

1. Site and Operations Overview

L. V. Hamilton, L. W. McMahon, and L. G. Shipe

Abstract

The U.S. Department of Energy currently oversees activities on the Oak Ridge Reservation, a government-owned, contractor-operated facility. Three sites compose the reservation: the Oak Ridge Y-12 Plant, Oak Ridge National Laboratory, and East Tennessee Technology Park (formerly the K-25 Site). The ORR was established in the early 1940s as part of the Manhattan Project, a secret undertaking that produced the materials for the first atomic bombs. The reservation's role has evolved over the years, and it continues to adapt to meet the changing defense, energy, and research needs of the United States. Both the work carried out for the war effort and subsequent research, development, and production activities have produced (and continue to produce) radiological and hazardous wastes.

1.1 BACKGROUND

This document contains a summary of environmental monitoring activities on the Oak Ridge Reservation (ORR) and its surroundings. The monitoring and documentation criteria are described within the requirements of U.S. Department of Energy (DOE) Order 5400.1, "General Environmental Protection Program." The results summarized in this report are based on the data collected prior to and through 1996. The 1996 results are compiled in *Environmental Monitoring on the Oak Ridge Reservation: 1996 Results* (LMES 1997a). Reports are available on request from Oak Ridge National Laboratory (ORNL) Laboratory Records, P.O. Box 2008, Oak Ridge, TN 37831-6285.

Environmental monitoring on the ORR consists 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 prior to release into the environment; these measurements allow the quantification and official reporting of contaminants, assessment of radiation exposures to the public, and demonstration of compliance with applicable standards and permit requirements. Environmental surveillance consists of the collection and analysis of environmental samples from the site and its environs; this provides direct measurement of contaminants in air, water, groundwater, soil, foods, biota, and other media subsequent to effluent release into the

environment. Environmental surveillance data verify ORR's compliance status and, combined with data from effluent monitoring, allow the determination of chemical and radiation dose/exposure assessment of ORR operations and effects, if any, on the local environment.

1.2 DESCRIPTION OF SITE LOCALE

The city of Oak Ridge lies in a valley between the Cumberland and Blue Ridge mountain ranges and is bordered on two sides by the Clinch River. The Cumberland Mountains are 16 km (10 miles) to the northwest; the Blue Ridge Mountains, which include the Great Smoky Mountains National Park, are 51 km (32 miles) to the southeast (Fig. 1.1).

The ORR encompasses approximately 34,516 acres of the contiguous land owned by DOE in the Oak Ridge area. A portion lies within the corporate limits of the city of Oak Ridge. The residential section of Oak Ridge forms the northern boundary of the reservation. The Tennessee Valley Authority's (TVA's) Melton Hill and Watts Bar reservoirs on the Clinch and Tennessee rivers form the southern and western boundaries (Fig. 1.2).

The population of the ten-county region is about 798,925, with 5% of its labor force employed on the ORR (Fig. 1.3).

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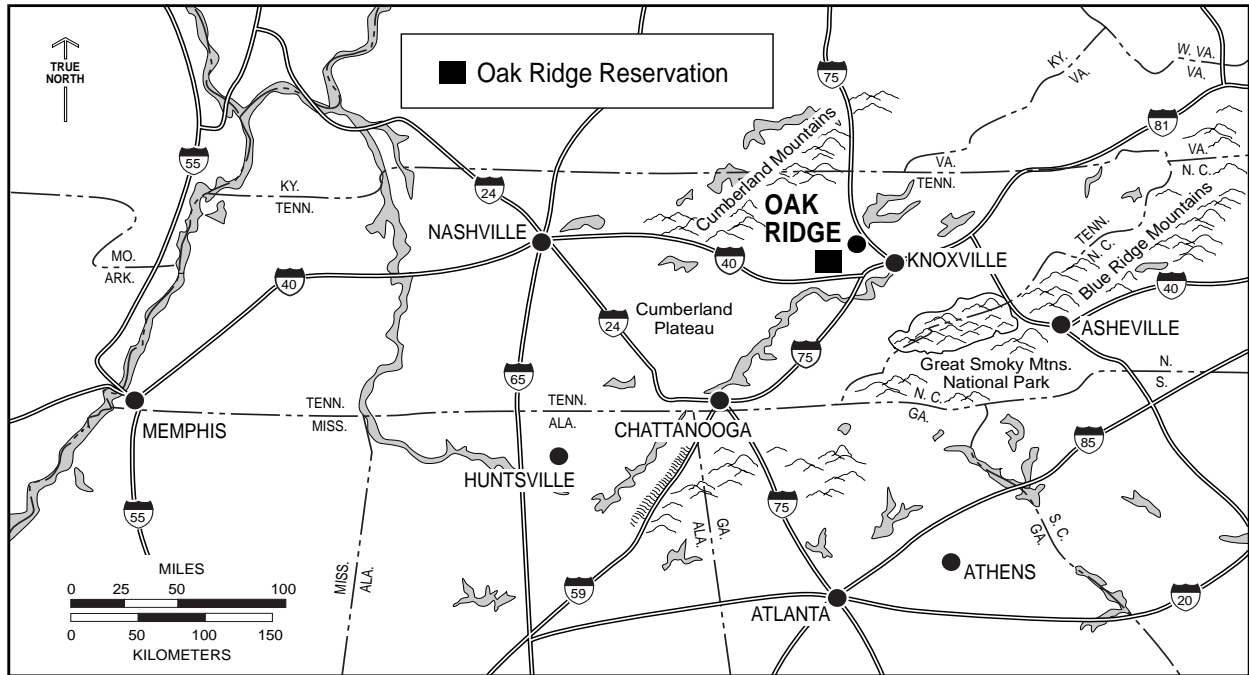


