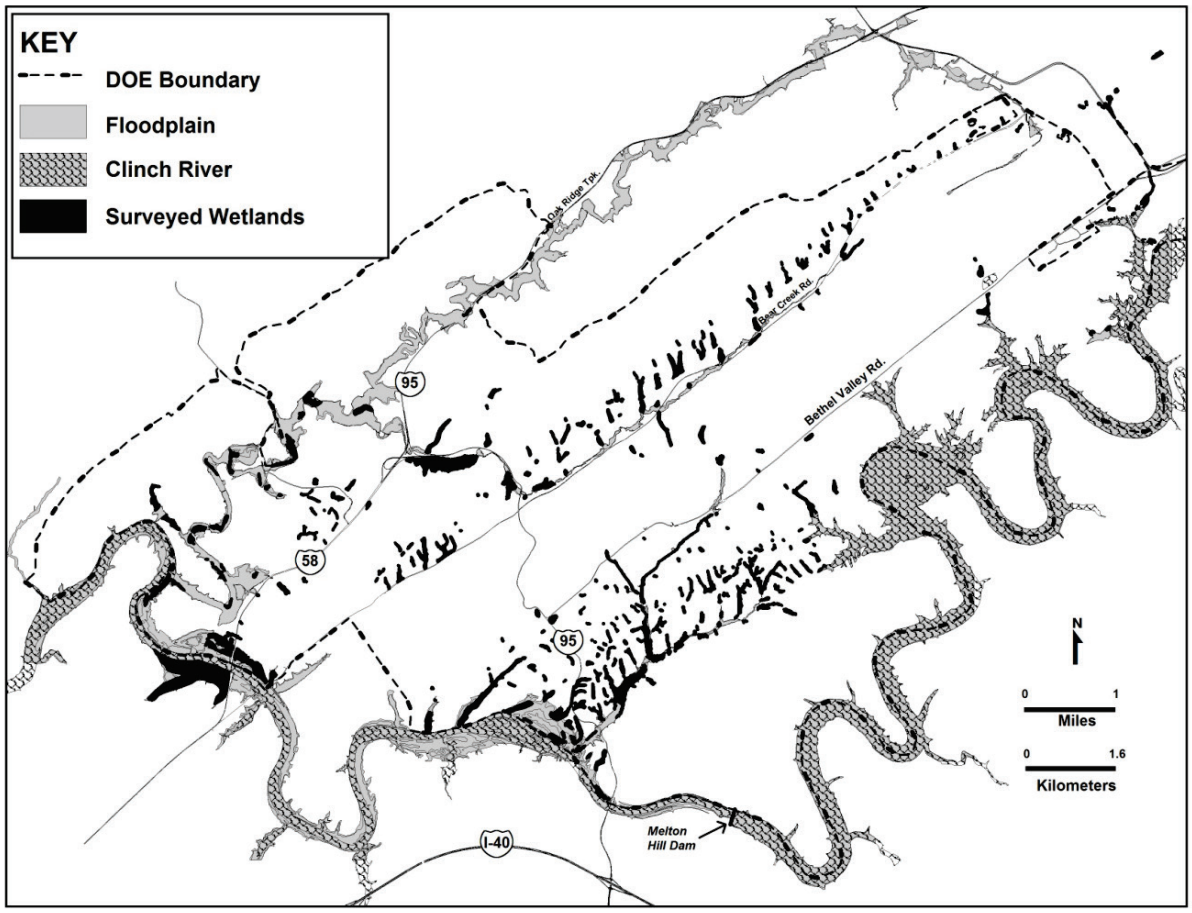

Fig. 1.4. Oak Ridge Reservation wetlands.

About 200 ft of an unnamed tributary to Fifth Creek and about 0.08 acres of wetland were impacted as a result of the construction of a new parking structure at ORNL. Compensatory mitigation, as per requirements set by the Tennessee Department of Environment and Conservation (TDEC), included the following.

- On-site expansion of an existing wetland (P2) by 0.04 acres adjacent to the new ORNL parking structure.
- On-site enhancement and preservation of about 800 ft of First Creek (between White Oak Avenue and West End Circle), 400 ft of White Oak Creek (at Building 4515—the High Temperature Materials Laboratory), and associated riparian zones.

Monitoring of restored or created mitigation sites for 5 years is a conventional requirement of TDEC's wetland-mitigation Aquatic Resource Alteration Permits (ARAPs), as required by Section 401 of the Clean Water Act (CWA). The first year of monitoring for this project was conducted in the summer of FY 2011.

Vegetation parameters were measured at the ORNL parking structure wetland (P2) before mitigation. Percent cover by species was measured for each plot. Information was also taken on any fauna present at the time of the survey.

