5. Oak Ridge National Laboratory

The Oak Ridge National Laboratory (ORNL), managed by UT-Battelle, LLC, is DOE's largest science and energy laboratory. ORNL has a staff of more than 4,200 and annually hosts approximately 3,000 guest researchers who spend two weeks or longer in Oak Ridge. Annual funding exceeds $1.2 billion. As an international leader in a range of scientific areas that support the Department of Energy's mission, ORNL has six major mission roles: neutron science, energy, high-performance computing, systems biology, materials science at the nanoscale level, and national security. ORNL's leadership role in the nation's energy future includes hosting the U.S. project office for the ITER international fusion experiment and the Office of Science–sponsored Bioenergy Science Center.

5.1 Description of Site and Operations

5.1.1 Mission

ORNL lies in the southwest corner of DOE's Oak Ridge Reservation (ORR) (Fig. 5.1). The main ORNL site occupies approximately 1,809 ha and includes facilities in two valleys (Bethel and Melton) and on a Chestnut Ridge. ORNL was established in 1943 as a part of the secret Manhattan Project to pioneer a method for producing and separating plutonium. During the 1950s and 1960s, and with the creation of DOE in the 1970s, ORNL became an international center for the study of nuclear energy and related research in the physical and life sciences. By the turn of the century, the Laboratory supported the nation with a peacetime science and technology mission that was just as important as, but very different from, the work carried out in the days of the Manhattan Project. ORNL is an international leader in a range of scientific areas that support DOE's mission. UT-Battelle's six major mission roles at ORNL include neutron science, energy, high-performance computing, bioenergy, materials sciences at the nanoscale level, and national security. ORNL is the home of the world's largest facility for materials research with the recently completed Spallation Neutron Source (SNS) and the upgraded High Flux Isotope Reactor (HFIR) as well as 16 other designated national user facilities. These facilities are available to national and international laboratory, industrial, and academic users.

UT-Battelle also manages several DOE Office of Science facilities and one DOE Office of Nuclear Energy facility located off of the main ORNL campus. Seven buildings and one trailer are located at the Y-12 Complex, and three buildings and one trailer, which house the American Museum of Science and Energy, are located in the city of Oak Ridge. In addition, UT-Battelle leases six buildings, five near Oak Ridge and one in Washington, D.C.

The National Transportation Research Center (NTRC), an alliance among ORNL; the University of Tennessee; DOE; NTRC, Inc.; and the Development Corporation of Knox County, is the site of activities that span the whole range of transportation research. The center is an 85,000-ft^2 building, located on a 2.4 ha site in the Pellissippi Corporate Center and is leased to UT-Battelle and the University of Tennessee separately by Pellissippi Investors LLC.

The Transuranic (TRU) Waste Processing Center (TWPC), managed by EnergX for DOE, is located on the western boundary of ORNL on about 2 ha of land adjacent to the Melton Valley Storage Tanks along State Route 95. The TWPC's mission is to receive TRU wastes for processing, treatment, repackaging, and shipment to designated facilities for final disposal. The TWPC consists of the Waste Processing Facility, the Personnel Building, and numerous support buildings and storage areas. The TWPC began processing supernatant liquid from the Melton Valley Storage Tanks in 2002, the contact-handled solids in December 2005, and the remote-handled solids in May 2008.

In March 2007, Isotek Systems LLC (Isotek) assumed responsibility for surveillance and maintenance activities at the Building 3019 Complex at ORNL. DOE awarded the contract to Isotek to accomplish the following principal objectives:

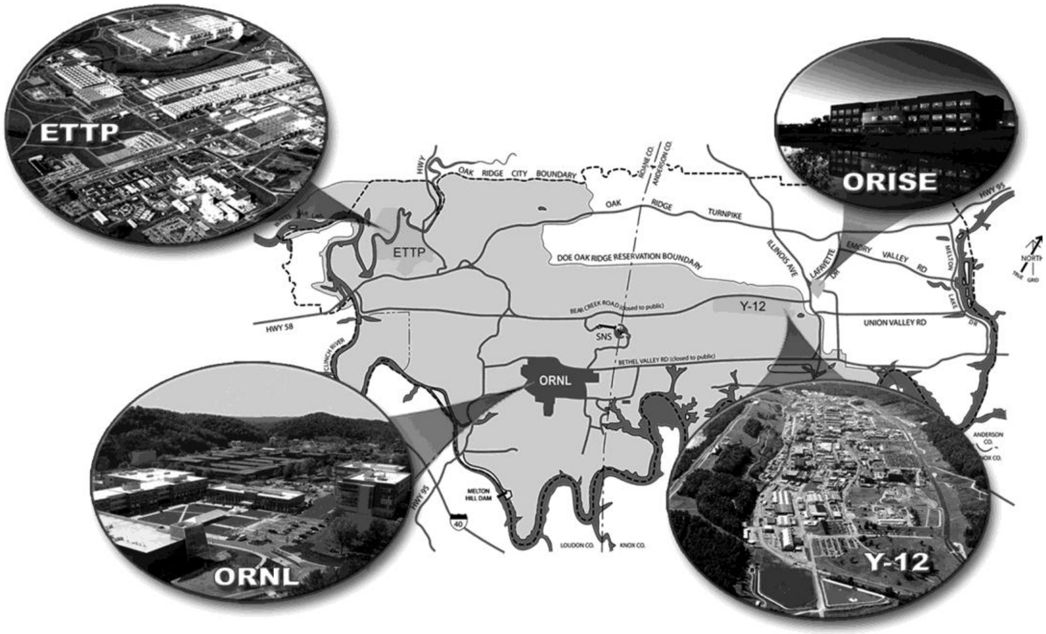

Fig 5.1. Location of ORNL within the ORR and its relationship to other local DOE facilities.

- process, down-blend, and package the DOE inventory of ^{233}U stored in the Building 3019 Complex to eliminate the need for safeguards, security, and nuclear criticality controls and to render the material suitable for disposition;
- remove the ^{233}U material from the Building 3019 Complex; and
- place the Building 3019 Complex in safe and stable shutdown mode for future decommissioning.

During CY 2008, Isotek has been active in planning for the design and construction of the operations needed to accomplish these objectives.

UT-Battelle continues to perform air and water quality monitoring for the 3019 facility, and the discussions in this chapter include the results for Isotek operations at ORNL.

Approximately 5 ha in the central portion of the ORNL has been leased to Halcyon, LLC, a subsidiary of the Community Reuse Organization of East Tennessee (CROET) for development into the Oak Ridge Science and Technology Park (ORSTP). The ORSTP will provide space for companies doing research at ORNL, partner universities, start-up companies built around ORNL technologies, and ORNL contractors to conduct business within a short distance of ORNL researchers and DOE user facilities such as the SNS, the Center for Nanophase Materials Sciences and the HFIR. Phase 1 of the Park's infrastructure was completed in 2008. Construction activities for the first ORSTP facility, Pro2Serve's 115,000 ft^2 National Security Engineering Center, are anticipated to be completed by the end of 2009. In addition, what was formally referred to as Building 2033 has been leased to Halcyon, LLC, and upgrades to the building were made in 2008. This multiple-tenant facility will be known as the Halcyon Commercialization Center.

5.1.2 Facilities Revitalization Program

In 1943, more than 6,000 workers began construction of some 150 buildings that became known as ORNL. Sixty-five years later, a massive effort to revitalize the site is literally rebuilding the Laboratory. Since 2000, more than 1,900,000 ft^2 of aged, expensive-to-maintain buildings have been vacated and some 1,000,000 ft^2 of new and renovated space has been constructed. The average age of ORNL facilities has decreased from 42 to 31 years. A combination of federal, state, and private financing has supported the construction of the new facilities (see Table 5.1).

Table 5.1. ORNL facilities constructed since 2000

Building number	Building name	Funding source
1060	Environmental and Life Sciences Laboratory	DOE
7972	Small-Angle Neutron Scattering Guide Hall Extension	DOE
1005	Laboratory for Comparative and Functional Genomics	DOE
7625	Multiprogram High Bay Facility	DOE
3625	Advanced Materials Characterization Laboratory	DOE
5200	Research Support Center	DOE
8610	Center for Nanophase Materials Sciences	DOE
NTRC	National Transportation Research Center	Private
5600	Computational Science Building	Private
5800	Engineering Technology Facility	Private
5700	Research Office Building	Private
5300	Multiprogram Research Facility	Private
5100	Joint Institute for Computational Sciences & Oak Ridge Center for Advanced Technologies	State
1520	Joint Institute for Biological Sciences	State
7880	TRU Waste Process Building	DOE
7880A	Contact-Handled Staging Area Building	DOE
7880B	Personnel Support Building	DOE
7880HH	Macroencapsulation Building	DOE
7880BB	Contact-Handled Marshalling Building	DOE
7880AA	Drum Venting Building	DOE

For the most part, the revitalization of ORNL's Chestnut Ridge and East Campuses is complete; the West and Melton Valley Campuses will be completed within the next 5 years. Over the next 10 years, UT-Battelle will continue to leverage federal, state, and private financing to deliver the site, facilities, and infrastructure for science and technical research at the Laboratory for the twenty-first century. Table 5.2 summarizes the levels and sources of funding for campus modernization to date.

Table 5.2. Levels and sources of funding for ORNL campus modernization, 2008

Source	Funding ($M)
DOE	525
Private sector	140
State of Tennessee	12
Total	677

5.1.2.1 2008 Modernization Activities at ORNL

During FY 2008, ORNL modernization efforts provided new facilities, enhanced staff interaction and space utilization, upgraded utility systems, and demolished old, expensive-to-maintain facilities. In FY 2008, ORNL expended approximately $8.8M to decrease the backlog of deferred maintenance in mission-critical facilities, to vacate substandard facilities, and to improve quality of remaining facilities.

East Campus

Design of the Modernization of Laboratory Facilities (MLF) project commenced in 2008. The new MLF will be located on ORNL's East campus, and will consist of a three-story building housing 160,000 ft^2 of research laboratory and support space thereby, enabling relocation of key research capabilities from aged facilities. MLF occupancy is scheduled for summer 2011.

Other 2008 projects in the East Campus addressed safety vulnerabilities and upgraded electrical and chilled-water capacity. Design and installation of early-warning smoke detectors in the corridors of Buildings 4500N and 4500S were initiated. In additional projects, the main power distribution point for Buildings 4500S, 4508, 4509, and 4515 was replaced. This replacement will prevent power loss to these buildings and will prevent loss of chilled water service to these and other facilities. Additionally, the 4000 Substation was reconfigured to increase power capacity to supply the power needed to support expanded growth in the East Campus Area. The 5000 Area 13.8 kV distribution system was upgraded to increase its capacity and reliability. Design of an underground chilled-water recirculating pipeline system to connect the 6000 Area with the chilled-water supply from Building 5800 (the Engineering Technology Facility) was also initiated in 2008. This project will also provide an underground recirculating chilled-water pipeline system, eventually enabling the transite chilled water pipeline between the 4509 Chilled Water Plant and the 6000 Area to be abandoned in place.

In keeping with its commitment to developing a sustainable campus, ORNL designed a 100 kW Elliott microturbine to provide electrical power to a general office building and to reclaim waste heat into building reheat loops. As part of this project, a large solar array panel north of the 3000 Area and Bethel Valley Road was assembled. The array provides 50 kW of electrical power previously derived from the main power grid. Use of reclaimed waste heat contributes to renewable energy goals set by DOE. The solar array and the micro-turbine conversion are two elements of a plan to transform Building 3137 into DOE's first zero-energy facility.

Central Campus

During 2008 design plans for an adjoining expansion to the Advanced Microscopy Laboratory (Building 3625) were initiated. The expansion to the Advanced Microscopy Laboratory will be constructed on the southwest side of the existing building to house a number of vibration sensitive instruments used for materials characterization.

West Campus

Renovations to existing West Campus facilities continued in 2008. First-floor laboratories and systems in Building 1505 were renovated to provide additional space for the Biological and Environmental Sciences Division staff. Construction of a quadrangle area in the West Campus was initiated in 2008. The quadrangle is an integral part of West Campus revitalization and is designed to integrate West Campus facilities and to facilitate an environment for growth and competitiveness in core research areas. Construction of the West End Research Support Facility, a 9,000 ft^2 preengineered metal building and supporting infrastructure was initiated in 2008. The facility will consolidate areas for research and operations storage as well as field sample collection and preparation. In late 2008, approval was received to proceed with design and construction of additional greenhouses on the West Campus in order to expand related research capabilities in the areas of bioenergy, ecosystems, bioremediation, and environmental genomics. Modernization of the West Campus will continue into 2009.

Chestnut Ridge Campus

Chestnut Ridge infrastructure investment continued in 2008, including design of three parking areas that provide a total of approximately 240 finished parking spaces; landscaping for approximately 16,000 ft^2 of area behind the site of the future Joint Institute for Neutron Sciences building; and design and construction of a cafeteria on the first floor of the Central Laboratory and Office building.

Melton Valley Campus

A warehouse in Melton Valley was designed and constructed during FY 2008. The warehouse will provide space to consolidate storage of equipment and materials previously stored across the ORNL site. Trailer 7964A, which housed staff, drawings, and records in Melton Valley, was replaced with a triple-wide trailer.

5.1.2.2 Integrated Facilities Disposition Initiative

Plans to disposition 1,500,000 ft^2 of aged, expensive-to-maintain facilities located at ORNL are proposed as part of the DOE Oak Ridge Office (DOE-ORO) Integrated Facility Disposition Project (IFDP). The IFDP is a multibillion-dollar collaborative proposal developed by DOE Offices of Environmental Management (EM), Science, and Nuclear Energy and the National Nuclear Security Administration (NNSA) that will complete the environmental cleanup of the ORR and that will enable ongoing modernization efforts at ORNL and the Y-12 National Security Complex. The IFDP will reduce risk to workers and the public, minimize ORNL and Y-12 mission risks resulting from the presence of deteriorating facilities and excess “legacy” materials, and provide valuable real estate for continued modernization. DOE approved the Alternative Selection and Cost Range Critical Decision-1 for the project in November 2008, and work on the 26-year project will continue in 2009 with development of the Critical Decision-2/3 package.

5.2 Environmental Management Systems

An important priority for DOE contractors performing management and operations activities at ORNL is the demonstration of environmental excellence through high-level policies that clearly state expectations for continual improvement, pollution prevention, and compliance with regulations and other requirements. UT-Battelle’s policy for ORNL is stated in Fig. 5.2.

Both UT-Battelle and EnergX have implemented Environmental Management Systems (EMSs), modeled after the International Organization for Standardization (ISO) standard 14001:2004 (ISO 2004), an international environmental management standard, as a tool to measure, manage, and control environmental impacts. An EMS is a continuing cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental goals. UT-Battelle’s EMS was initially registered to the ISO 14001 Standard by a third-party registrar in 2004, and was reregistered in June 2007 by NSF International Strategic Registrations, Ltd. Detailed information on the UT-Battelle EMS is provided in Sects. 5.2.1 through 5.2.4.2. EnergX’s EMS for activities at the TTWPC was registered to the ISO 14001:2004 Standard by NSF International Strategic Registrations, Ltd., in May 2008. No nonconformances or issues were identified during this assessment and several significant practices were noted. Section 5.2.5 describes the EnergX EMS and associated implementation activities.

5.2.1. UT-Battelle EMS

The UT-Battelle 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. Through the UT-Battelle Standards-Based Management System (SBMS), the EMS establishes the environmental policy and translates environmental laws, applicable DOE orders, and other requirements into Laboratory-wide subject area documents (procedures and guidelines). SBMS information is based on an evaluation of external requirements (i.e., directives and federal, state, and local laws), corporate policies, and best management practices that have been determined applicable to UT-Battelle operations and processes. Through environmental protection officers/environmental compliance representatives, and waste service representatives, the EMS assists the line organizations in identifying and addressing environmental issues in accordance with the SBMS requirements.

UT-Battelle is committed to

- ♦ complying with legal, contractual, and other applicable requirements;
- ♦ operating in a manner that protects and restores the environment and to integrating pollution prevention into planning and decision-making;
- ♦ providing and continually improving research, services, products, and management systems of the highest quality consistent with the needs, expectations, and resources of our customers; and
- ♦ communicating appropriate Environmental Management System information to staff, subcontractor personnel, customers, and other stakeholders.

Fig. 5.2. UT-Battelle policy for ORNL.

5.2.1.1 Integration with ISMS

The UT-Battelle EMS and Integrated Safety Management System (ISMS) are integrated to provide a unified strategy for the management of resources; the control and attenuation of risks; and the establishment and achievement of the organization's environment, safety, and health goals. ISMS and EMS both strive for continual improvement through a "plan-do-check-act" cycle. Under ISMS, the term "safety" also encompasses environmental safety and health, including pollution prevention, waste minimization, and resource conservation. Therefore, the guiding principles and core functions in ISMS apply both to the protection of the environment and to safety. Figure 5.3 depicts the relationship between EMS and ISMS.

Fig. 5.3. The relationship between the UT-Battelle EMS and the ISMS.

The UT-Battelle EMS is consistent with ISMS and includes the following elements:

- environmental policy;
- planning;
- legal and other requirements;
- objectives, targets, and programs;
- implementation and operation;
- resources, roles, responsibility, and authority;
- competence, training, and awareness;
- communication;
- documentation;
- control of documents;
- operational control;
- emergency preparedness and response;
- checking;
- monitoring and measurement;
- evaluation of compliance;
- nonconformity, corrective action, and preventative action;
- control of records;
- internal audit; and
- management review.

5.2.1.2 UT-Battelle Policy

The UT-Battelle Policy for ORNL (Fig. 5.2) is the highest level statement of how UT-Battelle conducts business. By clearly stating expectations, the policy provides the framework for setting and reviewing environmental objectives and targets.

5.2.1.3 Planning

5.2.1.3.1 UT-Battelle Environmental Aspects

Environmental aspects are elements of an organization's activities, products, or services that can interact with the environment. UT-Battelle identifies environmental aspects associated with its activities, products, and services at both the project and activity level. Activities that are relative to any of these aspects are carefully controlled to minimize or eliminate impacts to the environment. The following aspects have been identified as potentially having significant environmental impacts:

- hazardous waste,
- radioactive waste,
- mixed waste,
- polychlorinated biphenyl (PCB) waste,
- permitted air emissions,
- regulated liquid discharges, and
- storage or use of chemicals or radioactive materials.

5.2.1.3.2 UT-Battelle Legal and Other Requirements

Legal and other requirements that apply to the environmental aspects identified by UT-Battelle include federal, state, and local regulations, environmental permits, applicable DOE orders, UT-Battelle contract clauses, waste acceptance criteria, and voluntary requirements such as ISO 14001:2004. UT-Battelle has established procedures to ensure that all applicable requirements are reviewed and that changes and updates are communicated to staff and incorporated into work-planning activities.

5.2.1.3.3 UT-Battelle Objectives and Targets

UT-Battelle has established and implemented objectives, targets, and performance indicators for relative ORNL functions and activities. Where practical, the objectives, targets and performance indicators are measurable and in all cases, are consistent with the UT-Battelle Policy, and are supportive of the Laboratory Agenda.

5.2.1.3.4 UT-Battelle Programs

UT-Battelle has established an organizational structure to ensure that environmental stewardship practices are integrated into all facets of UT-Battelle's missions at ORNL. This system includes programs led by experts in environmental protection and compliance, energy and resource conservation, pollution prevention, and waste management to ensure that Laboratory activities are conducted in accordance with the environmental policy statements outlined in Fig. 5.2.

5.2.1.3.4.1 UT-Battelle Environmental Compliance Programs

UT-Battelle has established an organizational structure to help achieve full compliance with all applicable environmental regulatory requirements and permits. Environmental compliance experts provide critical support services to maintain a proper balance between cost and risk in the following areas:

- solid and hazardous waste compliance,
- National Environmental Policy Act (NEPA) compliance,
- air quality compliance,
- Water quality compliance,
- U.S. Department of Agriculture (USDA) compliance,
- environmental protection programs,
- environmental sampling and data evaluation, and
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) interface compliance.

The 2008 compliance status and information on UT-Battelle activities and accomplishments are presented in Sect. 5.3.

5.2.1.3.4.2 UT-Battelle Waste Management and Spill Response

The UT-Battelle staff includes experts who provide critical waste management and disposition support services to ORNL research, operations, and support divisions. These experts include

- waste services representatives who work with waste generators to identify, characterize, package, and certify wastes for disposal;
- the waste-handling team, which performs waste-packing operations and conducts inspections of waste items, areas, and containers;
- the waste and materials disposition team, which coordinates off-site disposition of ORNL's newly generated waste; and
- the hazardous material spill response team, which is ORNL's first line of response to hazardous materials spills and controls and contains such spills until the situation is stabilized.

5.2.1.3.4.3 Pollution Prevention Program

UT Battelle's Pollution Prevention (P2) Program has evolved from project-specific waste reduction efforts to a laboratory-wide philosophy of implementing sustainable practices that reduce ORNL's environmental impacts and provide monetary benefit to UT-Battelle, DOE, and the nation. The UT-Battelle EMS establishes annual goals and targets to reduce the impact of each organization's environmental aspects.

Over the past several years, UT-Battelle's P2 Program has been recognized by the U.S. Environmental Protection Agency (EPA) and DOE with the receipt of DOE Office of Science Pollution Prevention-Best in Class Awards in 2004, 2005, 2006, and 2008, two DOE P2 Star Awards in 2008, White House "Closing the Circle" Awards in 2004 and 2008, and an EPA WasteWise Gold Achievement Award in 2007.

During 2008, ORNL implemented 30 P2 initiatives with a reduction of more than 58 million kg of waste, resulting in a cost savings/avoidance of more than $3.5 million. The following sections describe some of UT-Battelle's 2008 sustainability, source reduction, and recycling projects.

ORNL's Green Transportation and Fleet Management Initiatives

UT-Battelle's Green Transportation Initiative has been recognized with a 2008 White House Closing the Circle Award in the Alternative Fuels and Fuel Conservation category and a DOE Pollution Prevention Star Award. Key features of the initiative include continuing expansion of the Laboratory's flex-fuel vehicle and biodiesel-fueled fleet, encouraging shared transportation, integrating maximized fuel efficiency features when upgrading roads, and encouraging personnel to walk and ride bicycles through innovative campus design. In 2008 the vehicle fleet included 150 flex fuel vehicles, which used 39,366 gal of E85, and 68 diesel vehicles and numerous pieces of equipment, which consumed 9,679 gal of biodiesel.

ORNL's Comprehensive Sustainability Initiative

In 2008, UT-Battelle received a DOE Pollution Prevention Star Award for the Comprehensive Sustainability Initiative, under which sustainable practices have been incorporated into planning, financing, and construction of new facilities and sustainable landscaping has been incorporated into the Laboratory's modernization campaign. ORNL's entire six-building East Campus, consisting of approximately 750,000 ft^2, is Leadership in Energy and Environmental Design (LEED®) certified by the U.S. Green Building Commission. Additionally during FY 2008, a new solar panel, one of the largest and most efficient in the state of Tennessee, was installed at ORNL at the intersection of Fifth Street and Bethel Valley Road (Fig. 5.4) as discussed in Sect. 5.1.2. The 288 × 10 ft solar panel generates 51.25 kW at peak power, and in combination with waste-heat recovery and other energy-efficiency techniques will enable the already Energy Star-rated Building 3147 to become a zero-energy building. Power from the solar panel will also be used to do research into power inverter technology and electric power distribution.

Fig. 5.4. The solar array installed in 2008 at ORNL generates 51.25 kW at peak power.

Environmentally Preferable Purchasing

Environmentally preferable purchasing, previously referred to as affirmative procurement, is a term used to describe an organization's policy to reduce packaging, and to purchase environmentally friendly products, such as products made with recycled material and bio-based materials. In 2008, purchases of recycled-content materials totaling more than $1.2 million were made for use at ORNL, demonstrating UT-Battelle's commitment to procure environmentally preferable materials.

ORNL's Transformers Transform to Biobased Oil

In 2008, the UT-Battelle Fusion Energy Division completed an initiative to replace petroleum-based oil in three transformers with a more environmentally friendly biobased oil (FR 3 Fluid). This project was also driven by the need to find a replacement oil with a higher flash point due to fire protection considerations. This initiative (1) improved fire protection safety, (2) replaced 1,200 gal of petroleum-based oil with an environmentally friendly biobased oil, (3) reduced used-oil generation, and (4) eliminated the need and associated cost to upgrade fire sprinkler systems.

Replacement of CRT Monitors with LCD Monitors

In 2008, UT-Battelle's Chemical Sciences Division, in conjunction with the Facilities Management Division, completed the Environmental Footprint Reduction Project, in which 176 cathode ray tube (CRT) monitors were replaced with more energy efficient liquid crystal display (LCD) monitors. The project resulted in both immediate and long-term energy reductions. It is estimated that LCDs require only 30% of the energy used by CRTs, in either the active or standby mode. By replacing the monitors, energy savings of 28,600 kWh and a cost avoidance of more than $1,500 were realized in 2008.

Materials Science and Technology Division Embraces Pollution Prevention

In FY 2008, the Materials Science and Technology Division identified and implemented two initiatives to reduce the types and amounts of waste generated as a result of division activities. The initiatives included (1) the replacement of lead in the storage of research samples and (2) the reduction of low-level radioactive waste (LLW) from used personal protective equipment (PPE). As a result, steel was substituted for lead, reducing the use of a hazardous material (lead) and decreasing the volume of mixed low-level radioactive waste and LLW at ORNL. UT-Battelle is investigating the possible expansion of these techniques to other ORNL operations. The two initiatives, which reduced lead use by 100 kg per year, mixed low-level radioactive waste by 100 kg per year, LLW by 10 yd^3 per year, resulted in an estimated nnual cost avoidance of $27,500.

UT-Battelle Reduces Water Use at ORNL through Pollution Prevention

UT-Battelle has implemented many-water-saving initiatives across ORNL, including the use of low-flow fixtures and faucets and the reuse of rainwater for irrigation of the newly modernized ORNL East Campus. UT-Battelle also incorporates water-saving strategies into research and support areas, including (1) closed-loop chiller systems (Figs. 5.5 and 5.6) in the Chemical Sciences Division, which were installed in FY 2008 and in previous years; (2) a cooling water elimination initiative implemented by the Nonreactor Nuclear Facilities Division; and (3) the ORNL steam plant water reduction initiative.

Fig 5.5. New closed-loop chilled water systems.

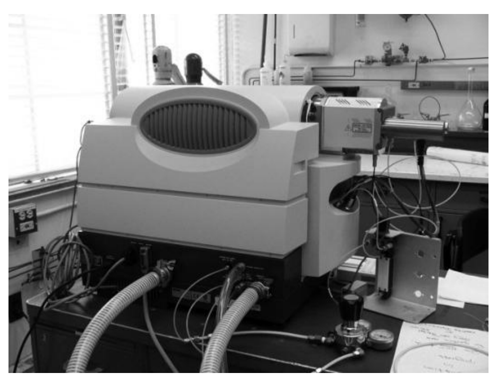

Fig. 5.6. Example of laboratory equipment using chilled water.

The initiatives not only reduced water usage and associated waste water generation by about 15 million gal per year but also improved operational efficiency, reduced the release of legacy mercury to the environment (White Oak Creek), reduced total regulated air emissions by 4,800 lb per year, saved 18,678 decatherms of natural gas and 3,446 gal of fuel oil, resulted in an estimated annual cost avoidance of $238,000, and increased the environmental awareness of lab personnel and the community. Further, to enhance water use and water quality awareness, UT-Battelle performs on-site lab-wide awareness activities, such as Earth Day events (Fig. 5.7), and conducts community outreach activities with water-awareness educational activities (e.g., assistance in the Appalachian Regional Commission—ORNL Summer Institute.

Fig. 5.7. ORNL Earth Day activities.

UT-Battelle Expands Oil Recycling

UT-Battelle has a well-established used-oil recycling program. During FY 2008 two additional used-oil streams were identified and were incorporated into the program: (1) used oil tainted with PCBs in the range of 2 to 50 ppm and (2) used Fomblin oil used in high vacuum equipment. Both streams were successfully reclaimed and recycled during FY 2008, resulting in a cost avoidance of more than $88,000. With the addition of the two newly identified streams, UT-Battelle recycled more than 6,100 gal of used oil during FY 2008.

UT-Battelle Radioactive Lead Recycling

UT-Battelle maintains an inventory of lead at ORNL for use in numerous laboratory activities. The lead is recycled so that the purchase and unnecessary disposal of lead as waste are minimized. During FY 2008, UT-Battelle successfully recycled a significant quantity of radioactively contaminated lead by making it available for use as a shielding material to an off-site DOE contractor. UT-Battelle established a multiorganizational team to ensure that all aspects of the transfer were completed safely, efficiently, and effectively. This project recycled 29,942 lb of radioactively contaminated lead.

UT-Battelle Solvent Purification and Recycling Initiative

The 2008 Center for Nanophase Materials Sciences (CNMS) Environmental Management System objectives and targets included a study to identify ways to reduce and eliminate solvent waste at the CNMS. Two alternatives were pursued: solvent recycle and solvent purification. CNMS identified the use of solvent-recycling systems as a means to minimize solvent use and waste generation on chromatography instruments in the polymer group and eliminated the need for five distillation systems by installing a solvent purification system. The solvent purification system relies on the purchase of higher-purity solvents that are passed through reusable/regeneratable columns, thereby removing the need for treatment with separate drying and purification chemicals that are usually one-time use. In addition, by not using distillation systems, CNMS eliminated the need for hazardous drying materials such as sodium-potassium alloy (NaK) or sodium metals, which require special handling and disposal. Consequently, this initiative (1) reduced the use of approximately 50 L of new solvent per year, (2) reduced the generation of approximately 50 L of hazardous waste solvent per year, and (3) resulted in an estimated annual cost avoidance of about $8,000.

Oak Ridge High School's Sustainable Green Transformation

Demonstrating its commitment to community outreach and sustainability, UT-Battelle, in cooperation with DOE, other DOE contractors, Oak Ridge corporate members, and Oak Ridge citizens, supported and participated in renovating the 53 year old Oak Ridge High School into a "green" learning environment that will serve current and future students well into the twenty-first century (Fig. 5.8). UT-Battelle provided corporate donations as well as technical expertise and resources that facilitated the "green" design and construction of this facility.

Fig. 5.8. Oak Ridge High School soccer field.

The "green" concepts that were integrated into the renovation will result in an estimated energy savings of 30%. They include the installation of a geothermal system consisting of 200 wells, each 300 ft deep. The system provides 50 to 60% of the school's heating and cooling needs. Other energy-saving features include using energy-efficient lighting and daylighting throughout the facility to reduce artificial lighting requirements, automatic light shutoff sensors, high-efficiency window systems, and high-emissivity roofing materials.

Additional green concepts integrated into the renovation include the use of recycled-content materials, low volatile organic compounds (VOC) materials, site reuse for a sustainable site, building material reuse, water conservation, use of local and regional materials, and integration of a recycling program.

Based on the incorporation of the of green concepts, this facility submitted an application for U.S. Green Building Council LEED Silver certification in February 2009. If certification is awarded, the Oak Ridge High School will be the first K–12 public school in Tennessee to be LEED certified.