Fig. 1.1. Location of the city of Oak Ridge.

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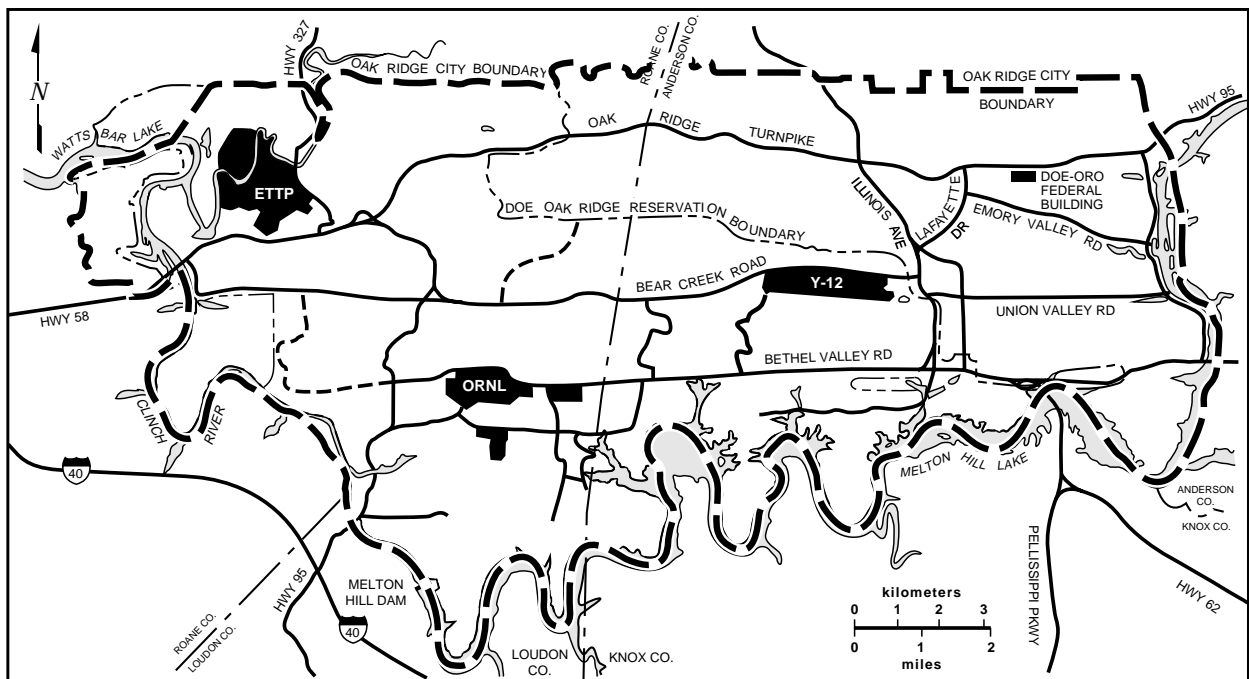


Fig. 1.2. The Oak Ridge Reservation.

