



Signs such as this were common in the city of Oak Ridge during the Manhattan Project era and for years afterward.

1

Introduction to the Oak Ridge Reservation

It was not shown on any maps. No visitors were allowed without special approval. US Army guards were posted at the entrances to the city, and all residents were required to wear badges at all times outside their homes. Thus Oak Ridge existed for seven years, from 1942 to 1949, as a truly secret city. It was here and in supporting locations where humankind made the leap from candlepower to nuclear power in a single generation. The engineering marvel that materialized in the Secret City changed the world, helped end World War II, and launched life-saving diagnostic tools such as magnetic resonance imaging and nuclear medicine. Today the former Secret City exists in two parts: the City of Oak Ridge and the Oak Ridge Reservation (ORR). ORR's mission continues to evolve as it adapts to meet the changing basic and applied research and national security needs of the United States.

ORR covers a little over 50 square miles of land in Anderson and Roane counties and is home to two major US Department of Energy (DOE) operating facilities: the Oak Ridge National Laboratory (ORNL) and the Y-12 National Security Complex (Y-12). Other ORR facilities include the East Tennessee Technology Park (ETTP), the site of a former gaseous diffusion plant that has undergone significant environmental cleanup and transitioned to a private sector business and industrial park; the Oak Ridge Institute for Science and Education (ORISE) South Campus, which includes training, laboratory, and support facilities; the government-owned, government-operated Agent Operations Eastern Command (AOEC) of the National Nuclear Security Administration (NNSA) Office of Secure Transportation (OST); the Transuranic Waste Processing Center (TWPC); and small government-owned, contractor-operated environmental cleanup facilities.

Due to different permit reporting requirements and instrument capabilities, this report uses various units of measurement. The lists of units of measure and conversion factors on pages xxx and xxxi are included to help readers convert numeric values as needed for specific calculations and comparisons.

1.1. Background

The ORR Annual Site Environmental Report (ASER) is a summary of environmental data that characterizes environmental performance, lists environmental occurrences reported during the year, confirms compliance with environmental standards and requirements, and highlights significant environmental program activities. The ASER meets the requirements of DOE Order 231.1B, *Environment, Safety, and Health Reporting*, and its Attachment 2 (DOE 2012) regarding the preparation of an integrated annual site environmental report.

Summary results in this report are based on data collected before and continuing through 2023. Not all results of the environmental monitoring associated with ORR are reported here, and this is not intended to be a comprehensive monitoring report. Data collected for other site and regulatory purposes, such as environmental restoration and 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 laws, regulations, policies, and guidance. These data are referenced herein as appropriate.

Environmental monitoring of ORR activities consists primarily of 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 their release to the environment. These measurements allow quantification and official reporting of contaminant levels, assessment of public exposures to radiation (see Appendix E) and chemicals (see Appendix F), and demonstration of compliance with applicable standards and permit requirements. Environmental surveillance consists of direct measurement, collection, and analysis of samples taken from the site and its environs, exclusive of effluents. These surveillance activities provide information on contaminant concentrations in air, water, groundwater, soil, foods, biota, and other media. Environmental surveillance data support environmental compliance and, when combined

with data from effluent monitoring, also support chemical and radiation dose and exposure assessments of any potential effects of ORR operations on the local environment.

1.2. History of the Area around the Oak Ridge Reservation

Native Americans first inhabited the ORR area during the Woodland Period (c. 900 BC to AD 1000). Their descendants still lived in the East Tennessee region when European settlers arrived in the late 1700s. The Cherokee Nation controlled the region at this time, but the 1791 Treaty of the Holston and the 1798 Treaty of Tellico allowed for European settlement, which forever altered the landscape. As settlements continued to grow in numbers, new counties were formed, including Roane County and Anderson County in 1801. Early European settlers of the area lived on farms or in four small communities named Elza, Robertsville, Wheat, and Scarborough. These villages served primarily as gathering centers and usually contained one or two churches and a general store. About one thousand families inhabited the area in the early 1940s (Souza 2001, Hogan 2021).

In 1939 President Franklin D. Roosevelt received the famous Einstein-Szilard letter informing him that German scientists were working on a nuclear weapon. In utmost secrecy, he formed the Advisory Committee on Uranium, a team of scientists and military officials tasked with researching uranium's potential role as a weapon, which later evolved into the Office of Scientific Research and Development. After the United States was thrust into World War II following the Japanese attack on Pearl Harbor, the Manhattan Project emerged in 1942 as a full-scale program to build an atomic bomb. The super-secret code name gave no indication of the classified activities it carried out, and the project was named for the location of its original headquarters at 270 Broadway in New York City's Manhattan district. In the summer of 1943, the project moved to East Tennessee where construction of America's first full-scale gaseous diffusion plant was underway, to fulfill the mission of isolating ^{235}U for the first atomic bomb.

The selection of the area now known as ORR for the nuclear development site was largely due to the vision of General Leslie Groves. The presence of abundant water from the Clinch River, a good source of labor in nearby Knoxville, railroad accessibility, and a supply of ample amounts of electricity from the Tennessee Valley Authority were viewed as key assets. Moreover, the parallel northeast-to-southwest valleys separated by 200- to 300-foot ridges were seen as useful to segregate the production areas and to provide protection in case of a catastrophe within any one of them. The federal government's acquisition of property for the uranium enrichment plants and a pilot scale nuclear reactor took place through eminent domain and immediately affected more than 3,000 individuals, many whose families had occupied homes and farms for generations. Although the families were compensated by the federal government, the urgency of the eviction was difficult for the landowners, who were forced to abandon their houses and crops. Many property owners also felt they were underpaid for the value of their homes and land, although many later successfully appealed the initial land valuations offered to them.

The site's wartime name was Clinton Engineer Works, and the area now known as Oak Ridge was the workers' city on the reservation's northern edge. Although Oak Ridge did not appear on any map until 1949, it quickly grew to a population of 75,000, becoming the fifth largest city in Tennessee. To the south of the residential area at the Y-12 Complex, an electromagnetic method separated ²³⁵U from natural uranium. The K-25 gaseous diffusion plant was built on the reservation's western edge. Near the reservation's southwest corner, about 16 km (10 mi) from the Y-12 Complex, a third facility—known as X-10 or Clinton Laboratories—housed the experimental graphite reactor. X-10 served as a pilot scale facility for the larger plutonium production facilities built at Hanford, Washington (Olwell 1999, Broad 2007, Reed 2014, Johnson 2018).

The missions of the three major ORR installations have continued to evolve, and operations have adapted to meet America's changing defense, energy, and research needs. Section 1.4 describes the current missions of these and several smaller ORR facilities and activities.

1.3. Location and Description

Situated in the Great Valley of East Tennessee between the Cumberland and Great Smoky Mountains, ORR borders the Clinch River (see Figures 1.1 and 1.2). The Cumberland Mountains are 16 km (10 mi) to the northwest and the Great Smoky Mountains are 51 km (31.6 mi) to the southeast. Except for the city of Oak Ridge, the land within 8 km (5 mi) 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. ORR encompasses 32,465 acres of mostly contiguous, federally owned land in Anderson and Roane Counties, and is under the management of DOE (DOE 2023a).

1.3.1. Population

As reported in *US Department of Energy FY 2020 Economic Impact in Tennessee* (East Tennessee Economic Council), ORR supports approximately 43,000 members of the region's labor force. The Vintage 2023 US Census Population Estimate for the Knoxville Metropolitan Statistical Area, including Oak Ridge, was 946,264.¹ (Census Bureau 2024a). The combined US Census Vintage 2023 Population Estimate for the 10 counties surrounding ORR (Anderson, Blount, Campbell, Cumberland, Knox, Loudon, McMinn, Monroe, Morgan, and Roane) was 1,069,874 (Census Bureau 2024b). Knoxville, the nearest major city, is about 40 km (25 mi) to the east and had a population of 198,162 according to the US Census Vintage 2023 Population Estimate (Census Bureau 2024c). Other municipalities within about 30 km (18.6 mi) of ORR include Oliver Springs, Clinton, Rocky Top, Lenoir City, Farragut, Kingston, and Harriman.

¹ Vintage 2023 is the base population of the 2020 census plus estimates from the time series starting April 1, 2020, through July 1, 2023.