5.2.1.4 Energy Management

UT-Battelle Energy Management and Conservation

The UT-Battelle Energy Management Program seeks to advance continuous improvements in energy efficiency in UT-Battelle facilities, coordinates energy related-efforts across UT-Battelle organizations, and promotes employee awareness of energy conservation programs and opportunities. The *Oak Ridge National Laboratory Executable Plan* (Palko 2008) outlines the general strategy for managing and implementing energy and energy-related activities at ORNL. The plan also addresses activities related to the accomplishment of the goals of Executive Order 13423, "Strengthening Federal Environmental, Energy, and Transportation Management" and the DOE Transformational Energy Action Management (TEAM) initiative. In a major effort, the DOE and Johnson Controls, Inc., energy savings performance contract (ESPC) has implemented the Sustainable Energy Education and Communications Program, which will allow ORNL staff to go through comprehensive web-based instructional modules on many aspects of energy management and conservation.

The Energy Policy Act (EPACT) of 2005 established the goal of reducing building energy intensity, using 2003 as the baseline year. Executive Order 13423 sets a more stringent reduction goal of 3% per year for the same time period, resulting in a planned 30% reduction over 10 years. As shown in Fig. 5.9, UT-Battelle energy conservation efforts have exceeded those levels with a 13.4% building energy intensity reduction between FY 2003 and FY 2008. In fact, UT-Battelle has realized energy intensity reductions at ORNL of about 34% since 1985.

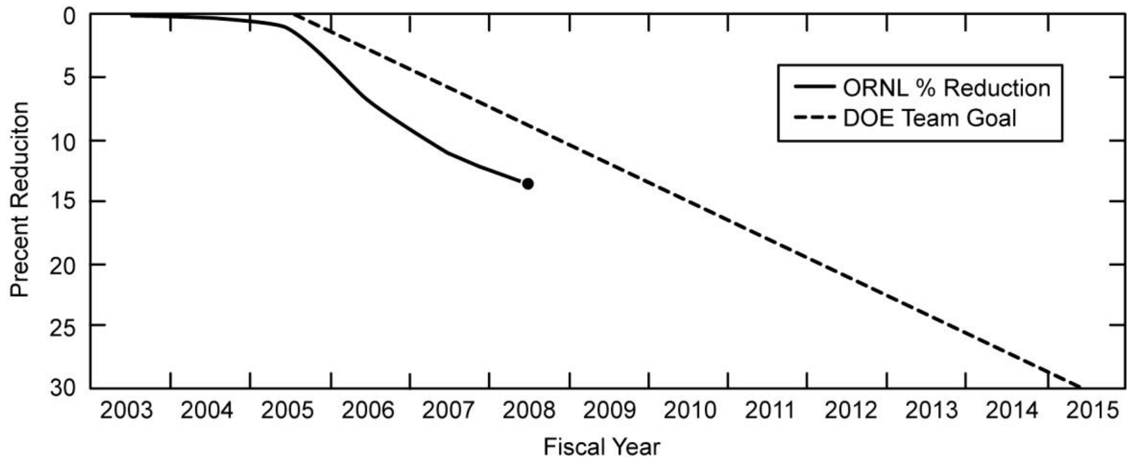

Fig. 5.9. ORNL building energy reduction vs the DOE TEAM goal.

The EPACT also requires federal agencies to install advanced electric metering, where practical, to improve the operating efficiencies of federal buildings. Measuring and managing energy use at the building level provide baseline data for assessing the effectiveness of energy savings programs and promote energy use awareness among building managers and occupants.

Data obtained through metering activities is essential for identifying cost-effective equipment retrofit opportunities, optimizing building and equipment operations, purchasing energy resources, planning, and allocating resources. UT-Battelle has proactively employed a policy of installing, as a minimum, standard electric meters at ORNL facilities for several years.

Sustainable Building Design

As discussed in Sects. 5.1.2.1 and 5.2.1.11, UT-Battelle continued to make significant progress on the implementation of the Facility Revitalization Project at ORNL during 2008. Sustainable building design principles continue to be incorporated into site selection, design, and construction of new facilities. The entire six-building East Campus, consisting of approximately 750,000 ft^2, is LEED certified. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas:

- sustainable site development,
- water savings,
- energy efficiency,
- materials selection, and
- indoor environmental quality.

These six new buildings save more than 14 million gal of water annually compared to the water used by similar older buildings at ORNL, and energy demands are 54% less than those at typical existing ORNL buildings. The heating and air-conditioning systems are 25 to 30% more efficient than American Society of Heating, Refrigerating and Air-Conditioning Engineers standard ASHRAE 90.1. The standard is a recognized, comprehensive industry standard that outlines the best practices and expectations for efficient, sound, heating, ventilating and air-conditioning design.

Energy Intensity Reduction Performance in Subject Buildings

DOE’s TEAM initiative goal for reducing energy intensity in standard office and laboratory buildings is 3% per fiscal year using FY 2003 as the baseline year. The “subject” buildings are those buildings that are subject to legislated energy goals and that are not excluded from the goals that can be approved when buildings use an extraordinary amount of energy for research purposes. FY 2006 has been defined as the first performance year. (Major excluded buildings at ORNL are the HFIR, the Computational Sciences

Building's computer center, the Holifield Heavy Ion Research Facility, and the process buildings at the Spallation Neutron Source project.) In FY 2003, the baseline year, ORNL's energy intensity was 364,539 Btu per gross square foot (GSF), as shown in Fig. 5.9. After a brief plateau, ORNL's energy intensity is trending downward.

ORNL's energy intensity was 5.78% less in FY 2006 than it was in FY 2005, 6.31% less in FY 2007 than in was in FY 2006, and 1.54% less in FY 2008 than it was in FY 2007. Considering all years since the baseline year of FY 2003, the cumulative progress represents a 13.4% Btu/GSF reduction in energy intensity through FY 2008. Because FY 2008 was the third performance year, the target reduction was 9%; therefore, ORNL is currently ahead of the pace for meeting the FY 2015 goal of a 30% reduction. Various factors affect the results each quarter and each year, and fluctuations or plateaus in the results are not uncommon. Variables include the addition of new, efficient buildings; the shutdown or demolition of inefficient buildings; the implementation of new energy efficiency projects; the operation and management of systems that use energy; and weather conditions. Overall, ORNL's energy use trend is downward and currently on a pace to meet the DOE goal.

Energy Savings Performance Contracting

On July 30, 2008, Johnson Controls, Inc., was awarded an ESPC project at ORNL in support of the DOE TEAM Initiative. Recognizing that the core mission and responsibility of DOE is to lead the nation in promoting and using the best available energy management technologies and practices, the TEAM Initiative embarks on a program to meet, exceed, and lead in the implementation of the Executive Order 13423 energy, environmental and transportation goals.

The ESPC outlines various energy conservation measures (ECMs) that were developed to meet the goals of the DOE TEAM criteria, the *ORNL Ten-Year Site Plan*, and the Laboratory mission requirements.

The ECMs, savings projections, and project costs in the initial proposal were developed based on

- site visits by Johnson Controls personnel ,subcontracting partners and outside engineering support;
- extensive discussions with ORNL personnel, including facilities, utilities, energy management, contracting, accounting, master planning, and facility occupants and building users;
- analysis of facility construction documentation and ten-year site planning goals; and
- analysis of site energy consumption and history.

In addition to meeting the goals of the TEAM Initiative, the purpose of the ESPC effort is to support and modernize facility infrastructure, provide utility support and capacity, and ensure that mission-related activities can be performed without interruption.

ORNL will receive the following specific benefits from this project:

- modernization or significant infrastructure improvements of the existing steam plant and distribution system to create a world-class combined heat and power system fueled by renewable energy;
- improved chilled water system efficiency and reliability as a result of expanding and automating the plant;
- installation of advanced metering technology to continue ORNL's path toward meeting Sect. 103 of EPACT 2005;
- expansion of the Building Management System to provide automation in key areas and critical systems;
- extensive heating, ventilating, and air-conditioning system improvements and upgrades to improve comfort and meet facility consolidation needs;
- approximately $65 million in necessary deferred infrastructure improvements funded through energy savings;
- annual energy savings of 768,061 million Btu;
- water use reduction of about 170 million gal per year;

- carbon sequestration equivalent to 1,325,744 tree seedlings grown in an urban environment for 10 years or 11,751 acres of pine forests; and
- emission reductions equivalent to the reduction of 9,470 passenger vehicles; 120,242 barrels of oil; the energy used by 4,563 homes annually; or 270 coal rail cars.

Table 5.3 demonstrates the ESPC goals implemented to meet or exceed TEAM goals.

The status of the ECMs is outlined in Table 5.4.

Table 5.3. Energy savings performance contracting goals

	TEAM goal	Projected results
Percentage energy intensity reduction	30	50
Percentage water usage reduction	16	23
Required advanced electric metering installations	100	100
Percentage of energy from renewable sources	7.5	21
Measurement and verification of results	Yes	Yes
Incorporate sustainable designs	Yes	Yes

TEAM: Transformational Energy Action Management Initiative

Table 5.4. Energy conservation measure status

Measure	Status
Central Steam Plant Biomass Solution	Design and procurements are being finalized with construction to begin late FY 2009. Construction will be completed in mid-FY 2011
Select Steam Decentralization of Remote Buildings	Design and procurements are nearly complete. Some initial installation work is beginning with completion scheduled for fall 2009
Building Management System Upgrade	Design and procurements are being finalized and initial construction has started. Construction period is scheduled to be completed by spring 2010
Advanced Electric Metering	Design and procurement is complete, and installation is approximately 50% complete. Work is to be complete in May 2009
Comprehensive HVAC Upgrade	Design is being finalized and procurements have begun. An alternative scope of work may be needed for Bldg. 1505 due to another project; evaluation needs to be completed. Work is currently scheduled to be completed in February 2010
Energy-Efficient Lighting Upgrade	Design and procurements have been completed with construction approximately 50% complete. Scheduled for completion in September 2009
Water Conservation	Domestic water projects are complete. Once-through cooling project is still being designed with completion scheduled for FY 2009

Electric Metering

UT-Battelle has had a policy of metering for electricity at the building or substation level for many years. There are currently about 350 standard electric meters installed at ORNL (Table 5.5.) Almost all buildings that use electricity have at least a standard meter. While the site has approximately 450 structures identified as buildings, many of them are warehouses and equipment sheds that use little, if any, electricity. Of this total, approximately 120 buildings represent 70% of the space and 80% of the electricity use. Based on the criteria established in *Guidance for Electric Metering in Federal Buildings* (DOE 2006), thirty-eight buildings at ORNL which use over $32,000 in electricity each year, require advanced metering. When complete, buildings that account for 65% of UT-Battelle's total electrical consumption will have advanced metering and all buildings will have at least a standard meter (Table 5.6).

Table 5.5. Metering status

Building classification	Number of buildings
Total number of buildings at ORNL[a]	~450
Number of standard meters on site	~350
Total number of buildings considered for metering	121
Number of buildings with advanced meters[b]	18
Number of buildings with no existing meter/standard meter requiring advanced meters	20

[a]Many of the 450 structures at ORNL are warehouses, equipment sheds, and storage areas that use little or no electricity.

[b]Once implemented, advanced metering will be present in buildings representing 65% of the electrical consumption. All buildings will have at least a standard meter.

Table 5.6. Buildings to receive advanced meters by FY 2009 as part of ESPC

Year	Building number
2009	1005, 1060, 1505, 1506, 2519, 3020, 3047, 3144, 3500, 3525, 3608, 3625, 4500N, 4500S, 4501, 4505, 4508, 4509, 4515, 5100, 5200, 5300, 5500, 5505, 5510, 5510A, 5600, 5700, 5800, 6000, 6010, 7012, 7603, 7900, 7917, 7920, 7930, 7977

UT-Battelle Employee Energy Conservation Education and Involvement Opportunities

During 2008, UT-Battelle sponsored several events to promote employee awareness of opportunities to conserve energy and promote energy efficiency.

ORNL Earth Day Celebration

ORNL's Earth Day 2008 celebration, held on April 22, 2008, was headlined with a talk by Jeff Christian, focusing on his work on near zero energy homes in the Lenoir City Habitat for Humanity development. The slate of activities for the celebration also included an East Campus Pond tour. More than 2,000 people attended and were presented with a green recycled grocery bag containing energy efficiency, conservation, and sustainability items (Fig. 5.7).

ORNL Energy Awareness Month

October is National Energy Awareness Month, billed as a time to promote wise and efficient use of our nation's energy and a time to emphasize the commitment to a more secure energy future. The year's theme was "Working to secure a clean energy future, where energy is abundant, reliable and affordable." ORNL participated in several October activities to promote energy awareness, beginning with the Energy Star Change a Light, Change the World Campaign. The campaign is a national call to action to encourage individuals to help change the world, one light—one energy-saving step—at a time.

New Transportation Options

During the month of October, ORNL highlighted two new transportation options on campus: bicycles and electric vehicles (see Figs. 5.10 and 5.11). Bikes are available for employees looking for an alternative to driving or walking from one building to another at ORNL. The Laboratory's extended campus makes transportation a periodic challenge, especially for those who are thinking about energy efficiency. The bike program is the joint effort of ORNL's Wellness Program and F&O's Energy Management group. The two-wheelers, which have automatic three-speeds, are stationed at various places around the campus and available for all staff. Safety training is required for employees who use the bikes.

Fig. 5.10. The fleet for the ORNL Bicycle Program.

Fig. 5.11. Example of the electric vehicles in service at ORNL.

ORNL is aggressively pursuing efficient energy management. The federal government as a whole spends more than $9 billion to power its vehicles, operations and approximately 500,000 facilities across America. As one of those facilities, the Lab is working to make buildings more efficient and our fleets less dependent on foreign sources of fuel. Bicycles provide an opportunity for employees to reduce fuel consumption and get exercise simultaneously. Electric vehicles also recently made their debut on campus as a means to improve the energy efficiency of the ORNL vehicle fleet.

Additional Photvoltaic Capacity Added

In 2008, ORNL installed 50 kW of solar photovoltaic generating capacity. This array is 10 ft wide and 280 ft long.

5.2.2 Implementation and Operation

5.2.2.1 Structure and Responsibility

The UT-Battelle policy statements (Fig. 5.2) represent the philosophy of UT-Battelle management for the conduct of research, operations, and other activities at ORNL. A key tenet of the policy is the integration of environmental and pollution prevention principles into work practices at all levels. Prior to performing any work at ORNL, all staff are required to complete comprehensive site orientation and training that outline employee responsibilities for environmental compliance and set forth expectations for all employees to comply with the policy statements and with the UT-Battelle EMS. Specific roles and responsibilities are further defined in position descriptions and individual performance plans.

An Environmental Protection Officer (EPO) Program, an Environmental Compliance Representative (ECR) Program, and a Waste Services Representative (WSR) Program have also been established to ensure that work planning activities for all UT-Battelle organizations address environmental protection and pollution prevention measures. The objectives of these programs are as follows:

- The EPO and ECR Programs
  - coordinate efforts to seek, accomplish, and maintain environmental compliance across all UT-Battelle organizations;
  - communicate environmental requirements and compliance strategies; and
  - provide liaisons between individual UT-Battelle organizations and the Environmental Protection and Waste Services Division.
- The WSR Program
  - provides a technical interface between waste generators and the Environmental Protection and Waste Services Division;
  - provides expertise in identifying, characterizing, packaging, and certifying wastes for disposal; and
  - coordinates the support required to complete necessary forms, properly classify waste streams, and develop characterization basis to successfully complete the waste certification and disposal process.

5.2.2.2 Communication and Community Involvement

Information on the UT-Battelle EMS is routinely communicated internally to staff and externally to stakeholders in several ways:

- EPO, ECR, WSR, and Management System owner meetings and workshops dedicated to EMS topics;
- Environmental Protection web sites;
- SBMS documentation available to all employees;
- EMS brochures and badge cards; and
- *ORR Annual Site Environmental Report*, which includes information on significant aspects, compliance status, pollution prevention programs, and other EMS elements and is made available to the public, to regulators, and to stakeholders.

5.2.3 Emergency Preparedness and Response

The Emergency Management System provides the resources and capabilities to provide emergency preparedness services and, in the event of an accident, emergency response services. Emergency Preparedness personnel perform hazard surveys and hazard assessments to identify potential emergency situations. Procedures and plans have been developed to prepare for and respond to a wide variety of potential emergency situations. Training is provided to ensure appropriate response and performance during emergency events. Frequent exercises and drills are scheduled to ensure the effective performance of the procedures and plans. An environmental subject matter expert is a member of the emergency response team and participates in drills and exercises to ensure that environmental requirements are met and that environmental impacts from the event (and the response) are mitigated.

5.2.4 Checking

5.2.4.1 Monitoring and Measurement

UT-Battelle has developed monitoring and measurement processes for each operation or activity that can have a significant impact on the environment. Several SBMS subject areas include requirements for managers to establish performance objectives, indicators, and targets; conduct performance assessments to collect data and monitor progress; and evaluate the data to identify strengths and weaknesses in performance and areas for improvement.

5.2.4.2 EMS Assessments

Several methods are used by UT-Battelle to evaluate compliance with legal and other environmental requirements. Most of the compliance evaluation activities are implemented by the EMS or are a part of line organization assessment activities.

The SBMS Assessment subject area requires organizations to perform periodic environmental assessments that cover both legal and other requirements and requires management system owners to conduct annual self-assessments of their systems to ensure continual improvement.

UT-Battelle also uses the results from numerous external compliance inspections conducted by regulators to verify compliance to requirements. In addition to regulatory compliance assessments, there are internal and external EMS assessments performed annually to ensure that the UT-Battelle EMS continues to conform to ISO requirements. In 2008, an internal audit and an external surveillance audit were conducted and verified that the EMS continued to conform to ISO 14001:2004.

5.2.5 Environmental Management System for the Transuranic Waste Processing Center

EnergX's EMS for activities at the TWPC was registered to the ISO 14001:2004 Standard by NSF International Strategic Registrations, Ltd., in May 2008. No nonconformances or issues were identified during this assessment, and several significant practices were noted. The EnergX TWPC EMS and ISMS are integrated to provide a unified strategy for the management of resources; the control and reduction of risks; and the establishment and achievement of the organization's environment, safety, and health goals. The EMS and ISMS are incorporated into the *Integrated Safety Management Description Plan* at the TWPC. ISMS and EMS both strive for continual improvement through a "plan-do-check-act" cycle.

The EnergX EMS incorporates applicable environmental laws, DOE orders, and other requirements (i.e., directives and federal, state, and local laws) through the *EnergX Contract Requirements Document and Regulatory Management Plan*, which dictates how the various requirements are incorporated into TWPC subject area documents (procedures and guidelines). Through environmental program personnel and EMS representatives, the EMS assists the line organizations in identifying and addressing environmental issues in accordance with the EMS requirements.

Environmental aspects are elements of an organization's activities, products, or services that can interact with the environment. EnergX has identified environmental aspects associated with TWPC activities, products, and services at both the project and activity level and has identified waste management activities, air emissions, storm water contamination, and pollution prevention as potentially having significant environmental impacts. Activities that are relative to any of those aspects are carefully controlled to minimize or eliminate impacts to the environment.

EnergX has established and implemented objectives and measurable performance indicators for the targets associated with the identified significant impacts.

The P2 programs at the TWPC involve waste reduction efforts and implementation of sustainable practices that reduce the environmental impacts of the activities conducted at the TWPC. The EnergX EMS establishes annual goals and targets to reduce the impact of the TWPC's environmental aspects.

EnergX has a well-established recycling program at TWPC and continues to identify new material-recycling streams and to expand the types of materials included in the program. Currently, recycle streams at the TWPC range from office materials such as paper, aluminum cans, plastic drinking bottles, and toner cartridges to operations-oriented materials, such as scrap metal, cardboard, and batteries.

"Environmentally preferable purchasing" is a term used to describe an organization's policy to reduce packaging and to purchase products made with recycled material or bio-based materials and other environmentally friendly products. In 2008, EnergX procured environmentally preferable materials totaling more than $70,000 for use at TWPC.

Several methods are used by EnergX to evaluate compliance with legal and other requirements. Most of these compliance evaluation activities are implemented by internal and external environmental and management assessment activities and routine reporting and reviews. EnergX also uses the results from numerous external compliance inspections conducted by regulators and independent contractors to verify compliance to requirements.

5.3 Compliance Status

5.3.1 Environmental Permits

Table 5.7 contains a list of environmental permits that were effective in 2008 at ORNL.

5.3.2 Notices of Violations and Penalties

ORNL did not receive any notices of violations or penalties from regulators during 2008.

5.3.3 Audits and Oversight

Table 5.8 presents a summary of environmental audits conducted at ORNL in 2008.

5.3.4 National Environmental Policy Act/National Historic Preservation Act

NEPA provides a means to evaluate the potential environmental impact of proposed federal activities and to examine alternatives to those actions. UT-Battelle maintains compliance with NEPA through the use of site-level procedures and program descriptions that establish effective and responsive communications with program managers and project engineers to establish NEPA as a key consideration in the formative stages of project planning. Table 5.9 summarizes NEPA activities conducted at ORNL during 2008.

During 2008, UT-Battelle continued to operate under a site-level procedure that provides requirements for project reviews and NEPA compliance. This procedure calls for a review of each proposed project, activity, or facility to determine the potential for impacts to the environment. To streamline the NEPA review and documentation process, DOE-ORO has approved "generic" categorical exclusions (CXs) that cover proposed bench- and pilot-scale research activities and generic CXs that cover proposed nonresearch activities (i.e., maintenance activities, facilities upgrades, personnel safety enhancements). A CX is one of a category of actions defined in 40 CFR 1508.4 that does not individually or cumulatively have a significant effect on the human environment and for which neither an environmental assessment nor an environmental impact statement is normally required. Table 5.9 provides information on project-specific CXs that were approved by DOE-ORO during 2008.

UT-Battelle utilizes SBMS as the delivery system to manage and control work at ORNL. NEPA is an integral part of SBMS, and a UT-Battelle NEPA coordinator, along with principal investigators, environmental compliance representatives, and environmental protection officers within each UT-Battelle division, participate in determining appropriate NEPA decisions.

An Environmental Assessment was completed in 2008 for the *Oak Ridge National Laboratory Modernization Initiative* (DOE/EA-1618, July 2008) to provide facilities and infrastructure to accomplish DOE's research mission at ORNL. The proposed action will also enhance worker health and safety, reduce operating costs, accommodate project growth and allow relocation of staff, facilities and support services in the Central Campus.

Table 5.7. ORNL environmental permits, 2008

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	Radioactive Materials Analytical Laboratory	556850	10-21-04	10-21-09	DOE	UT-B	UT-B
CAA	Radiochemical Development Facility	556850	10-21-04	10-21-09	DOE	UT-B	UT-B
CAA	Steam Plant	556850	10-21-04	10-21-09	DOE	UT-B	UT-B
CAA	Manipulator Boot Shop	556850	10-21-04	10-21-09	DOE	UT-B	UT-B
CAA	SNS Central Utilities Building Boilers	556850	10-21-04	10-21-09	DOE	UT-B	UT-B
CAA	Surface Coating and Cleaning Operation	556850	10-21-04	10-21-09	DOE	UT-B	UT-B
CAA	SNS and CNF (construction permit)	956542P	10-29-04	03-01-08	DOE	UT-B	UT-B
CAA	SNS Central Laboratory and Office Boilers	556850	10-21-04	10-21-09	DOE	UT-B	UT-B
CAA	EGCR Boilers	556850	10-21-04	10-21-09	DOE	UT-B	UT-B
CAA	Air Stripper (BJC permit)	547563	10-21-04	10-21-09	DOE	BJC	BJC
CAA	HFIR & Radiochemical Engineering Development Center	556850	10-21-04	10-21-09	DOE	UT-B	UT-B
CAA	Off Gas & Hot Cell Ventilation (BJC permit)	547563	10-21-04	10-21-09	DOE	BJC	BJC
CAA	NTRC	0904-12[b]	05-10-01	Annually	DOE	UT-B	UT-B
CAA	TN Operating Permit (Emissions Source)	057077P	04-13-04	10-31-14	DOE	EnergX	EnergX
CAA	NTRC Engine Test (Construction Permit)	C-0419-2	07-29-08	07-07-09	DOE	UT-B	UT-B
CWA	ORNL NPDES Permit (ORNL site-wide wastewater discharge permit)	TN0002941	07-01-08	07-30-13	DOE	DOE	UT-B, BJC
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—SNS	TNR139975	09-30-00	NA	DOE	DOE	UT-B

Table 5.7 (continued)

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—ORNL Research Support Center	TNR130471	06-02-03	02-07-08	DOE	DOE	UT-B
CWA	General Permit For Construction & Removal of Minor Road Crossings-ORNL West Campus Improvements	NR0803.058	04-07-08	04-07-09	DOE	DOE	UT-B
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—ORNL 24-Inch Water Line Replacement	TNR132022	06-23-06	02-07-08	DOE	DOE	UT-B
CWA	Tennessee General Permit No. TNR10-0000, Stormwater Discharges from Construction Activity—ORNL Decommissioning & Demolishing Buildings	TNR1301343	05-26-05	NA	DOE	DOE	UT-B
CWA	Tennessee General Permit No. TNR10-0000, Stormwater Discharges from Construction Activity—ORNL West Campus Improvements	TNR132878	12-04-07	NA	DOE	DOE	UT-B
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—Pro2Serve National Security Engineering Center		10-06	NA	DOE	DOE	Pro2Serve
CWA	TN Operating Permit (sewage)	SOP-02056	02-01-08	12-31-12	DOE	EnergX	EnergX
CWA	Tennessee Multi-Sector General NPDES Storm Water Permit No Exposure Exclusion	TNR053814	11-22-05	11-22-10	TDEC	EnergX	EnergX
RCRA	Hazardous Waste Transporter Permit	TN18900900 03	01-22-08	01-31-09	DOE	DOE	UT-B, BJC, Weskem

Table 5.7 (continued)

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
RCRA	Hazardous Waste Corrective Action Permit	TNHW-121	09-28-04	09-28-14	DOE	DOE/all[e]	BJC/EnergX
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-134[c]	09-26-08	09-26-18	DOE	DOE/UT-B[d]	UT-B[d]
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-097	09-30-97	09-30-07[d]	DOE	DOE/BJC/ Weskem, EnergX	

Abbreviations:

BJC	Bechtel Jacobs Company
CAA	Clean Air Act
CNF	Central Neutralization Facility
CWA	Clean Water Act
DOE	U.S. Department of Energy
EGCR	Experimental Gas-Cooled Reactor
HFIR	High Flux Isotope Reactor
NPDES	National Pollutant Discharge Elimination System
NTRC	National Transportation Research Center
ORNL	Oak Ridge National Laboratory
RCRA	Resource Conservation and Recovery Act
SNS	Spallation Neutron Source
UT-B	UT-Battelle

[b]Permit issued by Knox County Department of Air Quality Management.
[c] Permit TNHW-10A reissued as TNHW-134 on September 26, 2008.
[d]BJC and WESKEM removed from permit and UT-Battelle added to permit on October 28, 2008.
[e]DOE and all Oak Ridge Reservation co-operators of hazardous waste permits

Table 5.8. Summary of environmental audits, assessments and regulatory visits conducted at ORNL, 2008

Date	Reviewer	Subject	Issues
		UT-Battelle	
February 19	TDEC	NPDES permit renewal discussion	0
February 20	TDEC/EPA	Annual CAA inspection	0
February 25	TDEC	CAA visible emissions inspection	0
April 15	EPA/TDEC	Underground tank inspection	0
May 12–14	TDEC, RCRA	TDEC annual RCRA inspection	0
July 2	TDEC	Fish kill follow-up	0
July 22–25	NSF-ISR	EMS assessment	2
September 16	TDEC	Fish kill follow-up	0
September 25	TDEC	RATA for predictive emissions	
October 27–29	TDEC	Annual RCRA inspection at Y-12 Complex	0
December 3	TDEC	RATA for continuous emissions	0
December 16	TDEC	Annual CAA inspection	0
December 18	Knox County Air Quality Management Division	Annual NTRC inspection	0
		Bechtel Jacobs Company/WESKEM/Energy Solutions	
May 12–14	TDEC, RCRA	TDEC Annual RCRA inspection	0
		EnergX	
May 13–14	TDEC, RCRA	TDEC Annual RCRA inspection	0

Abbreviations

CAA	Clean Air Act
EMS	Environmental Management System
EPA	Environmental Protection Agency
NPDES	National Pollutant Discharge Elimination System
NSF-ISR	NSF International Strategic Registrations, LTD
NTRC	National Transportation Research Center
ORNL	Oak Ridge National Laboratory
RATA	relative accuracy test audit
RCRA	Resource Conservation and Recovery Act
TDEC	Tennessee Department of Environment and Conservation

Compliance with National Historic Preservation Act (NHPA) at ORNL is achieved and maintained in conjunction with NEPA compliance. The scope of proposed actions is reviewed in accordance with the *Cultural Resource Management Plan* (DOE 2001).

5.3.5 Clean Air Act Compliance Status

The Clean Air Act (CAA), passed in 1970 and amended in 1977 and 1990, forms the basis for the national air pollution control effort. This legislation establishes comprehensive federal and state regulations to limit air emissions and includes four major regulatory programs: the National Ambient Air Quality Standards, State Implementation Plans (SIPs), New Source Performance Standards (NSPS), and National Emission Standards for Hazardous Air Pollutants (NESHAP). Airborne discharges from DOE Oak Ridge facilities, both radioactive and nonradioactive, are subject to regulation by EPA and the Tennessee Department of Environment and Conservation (TDEC) Division of Air Pollution Control. There were no ORNL CAA violations or exceedances in 2008. Section 5.4 provides detailed information on 2008 UT-Battelle activities conducted in support of the CAA.

Table 5.9. National Environmental Policy Act (NEPA) activities, 2008

Types of NEPA documentation	Number of instances
ORNL	
Categorical exclusions (CXs) approved	1
Approved under general actions or generic CX documents	45[a]
Environmental assessment	1
EnergX	
Approved under general actions or generic CX documents	6[a]

[a]Projects that were reviewed and documented through the site NEPA compliance coordinator.

5.3.6 Clean Water Act Compliance Status

The objective of the Clean Water Act (CWA) is to restore, maintain, and protect the integrity of the nation's waters. This act serves as the basis for comprehensive federal and state programs to protect the nation's waters from pollutants. (See Appendix D for water reference standards.) One of the strategies developed to achieve the goals of the CWA was EPA's establishment of limits on specific pollutants allowed to be discharged to U.S. waters by municipal sewage treatment plants and industrial facilities. The EPA established the National Pollutant Discharge Elimination System (NPDES) Permitting Program to regulate compliance with pollutant limitations. The program was designed to protect surface waters by limiting effluent discharges into streams, reservoirs, wetlands, and other surface waters. EPA has delegated authority for implementation and enforcement of the NPDES program to the state of Tennessee.