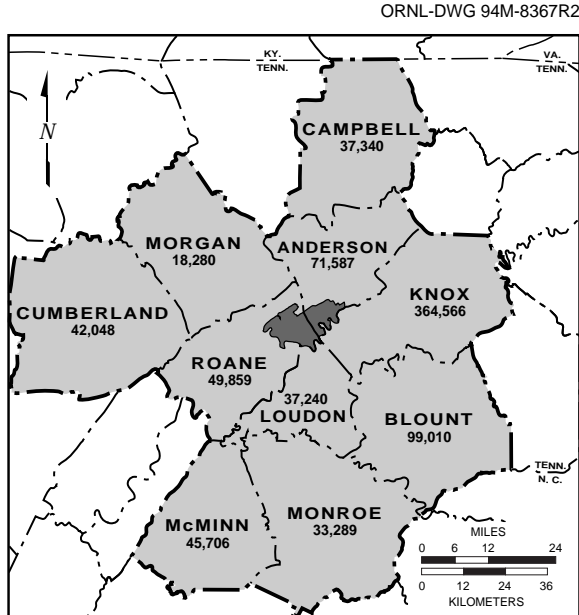


Fig. 1.3. The ten-county region surrounding the Oak Ridge Reservation. (Population figures are July 1, 1996, estimates taken from *Population Estimates for Tennessee Counties, 1990–1996* (TDECD 1996).

Other towns in close proximity to the reservation include Oliver Springs, Clinton, Lenoir City, Farragut, Kingston, and Harriman (Fig. 1.4).

Knoxville, the major metropolitan area nearest Oak Ridge, is located about 40 km (25 miles) to the east and has a population of about 169,311 as reported in *Population Estimates of Tennessee Cities, 1990–1994* (TDECD 1994). Except for the city of Oak Ridge, the land within 8 km of the ORR is predominantly rural and is used primarily for residences, small farms, and cattle pasture. Fishing, boating, water skiing, and swimming are popular recreational activities in the area.

1.3 CLIMATE

The climate of the region may be broadly classified as humid continental. The Cumberland Mountains to the northwest help to shield the region from cold air masses that frequently penetrate far south over the plains and prairies in the central United States during the winter months.

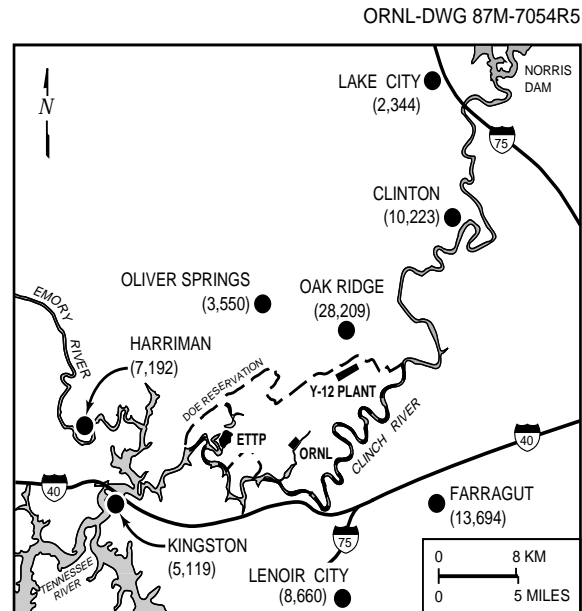


Fig. 1.4. Locations and populations of towns nearest to the Oak Ridge Reservation. (Population figures are July 1, 1994, estimates taken from *Population Estimates of Tennessee Cities, 1990–1994* (TDECD 1994).

During the summer, tropical air masses from the south provide warm and humid conditions that often produce thunderstorms; however, anticyclonic circulation around high-pressure systems centered in the western Gulf of Mexico can bring dry air from the southwestern United States into the region, leading to occasional periods of drought.

1.3.1 Temperature

The mean annual temperature for the Oak Ridge area is 14.0°C (57.2°F) (NOAA 1997). The coldest month is usually January, with temperatures averaging about 2.2°C (36°F) but occasionally dipping as low as -31°C (-24°F). July is typically the hottest month of the year, with temperatures averaging 24.9°C (76.8°F) but occasionally peaking at over 37.8°C (100°F). In the course of a year, the difference between maximum and minimum daily temperatures averages 12.5°C (22.5°F).

