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's mission is to provide solutions to America's scientific challenges, and a diverse, highly qualified staff of more than 4,800 continues a rich tradition of scientific exploration to support this mission. In addition, more than 3,000 visiting scientists spend 2 weeks or longer in Oak Ridge each year at the 12 advanced research user facilities made available to scientists all over the world. As an international leader in a range of scientific areas that support DOE's mission, ORNL has six major mission roles: neutron science, energy, high-performance computing, systems biology, materials science at the nanoscale, and national security. ORNL's leadership role in the nation's energy future includes hosting the U.S. project office for the ITER international fusion experiment and the Office of Science−sponsored Bioenergy Science Center. During 2010 UT-Battelle, Wastren Advantage, Inc. (WAI), and Isotek operations were conducted in compliance with contractual and regulatory environmental requirements with the exception of two interrelated exceedances of National Pollutant Discharge Elimination System permit discharge limits. There were no notices of violation or penalties issued by the regulatory agencies.

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

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) and is managed for the DOE by UT-Battelle, LLC, a partnership of the University of Tennessee and Battelle Memorial Institute. The main ORNL site occupies approximately 1,809 ha (4,470 acres) and includes facilities in two valleys (Bethel and Melton) and on 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 supports DOE's mission and is completing a $350 million project to provide a modern campus for the next generation of great science. The $1.4 billion Spallation Neutron Source (SNS), located adjacent to the new Center for Nanophase Materials Sciences, combines with one of the nation's largest research reactors to continue the Laboratory's reputation as a leader in the study of materials.

With unmatched capacity for open scientific research, Oak Ridge's Jaguar supercomputer has broken the "petaflop" barrier, or 1,000 trillion mathematical calculations per second, making it possible to model the most complex scientific problems. ORNL's Bioenergy Science Center, funded by DOE, is developing new forms of cellulosic ethanol that can be grown on millions of acres of marginal land with little need for water or fertilizer.

UT-Battelle also manages several facilities located off the main ORNL campus. These include several buildings and trailers located at the Y-12 Complex, at the American Museum of Science and Energy in the city of Oak Ridge, and several other locations around the Oak Ridge vicinity.

ORNL 2011-G00538/chj

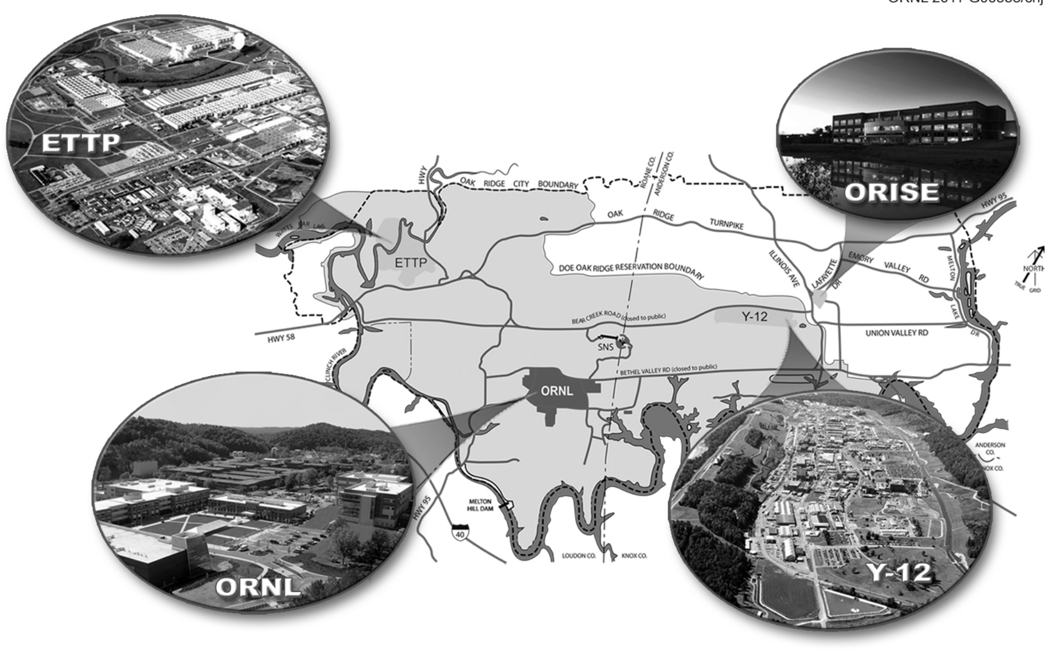

Fig. 5.1. Location of ORNL within the ORR and its relationship to other local DOE facilities.

The National Transportation Research Center (NTRC), an alliance among UT-Battelle; 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 (6-acre) site in the Pellissippi Corporate Center and is leased to UT-Battelle and the University of Tennessee separately by Pellissippi Investors LLC.

The Transuranic Waste Processing Center (TWPC), managed by Wastren Advantage Inc. (WAI) for DOE, is located on the western boundary of ORNL on about 10 ha (25 acres) of land adjacent to the Melton Valley Storage Tanks along State Route 95. The TWPC's mission is to receive transuranic (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 debris waste in December 2005, and the remote-handled debris waste in May 2008. Based on the definition of TRU waste, some waste being managed as TRU is later determined to be liquid low-level waste (LLW) or mixed low-level waste (MLLW).

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:

- process, downblend, and package the DOE inventory of ^{233}U (and the 715 gal of ^{233}U-contaminated thorium nitrate stored in Tank P-24) to eliminate the need for safeguards, security, and nuclear criticality controls and to render these materials suitable for safe disposition;
- remove the ^{233}U material from the Building 3019 Complex;
- transport the downblended material to one or more licensed disposal facilities; and
- place the Building 3019 Complex in safe and stable shutdown condition.

During 2010, Isotek continued to manage the Building 3019 Complex in a surveillance and maintenance mode and design the facilities and operations needed to accomplish the above objectives. At the end of 2010, 90% design had been achieved and remaining design comments continued to be resolved. In January 2010, an environmental assessment for the U-233 Material Downblending and Disposition Project was completed, and a Finding of No Significant Impact under the National Environmental Policy Act (NEPA) process was issued [see *Final Environmental Assessment for U-233*

Material Downblending and Disposition Project at the Oak Ridge National Laboratory, Oak Ridge, Tennessee (DOE 2010)].

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

Approximately 5 ha (12 acres) 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 private companies doing research at ORNL, partner universities, start-up companies built around ORNL technologies, and ORNL contractors to conduct business within a short distance of ORNL researchers and DOE user facilities such as the SNS, the Center for Nanophase Materials Sciences, and the High Flux Isotope Reactor (HFIR). Construction of the first ORSTP facility, Pro2Serve's 115,000-ft^2 National Security Engineering Center, was completed in 2009, and the company has moved into the building. In addition, the former Building 2033, which has been leased to Halcyon, LLC, and is now known as the Halcyon Commercialization Center (HCC), and continues to attract tenants. The largest tenant in the HCC is Roane State Community College, which is offering job training classes on site in the areas of carbon fiber and solar energy. Other tenants in the HCC include several consulting firms and a carbon fiber manufacturer that is partnering with ORNL for research. Expansion of the ORSTP will continue as more environmental cleanup in ORNL's central campus is completed. The EPA has designated ORSTP lessees as collocated workers since these tenants are located on DOE property and are issued security badges to access the facilities. These badges provide access to the ORSTP facilities and, during regular business hours, the ORNL Conference Center (Building 5200) only. Access to any other ORNL facility requires additional DOE approval.

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, WAI, Bechtel Jacobs Company (BJC), and Isotek have implemented Environmental Management Systems (EMSs), modeled after the International Organization for Standardization (ISO) standard 14001:2004 (ISO 2004), 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 and June 2010 by NSF International Strategic Registrations, Ltd. No nonconformities were identified during the most recent reregistration audit. Detailed information on the UT-Battelle EMS is provided in Sects. 5.2.1 through 5.2.1.7. WAI's EMS for activities at TWPC was registered to the ISO 14001:2004 Standard by NSF International Strategic Registrations, Ltd., in May 2008. NSF International Strategic Registrations, Ltd., conducted a Surveillance Audit for the WAI EMS program in May 2010, and no nonconformities or issues were identified and several significant practices were noted. Section 5.2.2 describes the WAI EMS and associated implementation activities. In June 2009, DOE conducted an external validation audit and concluded "that Isotek Systems, LLC (Isotek) has implemented an Environmental Management System (EMS) that is consistent with the requirements of DOE Order 450.l A, Environmental Protection Program." This validation is good through 2012.

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.

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 "plan-do-check-act" cycles. 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 5.2 depicts the relationship between EMS and ISMS.

Fig. 5.2. The relationship between the UT-Battelle Environmental Management System and the Integrated Safety Management System.

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.

The DOE Office of Health, Safety and Security (HSS) annual environmental progress reports on implementation of EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management (Executive Order 2007) and Office of Management and Budget's Environmental Stewardship Scorecard gave UT-Battelle an EMS scorecard rating for FY 2010 of green, indicating full implementation of EO 13423 requirements.

5.2.1.2 UT-Battelle Policy

The UT-Battelle environmental policy statements are part of the UT-Battelle Policy for ORNL (Fig. 5.3), which 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.

Fig. 5.3. ORNL environmental policy statements.

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. Environmental aspects associated with UT-Battelle activities, products, and services have been identified 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,
- energy use/intensity,
- greenhouse gas emissions,
- 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 laws and 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. UT-Battelle's environmental compliance status is discussed in Section 5.3.

5.2.1.3.3 UT-Battelle Objectives and Targets

To improve environmental performance, UT-Battelle has established and implemented objectives, targets, and performance indicators for appropriate 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 mission. These objectives and targets were entered into a commitment tracking system and tracked to completion. In 2010, Laboratory-level and organization-level objectives and targets focused on chemical inventory reduction, energy conservation, waste minimization, and recycling. Thirteen EMS objectives and targets were identified and accomplished in 2010 and are described below.

- **Objective: Reduce environmental impact associated with two division activities**
- **Targets:** Specific line organization targets, actions, responsible persons, and due dates. Project specifics are captured in an internal tracking system

- **Objective: Update ORNL Executable Plan to implement requirements of DOE Order 430.2B**
- **Target:** Complete Executable Plan and submit to DOE

- **Objective: Reduce energy intensity**
- **Target:** By 2015, achieve no less than a 30% energy intensity reduction across the contractor's facility/site in accordance with the executable plan

- **Objective: Maximize use of renewable energy**
- **Target:** Maximize installation of on-site renewable energy projects at the contractor's facility/site where technically and economically feasible to acquire at least 7.5% of each site's annual electricity and thermal consumption from on-site renewable sources by FY 2010

- **Objective: Reduce potable water consumption**
- **Target:** Reduce potable water consumption at least 16% relative to the baseline of the facility/site's potable water consumption in FY 2007

- **Objective: Maximize the acquisition and use of environmentally preferable products in the conduct of operations**
- **Target:** A number of actions are being taken to continue UT-Battelle's performance in this area. Project specifics are captured in an internal tracking system

- **Objective: Upgrade building management systems**
- **Target:** Improve HVAC control in 4500N, 4500S, 4501/4505, 4508, 5500, and 6000

- **Objective: Advance metering and energy awareness campaign**
- **Target:** Installation of advanced electricity metering system and implementation of Sustainable Energy Education and Communication campaign

- **Objective: Transportation/fleet management requirements**
- **Target:** Specific targets are contained in DOE O 430.2B

- **Objective: Sustainable design/high-performance building requirements**
- **Target:** Specific targets are contained in DOE O 430.2B

- **Objective: Reduce or eliminate the generation and/or toxicity of waste and other pollutants at the source through pollution prevention**
- **Target:** Specific targets have been established and met by the ORNL Pollution Prevention Program

- **Objective: Reduce or eliminate the environmental impacts of electronic assets**
- **Target:** Specific targets were established and met by enabling energy savings features on computers and recycling excess electronic equipment

- **Objective: Reduce degradation and depletion of environmental resources through post-consumer material recycling**
- **Target:** Specific targets have been established and met by the ORNL Pollution Prevention Program

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 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 outlined in Fig. 5.3. Information on UT-Battelle's 2010 compliance status, activities, and accomplishments is presented in Sect. 5.3.

Environmental protection staff provides critical support services to maintain a proper balance between cost and risk in many areas, including the following:

- waste management,
- NEPA compliance,
- air quality compliance,
- water quality compliance,
- U.S. Department of Agriculture (USDA) compliance,
- environmental sampling and data evaluation, and
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) interface.

The UT-Battelle staff also includes experts who provide critical waste management and disposition support services to ORNL research, operations, and support divisions. These 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 UT-Battelle's newly generated waste;
- the hazardous material spill response team, which is the first line of response to hazardous materials spills at ORNL and controls and contains such spills until the situation is stabilized; and
- the Environmental Management Program Office (EMPO) coordinates and directs specific CERCLA decommissioning and demolition work being done on the UT-Battelle site. EMPO activities include

developing and implementing interface agreements applicable to multiple contractors, CERCLA Applicable or Relevant and Appropriate Requirements, and project work plans.

5.2.1.4 UT-Battelle Sustainable Campus Initiative

"The Sustainable Campus for the Year 2018 Initiative" is an ORNL-wide effort that builds upon the Laboratory's strength as a premier science and technology organization in integrating energy efficiency, cutting-edge technologies, and operational and business processes to achieve sustainability. UT-Battelle implemented this multidisciplinary initiative to provide an overarching support structure to capture current efforts, to accelerate future implementation, and to provide a comprehensive sustainable vision of ORNL in the future. The ultimate goal is to achieve benchmark sustainability in campus operation and in the research, development, and deployment of key technologies by 2018. The initiative was launched in October 2008 and continues a modernization program that began in 2002.

A diverse team, representing multiple organizations and areas of expertise, was formed to develop and implement a roadmap to achieve a sustainable campus at ORNL by 2018. Implementation of this roadmap began in 2009. Four components collectively build a base for the roadmap. The first component, foundational methods, includes historically proven methods such as energy efficiency in buildings and processes, zero process water discharge, zero solid waste discharge, zero adverse health effects, recycle and reuse strategies, and employee and family engagement. The second component, known technology, includes recently proven methods such as renewable energy sources, green building design, hybrid vehicles, and certain alternative fuel applications. The third component, leading-edge technology, involves bringing together known technologies in innovative ways and includes methods currently being tested such as solar covered parking with plug-in hybrid electric vehicles (PHEVs), solar application with highly efficient buildings, innovative transportation technology, advanced building design technologies, and biofuel developments. The fourth component, transformational technology, is forward-thinking high-impact demonstration projects identified by appointed panels of scientists.

Sustainable successes achieved at ORNL during 2010 are discussed in the following sections (Fig. 5.4). For more information see http://sustainability-ornl.org.

ORNL 2011-G00719/chj

Fig. 5.4. Demolition activities at Building 2000.

5.2.1.4.1 Modernization and Facilities Revitalization

In 1943, more than 6,000 workers began construction of some 150 buildings that became known as ORNL. More than 65 years later, a massive effort to modernize and revitalize the Laboratory continues. Since 2000, more than 2,000,000 ft^2 of aged, expensive-to-maintain buildings have been vacated and some 1,500,000 ft^2 of new and renovated space has been constructed. The average age of ORNL facilities has decreased from 42 to 32 years. A combination of federal, state, and private financing has supported the construction of the new facilities.

During 2010, modernization and revitalization efforts at ORNL provided new facilities, enhanced staff interaction and space utilization, and upgraded utility systems and demolished old, expensive-to-maintain facilities (Fig. 5.5).

ORNL 2011-G00720/chj

Fig. 5.5. Modernization and facilities revitalization.

During 2010, UT-Battelle made substantial progress toward completion of new research facility and infrastructure projects in the East Campus. Occupancy of the Materials and Chemical Sciences Building [commonly known as the Multiprogram Laboratory Facility (MLF)], a three-story building housing 160,000 ft^2 of research laboratory and support space, is scheduled for summer 2011. Construction of critical parking and utility infrastructure projects for the Bethel Valley East Campus continued in 2010, including replacement of a 3 million gallon reservoir, which has been in continuous use since 1948, that provides potable and fire water to ORNL and improvements to electric power equipment and distribution systems.

Much work remains for modernization of the Bethel Valley Central Campus including completion of DOE Environmental Management Program (EM) demolition and remediation followed by phased redevelopment of the area.

Modernization activities completed during the year included the following:

- expansion to the Advanced Microscopy Laboratory located on the southwest side of the existing building to house a number of vibration-sensitive instruments used for materials characterization,
- construction of the West Campus Greenhouse was substantively completed,
- construction on Chestnut Ridge of the Guest House commenced, and a new state of Tennessee building, the Joint Institute for Neutron Sciences, was commissioned, and
- construction continued on the American Reinvestment and Recovery Act (ARRA)–funded Melton Valley Maintenance Facility, which will consolidate maintenance operations in Melton Valley.

Integrated Facilities Disposition Initiative at ORNL

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, Science, and Nuclear Energy and the National Nuclear Security Administration (NNSA) that will complete the environmental cleanup of the ORR and 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 modernization and the continued enhancement of complex facilities and infrastructure.

Although the details of the IFDP baseline plan for the next 10 years have yet to be finalized, it is expected that the remaining 95 Office of Science facilities identified in the approved Critical Decision-1 will be demolished by the IFDP in future years.

During FY 2010, ORNL's complementary Excess Facilities Deactivation and Disposition Program activities focused on readying facilities for transfer to the IFDP for demolition. As noted, the influx of ARRA funding accelerated the IFDP demolition schedule and, as a result, operations in several Office of Science facilities had to be relocated, facilities had to be cleaned out to meet space return criteria for transfer, and the real property asset information management system had to be updated to reflect the facility status change. Concurrently, these facilities were deactivated and all utilities isolated and air-gapped prior to transfer and demolition. Efforts over the 10-year planning period will continue to support the IFDP but will expand to support the UT-Battelle master plan for the 7000 area. Efforts will focus on clean out and demolition of facilities to support new facilities construction.

Over the next 10 years, a total of approximately 172 facilities, structures, and trailers will be demolished by these two programs.

5.2.1.4.2 Energy Management and Conservation

The UT-Battelle Energy Management Program makes 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 program also includes 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 of 2005 established the goal of reducing building energy intensity using 2003 as the baseline year (EPAct 2005). 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. 5.6, UT-Battelle energy conservation efforts have exceeded those levels with a 16.9% building energy intensity reduction between FY 2003 and FY 2010. In fact, UT-Battelle has realized energy intensity reductions at ORNL of about 37% since 1985.

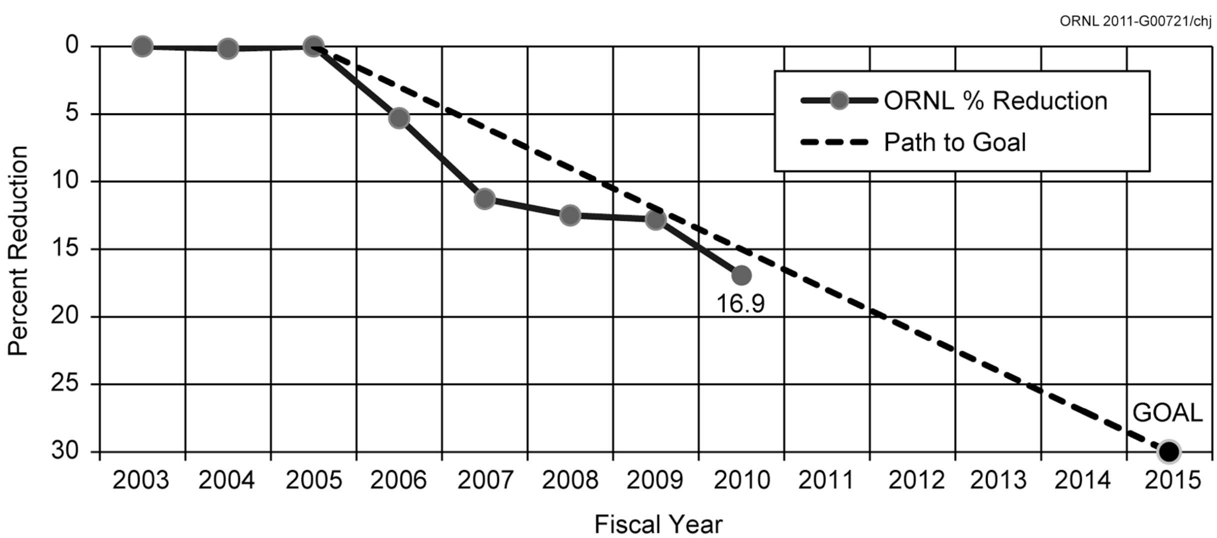

Fig. 5.6. ORNL Building Energy Reduction versus the DOE Transformational Energy Action Management Goal.

UT-Battelle is making steady progress toward the required reduction in energy intensity of 30% by FY 2015 from a FY 2003 baseline. This will be accomplished through continued construction of new facilities and demolition of legacy facilities. Aggressive energy reduction activities in current facilities will be combined with ongoing audit and Energy Conservation Measures (ECM) program and new efforts in building commissioning. The ESPC Biomass Steam Plant project is on schedule for completion, and projections show attaining the energy intensity target on or in advance of the deadline. Additional actions for FY 2011 will focus on planning for future projects in high-energy mission-specific (HEMS) facilities at ORNL. Although these facilities have been granted exclusions from the energy intensity reduction goals, they are major contributors to the greenhouse gas (GHG) emissions at ORNL. It is appropriate to develop a strategy for energy reductions in these facilities since energy consumption in them makes up a significant portion of the GHG reductions needed.

Based on FY 2010 data, Buildings Category energy usage at ORNL is 1.29×10^{12} BTUs, accounting for ORNL excluded facilities as defined by the Energy Policy Act of 1992 (EPAct 1992). Given a building area of 4,272,150 gross square feet (GSF), the FY 2010 estimated energy intensity is 302,810 BTUs/GSF, which represents a 4.74% reduction compared to FY 2009. When compared to the EPAct 2005 baseline year of FY 2003, this represents a 16.93% reduction to date.

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.

Table 5.1 shows a summary of actual and planned overhead funding for the categories shown based on the Annual Consolidated Energy Data Report (CEDR) Tab 5 data. It is understood that all out-year projects and their costs estimates identified in the CEDR Tab 5 are considered planning information and may change based on emerging requirements and evolving priorities.

Table 5.1. Summary of Overhead Funded Projects in CEDR Tab 5 ($K)

Category:	FY 2010 Actual	FY 2011 Plan	FY 2012 Projected	FY 2013 Projected
Water	13	50	100	100
Energy Efficiency (non-data centers)	345	750	600	500
Energy Efficiency (data centers)	0	0	200	200
High-Performance Sustainable Buildings (HPSB)[a]	120	120	120	120
Metering	100	100	100	100
Cool Roofs	0	0	0	0
Behavior Change	150	150	150	150
Lighting	170	200	100	100
High-Energy Mission-Specific Buildings	0	0	200	200
Sustainable Campus Initiative Management and Roadmap Project Funding	2,928	2,100	2,100	2,100
Total	3,826	3,470	3,670	3,570

[a]HPSB – only include in this category projects that are specific to meeting the Guiding Principles and contain a mix of tasks such as lighting, meters, roofing, HVAC, etc.

Sustainable Building Design

As discussed in Section 5.2.1.4.1, UT-Battelle continued to make significant progress on the implementation of the Facility Revitalization Project at ORNL during 2010.

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**.** In 2010, construction continued on two additional facilities, the Melton Valley Maintenance Facility (25,000–30,000 ft^2) and the Chemical and Material Science Building (160,000 ft^2). This will result in an additional 190,000 ft^2 of sustainable construction in FY 2011.