Stream habitat assessments were conducted at both First Creek and White Oak Creek reaches using Habitat Assessment Data Sheets found in the Tennessee Mitigation Guidelines. Metrics evaluated at both sites included epifaunal substrate, embeddedness (amount of silt, etc. between rocks), velocity/depth regime, sediment deposition, channel flow, frequency of riffles, bank stability, and vegetative cover. These parameters were measured using rapid bioassessment protocols for use in wadeable streams and rivers (Barbour et al. 1999).

First Creek mitigation activities had already been completed before this habitat assessment. Therefore, quantitative habitat measurements recorded at the First Creek site represent post-mitigation habitat conditions. Pre-mitigation conditions for First Creek are discussed qualitatively from information contained in previous reports (Ryon and Quarles 2008). The White Oak Creek habitat assessment was based on pre-mitigation habitat conditions.

Riparian zone vegetation surveys were conducted by establishing 10 by 5 m plots about 10 m apart (First Creek—east bank, White Oak Creek—north and south banks). A total of 11 plots were established at First Creek and 13 plots were established at White Oak Creek. For each plot the following parameters were measured: trees (≥ 3 in. diameter at breast height)—measured, shrub stems (< 3 in. diameter at breast height)—counted, percent groundcover, percent canopy cover, canopy height, vegetation overhang (cm) for each stream bank.

Fish and benthic community monitoring results were evaluated as an indicator of whether or not the stream sections were functioning as suitable habitat for in-stream organisms. Benthic macroinvertebrate community data were gathered at First Creek (July 8, 2011) and White Oak Creek (June 8, 2011) using an EPA approved rapid qualitative assessment technique. At each site seven aquatic habitats were identified and sampled for aquatic macroinvertebrates, riffles, leaf packs, woody debris, rocks, root wads, aquatic vegetation, and in-stream sediment deposition. These habitats were located within 100 m upstream and downstream of the sampling site established along each reach. When habitats were missing from the site they were not sampled. For each habitat a 12 in. rim D-Net with 500 μm nylon netting was used to collect samples. After all habitats were sampled and recorded, the total number of families of insects was tallied to determine the number of families represented by the orders Ephemeroptera, Plecoptera, and Trichoptera. Biological Monitoring and Abatement Program (BMAP) fish survey data used for evaluation of First Creek were from close proximity to the subject reach. The fish community data used for evaluation of the White Oak Creek site were from data taken during routine BMAP surveys within the subject reach. The fish communities within these reaches were monitored using a multiple pass removal estimate method (Ryon 2011). The sample sites were isolated by block nets, multiple passes were made using backpack or barge electrofishers, and all stunned fish were collected. Fish were identified by species, measured for length and weight, and returned to the site.

Baseline data obtained for the P2 wetland showed sparse vegetation with limited habitat before mitigation. Although vegetation was sparse before mitigation, volunteer wetland plants had already become established on the site, providing a good initial start to the recovery of the wetland. The marginal habitat present on the site was evident in the lack of fauna recorded during initial surveys. Supplemental planting conducted on the site with native wetland plants in June 2011 is expected to significantly improve the quality of these wetlands. The first year of post-mitigation monitoring for this site will be conducted in the summer of 2012.

The results of habitat measurements conducted along the First Creek reach showed that the creek provided good overall habitat and was in a nonimpaired state. The relatively linear condition of the creek was evidence of past channelization with the development of the area. Relatively narrow riparian zones are a weakness of the site from the perspective of providing good quality habitat. However, riparian zones in this area are restricted by paved and landscaped areas because the creek runs through a developed area. Mitigation plantings on the east side of the creek have improved habitat quality in that area over original habitat conditions that included large mowed turf grass areas and a high number of invasive plant species. The riparian zone on the west side is highly restricted because of the close proximity of landscaped and parking areas associated with a building complex. Cover is maintained to the maximum extent possible in this narrow zone. The presence of invasive plants in these zones such has winter creeper (both sides) and Johnson grass (west side) is a potential concern.

Survivorship of east side First Creek riparian plantings has been excellent thus far, based on the 2011 surveys. Planted vegetation appears to be thriving, with very few failures. Dense growths of shrubs previously existing on the site (e.g., silky dogwood, spicebush) provided significant cover along the creek banks, particularly along northern portions of the study area. Overall conditions at the site related to vegetation growth and success remain very good.

A moderately diverse benthic macroinvertebrate population was recorded at the First Creek site in 2011. This included taxa typically found in clear streams. Fish population densities (sampled upstream and downstream of the site) were similar to certain reference streams on ORR. The number of fish species at the downstream sampling location was similar to or lower than reference streams, and the number of species recorded at the upstream location was lower than reference streams.

The second year of post-mitigation monitoring for the First Creek site will be conducted in the summer of 2012.