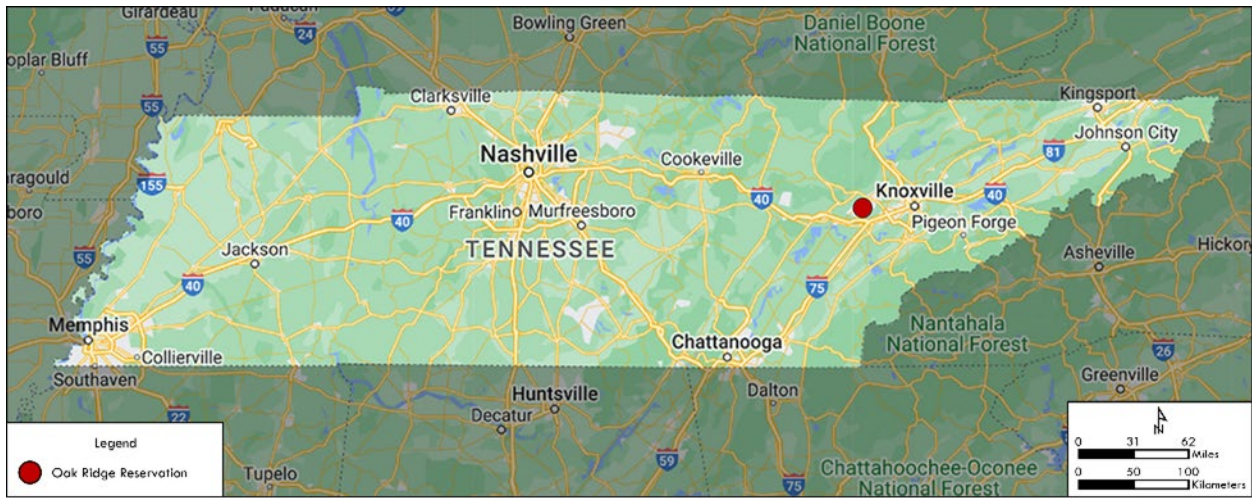


Figure 1.1. Location of the Oak Ridge Reservation in Tennessee

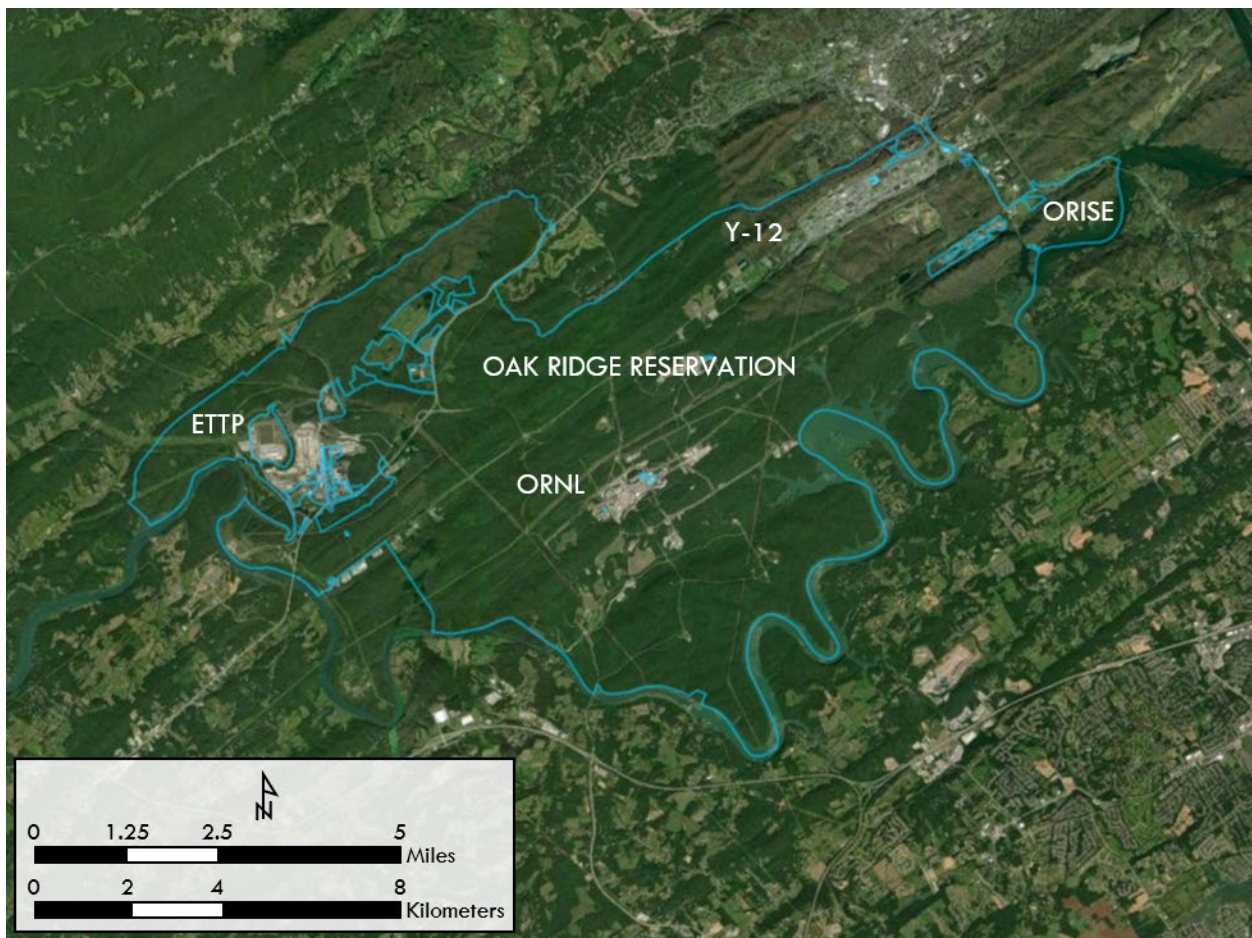


Figure 1.2. Map of the Oak Ridge Reservation

1.3.2. Climate

Although it features significant temperature changes between summer and winter, the climate of the Oak Ridge region qualifies as humid subtropical. The 30-year average temperature for 1991–2020 was 14.9°C (58.8°F). The average temperature for the Oak Ridge area in 2023 was 14.6°C (57.3°F). January temperatures were coldest in 2023, averaging 5.5°C (41.9°F). July was the warmest month, with an average temperature of 24.0°C (75.2°F). Monthly summaries of temperature averages, extremes, and 2023 values are provided in Appendix B, Table B.1.

Average annual precipitation in the Oak Ridge area for the 30-year period from 1991 to 2020 was 1,417.8 mm (55.82 in.), including about 14.5 cm (5.7 in.) of snowfall. Total precipitation during 2023 as measured at meteorological tower (MT)2 was 1200 mm (47.2 in.), which is 15 percent below the 30-year average of 1417.8 mm. Monthly summaries of precipitation averages, extremes, and 2023 values can also be found in Appendix B, Table B.1.

The average annual wind data recovery rates (a measure of acceptable data) across locations used for modeling during 2023 were greater than 98 percent for wind sensors at the ORNL towers MT3, MT4, and MT12. ORNL tower MT2 was down a portion of the year because of maintenance, but a recovery rate greater than 40 percent was recorded in 2023. Annual wind data recovery during 2023 exceeded 99 percent for ETTP tower MT13. Y-12 tower MT6, which was down most of the year for maintenance, recorded an annual recovery rate of 19.6 percent.

In 2023, wind speeds at ORNL Tower D (MT2) measured at 15 m (49 ft) above ground level averaged 1.4 meters per second (3.1 mph). This value was 2.1 meters per second (4.7 mph) for winds at 60 m (198 ft) above ground level. The local ridge-and-valley terrain reduces average wind speeds at valley bottoms, resulting in frequent periods of calm or near-calm conditions, particularly during clear early morning hours in weak synoptic weather environments.

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 report. An in-depth analysis of wind patterns for ORR conducted from 2009 to 2011 and documented in “Wind Regimes in Complex Terrain in the Great Valley of Eastern Tennessee” (Birdwell 2011) is available online [here](#).

1.3.3. Regional Air Quality

The US Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards set national ambient air quality standards (NAAQS) for key pollutants, also known as criteria pollutants. These key pollutants are sulfur dioxide, carbon monoxide, nitrogen dioxide, lead, ozone, particulate matter with an aerodynamic diameter less than or equal to 10 µm (PM₁₀), and fine particulate matter with an aerodynamic diameter less than or equal to 2.5 µm (PM_{2.5}). EPA evaluates NAAQS based on ambient, or outdoor, levels of the criteria pollutants. Areas that satisfy NAAQS are classified as attainment areas, and areas that exceed NAAQS for a particular pollutant are considered non-attainment areas for that pollutant.

As of August 30, 2017, EPA designated Anderson, Knox, Blount, and Roane Counties as attainment areas for the PM_{2.5} air quality standard. (ORR is located in Anderson and Roane Counties.) The greater Knoxville and Oak Ridge area is a NAAQS attainment area for all other criteria pollutants for which EPA has made attainment designations (EPA 2023).

1.3.4. Surface Water

The ORR area comprises a series of drainage basins or troughs containing numerous small streams that feed the Clinch River. Surface water on ORR drains into a series of tributaries, streams, or creeks in different watersheds. Each of these watersheds drains into the Clinch River, which in turn flows into the Tennessee River. The Tennessee Valley Authority reported 49 inches of precipitation in 2023 for the Tennessee River Valley region (TVA 2024). 2023 was the first year

since 2016 the 41,000 square-mile Tennessee River basin received below-normal rainfall and only the second year since 2012.

The largest of the ORR drainage basins is Poplar Creek, which receives drainage from a 352 km² (136 mi²) area, including the northwestern sector of ORR. Flow is from northeast to southwest, roughly through the center of ETTP, and the creek 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 complex. Bear Creek also originates within the Y-12 Complex and flows southwest. Bear Creek is 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 (WOC) drainage basin, which covers 16.5 km² (6.4 mi²). The headwaters of WOC originate on Chestnut Ridge, north of ORNL and near the Spallation Neutron Source site. The creek flows west along the southern boundary of the developed area of the ORNL site, then flows southwest through a gap in Haw Ridge to the western portion of Melton Valley, forming a confluence with Melton Branch. The headwaters of Melton Branch originate in Melton Valley east of the High Flux Isotope Reactor complex, and the area of the drainage basin is about 3.8 km² (1.47 mi²). The waters of WOC enter White Oak Lake, an impoundment formed by White Oak Dam. Water flowing over White Oak Dam enters the Clinch River after passing through the WOC embayment area.

1.3.5. Geological Setting

ORR is in the Tennessee portion of the Valley and Ridge Physiographic Province, which is part of the southern Appalachian fold-and-thrust belt. Thrust faulting, associated fracturing of the rock, and differential erosion rates created a series of

parallel valleys and ridges that trend southwest to northeast.

Two geologic units on ORR, the Knox Group and the Maynardville Limestone of the Upper Conasauga Group, consist of dolostone and limestone, respectively, and make up the most significant water-bearing hydrostratigraphic units in the Valley and Ridge Province (Zurawski 1978) and on ORR. Composed of moderately 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, under some circumstances, form caverns and extensive solution conduit networks. This hydrostratigraphic unit is locally known 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 (91.5 to 122 m, or 300 to 400 ft) in the Knox Aquifer. The Knox Aquifer is the primary source of groundwater (base flow) for many streams, and most large springs on ORR receive discharge from the Knox Aquifer. Yields of some wells penetrating larger solution conduits exceed 3,785.4 liters per minute (1,000 gallons per minute). The high productivity of the Knox Aquifer results from 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 shale, siltstones, and sandstones with a subordinate and locally variable amount of carbonate bedrock. These formations are primarily composed of insoluble minerals such as clays and quartz that were derived from ancient continental erosion. Groundwater occurs in and moves through fractures in these bedrock units. Groundwater availability in such settings depends on the abundance and interconnectedness of fractures

and the connection of fractures to sources of recharge, such as alluvial soils along streams, which 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 localized areas where carbonate beds may provide greater groundwater storage than adjacent clastic bedrock. Detailed information on ORR groundwater hydrology and flow is available in *Oak Ridge Reservation Physical Characteristics and Natural Resources* (Parr and Hughes 2006).

1.3.6. Natural, Cultural, and Historic Resources

ORR has an exceptional 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

Wetlands occur across ORR at low elevations, primarily in riparian zones of headwater streams and receiving streams and in the Clinch River embayments, as shown in Figure 1.3. Surveys of wetland 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 wetland assessments for upcoming projects and activities.

About 235 hectares (580 acres) of potential wetlands (jurisdictional and non-jurisdictional wetland areas) have been identified on ORR; most are classified as forested palustrine, scrub/shrub, and emergent wetlands (Parr and Hughes 2006). Wetlands identified to date range from several square meters at small seeps and springs to about 10 hectares (25 acres) at White Oak Lake. The Tennessee Department of Environment and

Conservation's wetland mitigation aquatic resource alteration permits, required by Section 401 of the Clean Water Act (CWA 1972), entail monitoring restored or created wetland mitigation sites for 5 years. Activities and conditions in and around ORR wetlands are verified by site inspections when appropriate.

1.3.6.2. Wildlife and Endangered Species

Animals listed as species of concern by state, federal, or international organizations and known to have occurred on the reservation (excluding the Clinch River bordering the reservation) are listed, along with their status, in Table 1.1. Some of these, such as hellbender, have been seen only once or a few times; others, including wood thrush, are comparatively common and widespread on ORR. As of May 2024, Tennessee had 58 species listed under the federal Endangered Species Act (ESA 1973), including 25 endangered and 33 threatened species. The complete Tennessee Threatened and Endangered List–New Rules is available [here](#) (TDEC 2024a).