In 2008, compliance with the ORNL NPDES permit was determined by approximately 4000 laboratory analyses and field observations. The NPDES permit limit compliance rate for all discharge points for 2008 was nearly 100% with only 6 measurements exceeding numeric NPDES permit limits. The noncompliances occurred at the former ORNL Coal Yard Runoff Treatment Facility (CYRTF), now known as the Steam Plant Wastewater Treatment Facility (SPWTF). Three of these noncompliances occurred in February 2008, when results of measurements for copper (0.205 mg/L) and iron (1.13 mg/L) exceeded daily maximum limits of 0.11 and 1.0 mg/L, respectively. The copper measurement resulted in a third, calculated exceedance of a monthly average limit. In July 2008, similar exceedances occurred, with daily maximum limit exceedances of silver and iron also resulting in a third, calculated exceedance of a monthly average iron limit. The February 2008 exceedances were attributed to a pump discharge line that froze and broke, and was promptly repaired. The July 2008 exceedances were investigated but were not attributable to any operational event or other known cause. Information on the exceedances is provided in Appendix E, Sect. E.3. None of the six exceedances resulted in any discernable ecological impact. Section 5.5 contains detailed information on the activities and programs carried out at 2008 by UT-Battelle in support of the CWA.

Two fish kills occurred in White Oak Creek at ORNL in 2008, one on July 1 and one on September 15. Each kill resulted in the death of about 180 aquatic organisms, including fish and other aquatic species. The kills were attributed to excessive chlorinated-water discharge from outfall 227. Both kills were investigated, and improved dechlorination systems are being installed to guard against recurrence.

In August 2008, TDEC issued a renewed NPDES permit to DOE for the ORNL site. The reissued permit reflects the current configuration of ORNL wastewater discharges and includes monitoring requirements geared toward more informative, adaptive monitoring strategies.

5.3.7 Safe Drinking Water Act Compliance Status

ORNL's water distribution system is designated as a Non-Transient, Non-Community water system by TDEC's Division of Water Supply. The *Tennessee Regulations for Public Water Systems and Drinking Water Quality*, Chap. 1200-5-1, sets limits for biological contaminants and for chemical activities and chemical contaminants. TDEC requires sampling for the following constituents for compliance with state and federal regulations:

- chlorine residual levels,
- bacteriological (total coliform),
- lead and copper, and
- disinfectant by-products (trihalomethanes and haloacetic acids).

The city of Oak Ridge supplies potable water to the ORNL water distribution system and meets all regulatory requirements for drinking water. The water treatment plant, located on the ORR, north of the Y-12 Complex, is owned and operated by the city of Oak Ridge.

In 2008, sampling results for ORNL's water system chlorine residual levels, bacterial constituents, and disinfectant by-products were all within acceptable limits. TDEC requires triennial sampling of the ORNL potable water system for lead and copper. The next scheduled sample period is June–September 2009.

5.3.8 Resource Conservation and Recovery Act Compliance Status

ORNL is regulated as a large-quantity generator of hazardous waste because the facility generates more than 1,000 kg of hazardous waste per month. This amount includes hazardous waste that is generated under permitted activities (including repackaging or treatment residuals). At the end of 2008, ORNL had roughly 375 generator accumulation areas for hazardous or mixed waste serving various contractor organizations, including UT-Battelle, Bechtel Jacobs Company, Energy Solutions, Isotek, EnergX, and others.

ORNL is also regulated as a handler of universal waste (e.g., fluorescent lamps, batteries, and other items regulated under 40 CFR 273). Mercury-containing equipment at ORNL is managed at UT-Battelle as hazardous waste.

ORNL is regulated as a generator of used oils under 40 CFR 279. At the end of 2008, ORNL had approximately 100 used oil areas for management of used oil prior to off-site recycle or disposal.

ORNL's NTRC was classified as a conditionally exempt small-quantity generator for CY 2008, meaning that the site generated less than 100 kg of hazardous waste per month. At the end of 2008, the NTRC operated three generator areas in support of operations that generate hazardous wastes and one used oil area for management of recyclable used oil.

In 2008, the DOE Office of Scientific and Technical Information (OSTI), ORNL Records, applied for and received an EPA identification (ID) number, TNR000026765 for the generation and temporary storage of hazardous waste. OSTI was classified as a large quantity generator for 2008 due to a cleanout of microfiche at the facility, which is considered hazardous waste because of its leachable silver content.

OSTI operated a 90 day accumulation area for temporary management of the waste. The waste was shipped off site for silver reclamation prior to the end of 2008; therefore, there were no generator areas open at the end of the calendar year.

The 0800 Area and the Freels Bend Area generated no regulated wastes or used oils in 2008.

ORNL is registered as a large-quantity generator under EPA ID No. TN1890090003 and is permitted to transport hazardous wastes, to operate a transfer facility for temporary storage of hazardous wastes transported from off-site locations (such as NTRC), and to operate RCRA-permitted hazardous waste treatment and storage units. During 2008, 22 units operated as permitted units; another 6 units were permitted as proposed units (but will not be built and have been eliminated in a permit renewal application submitted in 2006).

ORNL's RCRA storage and treatment facilities (or units) operate under three permits: TNHW-097, TNHW-134, and TNHW-121. TNHW-121 is the existing RCRA Hazardous and Solid Waste Amendments permit for the ORR (see Table 5.10). The permits are modified when necessary. Permit TNHW-10A was reissued as TNHW-134 on September 26, 2008. Eight permit modifications were approved by TDEC in 2008. Most of the permit modifications submitted and approved in 2008 were minor and addressed administrative, editorial, or other nonintent changes. One Class 3 modification included adding additional storage and treatment capacity to TNHW-097, including WPF-6 Contact Handled Marshalling Building, T-2 Amalgamation Treatment, and T-3 Solidification/Stabilization. A temporary authorization was granted for TNHW-010A for hazardous waste deactivation and stabilization treatment processes. The renewal application for the TNHW-097 permit submitted in March 2007 was still pending throughout 2008.

Table 5.10. ORNL Resource Conservation and Recovery Act operating permits, 2008

Permit number	Building/description
	ORNL
TNHW-134[a]	Building 7651 Container Storage Unit
	Building 7652 Container Storage Unit
	Building 7653 Container Storage Unit
	Building 7654 Container Storage Unit
	Portable Units 1 & 2 Storage & Treatment Units
TNHW-097	Building 7574 Container Storage Unit
	Building 7576 Container Storage Unit
	Building 7577 Container Storage Unit
	Building 7580 Container Storage Unit
	Building 7823 Container Storage Unit
	Building 7842 Container Storage Unit
	Building 7855 Container Storage Unit
	Building 7878 Container Storage Unit
	Building 7879 Container Storage Unit
	Building 7883 Container Storage Unit
	Building 7884 Container Storage Unit
	Building 7880 Waste Processing Facility 2
	Building 7880 Waste Processing Facility 4
	Building CHSA Waste Processing Facility 1
	Building DAC Waste Processing Facility 3
	Building CSA Waste Processing Facility 5
	Building CHMB Waste Processing Facility 6
	Macroencapsulation T-1
	Amalgamation T-2[b]
	Solidification/Stabilization T-3 and T-4[b]
	Oak Ridge Reservation
TNHW-121	Hazardous Waste Corrective Action Permit

[a] Permit TNHW-10A reissued as TNHW-134 on September 26, 2008.
[b] Treatment operating units within Building 7880.

5.3.9 RCRA Underground Storage Tanks

Underground storage tanks (USTs) containing petroleum and hazardous substances are regulated under Subtitle I of RCRA (40 CFR 280). TDEC has been granted authority by EPA to regulate USTs containing petroleum under TDEC Rule 1200-1-15; however, hazardous-substance USTs are still regulated by EPA.

ORNL has responsibility for 54 USTs registered with TDEC under Facility ID Number 0-730089. These 54 USTs can be classified as follows:

- 49 USTs closed to meet the RCRA Subtitle I requirements,
- 3 USTs in service that meet the 1998 standards for new UST installations, and
- 2 USTs not in service that were deferred or exempt from Subtitle I because they were regulated by other statutes (1 UST under the RCRA Subtitle C and 1 UST under the CWA).

Of the 49 closed USTs, 24 were replaced by double-walled, concrete-encased aboveground storage tanks; three were replaced by the new, state-of-the-art USTs; and 22 were not replaced because they were no longer needed. Closure approval letters have been received for all USTs closed between 1988 and 1998.

5.3.10 Comprehensive Environmental Response, Compensation, and Liability Act Compliance Status

CERCLA, also known as Superfund, was passed in 1980 and was amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA). Under CERCLA, a site is investigated and remediated if it poses significant risk to health or the environment. The EPA National Priorities List (NPL) is a comprehensive list of sites and facilities that have been found to pose a sufficient threat to human health and/or the environment to warrant cleanup under CERCLA.

In 1989, the ORR was placed on the NPL. In 1992, the ORR Federal Facility Agreement among EPA, TDEC, and DOE became effective and established the framework and schedule for developing, implementing, and monitoring remedial actions on the ORR. The on-site CERCLA Environmental Management Waste Management Facility (EMWMF), located in Bear Creek Valley, is used for disposal of waste resulting from CERCLA cleanup actions on the ORR, including ORNL. The EMWMF is an engineered landfill that accepts low-level radioactive, hazardous, asbestos, and PCB wastes and combinations of the aforementioned wastes in accordance with specific waste acceptance criteria under an agreement with state and federal regulators.

5.3.10.1 ORNL RCRA-CERCLA Coordination

The ORR Federal Facility Agreement is intended to coordinate the corrective action processes of RCRA required under the Hazardous and Solid Waste Amendments permit with CERCLA response actions.

In May 2005 ORNL applied for, but has not yet received, a RCRA postclosure permit for SWSA 6. RCRA groundwater monitoring data is reported yearly to TDEC and EPA in the annual CERCLA *Remediation Effectiveness Report* (DOE 2008a) for the ORR.

Periodic updates of proposed construction and demolition activities and facilities at ORNL have been provided to managers and project personnel from the TDEC DOE Oversight Division and EPA Region 4. A CERCLA screening process is used to identify proposed construction and demolition projects and facilities that warrant CERCLA oversight. The goal is to ensure that modernization efforts do not impact the effectiveness of previously completed CERCLA environmental remedial actions and that they do not adversely impact future CERCLA environmental remedial actions.

5.3.11 Toxic Substances Control Act Compliance Status

5.3.11.1 Polychlorinated Biphenyls

PCB waste generation, transportation, and storage at ORNL is regulated under the EPA ID number TN1890090003. In 2008, UT-Battelle, LLC operated approximately 11 PCB waste storage areas in generator buildings and RCRA-permitted storage buildings at ORNL for longer-term storage of PCB/radioactive wastes when necessary. Two PCB waste storage areas were operated at Y-12 facilities. The continued use of authorized PCBs in electrical systems and/or equipment (e.g., transformers, capacitors, rectifiers) is regulated at ORNL. The majority of equipment at ORNL that required regulation under the Toxic Substances Control Act has been disposed of. However, some of the ORNL facilities at Y-12 continue to use (or store for future reuse) PCB equipment (such as transformers, capacitors, and rectifiers).

Because of the age of many of the ORNL facilities and the varied uses for PCBs in gaskets, grease, building construction and equipment, DOE self-disclosed unauthorized use of PCBs to EPA in the late 1980s. As a result, DOE and ORNL contractors negotiated a compliance agreement with EPA (see Sect. 5.3.11.1.1) to address the compliance issues related to these unauthorized uses and to allow for continued use pending decontamination or disposal. As a result of that agreement, DOE continues to notify EPA when additional unauthorized uses of PCBs, such as PCBs in paint, adhesives, electrical wiring, or floor tile are found at ORNL.

5.3.11.1.1 PCB Compliance Agreements

The ORR PCB Federal Facilities Compliance Agreement (ORR PCB FFCA) between EPA Region 4 and DOE-ORO became effective on December 16, 1996. The agreement addresses PCB compliance issues at ETTP, ORNL, the Y-12 Complex, and ORISE and specifically addresses the unauthorized use of PCBs, storage and disposal of PCB wastes, PCB spill cleanup and/or decontamination, PCBs mixed with radioactive materials, PCB R&D, and records and reporting requirements for the ORR.

EPA is updated annually on the status of DOE actions with regard to management and disposition of PCBs covered under the ORR PCB FFCA.

5.3.12 Emergency Planning and Community Right-to-Know Act Compliance Status

The Emergency Planning and Community Right-to-Know Act (EPCRA) and Title III of SARA require that facilities report inventories and releases of certain chemicals that exceed specific release thresholds. The reports are submitted to the local emergency planning committee and the state emergency response commission. Table 5.11 describes the main elements of the act. UT-Battelle complied with these requirements in 2008 through the submittal of reports under EPCRA Sects. 302, 303, 311, and 312.

ORNL had no releases of extremely hazardous substances, as defined by EPCRA, in 2008.

Table 5.11. Descriptions of the main parts of the Emergency Planning and Community Right-to-Know Act (EPCRA)

Title	Description
Sections 302 and 303, Planning Notification	Requires that local planning committee and state emergency response commission be notified of EPCRA-related planning
Section 304, Extremely Hazardous Substance Release Notification	Addresses reporting to state and local authorities of off-site releases
Sections 311–312, Material Safety Data Sheet (MSDS)/Chemical Inventory	Requires that either MSDSs or lists of hazardous chemicals for which they are required be provided to state and local authorities for emergency planning. Requires that an inventory of hazardous chemicals maintained in quantities over thresholds be reported annually to the Environmental Protection Agency (EPA)
Section 313, Toxic Chemical Release Reporting	Requires that releases of toxic chemicals be reported annually to EPA

5.3.12.1 Material Safety Data Sheet/Chemical Inventory (Sects. 312)

Inventories, locations, and associated hazards of hazardous and extremely hazardous chemicals were submitted in an annual report to state and local emergency responders as required by the Sect. 312 requirements. Of the chemicals identified for CY 2007 on the ORR, 28 were located at ORNL.

Private-sector lessees associated with the reindustrialization effort were not included in the 2008 submittals. Under the terms of their lease, lessees must evaluate their own inventories of hazardous and extremely hazardous chemicals and must submit information as required by the regulations.

5.3.12.2 Toxic Chemical Release Reporting (Sect. 313)

DOE submits annual toxic release inventory reports to EPA and TDEC on or before July 1 of each year. The reports cover the previous calendar year and address releases of certain toxic chemicals to air, water, and land as well as waste management, recycling, and pollution prevention activities. Threshold determinations and reports for each of the ORR facilities are made separately. Operations involving toxic release inventory chemicals were compared with regulatory thresholds to determine which chemicals exceeded the reporting thresholds based on amounts manufactured, processed, or otherwise used at each facility. After threshold determinations were made, releases and off-site transfers were calculated for each chemical that exceeded one or more of the thresholds.

For CY 2008, ORNL reported releases of 25,739 lb of nitric acid and 47,000 lb of nitrate compounds (Table 5.12). Of this, 25,456 lb of the nitric acid was not actually released but rather was used for waste treatment at the Process Waste Treatment Complex and at HFIR. This use is considered a “release” under the Toxic Release Inventory regulations. The remaining 283 lb was sent off site for disposition. Nitrate compounds are coincidentally manufactured as by-products of neutralizing nitric acid waste and as by-products of sewage treatment. The neutralized nitric acid is not released; it is stored for future disposal as radiological waste because it becomes radioactive during the treatment process. The nitrate compounds from the sewage treatment plant are released into the environment. The discharge of nitrate compounds is not regulated in the NPDES permit for the sewage plant.

Table 5.12. Emergency Planning and Community Right-to-Know Act Sect. 313 toxic chemical release and off-site transfer summary [a] for ORNL, 2008

Chemical	Year	Quantity (lb)[b]
Nitrate compounds	2007	35,000
	2008	47,000
Nitric acid	2007	26,904
	2008	25,739
Total	2007	61,904
	2008	72,739

[a]Represents total releases to air, land, and water and includes off-site waste transfers. Also includes quantities released to the environment as a result of remedial actions, catastrophic events, or one-time events not associated with production processes.

[b]1 lb = 0.45359237 kg.

5.4 Air Quality Program

5.4.1 Nonradiological Monitoring

UT-Battelle holds a Title V permit for ten emission sources. The primary sources of nonradioactive emissions at ORNL include the steam plant, boilers 1–6 on the main ORNL site, two boilers located at the 7600 complex, and four boilers located at the SNS site. The units use fossil fuels; therefore, criteria pollutants are emitted. Actual and allowable emissions from the sources are compared in Table 5.13. Actual emissions were calculated from fuel use and EPA emission factors. All UT-Battelle emission sources operated in compliance with Title V permit conditions during 2008.

Boiler 6, a 125-MMBtu/h boiler, is subject to the new source performance standards of 40 CFR 60 Subpart Db with continuous emission monitoring requirements for NO_x and opacity. During 2008, no permit limits were exceeded. ORNL also holds one construction permit for the Central Exhaust Facility at the SNS. The initial start-up certification for the SNS was submitted to TDEC on January 11, 2008.

The facility will collect, monitor, and discharge radionuclides from SNS operational components. Sources will include accelerator tunnels, beam dumps, and the target building. On March 16, 2007, UT-Battelle submitted a Title V operating permit application to TDEC, requesting that the UT-Battelle Title V permit be modified to include the SNS Central Exhaust Facility. In accordance with the provisions of the construction permit, the SNS can continue to operate until TDEC incorporates the source in the UT-Battelle Title V Permit.

Table 5.13. Actual vs allowable air emissions from ORNL steam production, 2008

Pollutant	Emissions (tons per year)[a]		Percentage of allowable (%)
	Actual	Allowable	
SO_2	7	1277	0.5
PM	4	71	5.0
CO	38	196	19.4
VOC	3	14	21.4
NO_X	69	380	18.0

[a] 1 ton = 907.2 kg.

From July 1, 2007, through June 30, 2008, UT-Battelle paid $6,378.21 in annual emission fees to TDEC. The fees are based on a combination of actual and allowable emissions.

The TWPC holds an operating air permit for one emission source. During CY 2008, no permit limits were exceeded.

5.4.2 NESHAP for Asbestos

There are numerous buildings and pieces of equipment at ORNL that contain asbestos-containing materials. The compliance program for management of removal and disposal of asbestos-containing materials includes demolition and renovation notifications to TDEC and inspections, monitoring, and prescribed work practices for abatement and disposal of asbestos materials. No releases of reportable quantities of asbestos were reported at ORNL during 2008.

5.4.3 ORNL Radiological Airborne Effluent Monitoring

Radioactive airborne discharges at ORNL consist primarily of ventilation air from radioactively contaminated or potentially contaminated areas, vents from tanks and processes, and ventilation for hot cell operations and reactor facilities. (See Appendix F, Table F.1, for a list of radionuclides and associated radioactive half-lives.) The airborne emissions are treated and then filtered with high-efficiency particulate air filters and/or charcoal filters before discharge. Radiological airborne emissions from ORNL consist of solid particulates, adsorbable gases (e.g., iodine), tritium, and nonadsorbable gases (e.g., noble gases).

In 2006, construction of the SNS project was completed. The purpose of the project was to design, construct, and commission into operation an accelerator-based, pulsed-neutron facility for studies of the structure and dynamics of materials. In December 2007, commencement of user operations for beamlines was authorized. In 2008, the SNS facility was fully operational. SNS radionuclide emissions are discharged through a single emission point, the SNS Central Exhaust Facility stack (8915), which has the potential to emit radionuclides that would result in a dose equal to or greater than 0.1 mrem/year to the most exposed member of the public; therefore, continuous emission sampling or monitoring is required.

The major radiological emission point sources for ORNL consist of the following six stacks located in Bethel and Melton Valleys (Fig. 5.12); the SNS Central Exhaust Facility stack located on Chestnut Ridge:

- 2026 Radioactive Materials Analytical Laboratory;
- 3020 Radiochemical Development Facility;

- 3039 central off-gas and scrubber system, which includes the 3500 and 4500 areas cell ventilation system, isotope solid-state ventilation system, 3025 and 3026 areas cell ventilation system, 3042 ventilation system, and 3092 central off-gas system;
- 7503 Molten Salt Reactor Experiment Facility;
- 7880 TWPC;
- 7911 Melton Valley complex, which includes HFIR and the Radiochemical Engineering Development Center; and
- 8915 SNS Central Exhaust Facility stack.

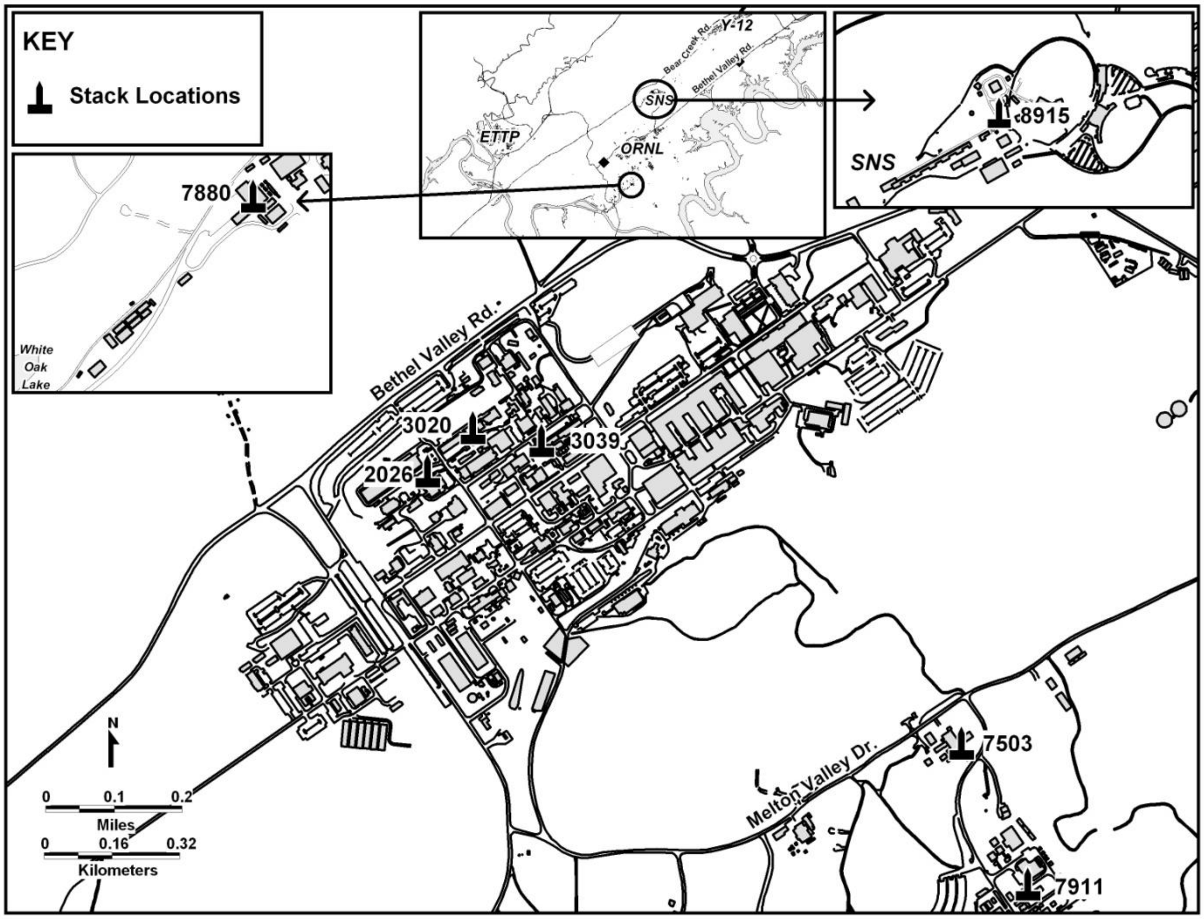

Fig. 5.12. Locations of major stacks (radiological emission points) at ORNL.

The Radioactive Materials Analytical Laboratory was moved from Building 2026 to Building 4501 in 2007. Building 2026 has been slated for decontamination and decommissioning. However, the building name is still Radioactive Materials Analytical Laboratory.

In 2008, there were 15 minor point/group sources, and emission calculations/estimates were made for each of them.

5.4.3.1 Sample Collection and Analytical Procedure

Five of the major point sources (2026, 3020, 3039, 7503, and 7911) are equipped with in-stack source-sampling systems that comply with criteria in the American National Standards Institute (ANSI) standard ANSI N 13.1-1969 (ANSI 1969). The sampling systems generally consist of a multipoint in-stack sampling probe, a sample transport line, a particulate filter, activated charcoal cartridges, a silica-gel cartridge (if required), flow-measurement and totalizing instruments, a sampling pump, and a return line to the stack. In addition to that instrumentation, the system at Stack 7911 includes a high-purity germanium detector with a NOMAD™ analyzer, which allows continuous isotopic identification and quantification of radioactive noble gases (e.g., ^{41}Ar) in the effluent stream. The sample probes are annually removed, inspected, and cleaned. The 7880 stack is equipped with an in-stack source-sampling system that complies with criteria in the ANSI Health Physics Society standard ANSI/HPS N13.1-1999 (ANSI 1999). The system consists of a stainless-steel, shrouded probe; an in-line filter-cartridge holder placed at the probe to minimize line losses; a particulate filter; a sample transport line; a rotary vane vacuum pump; and a return line to the stack. The sample probe is annually removed, inspected, and cleaned. The 8915 stack is equipped with an in-stack radiation detector that complies with criteria in ANSI/HPS N13.1-1999. The detector monitors radioactive gases flowing through the exhaust stack and provides a continual readout of detected activity using a scintillator probe. The detector is calibrated to correlate with isotopic emissions.

Velocity profiles are performed quarterly following the criteria in EPA Method 2 at major sources and at some minor sources. The profiles provide accurate stack flow data for subsequent emission-rate calculations. An annual leak-check program is carried out to verify the integrity of the sample transport system. For the 7880 stack, an annual comparison between the effluent flow rate totalizer and EPA Method 2 is performed. The stack effluent flow rate monitoring system response is checked quarterly against the manufacturer's instrument test procedures. The stack sampler rotameter is calibrated at least quarterly in comparison with a secondary (transfer) standard. Only a certified secondary standard is used for all rotameter tests.

In addition to the major sources, ORNL has a number of minor sources that have the potential to emit radionuclides to the atmosphere. A minor source is defined as any ventilation system or component such as a vent, laboratory hood, room exhaust, or stack that does not meet the approved regulatory criteria for a major source but that is located in or vents from a radiological control area as defined by Radiological Support Services of the UT-Battelle Nuclear and Radiological Protection Division. A variety of methods are used to determine the emissions from the various minor sources. Methods used for minor source-emission calculations comply with EPA criteria. The minor sources are evaluated on a 1 to 5 year basis. Emissions, major and minor, are compiled annually to determine the overall ORNL source term and associated dose.

The charcoal cartridges, particulate filters, and silica-gel traps are collected weekly to biweekly. The use of charcoal cartridges is a standard method for capturing and quantifying radioactive iodine in airborne emissions. Gamma spectrometric analysis of the charcoal samples quantifies the adsorbable gases. Analyses are performed weekly to biweekly. Particulate filters are held for 8 days prior to a weekly gross alpha and gross beta analysis to minimize the contribution from short-lived isotopes such as ^{220}Rn and its daughter products. At Stack 7911, a weekly gamma scan is conducted to better detect short-lived gamma isotopes. The filters are then composited quarterly and are analyzed for alpha-, beta-, and gamma-emitting isotopes. At Stack 7880, the filters are composited monthly and analyzed for alpha-, beta-, and gamma-emitting isotopes. Compositing provides a better opportunity for quantification of the low-concentration isotopes. Silica-gel traps are used to capture water vapor that may contain tritium. Analysis is performed weekly to biweekly. At the end of the year, the sample probes for all of the stacks are rinsed, except for 8915 and 7880, and the rinsate is collected and submitted for isotopic analysis identical to that performed on the particulate filters. A probe-cleaning program has been determined unnecessary for 8915 because the sample probe is a scintillator probe used to detect radiation and not to extract a sample of stack exhaust emissions. It is not anticipated that contaminant deposits would collect on the scintillator probe.

The data from the charcoal cartridges, silica gel, probe wash, and the filter composites are compiled to give the annual emissions for each major source and some minor sources.

5.4.3.2 Results

Annual radioactive airborne emissions for ORNL in 2008 are presented in Table 5.14. All data presented were determined to be statistically different from zero at the 95% confidence level. Any number not statistically different from zero was not included in the emission calculation. Because measuring a radionuclide requires counting random radioactive emissions from a sample, the same result may not be obtained if the sample is analyzed repeatedly. This deviation is referred to as the “counting uncertainty.” Statistical significance at the 95% confidence level means that there is a 5% chance that the results could be erroneous.