Energy Savings Performance Contracting

At ORNL, the ESPC with Johnson Controls, Inc. (JCI) is the primary mechanism for achieving the goals established in the Executive Order 13423. A Delivery Order with JCI was awarded in July 2008. Most ECMs are in place, with the balance expected to be completed during FY 2011. ESPC/ECMs include steam system decentralization, building management system improvements, mechanical equipment upgrades, and a biomass steam production system. In recent years, additional ECMs, not addressed by the ESPC, have been implemented to further reduce energy usage. These additional measures include Energy Star assessments and related actions; improvements in heating, ventilation, and air-conditioning (HVAC) equipment; lighting improvements; replacing motors with more efficient units; and improving the efficiency of the steam distribution system.

Table 5.2 demonstrates the ESPC goals implemented to meet or exceed Transformational Energy Action Management (TEAM) goals.

The status of the ECMs is outlined in Table 5.3.

Table 5.2. Energy savings performance contracting goals (%)

	TEAM goal[a]	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

[a]TEAM: Transformational Energy Action Management Initiative

Table 5.3. Energy conservation measure status

Central Steam Plant Biomass Solution	Construction will be completed in mid-FY 2011.
Select Steam Decentralization of Remote buildings	Design and procurements are nearly complete; installation of equipment in the 7000 area is complete; and commissioning has begun on the new Melton Valley Steam Plant.
Building Management System Upgrade	Design and procurements are finalized and installation of equipment is under way.
Advanced Electric Metering	Installation of equipment is at 90%.
Comprehensive HVAC Upgrade	Design is being finalized and procurements have begun.
Energy-Efficient Lighting Upgrade	Complete
Water Conservation	Domestic water projects are complete. The once-through cooling project is designed with completion scheduled for FY 2011.

Energy Audits

The energy audit program is progressing with audits completed in FY 2009 and FY 2010 covering more than 60% of the ORNL campus square footage. Potential ECMs developed during these audits are being vetted to determine which actions are most cost-effective and complementary to the Laboratory mission and existing building use and plans. Once this evaluation is completed, additional audit-related ECMs will be identified for FY 2011 implementation. Additionally, as described elsewhere in this report, projects are being evaluated and will be included in the Consolidated Energy Data Report (CEDR) upon Laboratory management review and approval.

Planning will begin in FY 2011 for addressing energy consumption in HEMS facilities at ORNL. These include the SNS, High Flux Isotope Reactor (HFIR), Holifield Radioactive Ion Beam Facility (HRIBF), and the supercomputing facilities. In the past these facilities have been given exclusions from the energy intensity reduction requirements, in recognition of the fact that the science mission energy loads in these facilities were difficult to modify without directly impacting mission. The Federal GHG target goals that were recently established as a result of Executive Order (EO) 13514, Federal Leadership in Environmental, Energy, and Economic Performance, do not allow for exclusion of these high-energy facilities. The goal of EO 13514 is "to establish an integrated strategy towards sustainability in the Federal Government and to make reduction of GHG a priority for Federal agencies."

Since these critical loads must be included in reduction goals in FY 2011, UT Battelle will develop a process that will accommodate energy saving projects in these facilities, while continuing to acknowledge the following.

- Mission critical outcomes must be maintained.
- No funding mechanism for "self-financing" is in place.
- Due to operational and research complexities, the planning horizon for projects affecting these facilities represents a long-term commitment.

A multi-organization team will develop a process for vetting potential energy savings projects, identifying funding mechanisms, and integrating the projects within the planning horizon of the respective facilities.

Electric Metering

As required by DOE Order 430.2B, Departmental Energy, Renewable Energy and Transportation Management, UT-Battelle implemented an Electrical Metering Plan in 2006. An updated plan was submitted in August 2010. This update shows significant progress toward the electrical metering requirements, with completion anticipated ahead of schedule. A copy of the latest update, submitted in August 2010, is available as an attachment to the 2010 ORNL Site Sustainability Plan, which can be found at http://sustainability-ornl.org/sc18/. Metering systems represent the first critical component of a comprehensive energy data center and energy management plan.

Based on information provided in the latest metering plan, ORNL has approximately 450 structures, many of which are storage sheds, warehouses, etc., with minimal energy use. Approximately 120 buildings represent 70% of the space and 80% of the total energy usage on the ORNL campus.

- Using DOE criteria, 42 buildings at ORNL should have advanced meters. To date, 30 meters have been installed, leaving about 29% of eligible buildings to be metered in 2011.
- The latest Metering Plan, submitted to DOE in August 2010, shows progress on all buildings initially deemed appropriate for metering.
- Four buildings have been, or are slated to be, demolished.
- One building is no longer under ORNL control – having been transferred to Community Reuse Organization of East Tennessee (CROET), a regional economic development entity.
- The metering installation in three buildings is on hold, awaiting an appropriate power outage, given research underway in those buildings.

Steam metering was initiated in FY 2010 and will continue in FY 2011. A water metering plan is being developed, including a table prioritizing water meter installation that will be implemented as funds are identified. The water meter installation project is planned to be completed in FY 2016.

A comprehensive energy data system utilizing data from electricity, water, gas, and steam metering will enable UT-Battelle to improve conservation efforts and meet a variety of DOE and EO goals. This system is being piloted in FY 2011.

Green Transportation

UT-Battelle performs a broad range of green transportation–related research and development activities at ORNL and also embraces current technologies and techniques to reduce fuel consumption. UT-Battelle has implemented a multi-pronged approach to green transportation: (1) encouraging personnel to walk and to ride bikes through innovative campus design, (2) encouraging shared transportation, (3) integrating maximized fuel efficiency features when upgrading roads, (4) continuing the expansion of alternative vehicles and fuel including hybrid vehicles, flex fuel vehicles using E85, electric vehicles, and diesel vehicles using B20 bio-diesel, and (5) researching and implementing future alternative vehicles and fuel options. These efforts have helped ORNL reduce its fleet from 515 vehicles in 2006 to 496 vehicles in 2010.

In FY 2010, UT-Battelle had a vehicle fleet that included 37 electric vehicles and 41 hybrid cars (Fig. 5.7). There were also 278 flex fuel vehicles in the fleet (56%), and 79% of new vehicle procurements during the year were flex fuel vehicles. During 2010 a reduction in vehicle emissions was achieved in part due to the use of 74,882 gal of E85 to fuel the UT-Battelle fleet, which is up from 50,503 gal in 2009. In addition there are 91 diesel vehicles at ORNL and numerous pieces of equipment that use bio-diesel as opposed to diesel fuel, resulting in additional reductions in emissions. As part of the Sustainable Campus Initiative, the Laboratory is implementing the use and support of plug-in hybrid electric vehicles (PHEV) in combination with solar-covered parking.

ORNL 2011-G00724/chj

Fig. 5.7. Vehicle Fleet.

5.2.1.4.3 Sustainable Practices

Green building and landscaping as well as energy management efforts are included in all activities at ORNL including research, design, construction, retrofit, operation, and maintenance. Over 1 million square feet of Leadership in Energy and Environmental Design (LEED)–certified campus space provides a multitude of opportunities to perform research on emerging energy-efficient technologies, green construction, and proper operation and maintenance of green facilities. An aggressive commitment to building LEED-certified buildings at ORNL along with the incorporation of other energy-saving measures has added 35% more facility and building area with only a 6% increase in energy consumption when comparing FY 2009 data to a 2000 baseline.

UT-Battelle has also maintained and expanded sustainable landscaping activities at ORNL including native planting on 7 ha (17 acres) at ORNL (Fig. 5.8) and 124 ha (307 acres) across the ORR and removal of invasive plants from 57 ha (140 acres) at ORNL and 202 ha (500 acres) across the ORR.

2011-G00723/chj

Fig. 5.8. Going Green.

Four solar arrays on the ORNL campus provide research opportunities as well as renewable energy to the Laboratory. ORNL's first solar collector, an array of 24 solar panels, was originally used as a symbol of alternative energy research and continues to generate renewable electricity. The second solar collector is an 88 m by 3 m (288 ft by 10 ft) collector made up of 168 modules. Designed to provide 51.25 kW at peak power, the array feeds direct current to an inverter, which produces alternating current for the ORNL distribution grid. A total of 88 MWh of direct current is produced annually, or about 70 MWh alternating current (equivalent to the average annual power needs of 5.5 Tennessee homes). This array is designed to be 18.7% efficient and to displace approximately 51,710 kg (114,000 lb) of carbon dioxide every year (more than seven times the amount produced annually by the average American). The electricity added to the grid is used to offset electricity for Buildings 3147 and 3156. This array supports UT-Battelle's aggressive maximum energy-efficient building goal, which will transform the four buildings that comprise the ORNL Buildings Technology and Research Integration Center to maximum energy-efficient buildings. UT-Battelle accomplished the first step in meeting this goal by achieving certification of Building 3156 as a net-zero-energy building, which included decreasing its power consumption from about 100 MWh/yr to 65 MWh/yr, which is offset by the solar power. During 2011, UT-Battelle is completing the installation of two additional arrays, one of 50 kW for solar-assisted EV charging and one atop the new MLF Building on campus (Building 4100).

In addition, ORNL has made substantial progress in diverting waste from the landfill, reducing desktop computer energy consumption (34% reduction), employee engagement, improving the vehicle fleet to a higher percentage of alternatively fueled vehicles, and developing key regional partnerships, as well as in a host of other areas.

UT-Battelle Employee Energy Conservation Education and Involvement Opportunities

UT-Battelle has developed numerous programs, processes, and activities that are intended to increase awareness and promote behavioral changes across the campus in conjunction with the Sustainable Campus Initiative. The goal is to implement policies and procedures that encourage sustainable practices, including reduced waste production, reduced use of energy, reduced GHG emissions, and changes in transportation habits. Additionally, the sustainability efforts undertaken through the various programs are intended to extend to the surrounding communities and beyond.

As the sustainable campus effort has evolved, it is apparent that many of the associated roadmap elements encourage behavior changes that will complement other projects and sustainability objectives as a whole. This relationship provides an ideal catalyst to encourage behavior changes and engage employees in the drive to achieve both a sustainable campus and a sustainable community. Examples of roadmap segments and aspects directed at influencing behavior are listed as follows.

Employee, Family, and Community Engagement Roadmap

UT-Battelle's Sustainable Campus Initiative includes a large, active Employee, Family, and Community Engagement Roadmap, which encourages a broad suite of outreach activities. For instance, the Employee Engagement Roadmap team developed and actively maintains a Web site (http://sustainability-ornl.org) and a related discussion and question blog. This site contains information about how UT-Battelle is moving toward sustainability, and what people can do at work, at home, and in their communities to achieve greater sustainability. The Roadmap Team launched a monthly e-newsletter in 2010, held four Sustainability at Home seminars as well as an ORNL-oriented discussion forum, and posted an average of 2–3 items on each week's internal ORNL e-newsletter to raise awareness about sustainability and the Sustainable Campus Initiative. In addition, UT-Battelle sponsored a large Earth Day celebration and participated in community Earth Day and related celebrations or events.

UT-Battelle's Earth Day 2010 Celebration was held on Monday, April 19, titled "The Green Generation." The event involved a variety of activities, including a poster display, green transportation show, "Green" Vendors Fair and an East Campus Pond Tour. Also featured was the first annual "Green Mile" bike ride, consisting of a short route around campus, as well as a long route off campus. The poster display showcased exhibits including pollution prevention and recycling, energy conservation and management, and research topics such as CO_2 sorption in coal, switch grass and battery production and longevity (Fig. 5.9).

Items such as water bottles, tote bags, and reusable lunch bags were offered as incentives to participate in these events, and to encourage more sustainable behavior.

ORNL 2011-G00722/chj

Fig. 5.9. 2010 Earth Day.

Training for managers of energy and water management programs

UT-Battelle is developing training that incorporates a sustainability component for individuals who direct energy and water management programs, which will be implemented in 2011 and 2012. In addition UT-Battelle's Energy Management Program Director and the Energy Manager have both held Facility Manager Certifications since 2005.

Employee Transportation Survey

During 2010 a survey was conducted to record the commute behaviors of ORNL employees in order to identify and implement opportunities for employees to modify transportation habits. These include the following.

- Investigation of shared transit to ORNL from regional park and ride lots
- Implementation of travel policies to reduce travel emissions through web-based meetings
- Electric Vehicle (EV) facilitation for staff
- Installation of solar-assisted EV charging in order to encourage staff purchases of EVs
- Various initiatives, including involving Nissan in special financing offers and work-from-home programs

5.2.1.4.4 Pollution Prevention

UT-Battelle implemented 42 new pollution prevention projects at ORNL during 2010, eliminating more than 42 million kg (~92 million lb) of waste and leading to cost savings/avoidance of more than $13 million (including ongoing reuse/recycle projects). Major 2010 pollution prevention successes at ORNL included source reduction projects such as the certification of a LEED-Existing Building (EB) facility, Green Information Technology (IT) power management, water conservation efforts, and recycling, including radioactive lead, Tyvek, and electronics (Fig 5.10).

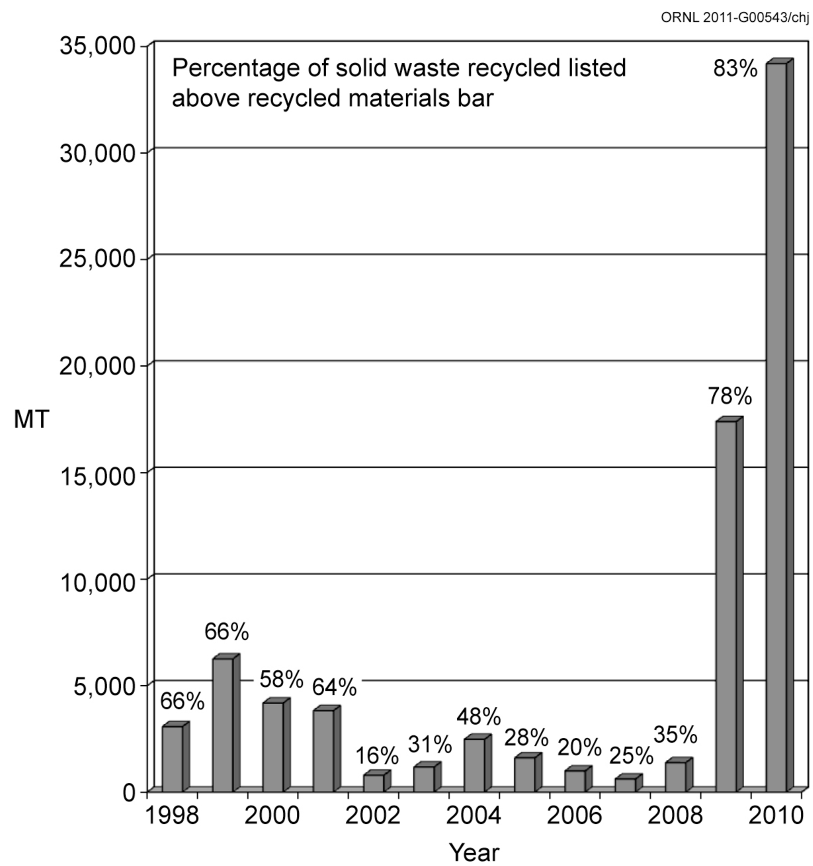

Fig. 5.10. ORNL Recycling Program.

One of UT-Battelle's established sustainability goals is to achieve LEED-EB certification for 10 buildings at ORNL by 2014. A process has been developed by a multidisciplinary group to ensure cross-cutting collaboration to reach this goal, and to provide documentation and information on lessons learned. This will ensure consistency and improved efficiency in future certification activities.

Building 1059 was selected to be the pilot for UT-Battelle's efforts to pursue LEED-EB certification for existing facilities. The 6,998 ft^2 building was built in 1993 and is one of several standard office buildings located on the West Campus of ORNL. LEED-EB, gold level certification for Building 1059 was achieved in 2010. Enhancements include lighting control; Metasys Building Automation System (BAS); roofing upgrade; low-flow plumbing; exterior site upgrades; energy awareness; source reduction, salvage, reuse, and recycling improvements; finish materials upgrades; and electronics energy usage enhancements.

While several new buildings on ORNL's East Quad have received LEED certification, Building 1059 is the first retrofitted building on the ORNL campus to achieve this distinction.

In FY 2010, the Information Technology Services Division completed the deployment of the Verdiem Surveyor, a software application system than enforces a set of energy management policies through the central information technology system.

UT-Battelle has implemented numerous water-saving activities during the past several years and has funded additional projects that will reap results in the future. These projects include integration of low-flow fixtures and faucets in new construction and the reuse of rainwater for irrigation. The entire modernized East Campus research complex saves more than 32 million liters (8.5 million gal) of water per year. In addition to water-savings measures incorporated into new construction, several existing facilities have been retrofitted with a variety of water-saving options, and as a result, a reduction in the use and discharge of an additional 25 million liters (6.5 million gal) of water per year was realized.

In 2010, UT-Battelle continued to drive down the use of water and improve water quality by (1) expanding the Physics Division's cooling water flow reduction efforts, reducing approximately 20.7 million gallons per year, and (2) installing a mercury treatment system which will pretreat more than 6 million gallons of water a year to significantly reduce trace amounts of mercury contamination.

These initiatives have reduced water usage and the associated waste water generation, improved operational efficiency, reduced total regulated air emissions, reduced natural gas and fuel oil use, and resulted in significant cost savings. In FY 2010 alone, ORNL's water conservation efforts reduced water usage and the associated wastewater generation by more than 20.7 million gal per year with an associated cost avoidance of more than $27,000. In the last 3 fiscal years, UT-Battelle has reduced more than 96 million gal per year with an associated cost avoidance of more than $367,000. In total, once all identified water conservation efforts are complete, a total of more than 282 million gal per year of water and associated wastewater generation will be reduced with an associated cost avoidance of more than $5 million, which includes all cost avoidance associated with the biomass gasification steam plant (BGSP).

During the year UT-Battelle aggressively supported the recycling program at ORNL with more than 83% of FY 2010–generated materials being diverted for recycle or beneficial use. One successful FY 2010 activity involved piloting zero-waste employee gatherings. The UT-Battelle Environmental Protection and Waste Services Division (EP&WSD) successfully hosted a picnic for 75–100 people while completely avoiding the generation of waste.

For more information on these and other UT-Battelle conservation and recycling activities, see http://sustainability-ornl.org.

ORNL Site Pollution Prevention (P2) Awards

- Federal Energy and Water Management Award – ORNL received this award for ORNL's Sustainable Campus Initiative.
- DOE's Management Award – ORNL received this award in 2010 for outstanding achievements in energy, water, and fleet management in FY 2009 specifically associated with ORNL's Sustainable Campus Initiative.
- DOE's Environmental Sustainability (EStar) Awards – ORNL received notification that ORNL's LEED-EB Effort, LEED by Example, Going for Gold Lab-wide nomination will receive a DOE Headquarters 2011 EStar Award and that ORNL's Goes Beyond Comprehensive Energy and Fleet Management to Comprehensive Sustainability Management nomination will receive a 2011 EStar Honorable Mention.

- DOE Office of Science Best in Class Award – UT-Battelle was awarded an Office of Science Best in Class Award for environmental sustainability and recognized two other initiatives with Noteworthy Practices Awards. Best in Class and Noteworthy Practices Awards were received for accomplishments associated with ORNL's LEED-EB Effort and the Comprehensive Energy Efficiency/Renewable Energy and Fleet Management Efforts and in recognition of DOE Headquarters' support to the sites.
- Tennessee Department of Environment and Conservation (TDEC) Tennessee Pollution Prevention Partnership (TP3) Performer Member Flag, Performer Level Status Maintained – UT-Battelle completed the required project summary information and annual review required for maintaining the TP3 Performer Level that demonstrates a commitment to preventing pollution of air, land, and water while conserving natural resources.

5.2.1.5 Implementation and Operation

5.2.1.5.1 Structure and Responsibility

The UT-Battelle Environmental Policy (Fig. 5.3) represents 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 the characterization basis to successfully complete the waste certification and disposal process.

5.2.1.5.2 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
- Notices on ORNL Today, an electronic publication which provides current information to staff on activities, programs, and events at the Laboratory

- EMS brochures and badge cards
- 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, regulators, and stakeholders

5.2.1.6 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.

5.2.1.7 Checking

5.2.1.7.1 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.

5.2.1.7.2 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. Should a nonconformance be identified, the ORNL issues management process requires that any regulatory or management system nonconformance be reviewed for cause and corrective and/or preventive action developed. These actions are then implemented and tracked to completion.

The SBMS Assessments 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 the systems are effective and are continually improving.

UT-Battelle also uses the results from numerous external compliance inspections conducted by regulators to verify compliance with 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 2010, an internal audit and an external reregistration audit were conducted and verified that the EMS continued to conform to ISO 14001:2004. In addition to verifying conformance, these management system assessments also identify continual improvement opportunities.

5.2.2 Environmental Management System for the TRU Waste Processing Center

The WAI EMS for activities at the TWPC was registered to the ISO 14001:2004 Standard by NSF International Strategic Registrations, Ltd., in May 2008. NSF International Strategic Registrations, Ltd. conducted a Surveillance Audit for the WAI EMS program in May 2010, and again no nonconformances or issues were identified and several significant practices were noted. The WAI 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* (BJC 2009), and both strive for continual improvement through a "plan-do-check-act" cycle.

The WAI EMS incorporates applicable environmental laws, DOE orders, and other requirements (i.e., directives and federal, state, and local laws) through WAI's contract requirements document (WAI 2010) and its Regulatory Management Plan (WAI 2008), which dictate how the various requirements are incorporated into 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 with the EMS requirements.

Environmental aspects are elements of an organization's activities, products, or services that can interact with the environment. WAI 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, pollution prevention, habitat alteration, and energy consumption 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.

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

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

WAI 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. WAI evaluated and put into place during the last part of 2009 a "single stream" recycling program that allows the mixing of multiple types of recyclables and increases the population of recyclable items. In 2010, WAI also began a recycling program for alkaline batteries. In addition, WAI implemented a Styrofoam cup recycling program.

"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 2010, WAI procured environmentally preferable materials totaling approximately $81,767 for use at TWPC.

Several methods are used by WAI 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. WAI also uses the results from numerous external compliance inspections conducted by regulators and contractors to verify compliance with requirements.

5.3 Compliance Programs and Status

During 2010 UT-Battelle, BJC, WAI, and Isotek operations were conducted in compliance with contractual and regulatory environmental requirements with the exception of two unrelated exceedances of National Pollutant Discharge Elimination System (NPDES) permit discharge limits and one release associated with BJC operations in 2010. While performing excavation operations at the White Oak Dam near ORNL on July 8, 2010, a hydraulic line on an excavator ruptured, releasing a small quantity (approximately ½ gallon) of hydraulic fluid to the White Oak Creek Embayment of the Clinch River. This resulted in a visible sheen on the water, which required notification to the National Response Center. The sheen was cleaned up, and subsequent monitoring has revealed no detectable adverse impact to the environment from the spill. In addition, operational changes were instituted to prevent a recurrence.

There were no notices of violation or penalties issued by the regulatory agencies. Table 5.4 presents a summary of environmental audits conducted at ORNL in 2010.

Table 5.4. Summary of regulatory environmental audits, evaluations, inspections, and assessments conducted at ORNL, 2010

Date	Reviewer	Subject	Issues
February 9	Knox County	Annual CAA Inspection for NTRC Facility	0
May 10–12	TDEC	Annual RCRA Inspection	0
May 25	TDEC	Underground Storage Tanks	0
November 16–18	TDEC	Annual RCRA inspection at Y-12 Complex	0

Abbreviations
CAA Clean Air Act
NTRC National Transportation Research Center
RCRA Resource Conservation and Recovery Act
TDEC Tennessee Department of Environment and Conservation

No Resource Conservation and Recovery Act (RCRA) Subtitle D disposal facilities are operated at ORNL. Industrial solid waste is sent to the Y-12 industrial solid waste disposal landfills. ORNL complies with the requirements by meeting the waste acceptance criteria at the Y-12 facilities.

The following discussions summarize the major environmental programs and activities carried out at ORNL during 2010 and provide an overview of compliance status for the year.

5.3.1 Environmental Permits

Table 5.5 contains a list of environmental permits that were effective in 2010 at ORNL.