The results of habitat measurements conducted along the White Oak Creek reach showed that the creek provided average overall habitat in the pre-mitigation condition and was in a nonimpaired state. Epifaunal substrate was somewhat lacking in the presence of logs and snags; however, the creek provided numerous riffles, some undercut banks, a variety of particle sizes, and overhanging branches. One velocity/depth regime (fast-deep) was missing from the reach. Channel alteration from past development of the area was evident along some areas of the reach. Vegetative protection at the banks was compromised by the presence invasive plant species (i.e., winter creeper, crown-vetch, Chinese privet, and Johnson grass). Very narrow riparian zones were a significant weakness on the site, mainly due to the existence of adjacent areas that contained large areas of low turf grasses and weedy species. Although riparian zone width is restricted on the north side by an existing paved road and on the south side by a building, modifications made to the site with the mitigation plantings (August 2011) should significantly improve the quality of this zone in the future.

The White Oak Creek site, pre-mitigation, displayed good vegetation cover. However, much of the area was covered by either managed/mowed turf areas or nonnative invasive plant species. Areas of higher habitat quality were found directly adjacent to the creek, where green ash and black willow trees and shrubs were present.

A moderately diverse benthic macroinvertebrate population was recorded at the White Oak Creek site in 2011. This included some of the more tolerant taxa found in ORR streams. Fish population densities sampled within the reach were similar to certain reference streams on ORR. The number of fish species recorded tended to be lower than reference streams.

The first year of post-mitigation monitoring for the White Oak Creek site will be conducted in the summer of 2012.

Wetland assessments were conducted at two sites in the Bear Creek Watershed at the Y-12 Complex in late FY 2011. The assessments were conducted to determine whether jurisdictional wetlands were present in areas that could be adjacent to or within proposed facility modernization projects. The areas were evaluated for hydrology, wetland soils, and wetland vegetation. A total of two wetlands that satisfied soils, hydrologic, and vegetation criteria of the US Army Corps of Engineers (USACE) wetland protocols were identified. The two wetlands delineated, totaling 0.34 acres, are located south of an existing Uranium Processing Facility (UPF) storage structure near EMWMF. The wetlands will be avoided, with the required buffer zone, and not otherwise impacted by the project.

The UPF project has performed no field work to impact or mitigate the wetlands evaluated in 2011. However, UPF design evolution and modifications have resulted in the designation of an additional 0.5 acres of wetland mitigation area (3.51 acres total) for the project. The revision of the existing USACE Section 404 and TDEC Aquatic Resource Alteration Permit to reflect these changes is in process.

1.3.6.2 Wildlife/Endangered Species

Animals listed as species of concern and known to be present on the reservation (excluding the Clinch River bordering the reservation) are listed along with their status in Table 1.1.The list identifies sensitive wildlife species found on ORR. Some of these (e.g., anhinga) have been seen only once or a few times; others (e.g., sharp-shinned hawk, southeastern shrew) are comparatively common and widespread on the reservation.

Table 1.1. Animal species of special concern reported from the Oak Ridge Reservation[a]

Scientific name	Common name	Status[b]		
		Federal	State	PIF[c]
	FISH			
Phoxinus tennesseensis	Tennessee dace		NM	
	AMPHIBIANS AND REPTILES			
Cryptobranchus alleganiensis	Hellbender	MC	NM	
Hemidactylium scutatum	Four-toed salamander		NM	
	BIRDS			
	Darters			
Anhinga anhinga	Anhinga		NM	
	Bitterns and Herons			
Ardea alba	Great egret		NM	
Egretta caerulea	Little blue heron		NM	
Egretta thula	Snowy egret		NM	
	Kites, Hawks, Eagles, and Allies			
Haliaeetus leucocephalus	Bald eagle	d	NM	
Circus cyaneus	Northern harrier		NM	
Accipiter striatus	Sharp-shinned hawk		NM	
Buteo platypterus	Broad-winged hawk			RI
	Falcons			
Falco peregrinus	Peregrine falcon	e	E	RI
	Grouse, Turkey, and Quail			
Bonasa umbellus	Ruffed grouse			RI
Colinus virginianus	Northern bobwhite			RI
	Rails, Gallinules, and Coots			
Gallinula chloropus	Common moorhen		NM	
	Owls			
Aegolius acadicus	Northern saw-whet owl	MC	T	RI
Tyto alba	Barn owl		NM	
	Goatsuckers			
Caprimulgus carolinensis	Chuck-will's-widow			RI
Caprimulgus vociferus	Whip-poor-will			RI
	Swifts			
Chaetura pelagica	Chimney swift			RI
	Kingfishers			
Megaceryle alcyon	Belted kingfisher			RI
	Woodpeckers			
Melanerpes erythrocephalus	Red-headed woodpecker			RI
Sphyrapicus varius	Yellow-bellied sapsucker	MC	NM	
Picoides pubescens	Downy woodpecker			RI
Colaptes auratus	Northern flicker			RI
	Tyrant Flycatchers			
Contopus cooperi	Olive-sided flycatcher		NM	RI
Contopus virens	Eastern wood-pewee			RI
Empidonax traillii	Willow flycatcher			RI
Empidonax virescens	Acadian flycatcher			RI
	Swallows			
Progne subis	Purple martin			RI
	Titmice and Chickadees			
Poecile carolinensis	Carolina chickadee			RI