1.3.2 Winds

Winds in the Oak Ridge area are controlled in large part by the valley-and-ridge topography. Prevailing winds are either up-valley (northeasterly) daytime winds or down-valley (southwesterly) nighttime winds. Wind speeds are less than 11.9 km/hour (7.4 mph) 75% of the time; tornadoes and winds exceeding 30 km/hour (18.5 mph) are rare. Air stagnation is relatively common in eastern Tennessee (about twice as common as in western Tennessee). An average of about two multiple-day air stagnation episodes occurs annually in eastern Tennessee, to cover an average of about 8 days per year. August, September, and October are the most likely months for air stagnation episodes.

1.3.3 Precipitation

The 30-year annual average precipitation is 138.5 cm (54.5 in.), including about 24 cm (9.3 in.) of snowfall (NOAA 1977). Precipitation in 1996 was 169.0 cm (66.5 in.), about 30.5 cm (12 in.) above the annual average. Precipitation in the region is greatest in the winter months (December through February). Precipitation in the spring exceeds the summer rainfall, but the summer rainfall may be locally heavy because of thunderstorm activity. The driest periods generally occur during the fall months, when high-pressure systems are most frequent.

1.3.4 Evapotranspiration

Regionally, annual evapotranspiration has been estimated to range from 81 to 89 cm (32 to 35 in.), or 60 to 65% of rainfall (Farnsworth et al. 1982). Evapotranspiration in the Oak Ridge area is 74 to 76 cm (29 to 30 in.), or 55 to 56% of annual precipitation (TVA 1972, Moore 1988, and Hatcher et al. 1989). Evapotranspiration is greatest in association with the growing season, which in the vicinity of the ORR is 220 days, from mid-March through mid-October. During this period, evapotranspiration often exceeds the rate of precipitation, resulting in soil moisture deficits.

1.4 DESCRIPTION OF SITE, FACILITIES, AND OPERATIONS

The facilities on the ORR began operating in 1943 as part of the Manhattan Project, producing components for the first nuclear weapons. The ORR remains a government-owned, contractor-Operated facility, although the nature of the work has changed. The primary missions of the three sites have evolved during the past 50 years and continue to adapt to meet the changing defense, energy, and research needs of the United States. The reservation contains three major DOE installations: the Oak Ridge Y-12 Plant (Y-12 Plant), ORNL, and East Tennessee Technology Park (ETTP).

The DOE buildings and structures that are located on the reservation but outside the major sites consist of the Oak Ridge Institute for Science and Education (ORISE) Scarboro Operations Site, Clark Center Recreational Park, the Central Training Facility, and the Transportation Safeguards maintenance facility.

The off-reservation DOE buildings and structures consist of the Federal Office Building, Office of Scientific and Technical Information, most of the ORISE offices and laboratories, the Atmospheric Turbulence and Diffusion Division of the National Oceanic and Atmospheric Administration (NOAA) Air Resources Laboratory, the American Museum of Science and Energy, the Lockheed Martin Energy Systems, Inc. (LMES, formerly Martin Marietta Energy Systems, Inc.) administrative support office buildings, and the former museum building. In addition to government-owned property, there are numerous leased buildings housing about 7% of the government and contractor work force.

1.4.1 Lockheed Martin Energy Systems, Inc.

On March 15, 1995, Lockheed and Martin Marietta completed a merger to create the Lockheed Martin Corporation. Following the merger, Martin Marietta Energy Systems, Inc., the

prime contractor for the ORR, was renamed Lockheed Martin Energy Systems, Inc. (LMES). In late 1995 Lockheed Martin Corporation organized into several business sectors, each of which focused on a particular aspect of the company's business. During this reorganization, the Energy and Environment Sector was formed. All of the company's DOE business became part of the sector, including a new corporation, Lockheed Martin Energy Research Corporation (LMER), which was formed to operate ORNL. As a result, in 1996 LMES managed the Y-12 Plant, ETTP, and programs at the Paducah, Kentucky, facility and the Portsmouth plant in Piketon, Ohio. LMES carries out energy research and development (R&D), production of enriched uranium and weapons components, and other goals of national importance. For more information, visit the LMES home page on the World-Wide Web (<http://www.ornl.gov/mmes.html>).