5.3.2 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, WAI, and Isotek maintain 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 5.6 summarizes NEPA activities conducted at ORNL during 2010.

During 2010, UT-Battelle and WAI continued to operate under site-level procedures that provide requirements for project reviews and NEPA compliance. These procedures call 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 non-research activities (e.g., 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.

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.

In 2010, an environmental assessment for the Isotek-managed U-233 Material Downblending and Disposition Project (Building 3019 Complex) was completed, and a Finding of No Significant Impact under the NEPA process was issued (DOE 2010).

Table 5.5. ORNL environmental permits, 2010

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[a]	DOE	UT-B	UT-B
CAA	Steam Plant	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	Manipulator Boot Shop	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	SNS Central Utilities Building Boilers	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	Surface Coating and Cleaning Operation	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	SNS and CNF (construction permit)	956542P	10/29/04	03-01-08[a]	DOE	UT-B	UT-B
CAA	SNS Central Laboratory and Office Boilers	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	EGCR Boilers	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	Air Stripper (BJC permit)	547563	10/21/04	10-21-09[a]	DOE	BJC	BJC
CAA	HFIR & Radiochemical Engineering Development Center	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	Off Gas & Hot Cell Ventilation (BJC permit)	547563	10/21/04	10-21-09[a]	DOE	BJC	BJC
CAA	NTRC	0941-02[b]	03/12/09	Annually[a]	DOE	UT-B	UT-B
CAA	NTRC (Construction Permit)	0941-03[b]	12/22/10	12/22/11	DOE	UT-B	UT-B
CAA	TN Operating Permit (emissions source)	057077P	04/13/04	10-31-14[a]	DOE	WAI	WAI
CAA	Radiochemical Development Facility	560898	07/27/09	07-26-14[a]	DOE	Isotek	Isotek
CAA	Biomass Boiler and Melton Valley Steam Plant (construction permit)	962300F	03/27/09	03-01-10[a]	DOE	UT-B	UT-B, JCI
CAA	CNMS, Boilers (Construction)	963740F	08/18/10	09/01/11	DOE	UT-B	UT-B
CWA	ORNL NPDES Permit (ORNL sitewide 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	05-23-16	DOE	DOE	UT-B
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—Spallation Neutron Source	TNR139975	10-10-00	05-23-16	DOE	DOE	UT-B

Table 5.5 (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 Modernization of Laboratory Facilities	TNR133485	05-29-09	05-23-16	DOE	DOE	UT-B
CWA	Corps of Engineers Nationwide Permit #39, Commercial and Institutional Developments for "Minor Wetland Fill Associated with Proposed Parking Structure, White Oak Creek Mile 2.7R, Clinch River mile 50.8R, Roane County, Tennessee, ORNL Parking Structure."	LRN-2009-01598	12-03-09	12-03-11	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	Individual ARAP, "Installation of approximately 200 feet of culvert in an unnamed tributary to Fifth Creek and the fill of approximately 0.08 acres of associated wetland for the construction of a parking structure."	NRS09.320	01-15-10	01-14-11	DOE	DOE	UT-B
CWA	Tennessee Storm Water Multi-Sector General Permit for Industrial Activities for Storm Water Discharges Associated with Construction Activity (CGP)—0975 Water Reservoir	TNR133727	07-08-10	05-14-14	DOE	DOE	UT-B
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—ORNL Steam Plant Boiler Building (Melton Valley Steam Plant)	TNR133507	06-09-10	05-23-16	DOE	DOE	JCI
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—Biomass Gassification System Project	TNR133428	06-09-10	05-23-16	DOE	DOE	JCI
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—Pro2Serve National Security Engineering Center		10-06	NA	DOE	DOE	CROET
CWA	TN Operating Permit (sewage)	SOP-02056	02-01-08	12-31-12	DOE	WAI	WAI
CWA	Tennessee General Permit No. TNR10-0000, Stormwater Discharges from Construction Activity—Site Expansion Project	TNR 133560	08-31-09	NA	DOE	WAI	WAI

Table 5.5 (continued)

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
RCRA	Hazardous Waste Transporter Permit	TN1890090003	01-24-11	01-31-12	DOE	DOE	UT-B, BJC
RCRA	Hazardous Waste Corrective Action Permit	TNHW-121	09-28-04	09-28-14	DOE	DOE/all[c]	DOE/all
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-134	09-26-08	09-26-18	DOE	DOE/UT-B	UT-B
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-145[d]	02-03-10	02-03-20	DOE	DOE/BJC/WAI	BJC/WAI

Abbreviations

BJC	Bechtel Jacobs Company
CAA	Clean Air Act
CNF	Central Neutralization Facility
CROET	Community Reuse Organization of East Tennessee
CWA	Clean Water Act
DOE	U.S. Department of Energy
EGCR	Experimental Gas-Cooled Reactor
HFIR	High Flux Isotope Reactor
JCI	Johnson Controls, Inc.
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
WAI	Wastren Advantage Inc.

[a]Continued construction/operation under an expired permit is allowed under air pollution control regulations when timely renewal or construction permit applications are submitted.

[b]Permit issued by Knox County Department of Air Quality Management.

[c]DOE and Oak Ridge Reservation contractors are co-operators of hazardous waste permits.

[d]In 2010, TNHW-145 replaced permit TNHW-097.

Table 5.6. National Environmental Policy Act (NEPA) activities, 2010

Types of NEPA documentation	Number of instances
ORNL	
Environmental Assessment	1
Categorical exclusions (CXs) approved	6
Approved under general actions or generic CX documents	85[a]
WAI	
Approved under general actions or generic CX documents	10[a]
Isotek	
Environmental Assessment approved and Finding of No Significant Impacts (FONSI) issued	1

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

In 2010 an environment assessment was initiated and documented in *Spruce and Peatland Responses under Climatic and Environmental Change Experiment (SPRUCE)*, DOE/EA-1764 (DOE 2011). This research project would be conducted by UT-Battelle researchers at the Marcell Experimental Forest near Grand Rapids, Minnesota.

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).

5.3.3 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 established 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 TDEC Division of Air Pollution Control. ORNL The first sitewide operating air permit was issued in 2004. To demonstrate compliance with this Title V Major Source Operating Permit, more than 1500 data points are collected and reported every year. In addition, there are 2 continuous monitors for criteria pollutants, 9 continuous samplers for radionuclide emissions, 15 minor radionuclide sources, and numerous demonstrations of compliance with generally applicable air quality protection requirements (asbestos, stratospheric ozone, etc.). Also, a Knox County Air Quality permit is maintained for the offsite NTRC. In 2010, an annual compliance report was submitted for this permit. In summary, there were no UT-Battelle, Isotek, or WAI CAA violations or exceedances in 2010. Section 5.4 provides detailed information on 2010 activities conducted at ORNL in support of the CAA.

5.3.4 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 quality 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 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 2010, compliance with the ORNL NPDES Permit was determined by approximately 2,300 laboratory analyses and field measurements. The NPDES permit limit compliance rate for all discharge points for 2010 was nearly 100%, with only one measurement exceeding numeric NPDES permit limits. This occurred at the ORNL Sewage Treatment Plant when a daily maximum limit for E. coli bacteria was exceeded at the ORNL Sewage Treatment Plant due to a rain event on May 5, 2010. A second permit nonconformance occurred on June 18, 2010, when miscommunication resulted in missed effluent measurement at the ORNL Steam Plant Wastewater Treatment Facility. Section 5.5 contains detailed information on the activities and programs carried out in 2010 by UT-Battelle in support of the CWA.

5.3.5 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. TDEC's Bureau of Environment Division of Water Supply Chapter 1200-5-1, Public Water Systems (TDEC 2009) 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), 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 2010, 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 sampling is scheduled to be performed during June –September 2012.

5.3.6 RCRA Compliance Status

The Hazardous Waste Program under the Resource Conservation and Recovery Act (RCRA) establishes a system for regulating hazardous wastes from the initial point of generation through final disposal. In Tennessee, TDEC has been delegated authority by EPA to implement the Hazardous Waste Program; EPA retains an oversight role. In 2010, DOE and its contractors at ORNL were jointly regulated as a large-quantity generator of hazardous waste under EPA ID No. TN1890090003 because, collectively, more than 1,000 kg of hazardous/mixed wastes was generated in at least 1 calendar month during 2010. Mixed wastes are both hazardous (under RCRA regulations) and radioactive. Hazardous/mixed wastes were accumulated in satellite accumulation areas or less-than-90-day accumulation areas by DOE and its contractors including UT-Battelle, BJC, WAI, and Isotek. Hazardous/mixed wastes were also stored and/or treated in RCRA-permitted units by DOE, UT-Battelle, BJC, and WAI. The RCRA units operate under three permits at ORNL: TNHW-145, TNHW-134, and TNHW-121, as shown in Table 5.7. TNHW-145 was issued in early 2010 and replaced the TNHW-097 permit. In 2010, UT-Battelle and BJC were permitted to transport hazardous wastes under ORNL's EPA ID number, and UT-Battelle was registered to operate a transfer facility for temporary storage (less than 10 days) of hazardous wastes transported from off-site locations (such as DOE's NTRC).

Table 5.7. ORNL Resource Conservation and Recovery Act operating permits, 2010

TNHW permit number	Building/description
	ORNL
TNHW-134	Building 7651 Container Storage Unit Building 7652 Container Storage Unit Building 7653 Container Storage Unit Building 7654 Container Storage Unit Portable Unit 2 Storage & Treatment Unit
TNHW-145	Portable Unit 1 Storage Unit Building 7572 Container Storage Unit Building 7574 Container Storage Unit Building 7823 Container Storage Unit Building 7855 Container Storage Unit Building 7860A Container Storage Unit Building 7879 Container Storage Unit Building 7883 Container Storage Unit Building 7880A TWPC-1 (Contact-Handled Storage Area) Container Storage Unit TWPC-2 (Second Floor WPB) Container Storage Unit TWPC-3 (Drum Aging Criteria) Container Storage Unit TWPC-4 (First Floor WPB) Container Storage Unit TWPC-5 (Container Storage Area) Container Storage Unit Building 7880BB TWPC-6 (Contact-Handled Marshaling Building) Container Storage Unit Building 7880AA TWPF-7 (Drum Venting Building) Container Storage Unit Macroencapsulation T-1 Treatment Unit Amalgamation T-2[a] Treatment Unit Solidification/Stabilization T-3[a] Treatment Unit Hot Cell Table T-4 [a] Treatment Unit Size Reduction T-5[a] Treatment Unit
	Oak Ridge Reservation
TNHW-121	Hazardous Waste Corrective Action Permit

[a]Treatment operating units within Building 7880.

ORNL reports hazardous waste activities on 42 active waste streams, some of which are mixed wastes. The quantity of hazardous/mixed waste generated at ORNL in 2010 was 708,859 kg. Mixed wastewater accounted for 449,199 kg. Excluding the wastewater generation, which remains fairly constant from year to year, 2010 hazardous waste generation increased approximately 122%. The increase was primarily due to (1) increased generation of macroencapsulated waste, (2) increased generation of transuranic mixed waste, (3) generation of contaminated debris from building clean-outs and demolitions, and (4) waste from laboratory clean-outs. ORNL generators treated 5,736 kg of hazardous/mixed waste by elementary neutralization and silver recovery; 1,105 kg of mixed wastewaters was received from the East Tennessee Technology Park for treatment in an onsite wastewater treatment system at ORNL and 377 kg of hazardous/mixed waste was received from UT-Battelle generators at the Y-12 Complex, which was stored at ORNL and then shipped offsite to a commercial RCRA-permitted facility for treatment. The quantity of hazardous/mixed waste treated in RCRA-permitted treatment facilities at ORNL in 2010 was 66,176 kg. This includes waste treated by macroencapsulation, amalgamation, size reduction, and stabilization/solidification. In addition, 449,199 kg of mixed waste was treated at an onsite wastewater treatment facility. The amount of hazardous/mixed waste shipped offsite to commercial treatment, storage, and disposal facilities increased approximately 280% to 512,501 kg in 2010. The increase is due primarily to (1) transuranic waste shipped to the Waste Isolation Pilot Plant, (2) macroencapsulated waste shipped to the Nevada National Security Site (formerly Nevada Test Site), and (3) shipments of contaminated debris and laboratory clean-out wastes noted above. Excluding these large waste streams, the amount of hazardous/mixed waste shipped offsite in 2010 increased by approximately 86%.

In May 2010, TDEC conducted an annual RCRA inspection of ORNL generator areas, battery collection areas, RCRA-permitted treatment, storage, and disposal facilities, and RCRA records including required training, generator inspections, permitted facility records, shipments, transfer facility log, the 2009 RCRA Annual Report of Hazardous Waste Activities, and the 2009 Hazardous Waste Reduction Progress Report. All activities and records were found to be in compliance with RCRA regulations and the RCRA permits, and there were no notices of violation or penalties associated with this inspection.

At NTRC, DOE and UT-Battelle were regulated as a conditionally exempt small-quantity generator in 2010, meaning that less than 100 kg of hazardous waste per month was generated.

There were no hazardous/mixed wastes generated, accumulated, or shipped by DOE and UT-Battelle at the 0800 Area or the DOE Office of Scientific and Technical Information, ORNL Records in 2010.

5.3.7 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. Annual updates for 2010 for ORNL's Solid Waste Management Units and Areas of Concern were consolidated with updates for ETTP, Y-12, and the ORR and were reported to TDEC, DOE, and EPA Region 4 in January 2011.

In May 2005 BJC applied for, but has not yet received, a RCRA postclosure permit for Solid Waste Storage Area (SWSA) 6. RCRA groundwater monitoring data is reported yearly to TDEC and EPA in the annual CERCLA Remediation Effectiveness Report (DOE 2011a) 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 do not adversely impact future CERCLA environmental remedial actions.

The UT-Battelle Environmental Management Program Office (EMPO) manages the DOE-EM-funded IFDP and ARRA work at ORNL. Although the conduct of DOE-EM-related work (i.e., environmental remediation and building decontamination and demolition) is not a UT-Battelle core business function, UT-Battelle has endorsed participation in ARRA-funded cleanup work to accelerate ORNL revitalization by removing legacy facilities and materials. This reduces the liabilities and risks to current and future ORNL science missions. During 2010, the demolition of 10 buildings at ORNL was completed (2001, 2019, 2024, 2087, 2088, 2092, 3074, 2009, 2018, 2517), and remediation activities in SWSA 1 were completed under the Record of Decision/Remedial Action Work Plan (RAWP) for the Bethel Valley Burial Grounds. These activities and other 2010 EM accomplishments at ORNL are discussed in more detail in Section 5.8 and in the FY 2010 Cleanup Progress Annual Report to the Oak Ridge Community (DOE 2010a).

5.3.7.1 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 three USTs registered with TDEC under Facility ID Number 0-730089; all three are in service (petroleum) and are state-of-the-art USTs that meet the 1998 standards for new UST installations.

5.3.8 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) is operated by the BJC for DOE. Located in Bear Creek Valley, EMWMF 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.

5.3.9 Toxic Substances Control Act Compliance Status

PCB waste generation, transportation, and storage at ORNL are regulated under the EPA ID number TN1890090003. In 2010, UT-Battelle operated approximately 28 PCB waste storage areas in generator buildings and RCRA-permitted storage buildings at ORNL for longer-term storage of PCB/radioactive wastes when necessary. Four PCB waste storage areas were operated at UT-Battelle facilities at Y-12. 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 Table 2.1) 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. In 2010, there was a discovery of unauthorized uses of PCBs in paints at Building 4508.

5.3.10 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 5.8 describes the main elements of the Act. UT-Battelle complied with these requirements in 2010 through the submittal of reports under EPCRA Sections 302, 303, 311, and 312. These reports reflect information pertinent to all DOE prime contractors and their subcontractors who reported activities at the ORNL site.

ORNL had no releases of extremely hazardous substances, as defined by EPCRA, in 2010.

Table 5.8. Main elements 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/Chemical Inventory	Requires that either material safety data sheets 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

5.3.10.1 Material Safety Data Sheet/Chemical Inventory (Section 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 EPCRA's Section 312 requirements. Of the 101 chemicals identified for 2010 on the ORR, 20 were located at ORNL.

Private-sector lessees associated with the reindustrialization effort were not included in the 2010 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.

5.3.10.2 Toxic Chemical Release Reporting (EPCRA Section 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 other waste management activities were calculated for each chemical that exceeded one or more of the thresholds.

For CY 2010, ORNL reported the otherwise use of 32,092 lb of nitric acid and the manufacture of 55,260 lb of nitrate compounds (Table 5.9). Of this, 31,744 lb of the nitric acid was used for waste treatment at the Process Waste Treatment Complex (PWTC) and 348 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 nitrate compounds from the sewage treatment plant (STP) are released into the environment. The discharge of nitrate compounds is not regulated in the NPDES permit for the sewage plant.

Table 5.9. Emergency Planning and Community Right-to-Know Act Section 313 toxic chemical release and off-site transfer summary[a] for ORNL, 2009 and 2010

Chemical	Year	Quantity (lb)
Nitrate compounds	2009	73,041
	2010	55,260
Nitric acid	2009	52,762
	2010	32,092
Total	2009	125,803
	2010	87,352

[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.

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

In 2010, UT-Battelle personnel had eight domestic soil agreements for receipt of or movement of quarantined soils, three soil permits for receipt of or movement of nondomestic soils (from outside the continental United States), and eight other 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.

All activities conducted under soil compliance agreements and soil permits were in compliance with the applicable regulations.

5.4 Air Quality Program

5.4.1 Construction and Operating Permits

Permits issued by the state of Tennessee convey the clean air requirements that are applicable to ORNL. New projects are governed by construction permits until converted to operating status. The sitewide Title V Major Source Operating Permit includes requirements that are generally applicable to large operations such as a national laboratory (e.g., asbestos and stratospheric ozone), as well as specific requirements directly applicable to individual air emission sources. Source-specific requirements include NESHAP for Radionuclides (see Sect. 5.4.3), requirements applicable to sources of ambient air criteria pollutants, and sources of other hazardous air pollutants (nonradiological). DOE/UT-Battelle holds a Title V permit for 10 emission sources. In April 2009, an application was submitted to the state of Tennessee to renew this sitewide permit.

The permit renewal application was updated in September 2010 to reflect facility changes and also identify new regulatory requirements that have been issued since the original submittal in April 2009. On August 18, 2010, TDEC issued a construction permit for two natural-gas-fired boilers to be constructed for the Center for Nanophase Materials Science.

The primary emission points of nonradioactive emissions at ORNL included three boilers located on the main ORNL site, two boilers located at the 7600 complex, four boilers located at the SNS site, and four new boilers located at the Melton Valley Steam Plant.(MVSP). All of these units use fossil fuels; therefore, criteria pollutants are emitted. Actual and allowable emissions from the sources are compared in Table 5.10. Actual emissions were calculated from fuel usage and EPA emission factors. Boiler 6, located on the main ORNL site, is a 125-MBtu/h boiler and is subject to the new source performance standards of 40 CFR 60 Subpart Db with continuous emission monitoring requirements for nitrogen oxides (NO_x) and opacity. In 2010 ORNL also replaced the continuous in-stack NO_x monitoring system on boiler 6 with a Predictive Emissions Monitoring System (PEMS). The PEMS monitors inputs from existing boiler control sensors and uses statistical based software to predict actual NO_x emissions. The PEMS was approved by both EPA and TDEC as an approved method to demonstrate continual compliance with 40 CFR 60 Subpart Db monitoring requirements for NO_x. The advantages of the PEMS will be an increase in operational availability and reduced operating expenses.

As part of the ESPC construction project, initiated in 2009, the MVSP was brought on-line in December 2010. As an energy-saving measure the MVSP will provide local steam and building heat for the 7900 complex area. Significant progress was also realized through physical modifications to improve operating efficiency to boilers 5 and 6 located at the main ORNL site steam plant. The biomass gasification boiler, the main component in the ESPC Project, is still under construction and is expected to be brought on-line in early 2012. The biomass boiler will gasify wood fuel to provide a clean source of steam and will significantly displace fossil fuels used by the existing steam plant and will reduce fossil fuel consumption at ORNL. All UT-Battelle emission sources operated in compliance with Title V permit conditions during 2010.

Table 5.10. Actual versus allowable air emissions from ORNL steam production, 2010

Pollutant	Emissions (tons per year)[a]		Percentage of allowable (%)
	Actual	Allowable	
Sulfur dioxide	23.6	1277	1.8
Particulate matter	3.4	71	4.8
Carbon monoxide	33.1	196	16.9
Volatile organic compounds	2.1	14	15.0
Nitrogen oxides	64.0	380	16.8

[a]1 ton = 907.2 kg.

For state fiscal year 2010, UT-Battelle paid $7,500 in annual emission fees to TDEC. The fees are based on a combination of actual and allowable emissions.

DOE/WAI has an operating air permit for one emission source, a TRU waste processing facility. DOE/Isotek has a Title V Major Source Operating permit for the Radiochemical Development Facility. During CY 2010, no permit limits were exceeded.

5.4.2 NESHAP for Asbestos

There are numerous facilities, structures, components, and various pieces of equipment associated with facilities at ORNL that contain asbestos-containing material (ACM). UT-Battelle's Asbestos Management Program manages the compliance of work activities involving the removal and disposal of ACM, which include notifications to TDEC for all demolition activities and required renovation activities, and current use of engineering controls and work practices, inspections, and monitoring for proper removal and waste disposal activities of ACM. No releases of reportable quantities of ACM occurred at ORNL during 2010.

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).

The major radiological emission point sources for ORNL consist of the following six stacks located in Bethel and Melton Valleys and the SNS Central Exhaust Facility stack located on Chestnut Ridge (Fig. 5.11).

- 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 area 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 (REDC)
- 8915 SNS Central Exhaust Facility stack

In 2010, there were 15 minor point/group sources, and emission calculations/estimates were made for each of them.

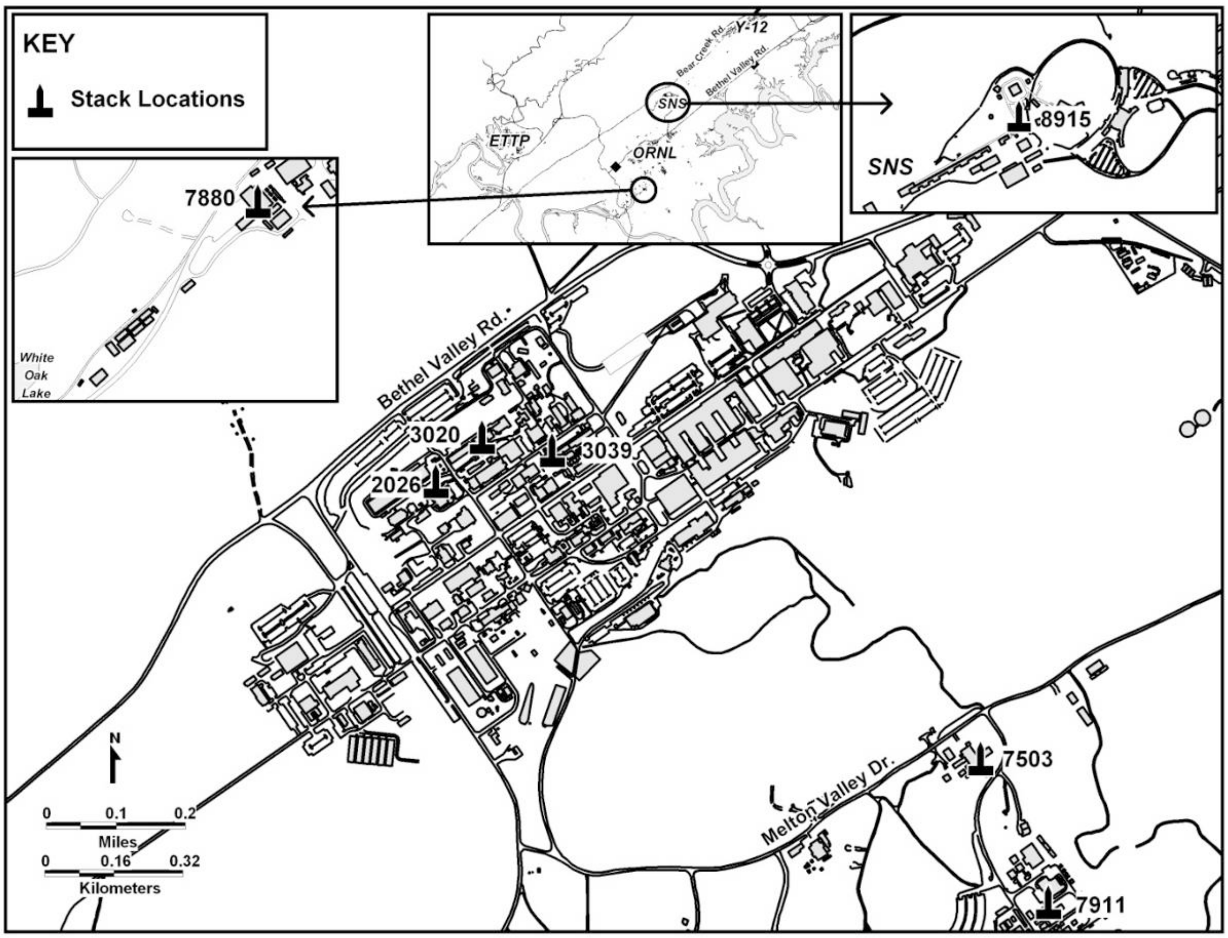

Fig. 5.11. Locations of major radiological emission points at ORNL.