Table 1.1. (continued)

Scientific name	Common name	Status[b]		
		Federal	State	PIF[c]
	Nuthatches			
Sitta pusilla	Brown-headed nuthatch			RI
	Kinglets, Gnatcatchers, and Thrushes			
Hylocichla mustelina	Wood thrush			RI
	Thrashers & Mockingbirds			
Toxostoma rufum	Brown thrasher			RI
	Shrikes			
Lanius ludovicianus	Loggerhead shrike	MC	NM	RI
	Vireos			
Vireo flavifrons	Yellow-throated vireo			RI
	Wood Warblers			
Vermivora chrysoptera	Golden-winged warbler	MC	NM	RI
Vermivora pinus	Blue-winged warbler			RI
Setophaga cerulea	Cerulean warbler		NM	RI
Setophaga discolor	Prairie warbler			RI
Setophaga fusca	Blackburnian warbler			RI
Mniotilta varia	Black-and-white warbler			RI
Helmitheros vermivorus	Worm-eating warbler			RI
Parkesia motacilla	Louisiana waterthrush			RI
Geophlypis formosus	Kentucky warbler			RI
Cardellina canadensis	Canada warbler			RI
Setophaga citrina	Hooded warbler			RI
Icteria virens	Yellow-breasted chat			RI
	Tanagers			
Piranga olivacea	Scarlet tanager			RI
Piranga rubra	Summer tanager			RI
	Cardinals, Grosbeaks, and Allies			
Passerina cyanea	Indigo bunting			RI
	Towhees, Sparrows, and Allies			
Pipilo erythrophthalmus	Eastern towhee			RI
Spizella pusilla	Field sparrow			RI
Ammodramus savannarum	Grasshopper sparrow			RI
Pooecetes gramineus	Vesper sparrow		NM	
Ammodramus henslowii	Henslow's sparrow	MC	NM	RI
	Blackbirds and Allies			
Sturnella magna	Eastern meadowlark			RI
	MAMMALS			
Myotis grisescens	Gray bat	E	E	
Sorex longirostris	Southeastern shrew		NM	
Zapus hudsonius	Meadow jumping mouse		NM	

[a]Land and surface waters of the Oak Ridge Reservation (ORR) exclusive of the Clinch River, which borders ORR.
[b]Status codes
E = endangered
T = threatened
MC = species of management concern
NM = in need of management
RI = regional importance
[c]Partners in Flight
[d]The bald eagle was federally delisted effective August 8, 2007.
[e]The peregrine falcon was federally delisted effective August 25, 1999.

Birds, fish, and aquatic invertebrates are the most thoroughly surveyed animal groups on ORR. The only federally listed animal species that has been observed on ORR in recent years is the gray bat, which was observed over water bordering ORR (the Clinch River) in 2003 and over a pond on ORR in 2004. Three gray bats were mist-netted outside a cave on ORR in 2006. Several state-listed bird species, such as the anhinga, olive-sided flycatcher, and little blue heron, are uncommon migrants or visitors to the reservation; however, the little blue heron is believed to be increasing in numbers. The cerulean warbler, listed by the state as in need of management, has been recorded during the breeding season; however, this species is not actually known to breed on the reservation. The bald eagle (Fig. 1.5), also listed by the state as in need of management, is increasingly seen at all times of the year, and one nest was confirmed on the reservation in 2011. Others, such as the northern harrier, great egret, and yellow-bellied sapsucker, are migrants or winter residents that do not nest on the reservation. The golden-winged warbler, listed by the state as in need of management, has been sighted once on the reservation. Barn owls have been known to nest on the reservation in the past.

ORNL2012-P01070

Fig. 1.5. Bald eagle nest on the Oak Ridge Reservation. *[Source:* Jason Richards, ORNL photographer.]

One species of fish, the spotfin chub (*Erimonax monachus*), which is listed as threatened by both the state and the federal government, has been sighted and collected in the city of Oak Ridge and may be present on ORR. The Tennessee dace, listed by the state as being in need of management, has been found in Bear Creek watershed, tributaries to lower East Fork watershed, and Ish Creek and may occur in some sections of Grassy Creek upstream of Scientific Ecology Group, Inc., and International Technology Corporation at Clinch River Kilometer 23 (e.g., south of west Bear Creek Road near Grassy Creek sampling point 1.9).

1.3.6.3 Threatened and Endangered Plants

Four species (spreading false-foxglove, Appalachian bugbane, tall larkspur, and butternut) have been under review for listing at the federal level and were listed under the formerly used "C2" candidate designation. These species are now informally referred to as "special concern" species by the US Fish and Wildlife Service.