Table 5.14. Radiological airborne emissions from all sources at ORNL, 2008 (Ci)[a]

Isotope	Stack								
	X-2026	X-3020	X-3039	X-7503	X-7911	X-7880	X-8915	Total minor sources	Total ORNL
^{225}Ac								1.00E-06	1.00E-06
^{228}Ac								7.49E-06	7.49E-06
^{110m}Ag						4.75E-06			4.75E-06
^{241}Am			3.20E-07	4.26E-09		3.29E-06		2.59E-09	3.62E-06
^{241}Am	7.36E-08	2.83E-07			1.57E-08			4.29E-07	8.01E-07
^{243}Am								7.40E-10	7.40E-10
^{41}Ar					5.78E+03		3.38E+00	1.85E-01	5.78E+03
^{139}Ba					1.30E-01				1.30E-01
^{140}Ba					1.04E-04				1.04E-04
^{7}Be			1.06E-05			3.63E-05		4.33E-07	4.73E-05
^{7}Be	2.96E-07				1.42E-05			1.35E-05	2.80E-05
^{213}Bi								1.10E-05	1.10E-05
^{214}Bi								2.61E-06	2.61E-06
^{11}C							2.71E+02	2.47E-01	2.71E+02
^{14}C								5.09E-10	5.09E-10
^{252}Cf[b]					3.37E-09			1.00E-07	1.03E-07
^{242}Cm								5.65E-08	5.65E-08
^{243}Cm						9.00E-07		6.42E-10	9.01E-07
^{243}Cm								7.20E-12	7.20E-12
^{244}Cm			8.44E-08	2.22E-08		9.00E-07		3.25E-09	1.01E-06
^{244}Cm	5.77E-07	1.33E-08			4.01E-08			4.21E-06	4.84E-06
^{57}Co								2.09E-06	2.09E-06
^{58}Co								3.37E-07	3.37E-07
^{58}Co						1.95E-06			1.95E-06
^{60}Co			9.33E-06			5.84E-06			1.52E-05
^{60}Co								1.58E-04	1.58E-04
^{51}Cr								2.87E-08	2.87E-08
^{134}Cs								1.06E-08	1.06E-08
^{134}Cs						4.99E-06			4.99E-06
^{135}Cs								2.18E-13	2.18E-13
^{135}Cs						2.91E-06			2.91E-06
^{137}Cs	1.60E-06	1.48E-06			2.63E-06			2.18E-03	2.19E-03
^{137}Cs			8.57E-05			5.19E-06		7.77E-07	9.17E-05
^{138}Cs					7.38E+02				7.38E+02
^{152}Eu								2.62E-07	2.62E-07
^{154}Eu								1.58E-07	1.58E-07
^{155}Eu								2.49E-10	2.49E-10
^{55}Fe								2.37E-07	2.37E-07
^{59}Fe								1.13E-10	1.13E-10
^{59}Fe						2.81E-06			2.81E-06
^{153}Gd								1.06E-13	1.06E-13
^{3}H	1.52E+00		1.29E+01	1.64E+00	5.61E+01		2.34E+01	8.76E-01	9.64E+01
^{203}Hg								9.28E-07	9.28E-07
^{124}I								4.03E-16	4.03E-16
^{125}I							5.00E-02	7.72E-08	5.00E-02
^{126}I								1.19E-08	1.19E-08
^{129}I								1.08E-05	1.08E-05

Table 5.14 (continued)

Isotope	Stack								
	X-2026	X-3020	X-3039	X-7503	X-7911	X-7880	X-8915	Total minor sources	Total ORNL
^{131}I					1.90E-02			3.21E-06	1.90E-02
^{132}I					2.16E-01				2.16E-01
^{133}I					1.02E-01				1.02E-01
^{134}I					1.74E-01				1.74E-01
^{135}I					3.23E-01				3.23E-01
^{192}Ir								1.01E-06	1.01E-06
^{40}K								3.58E-05	3.58E-05
^{40}K						2.14E-05			2.14E-05
^{79}Kr							5.88E+00	2.09E-10	5.88E+00
^{81}Kr								5.80E-13	5.80E-13
^{83m}Kr								8.92E-04	8.92E-04
^{85}Kr					1.09E+03			2.80E+01	1.12E+03
^{85m}Kr					5.60E+00		1.81E+01	1.22E-03	2.37E+01
^{87}Kr					8.75E+01		7.82E+00	4.55E-03	9.53E+01
^{88}Kr					9.13E+01		3.19E+00	3.39E-03	9.45E+01
^{89}Kr[c]					6.70E+01			3.92E-05	6.70E+01
^{140}La					1.09E-04				1.09E-04
^{140}La						1.15E-05			1.15E-05
^{177}Lu								1.50E-07	1.50E-07
^{54}Mn								3.45E-08	3.45E-08
^{54}Mn						5.34E-06			5.34E-06
^{93}Mo								4.07E-10	4.07E-10
^{99}Mo						3.77E-03			3.77E-03
^{13}N							5.93E+00	9.28E-01	6.86E+00
^{22}Na								3.72E-14	3.72E-14
^{93m}Nb								2.05E-11	2.05E-11
^{94}Nb								7.36E-12	7.36E-12
^{94}Nb						1.02E-06			1.02E-06
^{95}Nb								5.79E-08	5.79E-08
^{59}Ni								1.06E-07	1.06E-07
^{63}Ni								1.34E-07	1.34E-07
^{237}Np								6.81E-11	6.81E-11
^{239}Np								2.33E-12	2.33E-12
^{191}Os			1.27E-03						1.27E-03
^{212}Pb	4.76E-01	3.10E-01			2.94E-02			9.45E-06	8.15E-01
^{212}Pb			1.07E+00	1.25E-01				1.31E-02	1.21E+00
^{238}Pu			3.33E-08	1.70E-09		1.08E-06		5.43E-10	1.12E-06
^{238}Pu	3.07E-08	2.74E-08			1.71E-09			5.08E-07	5.68E-07
^{239}Pu			8.47E-07	6.63E-09				9.38E-10	8.55E-07
^{239}Pu	1.06E-07	1.80E-07			5.77E-08			1.49E-07	4.93E-07
^{240}Pu								3.73E-08	3.73E-08
^{240}Pu								4.28E-10	4.28E-10
^{241}Pu								1.78E-07	1.78E-07
^{242}Pu								4.55E-13	4.55E-13
^{225}Ra								1.00E-06	1.00E-06
^{226}Ra						1.88E-05			1.88E-05
^{228}Ra								7.49E-06	7.49E-06
^{88}Rb							1.06E+00		1.06E+00
^{188}Re								5.20E-07	5.20E-07
^{103}Ru								1.01E-09	1.01E-09
^{106}Ru								1.00E-05	1.00E-05
^{35}S								3.68E-11	3.68E-11
^{124}Sb								2.29E-10	2.29E-10
^{125}Sb								1.14E-09	1.14E-09
^{125}Sb						2.52E-06			2.52E-06
^{46}Sc								5.87E-11	5.87E-11
^{75}Se								1.41E-11	1.41E-11
^{75}Se			9.49E-06			4.37E-06			1.39E-05

Table 5.14 (continued)

Isotope	Stack								
	X-2026	X-3020	X-3039	X-7503	X-7911	X-7880	X-8915	Total minor sources	Total ORNL
^{113}Sn								1.15E-11	1.15E-11
^{119m}Sn								1.39E-10	1.39E-10
^{85}Sr								1.00E-08	1.00E-08
^{89}Sr	1.70E-07	6.05E-07			3.14E-06			1.89E-05	2.28E-05
^{89}Sr			1.29E-06	5.30E-09				3.34E-08	1.32E-06
^{90}Sr	1.70E-07	6.05E-07			3.14E-06			9.72E-04	9.76E-04
^{90}Sr			1.29E-06	5.30E-09		9.24E-06		3.44E-08	1.06E-05
^{179}Ta								5.95E-14	5.95E-14
^{182}Ta								3.23E-11	3.23E-11
^{99}Tc								9.87E-11	9.87E-11
^{99}Tc						2.21E-05			2.21E-05
^{125m}Te								1.20E-06	1.20E-06
^{129}Te								9.92E-12	9.92E-12
^{129m}Te								1.55E-11	1.55E-11
^{228}Th	1.69E-08	1.19E-08	7.31E-09	5.89E-10	6.83E-09	1.33E-06		3.19E-07	1.69E-06
^{229}Th								2.00E-10	2.00E-10
^{230}Th			3.73E-09	2.16E-10				4.89E-10	4.43E-09
^{230}Th	5.03E-10	1.87E-10			4.06E-09			4.67E-09	9.42E-09
^{232}Th	3.46E-10	8.79E-10			8.98E-09			3.53E-09	1.37E-08
^{232}Th			1.02E-06	5.94E-09		4.47E-06		1.56E-10	5.50E-06
^{234}Th								3.49E-05	3.49E-05
^{170}Tm								1.00E-09	1.00E-09
^{232}U								2.83E-12	2.83E-12
^{233}U								3.85E-12	3.85E-12
^{233}U						4.01E-07		7.05E-06	7.45E-06
^{234}U	1.13E-07							4.20E-07	5.33E-07
^{234}U		8.40E-08	8.67E-08	6.85E-09	3.14E-08	4.01E-07		7.06E-06	7.67E-06
^{235}U	1.04E-09							1.16E-04	1.16E-04
^{235}U		2.92E-09	1.08E-08	3.35E-10	5.13E-09	7.21E-07		4.52E-07	1.19E-06
^{236}U								1.23E-09	1.23E-09
^{236}U								5.03E-07	5.03E-07
^{238}U	8.04E-10							6.77E-04	6.77E-04
^{238}U		7.48E-09	3.25E-08	4.88E-10	1.01E-08	7.24E-07		8.53E-07	1.63E-06
^{181}W								1.19E-11	1.19E-11
^{185}W								3.57E-08	3.57E-08
^{188}W								5.65E-08	5.65E-08
^{125}Xe							4.37E+00		4.37E+00
^{127}Xe							5.77E+00	3.98E-09	5.77E+00
^{129m}Xe								4.65E-08	4.65E-08
^{131m}Xe					5.57E+01			6.09E-06	5.57E+01
^{133}Xe					5.23E+00			4.73E-04	5.23E+00
^{133m}Xe					2.05E+01			1.09E-03	2.05E+01
^{135}Xe					3.51E+01			3.97E-03	3.51E+01
^{135m}Xe					1.61E+01			1.13E-02	1.61E+01
^{137}Xe[d]					5.02E+01			5.12E-04	5.02E+01
^{138}Xe					8.87E+01			1.39E-02	8.87E+01
^{88}Y						7.00E-06			7.00E-06
^{91}Y								1.60E-08	1.60E-08
^{65}Zn						1.25E-05			1.25E-05
^{65}Zn								5.31E-11	5.31E-11
^{95}Zr						8.67E-06			8.67E-06
^{95}Zr								2.61E-08	2.61E-08

[a]1Ci = 3.7E+10 Bq.
[b]Cf-248 was used as a surrogate for ^{252}Cf.
[c]Kr-88 was used as a surrogate for ^{89}Kr.
[d]Xe-135 was used as a surrogate for ^{137}Xe.

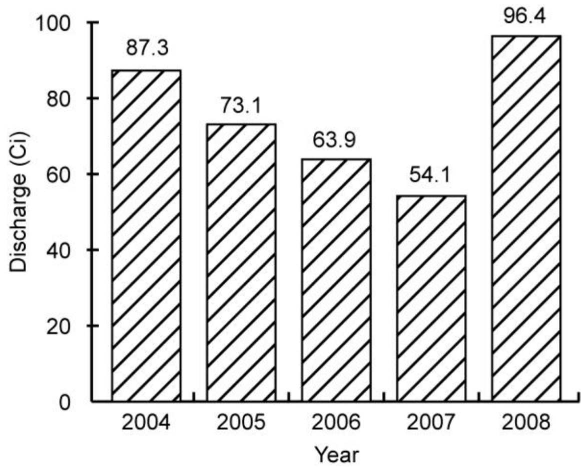

Fig. 5.13. Total discharges of ^{3}H from ORNL to the atmosphere, 2004–2008.

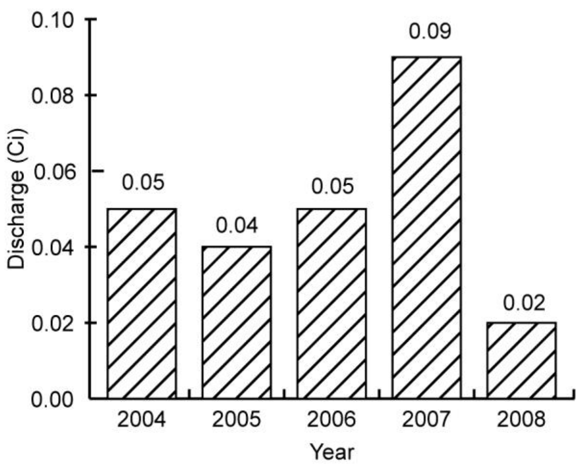

Fig. 5.14. Total discharges of ^{131}I from ORNL to the atmosphere, 2004–2008.

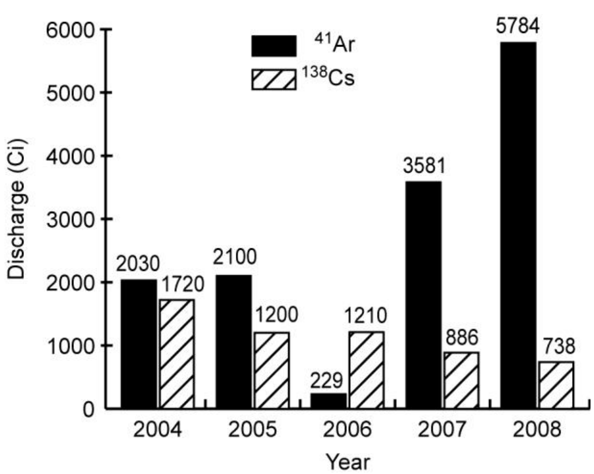

Fig. 5.15. Total discharges of ^{41}Ar and ^{138}Cs from ORNL to the atmosphere, 2004–2008.

Historical trends for tritium and ^{131}I are presented in Figs. 5.13 and 5.14, respectively. The tritium emissions for 2008 totaled approximately 96.4 Ci (Fig. 5.13), which is an increase from 2007. The ^{131}I emissions for 2008 totaled 0.02 Ci (Fig. 5.14), which is an 80% decrease from 2007 and the lowest it has been in the past 5 years. The major contributor to the off-site dose at ORNL historically has been ^{41}Ar, which is emitted as a nonadsorbable gas from the 7911 Melton Valley complex stack. Emissions of ^{41}Ar result from HFIR operations and research activities. However, from 2001 to 2006, ^{138}Cs became the major contributor to the off-site ORNL plant dose because HFIR was down for an extended maintenance period and the installation of the Cold Neutron Source. Emissions of ^{138}Cs result from research activities in the Radiochemical Engineering Development Center, which also exhausts through the 7911 Melton Valley complex stack. In 2007 and 2008, HFIR was in full operation and completed several operating cycles, which resulted in ^{41}Ar once again becoming the major off-site dose contributor to the ORNL plant dose (approximately 61% in 2008). Cesium-138 contributed approximately 14% of the ORNL plant dose in 2008. The ^{41}Ar emissions for 2008 were 5,784 Ci; ^{138}Cs emissions were 738 Ci (Fig. 5.15). The calculated radiation dose to the maximally exposed off-site individual from all radiological airborne release points at ORNL during 2008 was 0.4 mrem. This dose is well below the NESHAP standard of 10 mrem and is less than 0.13 % of the 300 mrem that the average individual receives from natural sources of radiation. (See Sect. 7.1.2.1 for an explanation of how the airborne radionuclide dose was determined.)

5.4.4 Stratospheric Ozone Protection

As required by Title VI of the CAA Amendments of 1990, actions have been implemented to comply with the prohibition against releasing ozone-depleting substances during maintenance activities performed on refrigeration equipment. In addition, service requirements for refrigeration systems (including motor vehicle air conditioners), technician certification requirements, and labeling requirements have been implemented. ORNL has implemented a plan to phase-out the use of all

Class I ozone-depleting substances. All critical applications of Class I ozone-depleting substances have been eliminated, replaced, or retrofitted with other materials. Work is progressing as funding becomes available for noncritical applications with no disruption of service.

5.4.5 Ambient Air

The objectives of the ORNL ambient air monitoring program are to collect samples at perimeter air monitoring (PAM) stations most likely to show impacts of airborne emissions from ORNL and to provide for emergency response capability. Four stations, identified as Stations 1, 2, 3, and 7 (Fig. 5.16) make up the ORNL PAM network. Sampling is conducted at each ORNL station to quantify levels of tritium; adsorbable gases (e.g., iodine); and gross alpha-, beta-, and gamma-emitting radionuclides (Table 5.15).

The sampling system consists of a low-volume air sampler for particulate collection in a 47-mm glass-fiber filter. The filters are collected biweekly, composited annually, then submitted to the laboratory for analysis. Following the filter is a charcoal cartridge that collects adsorbable gases and is collected and analyzed bi-weekly. A silica-gel column is used for collection of tritium as tritiated water. These samples are collected biweekly or weekly and composited quarterly for tritium analysis.

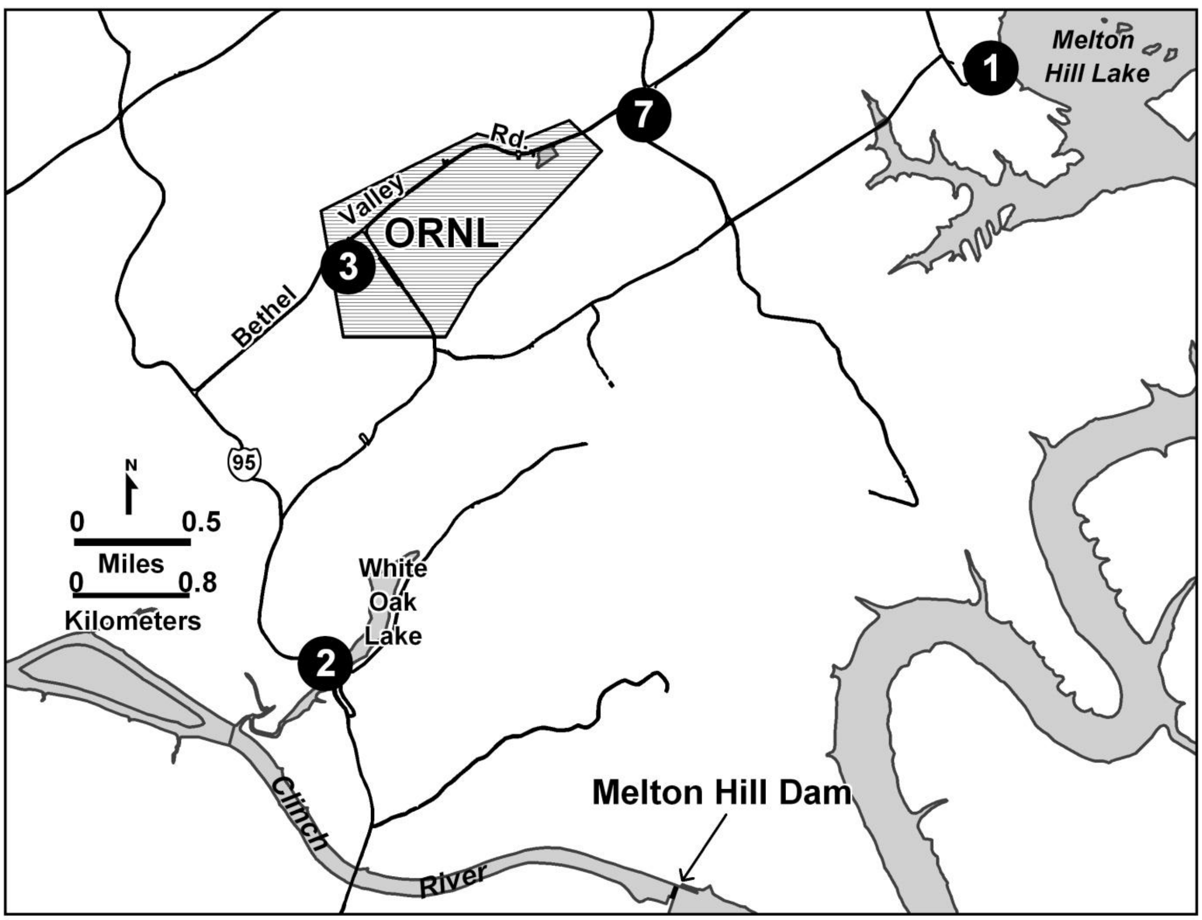

Fig. 5.16. Locations of ambient air monitoring stations at ORNL.

5.4.5.1 Results

The ORNL PAM stations are designed to provide data for collectively assessing the specific impact of ORNL operations on local air quality. Sampling data from the ORNL PAM stations (Table 5.15) are compared with the derived concentration guides (DCGs) for air established by DOE as reference values for conducting radiological environmental protection programs at DOE sites. (DCGs are listed in DOE Order 5400.5.) Average radionuclide concentrations measured for the ORNL network were less than 1% of the applicable DCGs in all cases.

Table 5.15. Radionuclide concentrations (pCi/mL)[a] measured at ORNL perimeter air monitoring stations, 2008

Parameter	No. detected/ sampled	Concentration		
		Average	Minimum	Maximum
		Station 1		
Alpha	1/1	5.6E-09	*b*	*b*
^{7}Be	1/1	2.6E-08	*b*	*b*
Beta	1/1	1.9E-08	*b*	*b*
^{3}H	0/4	6.9E-08	-1.7E-06	1.3E-06
^{40}K	28/28	2.7E-07	1.3E-07	5.3E-07
^{234}U	1/1	6.7E-12	*b*	*b*
^{235}U	0/1	2.2E-13	*b*	*b*
^{238}U	1/1	9.0E-12	*b*	*b*
Total uranium	1/1	1.6E-11	*b*	*b*
		Station 2		
Alpha	1/1	5.0E-10	b	*b*
^{7}Be	1/1	2.2E-08	b	*b*
Beta	1/1	1.9E-08	b	*b*
^{3}H	2/4	2.9E-06	-1.4E-07	9.7E-06
^{40}K	28/28	3.1E-07	1.3E-07	5.7E-07
^{234}U	1/1	5.3E-12	b	*b*
^{235}U	0/1	9.4E-13	*b*	*b*
^{238}U	1/1	5.0E-12	*b*	*b*
Total uranium	1/1	1.1E-11	*b*	*b*
		Station 3		
Alpha	1/1	1.8E-09	*b*	*b*
^{7}Be	1/1	2.1E-08	*b*	*b*
Beta	1/1	1.9E-08	*b*	*b*
^{3}H	0/4	7.1E-08	-2.8E-06	3.5E-06
^{40}K	28/28	3.2E-07	1.1E-07	1.2E-06
^{234}U	1/1	6.6E-12	*b*	*b*
^{235}U	0/1	4.2E-13	*b*	*b*
^{238}U	1/1	7.0E-12	*b*	*b*
Total uranium	1/1	1.4E-11	*b*	*b*
		Station 7		
Alpha	1/1	1.4E-09	*b*	*b*
^{7}Be	1/1	2.2E-08	*b*	*b*
Beta	1/1	2.1E-08	*b*	*b*
^{3}H	0/4	1.1E-06	-1.5E-07	2.9E-06
^{40}K	28/28	1.9E-07	1.7E-07	4.8E-07
^{234}U	1/1	6.4E-12	*b*	*b*
^{235}U	1/1	1.4E-12	*b*	*b*
^{238}U	1/1	7.1E-12	*b*	*b*
Total uranium	1/1	1.5E-11	*b*	*b*

[a] 1 pCi 3.7×10^{-2} Bq.

[b] Not applicable.

5.5 Water Quality Program

5.5.1 NPDES/Surface Water

5.5.1.1 NPDES Permit Monitoring

ORNL's wastewater discharges are monitored and regulated under NPDES Permit TN0002941, which was renewed by TDEC on July 1, 2008, and became effective on August 1, 2008. The permit includes 168 separate outfalls and monitoring points, including 3 outfalls at the TWPC facility, and includes NPDES permit conditions and monitoring requirements for effluents from the SNS facility that were previously established in a separate NPDES permit for the SNS site (TN0077895). The NPDES permit for the SNS site was terminated when permit for the overall ORNL site was renewed in July 2008. Table 5.16 includes SNS NPDES compliance information from January through July 2008, the time at which the SNS permit was terminated. ORNL NPDES compliance information, including that for the SNS facility that was gathered from July through December 2008, is included in Table 5.17. Compliance information for the ORNL site from January through July 2008, excluding the SNS facility, is described in Table 5.18.

Table 5.16. National Pollutant Discharge Elimination System (NPDES) compliance at Spallation Neutron Source, 2008

NPDES permit effective December 1, 2003 through July 31, 2008

Effluent parameters	Permit limits					Permit compliance		
	Monthly average (kg/d)	Daily max. (kg/d)	Monthly average (mg/L)	Daily max. (mg/L)	Daily min. (mg/L)	Number of noncompliances	Number of samples	Percentage of compliance[a]
pH (std. units)				9	6.5	0	61	100
Total residual chlorine			0.011	0.019		0	61	100

[a]Percentage compliance 100 – [(number of noncompliances/number of samples) H 100].

Table 5.17. National Pollutant Discharge Elimination System (NPDES) compliance at ORNL, 2008

(NPDES permit effective August 1, 2008)

Effluent parameters	Permit limits					Permit compliance		
	Monthly average (lbs/d)	Daily max. (lbs/d)	Monthly average (mg/L)	Daily max. (mg/L)	Daily min. (mg/L)	Number of noncompliances	Number of samples	Percentage of compliance[a]
X01 (Sewage Treatment Plant)								
LC_{50} for *Ceriodaphnia* (%)					69.4	0	2	100
LC_{50} for fathead minnows (%)					69.4	0	2	100
Ammonia, as N (summer)	6.26	9.39	2.5	3.75		0	40	100
Ammonia, as N (winter)	13.14	19.78	5.25	7.9		0	56	100
Carbonaceous BOD	19.2	28.8	10	15		0	93	100
Dissolved oxygen					6	0	93	100
Escherichia coliform (col/100 mL)			941	126		0	93	100
IC_{25} for *Ceriodaphnia* (%)					12.3	0	2	100

Table 5.17. (Continued)

Effluent parameters	Permit limits: Monthly average (lbs/d)	Daily max. (lbs/d)	Monthly average (mg/L)	Daily max. (mg/L)	Daily min. (mg/L)	Permit compliance: Number of noncompliances	Number of samples	Percentage of compliance[a]
IC_{25} for fathead minnows (%)					12.3	0	2	100
Oil and grease	19.2	28.8	10	15		0	93	100
pH (std. units)				9	6	0	93	100
Total suspended solids	57.5	86.3	30	45		0	93	100
X02 (Coal Yard Runoff Treatment Facility)								
pH (std. units)				9.0	6	0	30	100
Total suspended solids				50		0	30	100
X12 (Process Waste Treatment Complex)								
LC_{50} for *Ceriodaphnia* (%)					100	0	1	100
LC_{50} for fathead minnows (%)					100	0	1	100
Arsenic, total			0.007	0.014		0	4	100
Cadmium, total	1.73	4.60	0.003	0.038		0	4	100
Chromium, total	11.40	18.46	0.22	0.44		0	4	100
Copper, total	13.8	22.53	0.07	0.11		0	4	100
Cyanide, total	4.33	8.00	0.008	0.046		0	2	100
Lead, total	2.87	4.60	0.028	0.69		0	4	100
IC_{25} for *Ceriodaphnia* (%)					30.9	0	1	100
IC_{25} for fathead minnows (%)					30.9	0	1	100
Oil and grease	66.7	100	10	15		0	5	100
pH (std. units)				9.0	6.0	0	22	100
Temperature (ºC)				30.5		0	22	100
Instream chlorine monitoring points								
Total residual oxidant			0.011	0.019		0	120	100

[a]Percentage compliance 100 – [(number of noncompliances/number of samples) * 100].

Abbreviations

LC_{50} the concentration (as a percentage of full-strength wastewater) that kills 50% of the test species in 48 h.

BOD biological oxygen demand.

IC_{25} inhibition concentration; the concentration as a percentage of full-strength wastewater that caused 25% reduction in survival, reproduction, or growth of the test organisms.

Table 5.18. National Pollutant Discharge Elimination System (NPDES) compliance at ORNL, 2008
NPDES permit effective February 3, 1997 through July 31, 2008

Effluent parameters	Permit limits					Permit compliance		
	Monthly average (kg/d)	Daily max. (kg/d)	Monthly average (mg/L)	Daily max. (mg/L)	Daily min. (mg/L)	Number of noncompliances	Number of samples	Percentage of compliance[a]
X01 (Sewage Treatment Plant)								
LC_{50} for *Ceriodaphnia* (%)					41.1	0	2	100
LC_{50} for fathead minnows (%)					41.1	0	2	100
Ammonia, as N (summer)	2.84	4.26	2.5	3.75		0	40	100
Ammonia, as N (winter)	5.96	8.97	5.25	7.9		0	56	100
Carbonaceous BOD	8.7	13.1	10	15		0	93	100
Dissolved oxygen					6	0	93	100
Fecal coliform (col/100 mL)			1000	5000		0	93	100
NOEC for *Ceriodaphnia* (%)					12.3	0	2	100
NOEC for fathead minnows (%)					12.3	0	2	100
Oil and grease	8.7	13.1	10	15		0	93	100
pH (std. units)				9	6	0	93	100
Total residual chlorine			0.038	0.066		0	93	100
Total suspended solids	26.2	39.2	30	45		0	93	100
X02 (Coal Yard Runoff Treatment Facility)								
LC_{50} for *Ceriodaphnia* (%)					4.2	0	2	100
LC_{50} for fathead minnows (%)					4.2	0	2	100
Copper, total			0.07	0.11		2[b]	14	86
Iron, total			1.0	1.0		3[c]	14	79
NOEC for *Ceriodaphnia* (%)					1.3	0	0[d]	100
NOEC for fathead minnows (%)					1.3	0	0[d]	100
Oil and grease			10	15		0	30	100
pH (std. units)				9.0	6	0	30	100
Selenium, total			0.22	0.95		0	14	100
Silver, total				0.008		1[e]	14	93
Total suspended solids				50		0	30	100
Zinc, total			0.87	0.95		0	14	100

Table 5.18 (continued)

Effluent parameters[a]	Permit limits: Monthly average (kg/d)	Daily max (kg/d)	Monthly average (mg/L)	Daily max (mg/L)	Daily min (mg/L)	Permit compliance: Number of noncompliances	Number of samples	Percentage of compliance[b]
X12 (Process Waste Treatment Complex)								
LC_{50} for *Ceriodaphnia* (%)					100	0	2	100
LC_{50} for fathead minnows (%)					100	0	2	100
Cadmium, total	0.79	2.09	0.008	0.034		0	31	100
Chromium, total	5.18	8.39	0.22	0.44		0	31	100
Copper, total	6.27	10.24	0.07	0.11		0	31	100
Cyanide, total	1.97	3.64	0.008	0.046		0	3	100
Lead, total	1.3	2.09	0.028	0.69		0	31	100
Nickel, total	7.21	12.06	0.87	3.98		0	31	100
NOEC for *Ceriodaphnia* (%)					30.9	0	2	100
NOEC for fathead minnows (%)					30.9	0	2	100
Oil and grease	30.3	45.4	10	15		0	31	100
pH (std. units)				9.0	6.0	0	93	100
Silver, total	0.73	1.3		0.008		0	31	100
Temperature (ºC)				30.5		0	93	100
Total toxic organics		6.45		2.13		0	7	100
Zinc, total	4.48	7.91	0.87	0.95		0	31	100
Instream chlorine monitoring points								
Total residual oxidant			0.011	0.019		0	154	100
Steam condensate outfalls								
pH (std. units)				9.0/8.5	6.0/6.5	0	9	100
Groundwater/pumpwater outfalls								
pH (std. units)				9.0/8.5	6.0/6.5	0	3	100
Cooling tower blowdown outfalls								
pH (std. units)				9.0	6.0	0	3	100
Category I outfalls								
pH (std. units)				9.0	6.0	0	3	100
Category II outfalls								
pH (std. units)				9.0	6.0	0	9	100
Category III outfalls								
pH (std. units)				9.0	6.0	0	39	100
Category IV outfalls								
pH (std. units)				9.0	6.0	0	192	100

Table 5.18 (continued)

Effluent parameters[a]	Permit limits					Permit compliance		
	Monthly average (kg/d)	Daily max (kg/d)	Monthly average (mg/L)	Daily max (mg/L)	Daily min (mg/L)	Number of noncompliances	Number of samples	Percentage of compliance[b]
Cooling tower blowdown/cooling water outfalls								
pH (std. units)				9.0	6.0	0	14	100
Total residual oxidant			0.011	0.019		0	28	100

[a]Percentage compliance 100 – [(number of noncompliances/number of samples) * 100].

[b]The copper measurement from February 2, 2008, resulted in a daily max. concentration exceedance and an average monthly concentration exceedance.

[c]The iron measurement from February 2, 2008 resulted in a daily max. concentration exceedance. The iron measurement from July 16, 2008 resulted in a daily max. concentration exceedance and an average monthly concentration exceedance.

[d]Insufficient discharge for chronic test and determination of no-observed-effect concentration for each of the quarterly tests.

[e]The silver measurements from July 10, 2008, and July 16, 2008, resulted in an average monthly concentration exceedance.

Abbreviations

LC_{50} the concentration (as a percentage of full-strength wastewater) that kills 50% of the test species in 96 h.

BOD biological oxygen demand.

NOEC no-observed-effect concentration; the concentration as a percentage of full-strength wastewater that caused no reduction in *Ceriodaphnia* survival or reproduction or fathead minnow survival or growth.

Data collected to meet the requirements of the permit are submitted to the state of Tennessee in the monthly *NPDES Discharge Monitoring Report*.