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 (EPA 2010) at major and 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. The sampling system on Stack 7880 requires no other type of radionuclide collection media. 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. A probe-cleaning program for 7880 has established that rinse analysis has historically shown no detectable contamination. Therefore, the frequency of probe rinse collection and analysis is no more often than every 3 years unless there is an increase in particulate emissions, increase in detectable radionuclides in the sample media, or process modifications.

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 2010 are presented in Table 5.11. 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 5.11 shows total radionuclide emissions from point sources on the ORR. Also shown are the assumed lung clearance type and activity median aerodynamic diameters (AMADs). The designation of F, M, and S refers to the lung clearance type—Fast (F), Moderate (M), and Slow (S) for the given radionuclide. The default AMAD of 1.0 µm was used for modeling unless it was a gas, vapor, or otherwise requested. The chemical form used in most cases was unspecified, except when the chemical form was known and available in CAP88PC Version 3.

Historical trends for ^{3}H and ^{131}I are presented in Figs. 5.12 and 5.13, respectively. For 2010, ^{3}H emissions totaled approximately 170.4 Ci (Fig. 5.12), an increase from 2009; ^{131}I emissions totaled 0.04 Ci (Fig. 5.13), a significant decrease from 2009 but in line with historical emissions from the previous 5 years. The increase in ^{3}H was due to research activities in 2010 in the REDC involving the processing of heavy element targets and increases in beam power at the SNS. (REDC emissions discharge through the 7911 Melton Valley complex stack.) For 2010, the major dose contributors to the radiation dose at ORNL were ^{212}Pb, ^{125}I, ^{11}C, ^{238}U, ^{138}Cs, and ^{41}Ar with dose contributions of approximately 75%, 10%, 4%, 3%, 1%, and 1%, respectively. Emissions of ^{212}Pb result from the radiation decay of legacy material stored onsite and contamination areas containing isotopes of ^{228}Th, ^{232}Th, and ^{232}U. Emissions of ^{212}Pb were from the following stacks: 2026, 3020, 3039, 3544, 7503, 7856, 7877, 7935, and 7911. Emissions of ^{125}I and ^{11}C result from Spallation Neutron Source (SNS) operations and research activities. Emissions of ^{41}Ar result from High Flux Isotope Reactor (HFIR) operations and research activities and are emitted as a nonadsorbable gas from the 7911 Melton Valley complex stack. Emissions of ^{138}Cs result from research activities in the Radiochemical Engineering Development Center (REDC), which also exhaust through the 7911 Melton Valley complex stack. For 2010, ^{212}Pb emissions totaled 2 Ci, ^{125}I emissions totaled 0.15 Ci, ^{11}C emissions totaled 800 Ci, ^{238}U emissions totaled 3.65E-03 Ci, ^{138}Cs emissions totaled 712 Ci, and ^{41}Ar emissions totaled 957 Ci (Fig. 5.14). Emissions of ^{41}Ar increased slightly in 2010 but are comparable to 2009 emissions. Emissions of ^{138}Cs decreased because less heavy-element target process work was performed in 2010 than in 2009.

The calculated radiation dose to the maximally exposed individual (MEI) from all radiological airborne release points at the Oak Ridge Reservation (ORR) during 2010 was 0.4 mrem. The dose contribution to the MEI from all ORNL radiological airborne release points was 0.34 mrem. In 2010, the MEI was an on-site member of the public (business) located within the ORR and on the ORNL site. Historically, the MEI location has been outside the boundary of the ORR (off-site). In 2010, the dose to the off-site MEI was estimated to be about 0.3 mrem/year, which was slightly below the on-site MEI dose. The ORNL contribution to the off-site MEI dose was 0.1 mrem. The dose to both the on-site and off-site MEI locations are well below the NESHAP standard of 10 mrem and is less than 0.13% of the 310 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.)

Table 5.11. Radiological airborne emissions from all sources at ORNL, 2010 (Ci)[a]

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{225}Ac	M								1.16E-09	1.16E-09
^{110}Ag	M								2.76E-12	2.76E-12
^{110m}Ag	M								7.99E-12	7.99E-12
^{110m}Ag	S					2.90E-06				2.90E-06
^{241}Am	M	1.48E-07	5.89E-07				8.05E-08		2.80E-07	1.10E-06
^{241}Am	F			4.13E-07	1.53E-08	1.57E-06			1.75E-08	2.02E-06
^{243}Am	M								7.57E-12	7.57E-12
^{41}Ar	G						9.47E+02	1.00E+01		9.57E+02
^{139}Ba	M						1.16E-01			1.16E-01
^{140}Ba	M						8.31E-04			8.31E-04
^{140}Ba	S					1.02E-04				1.02E-04
^{7}Be	M	2.04E-07	4.32E-07						4.47E-06	5.10E-06
^{7}Be	S			1.20E-05		3.58E-05			4.11E-07	4.82E-05
^{207}Bi	M								9.70E-11	9.70E-11
^{210}Bi	M								3.00E-16	3.00E-16
^{212}Bi	M								4.73E-13	4.73E-13
^{212}Bi	S								1.58E-08	1.58E-08
^{214}Bi	M								2.05E-13	2.05E-13
^{11}C	G							8.00E+02		8.00E+02
^{14}C	M								1.00E-08	1.00E-08
^{109}Cd	M								5.00E-11	5.00E-11
^{141}Ce	M						8.80E-06		8.00E-09	8.81E-06
^{144}Ce	M								4.16E-11	4.16E-11
^{252}Cf[b]	M						1.43E-08		6.47E-11	1.44E-08
^{36}Cl	M								5.00E-10	5.00E-10
^{242}Cm	M								5.65E-08	5.65E-08
^{243}Cm	F				4.03E-08	7.50E-07			7.47E-10	7.91E-07
^{243}Cm	M						1.80E-08		5.07E-12	1.80E-08
^{244}Cm	M	1.15E-06	1.34E-07				1.80E-08		3.68E-06	4.98E-06
^{244}Cm	F			1.08E-07	4.03E-08	7.50E-07			4.16E-09	9.02E-07
^{245}Cm	M								7.08E-11	7.08E-11
^{247}Cm	M								1.14E-13	1.14E-13
^{248}Cm[c]	M								1.85E-13	1.85E-13
^{57}Co	M								6.26E-13	6.26E-13
^{57}Co	S			4.49E-07						4.49E-07
^{58}Co	M						1.79E-05		3.37E-07	1.82E-05

Table 5.11. (continued)

Isotope	Solubility	Stack							Total Minor Source	ORNL Total
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915		
^{60}Co	M								7.12E-07	7.12E-07
^{60}Co	S			3.13E-06		3.13E-06				6.26E-06
^{51}Cr	M								9.11E-10	9.11E-10
^{134}Cs	F								1.07E-08	1.07E-08
^{134}Cs	S					2.72E-06				2.72E-06
^{135}Cs	F								2.18E-13	2.18E-13
^{137}Cs	F	2.44E-06	2.76E-06				3.27E-06		2.87E-04	2.96E-04
^{137}Cs	S			1.42E-04	2.72E-08	3.01E-06			2.62E-03	2.77E-03
^{138}Cs	F						7.12E+02			7.12E+02
^{253}Es	M								2.14E-10	2.14E-10
^{152}Eu	F			7.43E-07						7.43E-07
^{152}Eu	M								2.41E-07	2.41E-07
^{154}Eu	M								1.45E-07	1.45E-07
^{155}Eu	M								2.43E-10	2.43E-10
^{156}Eu	M								1.38E-16	1.38E-16
^{55}Fe	M								2.36E-07	2.36E-07
^{59}Fe	M								1.13E-10	1.13E-10
^{153}Gd	M								1.00E-10	1.00E-10
^{3}H	V	9.17E-01		7.08E+00	1.62E+00		9.11E+01	6.90E+01	4.22E+00	1.74E+02
^{181}Hf	M								3.31E-14	3.31E-14
^{203}Hg	M								1.02E-13	1.02E-13
^{124}I	F								2.84E-16	2.84E-16
^{125}I	F							1.50E-01	2.70E-05	1.50E-01
^{126}I	F								6.00E-09	6.00E-09
^{129}I	F								1.79E-04	1.79E-04
^{131}I	F					1.90E-05	3.71E-02		1.59E-06	3.71E-02
^{132}I	F						3.69E-01			3.69E-01
^{133}I	F						1.97E-01			1.97E-01
^{134}I	F						5.59E-01			5.59E-01
^{135}I	F						6.02E-01			6.02E-01
^{192}Ir	M								1.21E-11	1.21E-11
^{40}K	S								5.91E-05	5.91E-05
^{40}K	M		7.96E-07						3.96E-07	1.19E-06
^{79}Kr	G							1.73E+01		1.73E+01
^{81}Kr	G								2.90E-13	2.90E-13
^{85}Kr	G						3.87E+02		2.91E-05	3.87E+02
^{85m}Kr	G						6.46E+00	5.33E+01		5.98E+01

Table 5.11. (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{87}Kr	G						7.29E+01	2.31E+01		9.60E+01
^{88}Kr	G						6.91E+01	9.40E+00		7.85E+01
^{89}Kr[d]	G						5.30E+01			5.30E+01
^{140}La	M						2.85E-04		4.45E-10	2.85E-04
^{140}La	S					4.37E-05				4.37E-05
^{177}Lu	M								8.64E-07	8.64E-07
^{54}Mn	M								3.64E-08	3.64E-08
^{54}Mn	S					3.09E-06				3.09E-06
^{93}Mo	M								4.09E-10	4.09E-10
^{13}N	G							1.75E+01		1.75E+01
^{22}Na	M								3.72E-14	3.72E-14
^{93m}Nb	M								2.05E-11	2.05E-11
^{94}Nb	M								1.24E-10	1.24E-10
^{95}Nb	M								5.82E-08	5.82E-08
^{147}Nd	M								3.10E-12	3.10E-12
^{59}Ni	M								1.06E-07	1.06E-07
^{63}Ni	M								1.34E-07	1.34E-07
^{237}Np	M								4.81E-11	4.81E-11
^{239}Np	M								4.81E-12	4.81E-12
^{191}Os	S			3.18E-03					1.11E-06	3.18E-03
^{191}Os	M		3.21E-04				2.78E-08			3.21E-04
^{32}P	M								3.37E-11	3.37E-11
^{33}P	M								1.29E-17	1.29E-17
^{210}Pb	M								4.34E-11	4.34E-11
^{212}Pb	M	5.35E-01	5.29E-01				1.98E-02		6.51E-14	1.08E+00
^{212}Pb	S			9.94E-01	9.77E-02				2.73E-02	1.12E+00
^{214}Pb	M								4.17E-13	4.17E-13
^{147}Pm	M								2.41E-12	2.41E-12
^{209}Po[e]	M								5.00E-11	5.00E-11
^{210}Po	M								3.00E-14	3.00E-14
^{238}Pu	M	5.33E-08	1.74E-08				1.36E-09		7.32E-07	8.04E-07
^{238}Pu	F			4.36E-08	5.59E-09	1.91E-06			4.55E-10	1.96E-06
^{239}Pu	F			1.60E-06	2.05E-08	5.45E-07			5.35E-10	2.17E-06
^{239}Pu	M	2.10E-07	2.53E-07				2.46E-09		1.68E-07	6.34E-07
^{240}Pu	F					5.45E-07			2.03E-10	5.45E-07
^{240}Pu	M						2.46E-09		1.16E-09	3.62E-09
^{241}Pu	M								1.78E-07	1.78E-07

Table 5.11. (continued)

Isotope	Solubility	Stack							Total Minor Source	ORNL Total
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915		
^{242}Pu	M								8.29E-14	8.29E-14
^{224}Ra	M								2.40E-12	2.40E-12
^{225}Ra	M								9.31E-09	9.31E-09
^{226}Ra	M		1.63E-07				3.27E-07		2.67E-15	4.90E-07
^{88}Rb	M							3.10E+00		3.10E+00
^{188}Re	M								8.30E-08	8.30E-08
^{103}Ru	S					5.66E-06				5.66E-06
^{103}Ru	M								1.01E-09	1.01E-09
^{106}Ru	M								2.27E-08	2.27E-08
^{106}Ru	S								1.40E-04	1.40E-04
^{35}S	M								1.04E-09	1.04E-09
^{124}Sb	M								1.01E-07	1.01E-07
^{125}Sb	M								2.63E-07	2.63E-07
^{46}Sc	M								9.58E-11	9.58E-11
^{75}Se	F								1.41E-11	1.41E-11
^{75}Se	S			3.17E-05		2.94E-06				3.46E-05
^{113}Sn	M								1.79E-11	1.79E-11
^{119m}Sn	M								1.47E-10	1.47E-10
^{85}Sr	M								9.71E-13	9.71E-13
^{89}Sr	S			1.88E-05	1.59E-08				2.89E-04	3.08E-04
^{89}Sr	M	2.98E-07	9.40E-07				4.03E-06		6.78E-09	5.27E-06
^{90}Sr	M	2.98E-07	9.40E-07				4.03E-06		1.24E-04	1.29E-04
^{90}Sr	S			1.88E-05	1.59E-08	8.15E-06			2.89E-04	3.16E-04
^{179}Ta	M								5.95E-14	5.95E-14
^{182}Ta	M								3.40E-11	3.40E-11
^{95m}Tc	M								5.83E-13	5.83E-13
^{99}Tc	M								9.84E-11	9.84E-11
^{99}Tc	S					8.86E-06				8.86E-06
^{129}Te	M								9.92E-12	9.92E-12
^{129m}Te	M								3.76E-07	3.76E-07
^{228Th}	S	1.01E-08	1.55E-08	1.23E-08			2.81E-08		8.19E-08	1.48E-07
^{230Th}	F			2.00E-08	9.13E-10				4.32E-09	2.52E-08
^{230Th}	S	2.78E-09	7.01E-09				8.64E-10		4.30E-09	1.50E-08
^{232}Th	F			7.00E-09	6.23E-10				1.25E-09	8.88E-09
^{232}Th	S	4.31E-10	2.47E-09				4.83E-09		3.25E-09	1.10E-08
^{208}Tl	M								1.46E-13	1.46E-13
^{232}U	M								2.82E-12	2.82E-12

Table 5.11. (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{233}U	S				2.03E-08	4.32E-07			9.15E-05	9.20E-05
^{233}U	M						1.15E-07		8.70E-12	1.15E-07
^{234}U	S			5.90E-07	2.03E-08	4.32E-07	1.15E-07		9.15E-05	9.27E-05
^{234}U	M	3.90E-07	2.32E-07						1.28E-04	1.28E-04
^{235}U	M	1.43E-08	1.63E-08						4.85E-05	4.86E-05
^{235}U	S			4.49E-08	3.85E-09	9.50E-07	2.79E-08		7.22E-06	8.25E-06
^{236}U	M								1.44E-12	1.44E-12
^{236}U	S								1.03E-05	1.03E-05
^{238}U	M	6.56E-09	3.55E-08						3.65E-03	3.65E-03
^{238}U	S			3.52E-08	3.76E-09	8.36E-07	2.82E-08		9.38E-06	1.03E-05
^{181}W	M								1.19E-11	1.19E-11
^{185}W	M								3.57E-08	3.57E-08
^{188}W	M								6.85E-08	6.85E-08
^{125}Xe	G							1.29E+01		1.29E+01
^{127}Xe	G							1.68E+01	1.96E-09	1.68E+01
^{129m}Xe	G								6.16E-10	6.16E-10
^{131m}Xe	G						1.53E+02		7.56E-07	1.53E+02
^{133}Xe	G						3.93E+00		1.47E-07	3.93E+00
^{133m}Xe	G						3.60E+00		1.01E-18	3.60E+00
^{135}Xe	G						3.92E+01			3.92E+01
^{135m}Xe	G						1.70E+01			1.70E+01
$^{137}Xe^{f}$	G						6.22E+01			6.22E+01
^{138}Xe	G						9.35E+01			9.35E+01
^{88}Y	F					4.85E-06				4.85E-06
^{91}Y	M								1.60E-08	1.60E-08
^{65}Zn	F					6.98E-06				6.98E-06
^{65}Zn	M								2.70E-10	2.70E-10
^{95}Zr	M								2.64E-08	2.64E-08
^{95}Zr	S					7.46E-06				7.46E-06

[a] 1 Ci = 3.7E+10
[b] ^{248}Cf surrogate for ^{252}Cf
[c] ^{245}Cm surrogate for ^{248}Cm
[d] ^{88}Kr surrogate for ^{89}Kr
[e] ^{210}Po surrogate for ^{209}Po
[f] ^{135}Xe surrogate for ^{137}Xe

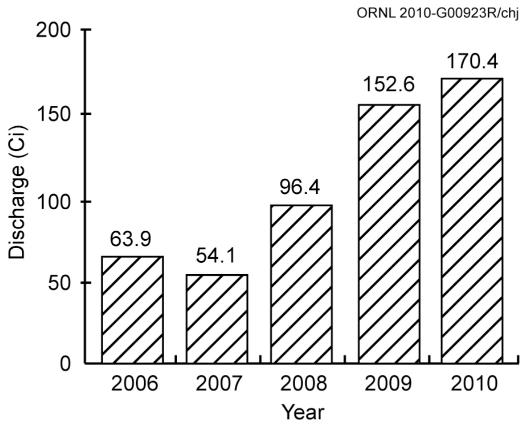

Fig. 5.12. Total discharges of ^{3}H from Oak Ridge National Laboratory to the atmosphere, 2006–2010.

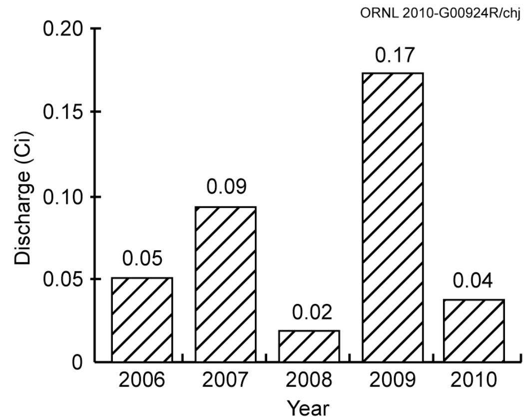

Fig. 5.13. Total discharges of ^{131}I from Oak Ridge National Laboratory to the atmosphere, 2006–2010.

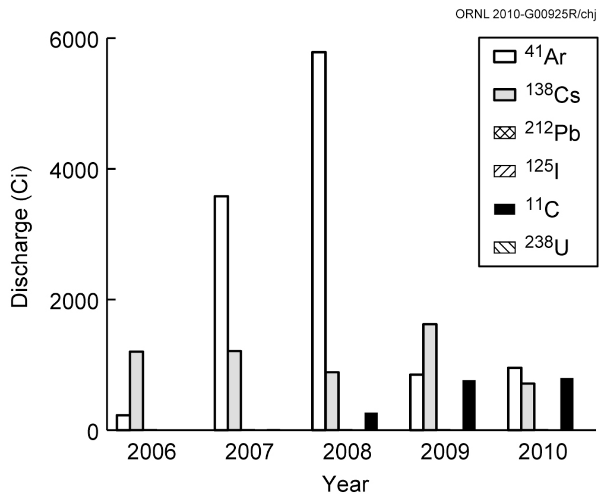

Fig. 5.14. Total discharges of ^{41}Ar, ^{138}Cs, ^{212}Pb, ^{125}I, ^{11}C, and ^{238}U from ORNL to the atmosphere, 2006–2010.

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 intentionally 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.

5.4.5 Ambient Air

The objectives of the ORNL ambient air monitoring program are to collect samples at site perimeter air monitoring (PAM) stations located in areas most likely to show impacts of airborne emissions from ORNL and to provide information to support emergency response activities. Four stations, identified as

Stations 1, 2, 3, and 7 (Fig. 5.15) make up the ORNL PAM network. Sampling is conducted at each station to quantify levels of tritium; uranium; adsorbable gases (e.g., iodine); and gross alpha-, beta-, and gamma-emitting radionuclides (Table 5.12).

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. A charcoal cartridge located behind the glass-fiber particulate filter is used to collect adsorbable gases. The charcoal cartridges are changed out and analyzed biweekly. A silica-gel column is used for collection of tritium as tritiated water. These samples are typically collected biweekly or weekly, depending on ambient humidity levels, and composited quarterly for tritium analysis.

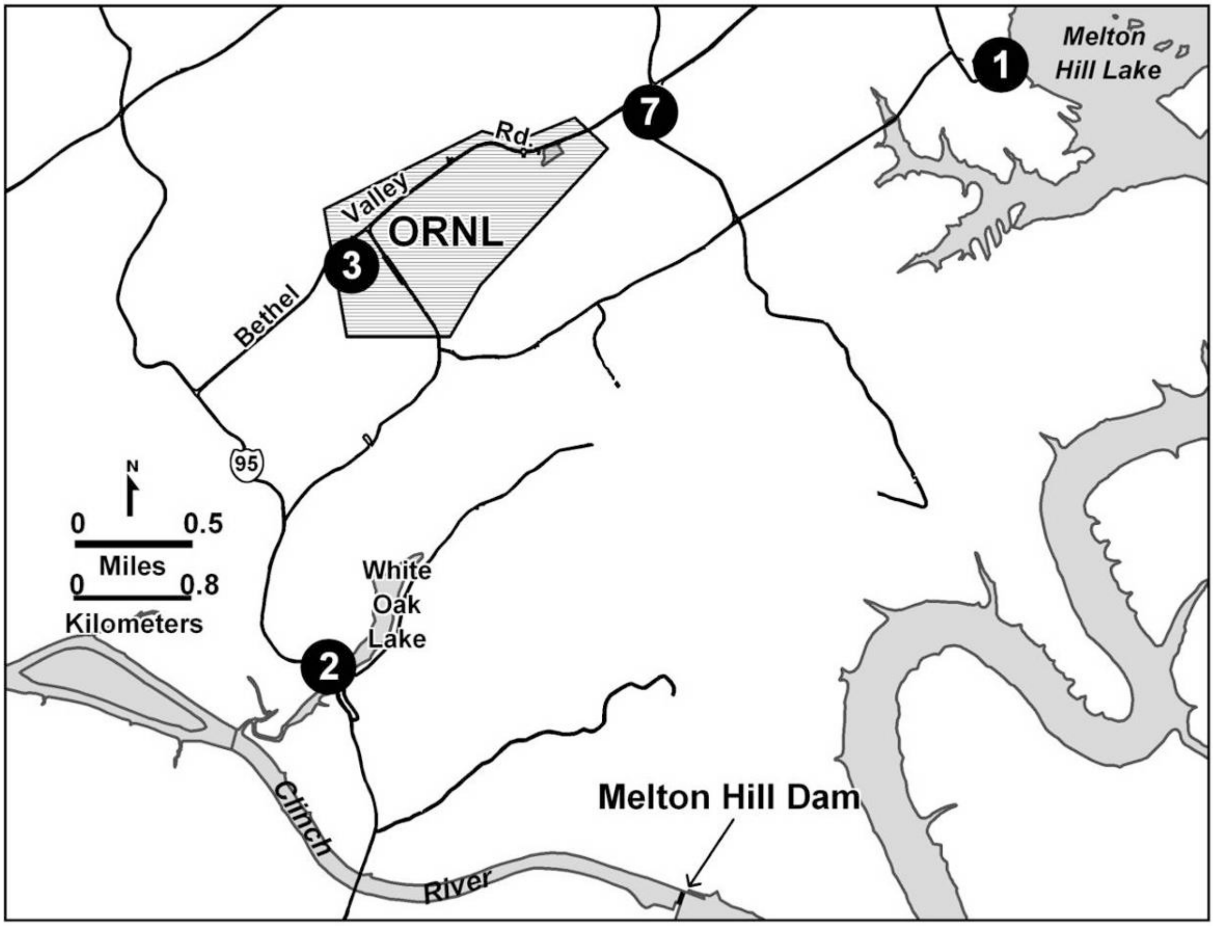

Fig. 5.15. Locations of ambient air monitoring stations at ORNL.