The most recent addition (2009) to the ORR list of state-protected plants (Table 1.2) is American barberry, which is listed as a species of special concern by the state. Also, early in 2011 butternut was confirmed to be currently extant on ORR.

The Tennessee Heritage Program scientific advisory committee met in 2009 to revise the state list, but its changes to the state list are not yet official. These changes are expected to add one species to the ORR list while deleting two. In addition, the ORR list (Table 1.2) reflects changes made by the state to the scientific names used for plants.

Table 1.2. Vascular plant species listed by state or federal agencies, 2011

Species	Common name	Habitat on ORR	Status code[a]
Currently known or previously reported from ORR			
Aureolaria patula	Spreading false-foxglove	River bluff	FSC, S
Berberis canadensis	American barberry	Rocky bluff	S
Bolboschoenus fluviatilis	River bulrush	Wetland	S
Carex gravida	Heavy sedge	Forest	S
Carex oxylepis var. pubescens[b]	Hairy sharp-scaled sedge	Shaded wetlands	S
Cimicifuga rubifolia	Appalachian bugbane	Forested River slope	FSC, T
Cypripedium acaule	Pink lady's-slipper	Dry to rich woods	S-CE
Delphinium exaltatum	Tall larkspur	Barrens and woodlands	FSC, E
Diervilla lonicera	Northern bush-honeysuckle	Rocky River bluff	T
Draba ramosissima	Branching whitlow-grass	Limestone cliff	S
Elodea nuttallii	Nuttall waterweed	Pond, embayment	S
Fothergilla major	Mountain witch-alder	Woods	T
Helianthus occidentalis	Naked-stem sunflower	Barrens	S
Hydrastis canadensis	Golden seal	Rich woods	S-CE
Juglans cinerea	Butternut	Lake shore	FSC, T
Juncus brachycephalus	Small-head rush	Open wetland	S
Lilium canadense	Canada lily	Moist woods	T
Lilium michiganense[c]	Michigan lily	Moist woods	T
Liparis loeselii	Fen orchid	Forested wetland	E
Panax quinquefolius	Ginseng	Rich woods	S-CE
Platanthera flava var. herbiola	Tuberculed rein-orchid	Forested wetland	T
Ruellia purshiana	Pursh's wild-petunia	Dry, open woods	S
Spiranthes lucida	Shining ladies-tresses	Boggy wetland	T
Thuja occidentalis	Northern white cedar	Rocky river bluffs	S
Viola tripartite var. tripartite	Three-parted violet	Rocky woods	S
Rare plants that occur near and could be present on ORR			
Agalinis auriculata	Earleaf false foxglove	Calcareous barren	FSC, E
Allium burdickii or *A. Tricoccom*[d]	Ramps	Moist woods	S, CE
Pseudognaphalium helleri	Heller's catfoot	Dry woodland edge	S
Lathyrus palustris	A vetch	Moist meadows	S
Liatris cylindracea	Slender blazing star	Calcareous barren	E

Table 1.2. (continued)

Species	Common name	Habitat on ORR	Status code[a]
	***Rare plants near or on ORR* (continued)**		
Lonicera dioica	Mountain honeysuckle	Rocky river bluff	S
Meehania cordata	Heartleaf meehania	Moist calcareous woods	T
Pedicularis lanceolata	Swamp lousewort	Calcareous wet meadow	T
Pycnanthemum torrei	Torrey's mountain-mint	Calcareous barren edge	S
Solidago ptarmicoides	Prairie goldenrod	Calcareous barren	E

[a]Status codes:
CE = Status due to commercial exploitation.
E = Endangered in Tennessee.
FSC = Federal Special Concern; formerly designated as C2. See *Federal Register*, February 28, 1996.
S = Special concern in Tennessee.
T = Threatened in Tennessee.

[b]*Carex oxylepis var. pubescens* has not been observed during recent surveys.

[c]*Lilium michiganense* is believed to have been extirpated from the Oak Ridge Reservation (ORR) by the impoundment at Melton Hill.

[d]Ramps have been reported near ORR, but there is not sufficient information to determine which of the two species is present or if the occurrence may have been introduced by planting. Both species of ramps have the same state status.

Abbreviations
ORR = Oak Ridge Reservation

1.3.6.4 Historical and Cultural Resources

Efforts continue to preserve ORR's rich prehistoric and historic cultural resources. The reservation contains more than 45 known prehistoric sites (primarily burial mounds and archeological evidence of former structures), more than 250 historic pre-World War II structures, 32 cemeteries, and several historically significant Manhattan Project–era structures. Six historic ORR properties are individually listed in the *National Register of Historic Places*:

- Freels Bend Cabin,
- Graphite Reactor,
- New Bethel Baptist Church and Cemetery,
- Oak Ridge Turnpike Checking Station,
- George Jones Memorial Baptist Church and Cemetery, and
- Scarboro Road Checking Station.