Birds, fish, reptiles and amphibians, and aquatic invertebrates are the most thoroughly surveyed animal groups on ORR. Nevertheless, the only federally listed animal species observed on ORR in recent years are mammals. The only federally listed animal species known to occur on the ORR in recent years are bat species. Endangered gray bats have been detected in acoustic surveys and mist net captures for more than 30 years. Endangered Indiana bats and northern long-eared bats have been detected in acoustic surveys and mist net captures since 2013 (McCracken et al. 2015). Surveys conducted in 2022 indicate use of several caves on the ORR by gray bats and other bat species. Suitable roosting and foraging habitat for the three federally listed bat species is abundant across the ORR. Additional bat species found on the ORR include the tricolored bat (state-listed as threatened and proposed for federal listing), little brown bat (state-listed as threatened and under consideration for federal listing), Rafinesque's big-eared bat (state-listed as in need of management), and eastern small-footed bat (state-listed as in need of management) (TDEC 2024a, TDEC 2024b).

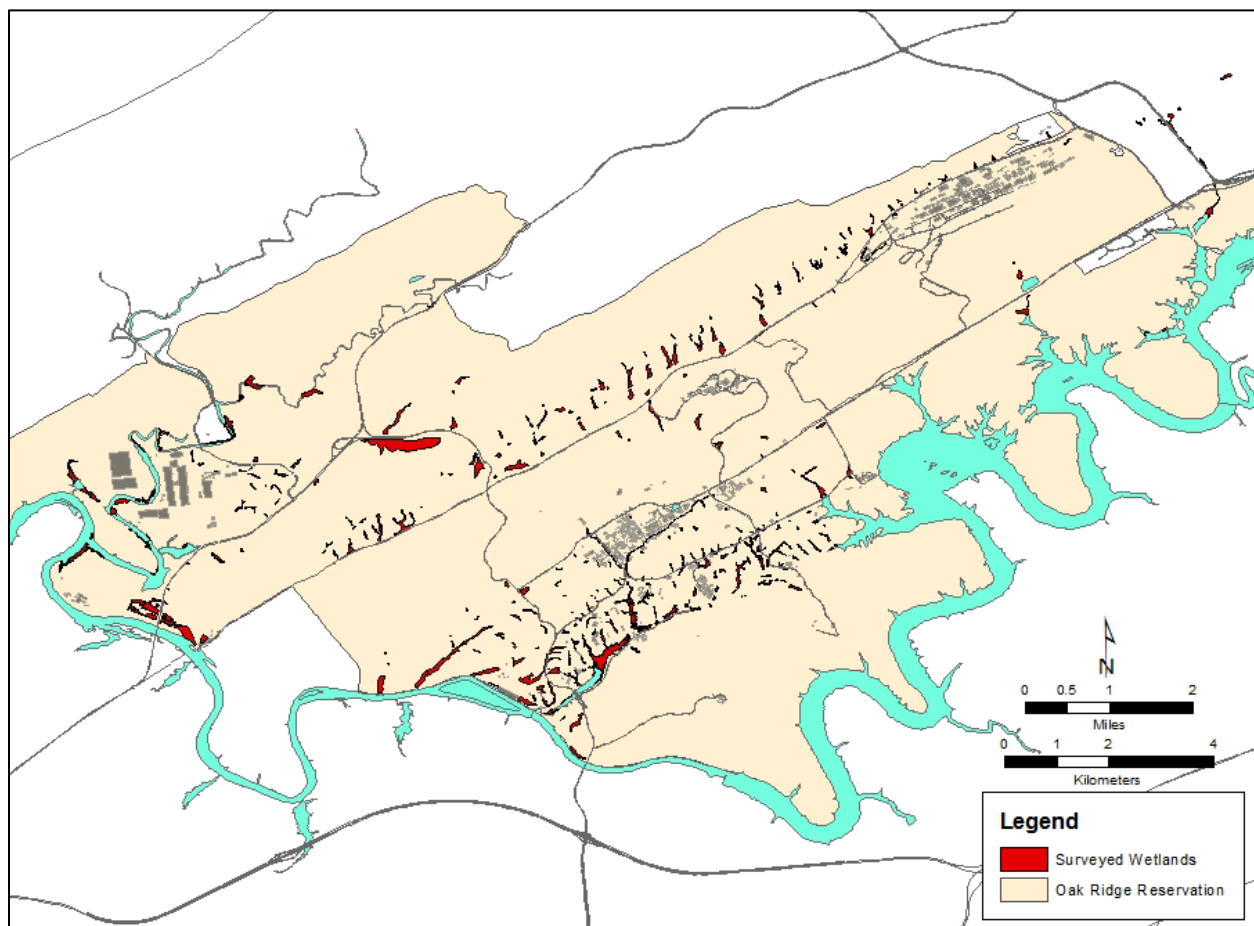


Figure 1.3. Location of Oak Ridge Reservation wetlands

Table 1.1. Animal species of special concern reported on ORR^a

Scientific name	Common name	Status ^b		
		Federal	TN	NatureServe ^c PIF ^d
FISH				
<i>Phoxinus tennesseensis</i>	Tennessee dace		NM	S3
AMPHIBIANS AND REPTILES				
<i>Cryptobranchus alleganiensis</i>	Hellbender		E	S3
<i>Hemidactylum scutatum</i>	Four-toed salamander		NM	S3
<i>Ophisaurus attenuatus longicaudus</i>	Eastern slender glass lizard		NM	S3
<i>Pituophis melanoleucus</i>	Northern pinesnake		T	S3
BIRDS				
Swans, Geese, and Ducks				
<i>Branta canadensis</i>	Canada goose	BMC, OA		S5
<i>Aix sponsa</i>	Wood duck	BMC		S5
<i>Mareca strepera</i>	Gadwall	BMC		S4

Table 1.1. Animal species of special concern reported on ORR^a (continued)

Scientific name	Common name	Status ^b			
		Federal	TN	NatureServe ^c	PIF ^d
<i>Mareca americana</i>	American wigeon	BMC		S4	
<i>Anas rubripes</i>	American black duck	BMC		S3	IM
<i>Anas platyrhynchos</i>	Mallard	BMC		S5	
<i>Spatula discors</i>	Blue-winged teal	BMC		S2	
<i>Anas crecca</i>	Green-winged teal	BMC		S4	
<i>Spatula clypeata</i>	Northern shoveler	BMC		S4	
<i>Anas acuta</i>	Northern pintail	BMC		S4	
<i>Aythya valisineria</i>	Canvasback	BMC		S3	
<i>Aythya americana</i>	Redhead	BMC		S4	
<i>Aythya collaris</i>	Ring-necked duck	BMC		S5	
<i>Aythya affinis</i>	Lesser scaup	BMC		S4	
Grebes					
<i>Podilymbus podiceps</i>	Pied-billed grebe	BMC		S4	
<i>Podiceps auritus</i>	Horned grebe	BMC		S4	
Frigatebirds, Boobies, Cormorants					
<i>Nannopterum auritum</i>	Double-crested cormorant	BMC, OA		S2	
Bitterns and Herons					
<i>Ixobrychus exilis</i>	Least bittern	BMC	NM	S2	
<i>Egretta caerulea</i>	Little blue heron	BMC	NM	S2	
<i>Nycticorax nycticorax</i>	Black-crowned night heron	BMC		S2	
<i>Butorides virescens</i>	Green heron			S4	MA
<i>Mycteria americana</i>	Wood stork	T		S3	
Kites, Hawks, Eagles, and Allies					
<i>Haliaeetus leucocephalus</i>	Bald eagle	BMC ^e		S3	
Rails, Gallinules, and Coots					
<i>Rallus limicola</i>	Virginia rail	BMC		S1	
<i>Porzana carolina</i>	Sora	BMC		S1	
<i>Fulica americana</i>	American coot	BMC		S2	
<i>Tringa solitaria</i>	Solitary sandpiper	BMC, BCC		S5	
<i>Tringa flavipes</i>	Lesser yellowlegs	BMC, BCC		S5	
<i>Scolopax minor</i>	American woodcock	BMC		S4	MA
Grouse, Turkey, and Quail					
<i>Colinus virginianus</i>	Northern bobwhite	BMC, BCC, E		S2	CR
Pigeons and Doves					
<i>Zenaida macroura</i>	Mourning dove	BMC		S5	
Cuckoos and Roadrunners					
<i>Coccyzus americanus</i>	Yellow-billed cuckoo	BMC, BCC, T		S4	IM

Table 1.1. Animal species of special concern reported on ORR^a (continued)

Scientific name	Common name	Status ^b			
		Federal	TN	NatureServe ^c	PIF ^d
Goatsuckers					
<i>Antrastomus carolinensis</i>	Chuck-will's widow	BMC, BCC		S3	IM
<i>Antrastomus vociferus</i>	Eastern whip-poor-will	BMC, BCC		S3	IM
<i>Chordeiles minor</i>	Common nighthawk	BCC		S4	IM
Swifts					
<i>Chaetura pelagica</i>	Chimney swift	BCC		S5	IM
Kingfishers					
<i>Megaceryle alcyon</i>	Belted kingfisher	BCC		S5	MA
Woodpeckers					
<i>Melanerpes erythrocephalus</i>	Red-headed woodpecker	BMC, BCC		S4	PR
<i>Colaptes auratus</i>	Northern flicker	BMC		S5	MA
Tyrant Flycatchers					
<i>Contopus virens</i>	Eastern wood-pewee			S5	MA
<i>Empidonax virescens</i>	Acadian flycatcher			S5	MA
<i>Contopus cooperi</i>	Olive-sided flycatcher	BMC, BCC		S1	PR
<i>Empidonax trailii</i>	Willow flycatcher	BMC, BCC, E		S2	
Swallows					
<i>Progne subis</i>	Purple martin			S5	MA
<i>Hirundo rustica</i>	Barn swallow			S5	MA
Kinglets, Gnatcatchers, and Thrushes					
<i>Hylocichla mustelina</i>	Wood thrush	BMC, BCC		S4	MA
Shrikes					
<i>Lanius ludovicianus</i>	Loggerhead shrike	BMC, BCC, E	NM	S1	
Wood Warblers					
<i>Vermivora chrysoptera</i>	Golden-winged warbler	BMC, BCC	T	S3	IM
<i>Setophaga cerulea</i>	Cerulean warbler	BMC, BCC	NM	S3	IM
<i>Setophaga discolor</i>	Prairie warbler	BMC, BCC		S3	MA
<i>Mniotilta varia</i>	Black-and-white warbler			S4	MA
<i>Protonotaria citrea</i>	Prothonotary warbler	BMC, BCC		S4	MA
<i>Geothlypis formosa</i>	Kentucky warbler	BMC, BCC		S4	MA
<i>Cardellina canadensis</i>	Canada warbler	BMC, BCC		S3	MA
<i>Icteria virens</i>	Yellow-breasted chat	BCC		S4	MA
Tanagers					
<i>Piranga rubra</i>	Summer tanager	BMC		S4	MA
Towhees, Sparrows, and Allies					
<i>Pipilo erythrophthalmus</i>	Eastern towhee			S5	MA
<i>Spizella pusilla</i>	Field sparrow	BMC, BCC		S4	MA
<i>Ammodramus savannarum</i>	Grasshopper sparrow	BMC, BCC		S4	IM

Table 1.1. Animal species of special concern reported on ORR^a (continued)

Scientific name	Common name	Status ^b			
		Federal	TN	NatureServe ^c	PIF ^d
<i>Ammodramus henslowii</i>	Henslow's sparrow	BMC, BCC	T	S1	IM
MAMMALS					
<i>Myotis grisescens</i>	Gray bat	E	E	S2	
<i>Myotis lucifugus</i>	Little brown bat ^f		T	S3	
<i>Myotis sodalis</i>	Indiana bat ^g	E	E	S1	
<i>Myotis septentrionalis</i>	Northern long-eared bat	E	E	S1	
<i>Myotis leibii</i>	Eastern small-footed bat		NM	S2	
<i>Perimyotis subflavus</i>	Tri-colored bat ^f	PE	T	S2	
<i>Corynorhinus rafinesquii</i>	Rafinesque's big-eared bat		NM	S3	
<i>Sorex dispar</i>	Long-tailed shrew		NM	S2	

^a Land and surface waters of the Oak Ridge Reservation (ORR) exclusive of the Clinch River, which borders ORR.