Table 5.12. Radionuclide concentrations (pCi/mL)[a] measured at ORNL perimeter air monitoring stations, 2010

Parameter	No. detected/ sampled	Concentration		
		Average	Minimum	Maximum
		Station 1		
Alpha	1/1	3.90E-10	*b*	*b*
^{7}Be	1/1	2.49E-08	*b*	*b*
Beta	1/1	1.80E-08	*b*	*b*
^{3}H	0/4	7.22E-06	4.11E-06	1.37E-05
^{40}K	26/26	2.38E-07	1.59E-07	3.35E-07
^{234}U	1/1	8.81E-12	*b*	*b*
^{235}U	0/1	6.78E-13	*b*	*b*
^{238}U	1/1	3.93E-12	*b*	*b*

Table 5.12. (continued)

Parameter	No. detected/ sampled	Concentration		
		Average	Minimum	Maximum
		Station 2		
Alpha	1/1	5.55E-10	*b*	*b*
^{7}Be	1/1	2.31E-08	*b*	*b*
Beta	1/1	1.96E-08	*b*	*b*
^{3}H	2/4	9.79E-06	3.14-06	1.84E-05
^{40}K	26/26	2.53E-07	1.41E-07	3.67E-07
^{234}U	1/1	9.45E-12	*b*	*b*
^{235}U	1/1	1.26E-12	*b*	*b*
^{238}U	1/1	4.83E-12	*b*	*b*
		Station 3		
Alpha	1/1	5.98E-10	*b*	*b*
^{7}Be	1/1	2.33E-08	*b*	*b*
Beta	1/1	1.79E-08	*b*	*b*
^{3}H	0/3	1.65E-06	6.46E-08	3.85E-06
^{40}K	26/26	2.42E-07	1.52E-07	3.53E-07
^{234}U	1/1	9.70E-12	*b*	*b*
^{235}U	1/1	1.69E-12	*b*	*b*
^{238}U	1/1	6.69E-12	*b*	*b*
		Station 7		
Alpha	1/1	4.46E-10	*b*	*b*
^{7}Be	1/1	2.42E-08	*b*	*b*
Beta	1/1	1.64E-08	*b*	*b*
^{3}H	0/3	3.35E-06	2.08E-06	6.37E-06
^{40}K	26/26	2.68E-07	4.35E-07	1.29E-07
^{234}U	1/1	1.28E-11	*b*	*b*
^{235}U	0/1	6.29E-13	*b*	*b*
^{238}U	1/1	5.75E-12	*b*	*b*

[a] 1 pCi = 3.7×10^{-2} Bq.
[b] Not applicable.

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 5.12) 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.) During 2010, average radionuclide concentrations measured for the ORNL network were less than 1% of the applicable DCGs in all cases.

5.5 ORNL Water Quality Program

NPDES Permit (TN 0002941), issued to DOE for the ORNL site, was renewed by the state of Tennessee in 2008, and includes requirements for discharging wastewaters from the three ORNL on-site wastewater treatment facilities and for the development and implementation of a Water Quality Protection Plan (WQPP). The permit calls for the WQPP to "establish better linkages between water quality monitoring and detecting and abating water quality and ecological impact." Rather than prescribing rigid monitoring schedules, the WQPP is flexible, allows an annual assessment of all outfalls, and focuses on significant findings. The goals of the WQPP are to meet the requirements of the NPDES permit, improve the quality of aquatic resources on the ORNL site, prevent further impacts to aquatic resources from current activities, identify the stressors that contribute to impairment of aquatic resources, use available resources efficiently, and communicate outcomes with decision makers and stakeholders.

The WQPP was developed by UT-Battelle and approved by TDEC in 2008, and WQPP monitoring was initiated in 2009. The WQPP incorporated several control plans that were required under the previous NPDES permit, including a Biological Monitoring and Abatement Plan (BMAP) (ORNL 1986), a Chlorine Control Strategy, a Storm Water Pollution Prevention Plan (ORNL 2007), a Non-Storm Water Best Management Practices Plan (ORNL 1997), and the *Oak Ridge National Laboratory NPDES Water Quality Protection Plan*, October 2008 (unpublished). The WQPP has been reviewed and revised annually, and submitted to TDEC for review and comment.

To prioritize the stressors and/or contaminant sources that may be of greatest concern to water quality, and to define conceptual models that would guide any special investigations, the WQPP strategy was defined using EPA's Stressor Identification Guidance (EPA 2000). A summary of this process is shown in Fig. 5.16. The Stressor Identification Guidance involves three major steps for identifying the cause of any impairment:

1. list candidate causes of impairment (based on historical data and a working conceptual model),
2. analyze the evidence (using both case study and outside data), and
3. characterize the cause.

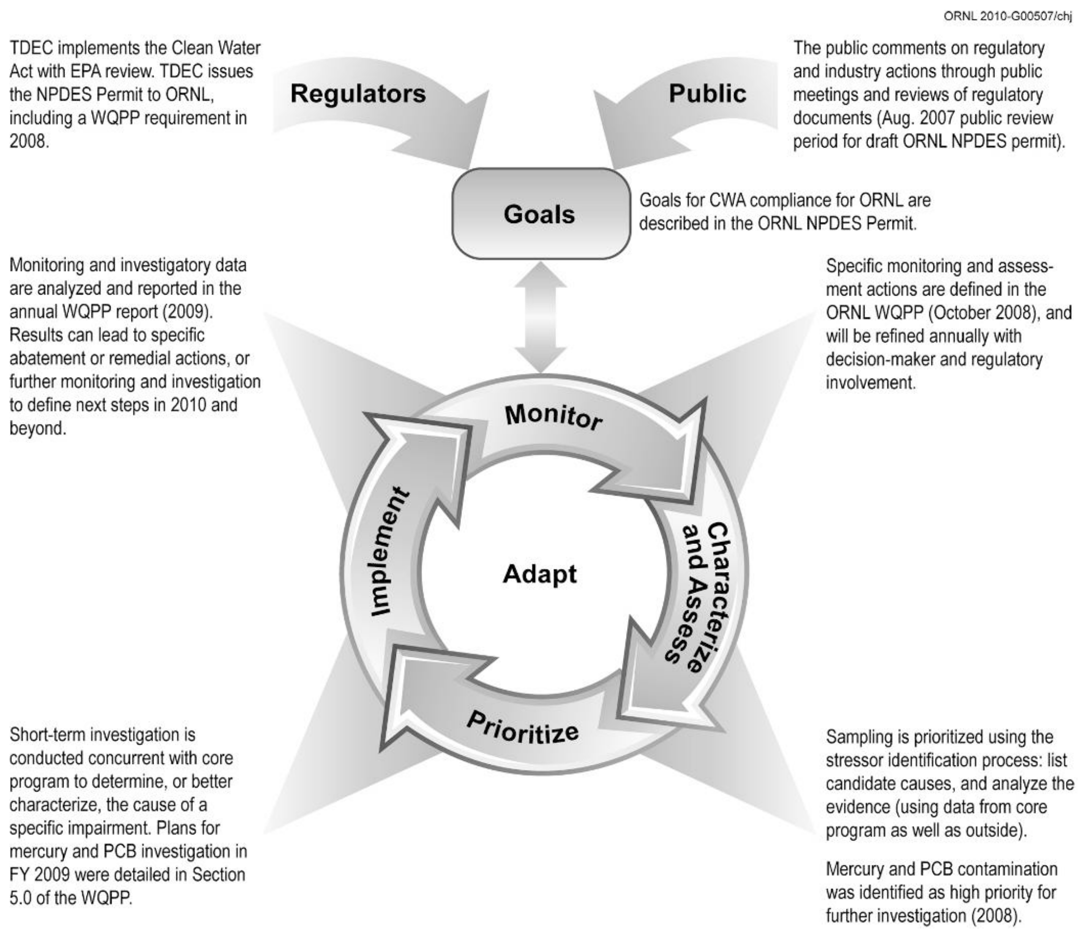

Fig. 5.16. Diagram of the adaptive management framework, with step-wise planning specific to the ORNL Water Quality Protection Plan. Adapted from EPA.

The first two steps of the stressor identification process were initiated in 2009, focusing first on mercury impairment (Fig. 5.17) and then on PCBs, since mercury and PCB concentrations in fish from White Oak Creek (WOC) are at or near human health risk thresholds (e.g., EPA ambient water quality criteria and TDEC fish advisory limits). Some of the major sources of mercury to biota in the WOC watershed are known, providing a good basis from which to define an appropriate conceptual model for mercury contamination in WOC. A list of potential causes of PCB contamination was also developed.

After listing potential causes and analyzing the available evidence on mercury and PCB contamination in the WOC watershed, it was clear that additional investigation was needed to complete the third step of the stressor identification process, "characterizing the cause." Special investigations were designed to identify specific source areas and to revise the conceptual model of the major causes of contamination in the WOC watershed.

At the end of each year, monitoring and investigation data collected under the WQPP will be analyzed, interpreted, reported, and compared with past results in the WQPP annual report. This information will provide a solid, overall assessment of the status of ORNL's receiving-stream watersheds and the impact of ongoing efforts to protect and restore those watersheds, and will guide efforts to improve the water quality in the watershed.

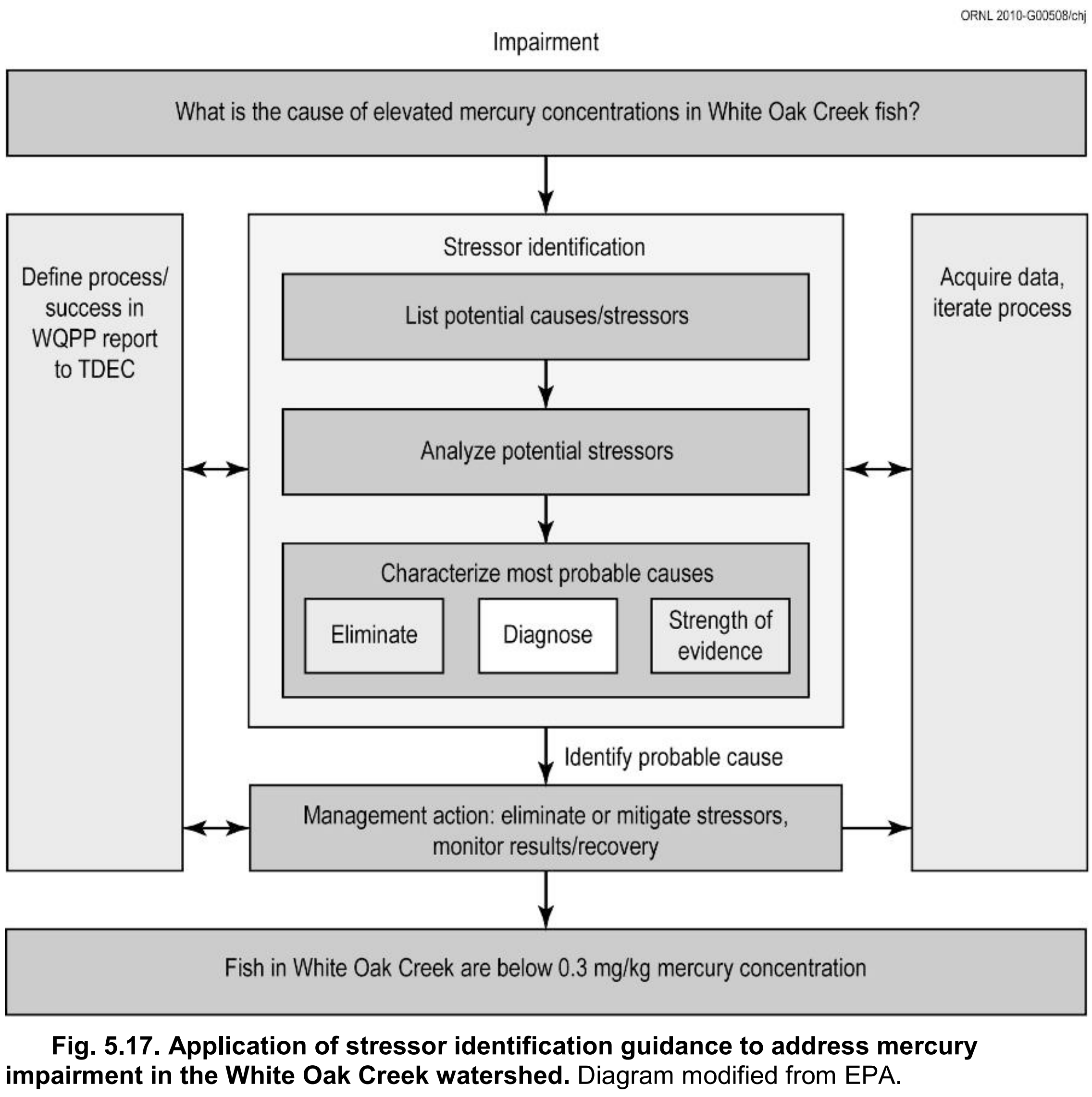

Fig. 5.17. Application of stressor identification guidance to address mercury impairment in the White Oak Creek watershed. Diagram modified from EPA.

5.5.1 Treatment Facility Discharges

Three onsite wastewater treatment systems are operated at ORNL to provide appropriate treatment of the various research and development, operational, and domestic wastewaters generated by site staff and activities. All three are permitted to discharge treated wastewater and are monitored under National Pollutant Discharge Elimination System (NPDES) Permit TN 0002941, issued to DOE for the ORNL site by TDEC. These are the ORNL STP (Outfall X01), the Steam Plant Wastewater Treatment Facility (SPWTF - Outfall X02), and the PWTC (Outfall X12). The ORNL NPDES Permit requirements include monitoring the three ORNL wastewater treatment facility effluents for conventional, water-quality-based, and radiological constituents, as well as for effluent toxicity, with numeric parameter-specific compliance limits established by TDEC as determined to be necessary. Monitoring results are available in the Oak Ridge Environmental Information System (OREIS). Access to this system can be requested via email (oreis@ettp.doe.gov) or by telephone at 865-574-3257.

The results of field measurements and laboratory analyses to assess compliance for the parameters required by the NPDES permit, as well as rates of compliance with numeric limits established in the permit, are also provided in Table 5.13. The three ORNL wastewater treatment facilities achieved 99.9% compliance with permit limits and conditions in 2010.

Table 5.13. National Pollutant Discharge Elimination System (NPDES) compliance at ORNL, 2010

(NPDES permit effective August 1, 2008)

Effluent parameters	Permit limits					Permit compliance		
	Monthly average (lb/d)	Daily max. (lb/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	26	100
Ammonia, as N (winter)	13.14	19.78	5.25	7.9		0	26	100
Carbonaceous biological oxygen demand	19.2	28.8	10	15		0	52	100
Dissolved oxygen					6	0	52	100
Escherichia coliform (col/100 mL)			941	126		1[b]	52	98
IC_{25} for *Ceriodaphnia* (%)					15.5	0	2	100
IC_{25} for fathead minnows (%)					15.5	0	2	100
Oil and grease	19.2	28.8	10	15		0	12	100
pH (standard units)				9	6	0	52	100
Total suspended solids	57.5	86.3	30	45		0	52	100
X02 (Steam Plant Wastewater Treatment Facility)								
pH (standard units)				9.0	6	1[c]	51	98
Total suspended solids				50		0	6	100

Table 5.13 (continued)

Effluent parameters	Permit limits					Permit compliance		
	Monthly average (lb/d)	Daily max. (lb/d)	Monthly average (mg/L)	Daily max. (mg/L)	Daily min. (mg/L)	Number of noncompliances	Number of samples	Percentage of compliance[a]
X12 (Process Waste Treatment Complex)								
LC_{50} for *Ceriodaphnia* (%)					100	0	2	100
LC_{50} for fathead minnows (%)					100	0	2	100
Arsenic, total			0.007	0.014		0	6	100
Cadmium, total	1.73	4.60	0.003	0.038		0	6	100
Chromium, total	11.40	18.46	0.22	0.44		0	6	100
Copper, total	13.8	22.53	0.07	0.11		0	6	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	6	100
IC_{25} for *Ceriodaphnia* (%)					30.5	0	2	100
IC_{25} for fathead minnows (%)					30.5	0	2	100
Oil and grease	66.7	100	10	15		0	12	100
pH (standard units)				9.0	6.0	0	52	100
Temperature (°C)				30.5		0	52	100
In-stream chlorine monitoring points								
Total residual oxidant			0.011	0.019		0	288	100

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

[b]The exceedance of E. coli at X01 occurred on May 5, 2010, and was attributed to heavy rainfall which resulted in modified operations at the Sewage Treatment Plant.

[c]On June 18, 2010, the SPWTF treated and discharged a batch of wastewater without NPDES effluent measurements being taken. Operational data indicated that the effluent met specifications but the missed NPDES measurement constitutes permit nonconformance.

Abbreviations

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

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.

Effluent toxicity testing provides an assessment of any harmful effects that could occur from the total combined constituents in the ORNL wastewater treatment facility effluents. The STP and SPWTF have been tested for toxicity to aquatic species under the NPDES Permit every year since 1986, and the PWTC since it went into operation in 1990. Test species have been *Ceriodaphnia dubia*, an aquatic invertebrate, and fathead minnow (*Pimephales promelas*) larvae. These have been tested using EPA chronic and acute test protocols at frequencies ranging from two to four times per year. Test results have been excellent. SPWTF and PWTC effluent have always been shown to be nontoxic. The STP has shown isolated indications of effluent toxicity, but confirmatory tests conducted as required by the permit have shown that either the result of the routine test was an anomaly or that the condition of toxicity that existed at the time of the routine test was temporary and of short duration.

Toxicity test requirements under the current NPDES permit include testing of the STP and PWTC twice per year each, using two test species. The toxicity potential of the SPWTF was mitigated in 2003 by the removal of the ORNL Steam Plant's Coal Yard (the Steam Plant was converted from coal burning to natural gas), thereby removing the need to treat and discharge coal yard storm water runoff. It was determined by TDEC that toxicity testing of the SPWTF effluent, which now includes only treated boiler blowdown and water-softener regeneration wastewaters from the ORNL Steam Plant, was no longer necessary. In 2010, toxicity test results for the ORNL wastewater treatment facilities were once again favorable, with no indication of toxicity in any of the tests that were conducted (Table 5.13).

5.5.2 Residual Bromine and Chlorine Monitoring

Chlorine is added to drinking water to disinfect it and to keep it safe for consumption. Chlorine and bromine are added to cooling system water to prevent bacterial growth in the system. When waters are discharged to streams, residual chlorine and bromine can be toxic to fish and other aquatic life. The ORNL NPDES permit controls the discharge of chlorinated and bromated waters, reported as Total residual oxidant (TRO), by limiting the TRO mass loading from outfalls and the TRO concentration in-stream. Outfalls with lower potential to discharge chlorinated water are generally monitored semiannually; outfalls with known sources that are dechlorinated are monitored more frequently to ensure operational integrity of the dechlorinator. In-stream locations are monitored bimonthly.

NPDES permit outfalls are monitored for TRO to ensure effective operation of cooling towers and dechlorination systems and maintenance of water lines. When the permit action level of 1.2 grams per day is exceeded at an outfall, the staff investigates and implements treatment and reduction measures. TRO is also monitored at in-stream points twice per month to verify that releases are not creating adverse conditions for fish and other aquatic life.

Thirty-two individual outfalls were checked for TRO either semiannually, quarterly, monthly, or bimonthly throughout the year for a total of 270 attempts. Flow was detected 239 times. Table 5.14 lists instances in 2010 where outfalls were found to be in excess of the TRO action level. Three outfalls, 265 and 368, on Fifth Creek, and 312, on White Oak Creek, exceeded the action level during 2010. The sources for Outfalls 265 and 368 have been determined to be from aging, underground water pipes that are leaking drinking water. Outfall 312 was inadvertently receiving once-through cooling water that has now been removed from that storm drain network.

Table 5.14. Outfalls exceeding total residual oxidant (TRO) action level[a] in 2010

Sample date	Outfall	TRO concentration (mg/L)	Flow (gpm)	Load (grams/ day)	Receiving stream	Downstream integration point	Instream TRO point
2/11/2010	312	0.255	12	16.35	White Oak Creek	WCK 3.9	X24
2/11/2010	368	1.25	15	102.2	Fifth Creek	FFK 0.2	X20
4/5/2010	265	0.2	6.5	7.08	Fifth Creek	FFK 0.2	X19
4/5/2010	312	0.15	6.5	5.31	White Oak Creek	WCK 3.9	X24

[a]1.2 grams per day.

5.5.3 Cooling Tower Blowdown Monitoring

As part of the WQPP at ORNL, cooling tower blowdown effluents were monitored twice in 2010. Only field parameters (conductivity, dissolved oxygen, pH, and temperature) were collected during the March sampling event. In August, field parameters were measured along with the following laboratory analyses: chemical oxygen demand, total suspended solids, and total metals. All samples were grab samples.

The cooling towers that were monitored in 2010 are listed in Table 5.15. In the second half of 2010, monitoring was added for two relatively new cooling towers—5309 and 5807. Cooling tower 6001 was decommissioned after the March sampling event and replaced with new cooling tower 6018 before the August sampling event. Two towers were targeted for sampling but were not sampled: tower 2535 was not operating during any sampling events, and tower 7923 was not sampled because blowdown does not reach a receiving stream (blowdown infiltrates into the ground before reaching a receiving stream). Field measurements are presented in Table 5.16, and results from laboratory analyses are presented in Table 5.17.

Where possible, cooling towers were sampled at the outfalls where blowdown is discharged to the receiving streams. In a few instances, tower water was sampled at the basin under the cooling tower. This was necessary in cases where it was not possible to determine if and when blowdown was present at the outfall. The release of cooling tower blowdown is intermittent, and its presence or absence can be masked when blowdown is commingled with other wastewaters prior to discharge.

Table 5.15. Cooling tower/cooling tower systems monitored at ORNL in 2010

Cooling tower/ tower system	NPDES outfall receiving blowdown	Sampled location
2026	249	Tower Basin
2539	204	Tower Basin
3047	367	Tower Basin
3517	304	Tower Basin
4510/4521	014	Outfall
5300	363	Outfall
5309[a]	363	Tower Basin
5600	227	Outfall
5807[a]	231	Tower Basin
6001[b]	314	Tower Basin
6018[b]	314	Tower Basin
7619	291	Outfall
7626	191	Outfall
7902	281	Outfall
8913	435	Outfall

[a] Towers 5309 and 5807, relatively new towers, were added to the sampling task for the second half of 2010.