The ORNL NPDES Permit requires sampling of point-source outfalls before their discharge into receiving waters or before being mixed with any other wastewater stream (see Fig. 5.17). Under the existing permit, there are numeric and narrative effluent limits applied at the following locations:

- X01—Sewage Treatment Plant;
- X02—SSPWTF;
- X12—Process Waste Treatment Complex (PWTC);
- X13—Melton Branch (MB1);
- X14—White Oak Creek (WOC);
- X15—White Oak Dam (WOD);
- instream chlorine monitoring points (X16–X27); and
- Category outfalls (storm drains, water discharged under best management practices, groundwater, water condensate, cooling water, cooling tower blowdown, and other facility wastewaters).

Instream data collection points X-13, X-14, and X-15 are not included in the table because only flow measurements and narrative conditions are required at these three points.

DOE is required by Part IV of the new ORNL NPDES permit to develop and implement a water quality protection plan (WQPP). The WQPP, which was implemented in January 2009, functionally replaces several monitoring plans that were required by the previous NPDES permit, including the Biological Monitoring and Abatement Program (BMAP), Chlorine Control Strategy, *Non-Storm Water Best Management Practices Plan*, *Radiological Monitoring Plan*, and *Storm Water Pollution Prevention*

Plan (SWP3). The WQPP also includes a monitoring program for category outfalls, which were previously included in specific permit requirements.

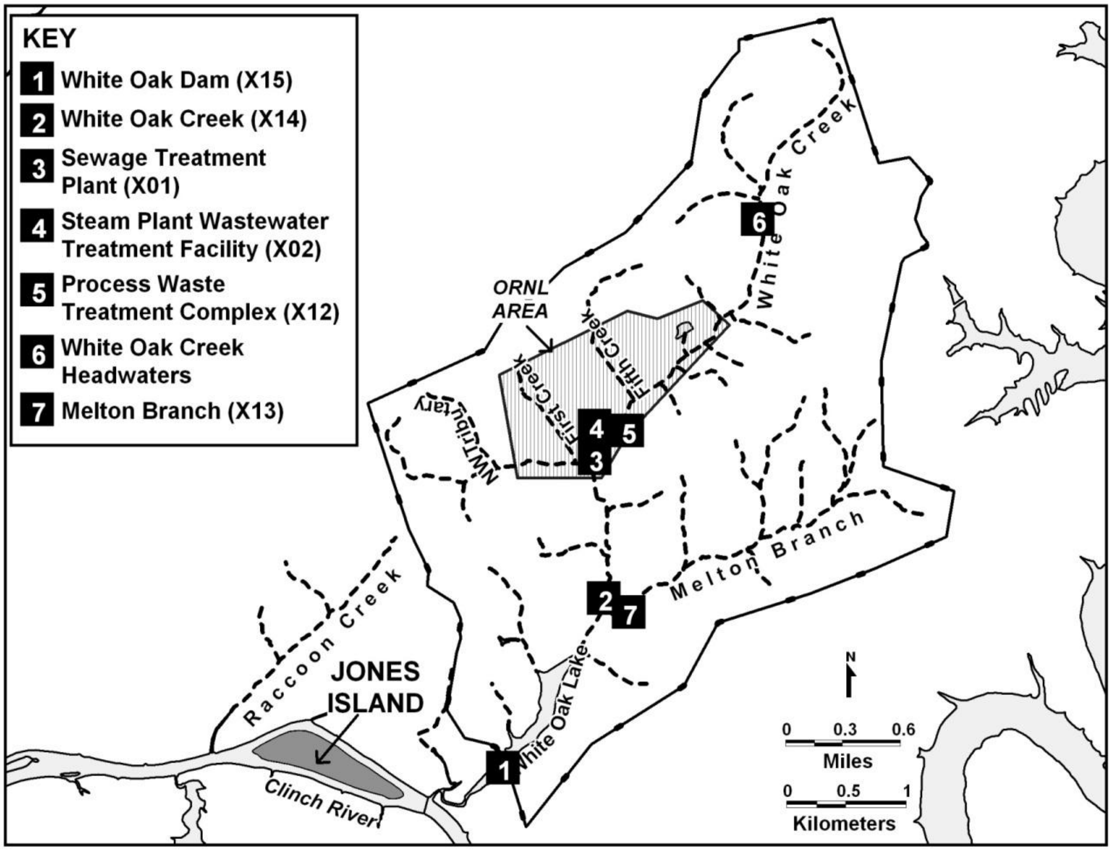

Fig. 5.17. ORNL surface water, National Pollutant Discharge Elimination System and reference sampling locations.

The WQPP is composed of two volumes. Volume 1 describes the policies and actions, or best management practices that will be implemented to protect the quality of aquatic and riparian resources on the ORNL site. Volume 2 contains descriptions of effluent monitoring, ambient water quality monitoring, and biological community monitoring that will be implemented to monitor the effectiveness of the best management practices and other water quality protection efforts, and to ultimately lead to improvements to water quality. The WQPP is organized in this manner to make the best management practices volume a more compact and practical resource for managers of ORNL facilities and others who are involved in activities that have a potential to impact water quality. The WQPP will be fully implemented in 2009.

5.5.1.2 Chlorine Control Strategy

The NPDES permit regulates the discharge of chlorinated water at ORNL by setting either total residual chlorine concentration limits or total residual oxidant mass-loading action levels, depending on outfall location and the volume of discharge. At ORNL, total residual oxidant measurements may include both chlorine and bromine residuals. Most outfalls with total residual oxidant mass-loading action levels are monitored semiannually; the rest are monitored weekly, semimonthly, or quarterly. Numerous outfalls with no dry-weather total residual oxidant discharges were dropped from the Chlorine Control Strategy during the duration of the NPDES permit. Outfalls included in the Chlorine Control Strategy have a mass-loading action level for total residual oxidants that requires ORNL to reduce or eliminate total residual oxidants in the discharge if they exceed the 1.2 gram per day action level specified in the permit.

Compliance with the action level is calculated by multiplying the instantaneously measured concentration by the instantaneous flow rate of the outfall.

UT-Battelle monitored 192 measurable dry-weather discharges during 2008 at 31 ORNL outfalls. The action level was exceeded a total of 15 times across five outfalls. A report detailing monitoring results, corrective actions, and proposed modifications is submitted to TDEC annually.

5.5.1.3 Storm Water Pollution Prevention

The ORNL NPDES Permit requires an SWP3 to document existing material management practices and to evaluate the vulnerability of those practices in contributing pollutants to area streams via storm water runoff. The plan consists of four major components:

- assessment and mapping of outdoor material storage/handling at ORNL,
- characterization of storm water runoff by monitoring,
- training of employees, and
- implementation of measures to minimize storm water pollution in areas of ORNL that may be vulnerable.

These four components of the plan were initiated in 1997 and are reviewed and updated by the facility at least annually. The SWP3 was revised in 2008 but due to the reissuance of the ORNL NDPES Permit, which became effective August 1, 2008, SWP3 activities have been significantly revised since then and included in the WQPP, which was implemented on January 1, 2009. Information on the WQPP and associated monitoring activities will be included in the *ORR Annual Site Environmental Report for 2009*.

Under the SWP3, storm water outfalls were grouped into four broad categories based on common land uses or pollutant sources and storm water pollutant potential. The four groups were further subdivided based on permit categorizations that have different monitoring schedule requirements. The former permit required that Category I and II outfalls be characterized over a 5 year period and that Category III and IV outfalls be characterized over a 3 year period. The outfalls sampled in 2008 were chosen to represent a group or were considered to be more vulnerable to runoff pollution. Other factors considered in selecting representative outfalls from each group included interest in a particular runoff quality at an outfall and ease of obtaining a representative sample. A rotation of representative outfalls occurred each sampling period as directed by the permit. The results of the storm water outfall effluent sampling are provided in Attachment 5.0 of the SWP3. Various water-quality reference values were used to compare to ORNL storm water data collected under this SWP3 for purposes of better characterizing outfalls and for targeting additional actions, such as focused investigations into storm water pollution sources, monitoring, or best management practices. One such reference included report levels adopted by the TDEC Multi-Sector General Storm Water Permit for Industrial Activities, which are developed specifically for “sectors” or classifications of industrial activity. ORNL storm water data have been consistently lower than TDEC report levels for applicable sectors.

Qualitative observations from a comparison between outfall storm water data collected to date show that grab samples generally have higher concentrations of analytes than flow-proportional composite samples. This is expected because grab samples are designed to collect and characterize the “first-flush” runoff from a watershed.

The EPA Nationwide Urban Runoff Program was developed to expand the understanding of urban runoff pollution by instituting data collection and applied research projects in U.S. urban areas. Urban storm-water runoff pollutant-loading factors for 10 standard water quality constituents, called “event mean concentrations” (EMCs), were developed for the 1983 program’s final report. Program findings were updated in 1999 by using results of storm water data collected by the U.S. Geological Survey and the NPDES Storm Water Program to refine the EMCs. A formal National Storm Water Quality Database (Version 1.1) was published in February 2004. This latest publication includes industrial median values that target land use components typical of industry. In a comparison of ORNL storm water data with data from the Nationwide Storm Water Quality Database, most values for the conventional storm water quality constituents measured are well below the Industrial EMCs. Patterns of values exceeding the industrial

EMCs can be generalized by elevations of copper, nitrate/nitrite, or zinc. Copper is natural in the soils and could also occur from coal-burning activities or corrosion of copper pipes. Nitrate is an inorganic form of nitrogen in water solution that can be attributed to the breakdown of many nitrogen-bearing sources (e.g., fertilizers, organic decay). Zinc can be attributed to vehicular degradation. There were also a few elevated levels of suspended solids that can probably be attributed to the numerous and ongoing construction projects in and around the main ORNL campus.

5.5.1.4 Radiological Monitoring Plan

In 2008, UT-Battelle monitored specific radiological constituents at NPDES outfalls identified as having the potential to discharge radioactivity and at instream monitoring stations under the *Radiological Monitoring Plan,* which was implemented on November 1, 1999, per the ORNL NPDES Permit. Table 5.19 details the monitoring frequency and target analyses for 27 category outfalls (dry-weather component of discharge), 3 treatment facility outfalls, and 3 instream monitoring locations.

Category outfalls are outfalls that discharge effluents with relatively minor constituent levels and that receive little or no treatment prior to discharge. Dry-weather discharges from category outfalls are primarily cooling water, groundwater, and condensate. In 2008, dry-weather grab samples were collected at 19 of the 27 category outfalls. The remaining eight outfalls were not sampled due to various factors, including the absence of flow or discharge or the discontinued use of the outfall The three treatment facilities monitored in 2008 in conjunction with the *Radiological Monitoring Plan* included the Sewage Treatment Plant (STP), the SPWTF (formerly known as the Coal Yard Runoff Treatment Facility), and the Process Waste Treatment Complex (PWTC). Three instream monitoring locations were: X13 on Melton Branch, X14 on WOC, and X15 at WOD (Fig. 5.17). At each of the treatment facilities and instream monitoring stations, monthly flow-proportional composite samples were collected using dedicated automatic water samplers.

Expressing radioactivity concentrations as percentage of DOE DCG values is used in this section to compare different radiological contaminants and concentrations measured at NPDES sampling points. Annual average concentrations are compared with DCG values where applicable (there are no DCGs for gross alpha and gross beta activities) and when at least one measurement was greater than or equal to the minimum detectable activity (MDA). When analytical procedures cannot differentiate between two radioisotopes (e.g., $^{89/90}$Sr), and for radioisotopes that have more than one DCG for different gastrointestinal tract absorption factors, the most restrictive (lowest) DCG was used. DCGs, which are intended to be used as thresholds for effluent discharges and not for instream comparisons, are nonetheless useful as a frame of reference for instream radiological constituent levels. In this section effluent and instream concentrations are compared to DCGs for human exposure to radiological contaminants via ingestion of water, but in practice ORNL effluents or ambient waters are not sources of drinking water.

In 2008, measured annual average concentrations of radioactivity exceeded 100% of DCG concentrations at one outfall -- outfall 302. The annual average $^{89/90}$Sr concentration was 1,400 pCi/L, or 1.4 times the DCG for ^{90}Sr. The annual average concentration of $^{233/234}$U was also notable at 120 pCi/L, or 24% of the DCG for ^{233}U and ^{234}U (the DCGs are the same for both isotopes). Elevated concentrations were first measured in the grab sample collected on February 7, 2008. In the February sample, the concentration of $^{89/90}$Sr was 11,000 pCi/L and the concentration of $^{233/234}$U was 430 pCi/L. The elevated concentrations were the result of a pump failure at Pump Station No. 1. The pump station is part of the process liquid waste management system and is located about ten feet from a portion of the stormwater pipe network that discharges at Outfall 302. Elevated water levels in the pump station vault, as a result of the pump failure, allowed water to escape the vault and seep via groundwater into the storm drain network. The pump was repaired within several days of the discovery of elevated radiological concentrations at the outfall; however, several months were required for concentrations to return to normal.

Table 5.19. ORNL National Pollutant Discharge Elimination System Radiological Monitoring Plan

Location	Frequency	Gross alpha[a]	Gross beta[a]	Gamma scan	Tritium	Total rad Sr	Isotopic uranium	Carbon 14
Outfall 001	Annually	X						
Outfall 080[c]	Monthly	X	X	X	X	X		
Outfall 081	Annually		X					
Outfall 085	Quarterly	X	X			X	X	
Outfall 086[b]	When discharges		X		X			
Outfall 087	Annually		X	X				
Outfall 203[c]	Annually		X					
Outfall 204	Quarterly	X	X			X		
Outfall 205[c]	Annually		X					
Outfall 207	Quarterly	X	X	X		X		
Outfall 211	Quarterly		X			X		
Outfall 217	Annually		X					
Outfall 219	Annually		X					
Outfall 234	Annually	X						
Outfall 241	Annually		X					
Outfall 265	Annually		X	X				
Outfall 281	Quarterly	X	X	X	X			
Outfall 282	Quarterly	X	X					
Outfall 284[c]	Annually		X					
Outfall 290[c]	Annually			X				
Outfall 302	Monthly	X	X	X	X	X		
Outfall 304	Monthly	X	X	X	X	X		
Outfall 365	Quarterly	X	X					
Outfall 368	Quarterly	X	X	X				
Outfall 381[d]	Quarterly		X	X	X			
Outfall 382[e]	Annually		X	X				
Outfall 383	Annually		X		X			
Sewage Treatment Plant (X01)	Monthly	X	X	X[f]	X[f]	X		X[f]
Coal Yard Runoff Treatment Facility (X02)	Monthly	X	X					
Process Waste Treatment Complex (X12)	Monthly	X	X	X	X	X	X	
Melton Branch 1 (X13)	Monthly	X	X	X	X	X		
WOC (X14)	Monthly	X	X	X	X	X		
WOD (X15)	Monthly	X	X	X	X	X		

[a]Isotopic analyses are performed to identify contributors to gross activities when results exceed screening criteria described in the *Radiological Monitoring Plan*, June 1999.

[b]Outfall no longer exists.

[c]No discharge present.

[d]Physically removed in late 2004; eliminated as part of the HFIR ponds remediation project.

[e]No longer discharges (plugged).

[f]Added to the plan in January 2006.

In addition to outfall 302, the annual average concentration of at least one radionuclide exceeded 4% of the relevant DCG concentration in dry-weather discharges from four other NPDES outfalls (X01, X12, 085, and 304) and at instream sampling locations X13 and X15 (Fig. 5.18). Four percent of the DCG is roughly equivalent to the 4 mrem dose limit on which the EPA radionuclide drinking water standards are based (4% of a DCG is only a comparison point, and ORNL effluents and ambient waters are not direct sources of drinking water). The annual average concentration of $^{89/90}$Sr in the ORNL STP Discharge (outfall X01) was 13% of the DCG. Concentrations of ^{137}Cs and tritium measured in the discharge from the PWTC (outfall X12) were greater than 4% of the DCG: ^{137}Cs (9.1%) and tritium (14%). Measured concentrations of parameters greater than 4% of applicable DCGs were also observed at outfalls 085 and 304. At outfall 085, $^{89/90}$Sr was 9.4% of the DCG; at outfall 304 $^{89/90}$Sr was 38%. At the instream monitoring station on Melton Branch (location X13), $^{89/90}$Sr was measured at 4.3% of the DCG, and at the X15 monitoring station at WOD, $^{89/90}$Sr was measured at 5.2% of the DCG.

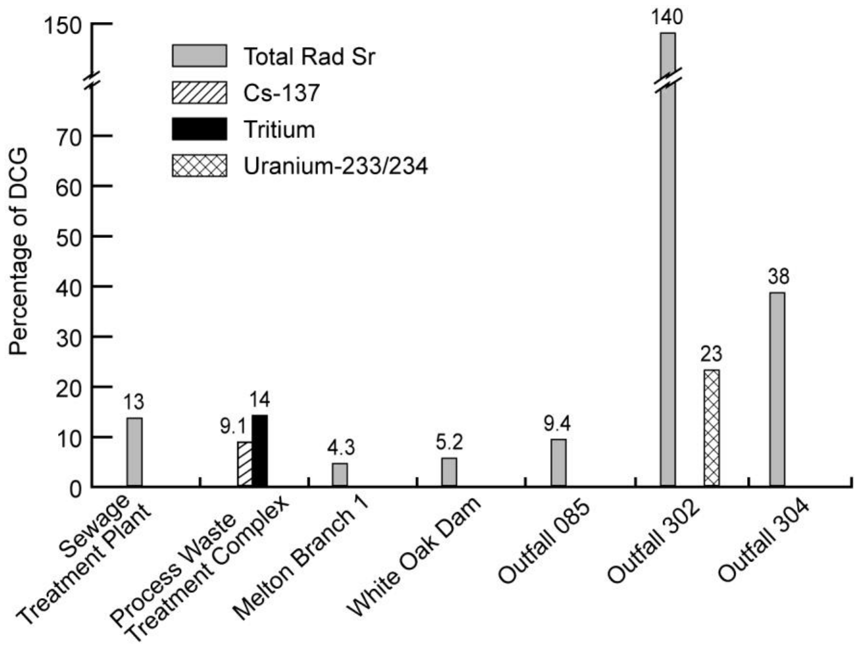

Fig. 5.18. Radionuclides at ORNL sampling sites having average concentrations greater than 4% of the relevant derived concentration guides in 2008

The total annual discharges of radioactivity measured in stream water at WOD, the final monitoring point on WOC before the stream flow leaves ORNL, were calculated from concentration and flow. Results of those calculations for each of the past 5 years are shown in Figs. 5.19 through 5.23. Discharges at White Oak Dam in 2008 continued to decline in comparison to the years preceding completion of the waste area caps in Melton Valley.

In 2008 the radiological monitoring also included monitoring at category outfalls during storm runoff conditions. A total of 10 storm water outfalls were monitored and analyzed for gross alpha, gross beta, and tritium. A gamma scan analysis was also performed. Additional analyses were performed when the gross alpha and/or gross beta activity levels in a sample indicated that DCG levels could be exceeded. In 2008, additional analyses were performed on samples from outfalls 204 and 341.

Of the 56 individual storm water sample results collected in 2008, 32 (57%) showed no detectable activity (measured activities were less than the MDAs of the tests). Concentrations of radioactivity in storm water discharges were compared with DCGs if a DCG existed for that parameter (there are no DCGs for gross alpha and gross beta activities) and if the concentration was greater than or equal to the MDA for the measurement. Two outfalls had measurements of radionuclide concentrations in storm water that were greater than 4% of DCG levels: at outfall 204, $^{89/90}$Sr was measured at 45% of the DCG for ^{90}Sr. At outfall 341, $^{89/90}$Sr was measured at 65% of the DCG for ^{90}Sr, and $^{233/234}$U was measured at 30% of the DCG for ^{233}U and ^{234}U.

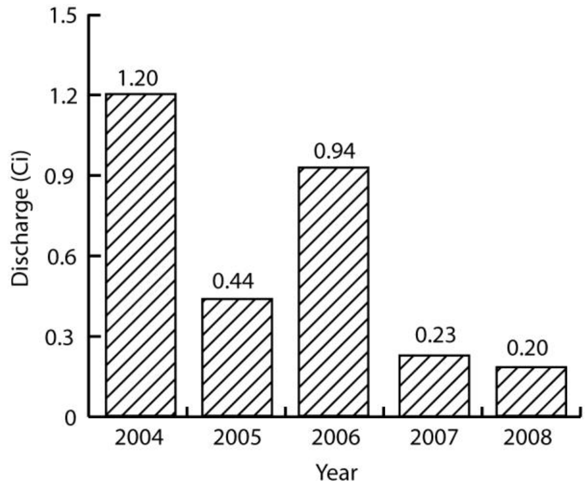

Fig. 5.19. Cesium-137 discharges at White Oak Dam, 2004–2008.

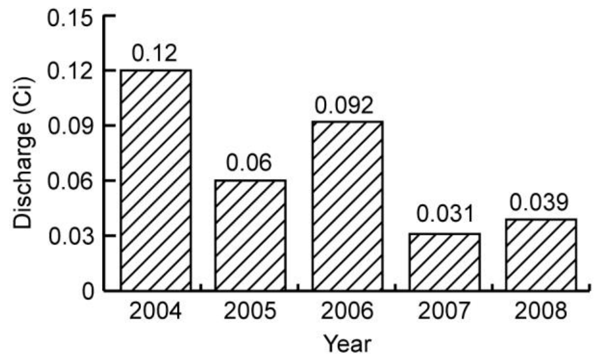

Fig. 5.20. Gross alpha discharges at White Oak Dam, 2004–2008.

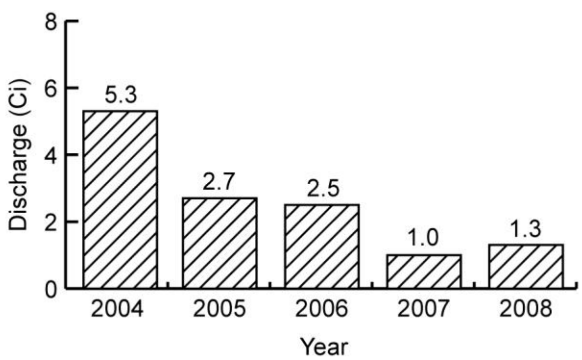

Fig. 5.21. Gross beta discharges at White Oak Dam, 2004–2008.

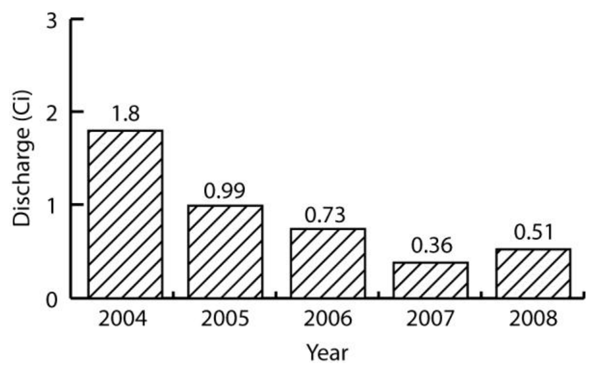

Fig. 5.22. Total radioactive strontium discharges at White Oak Dam, 2004–2008.

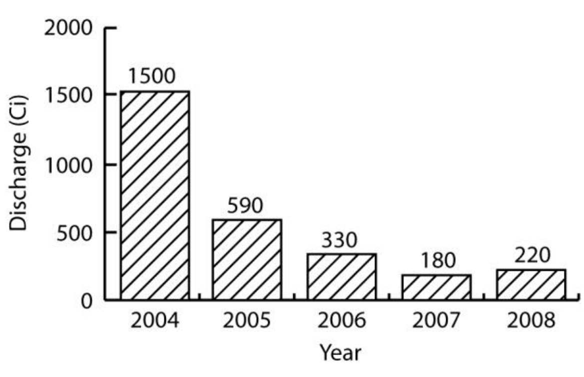

Fig. 5.23. Tritium discharges at White Oak Dam, 2004–2008.

5.5.1.5 Biomonitoring

Wastewaters from the STP, the SPWTF, and the PWTC were evaluated for toxicity during 2008 in accordance with NPDES requirements. The results of these toxicity tests are presented in Table 5.20, which includes the month the test was conducted, the concentration of wastewater that kills 50% of the test organisms (LC_{50}) for fathead minnows (*Pimephales promelas*) and daphnia (*Ceriodaphnia dubia*), the highest concentration that does not significantly reduce survival or growth of fathead minnows or survival or reproduction of *Ceriodaphnia* (the no-observed-effect concentration [NOEC]), and/or as applicable the concentration that inhibits survival, growth, or reproduction by 25% (IC_{25}). The NPDES permits defined the limits for the biomonitoring tests. For the outfall X01 (STP) discharge, toxicity in tests conducted prior to August 2008 (when a new NPDES permit became effective) was demonstrated if more than 50% lethality of the test organisms occurred in 96 h in 41.1% effluent (96 h LC_{50}) or if the NOEC was less than 12.3%. In STP tests conducted after August, toxicity was demonstrated if the 48 h LC_{50} was less than or equal to 69.4% effluent in any of four separate short-term (acute) tests conducted on wastewater samples collected at equal intervals over a 24 h period, or if the IC_{25} in longer-term (chronic) tests was less than or equal to 15.5%. For the outfall X02 discharge (SPWTF), toxicity in tests conducted prior to August was demonstrated if the LC_{50} was less than or equal to 4.2% effluent or if the NOEC was less than 1.3%. Because of the batch mode of discharge at the SPWTF, the limit for the NOEC applied only if the facility discharged for a sufficient length of time. Toxicity testing of the SPWTF was discontinued in the new NPDES permit. For the outfall X12 discharge (PWTC), toxicity in tests conducted prior to August was demonstrated if the 96-h LC_{50} was less than or equal to 100% effluent (LC_{50}) or if the NOEC was less than 30.9%. In PWTC tests conducted after August, toxicity was demonstrated if the 48-h LC_{50} was less than or equal to 100% effluent or if the IC_{25} was less than or equal to 30.5%.

During 2008, the STP and PWTC discharges were each tested for toxicity three times and the SPWTF was tested twice. Numeric biomonitoring limits in the NPDES permits were met in all cases.

5.5.1.6 Biological Monitoring and Abatement Program

The BMAP is a requirement of the ORNL NPDES Permit to assess the condition of aquatic life in WOC, the northwest tributary of WOC, Melton Branch, Fifth Creek, and First Creek. The results for bioaccumulation and macroinvertebrate and fish community studies in the WOC watershed for the BMAP in 2008 are summarized in the following sections.

5.5.1.6.1 Bioaccumulation Studies

The bioaccumulation task for the BMAP addresses two NPDES permit requirements at ORNL: (1) evaluate whether mercury at the site is contributing to a stream so that it will impact fish and aquatic life or violate the recreational criteria (instream water analyses for mercury are part of this activity), and (2) monitor the status of PCB contamination in fish tissue in the WOC watershed.

Mercury in Water. In continuation of a monitoring effort initiated in 1997, bimonthly water samples were collected from WOC at four sites in 2008. Stream conditions were selected to be representative of seasonal base-flow conditions (dry weather, clear flow) based on historical results that indicate higher mercury concentrations under these conditions.

The concentration of mercury in WOC upstream from ORNL was < 5 ng/L in 2008. Long-term trends in waterborne mercury in the WOC system downstream of ORNL are shown in Fig. 5.24. Waterborne mercury downstream of ORNL declined abruptly in 2008 as a result of rerouting highly contaminated sump water in Building 4505 to the Process Waste Treatment Complex (PWTC) in December 2007. The mean (± standard error [SE]) total mercury concentration at White Oak Creek kilometer (WCK) 4.1 was 22.5 ± 2.8 in 2008 compared with 108 ± 33 ng/L in 2007. The decrease was also apparent but less pronounced at WCK 3.4, with mercury averaging 18.4 ± 2.0 ng/L in 2008 vs 49 ± 23 ng/L in 2007. Similarly, the average mercury concentration in the White Oak Lake discharge was 29.9 ± 4.9 ng/L in 2008 compared with 45 ± 17 ng/L in 2007.

Bioaccumulation in Fish. In WOC, mercury and PCB concentrations in fish are at or near human health risk thresholds (e.g., EPA ambient water quality criteria [AWQC], TDEC fish advisory limits).

Mercury concentrations in fish collected in the WOC system (WCK 2.9, WCK 1.5) remained within historical ranges in 2008 (Fig. 5.25). Mercury concentrations in redbreast sunfish at WCK 3.9 (a site collected for the first time in 2007) averaged 0.47 µg/g in 2008. Mean PCB concentrations in fish continued to indicate the presence of upstream sources, with the redbreast sunfish samples from WOC (WCK 3.9) averaging 0.66 ± 0.28 µg/g PCBs, higher than the mean concentration of 0.26 ± 0.03 µg/g observed a kilometer downstream at WCK 2.9 and at WCK 1.5 (0.62 µg/g) for bluegill (Fig. 5.26).

Table 5.20. Toxicity test results of ORNL wastewaters, 2008

Test date	Test species	NOEC[a]/IC_{25}[b]	LC_{50}[c]
Sewage Treatment Plant (outfall X01)			
February	*Ceriodaphnia*	41.1	>41.1
	Fathead minnow	41.1	>41.1
June	*Ceriodaphnia*	41.1	>41.1
	Fathead minnow	41.1	>41.1
September/October	*Ceriodaphnia*	>100	>100
	Fathead minnow	>100	>100
Steam Plant Wastewater Treatment Facility (outfall X02)			
February	*Ceriodaphnia*	NA[d]	>4.2
	Fathead minnow	NA[d]	>4.2
June	*Ceriodaphnia*	NA[d]	>4.2
	Fathead minnow	NA[d]	>4.2
Process Waste Treatment Complex (outfall X12)			
February	*Ceriodaphnia*	100	>100
	Fathead minnow	100	>100
June	*Ceriodaphnia*	100	>100
	Fathead minnow	100	>100
September/October	*Ceriodaphnia*	>100	>100
	Fathead minnow	>100	>100

[a]NOEC no-observed-effect concentration; the concentration (as percentage of full-strength wastewater) that caused no reduction in *Ceriodaphnia* survival or reproduction or fathead minnow survival or growth. The NOEC applies to tests conducted prior to August 2008.

[b]IC_{25} the inhibition concentration causing a 25% reduction in survival, reproduction, or growth of the test organisms. The IC_{25} applies to tests conducted after August 2008.

[c]LC_{50} the concentration (as percentage of full-strength wastewater) that kills 50% of the test species in either 96 hours (tests conducted prior to August 2008) or 48 hours (tests conducted after August 2008).

[d]Insufficient duration of discharge for chronic test and determination of NOEC.