^b Status codes:

E = endangered (TDEC 2024a, TDEC 2024b, FWS 2021, TWRA 2024)

PE = proposed endangered (TDEC 2024b)

T = threatened (TDEC 2024a, TDEC 2024b, FWS 2021)

S1 = critically imperiled (NatureServe 2024, TDEC 2024b)

S2 = imperiled (NatureServe 2024, TDEC 2024b)

S3 = vulnerable (NatureServe 2024, TDEC 2024b)

S4 = apparently secure (NatureServe 2024, TDEC 2024b)

S5 = secure (NatureServe 2024, TDEC 2024b)

BMC = Birds of management concern (FWS 2011)

BCC = Birds of conservation concern (FWS 2021)

NM = in need of management (TDEC 2024a, TDEC 2024b, TWRA 2024)

OA = overly abundant (FWS 2011)

CR = critical recovery for Bird Conservation Region (BCR) 28 (Appalachian Mountains Bird Conservation Region) (PIF 2024)

IM = immediate management for BCR28 (PIF 2024)

MA = management attention for BCR28 (PIF 2024)

PR = planning and responsibility for BCR28 (PIF 2024)

^c NatureServe works with over 60 network organizations and over 1,000 conservation scientists to collect, aggregate, and standardize biodiversity statistics.

^d Partners in Flight (PIF) is an international organization devoted to conserving bird populations in the Western Hemisphere.

^e The bald eagle was federally delisted effective August 9, 2007.

^f Under review for federal listing.

^g A single specimen was captured in a mist net bordering the Clinch River in June 2013.

Birds recorded on ORR and its boundary waters include the 228 species documented by Roy et al. (2014) plus the cackling goose (*Branta hutchinsii*), purple gallinule (*Porphyrio martinicus*), American bittern (*Botaurus lentiginosus*), and federally threatened wood stork (*Mycteria Americana*) for a total of 236 species. Most of these species are protected under the Migratory Bird Treaty Act (MBTA 1918) and Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds* (EO 2001). DOE's updated memorandum of understanding on migratory birds with the US Fish and Wildlife Service (FWS) (DOE-FWS 2013) strengthens migratory bird conservation on ORR through enhanced collaboration between DOE and FWS.

Breeding bird surveys conducted along varying numbers of up to 10 routes on ORR provide data for the Partners in Flight Program. Four public nature walks organized by ORNL occurred in 2023 (bird, frog, Reptiles and Amphibians, and Historic Talks at Freels Bend). These walks began in the late winter and carried through mid-summer. They covered topics such as the American woodcock (shown in Figure 1.4), birds of prey, frog calls, inventories of reptiles and amphibians, and the history of ORR. In past years ORR has been nominated for the Presidential Migratory Bird Federal Stewardship Award. A technical manuscript, *Oak Ridge Reservation Bird Records and Population Trends* (Roy et al. 2014), documents known ORR bird records since 1950 and population trends for 32 species of birds.

Several state-listed bird species such as the golden-winged warbler, cerulean warbler, and little blue heron are uncommon migrants or visitors to the reservation. The cerulean warbler, listed by the state as in need of management, often appears during the breeding season on ORR, but it is currently listed as a potential breeding bird on the reservation (Roy et al. 2014), because its actual breeding status is still uncertain.



Source: Sarah Darling, ORNL

Figure 1.4. American woodcock fledgling on ORR

The bald eagle (Figure 1.5), which was removed from the federal list of threatened and endangered species on August 9, 2007, is a year-round resident in Tennessee, though it can be difficult to find on the reservation from September through November. At least three bald eagle nests were confirmed on the reservation in 2023, all located along the Clinch River/Melton Hill Lake, between Gallaher Bend and Melton Hill Dam. One nest was first observed in 2011 near the mouth of Walker Branch and has remained active every year since, and another nest near Melton Hill Dam has been documented by an area nature photographer for several years. More than two dozen eaglets fledged in East Tennessee during 2017, according to bald eagle information published by the East Tennessee State University College of Arts and Sciences Biological Sciences department.

Other bird species of interest include the migratory wood thrush and barn swallow, which have been observed nesting on the reservation. The Lincoln's sparrow (*Melospiza lincolni*) (no listed status) was sighted on ORR in May 2014. Barn owls were documented nesting on the reservation in 2019.



Source: Kelly Roy, ORNL

Figure 1.5. Bald eagle photographed on ORR

Uncommon birds for ORR recorded in recent years include several species associated with wetland habitats. Due to efforts in the early 2000s to mitigate ETP's K1007 P-1 pond into a high-quality wildlife habitat, purple martin (*Progne subis*) and willow flycatcher (*Epidonax tralillii*) make their home here every spring and summer. The limpkin (*Aramus guarauna*), which is not usually observed in Tennessee, was seen utilizing the ponds in June 2023. While collaborating on detection methodologies for secretive marsh birds, researchers from ORNL and Charles Sturt University in New South Wales, Australia, photographed a purple gallinule (*Porphyrio martinicus*) on a trail camera at the Heritage Center Greenway Powerhouse Trail in 2017 (Figure 1.6). This was the first documented appearance of a purple gallinule on ORR.

ORNL is continuing monitoring of state-listed four-toed salamanders (*Hemidactylum scutatum*) at the ORR. Although the ORR contains some of the highest densities of this species in eastern Tennessee, they are considered by the state as in need of management. Several of their largest subpopulations on the ORR occur in areas that are slated for development. ORNL has also documented what appear to be state-listed black mountain salamanders (*Desmognathus welteri*, considered by the state as in need of management) on the ORR, just south of the



Figure 1.6. Purple gallinule caught on a trail surveillance camera at ETP in 2017

Horizon Center. Two state-listed reptiles have inhabited the ORR: the northern pinesnake (*Pituophis melanoleucus melanoleucus*, state-listed as threatened) and the eastern slender glass lizard (*Ophisaurus attenuatus longicaudus*, state-listed as in need of management). However, there is limited evidence to suggest the number of either species on the reservation.

Several fish species listed and noted for management concern are known to inhabit areas in and around the ORR. One fish species, 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 the ORR. The tangerine darter (*Percina aurantiaca*), a species listed by the state as in need of management, has also been recorded near the ORR. The lake sturgeon (*Acipenser fulvescens*), state-listed as endangered, is known to inhabit the adjacent Clinch River. The Tennessee dace, listed by the state as in need of management, appears in the Bear Creek watershed, tributaries to the lower East Fork watershed, and Ish Creek. The Tennessee dace also occurs in some sections of Grassy Creek upstream of Scientific Ecology Group, Inc. and International Technology Corporation at Clinch River kilometer 23, south of west Bear Creek Road near Grassy Creek sampling point 1.9.

1.3.6.3. Threatened and Endangered Plants

Four plant species known to be on ORR (spreading false foxglove, Appalachian bugbane, tall larkspur, and butternut) have been under review for federal listing and were previously listed under the Category 2 candidate designation (Nature Conservancy 1995). FWS now informally refers to these as special concern species.

The state of Tennessee lists 16 plant species occurring on ORR as endangered, threatened, or of special concern; these are included in Table 1.2. An additional 10 threatened, endangered, or special concern species occur in the area and may be present on ORR, although currently unconfirmed. These are also included in Table 1.2. Other plant populations currently under study on ORR may be added to the table in future years (TDEC 2021, TDEC 2024b).

Table 1.2. Vascular plant species of special concern sighted or reported on or near ORR

Species	Common name	Habitat on ORR	Status/rank code ^{a,b}
Currently known to be or previously reported on ORR			
<i>Aureolaria patula</i>	Spreading false foxglove	River bluff	S, S3
<i>Berberis canadensis</i>	American barberry	Rocky bluff	S, S2
<i>Bolboschoenus fluviatilis</i>	River bulrush	Wetland	S, S1
<i>Delphinium exaltatum</i>	Tall larkspur	Barrens and woodlands	E, S2
<i>Diervilla lonicera</i>	Northern bush-honeysuckle	Rocky river bluff	T, S2
<i>Draba ramosissima</i>	Branching whitlow-grass	Limestone cliff	S, S2
<i>Elodea nuttallii</i>	Nuttall waterweed	Pond, embayment	S, S2
<i>Eupatorium godfreyanum</i>	Godfrey's thoroughwort	Dry woods edge	S, S1
<i>Fothergilla major</i>	Mountain witch-alder	Woods	T, S2
<i>Helianthus occidentalis</i>	Naked-stem sunflower	Barrens	S, S2
<i>Juglans cinerea</i>	Butternut	Lake shore	T, S3
<i>Juncus brachycephalus</i>	Small-head rush	Open wetland	S, S2
<i>Liparis loeselii</i>	Fen orchid	Forested wetland	T, S1
<i>Panax quinquefolius</i>	American ginseng	Rich woods	S, S3
<i>Platanthera flava</i> var. <i>herbiola</i>	Tubercled rein-orchid	Forested wetland	T, S2
<i>Spiranthes lucida</i>	Shining ladies'-tresses	Boggy wetland	T, S1
Rare plants that occur near and could be present on ORR			
<i>Agalinis auriculata</i>	Earleaf false foxglove	Calcareous barren	E, S2
<i>Allium burdickii</i> ^c	Narrow-leaf Ramps	Moist woods	T, CE, S1
<i>Allium tricoccum</i> ^c	Ramps	Moist woods	S, CE, S1
<i>Lathyrus palustris</i>	Marsh pea	Moist meadows	S, S1
<i>Liatris cylindracea</i>	Slender blazing star	Calcareous barren	T, S2
<i>Lonicera dioica</i>	Mountain honeysuckle	Rocky river bluff	S, S2
<i>Meehania cordata</i>	Heartleaf meehania	Moist calcareous woods	T, S2
<i>Pedicularis lanceolata</i>	Swamp lousewort	Calcareous wet meadow	S, S1

Table 1.2. Vascular plant species of special concern sighted or reported on or near ORR (continued)

Species	Common name	Habitat on ORR	Status/rank code ^{a,b}
<i>Pseudognaphalium helleri</i>	Heller's catfoot	Dry woodland edge	S, S2
<i>Pycnanthemum torreyi</i>	Torrey's mountain-mint	Calcareous barren edge	E, S1

^a State status codes (TDEC 2021):

CE = Status due to commercial exploitation

E = Endangered in Tennessee

S = Special concern in Tennessee

T = Threatened in Tennessee

^b State conservation status (NatureServe 2024):

S1 = Critically imperiled

S2 = Imperiled

S3 = Vulnerable

^c Ramps have been reported near ORR, but there is not sufficient information to determine which of the two species is present or whether the occurrence may have been the result of planting.