[b] The 6001 tower was decommissioned and replaced with tower 6018 in 2010.

The state of Tennessee has established water quality criteria (WQC) for instream temperature as a basis to control the effects of wastewater discharges on receiving waters designated for fish and aquatic life, recreation, domestic water supply, and/or industrial water supply uses. The WQC addresses maximum instream temperature (30.5°C), maximum rate of instream temperature change (2°C per hour), and instream temperature change relative to an upstream control point (3°C). Monitoring of instream temperature in the vicinity of the major cooling water discharges at ORNL was conducted on August 23, 2010. Monitoring was targeted to the third calendar quarter of the year when stream flows are typically low, air and water temperatures are warm and cooling demand is typically at a maximum. Instream temperature measurements at all monitored locations were in compliance with the aforementioned WQC. Individual temperature measurements from the August 23 monitoring are presented Table 5.18 and results of calculations of rates of temperature change and temperature changes relative to upstream control points are provided in Table 5.19.

Table 5.16. Field measurements collected in blowdown from ORNL cooling towers

Cooling Tower[a]	Sampled location	Date	Flow[b] (gpm)	Conductivity (mS/cm)	Dissolved oxygen (mg/L)	pH (standard unit)	Temperature (°C)
2026	2026 basin	3/30/2010	*Tower was not operating during the March sampling attempt*				
2026	2026 basin	8/17/2010	Unknown	1.2	6.1	8.8	26.9
2539	2539 basin	3/30/2010	Unknown	0.368	8.6	8.2	13.4
2539	2539 basin	8/17/2010	Unknown	0.875	6.5	8.1	23.5
3047	3047 basin	3/30/2010	*Tower was not operating during the March sampling attempt*				
3047	3047 basin	8/17/2010	Unknown	1.04	7.3	8.9	29.6
3517	3517 basin	3/30/2010	Unknown	0.32	7.1	8.4	18.3
3517	3517 basin	8/17/2010	Unknown	0.386	6.2	8.2	27.2
5300	Outfall 363	3/30/2010	8	0.639	6.9	8	18.7
5300	Outfall 363	8/17/2010	15	0.842	6.2	8.1	24.4
5309	5309 basin	3/30/2010	*Tower was added to sampling program after the March event*				
5309	5309 basin	8/17/2010	Unknown	0.95	6.1	8.7	26.9
5600	Outfall 227	3/30/2010	35	1.01	7.8	8.4	20.8
5600	Outfall 227	8/17/2010	20	0.809	7.3	8	28.3
5807	5807 basin	3/30/2010	*Tower was added to sampling program after the March event*				
5807	5807 basin	8/17/2010	Unknown	1.06	6.8	8.9	27.2
6001	6001 basin	3/30/2010	*Tower was not operating during the March sampling attempt*				
6001	6001 basin	8/17/2010	*Tower was decommissioned prior to the August sampling event*				
6018	6018 basin	3/30/2010	*Tower was placed into service after the March sampling event*				
6018	6018 basin	8/17/2010	Unknown	1.07	7.8	8.9	25.8
7619	Outfall 291	3/30/2010	2.5	0.308	7.9	7.7	12.4
7619	Outfall 291	8/17/2010	0.25	0.318	6	7.7	26.8
7626	Outfall 191	3/30/2010	4	0.237	8.1	7.8	12.1
7626	Outfall 191	8/17/2010	12	0.246	6.2	8	26.4
7902	Outfall 281	3/30/2010	30	0.102	6.5	7.5	22.7
7902	Outfall 281	8/17/2010	45	1.58	7.3	7.8	26.1
8913	Outfall 435	3/30/2010	150	0.244	8.8	8.1	12.6
8913	Outfall 435	8/17/2010	30	0.391	6.2	7.7	22.2
4510/4521	Outfall 014	3/30/2010	*Tower was not operating during the March sampling attempt*				
4510/4521	Outfall 014	8/17/2010	30	1.2	7.9	8.2	27

[a]Cooling Towers 2535 and 7923 were not operating during either the March or August sampling attempts and are therefore not included in this table.

[b]Cooling tower blowdown flow rates are not known for towers that were sampled at the tower basins.

5.5.4 Radiological Monitoring

Monitoring of effluents and instream locations for radioactivity is conducted under the UT-Battelle WQPP. Table 5.20 details the monitoring frequency and target analyses for three treatment facility outfalls, three in-stream monitoring locations, and 22 category outfalls (outfalls that discharge effluents with relatively minor constituents that receive little or no treatment prior to discharge). Dry-weather discharges from category outfalls are primarily cooling water, groundwater, and condensate. Low levels of radioactivity can be discharged from category outfalls in areas where groundwater contamination exists and where groundwater enters category outfall collection systems from building and facility sumps, building footer drains, and from direct infiltration. In 2010, dry-weather grab samples were collected at 19 of the 22 category outfalls targeted for sampling. The remaining three outfalls were not sampled because there was no discharge present during sampling attempts.

Table 5.17. Results (in mg/L) from laboratory analyses of blowdown from ORNL cooling towers

Date sampled: August 17, 2010

	Cooling Tower (Sample Location)													
	2026 (2026 basin)	2539 (2539 basin)	3047 (3047 basin)	3517 (3517 basin)	4510/4521 (Outfall 014)	5300 (Outfall 363)	5309 (5309 basin)	5600 (Outfall 227)	5807 (5807 basin)	6018[a] (6018 basin)	7619 (Outfall 291)	7626 (Outfall 191)	7902 (Outfall 281)	8913 (Outfall 435)
COD	36.1	25.5	30.8	J9.74	49.2	41.3	57.1	33.4	41.3	67.6	20.3	J17.6	30.8	J17.6
TSS	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	7	17	< 2	< 2
Ag	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619
As	0.0037	< 0.001	0.00112	< 0.001	0.00296	0.00237	0.00352	0.00127	< 0.001	0.00404	< 0.001	< 0.001	< 0.001	0.00173
Be	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686
Ca	178	134	153	58.1	188	112	134	123	157	144	66.7	59	212	66.8
Cd	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	0.00117	< 0.000782	< 0.000782	< 0.000782	< 0.000782
Cr	0.00156	0.00138	0.00105	< 0.001	0.00143	0.00123	0.00132	0.00162	< 0.001	0.00176	< 0.001	0.00287	0.00183	0.00133
Cu	0.339	0.00802	0.0194	0.0306	0.00366	0.0547	0.069	0.0103	0.26	0.0452	0.00279	0.00689	0.00707	0.00272
Fe	0.0691	0.339	< 0.0206	0.0528	< 0.0206	0.0385	1.19	0.0537	0.0365	0.102	0.36	0.321	0.0249	0.103
Mg	58.7	39.3	53.3	15.1	56	35.2	40.7	34.7	46.8	44	12.8	10	61.1	21.5
Mn	0.00678	0.014	0.00167	0.00296	0.0025	0.00664	0.0036	0.00816	0.00277	0.00756	0.196	0.097	0.00251	0.138
Mo	0.063	0.389	0.00515	0.00159	0.172	0.401	0.146	0.0899	0.12	0.774	< 0.000931	0.0381	0.00296	0.00664
Ni	0.00731	0.00523	0.0054	0.00194	0.00779	0.0046	0.00598	0.00434	0.00561	0.00531	0.00187	0.00297	0.00939	0.00212
Pb	< 0.001	< 0.001	0.0012	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.00114	0.00158	< 0.001	< 0.001
Sb	< 0.00081	< 0.00081	< 0.00081	< 0.00081	0.00289	< 0.00081	< 0.00081	< 0.00081	< 0.00081	< 0.00081	< 0.00081	< 0.00081	0.00224	< 0.00081
Se	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406
Zn	0.132	0.104	0.051	0.0875	0.236	0.227	0.378	0.191	0.286	0.637	< 0.02	0.0408	0.066	0.0374

[a] The 6001 cooling tower was decommissioned prior to the August sampling event. It was replaced with Tower 6018, which was sampled in August.

Table 5.18. Field measurements from 2010 instream temperature assessment
Monitoring Date: August 23, 2010

Monitoring Locations	Field Measurements							
	Round 1		Round 2		Round 3		Round 4	
	Temp. (°C)	Time (EDT)	Temp. (°C)	Time (EDT)	Temp. (°C)	Time (EDT)	Temp. (°C)	Time (EDT)
Upstream of Outfall 014	23.8	08:30	23.9	09:34	25.2	13:00	25.4	14:05
Downstream of Outfall 014	23.8	08:31	23.9	09:35	25.3	13:01	25.5	14:06
Upstream of Outfall 227	23.8	08:50	23.9	09:54	25.6	12:55	25.8	14:00
Downstream of Outfall 227	23.6	08:51	23.7	09:55	25.0	12:56	25.2	14:01
Upstream of Outfall 281	23.1	08:45	23.1	09:46	23.7	13:17	23.8	14:21
Downstream of Outfall 281	25.5	08:46	25.6	09:47	23.4	13:18	23.4	14:22
Upstream of Outfall 314	21.1	09:06	21.3	10:09	22.5	13:30	22.6	14:39
Downstream of Outfall 314	21.2	09:07	21.6	10:10	22.1	13:31	22.2	14:40
Upstream of Outfall 363	18.6	08:34	18.9	09:39	19.7	13:04	19.9	14:10
Downstream of Outfall 363	19.7	08:35	19.9	09:40	20.4	13:05	20.6	14:11
Upstream of Outfall 435	16.9	09:00	17.1	10:03	18.8	13:24	18.8	14:46
Downstream of Outfall 435	19.2	09:01	19.4	10:04	20.7	13:25	20.8	14:47

Table 5.19. Measurements of instream temperature change for stream reaches receiving cooling tower blowdown at ORNL
Monitoring Date: August 23, 2010

Stream reach assessed (discharge outfall/cooling system)	Temperature change over length of stream reach (upstream to downstream of cooling system)				Rate of temperature change at downstream end of stream reach between rounds of sampling		
	Round 1 (°C)	Round 2 (°C)	Round 3 (°C)	Round 4 (°C)	Round 1 to Round 2 (°C/hr)	Round 2 to Round 3 (°C/hr)	Round 3 to Round 4 (°C/hr)
Outfall 014 (4510/4521) Cooling System	0.0	0.0	0.1	0.1	0.1	0.4	0.2
Outfall 227 (5600 Cooling System)	-0.2	-0.2	-0.6	-0.6	0.1	0.4	0.2
Outfall 281 (7902 Cooling System)	2.4	2.5	-0.3	-0.4	0.1	-0.6	0.0
Outfall 314 (6018 Cooling System)	0.1	0.3	-0.4	-0.4	0.4	0.1	0.1
Outfall 363 (5300 Cooling System)	1.1	1.0	0.7	0.7	0.2	0.1	0.2
Outfall 435 (8913 Cooling System)	2.3	2.3	1.9	2.0	0.2	0.4	0.1

Table 5.20. Radiological monitoring conducted under the ORNL Water Quality Protection Plan, 2010

Location	Frequency	Gross alpha/beta[a]	Gamma scan	^{3}H	Total rad Sr	Isotopic uranium	^{14}C	$^{243/244}Cm$
Outfall 001	Annually	X						
Outfall 080	Monthly	X	X	X	X			X
Outfall 081	Annually	X						
Outfall 085	Quarterly	X	X	X	X	X		
Outfall 203 [b]	Annually	X	X		X			
Outfall 204	Semiannually	X	X		X			
Outfall 205 [b]	Annually	X						
Outfall 207	Quarterly	X	X		X			
Outfall 211	Annually	X						
Outfall 217	Annually	X						
Outfall 219	Annually	X						
Outfall 234	Annually	X						
Outfall 241	Quarterly	X	X	X	X	X		
Outfall 265	Annually	X						
Outfall 281	Quarterly	X		X				
Outfall 282	Quarterly	X						
Outfall 284 [b]	Annually	X						
Outfall 302	Monthly	X	X	X	X			
Outfall 304	Monthly	X	X	X	X			
Outfall 365	Semiannually	X						
Outfall 368	Annually	X						
Outfall 383	Annually	X		X				
Sewage Treatment Plant (X01)	Monthly	X	X	X	X		X	
Steam Plant Wastewater Treatment Facility (X02)	Monthly	X			X			
Process Waste Treatment Complex (X12)	Monthly	X	X	X	X	X		
Melton Branch 1 (X13)	Monthly	X	X	X	X			
WOC (X14)	Monthly	X	X	X	X			
WOD (X15)	Monthly	X	X	X	X			

[a]Isotopic analyses are performed to identify contributors to gross activities when results exceed screening criteria described in the described in the Water Quality Protection Plan, October 2008.

[b]No discharge present during sampling attempts.

The three treatment facilities monitored were the STP, SPWTF and the PWTC. The three instream monitoring locations were X13 on Melton Branch, X14 on White Oak Creek, and X15 at White Oak Dam (WOD) (Fig. 5.18). At each of these treatment facilities and instream monitoring stations, monthly flow-proportional composite samples were collected using dedicated automatic water samplers.

Expressing radioactivity concentrations as percentage of the DOE DCG values is used in this section as a means of comparing effluent points with different radioisotope signatures. Annual average concentrations were compared with DCG concentrations where a DCG existed (there are no DCGs for gross alpha and gross beta activities) and when at least one individual measurement indicated detectable activity [i.e., at least one individual measurement had a concentration greater than or equal to the measurement's minimum detectable activity (MDA)]. For analyses that 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 in the comparison. DCGs are not intended to be thresholds for in-stream values as they are for effluents but are nonetheless

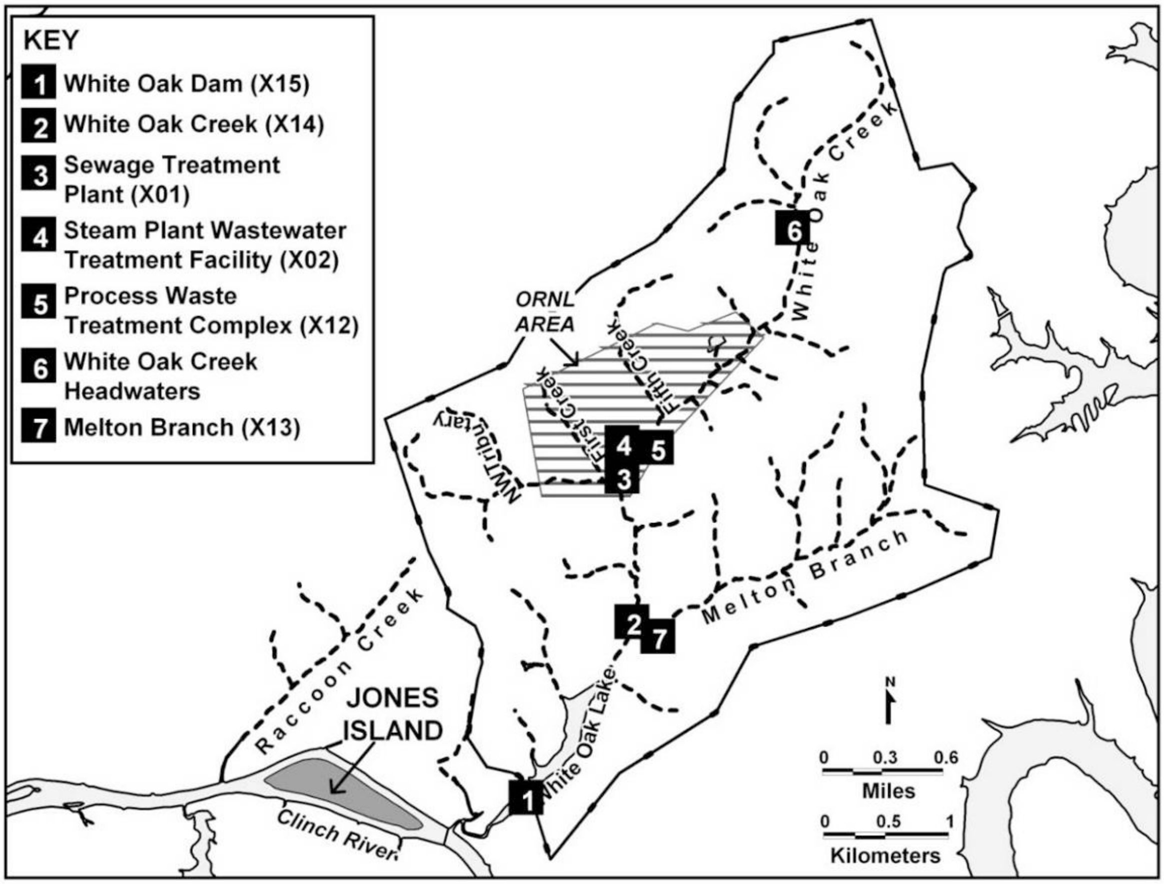

Fig. 5.18. ORNL surface water, National Pollutant Discharge Elimination System, and reference sampling locations.

useful as a frame of reference. Effluents and instream concentrations are compared to DCGs that were established for exposures to humans by ingesting water, but their use in this section does not imply that ORNL effluents or ambient waters are sources of drinking water.

Four percent of the DCG is used as a comparison point. Four percent of the DCG is roughly equivalent to the 4-mrem dose limit on which the EPA radionuclide drinking water standards are based. The annual average concentration of at least one radionuclide exceeded 4% of the relevant DCG concentration in dry-weather discharges from NPDES Outfalls 080, 085, 241, 302, 304, X01, X02 and X12 and at in-stream sampling locations X14 and X15 (Fig. 5.19).

In 2010, two outfalls had annual average radionuclide concentrations exceeding 100% of DCG concentrations. Outfall 080 in Melton Valley has exceeded DCG concentrations most years since 2006 when a release apparently occurred from a nearby remediation activity to grout an abandoned waste pipeline. It is believed that residual waste material in a compromised section of pipeline was lost during the grouting process, and infiltration of contaminated groundwater into the Outfall 080 pipe network occurs when the water table is high enough for groundwater to come into contact with the outfall's pipe network. In 2010, the average of two measurements of $^{243/244}$Cm was 240 pCi/L, 4.8 times the DCG for ^{243}Cm and 4 times the DCG for ^{244}Cm. (Although the analytical test does not differentiate between ^{243}Cm and ^{244}Cm, ^{244}Cm is thought to be the predominant radioisotope in this discharge.) Although these concentrations are greater than DCG levels, they are within the target human health risk range for the Record of Decision for Interim Actions in Melton Valley and no remediation activities are planned for this outfall. Average concentrations of ^{241}Am, $^{239/240}$Pu, and $^{89/90}$Sr were also notable: 28%, 9%, and 12% of their respective DCGs. The flow rates from Outfall 080 are typically low (1.5 and 0.1 gpm during the two sampling events in 2010), and therefore no significant changes in contaminant concentrations have

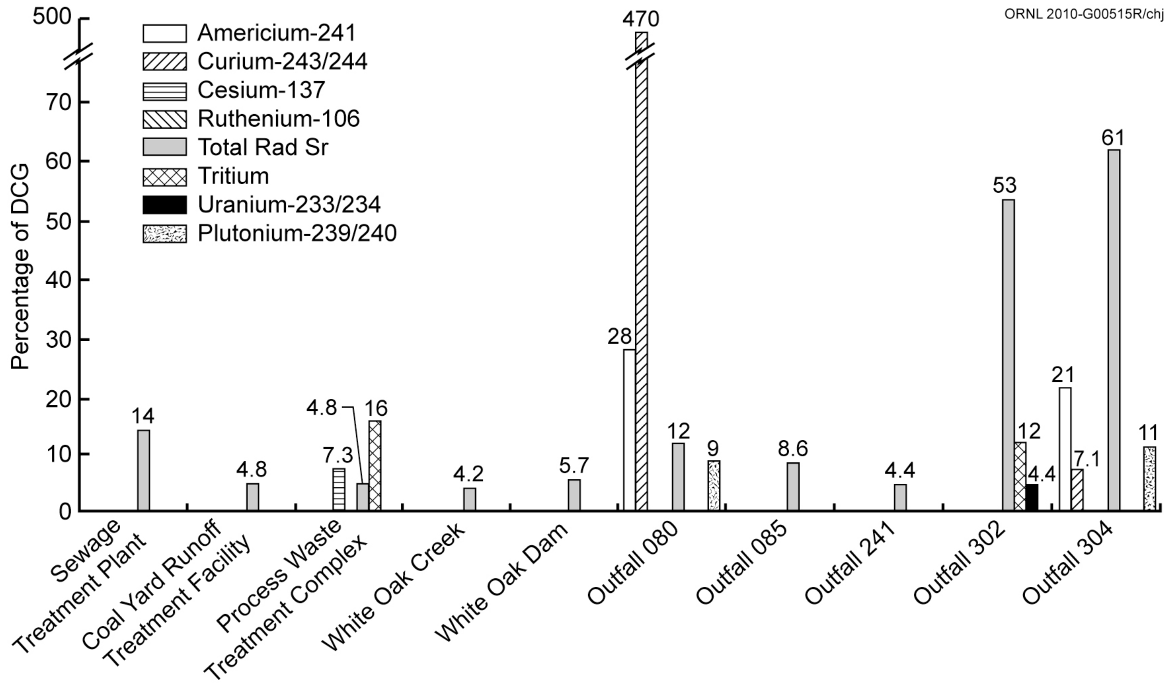

Fig. 5.19. Radionuclides at ORNL sampling sites having average concentrations greater than 4% of the relevant derived concentration guides in 2010.

been detected in downstream monitoring. It was first reported in the 2006 ASER, when annual average concentrations were considerably higher, that although concentrations are greater than DCG levels, they are within the target human health risk range for the Record of Decision for Interim Actions in Melton Valley. Therefore no remediation actions are planned for Outfall 080.

During 2010, average radioactivity levels at Outfall 304 exceeded DCG levels on a sum-of-fractions basis (i.e., the annual average concentrations of all individual radiological parameters were below their respective DCG levels, but the summation of DCG percentages of the multiple radiological parameters added up to approximately 108%). The radiological parameters with the largest concentrations at Outfall 304 in terms of percent of their respective DCGs were ^{241}Am (21%), $^{243/244}$Cm (7.1%), ^{137}Cs (2.7%), ^{40}K (2.3%), $^{239/240}$Pu (11%), $^{89/90}$Sr (61%), and $^{233/234}$U (2.6%). A dye tracer test conducted in November 2010 at the Process Waste Treatment Complex (Building 3544) identified a hydrologic connection via groundwater between the L-5 clearwell at the southeast corner of the facility and Outfall 304. It was determined that water was leaking from the north cell of the L-5 clearwell to the south cell, which was taken out of service several years prior because of a leak. Repairs were made to the L-5 clearwell in early 2011 to stop the leak between the north and south cells. Levels of radioactivity at Outfall 304 following the repair appear to be decreasing and are expected to return to normal over time.

The dye tracer test of the Building 3544 L-5 clearwell also revealed that some of the leaked water was finding its way into the pipe network leading to Outfall 302. Though concentrations of radioactivity were also elevated at Outfall 302 in 2010, they remained below DCG levels on an annual average basis. Flow rates from both Outfalls 302 and 304 were low enough in comparison to the receiving stream flow rate that significant changes in concentrations of radioactivity were not observed at downstream monitoring stations during the period of the release.

The total annual discharges (or amounts) 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. 5.20 through 5.24. CY 2010 discharges of radioactivity at WOD continue to be generally decreased in comparison to years preceding completion of the waste area caps in Melton Valley. Because discharges of radioactivity are somewhat correlated to stream flow, annual flow volumes measured at the WOD monitoring station are given in Fig. 5.25.

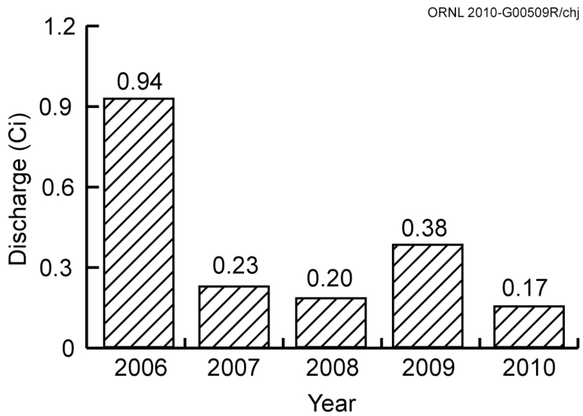

Fig. 5.20. Cesium-137 discharges at White Oak Dam, 2006–2010.