1.4.2 Oak Ridge Y-12 Plant

Until 1992, the primary mission of the Y-12 Plant (Fig. 1.5) was the production and fabrication of nuclear weapon components. Activities associated with these functions included production of lithium compounds, recovery of enriched uranium from scrap material, and fabrication of uranium and other materials into finished parts. Fabrication operations included vacuum casting, arc melting, powder compaction, rolling, forming, heat treating, machining, inspection, and testing.

Current assignments in the Y-12 Plant Defense Programs include dismantling nuclear weapon components returned from the national arsenal, serving as the nation's storehouse of special nuclear materials, and providing special production support to DOE programs. Another mission of long standing is the support of other federal agencies through the Work for Others Program. The technology transfer mission has as

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Fig. 1.5. The Oak Ridge Y-12 Plant.

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its goal to apply its unique expertise, initially developed for highly specialized military purposes, to a wide range of manufacturing problems to support the capabilities of the U.S. industrial base. The all-inclusive expertise at the Y-12 Plant includes proceeding from concept, through detailed design and specification, to building prototypes and configuring integrated manufacturing processes.

The Oak Ridge Centers for Manufacturing Technology, located on the Y-12 Plant site, apply skills, capabilities, and facilities developed during the 50-year history of the Oak Ridge complex to a variety of peacetime missions. Major programs exist at the Y-12 Plant in metrology (measurement science), machine tool technology, technology applications, manufacturing operations, and gear and thread technology. More than 15 centers are solving manufacturing problems and deploying technology. Oak Ridge has already helped more than 3,000 companies solve manufacturing problems, resulting in millions of dollars of savings and growth to industry.

Manufacturers nationwide can access information and services at the Y-12 Plant through a toll-free telephone service (1-800-356-4USA) that is a direct link to scientists, engineers, and other technical experts in the full range of manufacturing technologies. For more information, visit the Y-12 Plant home page on the World-Wide Web (<http://www.ornl.gov/mmes-www/general/OverviewY12.html>).

1.4.3 East Tennessee Technology Park

DOE renamed the Oak Ridge K-25 Site the “East Tennessee Technology Park” in an effort to further reindustrialize the former gaseous diffusion plant (Fig. 1.6).

The ETTP was built as the home of the Oak Ridge Gaseous Diffusion Plant (ORGDP). Construction of ORGDP began in the 1940s as part of the U.S Army’s Manhattan Project. The plant’s mission was production of highly enriched uranium for nuclear weapons.



Fig. 1.6. The East Tennessee Technology Park (formerly the Oak Ridge K-25 Site).

Enrichment was initially carried out in two process buildings, K-25 and K-27. Later, the K-29, K-31, and K-33 buildings were built to increase the production capacity of the original facilities by raising the assay of the feed material entering K-27. After military production of highly enriched uranium was concluded in 1964, the two original process buildings were shut down. For the next 20 years, the plant's primary mission was production of only slightly enriched uranium to be fabricated into fuel elements for nuclear reactors. Other missions during the latter part of this 20-year period included development and testing of the gas centrifuge method of uranium enrichment and R&D of laser isotope separation.

By 1985, demand for enriched uranium had declined, and the gaseous diffusion cascades at ORGDP were placed in standby mode. That same year, the gas centrifuge program was canceled. The decision to permanently shut down the diffusion cascades was announced in late 1987, and actions necessary to implement that decision were initiated soon thereafter. Because of the termination of the original and primary missions, ORGDP was renamed the Oak Ridge K-25 Site in 1990. In 1992, the site also became known as the Center for Environmental Technology and the Center for Waste Management. The ETTP is the home of the Environmental Management and Enrichment Facilities business unit (EMEF).

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

For more information, visit the ETTP home page on the World-Wide Web (<http://www.ornl.gov/mmes-www/ERWM/erwmout.html>).

1.4.4 Lockheed Martin Energy Research Corp.

On December 6, 1995, a contract was signed with DOE, effective January 1, 1996, that transferred the responsibility for operating ORNL from

LMES to the newly formed LMER. LMER is responsible for operating ORNL and managing the Oak Ridge National Environmental Research Park, which comprises 63.7% (almost 22,000 acres) of the reservation. Portions of the Park overlap areas of responsibility of ETTP, the Y-12 Plant, ETMC [East Tennessee Mechanical Contractors (formerly Johnson Controls)] and ORISE. For more information, visit the LMER home page on the World-Wide Web (<http://www.ornl.gov/home.html>).