Acronym: ORR = Oak Ridge Reservation

1.3.6.4. Historical and Cultural Resources

Efforts continue to preserve ORR's rich prehistoric and historic cultural resources. Compliance with the National Historic Preservation Act of 1966 (NHPA 1966) is maintained in conjunction with the National Environmental Policy Act (NEPA 1969) and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA 1980). The scope of proposed actions is reviewed in accordance with the Cultural Resource Management Plan, DOE Oak Ridge Reservation, Anderson and Roane Counties, Tennessee (DOE 2001). ORR has several facilities that were eligible for inclusion on the National Register of Historic Places (NHRP), a National Park Service program to identify, evaluate, and protect historic and archeological resources in the United States, as well as numerous facilities that were not eligible for NHRP inclusion. The reservation contains more than 44 known prehistoric sites (primarily archeological evidence of former structures), 254 historic pre-World War II structures, 32 cemeteries, and several historically significant structures from the Manhattan Project era.

The National Defense Authorization Act of 2015 (NDAA 2014), passed by Congress and signed into

law on December 19, 2014, included provisions authorizing the Manhattan Project National Historical Park. An agreement by the Secretaries of Energy and Interior established the Manhattan Project National Historical Park on November 10, 2015 (DOE-DOI 2015). The Park includes facilities and lands in Los Alamos, New Mexico, and Hanford, Washington, as well as Oak Ridge. On ORR, the National Park includes the X-10 Graphite Reactor, Buildings 9731 and 9204-3 at the Y-12 Complex, and the K-25 Building Site at ETTP.

The X-10 Graphite Reactor building has been a National Historic Landmark since 1966, and it has been open for public access in various ways since that time. Enhancing access and improving the visitor experience are important DOE objectives as it moves forward in implementing the National Park.

Occasional public access to Buildings 9731 and 9204-3 at the Y-12 Complex last occurred on November 12, 2015, when DOE facilitated public tours of both buildings to celebrate the establishment of the National Park. By helping to develop the National Park, DOE aims to enhance safe access to these buildings while protecting the agency's mission capabilities.

A memorandum of agreement signed in 2012 between DOE Oak Ridge Office, the State Historic Preservation Officer, the Advisory Council on Historic Preservation, the City of Oak Ridge, and the East Tennessee Preservation Alliance ensures consistent interpretation of site historic properties at ETTP. The memorandum of agreement is being implemented through the National Historic Preservation project that developed the K-25 History Center. The K-25 History Center serves to highlight the historic aspects of ETTP and of the communities that were displaced during the construction of the site.

On May 11, 2023, a groundbreaking was held for the K-25 Viewing Platform that will provide an expansive view of the building's original footprint. The facility is being constructed by the US Army Corps of Engineers using contractor Geiger Brothers Inc. to manage construction. The viewing platform will be completed in 2025 and is located just north of the K-25 History Center. It will include 10-foot-tall wraparound glass windows and exhibits that provide quick facts and visuals related to the historic importance of the K-25 Building, as well as view scopes and a scale model of the original facility.

The K-25 History Center and Viewing Platform complement the Manhattan Project National Historic Park established in 2015, which includes the footprint of the former K-25 Building (DOE-DOI 2015). The National Park Service is assisting in historic interpretation of the site, although the K-25 Building site is already undergoing extensive historic interpretation activities separate and independent from the National Park. As part of the activities to establish the park, DOE launched the K-25 Virtual Museum which details the history of the K-25 Gaseous Diffusion Plant through narrative and photographs, which can be viewed [here](#).

In addition to the X-10 Graphite Reactor, six additional historic ORR properties are listed individually in the planning for a History Center:

- Freels Bend Cabin
- New Bethel Baptist Church and Cemetery

- Oak Ridge Turnpike Checking Station
- George Jones Memorial Baptist Church and Cemetery
- Bear Creek (Scarboro) Road Checking Station
- Bethel Valley Road Checking Station

Although not yet included on the NRHP, an area known as the Wheat Community African Burial Grounds was dedicated in June 2000, and a memorial monument was erected.

ORNL and Y-12 programmatic agreements and memorandums of agreement among DOE, the State of Tennessee, the Advisory Council on Historic Preservation, and consulting parties serve to provide a system of review for projects that may potentially affect historic and archaeological resources on the ORR. The ORNL and Y-12 programmatic agreements are currently being updated to reflect new architectural building surveys and revisions to each site's Historic Preservation Plans. In 2023, work began to develop a new memorandum of agreement to address mitigation activities for the planned demolition of DOE ORNL Office of Science (SC) Buildings 9401-1, 9201-2, 9204-1, 9732-02, 3034, 3036, 3501, 5505, and 2523, and DOE Oak Ridge Office of Environmental Management (OREM) Buildings 3002, 3003, 3018, 3038, 3029, 3030, 3031, 3032, 3033, 3033A, 3118, 3042, 3515, 3542, and 3517. These historic contaminated buildings were determined to pose excessive environmental risks.

1.4. Oak Ridge Sites

ORR includes a number of sites critical to the mission of DOE. Eight of these sites are described in this section: ORNL, the Y-12 Complex, ETTP, EMWMF, the Oak Ridge National Environmental Research Park, ORISE, NNSA OST AOEC, and the TWPC.

United Cleanup Oak Ridge LLC (UCOR) is the lead DOE ORR cleanup contractor, led by Amentum, Jacobs, and Honeywell, and addresses expanded cleanup operations at ORNL and Y-12, in addition

to the continuing final soil and groundwater remediation at ETPP.

The scope of UCOR activities includes characterization and cleanup of former production facilities, building pads, and impacted environmental media; management and maintenance of active ORR facilities; long-term management of inactive waste disposal sites; and water quality monitoring. The *2023 Cleanup Progress: Annual Report on Oak Ridge Reservation Cleanup* (UCOR 2023) provides detailed information on UCOR activities at the ORR and is available [here](#).

1.4.1. Oak Ridge National Laboratory

ORNL (shown in Figure 1.7) is managed for DOE by UT-Battelle, LLC, a partnership between the University of Tennessee and the Battelle Memorial Institute. The largest science and energy national laboratory in the DOE system, ORNL conducts basic and applied research to deliver transformative solutions to compelling problems in energy and security. The laboratory is home to several of the world's top supercomputers and is a leading neutron science and nuclear energy research facility that includes the Spallation Neutron Source and the High Flux Isotope Reactor. ORNL hosts a DOE leadership computing facility, home of the Frontier supercomputer; one of DOE's nanoscience centers, the Center for Nanophase Materials Sciences; one of DOE's energy research centers; and the Bio-Energy Science Center. UT-Battelle, LLC also manages the US ITER project (formerly the International Thermonuclear Experimental Reactor project) for DOE.

Formerly known as X-10, ORNL was established in 1943 to support the Manhattan Project. From an early focus on chemical technology and reactor development, ORNL's research and development portfolio broadened to include programs supporting DOE missions in scientific discovery and innovation, clean energy, and nuclear security. Today ORNL employs about 5,800 workers, and the laboratory's extensive capabilities in scientific discovery and innovation are applied to the delivery of mission outcomes for DOE and other sponsors.

After completing facility upgrades and in-depth safety planning in 2022, OREM and its contractor, Isotek Systems, LLC (Isotek) conducted significant processing operations on the remaining inventory of ^{233}U stored at ORNL in 2023. The effort to process and dispose of the remaining high-dose ^{233}U is OREM's highest priority at ORNL. The current phase of the project, using hot cells, has enabled Isotek to enhance productivity by processing larger amounts of ^{233}U , as well as allowing employees to extract more medical isotopes. DOE and Isotek have partnered with TerraPower, a private nuclear innovation company, to extract ^{229}Th from the ^{233}U . TerraPower then uses the material to create the ^{225}Ac needed for targeted alpha therapy to treat diseases such as breast, prostate, colon, and neuroendocrine cancers, melanoma, and lymphoma.

UCOR continued to carry out characterization and deactivation of former reactors and isotope production facilities in 2023 and completed demolition and final packaging of the Low Intensity Test Reactor (Building 3005). At a group of buildings called "Isotope Row" that were constructed in the 1950s and early 1960s to process radioisotopes, deactivation was completed in Buildings 3030, 3031, and 3032, and significant progress was made in Buildings 3029, 3118, and 3033. Deactivation also proceeded at the Oak Ridge Graphite Reactor support facility buildings: Building 3003 deactivation was completed and significant decontamination was also completed in the 3002 filter house. This work focuses on asbestos, lead, and universal waste removal to eliminate high-risk contaminated structures and to create space for future research missions at ORNL.

Demonstrating environmental excellence through high-level policies that clearly state expectations for continual improvement, pollution prevention, and compliance with regulations and other requirements is a priority at ORNL. Implementing an environmental management system (EMS) allows environmental impacts to be systematically measured, managed, and controlled. UT-Battelle's EMS is a fully integrated set of environmental

management services for UT-Battelle activities and facilities. Services include pollution prevention, waste management, effluent management, regulatory review, reporting, permitting, and other environmental management programs.

Examples of environmental performance optimization during fiscal year (FY) 2023 include the following:

- The calculated energy use intensity was 237,514 Btu/gross square foot. This is a cumulative reduction of 34.7 percent since FY 2003 and a reduction of 1.43 percent from the FY 2021 baseline, but it is an increase of 1.41 percent from FY 2022.



Figure 1.7. Aerial view of the Oak Ridge National Laboratory

- The diversion rate for municipal solid waste at ORNL was 65.7 percent in FY 2023. Sustainable Campus Initiative staff plan to work with procurement staff to continue to employ terms and conditions within construction contracts to manage construction waste and recycling.
- UT-Battelle implemented 29 ongoing and new pollution prevention projects at ORNL during 2023, which eliminated more than 11.8 million kg of waste.

- Eighty percent of all ORNL vehicles are alternative fuel vehicles, with 88 percent of all replacements since FY 2020 being alternative fuel or electric vehicles. Ninety-three percent of light-duty vehicles operate on alternative fuels, exceeding DOE fleet management goals.

See Section 5.2.1.4 for additional details on ORNL environmental sustainability performance data for FY 2023.

1.4.2. Y-12 National Security Complex

The Y-12 Complex (shown in Figure 1.8) was originally 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 Y-12 site.