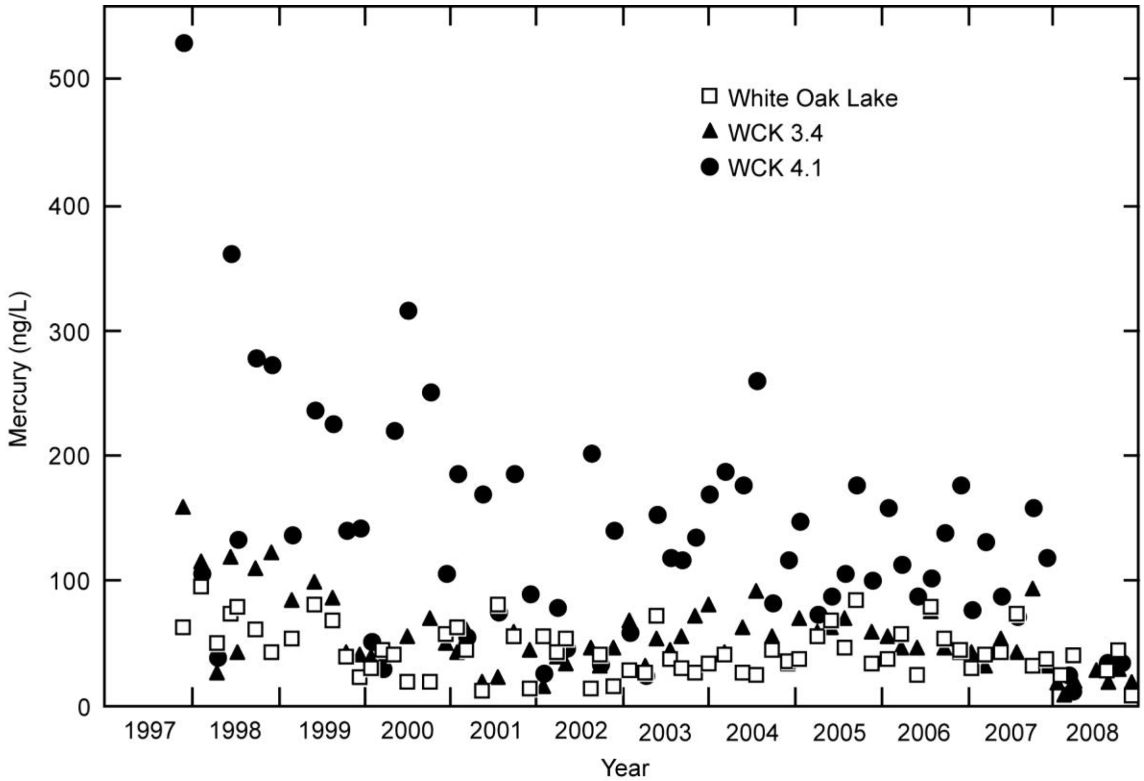

Fig. 5.24. Total aqueous mercury concentrations at sites in White Oak Creek downstream from ORNL, 1998-2008

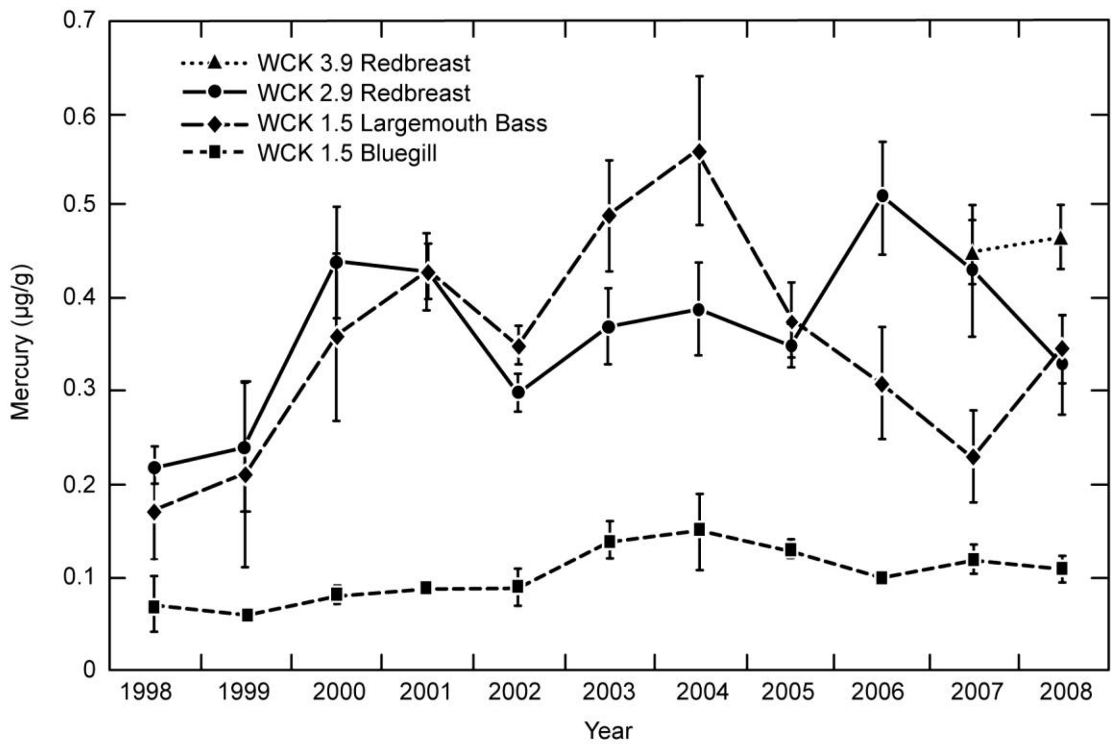

Fig. 5.25. Mean concentrations of mercury (µg/g, ± SE, N 6) in muscle tissue of sunfish and bass from WOC (WCK 2.9) and White Oak Lake (WCK 1.5), 1998–2008.

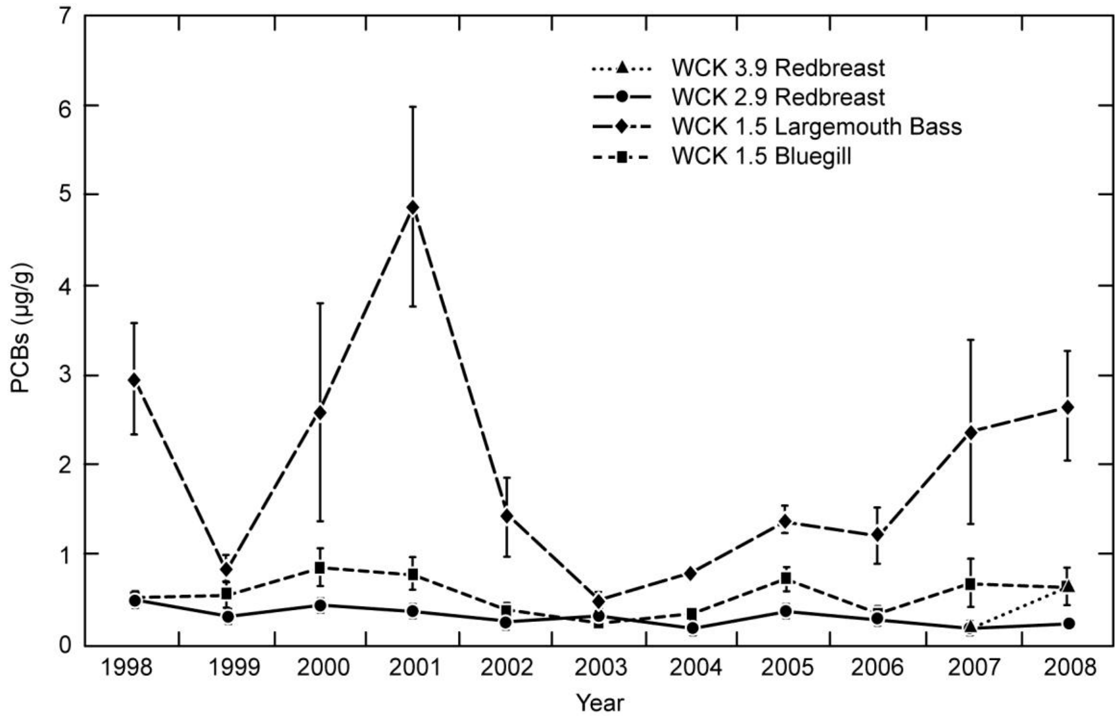

Fig. 5.26. Mean PCB concentrations (µg/g, ± SE N=6) in fish fillet collected from the WOC watershed, 1998–2008. (WCK WOC kilometer.)

Benthic Macroinvertebrate Communities

Monitoring of benthic macroinvertebrate communities in WOC, First Creek, and Fifth Creek continued in 2008. Additionally, monitoring of the macroinvertebrate community in lower Melton Branch continued under the Water Resources Restoration Program. Benthic macroinvertebrate samples are collected at sites upstream and downstream of the influence of ORNL operations; reference sites for WOC, First Creek and Fifth Creek are used as references for the Melton Branch site (Melton Branch kilometer [MEK] 0.6). These sites include impacted and unimpacted (reference site) locations. The objectives of this activity are to (1) help assess ORNL's compliance with the current NPDES permit requirements and (2) evaluate and verify the effectiveness of pollution abatement and remedial actions taken at ORNL.

The benthic macroinvertebrate communities in First Creek, Fifth Creek, and WOC downstream of effluent discharges have recovered significantly since 1987, but community characteristics indicate that ecological impairment remains (Figs. 5.27, 5.28, and 5.29). Total taxonomic richness (i.e., the number of different species per sample) and richness of the pollution-intolerant taxa (i.e., mayflies, stoneflies, and caddisflies or Ephemeroptera, Plectoptera, and Trichoptera [EPT] richness) continue to be lower at sites adjacent to and downstream of the main ORNL campus than at their respective reference sites. Prior to 2008, total and EPT taxa richness at downstream sites remained relatively stable, with the magnitude of annual changes being similar to those at the reference sites. However, the magnitude of reductions in both metrics in lower First Creek (First Creek kilometer [FCK] 0.1, Fig. 5.27) and lower Fifth Creek (FFK 0.2, Fig. 5.28) relative to their reference sites from 2007 and 2008 suggest that an additional stress may have been present. Long-term results from these sites show that changes between years can be considerable. Thus it is possible that the metric reductions in 2008 were just natural fluctuation. However, it is possible that several construction projects in each stream's catchment may be having short-term negative effects on macroinvertebrates through further alterations in storm water runoff and inputs of silt and sediment. Changes in the macroinvertebrate communities in lower WOC (WCK 3.9 and WCK 2.3, Fig. 5.29) and lower Melton Branch (MEK 0.6, Fig. 5.30) suggest that conditions remain stable in these streams. The benthic macroinvertebrate community in lower Melton Branch (MEK 0.6) continues to show no evidence of discernible degradation based on total and EPT richness. However, abundances of invertebrates at that site are somewhat elevated compared with reference sites (data not shown), which is a common characteristic of streams with elevated concentrations of nutrients (i.e., nitrogen and phosphorus), either from direct (e.g., from effluent discharges or stormwater runoff from fertilized land) or indirect (e.g., inputs from nutrients naturally present in freshly disturbed soils).

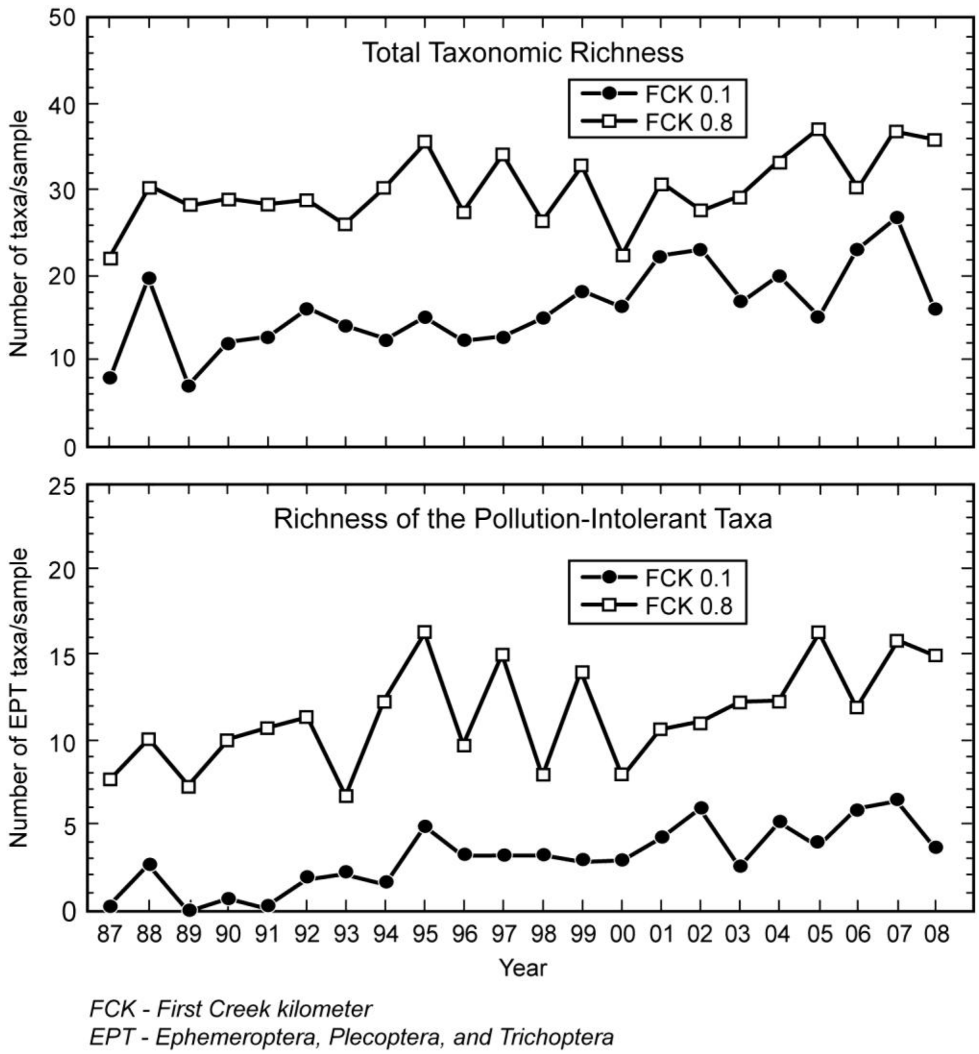

Fig. 5.27. Taxonomic richness (top) and richness of the pollution-intolerant taxa (bottom) of the benthic macroinvertebrate community in First Creek, April sampling periods, 1987−2008. FCK 0.8 is the reference site.

FCK First Creek kilometer
EPT Ephemeroptera, Plecoptera, and Trichoptera

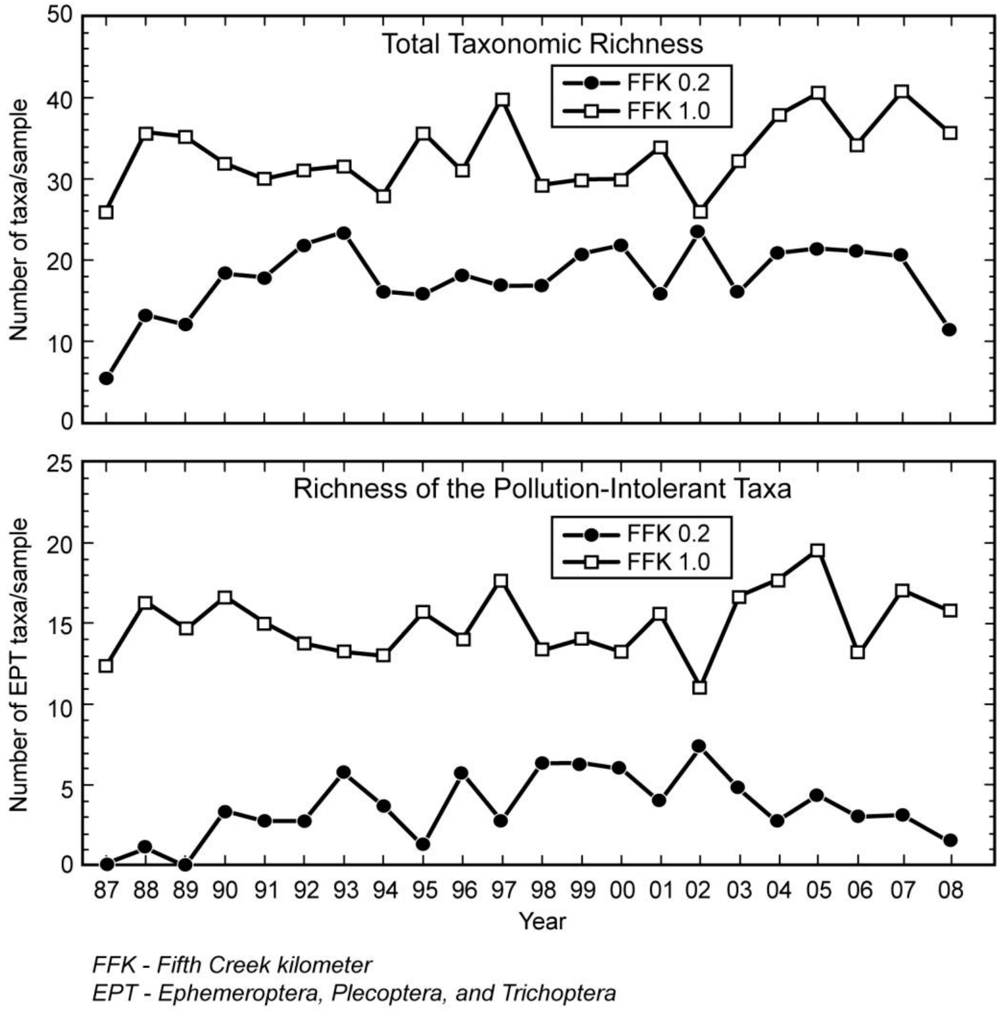

Fig. 5.28. Taxonomic richness (top) and richness of the pollution-intolerant taxa (bottom) of the benthic macroinvertebrate community in Fifth Creek, April sampling periods, 1987−2008. FFK 1.0 is the reference site.

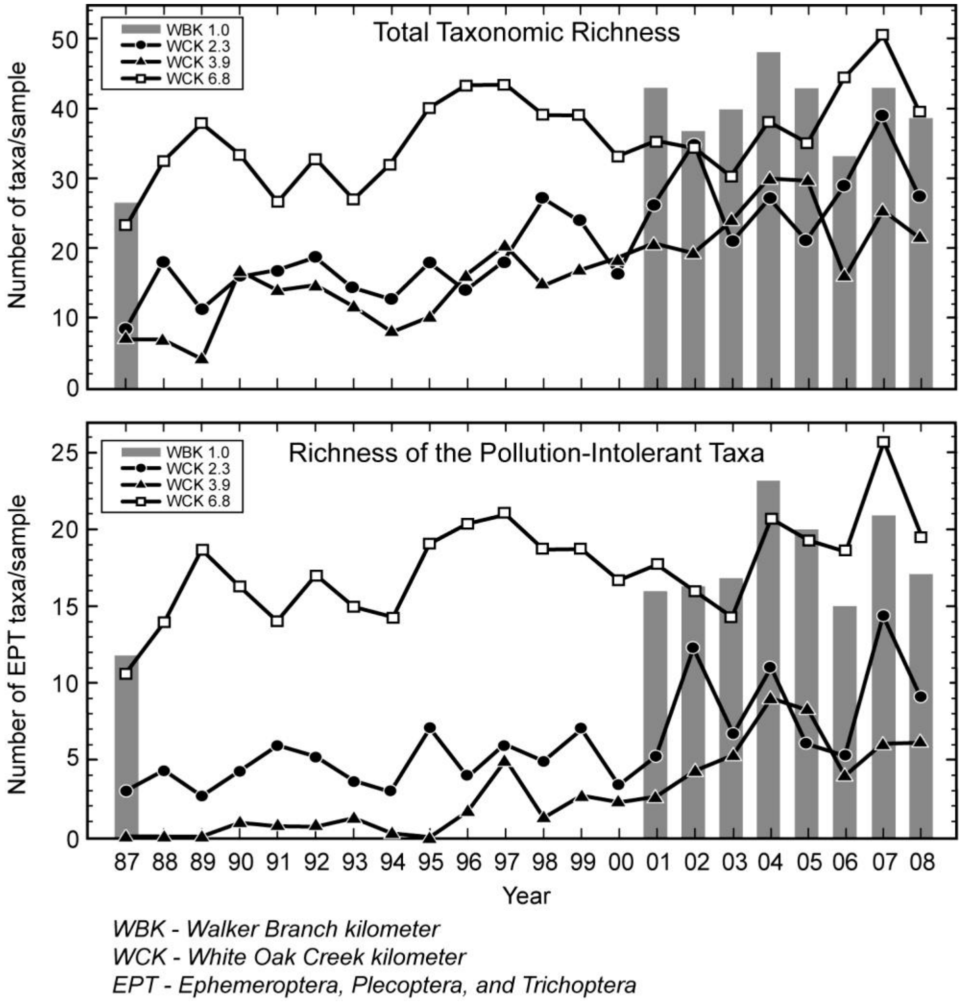

Fig. 5.29. Taxonomic richness (top) and richness of the pollution-intolerant taxa (bottom) of the benthic macroinvertebrate communities in White Oak Creek, April sampling periods, 1987−2008 WBK 1.0 is the reference site.

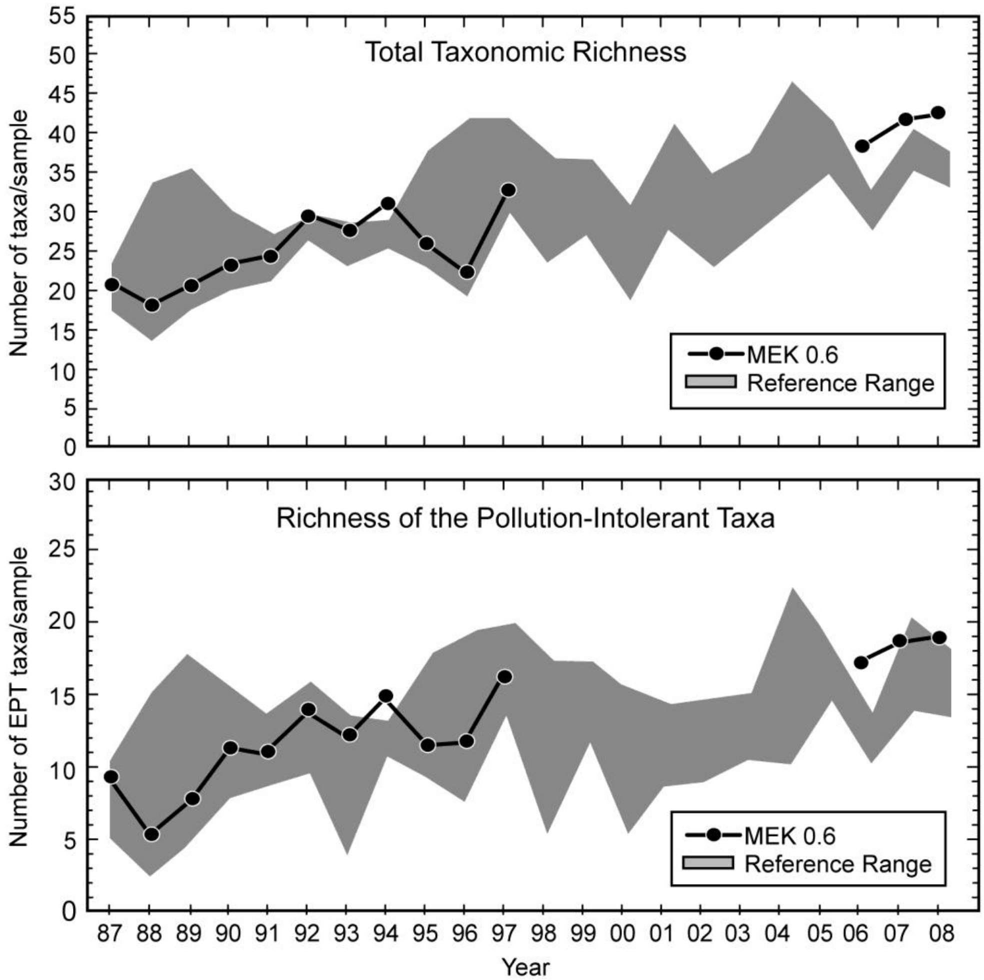

Fig. 5.30. Taxonomic richness (top) and richness of the pollution-intolerant taxa (bottom) of the benthic macroinvertebrate community in lower Melton Branch, April sampling periods, 1987−2008. The reference range delineates the minimum and maximum values for ORNL BMAP reference sites on First Creek, Fifth Creek, Melton Branch (1987–1997), Walker Branch (2001–2008), and White Oak Creek (1987–-2000).

MEK Melton Branch kilometer
EPT Ephemeroptera, Plecoptera, and Trichoptera.

Fish Communities

Monitoring fish communities in WOC and major tributaries continued in 2008. Fish samples were taken at 11 sites in the WOC watershed in the spring and fall. Streams located near or within the city of Oak Ridge were also sampled as reference sites: Mill Branch as a reference for smaller upstream locations within WOC and Brushy Fork as a reference for the larger downstream portions of WOC.

In WOC, the fish community continued to be degraded in 2008 compared with communities in reference streams, with sites closest to the outfalls having lower species richness (number of species), fewer pollution-sensitive species, more pollution-tolerant species, and elevated density (number of fish per square meter) compared with similar-sized reference streams. Densities at WOC sites have generally stabilized over the past couple of years, with some minor variability. The fish communities in 2008 showed changes in species richness at each site. Historically there has been little change in species richness in the WOC watershed relative to off-site reference locations because of barriers that limit immigration of new species from the Clinch River. A project to introduce some of these missing species into the watershed was initiated in 2008 and increased richness at 2 of the 3 monitoring sites (Fig. 5.31). The location where species richness declined was affected by episodic fish kills which may have influenced species to temporarily leave that section of the stream. A companion study also evaluated road crossings and in-stream structures within WOC to determine whether fish could openly move within the watershed. The study found there were numerous barriers to upstream fish movement which should be considered when evaluating stream recovery. The initial success of the introductions in WOC suggests that overall water quality has improved in the watershed over the past two decades.

Generally, the fish communities in tributary sites adjacent to and downstream of ORNL outfalls remained impacted in 2008 relative to reference streams or upstream sites (Figs. 5.32, 5.33 and 5.34). Species richness of fish in tributaries to WOC remained slightly lower in 2008 relative to reference streams not in the WOC watershed. The primary difference between these tributaries and reference streams is the absence of pollution-sensitive species, such as darters. The introduction of darters at one locale in Melton Branch as part of the species enhancement project has been successful initially, with survival and reproduction observed. The density of fish communities in First Creek and in Fifth Creek showed decreases in 2008 compared to 2007.

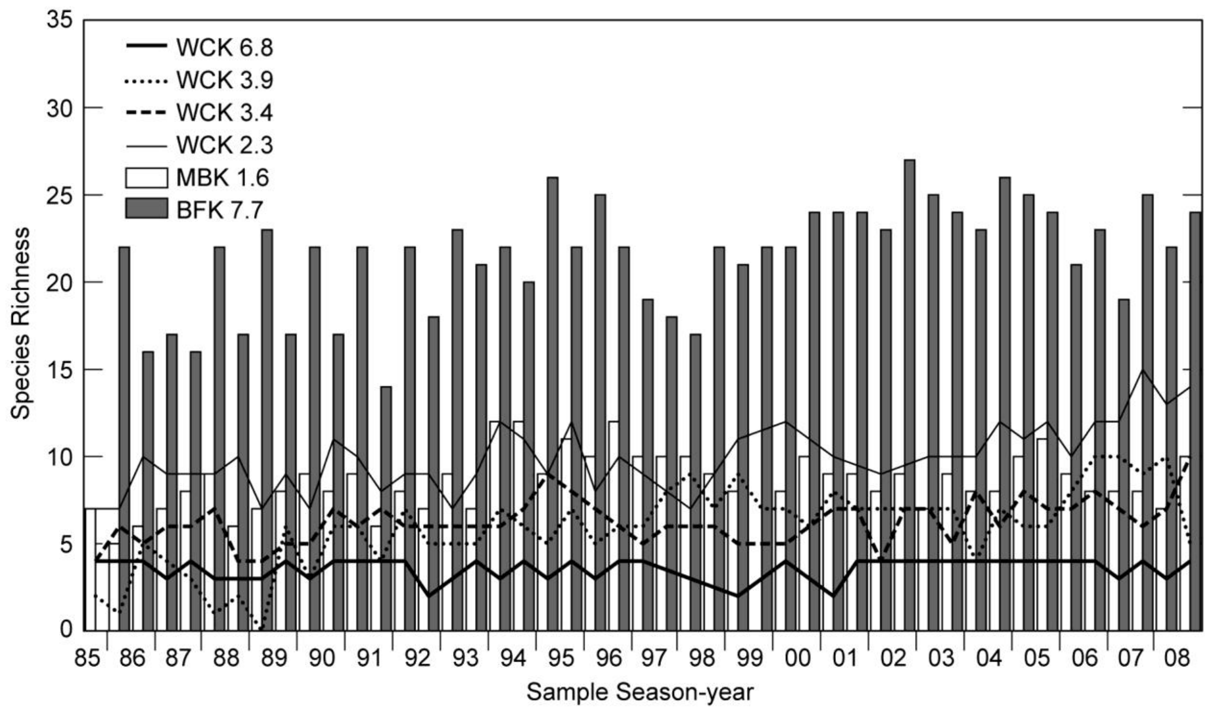

Fig. 5.31. Species richness for fish communities in spring and fall samples from White Oak Creek (WCK), and two reference sites, Mill Branch (MBK 1.6) and Brushy Fork (BFK 7.6), 1985–2008.

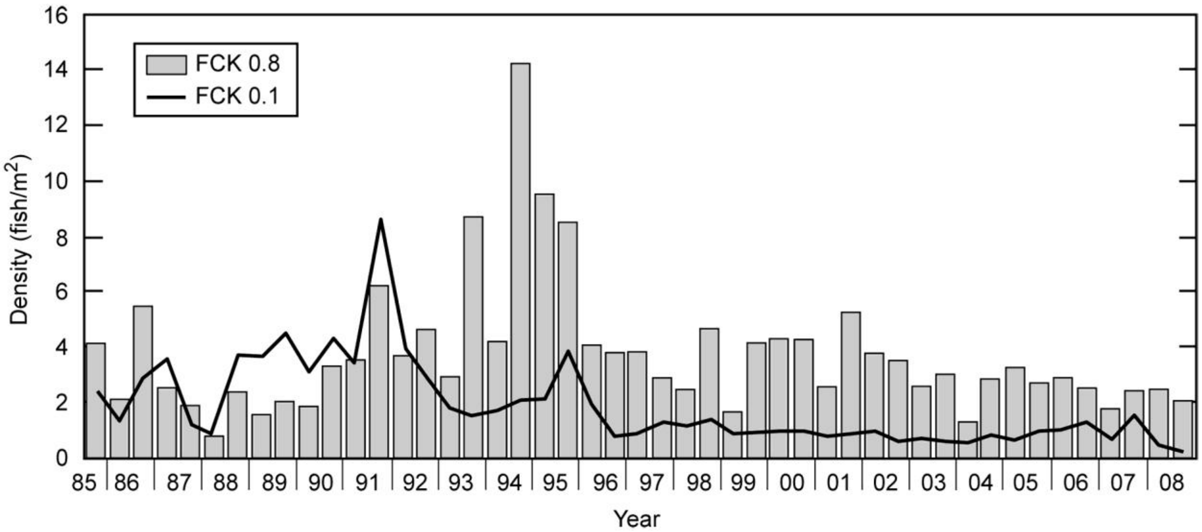

Fig. 5.32. Density (fish/m^2) estimates for fish in spring and fall samples from First Creek, 1985–2008. FCK 0.8 is the reference site.