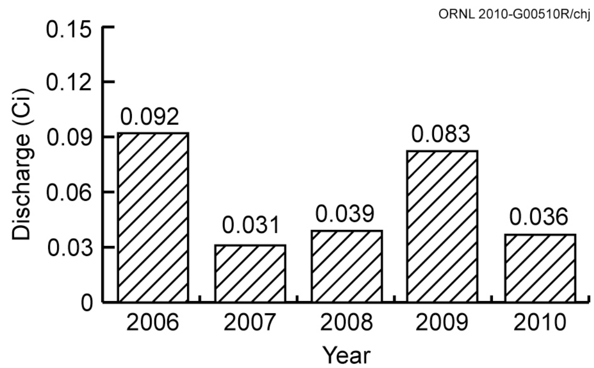

Fig. 5.21. Gross alpha discharges at White Oak Dam, 2006–2010.

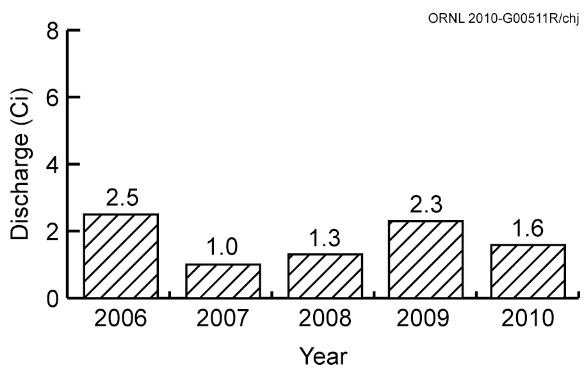

Fig. 5.22. Gross beta discharges at White Oak Dam, 2006–2010.

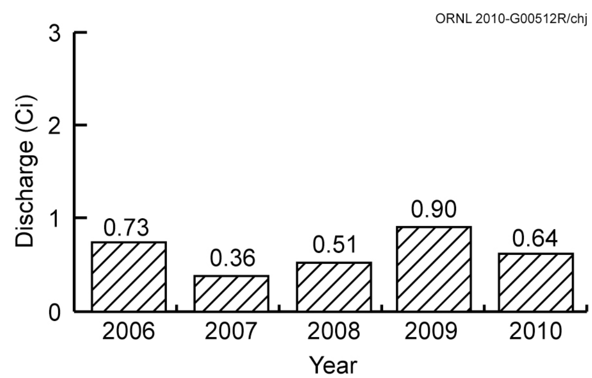

Fig. 5.23. Total radioactive strontium discharges at White Oak Dam, 2006–2010.

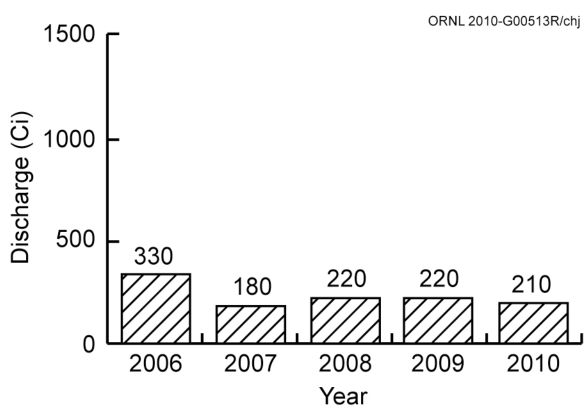

Fig. 5.24. Tritium discharges at White Oak Dam, 2006–2010.

5.5.5 Mercury in the WOC Watershed

Legacy mercury environmental contamination exists at ORNL, due largely to spills and releases that occurred in the 1950s during isotope separation pilot-scale work in Buildings 3503, 3592, 4501, and 4505. As a result, mercury is present in soils and groundwater in and around these four facilities. Mercury also is present in Fifth Creek and White Oak Creek surface streams that receive surface runoff and groundwater flow from the area of these buildings.

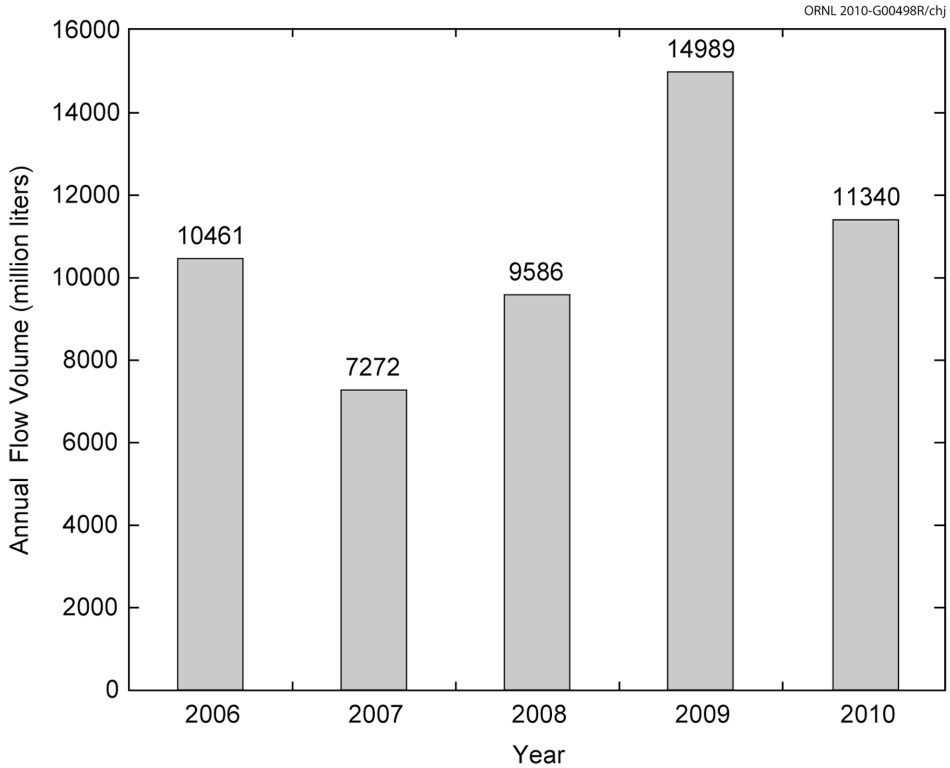

Fig. 5.25. Annual flow volume at White Oak Dam, 2006–2010.

Process wastewater drains and building sumps from Buildings 4501 and 4505, the facilities where most of the ORNL mercury work was conducted, are routed via underground collection-system piping to the ORNL PWTC for treatment to remove constituents including mercury prior to discharge to White Oak Creek. In 2007, another groundwater sump in Building 4501 that had accumulated legacy mercury contamination from building foundation drains was rerouted from storm drain Outfall 211 to the PWTC, and in 2009 a mercury pretreatment unit was installed in Building 4501 to remove most of the mercury from the sump discharge prior to routing to the PWTC for final treatment. These recent actions have significantly diminished the release of legacy mercury contamination from the ORNL site to the White Oak Creek watershed (Fig. 5.26).

For the mercury-investigation component of the WQPP, data collected during initial monitoring indicates effluent sampling at additional outfalls and instream reaches needs to be incorporated in future WQPP revisions to help prioritize future abatement actions and to delineate mercury sources.

In 2010, monitoring conducted under the WQPP included wet-weather (storm event) sampling at a number of instream points in the White Oak Creek watershed upstream, within, and downstream from ORNL and ORNL NPDES outfalls where previous monitoring or site history has shown the potential for effluent mercury. Flow measurements were made for instream and outfall sampling locations. Concentration and flux values were measured and calculated. Selected results of the 2010 monitoring are shown in Figs. 5.27 and 5.28, and complete mercury monitoring results are available in the Oak Ridge Environmental Information System (OREIS). Access to this system can be requested via email (oreis@ettp.doe.gov) or by telephone at 865-574-3257.

Monitoring results for 2009 indicated that Tennessee mercury criteria were met at all instream locations with a few stream reaches showing higher concentrations and/or fluxes than the others including Outfall 211 and the area downstream in White Oak Creek; a particular reach of Fifth Creek; and White Oak Creek downstream of the confluence with Fifth Creek. Wet-weather monitoring conducted in 2010 indicates that stormwater runoff in these areas contributes to the releases of mercury from the ORNL site.

In 2010 underground storm drain piping that discharges to Outfall 211 was investigated using remote-control mobile television cameras and resulted in visual evidence of mercury residues within the pipe, and evaluations of potential remedial activities were initiated.

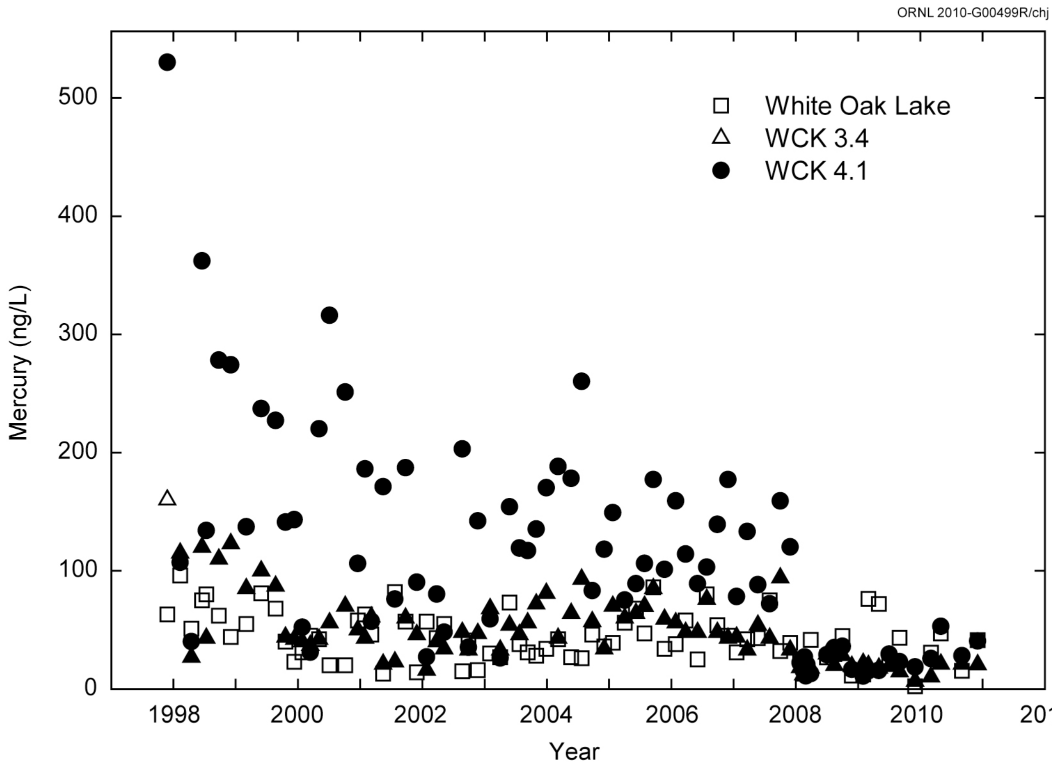

Fig. 5.26. Total aqueous mercury concentrations at sites in White Oak Creek downstream from ORNL, 1998–2010.

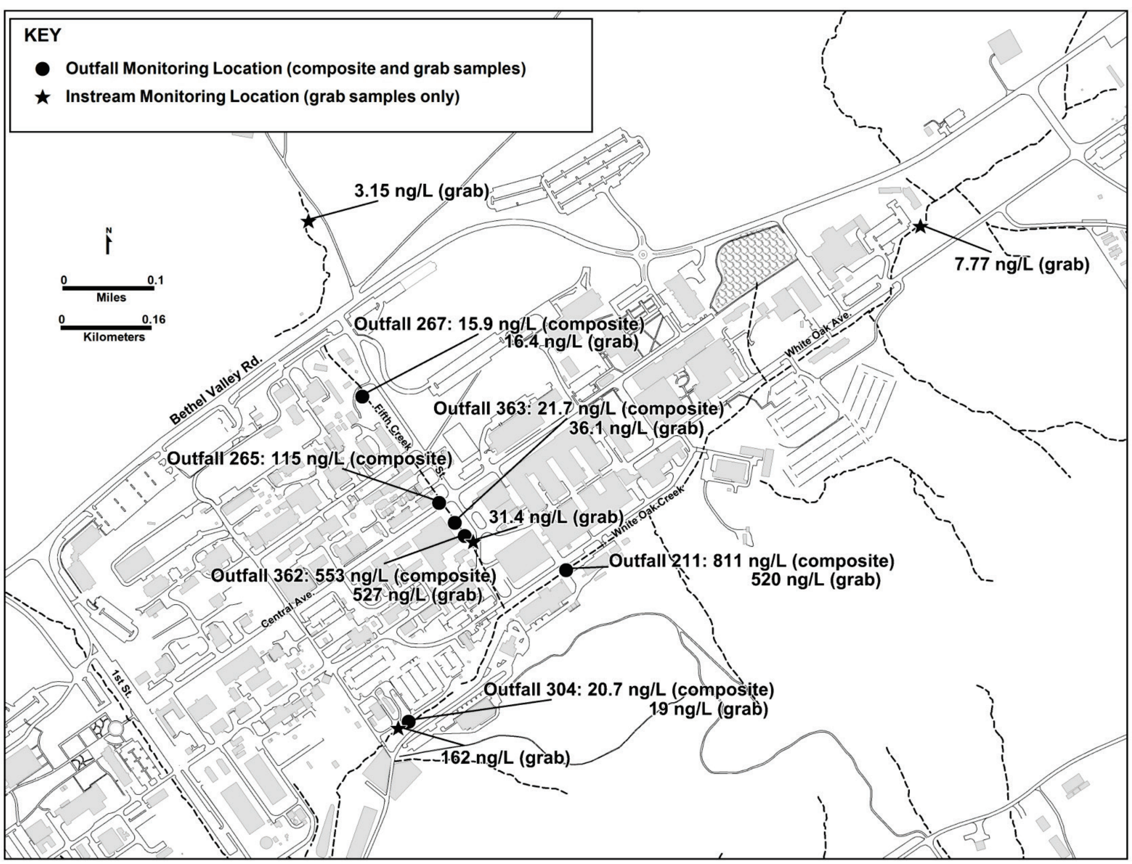

Fig. 5.27. Total mercury concentrations measured in storm water, November 15, 2010.

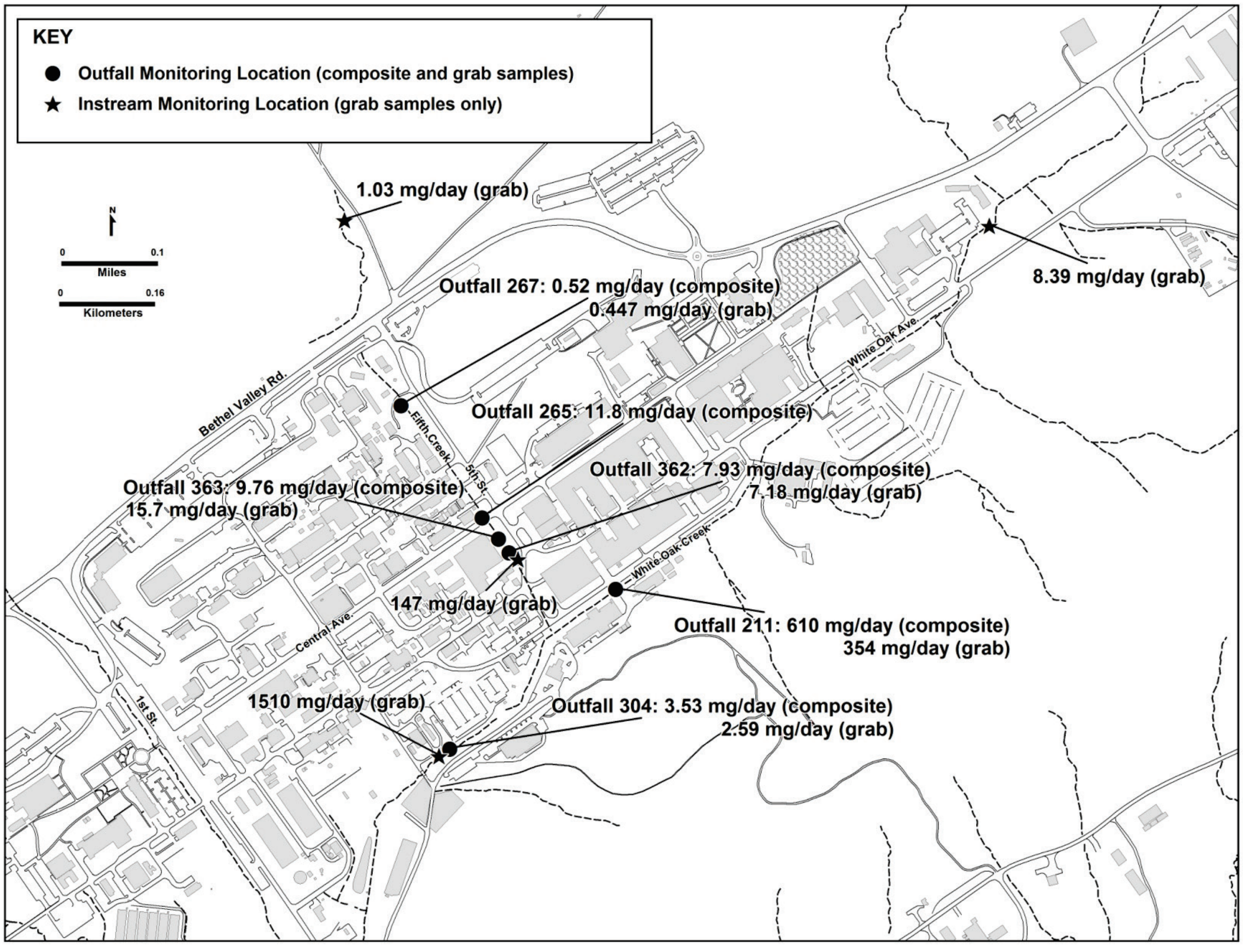

Fig. 5.28. Total mercury fluxes measured in storm water, November 15, 2010.

In 2011, WQPP mercury investigative efforts will focus on areas of interest that were identified from 2010 monitoring activities (e.g., the two stream reaches that indicate unexplained mercury flux increases). A subset of the 2009 characterization-monitoring protocol will also be conducted in 2011, to maintain ongoing data on the presence of mercury in the White Oak Creek watershed.

5.5.6 Water Quality Assessment of Selected Stream Reaches in the ORNL Main Campus Area

In 2010, monitoring was conducted under the ORNL WQPP to characterize water quality in the stream reaches of Fifth Creek, First Creek (FCK) and White Oak Creek that are in the heavily developed central-campus region of the ORNL complex. These characterizations were performed by monitoring water quality at instream locations bounding the selected study reaches while concurrently monitoring the most significant outfalls discharging to those reaches. Monitoring was performed in dry-weather (baseflow) conditions at seven instream locations and ten outfalls (Fig. 5.29) and in wet-weather (storm runoff) conditions at four instream locations and six outfalls (Fig. 5.30). The primary objective of this monitoring was to support one of the overall objectives of the WQPP: to discover the reasons for biological community impairment and to ultimately eliminate or reduce those impairments.

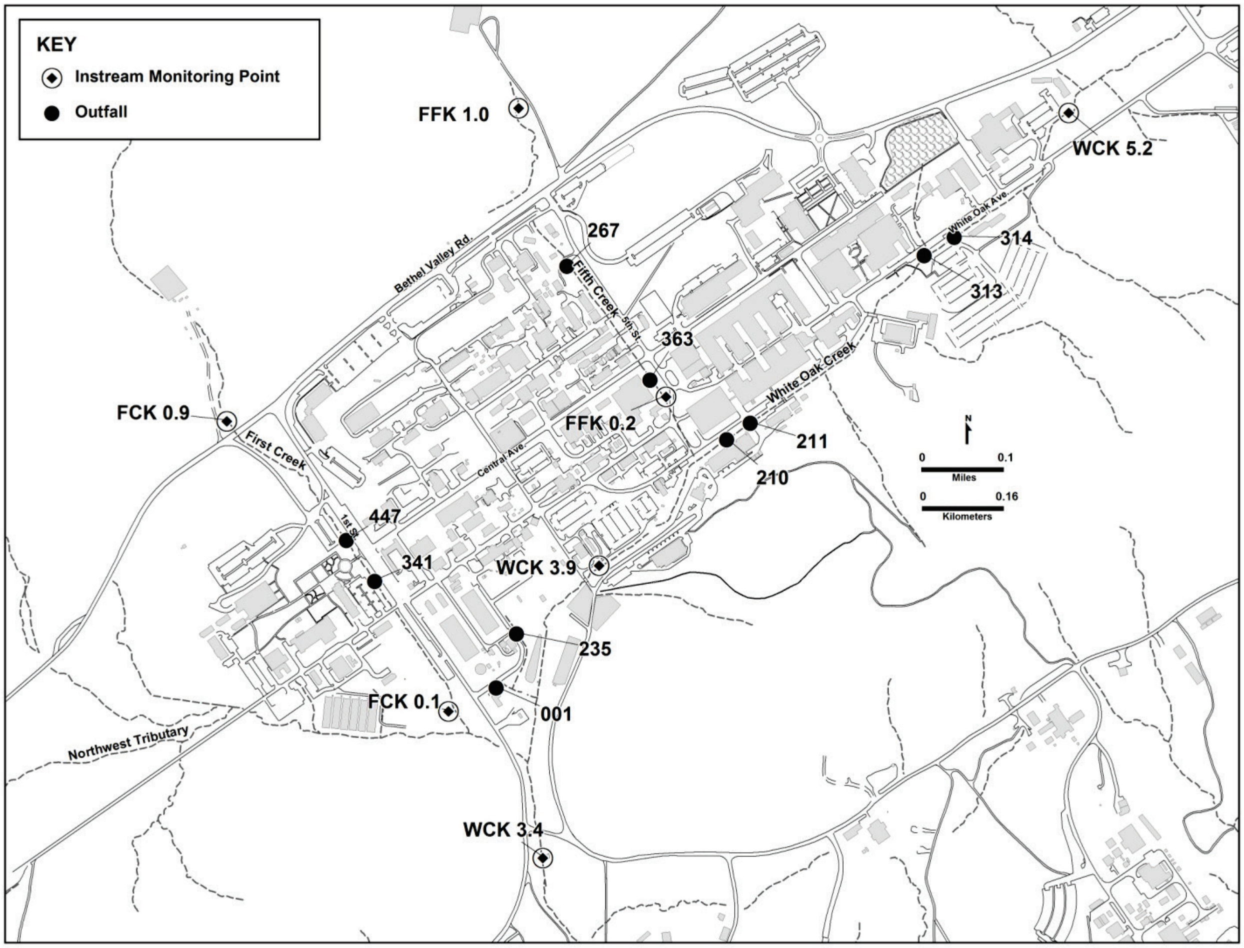

Fig. 5.29. In-stream locations and outfalls sampled for water quality parameters under the ORNL WQPP during dry-weather conditions, 2010.