Today, as part of the NNSA Nuclear Security Enterprise, the Y-12 Complex is a leader in materials science and precision manufacturing. As the main storage facility for the nation's supply of enriched uranium, Y-12 serves as the nation's only source of enriched uranium nuclear weapons components and provides enriched uranium for the US Navy. The Y-12 Complex also supports efforts to reduce the risk of nuclear proliferation and performs complementary work for other government agencies.

In December 2017, UCOR issued the Construction Execution/Management Plan, Outfall 200 Mercury Treatment Facility at the Y-12 National Security Complex, Oak Ridge, Tennessee (UCOR 2017). The Outfall 200 Mercury Treatment Facility is a vital piece of infrastructure that will open the door for demolition of Y-12's large, deteriorated, mercury-contaminated facilities and subsequent soil remediation by providing a mechanism to limit potential mercury releases into Upper East Fork Poplar Creek. The west end Y-12 storm drain system discharges to Upper East Fork Poplar Creek at Outfall 200, and mercury from historic operations is present at Outfall 200 where storm water enters Poplar Creek.

In FY 2023, progress continued with construction of the Outfall 200 Mercury Treatment Facility, DOE Environmental Management research in new remediation technologies to address mercury releases into the environment from past operations, and contracting for the first mercury remediation technology demonstration. In November 2023, OREM tasked UCOR to finish construction of the facility after the contract with APTIM-North Wind Construction expired. At the headworks site, the first lift of concrete walls is

complete, and work continues with construction of a 500,000-gallon equalization tank. All underground piping has been installed and tested, and the painting of concrete surfaces and structural steel is progressing. The new facility is slated to be operational in 2025. A new Technology Demonstration Facility is being developed (formerly the Disposal Area Remedial Action, or DARA, facility) to carry out demonstration of proposed mercury treatment technologies.

Deactivation activities continued at three large former uranium processing facilities—Alpha-2, Alpha-4, and Beta-1—throughout FY 2023. At Alpha-2 (Building 9201-02), all deactivation activities were completed in the aboveground floors to prepare for demolition in 2024. Deactivation of the upper floors of Beta-1 (Building 9204-01) is expected to be completed in early FY 2024, and more than 1 million gallons of water have been removed, treated, and discharged. At Alpha-4 (Building 9201-04), workers began preparing the facility for deactivation, which is contaminated with elemental mercury. Workers have been sampling asbestos-containing material, performing utility isolations to bring the building to cold and dark status, and characterizing more than 400 legacy drums.

Y-12's environmental policy reflects a commitment to providing sound environmental stewardship practices through the implementation of its EMS. At the end of FY 2023, the Y-12 Complex had achieved nine of twelve established environmental targets driven by the EMS, and the remaining targets were carried into future years. Highlights of achievements include the following (further details and additional successes are presented in Chapter 4 of this report):

- **Clean air.** Y-12 completed a project to seal the Stack 11 basin and identified its improved mission operations and improvements to air emissions.
- **Energy efficiency.** Y-12 obtained a Utility Energy Savings Contract and funding approval

and also completed chiller plant improvements in three locations.

- **Hazardous materials.** A project to disposition and ship legacy mixed waste according to the site treatment plan continued, and five items were shipped in FY 2023 to meet plan milestones. Unneeded materials and equipment were dispositioned from Building 9998 and two tanker trailers in FY 2023. Y-12 improved waste characterization processes and implemented

real-time radiography to improve control and management of low-level radioactive waste. Shipping resumed in February 2023.

- **Land, water, and natural resources.** Y-12 completed upgrading sanitary sewer networks in two areas as part of a project to protect the sanitary sewer lines from infill and infiltration. Y-12 also completed tank assessments on six aboveground inactive tanks and dikes in FY 2023.



Figure 1.8. Aerial view of the Y-12 National Security Complex

Y-12 continues to strive to reduce impacts on the environment through increased use of environmentally friendly products and processes and reductions in waste and emissions. In FY 2023, the Y-12 Complex implemented 105 pollution prevention initiatives that resulted in a reduction of more than 17.8 million lbs of waste and projected cost efficiencies of more than \$3.4 million. Also in 2023, Y-12 diverted 56.8 percent of municipal waste (over 4.1 million lbs) and 32 percent of construction and demolition waste

(over 13.2 million lbs) from landfill disposal through source reduction, reuse and recycle.

Compared to the FY 2003 baseline year, Y-12 has seen an energy intensity reduction of 50.38 percent as of FY 2023. During FY 2023, energy intensity was 207,645 Btu/gross square foot, a little over a half of a percentage above the prior year's 205,343 Btu/gross square foot. After the COVID-19 pandemic, rates have been rising slightly, especially compared to pandemic years 2020 and 2021, as the site's maximum

teleworking policy expired and the site's population increased with newly hired employees. Continuing and new construction projects also contribute to the slightly increased energy intensity. Sustainability goals and performance status for the Y-12 Complex are listed in Chapter 4, Table 4.1.

1.4.3. East Tennessee Technology Park

ETTP (see Figure 1.9), originally named K-25, is the site of the nation's first gaseous diffusion uranium enrichment plant. It was established as part of the World War II Manhattan Project. Additional uranium enrichment facilities K-29, K-31, and K-33 were built adjacent to K-25 during the Cold War, and these facilities formed a complex officially known as the Oak Ridge Gaseous Diffusion Plant. Uranium enrichment operations at the site ceased in 1986, 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.

ETTP completed and also made significant progress on several soil remedial actions in 2023 that help protect groundwater. The site is divided into two cleanup regions: Zone 1, a 1,300-acre area outside the main plant area; and Zone 2, the 800-acre area that comprises the main plant area. The areas in these zones are divided into Exposure Units (EUs) that vary in size from 6 to 38 acres.

EU-13 near Poplar Creek once housed many of the gaseous diffusion and uranium hexafluoride enrichment support facilities. Remedial action centered on soil and concrete associated with a radiologically contaminated release from a tie line adjacent to the former K-631 Surge and Waste Facility. Site restoration activities included placing clean fill topped with gravel to stabilize the site.

Remediation continued within EU-21, an area that is located in the middle of the K-25 footprint, which is part of the Manhattan Project National

Historical Park. Since July 2021, more than 61,600 yd³ of contaminated soil was removed and taken to the local disposal facilities. By the end of 2023, crews were excavating the final section of contaminated material.

At EU-16, soil remedial actions were completed at the former K-1064 Salvage Material Yard, the K-1064-H area, and a radiologically contaminated hot spot. Site restoration activities included placing soil fill and hydroseeding the area to stabilize the site. Crews also completed a remedial action to remove historical waste materials and contaminated soil at the former K-1064 North Trash Slope located along the bank of Poplar Creek. Site restoration activities included placing large stone (riprap) fill to stabilize the site.

At EU-17, a remedial action was completed to remove exposed transite pieces (material made using asbestos) that were historically disposed and located along the banks of Poplar Creek. Site restoration activities included placing large stone fill to stabilize the site.

A soil remedial action was completed in EU-38 at the former K-1417-B Drum Storage Yard. Site restoration activities included placing clean fill topped with gravel to stabilize the site. Crews also started a remedial action to remove sediment from sumps at the K-1417-A Concrete Block Casting Facility.

A remedial action was started at EU-39 to remove contaminated soil from the footprint of the K-1420 Equipment Decontamination Facilities.

In February 2023, UCOR completed a Time-Critical Removal Action of contaminated soils at the EU-19 mudflat. The mudflat was located at the end of a ditch that empties into Poplar Creek and had been impacted by past site operations. Severson Environmental Services teamed with UCOR to remove 8,000 yd³ from a floating work platform positioned in the creek. An onshore 125-ton crane was used to move the containers of excavated soil from the work platform for characterization and disposal.

The UCOR EMS environmental sustainability principles incorporate the procurement of

environmentally preferable products, recycling, and pollution prevention and waste minimization practices in work processes and activities at ETTP. UCOR recycles much of its universal waste, municipal solid waste, and scrap metal; reuses large amounts of construction and demolition debris; and encourages the reduction of waste wherever possible. In 2023, the Sustainability Leadership Award-winning projects saved more than 1,325 MTs of greenhouse gas emissions, 772,700 lbs of waste from landfills, and treated 16,029,000 gallons of wastewater. In addition to lessening the impact on the environment, these pollution prevention measures also saved

approximately \$7.8 million. UCOR's pollution prevention and waste minimization practices at ETTP are detailed further in Section 3.2.1.

OREM continued to see significant momentum in the Reindustrialization Program at ETTP. The former government-owned uranium enrichment complex is being turned into a multiuse industrial park that includes national historic preservation and conservation and greenspace areas. Accounting for committed land transfers to date, only a few hundred acres of the approximately 2,200 original acres remain for final transfer.

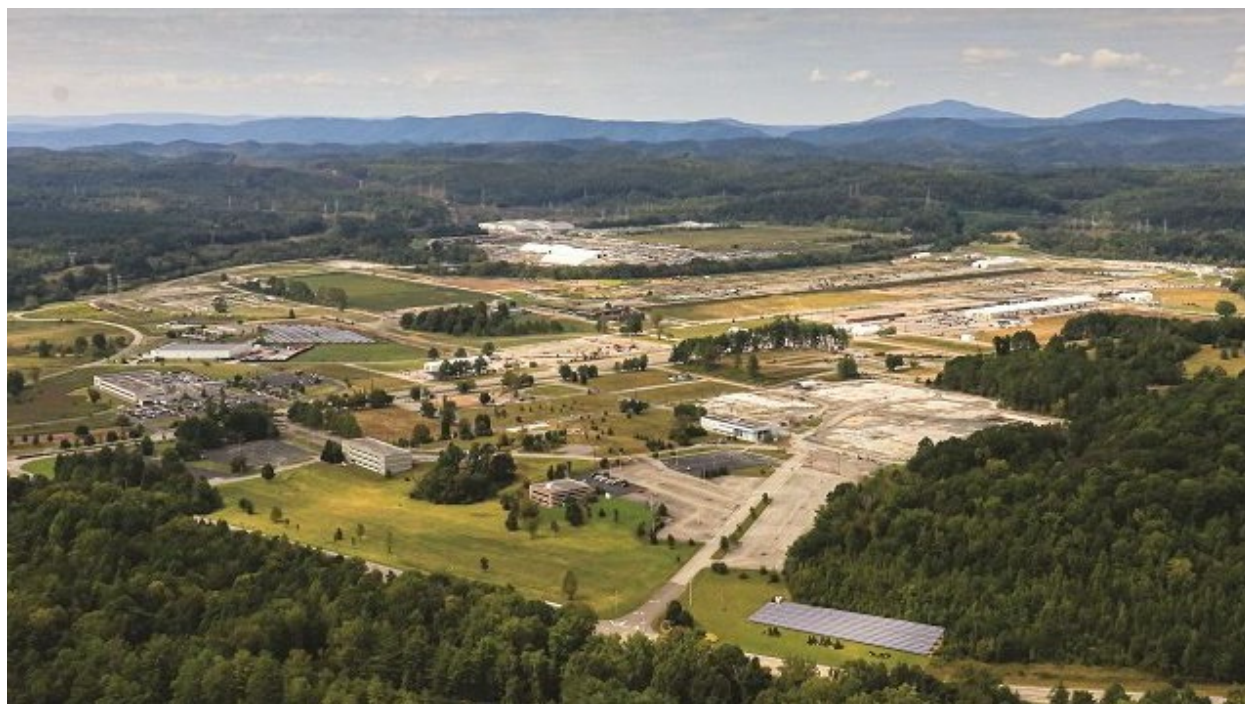


Figure 1.9. Aerial view of East Tennessee Technology Park

During 2023, the Reindustrialization team advanced the regulatory review of almost 500 acres of remediated land in transfer packages. This land includes the former K-1037 Steam Plant and Toxic Substances Control Act Incinerator package, the former Powerhouse Area, the former K-732 Switchyard, and multiple parcels intended for development of a new municipal airport. Upon regulatory approval, transfer packages are submitted for department and congressional approvals, which finalizes the process. Clean

energy and new nuclear businesses currently developing in these areas and the Oak Ridge Community include TRISO-X, Ultra Safe Nuclear Corporation, Kairos Power, and the Tennessee Valley Authority.