FCK First Creek kilometer

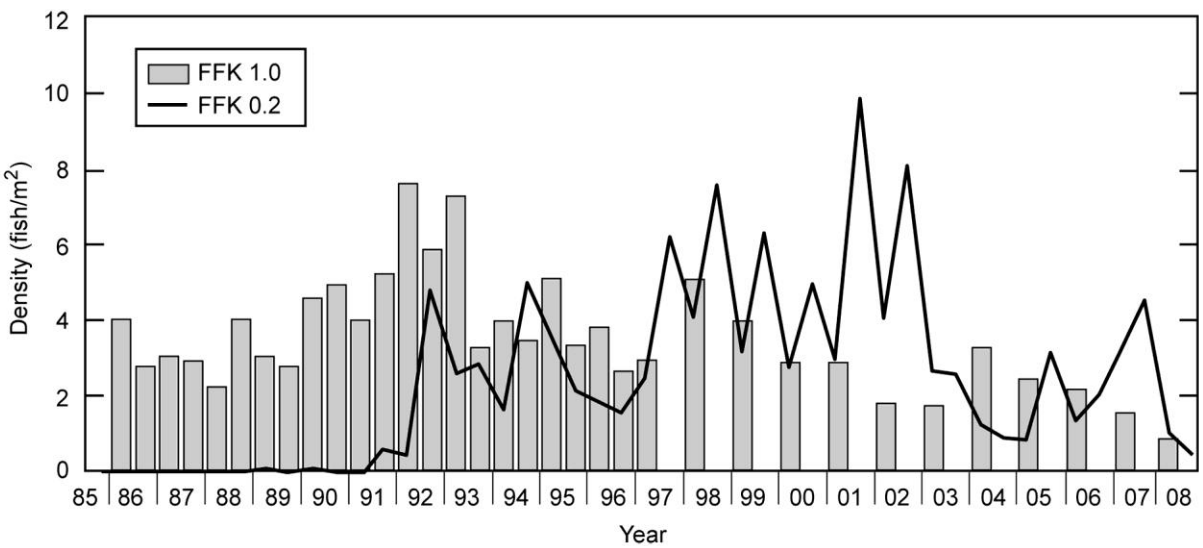

Fig. 5.33. Density (fish/m^2) estimates for fish in spring and fall samples from Fifth Creek, 1985–2008. FFK 1.0 is the reference site.

FFK Fifth Creek kilometer

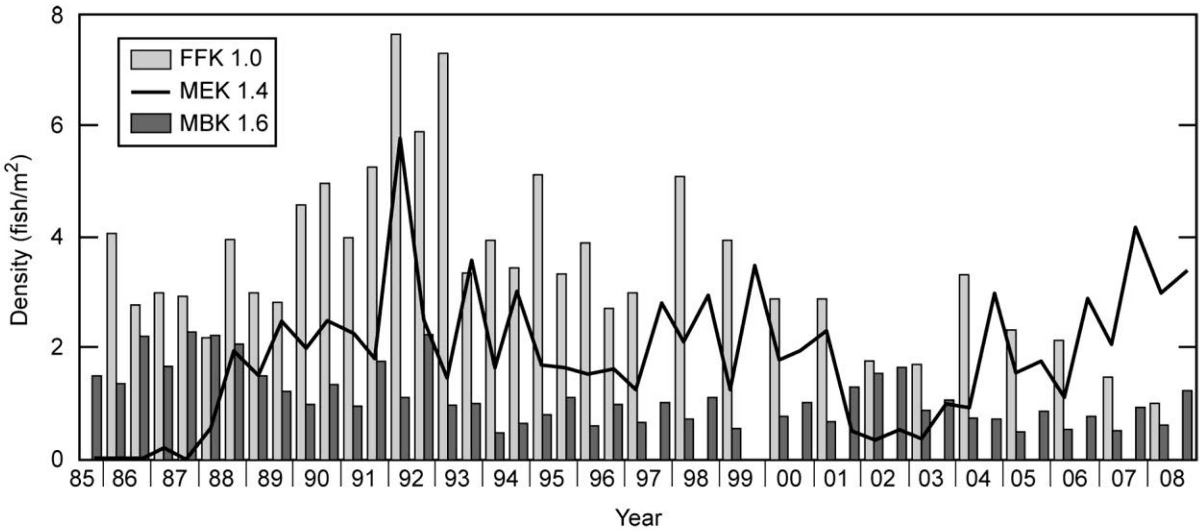

Fig. 5.34. Density (fish/m²) estimates for fish in spring and fall samples from Melton Branch, 1985–2008. MEK 1.4, FFK 1.0, and MBK 1.6 are reference sites.

MEK Melton Branch kilometer
FFK Upper Fifth Creek kilometer
MBK Mill Branch kilometer

5.5.2 Surface Water Monitoring at NPDES Reference Location

WOC headwaters were monitored in 2008 as a reference location for ORNL NPDES surface water monitoring.

In an effort to provide a basis for evaluation of analytical results and for assessment of nonradiological surface water quality, Tennessee general water quality criteria (TDEC 2008) have been used as reference values. The criteria for fish and aquatic life have been used at WOC headwaters. (See Appendix D, Table D.2, for Tennessee General Water Quality Criteria for all parameters in water. See Tables 2.3 and 3.4 in *Environmental Monitoring on the Oak Ridge Reservation: 2008 Results* [DOE 2009b] for surface water analyses.)

5.5.3 Sanitary Wastewater

At ORNL, sanitary wastewater is collected, treated, and discharged separately from other liquid wastewater streams through an on-site sewage treatment plant. Wastewater discharged into the system is regulated by means of internally administered waste-acceptance criteria based on the plant’s NPDES operating permit parameters. Wastewater streams currently processed through the plant include sanitary sewage from facilities in Bethel and Melton Valleys, area runoff of rainwater that infiltrates the system, and specifically approved nonhazardous biodegradable wastes, such as scintillation fluids. The effluent stream from the sewage treatment plant is ultimately discharged into WOC through an NPDES-permitted outfall (X-01). In 1998, ORNL’s sewage sludge was accepted into the city of Oak Ridge’s Biosolids Land Application Program. ORNL transported no sewage sludge to the Oak Ridge sewage treatment plant in 2008 because the plant was undergoing an expansion project. During 2008, ORNL’s sewage sludge was dried and handled as solid LLW. Shipments of sludge to the city of Oak Ridge may resume in 2009.

TWPC holds a state operating permit for sewage holding tanks, which are emptied and the sanitary wastewater taken for processing at an off-site sewage treatment plant.

5.5.4 Storm Water Protection Permits

Storm water discharges associated with construction activities that disturb 0.4 ha or more of land must be NPDES-permitted. Coverage under a general permit is typically approved for a construction project if the proper notice of intent is filed and if appropriate erosion-control measures are identified.

In 2008, ORNL had six construction projects covered by the Tennessee General Permit for Storm Water Runoff Associated with Construction Activity. These included the SNS project, the ORNL Research Support Center, the ORNL 24-Inch Water Line Replacement Project, a project to decommission and demolish specific excess buildings, the Pro2Serve Facility construction, and the West Campus Improvement Project.

5.5.5 Aquatic Resources Protection

The Army Corps of Engineers, The Tennessee Valley Authority (TVA), and TDEC conduct permitting programs for projects and activities that could affect aquatic resources, including navigable waters, surface waters (including tributaries), and wetlands. The permits include Corps of Engineers Sect. 404 dredge-and-fill permits, TDEC aquatic resource alteration permits (ARAPs), and TVA 26A approvals.

ORNL had one active ARAP in 2008, for the West Campus Improvements Project, which includes removal of an existing pedestrian bridge and steam pipe over First Creek and replacement of the pedestrian bridge.

5.5.6 Oil Pollution Prevention

Section 311 of the CWA regulates the discharge of oils or petroleum products to waters of the United States and requires the development and implementation of a spill prevention, control, and countermeasure plan to minimize the potential for oil discharges. Currently, each facility on the ORR implements a site-specific plan. This section of the CWA was significantly amended by the Oil Pollution Act of 1990, which has a primary objective of improving responses to oil spills. On July 17, 2002, EPA issued the new final rule for 40 CFR Part 112, “Oil Pollution Prevention and Response; Non-Transportation-Related Onshore and Offshore Facilities,” in the *Federal Register*. The rule contains significant changes in the requirements for spill prevention, control, and countermeasures plans (SPCCs), including how the plans are prepared, reviewed, and certified and the information that must be included in the plans. The ORNL SPCC was revised in September 2007, including incorporation of the new EPA requirements. A separate SPCC plan was prepared for the NTRC, an off-site facility in Knox County that now stores sufficient oil to require a plan. The NTRC SPCC plan was put into effect on September 15, 2008.

5.5.7 ORNL Surface Water Surveillance Monitoring

The ORNL surface water monitoring program includes sample collection and analysis from 12 locations at ORNL and around the ORR. This program is conducted in conjunction with the ORR surface water monitoring activities discussed in Sect. 6.4 to enable assessing the impacts of past and current DOE operations on the quality of local surface water. Sampling locations include streams downstream of ORNL waste sources, and reference points on streams and reservoirs upstream of waste sources (see Fig. 5.35).

Sampling frequency and parameters vary by site. Grab samples are collected and analyzed for general water quality parameters and are screened for radioactivity at all locations. Samples are further analyzed for specific radionuclides when general screening levels are exceeded. Samples from WOL at WOD are also checked for VOCs, PCBs, and metals. Table 5.21 lists sampling locations, frequencies and parameters.

Four of the 12 sampling locations are classified by the state of Tennessee for freshwater fish and aquatic life. Tennessee water quality criteria associated with these classifications are used as references where applicable (TDEC 2008). The Tennessee water quality criteria do not include criteria for radionuclides. Four percent of the DOE DCG is used for radionuclide comparison because this value is roughly equivalent to the 4 mrem dose limit from ingestion of drinking water on which the EPA radionuclide drinking water standards are based.

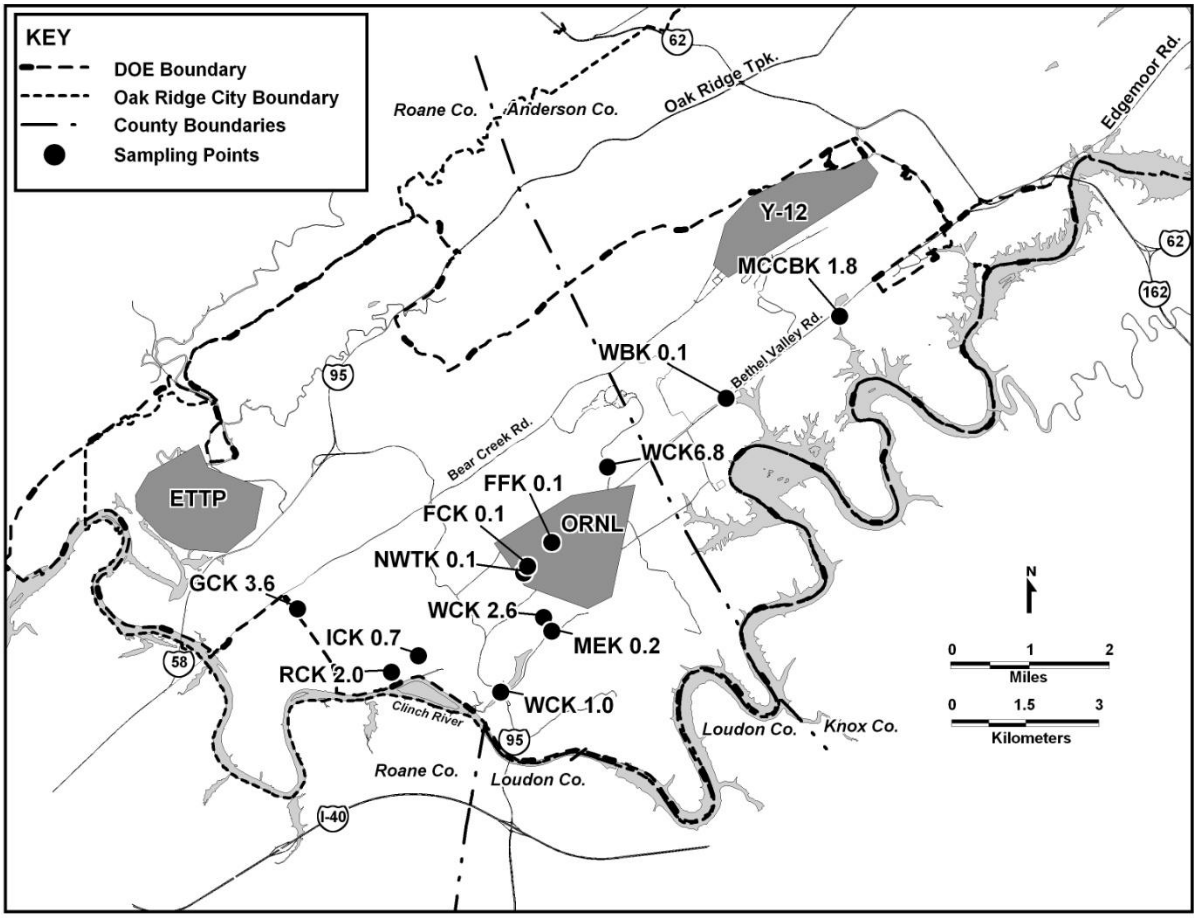

Fig. 5.35. ORNL surface water sampling locations.

Table 5.21. ORNL surface water sampling locations, frequencies, and parameters, 2008

Location[a]	Description	Frequency	Parameters
MEK 0.2	Melton Branch downstream from ORNL	Bimonthly (Jan., March, May, July, Sept., Nov.)	Gross alpha, gross beta, gamma scan, total radioactive strontium, ^{3}H, field measurements[b]
WCK 1.0	White Oak Lake at White Oak Dam	Monthly	Volatiles, metals, PCBs, gross alpha, gross beta, gamma scan, total radioactive strontium, ^{3}H, field measurements[b]
WCK 2.6	White Oak Creek (WOC) downstream from ORNL	Bimonthly (Jan., March, May, July, Sept., Nov.)	Gross alpha, gross beta, gamma scan, total radioactive strontium, ^{3}H, field measurements[b]
WCK 6.8	WOC upstream from ORNL	Quarterly (Feb., May, Aug., Nov.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, field measurements[b]
WBK 0.1	Walker Branch prior to entering CRK 53.4	Semiannually (April, Oct.)	Gross alpha, gross beta, gamma scan, field measurements[b]
GCK 3.6	Grassy Creek upstream of SEG and IT Corp. at CRK 23	Semiannually (April, Oct.)	Lead, gross alpha, gross beta, gamma scan, field measurements[b]
ICK 0.7	Ish Creek prior to entering CRK 30.8	Semiannually (April, Oct.)	Gross alpha, gross beta, gamma scan, field measurements[b]
MCCBK 1.8	McCoy Branch prior to entering CRK 60.3	Semiannually (April, Oct.)	Gross alpha, gross beta, gamma scan, field measurements[b]
RCK 2.0	Raccoon Creek sampling station prior to entering CRK 31	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, field measurements[b]
NWTK 0.1	Northwest Tributary prior to the confluence with First Creek	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, field measurements[b]
FCK 0.1	First Creek prior to the confluence with Northwest Tributary	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, field measurements[b]
FFK 0.1	Fifth Creek just upstream of WOC (ORNL)	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, field measurements[b]

[a]Locations identify bodies of water and locations on them (e.g., WCK 1.0   1.0 km upstream from the confluence of White Oak Lake and the Clinch River).

FCK	First Creek kilometer
FFK	Fifth Creek kilometer
GCK	Grassy Creek kilometer
ICK	Ish Creek kilometer
MCCBK	McCoy Branch kilometer
MEK	Melton Branch kilometer
NWTK	Northwest Tributary kilometer
RCK	Racoon Creek kilometer
WBK	Walker Branch kilometer
WCK	White Oak Creek (WOC) kilometer

[b]Field measurements consist of dissolved oxygen, pH, and temperature.

5.5.7.1 Results

Radionuclides were detected above MDAs at all of the 12 surface water locations in 2008. The locations with the highest radionuclide levels are in the ORNL main plant area or at locations downstream of the main plant. These locations are near or downstream of CERCLA sites. Over the past few years, several remedial actions have been completed within the main plant area, which have resulted in observed decreases in radionuclide concentrations in surface water samples as compared to concentrations observed in mid-1990s; future remedial actions in those areas are planned and, until completion, little change in surface water contaminant conditions is expected (DOE 2008). The results from 2008 sampling at those locations are consistent with historical data and with the processes or legacy activities nearby or upstream from these locations. The VOCs chloroform along with acetone and methylene chloride which are common laboratory contaminants were detected at WOC at WOD in 2008, all at low estimated levels.

Sampling locations west, southwest of ORNL [Raccoon Creek (RCK 2.0), Grassy Creek (GCK 3.6), and Ish Creek (ICK 0.7)] are impacted by contaminated groundwater from Solid Waste Storage Area 3. Future remedial actions should decrease these levels of radionuclides.

5.5.8 ORNL Sediment

Stream and lake sediments act as a record of some aspects of water quality by concentrating and storing certain contaminants. Sampling sites for sediment are the Clinch River downstream from all DOE inputs (CRK 16), the Clinch River downstream from ORNL (CRK 32), and the Clinch River at the Solway Bridge, upstream from all DOE inputs (CRK 70) (Fig. 5.36). The locations are sampled annually, and gamma scans are performed on the samples.

In addition, each year, two samples containing settleable solids are collected in conjunction with a heavy rain event to characterize sediments that exit ORNL during a storm event. The sampling locations are Melton Branch upstream from ORNL (MEK 2.1), White Oak Lake at White Oak Dam (WCK 1.0), WOC downstream from ORNL (WCK 2.6), and WOC Headwaters as a reference location (Fig. 5.36). These samples are filtered, and the residue (settleable solids) is analyzed for gross alpha, gross beta, and gamma emitters.

5.5.8.1 Results

Potassium-40, a naturally occurring radionuclide, and ^{137}Cs were detected in sediments at all three locations. The ^{137}Cs concentrations at CRK 70 and CRK 16 were higher than in previous sampling events; ^{137}Cs at CRK 32 was lower than either of the other two locations and was lower than previous sampling events at that location. Figure 5.36 shows 5 years of ^{137}Cs results in sediment.

Heavy rain event sampling took place in February and August 2008. Radionuclide concentrations for alpha, beta, and ^{137}Cs were higher at the downstream locations than those observed at the upstream reference location and there was no indication of significant trends in alpha, beta or ^{137}C at any of the locations.

During August 2008, the ^{40}K concentration at WOC headwaters was higher than at any of the other locations and higher than what has been observed historically; no cause was determined for the concentration.

During August 2008, the ^{7}Be concentration at WCK 2.6 was higher than at any of the other locations and higher than what has been observed historically. Beryllium is transferred through precipitation from the atmosphere to earth. It is possible that the higher concentration of ^{7}Be at WCK 2.6 was a result of runoff from a rain event associated with Hurricane Fay.

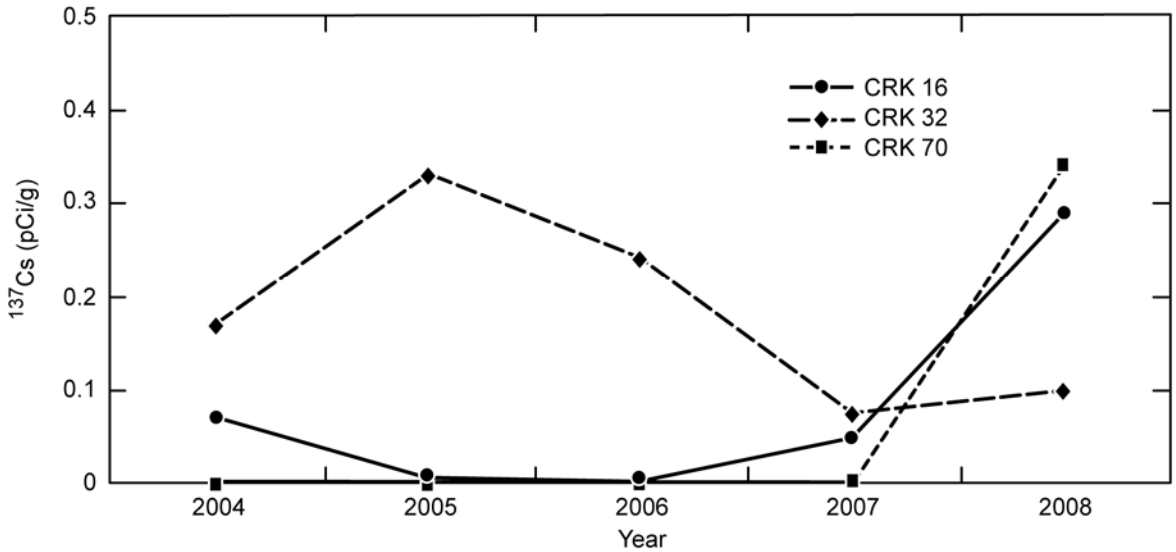

Fig. 5.36. ORNL sediment sampling results for ^{137}Cs, 2004–2008.

5.6 U.S. Department of Agriculture/Tennessee Department of Agriculture

In 2008, ORNL researchers had 13 domestic soil agreements for receipt of or movement of quarantined soils and four soil permits for receipt of or movement of nondomestic soils (from outside the continental United States). Three other researchers held permits or approvals for receipt of other material regulated by the USDA, such as animal or plant viruses or genetically engineered organisms. The domestic soil agreements are jointly issued by the USDA and the Tennessee Department of Agriculture, whereas permits are issued by the USDA.

5.7 Groundwater Protection Program

Groundwater monitoring at ORNL was conducted under two sampling programs in 2008: DOE EM monitoring and DOE Office of Science surveillance monitoring. The EM groundwater monitoring program was performed by cleanup contractor Bechtel Jacobs Company. The Office of Science groundwater monitoring surveillance program was conducted by UT-Battelle.

5.7.1 DOE EM Groundwater Monitoring

Under the EM program, monitoring was performed as part of an ongoing comprehensive cleanup effort in Bethel and Melton Valleys at ORNL, the two watersheds defined by the Water Resources Restoration Program (WRRP). The WRRP has been managed by Bechtel Jacobs Company for the EM program since its inception and is the vehicle for DOE to carry out the monitoring requirements outlined in the Federal Facility Agreement. The scope of the EM monitoring has largely dealt with remediation effectiveness monitoring at contaminated sites undergoing cleanup. In 2007 and in subsequent sampling events, radionuclides were detected in the Melton Valley picket wells located on the Oak Ridge Reservation proximate to the Clinch River. As required by the Melton Valley Interim Record of Decision, DOE is now working with TDEC and EPA to establish an additional network of wells on private property across the Clinch River. To date there has been no direct evidence that contaminated ground water originating from the Melton Valley Burial Grounds has migrated under the Clinch River or otherwise impacted groundwater west of the Clinch River. The monitoring results from EM activities on the ORR in 2008, including information on these picket wells, are presented in the *Remediation Effectiveness Report* (DOE 2009) and are not discussed in this document.

5.7.2 Office of Science Groundwater Monitoring

DOE Order 450.1A is the primary requirement for a site-wide groundwater protection program at ORNL. As part of the program, and to be consistent with UT-Battelle management objectives, a groundwater surveillance monitoring strategy was developed to monitor ORNL groundwater exit pathways and UT-Battelle facilities (“active sites”) potentially posing a risk to groundwater resources at ORNL. Results of the DOE Office of Science groundwater surveillance monitoring program are reported in the following sections.

Exit pathway and active sites groundwater surveillance monitoring points sampled during 2008 included seep/spring and surface water monitoring locations in addition to groundwater surveillance monitoring wells. Seep/spring and surface water monitoring locations were used in the absence of monitoring wells located in appropriate groundwater discharge areas.

Groundwater monitoring performed under the exit pathway groundwater surveillance and active sites monitoring programs is not regulated by federal or state regulations. Consequently, no permit or standards exist for evaluating sampling results. To provide a basis for evaluating analytical results and for assessment of groundwater quality at locations monitored by UT-Battelle for the Office of Science, federal drinking water standards and Tennessee water quality criteria for domestic water supplies (TDEC 2008) are used as reference standards in the following discussions. Four percent of the DOE DCGs are used if no federal or state standards have been established for a radionuclide. Although drinking water standards and DOE DCGs are used for comparative purposes, it is important to note that no members of the public consume groundwater from ORNL wells, nor do any groundwater wells furnish drinking water to personnel at ORNL.

5.7.2.1 Exit Pathway Monitoring

During 2008, exit pathway groundwater surveillance monitoring was performed under the guidance of *UT-Battelle Sampling and Analysis Plan for Surveillance Monitoring of Exit Pathway Groundwater at Oak Ridge National Laboratory* (Bonine 2008) (Exit Pathway SAP). Groundwater exit pathways at ORNL include areas from watersheds or subwatersheds where groundwater discharges to the Clinch River/Melton Hill Reservoir to the west, south, and east of the main campus of ORNL. The exit pathway monitoring points were chosen based on hydrologic features, screened intervals (for wells), and locations relative to discharge areas proximal to the ORNL main campus. The groundwater exit pathways at ORNL include four discharge zones identified by the groundwater data quality objectives process carried out in 2004. One of the original exit pathway zones was split into two zones for the sake of geographic expediency. The Southern Discharge Area Exit Pathway was carved from the East End Discharge Area Exit Pathway. Figure 5.37 shows the locations of the exit pathway monitoring points sampled in 2008.

The five zones include

- the WOC Discharge Area Exit Pathway (wells 857, 858, 1190, 1191, and 1239);
- the 7000/Bearden Creek Watershed Discharge Area Exit Pathway (wells 1198 and 1199 and Spring BC-01);
- the East End Discharge Area Exit Pathway (well 923 and Springs/Surface Water Monitoring Points EE-01 and EE-02);
- the Northwestern Discharge Area Exit Pathway (wells 531, 535, and 4579; see the *Remediation Effectiveness Report* for 4579 results); and
- the Southern Discharge Area Exit Pathway (Springs/Surface Water Monitoring Points S-01 and S-02).

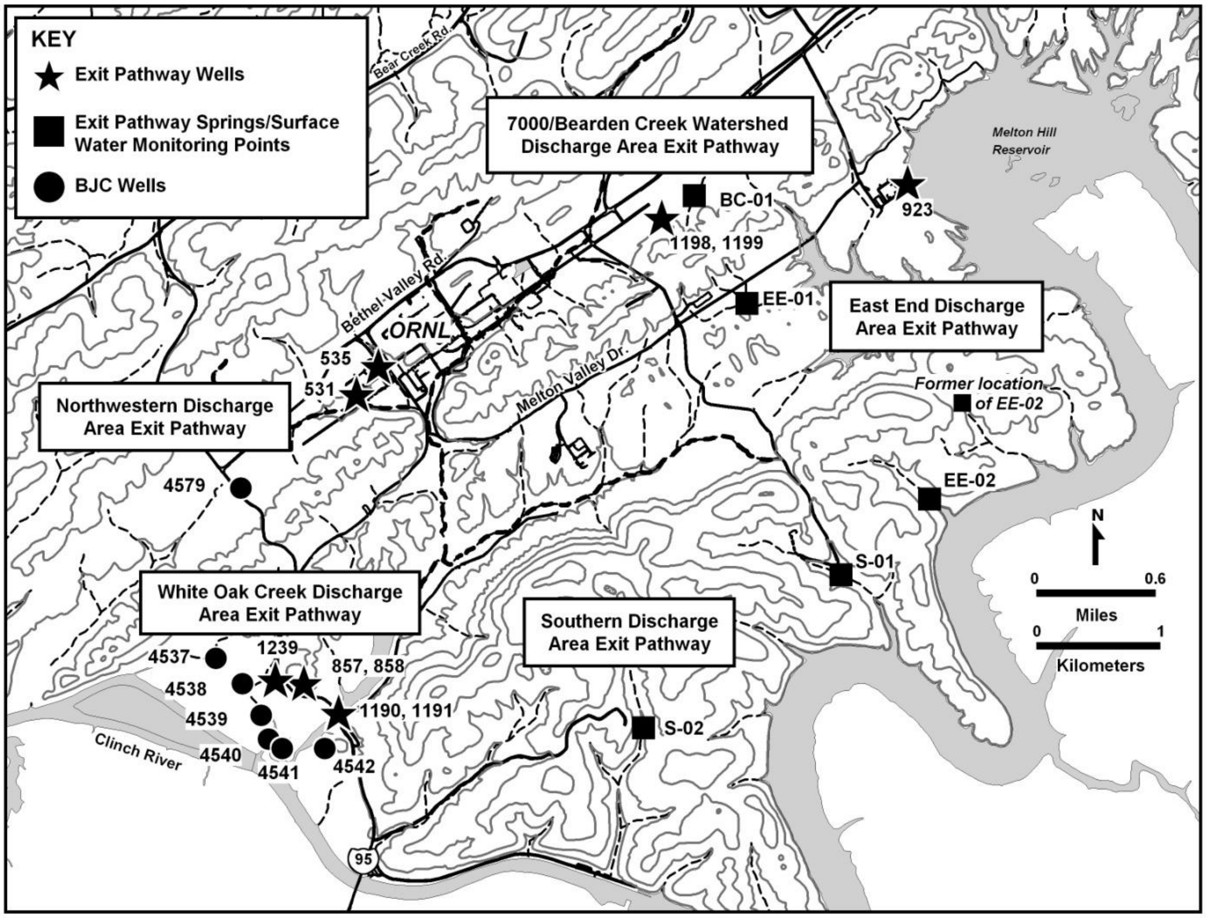

Fig. 5.37. UT-Battelle exit pathway groundwater monitoring locations at ORNL, 2008.

Samples were collected during 2008 from seven multiport monitoring wells (wells 4537, 4538, 4539, 4540, 4541, 4542, and 4579) installed west of the main ORNL campus by Bechtel Jacobs Company. Multiport wells enable multiple shallow to deep water-bearing strata to be monitored. Sampling data generated by the wells were used to supplement the data generated by the WOC Discharge Area Exit Pathway. The data were reviewed by UT-Battelle but are not reported in this document. The multi-port monitoring well analytical data are reported in Sect. 3 of the 2009 *Remediation Effectiveness Report* (DOE 2009) as well as the Oak Ridge Environmental Information System (OREIS).

Samples collected from the UT-Battelle exit pathway groundwater surveillance monitoring points in 2008 were analyzed for VOCs, semivolatile organic compounds, metals (including mercury), and radionuclides (including gross alpha/gross beta activity, gamma emitters, total radioactive strontium, and tritium). Under the monitoring strategy in place per the *Sampling and Analysis Plan*, samples were collected semiannually during wet and dry seasons in 2008.