Although not yet listed in the *National Register*, an area known as the Wheat Community African Burial Grounds was dedicated in June 2000, and a memorial monument was erected.

The DOE Oak Ridge Office (ORO) *Cultural Resource Management Plan* (DOE 2001) was developed to identify, assess, and document historic and cultural resources on ORR and establish a management strategy.

1.4 DOE Offices and Sites

1.4.1 The DOE Oak Ridge Office

ORR is home to one of the world's preeminent research and manufacturing parks, with major federal programs in the areas of science, environmental management, nuclear fuel supply, and national security. DOE ORO oversees and manages these programs at three primary sites: ORNL, ETTP, and ORISE.

The DOE presence in Oak Ridge has a major financial impact on the area as well; it serves as an economic engine, driving local, regional, and statewide development. DOE is credited with providing a

$3.6 billion increase in the gross state product. It supports some 44,889 full-time jobs statewide, results in $76.9 million in state and local sales tax, and is the fourth-largest employer in Tennessee.

With a federal and contractor workforce in Oak Ridge of more than 12,000 people, DOE is committed to continuing its strong ties to the communities in East Tennessee. The support of local communities has enabled ORO to undertake some of the most complex work in the department, and there is more to come as ORO advances public- and private-sector growth in the areas of science, manufacturing, national security, and reindustrialization.

1.4.2 The National Nuclear Security Administration Y-12 Site Office

NNSA is a semiautonomous agency within DOE that works in partnership with the US Department of Defense and the other components of the national security enterprise to perform routine maintenance and repair of nuclear weapons components, dismantlement of retired nuclear weapons, and refurbishment of nuclear warheads and to maintain the capability to design, manufacture, and certify new nuclear warheads.

The NNSA Y-12 Site Office (YSO), located on the Y-12 Complex, is responsible for operation of the Y-12 Complex. YSO employees perform contract and program management oversight, contract and administrative management, and technical evaluation and assessment.

1.4.3 Oak Ridge National Laboratory

ORNL is DOE's largest science and energy laboratory (Fig. 1.6). Managed since April 2000 by UT-Battelle, LLC, a partnership between the University of Tennessee and Battelle Memorial Institute, ORNL was established in 1943 as part of the Manhattan Project to pioneer a method for producing and separating plutonium. During the 1950s and 1960s, ORNL became an international center for the study of nuclear energy and related research in the physical and life sciences. With the creation of DOE in the 1970s, ORNL's mission broadened to include a variety of energy technologies and strategies. Today the laboratory supports the nation with a peacetime science and technology mission.

Fig. 1.6. The Oak Ridge National Laboratory.

As an international leader in a range of scientific areas that support DOE's mission, ORNL has six major mission roles: neutron science, energy, high-performance computing, systems biology, materials science at the nanoscale, and national security. ORNL's leadership role in the nation's energy future includes hosting the US project office for the ITER fusion experiment and the BioEnergy Science Center, which is sponsored by the DOE Office of Science.

The Transuranic Waste Processing Center (TWPC) is located on a tract of land approximately 26 acres in size in the Melton Valley area of ORNL about 120 ft west of the existing Melton Valley Storage Tanks. TWPC is managed by Wastren Advantage, Inc., (WAI) for DOE. TWPC's mission is to receive transuranic (TRU) wastes from ORNL for processing, treatment, repackaging, and shipment to designated facilities for final disposal. Processed TRU waste is shipped to the Waste Isolation Pilot Plant (WIPP) for disposal. Waste that is determined to be non-TRU (e.g., low-level radioactive waste, mixed low-level waste) is shipped to the Nevada National Security Site (NNSS) or another approved facility.

Isotek Systems LLC (Isotek) manages activities at ORNL's Building 3019 Complex for DOE and is responsible for activities associated with processing, down-blending, and packaging the DOE inventory of ^{233}U stored in the Building 3019 Complex.

SEC Federal Services Corporation (SEC) is involved in the decommissioning of ORNL facilities for the DOE Office of Environmental Management (EM) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Historically, these facilities were used in support of reactor area operations and for various laboratory support activities.

About 5 ha (12 acres) in the central portion of ORNL has been leased to Halcyon, LLC, a subsidiary of the Community Reuse Organization of East Tennessee (CROET), for development into the Oak Ridge Science and Technology Park (ORSTP). ORSTP provides space for private companies doing research at ORNL, partner universities, start-up companies built around ORNL technologies, and ORNL contractors to conduct business within a short distance of ORNL researchers and DOE user facilities such as SNS, the Center for Nanophase Materials Sciences, and HFIR. Construction of the first ORSTP facility, Pro2Serve's 115,000 ft^2 National Security Engineering Center, was completed in 2009, and the company is now well-established in the building. In addition, the former Building 2033, also leased to Halcyon, LLC, is now known as the Halcyon Commercialization Center (HCC) and continues to attract tenants. HCC's largest tenant is Roane State Community College, which is offering job training classes on-site in the areas of carbon fiber manufacturing and solar energy technology. Other HCC tenants include several consulting firms and a carbon fiber manufacturer that is partnering with ORNL for materials research. Expansion of ORSTP will continue as more environmental cleanup in ORNL's central campus is completed. EPA has designated ORSTP lessees as collocated workers because they are located on DOE property and are issued security badges to access the facilities.