1.4.4. Environmental Management Waste Management Facility

The EMWMF (shown in Figure 1.10) is located in eastern Bear Creek Valley near the Y-12 Complex

and is managed by UCOR. The EMWMF was built for the 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 m³ (1.7 million yd³) disposal facility. The approved capacity was subsequently increased to 1.8 million m³ (2.4 million yd³) to maximize use of the footprint designated in a 1999 record of decision. The facility currently consists of six disposal cells.

The EMWMF is an engineered landfill that accepts low-level, mixed low-level, and hazardous wastes from CERCLA cleanup activities on ORR 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 waste, stabilized waste, building debris, scrap equipment, and secondary waste such as personal protective equipment, all of which must meet land disposal restrictions. In addition to the solid waste disposal facility, the EMWMF operates a leachate collection system. In 2023, the facility collected, analyzed, and disposed of approximately 3.53 million gallons of leachate. The leachate is treated at the ORNL Liquids and Gaseous treatment facility, which is also operated by UCOR (UCOR 2023).



Figure 1.10. Aerial view of the Environmental Management Waste Management Facility

In FY 2023, EMWMF received 5,211 waste shipments from cleanup projects at ETTP, ORNL, and Y-12, plus 84 clean fill shipments for the enhanced operational cover expansion and constructing access roads and dump ramps. The EMWMF landfill has a design capacity of 2.331 million yd³ and is now over 85 percent filled. Planning continued in FY 2023 for another disposal facility, the Environmental Management Disposal Facility (EMDF), to provide the capacity required to complete Oak Ridge's cleanup mission.

A groundbreaking ceremony for the EMDF was held on August 2, 2023. OREM continues to work with EPA and TDEC on regulatory documents for the EMDF landfill. The Early Site Preparation Remedial Design Report/Remedial Action Work Plan was approved in June 2023, and the Groundwater Field Demonstration Remedial Design Work Plan/Remedial Action Work Plan was prepared and reviewed in 2023 with approval in October 2023 (DOE 2023b, DOE 2023c).

1.4.5. Oak Ridge Environmental Research Park

DOE established the Oak Ridge National Environmental Research Park (see Figure 1.11) in 1980. Managed for DOE by UT-Battelle, LLC, the research park serves as an outdoor laboratory to evaluate the environmental consequences of energy use and development and strategies to mitigate those effects. Its large blocks of forest and

diverse communities of vegetation 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.

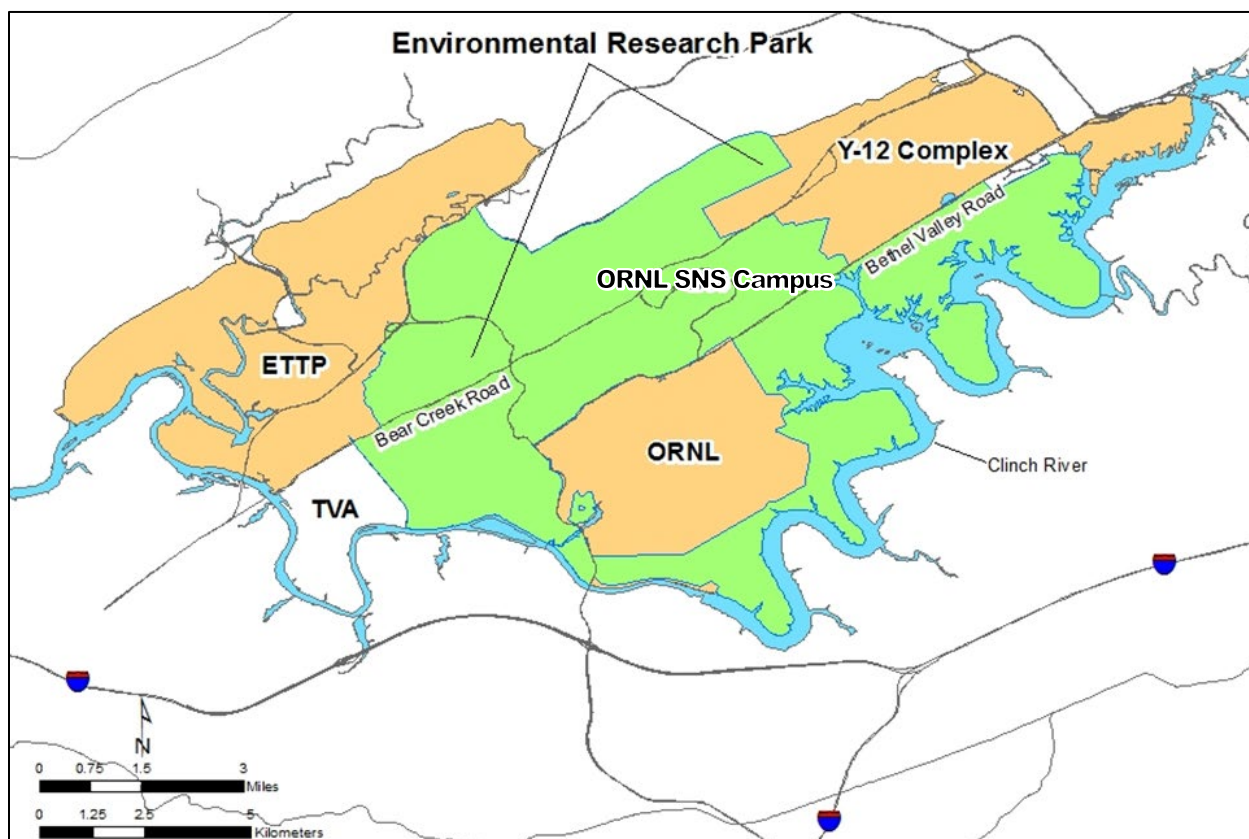


Figure 1.11. Location of the Oak Ridge National Environmental Research Park

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 measure environmental factors precisely and accurately for extended periods. Because the park is under the jurisdiction of the federal government, public access is restricted, and therefore experimental sites and associated

equipment are not disturbed. National recognition of the research park's value has led to its use in both regional- and continental-scale research projects. 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, wetland mitigation, and forest and wildlife management.

1.4.6. Oak Ridge Institute for Science and Education

The Oak Ridge Institute for Science and Education (ORISE) is managed for DOE by Oak Ridge Associated Universities and is located in an area on the southeastern border of ORR that was part of an agricultural experiment station owned by the federal government from the late 1940s to the mid-1980s. The ORISE mission is to develop people and solutions to strengthen our nation's competitive advantage in science. ORISE accomplishes its mission by recruiting and preparing the next generation of our nation's scientific workforce; promoting sound scientific and technical investment decisions through independent peer reviews; facilitating and preparing for the medical management of radiation incidents in the United States and abroad; evaluating health outcomes in workers exposed to chemical and radiological hazards on the job; and ensuring public confidence in environmental cleanup through independent environmental assessments. ORISE creates opportunities for collaboration through partnerships with other DOE facilities, federal agencies, academia, and industry consistent with DOE objectives and the ORISE mission.

In 2023, ORISE's Radiation Emergency Assistance Center/Training Site (REAC/TS) coordinated with the North Atlantic Treaty Organization (NATO) to host radiation emergency training events in Oak Ridge. ORISE also hosted its first annual ORISE Postdoctoral Mini Symposium open to members of the ORISE STEM Workforce Development community, which attracted 487 attendees over five separate professional development sessions (ORAU 2024).

1.4.7. National Nuclear Security Administration Office of Secure Transportation, Agent Operations Eastern Command

Beginning in 1947, DOE and its predecessor agencies moved nuclear weapons, weapons components, special nuclear materials, and other important national security assets by commercial and government modes of transportation. 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. Modified and redesigned transport equipment was created to incorporate features that more effectively enhance self-protection and deny unauthorized access to the materials. Also during this time, the use of commercial transportation systems was abandoned, and a totally federal operation was implemented. The organization responsible for this mission within DOE NNSA is the Office of Secure Transportation, or OST.

The NNSA OST AOEC Secure Transportation Center and Training Facility is situated on about 723 hectares (1,786 acres) at ORR. It operates under a user permit agreement with the DOE Oak Ridge Office. NNSA OST AOEC performs its assigned mission transportation operations, maintains applicable fleet and escort vehicles, and continues extensive training activities for its federal agents.

1.4.8. Transuranic Waste Processing Center

The TWPC is located on an approximately 10.5-hectare (26-acre) tract of land in the Melton Valley area of ORNL about 120 feet west of the existing Melton Valley Storage Tanks, and it is managed by UCOR. The TWPC's mission is to receive transuranic waste for processing, treatment, repackaging, and shipment to designated facilities for final disposal.

Transuranic waste consists of materials and debris that are contaminated with elements that have a higher atomic mass and are listed after uranium on the periodic table. The majority of Oak Ridge's inventory of transuranic materials originated from previous research and isotope production missions at ORNL. Waste determined to be non-transuranic (e.g., low-level radioactive waste or mixed low-level waste) is shipped to the Nevada National Security Site or other approved facilities. As of 2023, the TWPC has processed approximately 99 percent of the contact-handled transuranic waste and 98 percent of the remote-handled transuranic waste, and it has also completed regulatory milestones in the *Site Treatment Plan for Mixed Wastes on the US Department of Energy Oak Ridge Reservation* (TDEC 2020) on schedule.



Figure 1.12. Transuranic Waste Processing Center

Key progress for the project during 2023 included the following actions (UCOR 2023):

- TWPC completed critical actions associated with readiness preparation to commission new waste processing capabilities at TWPC for high-activity oxide wastes and wastes requiring special treatment to meet Waste Isolation Pilot Plant acceptance criteria. TWPC continued processing the legacy Nuclear Fuel Services waste (1.9 m³) and by-product wastes from transuranic waste processing (12.8 m³).
- TWPC continued certification and shipment of 159 m³ of transuranic waste to the Waste Isolation Pilot Plant, 72.5 m³ of mixed low-level waste to treatment and disposal, and 1.8 m³ of hazardous waste to treatment and disposal, eliminating 855 containers of the stored inventory.