5.7.2.1.1 Exit Pathway Monitoring Results

Trend analyses were performed on exit pathway monitoring data of interest that exceeded reference standards in 2008. Historical time series data collected from the late 1980s through 2008 were used as the bases for the trend analyses. In some cases there was insufficient data density to perform statistical trend analysis, and trending was not performed when concentrations of naturally occurring metals (i.e., aluminum, iron, and manganese) exceeded reference standards because those constituents are relatively common in the soil and rock composing the Valley and Ridge Physiographic Province and are regularly found in groundwater samples collected from wells at ORNL. Moreover, trend analyses were not performed on 2008 monitoring data that were reported as being undetected by the laboratory, even when minimum detection limits exceeded reference standards (i.e., semivolatile organic compounds atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol).

Samples were not collected at BC-01, S-01, or EE-02 during the dry season because of the continuing climate-based moisture deficit affecting east Tennessee during 2008. Drought conditions also impacted sampling at the BC-01 spring; it was dry during the wet season of 2008. In addition, samples were not collected from Well 535 during the dry season due to construction activities proximal to the well. Groundwater sampling results that exceeded reference standards as well as those that were detected in 2008 are found in Table 2.1 ("Constituents detected in exit pathway groundwater at ORNL, 2008") and Table 2.2 ("Constituents detected in SNS groundwater, 2008") in *Environmental Monitoring on the Oak Ridge Reservation: 2008 Results*. DOE/ORO/2298.

WOC Discharge Area Exit Pathway Results

Monitoring wells 857, 858, 1190, 1191, and 1239 were sampled during April and May and again in August 2008. Three radiological constituents continued to be detected in two wells at concentrations greater than the reference standards: ^{3}H in well 1190 and gross beta activity, total radioactive strontium, and ^{3}H in well 1191. No other radionuclides exceeded reference standards in WOC discharge area wells. A statistically significant downward trend exists for all three radiological constituents at both sampling locations. The following radionuclides were detected in WOC discharge area wells: gross alpha in Well 1239; gross beta activity in wells 857, 858, 1190, and 1239; and ^{3}H in well 857. Lead exceeded the associated reference standard in well 858, but trend analyses indicate a statistically significant downward trend in well 858 lead concentrations. Several other metals (iron, manganese, and aluminum) exceeded their reference standards during 2008, but they are routinely found in the soil, rock, and groundwater at ORNL. A number of other metals were detected at low concentrations in groundwater samples collected from WOC Discharge Area wells; among them were arsenic, barium, cadmium, chromium, lead, silver, sodium, and uranium.

Detection limits for several undetected semivolatile organic compounds exceeded reference standards in samples collected from WOC Discharge Area monitoring points. No other organic compounds were present in concentrations above reference standards in samples collected from WOC Discharge Area wells; however, a common plasticizer [bis(2-ethylhexyl) phthalate] was detected at low, estimated concentrations in wells 858 and 1190 and was detected in wells 1191 and 1239. Diethyl phthalate was also detected in low, estimated concentrations in a sample collected from well 1190 in 2008. Methylene chloride was found at low, estimated concentrations in a sample collected from well 1239, but was also detected in the lab blank indicating that the field sample was probably contaminated by laboratory staff during analysis.

7000/Bearden Creek Watershed Discharge Area Exit Pathway Results

Wells 1198 and 1199 were sampled by UT-Battelle in April and August 2008. Spring/seep BC-01 was not sampled during the wet or dry seasons due to prevailing drought conditions during 2008. No radionuclides exceeded their reference standards during the monitoring period. Tritium was detected in samples collected from both wells. Additionally, gross beta activity was detected in both wells. Iron was found to exceed its reference standard in samples collected from well 1198. Lead was found to exceed its reference standard in one sample collected from well 1199. No trending was performed on lead data for well 1199 due to a lack of data density. Other metals detected at low concentrations in samples collected at monitoring points within the 7000/Bearden Creek Discharge Area include barium, chromium, lead, silver, and uranium.

As noted in Sect. 5.8.1, detection limits for several undetected semi-volatile organic compounds exceeded reference standards. No other organic compounds were detected above reference standards; however, acetone was detected at a low concentration in well 1199. Chloroform and methylene chloride were also detected in wel1 1199 at estimated concentrations.

East End Discharge Area Exit Pathway Results

Well 923 was sampled in May and August 2008. EE-01 was sampled in April and August 2008. EE-02 was sampled once in 2008 during the wet season (May) because there was no flow at that monitoring point during the dry season. No radiological constituents were present above reference standards in samples collected from East End Discharge Area monitoring points, however low concentrations of gross beta activity were detected in the samples collected from EE-01 and well 923 in 2008. Aluminum, iron, and manganese exceeded reference standards in EE-01 and EE-02, and iron and manganese exceeded reference standards in well 923, but those metals are relatively common in the soil, rock, and groundwater at ORNL. Other metals detected at low concentrations in samples collected at monitoring points within the East End Discharge Area include arsenic, barium, cadmium, chromium, lead, and uranium.

As mentioned in Sect. 5.8.1, detection limits for several undetected semivolatile organic compounds exceeded reference standards. Bis(2-ethylhexyl) phthalate and acetone (estimated concentrations) were detected in well 923 in 2008. Plastic well casing materials used in the construction of the well may explain the presence of the phthalate in the sample. Acetone was also found in the trip blank that accompanied the sample collected from well 923. In addition, 2-butanone was detected at a low, estimated concentration in EE-01 during the monitoring period.

Northwestern Discharge Area Exit Pathway Results

Well 531 was sampled in May and August 2008. Due to access restrictions associated with construction activities related to ORNL campus upgrades, well 535 was sampled only once in 2008 (in May). The concentration of gross beta activity exceeded its reference standard at wells 531 and 535 in 2008. A statistically insignificant slight upward trend is observable in the historical gross beta data set for well 531. Detection of gross beta activity in the sample collected from Well 535 in 2008 increased significantly when compared to 2007 results. Despite the increase, a statistically downward trend is observable in the historical gross beta data set for well 535. No other radionuclides exceeded their reference standards at Northwestern Discharge Area monitoring points; however, ^{3}H was detected in a sample collected from well 535 during the wet season. The concentration of lead exceeded its reference standard in a sample collected from well 535. Lead exhibits a statistically significant upward trend in that well. Lead was also reported exceeding its reference standard in well 535 in 2006 and 2007. Aluminum, iron, and manganese exceeded reference standards in the sample collected from well 535, but those metals are common in groundwater at ORNL. Barium and chromium were detected in samples collected from well 531, and arsenic, barium, cadmium, chromium, and uranium were detected in the sample collected from well 535.

Detection limits for several undetected semivolatile organic compounds exceeded reference standards. No other organic compounds were present above reference levels in samples collected from Northwestern Discharge Area monitoring points. Acetone was detected at a low, estimated concentration in a sample collected from well 531. Acetone was also found in the trip blank that accompanied the sample collected from well 531. The plasticizer diethyl phthalate was found in a low, estimated concentration in a sample collected from well 535 during 2008. Plastic well casing materials used in the construction of the well may explain the presence of the phthalate in the sample. In addition, benzoic acid was detected at low, estimated value in a sample collected from well 535.

Southern Discharge Area Exit Pathway Results

Monitoring point S-01 was sampled by UT-Battelle in April 2008, but no samples were collected during the dry season sampling event (August 2008) because the monitoring point was dry. Monitoring point S-02 was sampled in April and August 2008. Aluminum, iron, manganese, and lead exceeded reference standards at S-02. Lead exhibits a statistically significant upward trend in S-02. Those metals are common constituents of earth materials at ORNL. No radiological constituents or organic compounds were present above detection limits in samples collected from Southern Discharge Area monitoring points. Detection limits for several undetected semivolatile organic compounds exceeded reference standards. Barium and uranium were detected in samples collected from S-01. Arsenic, barium, cadmium, chromium, and uranium were detected in samples collected from S-02.

5.7.2.2 Active Sites Monitoring

5.7.2.2.1 Active Sites Monitoring—HFIR

Routine groundwater monitoring at the HFIR site, which had been conducted by the ORNL Research Reactor Division, was discontinued in 2007. The decision to discontinue routine groundwater monitoring was based on a 6 year history of zero detectable subsurface releases of ^{3}H from the reactor's process waste drain system and observations of tritium concentration reductions in samples collected from monitoring wells located downgradient of the release site. It is expected that tritium concentrations should continue to decrease with the possibility of additional precipitation-driven concentration spikes or drought-induced tritium concentration stagnation. The main mass of the tritium plume was observed to continue in its movement from the release area to the south-southeast toward a tributary to Melton Branch and Melton Branch, itself. Tritium release detection at HFIR has continued under the auspices of the *NPDES Radiological Monitoring Plan*. See Sect. 5.5.1.4 for 2008 results. All wells used in the RRD groundwater monitoring program are being maintained for future use as needed.

5.7.2.2.2 Active Sites Monitoring—SNS

Active sites groundwater surveillance monitoring was performed in 2008 at the SNS site. The SNS site was monitored based on the potential for adverse impact on groundwater resources at ORNL should a release occur. Monitoring at the SNS site was performed in 2008 under the draft, biennial (2006–2008) *Operational Groundwater Monitoring Plan for the Spallation Neutron Source Site* (Operational Monitoring Plan) (Bonine, Ketelle, and Trotter, 2007). Operational monitoring was initiated following a 2 year (2004–2006) baseline monitoring program. Operational monitoring will continue throughout the duration of SNS operations.

The SNS site is located atop Chestnut Ridge northeast of the main ORNL facilities. The site slopes to the north and south, and small stream valleys, populated by springs and seeps, lie on the ridge flanks. Surface water drainage from the site flows into Bear Creek, to the north, and into WOC, to the south.

The SNS site is a hydrologic recharge area underlain by geologic formations that form karst geologic features. Groundwater flow directions at the site are based on the generally observed tendency for groundwater to flow parallel to geologic strike (parallel to the orientation of the rock beds) and via karst conduits which breakout at the surface in springs and seeps located down gradient of the SNS site. A sizable fraction of infiltrating precipitation (groundwater recharge) flows to springs and seeps via the karst conduits.

SNS operations have the potential for introducing radioactivity (via neutron activation) in the shielding berm surrounding the SNS linac, accumulator ring, and/or beam transport lines. A principal concern is the potential for water infiltrating the berm soils to transport radionuclide contamination generated by neutron activation to saturated groundwater zones. The ability to accurately model the fate and transport of neutron activation products generated by beam interactions with the engineered soil berm is complicated by multiple uncertainties resulting from a variety of factors, including hydraulic conductivity differences in earth materials found at depth, the distribution of water-bearing zones, the fate and transport characteristics of neutron activation products produced, diffusion and advection, and the presence of karst geomorphic features found on the SNS site. These uncertainties led to the initiation of the groundwater surveillance monitoring program at the SNS site. Objectives of the groundwater monitoring program outlined in the *Operational Monitoring Plan* include (1) determine compliance with applicable environmental quality standards and public exposure limits outlined in DOE Orders 450.1A and 5400.5, respectively, and (2) provide uninterrupted monitoring of the SNS site.

A total of seven seeps/springs and surface water sampling points (seeps/springs S-1, S-2, S-3, S-4, S-5, and SP-1 and surface water point SW-1) were routinely monitored as analogues to, and in lieu of, groundwater monitoring wells during 2008. Locations were chosen based on hydrogeological factors and proximity to the beam line. Figure 5.38 shows the locations of the specific monitoring points sampled during 2008.

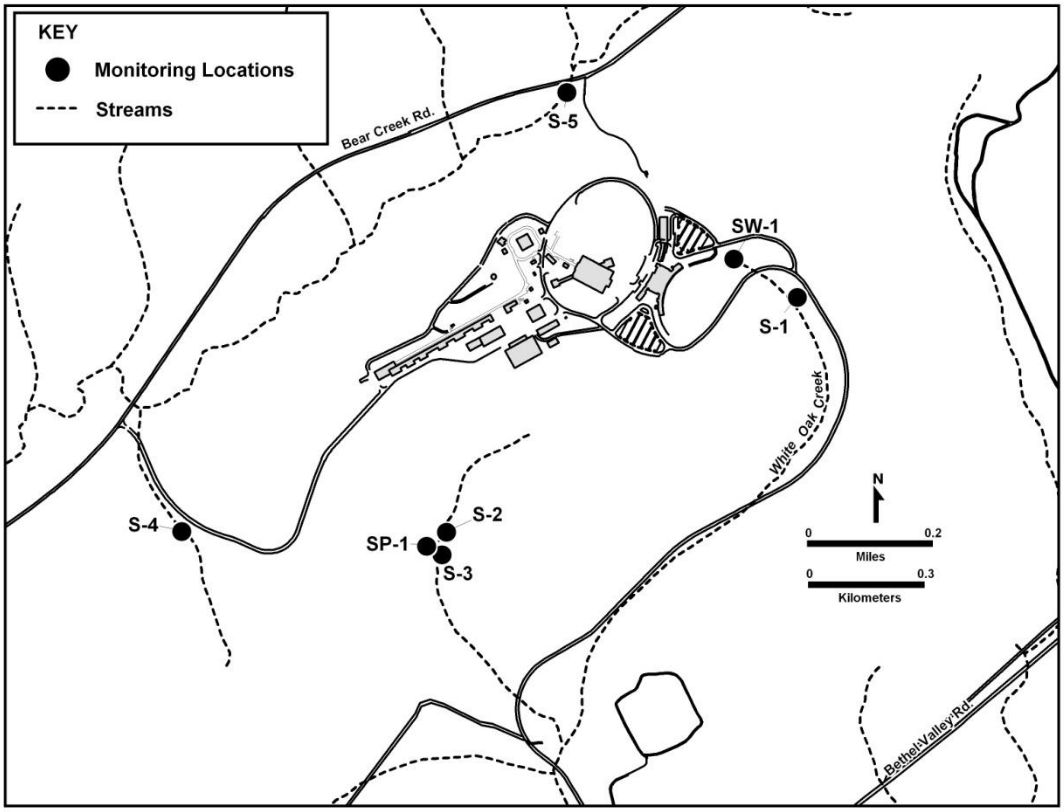

Fig. 5.38. Groundwater monitoring locations at the Spallation Neutron Source, 2008.

Because of the presence of karst geomorphic features at the SNS site, sampling of the seeps/springs was performed to characterize water quality throughout the expected range of flow observed at the selected monitoring locations. Three grab samples were collected from each seep/spring: one sample to represent base flow and two samples to represent higher stage/flow rates (i.e., one representing the rising limb of the storm hydrograph and one representing the recession [falling] limb of the storm hydrograph). Each monitoring point was sampled on a quarterly basis. Given their fate and transport characteristics, ^{3}H and ^{14}C are the principal groundwater constituents of concern at the SNS site. In 2008, samples were collected on a quarterly basis for ^{3}H and ^{14}C analyses. Additionally, samples were collected during wet season base flow conditions for gross activity (alpha and beta) and for selected gamma spectroscopic parameters.

SNS Site Results

Wet season sampling occurred in February, March, and December 2008. Dry season sampling occurred in June and August 2008. The results of the 2008 SNS monitoring effort were compared to reference standards. Gross alpha activity was detected in samples collected during the February 2008 base flow sampling event at monitoring points S-2, S-5 (both regular and duplicate samples collected), and SW-1. The gross alpha concentration reported for the field duplicate sample collected at S-5, 16.5 pCi/L, exceeded the reference standard (15 pCi/L). No other radionuclides exceeded reference standards during the 2008 monitoring period. Gross beta activity was detected in samples collected during the base flow sampling event in February 2008 at monitoring points S-1, S-2, S-3, S-5 (regular sample and field duplicate samples), and SW-1. Bismuth-214 was detected at S-3 during the base flow sampling event in

February 2008. Carbon-14 was detected in a sample collected at monitoring point S-2 during the falling limb sampling event in June 2008 and at monitoring points S-5 (field duplicate sample), SP-1, and SW-1 during the rising limb sampling event in February 2008. Tritium was detected in samples collected at monitoring points S-2 and S-5 (field duplicate sample) in the March 2008 during the falling limb sampling event. The levels reported for ^{14}C and ^{3}H in 2008 were at levels well below their respective reference standards.

Historical SNS ^{14}C and ^{3}H monitoring data (samples collected April 2004–December 2008) were reviewed to gain an insight into whether SNS operations have had an effect on groundwater quality on the SNS site. The vast majority of the ^{14}C and ^{3}H data are "censored" (i.e., below the analytical method limit of detection). However, review of the historical data set revealed that the count of detected ^{14}C and ^{3}H data increased slightly after initiation of SNS operations. Given the number of censored data in the historical data set, a 2×2 contingency table was used along with Fisher's Exact Method to test whether the proportion of detected data is that same based on the operational start date of the SNS facility. The statistical analysis incorporated each flow regime (base flow, rising limb, and falling limb). The results of the analysis indicate that the proportion of detected ^{14}C and ^{3}H data is statistically similar (at a level of significance, α, of 0.05) prior to and after the start-up of the SNS. The results of the statistical analysis and occurrence of very low concentrations of ^{14}C and ^{3}H in groundwater samples collected at the SNS site suggest that the operation of the SNS has had little impact on site groundwater quality.

Review and analysis of the data collected under the *Operations Monitoring Plan* are performed periodically, and modifications to the monitoring protocol are made as needed. The SNS staff is committed to performing groundwater monitoring throughout the duration of its operation.

5.8 Quality Assurance Program

The application of quality assurance (QA)/quality control (QC) programs for environmental monitoring activities on the ORR is essential for generating data of known and defensible quality. Each aspect of an environmental monitoring program from sample collection to data management and record keeping must address and meet applicable quality standards. The activities associated with administration, sampling, data management, and reporting for ORNL environmental programs are performed by the UT-Battelle Environmental Protection and Waste Services Division (EP&WSD).

UT-Battelle utilizes the SBMS to provide a systematic approach for integrating quality assurance, environmental, and safety considerations into every aspect of ORNL environmental monitoring. SBMS is a web-based system that provides a single point of access to all the requirements necessary for staff to safely and effectively perform work. SBMS translates laws, orders, directives, policies, and best management practices into Laboratory-wide subject areas and procedures.

5.8.1 Work/Project Planning and Control

UT-Battelle's Work/Project Planning and Control directives establish the processes and requirements for executing work activities at ORNL. All environmental sampling tasks are performed following the four steps required in the work control subject areas:

- define scope of work,
- work planning: analyzing hazards and defining controls,
- work execution, and
- provide feedback.

In addition, EP&WSD has approved project specific standard operating procedures for all activities which are controlled and maintained through the ORNL Integrated Document directives.

Environmental sampling standard operating procedures developed for ORNL environmental sampling programs provide detailed instructions on maintaining chain of custody, sample identification, sample collection and handling, sample preservation, equipment decontamination, and collection of quality control samples such as field and trip blanks, duplicates, and equipment rinses.

5.8.2 Personnel Training and Qualifications

The UT-Battelle Training and Qualification Management System provides employees and nonemployee staff of UT-Battelle, with the knowledge and skills necessary to perform their jobs safely, effectively, and efficiently with minimal supervision. This capability is accomplished by establishing site-level procedures and guidance for training program implementation with an infrastructure of supporting systems, services, and processes.

5.8.3 Equipment and Instrumentation

5.8.3.1 Calibration

The UT-Battelle Quality Management System includes subject area directives that require all ORNL staff to use equipment of known accuracy based on appropriate calibration requirements that are traceable to an authority standard. The UT-Battelle Facilities and Operations Instrumentation and Control Technical Support tracks all equipment used in ORR environmental monitoring programs through a maintenance recall program to ensure that equipment is functioning properly and within defined tolerance ranges. The determination of calibration schedules and frequencies is based on a graded approach at the activity planning level. EP&WSD environmental monitoring programs follow rigorous calibration schedules to eliminate gross drift and the need for data adjustments. Instrument tolerances, functions, ranges, and calibration frequencies are established based on manufacturer specifications, program requirements, actual operating environment and conditions, and budget considerations.

5.8.3.2 Standardization

EP&WSD sampling procedures, maintained in IDMS, include requirements and instructions for the proper standardization and use of monitoring equipment. Requirements include the use of traceable standards and measurements, performance of routine, before-use equipment standardizations, and actions to follow when standardization steps do not produce required values. Sampling SOPs also include instructions for designating nonconforming instruments as “out-of-service” and initiating requests for maintenance.

5.8.3.3 Visual Inspection, Housekeeping, and Grounds Maintenance

EP&WSD environmental sampling personnel conduct routine visual inspections of all sampling instrumentation and sampling locations. These inspections identify and address any safety, grounds keeping, general maintenance, and housekeeping issues or needs.

5.8.4 Assessment

Independent audits, surveillance, and internal management assessments are performed to verify that requirements have been accurately specified and that activities have been performed conform to expectations and requirements. External assessments are scheduled based on requests from auditing agencies. EP&WSD also conducts internal management assessments of ORNL environmental monitoring procedural compliance, safety performance, and work planning and control. Surveillance results, recommendations, and completion of corrective actions, if required, are also documented and tracked in the Assessment and Commitment Tracking System.

5.8.5 Analytical Quality Assurance

The contract laboratories that perform analyses of environmental samples from the ORR environmental monitoring programs are required to have documented QA/QC programs, trained and qualified staff, appropriately maintained equipment and facilities, and applicable certifications. A competitive award system is used by UT-Battelle to select laboratories that are contracted under basic ordering agreements to perform analytical work to characterize ORNL environmental samples. Oversight of subcontracted commercial laboratories is performed by the DOE Environmental Management Consolidated Audit Program. This program, administered by DOE and subcontractors from across the DOE complex, establishes required internal and external laboratory control and performance evaluation programs and conducts on-site laboratory reviews which monitor the performance of all subcontracted laboratories and verifies all quality requirements are met.

A statement of work for each project specifies any additional QA/QC requirements and includes detailed information on data deliverables, turnaround times, and required methods and detection limits. Blank and duplicate samples are routinely submitted along with ORR environmental samples to provide an additional check on analytical laboratory performance.

5.8.6 Data Management and Reporting

ORNL environmental surveillance and monitoring data management is accomplished using the Environmental Surveillance System (ESS), a web interface data management tool. A software QA plan for ESS has been developed to document ESS user access rules; verification and validation methods; configuration and change management rules; release history; software registration information; and the employed methods, standards, practices, and tools.

Field measurements and sample information are entered into ESS, and an independent verification is performed on all records to ensure accurate data entry. Sample results and associated information are loaded into ESS from electronic files provided by analytical laboratories. An automated compliance screening is performed to ensure that all required analyses were performed, appropriate analytical methods were employed, holding times were met, and specified detection levels were achieved.

Following the compliance screening, a series of checks is performed to determine whether results are consistent with expected outcomes and historical data. QC sample results (i.e., blanks and duplicates) are reviewed to check for potential sample contamination and to confirm repeatability of analytical methods within required limits. More in-depth investigations are conducted to explain results that are questionable or problematic.

5.8.7 Records Management

The UT-Battelle Records Management System provides the requirements for managing all ORNL records. Requirements include creating and identifying record material, scheduling, protecting, and record storage in both office areas and the ORNL Inactive Records Center and destroying records.

The TWPC maintains all of the records specific to the project and the records management program includes the requirements for creating and identifying record material, protecting and storing records in applicable areas, and destroying records.

5.9 Environmental Management Activities

Environmental Management (EM) is the largest DOE program in Oak Ridge, with cleanup programs under way to correct the legacies remaining from years of energy research and weapons production.

ORNL includes facilities located primarily within the Bethel and Melton Valley Watersheds and on the Chestnut Ridge. Historical processes, programs, and waste management practices associated with the mission of the Laboratory have led to environmental contamination in both Bethel and Melton Valleys, and separate RODs have been negotiated and signed by the EPA, TDEC, and DOE to define the selected remedial actions for each watershed.

The main ORNL operations center, located in Bethel Valley, includes key research facilities, primary administrative offices and various waste sites. Bethel Valley is defined by the upper drainage area of White Oak Creek and its tributaries and also includes the neighboring Raccoon Creek watershed and a small portion of Bearden Creek. Portions of Bethel Valley have been contaminated by laboratory-related chemicals and radionuclides through a number of release mechanisms (chemical spills, leaking lines, landfills, pits and sumps below buildings, basins, and burn pits). Mobile contaminants primarily leave the Bethel Valley Watershed via White Oak Creek. These contaminants travel from the Bethel Valley

Watershed to the Melton Valley Watershed, where further contaminants may enter White Oak Creek. Discharges to White Oak Creek are then released over White Oak Dam and into the Clinch River.

The Bethel Valley ROD specifies a variety of different remedies for waste areas, including decontamination and decommissioning buildings, capping buried waste areas, removing contaminated sediments and soils, removing or remediating contaminated tanks and pipelines, and addressing areas of contaminated groundwater. The ultimate goals are to protect human health and to reduce the amount of contaminants in White Oak Creek to acceptable levels.

The Melton Valley watershed occupies approximately 405 ha in the southern portion of the ORNL. Waste management was historically the principal activity that took place in Melton Valley, but research and development for two nuclear reactors also occurred there. In addition, the watershed was used in the 1950s and 1960s as the Atomic Energy Commission's Southeastern Regional Burial Ground for radioactive wastes from more than 50 other facilities. Portions of the watershed have been contaminated with a variety of wastes, including liquid and solid LLW through past disposal practices.

The *Melton Valley Remedial Action Report*, which documents remediation activity completion, was approved in September 2007 as described in the *Oak Ridge Reservation Annual Site Environmental Report 2007* (DOE 2008a). The site is now subject to routine monitoring and maintenance to ensure the remediation actions remain effective.

5.10 2008 ORNL Environmental Management Program Activities

5.10.1 Remedial Action Work Plan for Activities in Bethel Valley

In FY 2008, a Remedial Action Work Plan was submitted to regulators to describe soil and sediment characterization activities in Bethel Valley as set forth in the Bethel Valley ROD. The primary objectives of the plan are to define the scope of remediation, identify the controls that will be implemented to protect workers and the environment, and describe the methods of accomplishment to be used to execute the work. The plan further proposes a statistically based soil characterization strategy to acquire additional data, following remedial actions, to ensure that the remedial action objective requirements are met.

5.10.1.1 Waste Handling Plan

The *Waste Handling Plan* was prepared in FY 2008 as a primary document to support requirements under the Federal Facility Agreement. The plan presents the methods that will be used to manage and dispose of waste materials generated.

5.10.1.2 Molten Salt Reactor Experiment Fuel Removal

Nuclear fuel removal from a storage tank at the Molten Salt Reactor Experiment (MSRE) facility was completed in FY 2008. The MSRE facility operated from 1965 to 1969 and was fueled by molten salt that flowed through the reactor chamber, where the nuclear chain reaction produced heat. When the reactor was shut down, the molten salt and the flush salt were drained into three fuel storage tanks located in an underground, concrete-shielded drain tank cell adjacent to the reactor cell.

More detailed information on these 2008 Environmental Management activities is available in the *Clean Up Progress Report for 2008* (DOE 2009x).

5.10.2 Project to Resolve Safety and Security Issues in Building 3019

The goal of the Building 3019 Project at ORNL is to resolve legacy safety and security issues associated with ^{233}U stored in the building. In CY 2007, an environmental assessment for the project was completed and a Finding of No Significant Impact under the NEPA process was issued. During CY 2008, Isotek was active in planning for the design and construction of the operations and facilities needed to accomplish project objectives.

5.11 ORNL Waste Management

5.11.1 ORNL Wastewater Treatment

At ORNL, approximately 120 million gal of wastewater were treated and released at the PWTC in 2008. In addition, the liquid LLW evaporator at ORNL treated 125,000 gal of waste, and a total of 2.3 billion m^3 of gaseous waste were treated at the ORNL 3039 Stack facility. The waste treatment activities supported both EM and Office of Science mission activities in a safe and compliant manner.

5.11.2 Transfer of ORNL Newly Generated Waste Responsibilities

Since the late 1990s, waste management responsibilities at ORNL have been a shared responsibility between the DOE Office of Science (and its prime contractor, UT-Battelle) and DOE EM (and its prime Contractor, Bechtel Jacobs Company). UT-Battelle was responsible for taking appropriate steps in planning for waste generation in its research, development, and operational activities (termed "newly generated" waste), including characterizing and packaging the waste in accordance with requirements from the DOE Environmental Management Program. UT-Battelle was also responsible for completing the required waste documentation and turning the documentation over to Bechtel Jacobs Company for review and acceptance. After completing the waste acceptance step, Bechtel Jacobs was then responsible for picking the waste up from ORNL, transporting it to an appropriate waste storage facility, and arranging appropriate treatment and disposition of the waste in accordance with regulatory requirements.

In recent years, DOE has been changing the division of waste management roles and responsibilities at many of its sites, moving to a process where the waste generator has "cradle to grave" responsibility of the waste it generates. This change is intended to fully incentivize waste generators in finding new ways of doing business to eliminate and/or reduce waste generation. If the waste-generating organization is fully responsible for managing the waste it generates, it can also experience the full benefit in making investments in new technology and equipment to eliminate the generation of waste streams.

In 2008, the DOE decided to begin to transition the shared responsibility at ORNL and to make the DOE Office of Science and UT-Battelle fully responsible for the management of hazardous, low-level radioactive, and mixed hazardous and radioactive wastes they generate. The transition of responsibility was set to conclude October 1, 2008 (the start of FY 2009). After that date, UT-Battelle would be fully responsible for managing its waste streams, including off-site transport, treatment, and disposal of the waste it generates.

In order to manage the transition process, UT-Battelle, Bechtel Jacobs, and DOE jointly developed a detailed transition plan that listed and scheduled the actions that would be needed to accomplish the noted transfer of responsibility. Transition managers and support staff were identified to perform the work, a process that took about 9 months to complete. As scheduled, the transfer of responsibility happened on October 1, 2008. Transfer of the ORNL Hazardous Waste Management Area did not happen until about a month later, in order to allow time for changes to be made in associated permits; it had no adverse effect on the transfer process.

Beginning October 1, 2008, UT-Battelle is now fully responsible for management of the hazardous, low-level radioactive, and mixed wastes that it generates in performing research, development, and operational activities at ORNL. Only specialized waste streams, such as transuranic wastes or wastewaters that can be treated by on-site wastewater treatment facilities (which are jointly used by the different DOE programs at ORNL and are operated by DOE EM) are still handed off to Bechtel Jacobs Company for disposal.

5.11.3 Transuranic Waste Processing Center

TRU waste-processing activities carried out for DOE by EnergX address the three remaining waste streams stored at ORNL—contact-handled (CH) solids/debris, remote-handled (RH) solids/debris, and RH sludge—and involve processing, treatment, repackaging, and off-site transportation and disposal at either the Nevada Test Site or the Waste Isolation Pilot Plant in New Mexico.

The TWPC was designed and constructed to treat and dispose 900 m^3 of RH sludge, 550 m^3 of RH-TRU/alpha LLW solids, 1,600 m^3 of RH LLW supernate, and 1,000 m^3 of CH TRU/alpha LLW solids currently stored in Melton Valley. The forecast for waste quantities to be processed at the TWPC has been updated to include the latest estimates: 2,000 m^3 of RH sludge, 700 m^3 of RH-TRU solids, and 1,500 m^3 of CH-TRU solids. CH-TRU processing started December 2005 and RH-TRU processing started in May 2008. During 2008, 224.1 m^3 of CH-TRU waste was processed and 8.6 m^3 of RH-TRU waste was processed.

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