As of the date of this report, no construction was occurring within ORSTP.

1.4.4 The Y-12 National Security Complex

The original Y-12 Complex was constructed as part of the World War II Manhattan Project and began operations in November 1943. The first site mission was the separation of ^{235}U from natural uranium by an electromagnetic separation process. At its peak in 1945, more than 22,000 workers were employed at the site.

Today, as part of the NNSA Nuclear Security Enterprise, the Y-12 Complex (Fig. 1.7) performs critical roles in strengthening national security and reducing the global threat from weapons of mass destruction through work in support of the nation's nuclear weapons stockpile, nuclear nonproliferation, and naval reactors. The Y-12 Complex also provides unique and highly specialized manufacturing and software technologies to other federal agencies through the DOE Work for Others program.

ORNL 2012-G00348/chj

Fig. 1.7. Y-12 National Security Complex.

1.4.5 East Tennessee Technology Park

What is now known as ETTP (Fig. 1.8) was originally named the K-25 Site, where the nation's first gaseous diffusion plant for enriching uranium, as part of the Manhattan Project, was located.

ORNL 2010-G00441/chj

Fig. 1.8. East Tennessee Technology Park.

In the postwar years, additional uranium enrichment facilities were built adjacent to K-25, forming a complex officially known as the Oak Ridge Gaseous Diffusion Plant. Uranium enrichment operations at the site ceased in 1987, and restoration and decontamination and decommissioning activities began soon after in preparation for ultimate conversion of the site to a private-sector industrial park to be called the Heritage Center. Reindustrialization of the site began in 1996 when it was renamed the East Tennessee Technology Park. Restoration of the environment, decontamination, and decommissioning of facilities; disposition of wastes; and reindustrialization are the major activities at the site. During the first part of the CY 2011 period covered by this report, ETTP landlord contractor functions and the majority of the ETTP cleanup program actions were managed by Bechtel Jacobs, Inc., LLC (BJC). In August 2011, the BJC work scope at ETTP transitioned to URS | CH2M Oak Ridge LLC (UCOR), a newly formed partnership between URS and CH2M Hill.

1.4.6 Environmental Management Waste Management Facility

EMWMF is located in eastern Bear Creek Valley near the Y-12 Complex and was managed by BJC during the period covered by this report. In August 2011, management transitioned from BJC to UCOR. EMWMF was built for disposal of waste resulting from CERCLA cleanup actions on ORR. The original design was for the construction, operation, and closure of a projected 1.3 million m^3 (1.7 million yd^3) disposal facility. The approved capacity was subsequently increased to 1.8 million m^3 (2.4 million yd^3) to maximize use of the footprint designated in a 1999 record of decision (ROD). The facility currently consists of six disposal cells.

EMWMF is an engineered landfill that accepts low-level, mixed low-level, and hazardous wastes from DOE ORR sites that meet specific waste acceptance criteria developed in accordance with agreements with state and federal regulators. Waste types that qualify for disposal include soil, dried sludge and sediment, solidified wastes, stabilized waste, building debris, scrap equipment, and secondary waste such as personal protective equipment, all of which must meet the land disposal restrictions. In addition to the solid waste disposal facility, EMWMF operates a leachate collection system. The leachate is treated at the ORNL Liquids and Gaseous Treatment Facility (LGTF), which is operated by UCOR.

1.4.7 Oak Ridge Environmental Research Park

In 1980, DOE established the Oak Ridge Environmental Research Park (Fig. 1.9). The research park serves as an outdoor laboratory to evaluate the environmental consequences of energy use and development and the strategies to mitigate those effects. It contains large blocks of forest and diverse communities of vegetation that offer unparalleled resources for ecosystem-level and large-scale research. Major national and international collaborative research initiatives use it to address issues such as multiple stress interactions, biodiversity, sustainable development, tropospheric air quality, global climate change, innovative power conductors, solar radiation monitoring, ecological recovery, and monitoring and remediation.

Field sites at the research park provide maintenance and support facilities that permit sophisticated and well-instrumented environmental experiments. These facilities include elaborate monitoring systems that enable users to precisely and accurately measure environmental factors for extended periods of time. Because the park is under the jurisdiction of the federal government, public access is restricted and experimental sites and associated equipment are, therefore, not disturbed.

National recognition of the value of the research park has led to its use as a component of both regional- and continental-scale research projects. Various research park sites offer opportunities for aquatic and terrestrial ecosystem analyses of topics such as biogeochemical cycling of pollutants resulting from energy production, landscape alterations, ecosystem restoration, wetlands mitigation, and forest and wildlife management.