1.5. References

- Birdwell 2011. Birdwell, Kevin Ray, "Wind Regimes in Complex Terrain of the Great Valley of Eastern Tennessee." PhD dissertation, University of Tennessee, May.
- Broad 2007. Broad, William J, *Why They Called It the Manhattan Project*. New York Times, October 30, 2007. Retrieved May 25, 2024, from <https://www.nytimes.com/2007/10/30/science/30manh.html>.
- Census Bureau 2024a. *Metropolitan and Micropolitan Statistical Areas Population. Totals: 2020-2023*. US Census Bureau, Washington, DC. Retrieved July 20, 2024, from <https://www.census.gov/data/tables/time-series/demo/popest/2020s-total-metro-and-micro-statistical-areas.html>.

- Census Bureau 2024b. *County Population Totals and Components of Change: 2020-2023*. US Census Bureau, Washington, DC. Retrieved July 20, 2024, from <https://www.census.gov/data/tables/time-series/demo/popest/2020s-counties-total.html>.
- Census Bureau 2024c. *City and Town Population Totals: 2020-2023*. US Census Bureau, Washington, DC. Retrieved July 20, 2024, from <https://www.census.gov/data/tables/time-series/demo/popest/2020s-total-cities-and-towns.html>.
- CERCLA 1980. *Comprehensive Environmental Response, Compensation, and Liability Act*. Title 42 US Code Chapter 103.
- CWA 1972. *Clean Water Act*. Title 33 US Code §1251 et seq.
- DOE 2001. *Cultural Resource Management Plan, DOE Oak Ridge Reservation, Anderson and Roane Counties, Tennessee*. DOE/ORO-2085, US Department of Energy Oak Ridge Operations Office, Oak Ridge, Tennessee, July.
- DOE 2012. *Environment, Safety, and Health Reporting*. DOE Order 231.1B, June 27, 2011, US Department of Energy, Washington, DC.
- DOE-DOI 2015. "Memorandum of Agreement Between the United States Department of the Interior and the United States Department of Energy for the Manhattan Project National Historical Park". Washington, DC, November 10, 2015.
- DOE-FWS 2013. "Memorandum of Understanding between the United States Department of Energy and the United States Fish and Wildlife Service Regarding Implementation of Executive Order 13186, 'Responsibilities of Federal Agencies to Protect Migratory Birds'." US Department of Energy and US Fish and Wildlife Service, Washington, DC. Retrieved May 25, 2024, from <https://www.energy.gov/sites/prod/files/2013/10/f3/Final%20DOE-FWS%20Migratory%20Bird%20MOU.pdf>.
- DOE 2023a. *2023 Remediation Effectiveness Report for the US Department of Energy Oak Ridge Site, Oak Ridge, Tennessee, Data and Evaluations*. DOE/OR/01-2938&ID1, March 2023, US Department of Energy, Oak Ridge Office, Oak Ridge, Tennessee.
- DOE 2023b. *Remedial Design Report/Remedial Action Work Plan for the Environmental Management Disposal Facility, Oak Ridge, Tennessee: Early Site Preparation Activities*. DOE/OR/01-2934&D2, March 2023, US Department of Energy, Oak Ridge Office, Oak Ridge, Tennessee.
- DOE 2023c. *Remedial Design Work Plan/Remedial Action Work Plan for the Groundwater Field Demonstration at the Environmental Management Disposal Facility, Oak Ridge, Tennessee*. DOE/OR/01-2948&D1, October 2023, US Department of Energy, Oak Ridge Office, Oak Ridge, Tennessee.
- East Tennessee Economic Council. *US Department of Energy FY 2020 Economic Impact in Tennessee*. Oak Ridge, Tennessee.
- EO 2001. *Responsibilities of Federal Agencies to Protect Migratory Birds*. Issued January 10, 2001.
- EPA 2023. *Tennessee Nonattainment/Maintenance Status for Each County by Year for All Criteria Pollutants*. April 30, 2024. Retrieved May 25, 2024, from https://www3.epa.gov/airquality/greenbook/anayo_tn.html.
- ESA 1973. *Endangered Species Act*. Title 16 US Code Chapter 35 §1531 et seq.
- FWS 2011. *Birds of Management Concern and Focal Species*. US Department of the Interior, US Fish and Wildlife Service, Migratory Bird Program, Falls Church, Virginia. Retrieved May 25, 2024, from https://www.fws.gov/sites/default/files/documents/Birds-of-Management-Concern-and-Focal-Species.2011_2.pdf.

- FWS 2021. *Birds of Conservation Concern 2021*. US Department of the Interior, US Fish and Wildlife Service, Migratory Birds, Falls Church, Virginia. Retrieved May 25, 2024, from <https://www.fws.gov/sites/default/files/documents/birds-of-conservation-concern-2021.pdf>.
- Hogan 2021. Hogan, Colbi W, "Displaced to Save the World: Strategies for Using Historic Preservation and Education to Interpret Pre-1942 Communities in Oak Ridge, Tennessee." PhD dissertation, Middle Tennessee State University, August.
- Johnson 2018. Johnson, Charles W. (March 1, 2018). *Oak Ridge*. The Tennessee Historical Society. Retrieved May 26, 2024, from <https://tennesseencyclopedia.net/entries/oak-ridge>.
- MBTA 1918. *Migratory Bird Treaty Act*. Title 16 US Code §§703–712.
- McCracken et al. 2015. McCracken, M.K., N.R. Giffen, A.M. Haines, and J.W. Evans, *Bat Species Distribution on the Oak Ridge Reservation*. ORNL/TM-2015/248, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Nature Conservancy 1995. *The Oak Ridge Reservation, Biodiversity, and the Common Ground Process Final Report*. Prepared for DOE under contract DE-AC05-84OR21400, October. Retrieved May 26, 2024, from https://www.nerp.ornl.gov/wp-content/uploads/2018/07/orr_tnc_1995.pdf.
- NatureServe 2024. NatureServe Network Biodiversity Location Data accessed through NatureServe Explorer [web application]. NatureServe, Arlington, Virginia. Retrieved May 25, 2024, from <https://explorer.natureserve.org/>.
- NDAA 2014. National Defense Authorization Act of 2015. HR 3979, SEC. 3039.
- NEPA 1969. *National Environmental Policy*. Title 42, US Code Chapter 55.
- NHPA 1966. *National Historic Preservation Act*. Public Law 89-665; Title 54, US Code 300101 et seq.
- Olwell 1999. *Help Wanted for Secret City: Recruiting Workers for the Manhattan Project at Oak Ridge, Tennessee, 1942–1946*. Tennessee Historical Quarterly, Spring 1999, 58(1): 52–69.
- ORAU 2024. *ORAU Story 2023*. 2023 Annual Report for Oak Ridge Associated Universities, 100 ORAU Way, Oak Ridge, Tennessee 37830. Retrieved July 13, 2024, from <https://www.ornl.gov/news/annual-report.html>.
- Parr and Hughes 2006. Parr, P.D. and J.F. Hughes, *Oak Ridge Reservation Physical Characteristics and Natural Resources*. ORNL/TM-2006/110, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- PIF 2024. Avian Conservation Assessment Database Scores. Bird Conservancy of the Rockies. Database updated Spring 2024. Retrieved May 25, 2024, from <https://pif.birdconservancy.org/avian-conservation-assessment-database-scores/>.
- Reed 2014. Reed, Bruce Cameron. *The History and Science of the Manhattan Project, Second Edition*. Springer-Verlag, New York.
- Rosensteel 1996. Rosensteel, Barbara A., *Wetland Survey of the X-10 Bethel Valley and Melton Valley Groundwater Operable Units at Oak Ridge National Laboratory, Oak Ridge, Tennessee*. ORNL/ER 350, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Rosensteel 1997. Rosensteel, Barbara A., *Wetland Survey of Selected Areas in the Oak Ridge Y-12 Plant Area of Responsibility, Oak Ridge, Tennessee*. Y/ER-279, Y-12 National Security Complex, Oak Ridge, Tennessee.
- Rosensteel and Trettin 1993. Rosensteel, Barbara A. and Carl C. Trettin, *Identification and Characterization of Wetlands in the Bear Creek Watershed*. Y/TS-1016, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

- Roy et al. 2014. Roy, W.K., N.R. Giffen, M.C. Wade, A.M. Haines, J.W. Evans, and R.T. Jett, *Oak Ridge Reservation Bird Records and Population Trends*. ORNL/TM-2014/109, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Souza 2001. Souza, Peter A., *Cultural Resource Management Plan: Department of Energy Oak Ridge Operations Office, Anderson and Roane Counties, Tennessee*. DOE/ORO 2085, US Department of Energy, Oak Ridge Operations Office, Oak Ridge, Tennessee, July 2001.
- TDEC 2020. *Site Treatment Plan for Mixed Wastes on the US Department of Energy Oak Ridge Reservation*. TDEC-VER.24.2, Tennessee Department of Environment and Conservation, Nashville, Tennessee, May 13.
- TDEC 2021. *Tennessee Natural Heritage Program Rare Plant List*. Tennessee Department of Environment and Conservation, Division of Natural Areas, Nashville, Tennessee.
- TDEC 2024a. *Rules and Regulations for In Need Management, Threatened, and Endangered Species*. Chapter 1660-01-32, Rules of the Tennessee Wildlife Resources Agency, Biodiversity, Tennessee Department of Environment and Conservation, Nashville, Tennessee, May 14, 2024. Retrieved May 25, 2024, from <https://casetext.com/regulation/tennessee-administrative-code/title-1660-tennessee-wildlife-resource-agency/subtitle-1660-01-wildlife-resources/chapter-1660-01-32-rules-and-regulations-for-in-need-of-management-threatened-and-endangered-species/>.
- TDEC 2024b. *Rare Species Dataviewer*. Tennessee Department of Environment and Conservation, Nashville, Tennessee. Retrieved May 25, 2024, from <https://dataviewers.tdec.tn.gov/dataviewers/?p=9014:3:118904174220701>.
- TVA 2024. Tennessee Valley Authority “2023 was the first year since 2016 the 41,000 sq-mile Tennessee River basin received below-normal rainfall and only the second year since 2012.” *Linkedin*. January 5, 2024. Retrieved May 18, 2024, from https://www.linkedin.com/posts/tva_2023-was-the-first-year-since-2016-the-41000-activity-7149058276331028481-YxJ5.
- TWRA 2024. Tennessee Wildlife Resources Agency. Retrieved May 26, 2024, from <http://www.tn.gov/twra>.
- UCOR 2017. *Construction Execution/Management Plan, Outfall 200 Mercury Treatment Facility at the Y-12 National Security Complex, Oak Ridge, Tennessee*. UCOR-4972/R3, UCOR, Oak Ridge, Tennessee, October 15.
- UCOR 2023. *2023 Cleanup Progress: Annual Report to the Oak Ridge Regional Community, Oak Ridge, Tennessee*. OREM- 23-7637, UCOR, Oak Ridge, Tennessee.
- Zurawski 1978. Zurawski, A., “Summary Appraisals of the Nation’s Ground-Water Resources–Tennessee Region.” US Geological Survey Professional Paper 813-L.