1.4.5 Oak Ridge National Laboratory

ORNL was the smallest of three facilities built in 1942 and 1943 on the newly acquired 58,575-acre federal reservation in Oak Ridge, Tennessee. From its modest beginning as a war-time pilot plant, ORNL has grown to become one of the world's premier scientific research centers and home to DOE's largest and most diversified multiprogram national laboratory.

ORNL uses a total land area on the ORR approaching 26,580 acres. The primary ORNL site, known also as X-10, comprises a main laboratory building complex in Bethel Valley and outlying facilities and waste management storage areas in Melton Valley. Both areas utilize approximately 4,250 acres (Fig. 1.7). Of the remaining acreage, 21,980 acres comprise mostly undisturbed natural land that has been designated as the Oak Ridge National Environmental Research Park (Fig. 1.8), and approximately 350 acres are used by ORNL in the Solway Bend area for environmental monitoring. In addition, ORNL has contractual responsibility for wildlife management on the reservation as a result of an agreement between DOE and the Tennessee Wildlife Resources Agency (TWRA), which establishes the entire reservation land as a Tennessee Wildlife Management Area.

ORNL's mission is to support DOE in six broad areas:

- energy production and conservation technologies—ORNL conducts applied R&D in energy technologies, conservation, renewable



Fig. 1.7. The Oak Ridge National Laboratory.

- energy sources, magnetic fusion, fission, and fossil energy;
- physical and life sciences—experimental and theoretical research is undertaken to investigate fundamental problems in physical, chemical, materials, computational, biomedical, earth, environmental, and social sciences;
- scientific and technological user facilities—ORNL designs, builds, and operates unique research facilities for the benefit of university, industrial, federal agency, and other national laboratory researchers, bringing together national and international research elements for important scientific and technical collaborations;
- environmental protection and waste management—ORNL develops new technologies to correct existing environmental problems, to prevent future problems, and to reduce waste generation by recycling, reusing, and substituting less deleterious materials;

- science and technology transfer—the transfer of science and technology to U.S. industries and universities, a key factor in increasing the nation's international economic competitiveness, is an integral component of ORNL's R&D activities; and
- education—ORNL helps to prepare the scientific and technical work force of the future by offering innovative and varied learning and R&D experiences to students and faculty members from the preschool level through high school to postdoctoral studies and by establishing new relationships with educational institutions by teaming, partnering, and establishing joint initiatives.

1.4.5.1 Oak Ridge National Environmental Research Park

The Oak Ridge National Environmental Research Park is a 21,980-acre “outdoor laboratory” with relatively undisturbed ecosystems