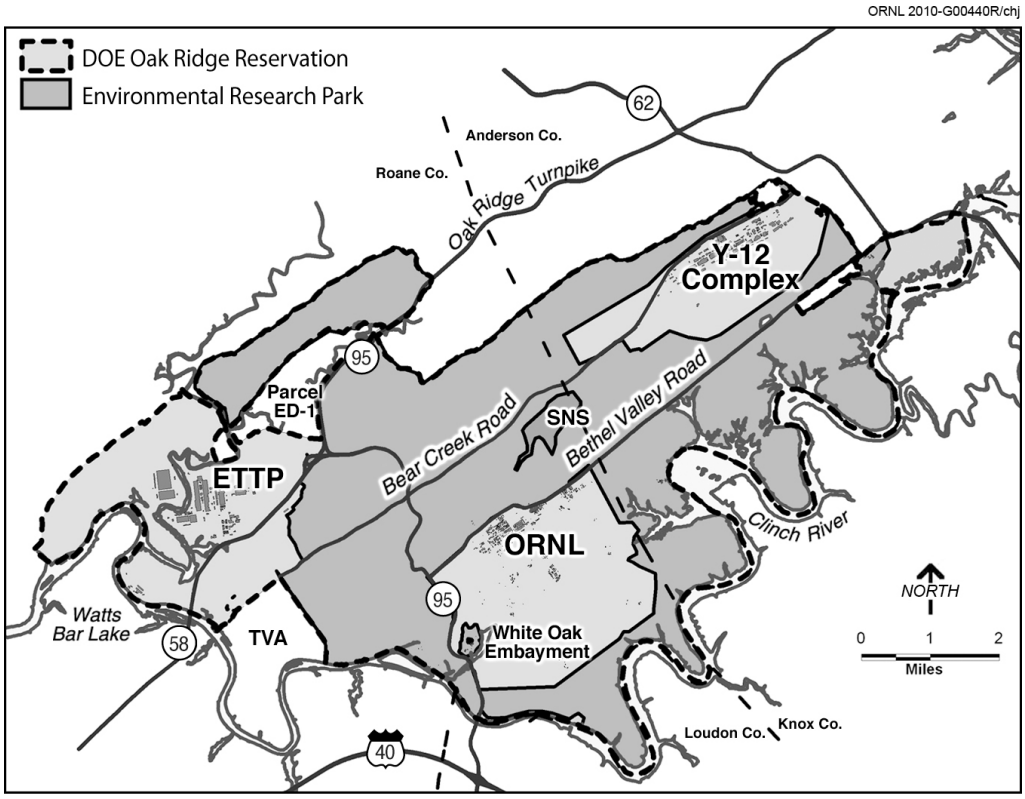

Fig. 1.9. The Oak Ridge Environmental Research Park.

1.4.8 Oak Ridge Institute for Science and Education

ORISE is a DOE institute managed by Oak Ridge Associated Universities (ORAU). ORISE addresses national needs in assessing and analyzing environmental and health effects of radiation, beryllium, and other hazardous materials; developing and operating medical and national security radiation emergency management and response capabilities; and managing education programs to help ensure a robust supply of scientists, engineers, and technicians to meet future science and technology needs. ORISE creates opportunities for collaboration through partnerships with other DOE facilities, federal agencies, academia, and industry in a manner consistent with DOE objectives and the ORISE mission.

ORISE is located on an area on the southeastern border of ORR that from the late 1940s to the mid-1980s was part of an agricultural experiment station owned by the federal government and, until 1981, operated by the University of Tennessee. The site houses offices, laboratories, and storage areas for the ORISE program offices and support departments.

1.4.9 The National Nuclear Security Administration Office of Secure Transportation, Agent Operations Eastern Command

Since 1947, DOE and its predecessor agencies have moved nuclear weapons, weapons components, special nuclear materials, and other important national security assets by commercial and government transportation modes. In the late 1960s, worldwide terrorism and acts of violence prompted a review of procedures for safeguarding these materials. As a result, a comprehensive new series of regulations and equipment was developed to enhance the safety and security of these materials in transit. Thus, modified and redesigned transport equipment to incorporate features that more effectively enhance self-protection and that deny unauthorized access to the materials was established. Also during this time, the use of commercial transportation systems was abandoned, and a totally federal operation was implemented. The organization within DOE NNSA responsible for this mission is OST.

The NNSA OST AOEC Secure Transportation Center and Training Facility is located on ORR. NNSA OST AOEC is situated on about 485 ha (1,198 acres) of ORR and operates under a user permit agreement with DOE ORO. NNSA OST AOEC implements its assigned mission transportation operations, maintains applicable fleet and escort vehicles, and continues extensive training activities for its federal agents.

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