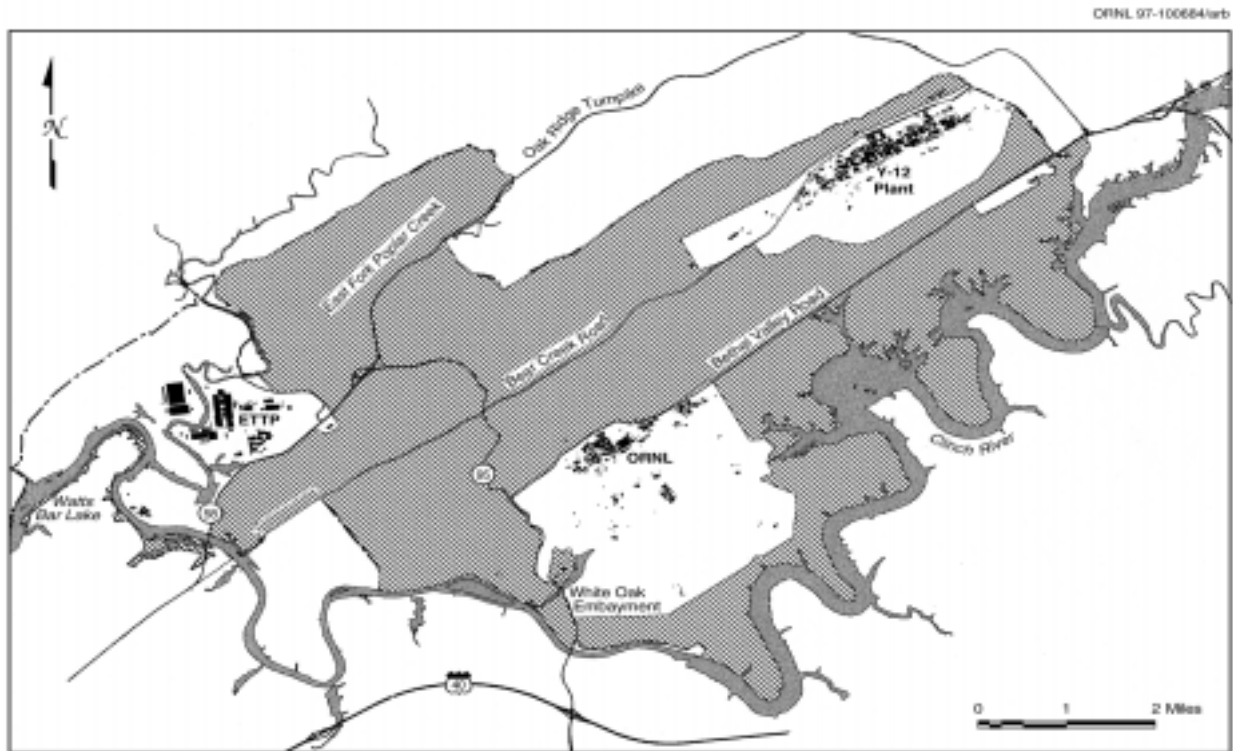


Fig. 1.8. The Oak Ridge National Environmental Research Park Covers 21,980 acres on the reservation.

(Fig. 1.8). The Research Park provides protected, biologically diverse land area for environmental research and education. It represents the eastern deciduous forest with more than 1,100 species of vascular plants, some of which are state-listed rare plants, and 315 wildlife species, some of which are state-listed or federally listed rare wildlife species (see Chap. 2, Tables 2.5 and 2.6). The park is a biosphere reserve, an ORNL user facility, a site that contains seven registered State Natural Areas, an area that plays a significant role in nesting and migration of breeding birds, and the location of two National Historic Landmarks, Freil's Cabin and the Graphite Reactor.

The biological diverseness of the Oak Ridge National Environmental Research Park serves as a foundation for ecological research into how the development and use of energy as well as other issues of national importance affect the environment. More than 700 individuals have performed research in the Oak Ridge National Environmental Research Park User Facility during the last five years. Users include students and faculty from

more than 75 colleges and universities as well as participants from ORNL and other state and federal agencies. Field research facilities occur across the reservation and include Walker Branch Watershed, the Global Change Field Research Facility, Melton Branch Watershed, and the Bear Creek Valley Hydrology Field Sites.

The National Environmental Research Park has supported research in the following areas:

- ecosystems dynamics and biodiversity—the large, unfragmented land provides a base for investigations into biogeochemical cycling, climate-change impacts, air quality, and biotechnology and offers opportunities for wildlife restoration; and
- environmental characterization—as the most hydrologically and geologically complex of all DOE sites, the Oak Ridge National Environmental Research Park provides opportunities for hydrogeologic and geophysical investigations, contaminant transport and fate studies, tracers for fractured media, microbial

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ecology, wetland surveys, and flora/fauna species/communities characterization.

1.4.6 Oak Ridge Institute for Science and Education

ORISE is managed for DOE by Oak Ridge Associated Universities (ORAU), a nonprofit consortium of 89 colleges and universities. ORISE includes 65 ha (162 acres) on the southeastern border of the 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, was operated by the University of Tennessee.

The ORISE Scarboro Operations Site (formerly the South Campus) currently occupies about 65 ha (162 acres) and lies immediately southeast of the intersection of Bethel Valley

Road and Pumphouse Road. It houses some of the offices and laboratories of one of ORISE's operating divisions, the Chemical Safety Building, and other support structures, and the site is being developed for other productive uses.

ORISE received the DOE Pollution Prevention Award in 1994 for work in transforming three lagoons on the Scarboro Site into functional wetlands for the degradation of hazardous wastes into harmless constituents. The Freels Bend tract, about 101 ha (250 acres) on the northeastern edge of Freels Bend abutting Melton Hill Lake, was transferred from ORISE to ORNL in late 1995 after removal of the six cobalt-60 sources (total of 2200 Ci) from the Variable Dose Rate Irradiation Facility (VDRIF) by a private contractor for recycling. For more information, visit the ORAU/ORISE home page on the World-Wide Web (<http://www.ornl.gov>).