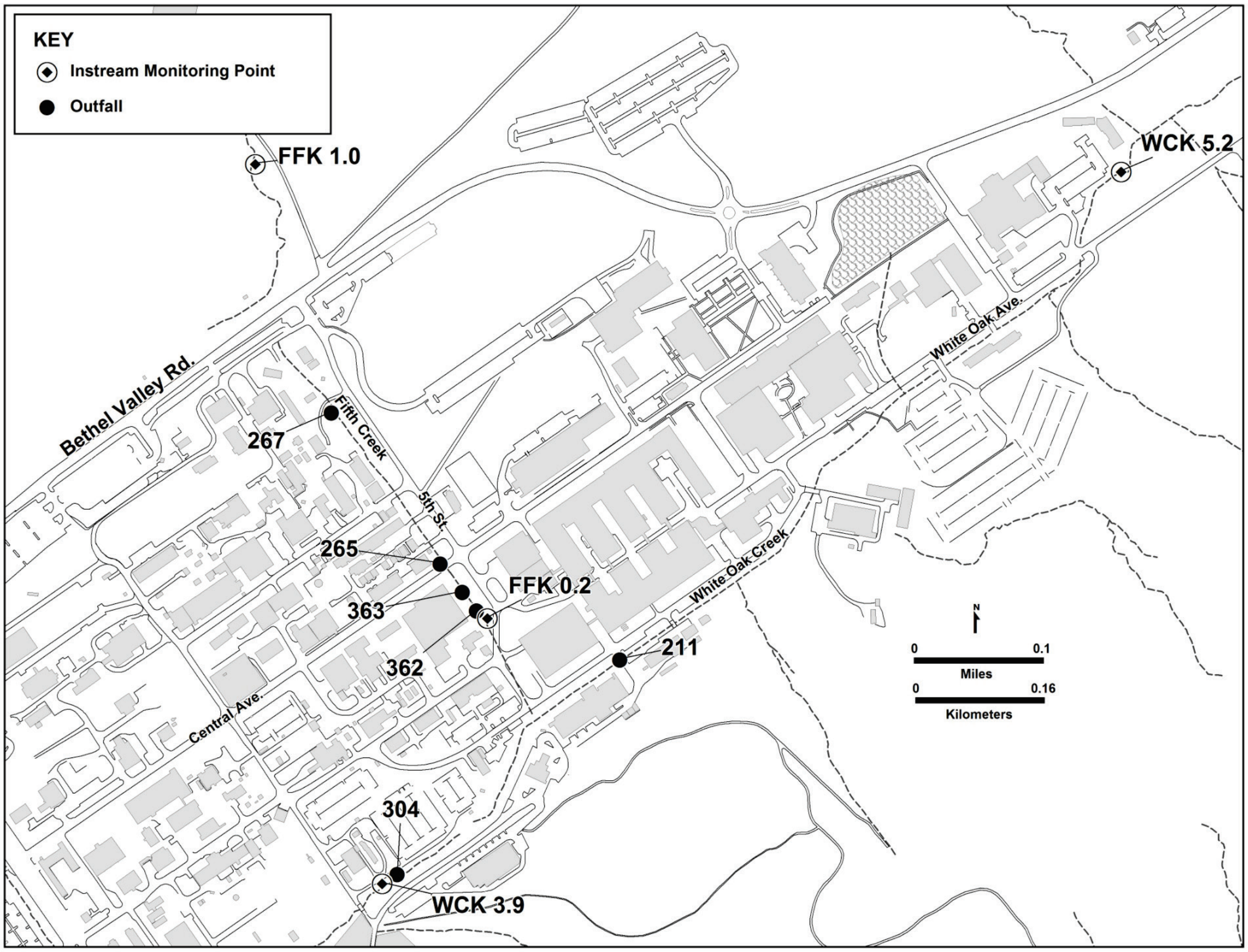

Fig. 5.30. In-stream locations and outfalls sampled for water quality parameters under the ORNL WQPP during wet-weather conditions, 2010.

Samples of solids (suspended and dissolved), metals (total and dissolved), and nutrients (total phosphorus, Kjeldahl nitrogen, nitrate+nitrite nitrogen, and ammonia) were collected and submitted for laboratory analysis, using 24-hr time-proportional compositing for assessing dry-weather conditions and a combination of flow proportional compositing and grab (first flush) sampling during wet-weather conditions at instream locations and outfalls, respectively. Field measurements (conductivity, dissolved oxygen, flow, pH, temperature, and turbidity) were conducted on grab samples. Results are presented in the *2010 Environmental Monitoring Results*. These results are being used to guide future efforts under the WQPP and, along with data from future sampling, will be useful in determining causes of biological community impairments in the WOC watershed. The data suggest that parameters warranting additional study under the WQPP are nutrients and metals.

5.5.7 Stormwater Surveillances and Construction Activities

Figure 5.31 depicts the location of construction sites that were considered significant in 2010 because of the need to be covered under the General TN NPDES Permit for Construction Activities and/or an Aquatic Resource Alteration Permit or because they had a footprint of greater than 1 acre. (Construction areas that are part of CERCLA remediation follow substantive requirements of the appropriate water pollution control permits but are not required to obtain official permit coverage). Five of these sites were inspected in 2010 to evaluate overall effectiveness of the best management practices in use. In general, while some short-term impacts to receiving streams were noted, no long-term adverse impacts were observed.

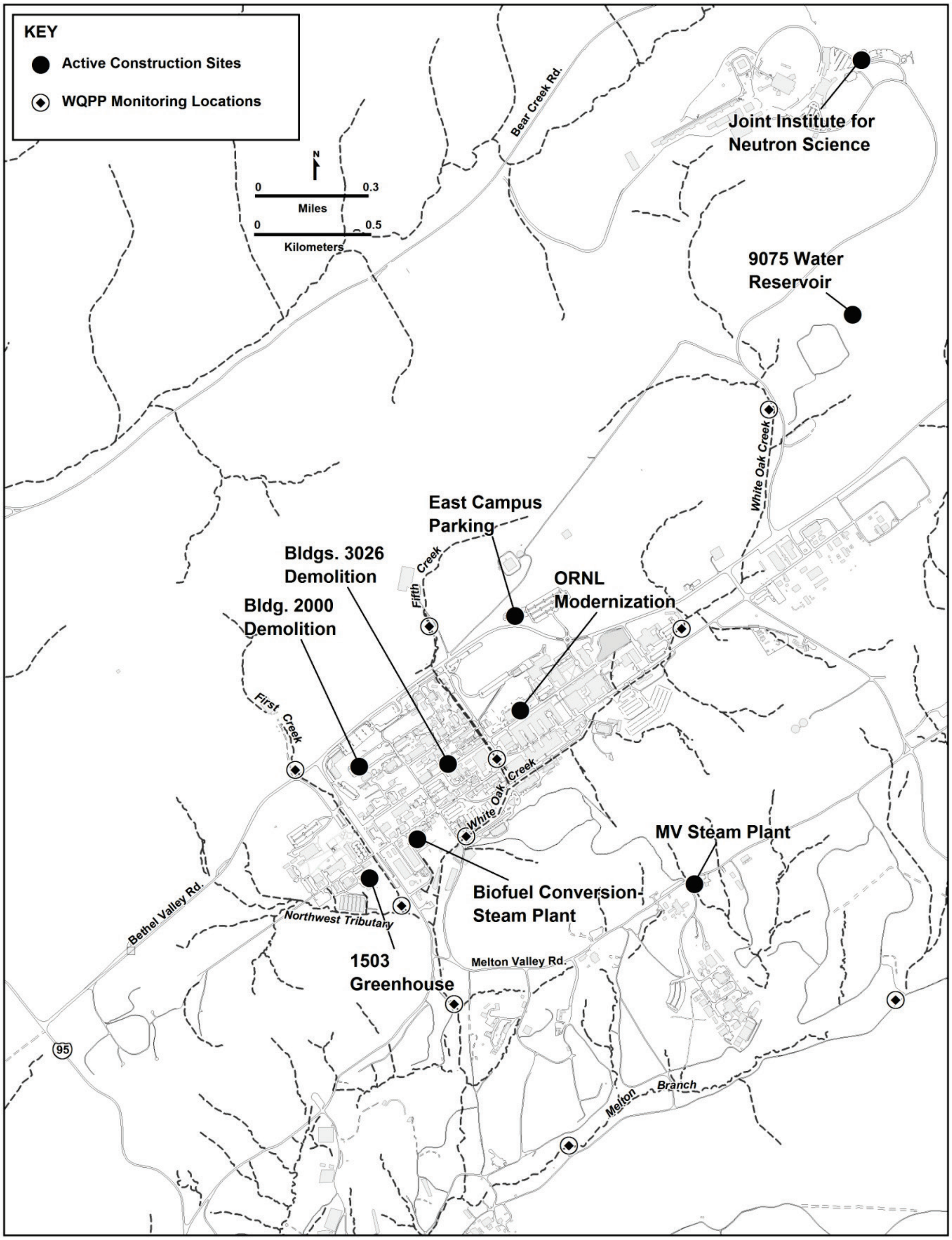

Fig. 5.31. Active construction sites and WQPP monitoring locations at ORNL, 2010.

NPDES outfall drainage areas were also inspected twice in 2010. Land use within drainage areas is typical of office/industrial settings with surface features including laboratories, support facilities, paved areas, and grassy lawns. Outdoor material storage is most prevalent in the 7000 Area on the east end of the main ORNL facility (where most of the craft and maintenance shops are located), with other smaller outdoor storage areas located throughout the facility in and around loading docks and material delivery areas at laboratory and office buildings. The types of materials stored outside include metal items (sheeting, pipes, and parts); equipment awaiting use, disposal, or repair; construction material; and deicer product. Flaking paint on some buildings (slated to be dismantled in the near future) also poses a potential mobile storm water pollutant source.

Some construction activities are performed by third-party contractors working as tenants under agreement with other local, state, and federal agencies on the DOE reservation. There are mechanisms in place for ensuring effective storm water controls at these third-party sites, one of which includes staff from UT-Battelle acting as points of contact for communication interface on environmental, spill/emergency response, and other key issues.

Certain instream and outfall locations identified under the WQPP were monitored in 2010 in storm conditions. A more detailed description of the WQPP wet-weather monitoring scenario can be found in Sect. 5.5.6.

5.5.8 Biological Monitoring

5.5.8.1 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 at a level that will impact fish and aquatic life or violate the recreational criteria 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 2010. 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 2010. Long-term trends in waterborne mercury in the WOC system downstream of ORNL are shown in Fig. 5.26. Waterborne mercury downstream of ORNL declined abruptly in 2008 and remained low through 2010 as a result of rerouting highly contaminated sump water in Building 4501 to the PWTC in December 2007. The mean total mercury concentration at White Oak Creek kilometer (WCK) 4.1 was 36.7 ± 11.8 ng/L in 2010 compared with 108 ± 33 ng/L in 2007. The decrease was also apparent but less pronounced at WCK 3.4, with mercury averaging 18.2 ± 5.4 ng/L in 2010 versus 49 ± 23 ng/L in 2007. Although mercury concentrations at these two sites were significantly lower than levels in 2007, they were slightly higher than in 2009. A pretreatment system for the sump water started operation on October 22, 2009, and will remove almost all of the mercury prior to sending the water to the PWTC. This system reduces the mercury concentration in the influent and effluent of the PWTC. Average aqueous mercury concentration at the White Oak Dam was 33.6 ± 13.9 ng/L in 2010, a level similar to results reported in recent years.

Bioaccumulation in Fish. In WOC, mercury and PCB concentrations in fish have been at or near human health risk thresholds [e.g., EPA ambient water quality criteria (AWQC), TDEC fish advisory limits]. For the first time in over 10 years, mercury concentrations in redbreast sunfish fillets collected from WCK 2.9 were below the AWQC. Mean fillet concentrations at WCK 3.9 (a site sampled for the first time in 2007) decreased from 0.38 μg/g in 2009 to 0.23 μg/g in 2010, bringing the mean concentrations observed at this site well below the AWQC (Fig. 5.32). It is too early to determine if these decreases are due to natural interannual variation or actual responses to the lowered aqueous concentrations at these sites, but the fact that the decreases in fish tissue were more pronounced at upstream sites where the decreases in aqueous mercury concentrations were most evident suggests a causal response. Mercury concentrations in sunfish and bass collected from WCK 1.5 were within the range of values observed in recent years, although slightly higher in 2010.

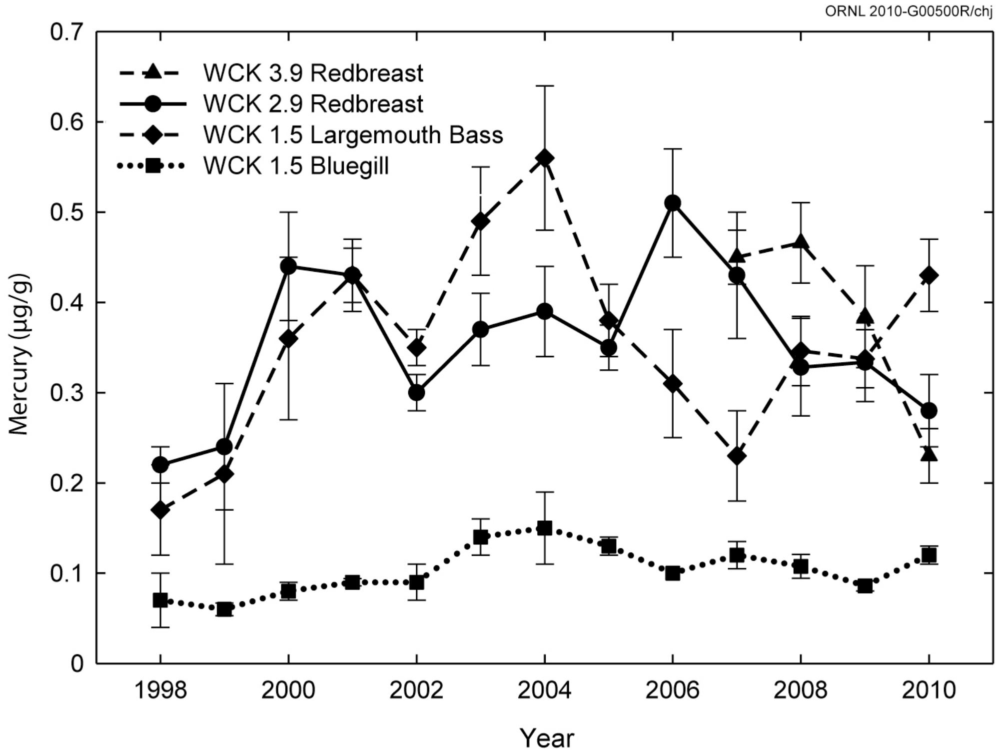

Fig. 5.32. Mean concentrations of mercury (µg/g, ± Standard Error, N = 6) in muscle tissue of sunfish and bass from WOC (WCK 3.9, WCK 2.9) and White Oak Lake (WCK 1.5), 1998–2010.

Mean PCB concentrations in redbreast sunfish at WCK 3.9 and WCK 2.9 were comparable to recent years (0.40 and 0.32 µg/g, respectively). In contrast, mean PCB concentrations in bluegill from WCK 1.5 were substantially higher in 2010 (1.39 µg/g) than in previous years. The mean PCB concentrations in sunfish and bass collected from WCK 1.5 were both above TDEC's fish advisory limit in 2010. (Fig. 5.33).

Benthic Macroinvertebrate Communities. Monitoring of benthic macroinvertebrate communities in WOC, First Creek, and Fifth Creek continued in 2010. Additionally, monitoring of the macroinvertebrate community in lower Melton Branch [Melton Branch kilometer (MEK) 0.6] continued under the DOE-EM Water Resources Restoration Program. Benthic macroinvertebrate samples are collected at sites upstream (reference sites) and downstream of the influence of ORNL operations; reference sites for WOC, First Creek, and Fifth Creek also are used as references for the Melton Branch site. 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. 5.34, 5.35, and 5.36). Relative to reference sites, the metrics total taxonomic richness (i.e., the mean number of different species per sample) and richness of the pollution-intolerant taxa (i.e., the mean number of mayfly, stonefly, and caddisfly per sample or *Ephemeroptera, Plecoptera*, and *Trichoptera* [EPT] richness) continue to be lower at sites adjacent to and downstream of the main ORNL campus. Reductions in metric values observed at Fifth Creek kilometer (FFK) 0.2 in 2008 persisted into 2010, indicating that an additional and persistent stress (or stresses) occurred after April 2007. Metric values at FCK 0.1 and WCK 3.9 continued to be within the range of values that have been observed at the sites for ≥10 years, while at WCK 2.3, metric levels were similar to those observed in 2007 when they achieved the highest levels observed since monitoring began in 1987. Since metric values for this site have exhibited extensive annual variation since 2002 compared with reference sites and other sites in WOC watershed, it is not known if the metric increases in 2010 are just a continuation of this pattern of annual change or a possible indication of further recovery. Macroinvertebrate community metrics for lower Melton Branch (MEK 0.6, Fig. 5.37) suggest that conditions at this site continue to be stable. The taxa richness metrics examined for this site continue to show no discernable evidence of degradation based on total and EPT richness. However, compared with reference sites, the combination of relatively high total density and relatively high densities of a few of the most pollution-tolerant species (e.g., Orthocladiinae midges and aquatic worms) and a few of the most tolerant of the EPT species (e.g., the caddisfly *Ochrotricia* and the stonefly *Amphinemura*) continue to suggest that nutrient (i.e., nitrogen and phosphorus) concentrations are possibly modestly elevated. Sources of nutrients in lower Melton Branch could either be from direct inputs (e.g., from effluent discharges or stormwater runoff from fertilized land) or indirect inputs (e.g., natural release from freshly disturbed soils).

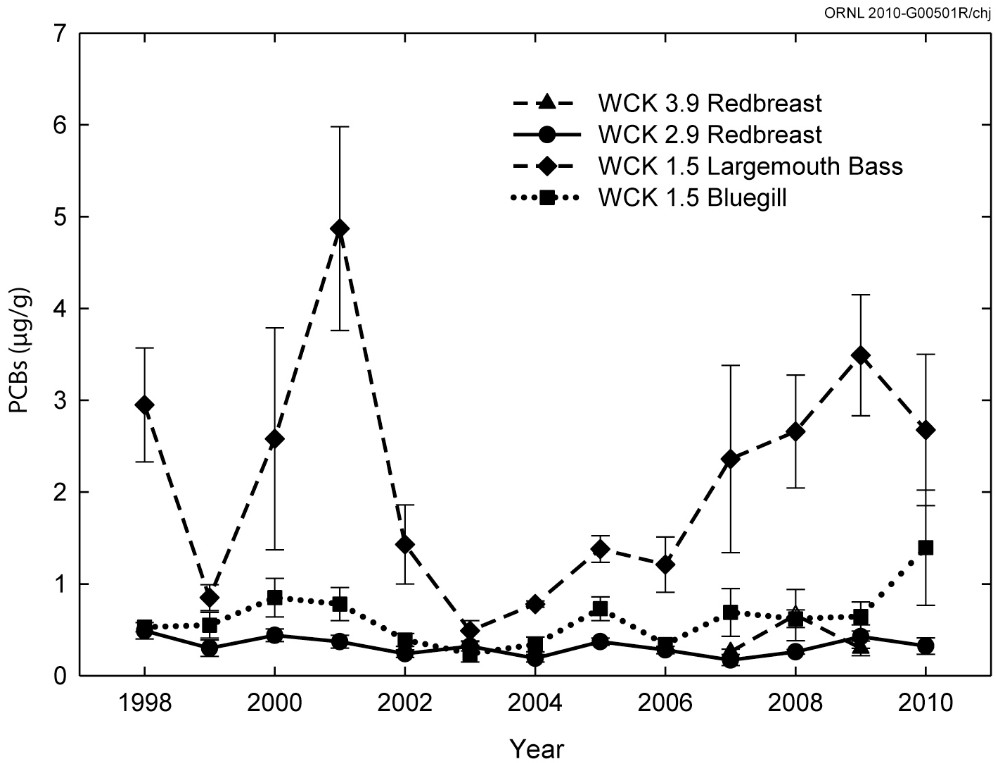

Fig. 5.33. Mean PCB concentrations (µg/g, ± Standard Error N = 6) in fish fillets collected from the WOC watershed, 1998–2010. WCK = WOC kilometer.

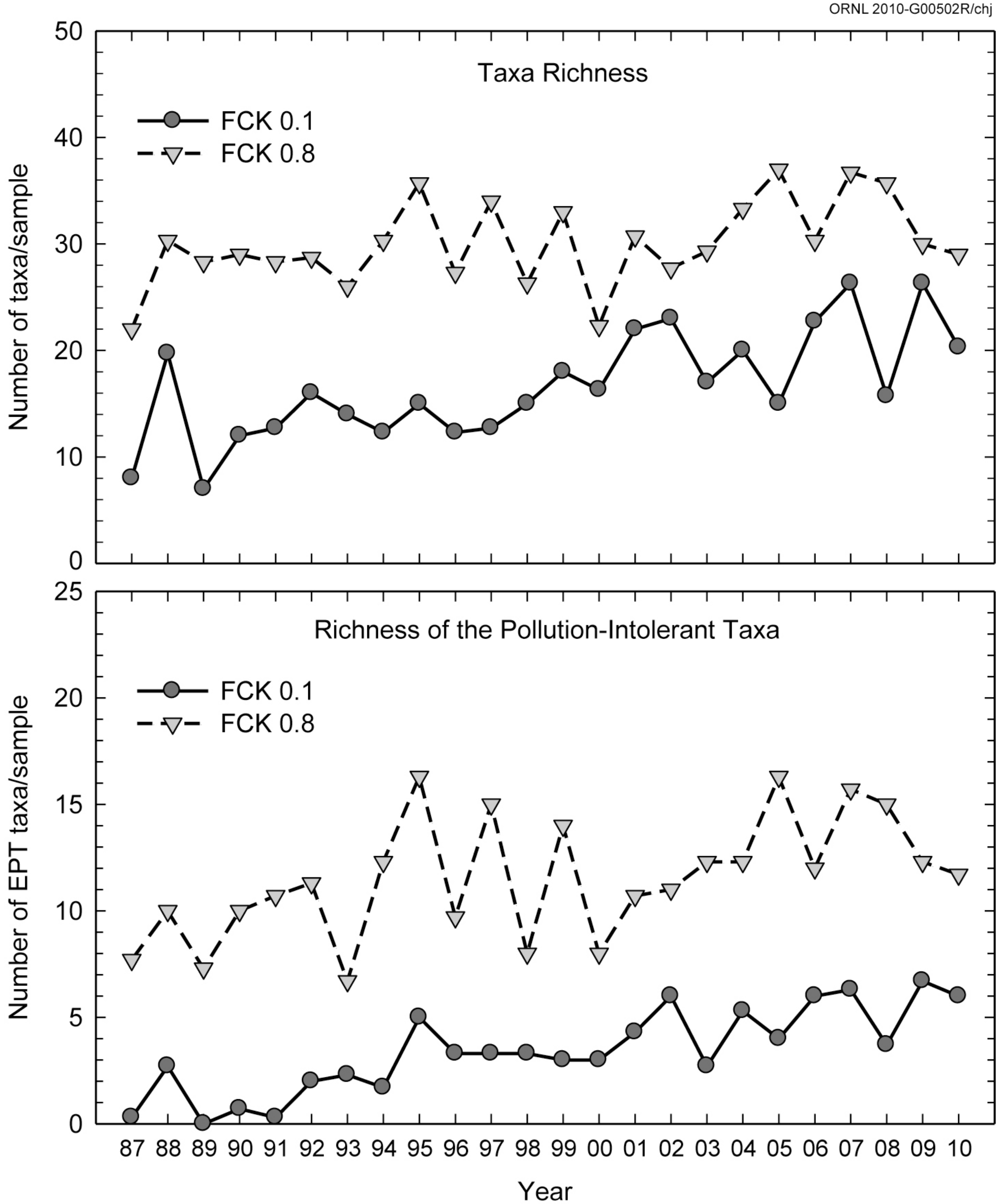

Fig. 5.34. Taxonomic richness (mean number of all taxa/sample) (top) and taxonomic richness of the *Ephemeroptera, Plecoptera,* and *Trichoptera* (mean number of EPT taxa/sample) (bottom) of the benthic macroinvertebrate community in First Creek, April sampling periods, 1987−2010. FCK = First Creek kilometer; EPT = Ephemeroptera, Plecoptera, and Trichoptera; FCK 0.8 = reference site.

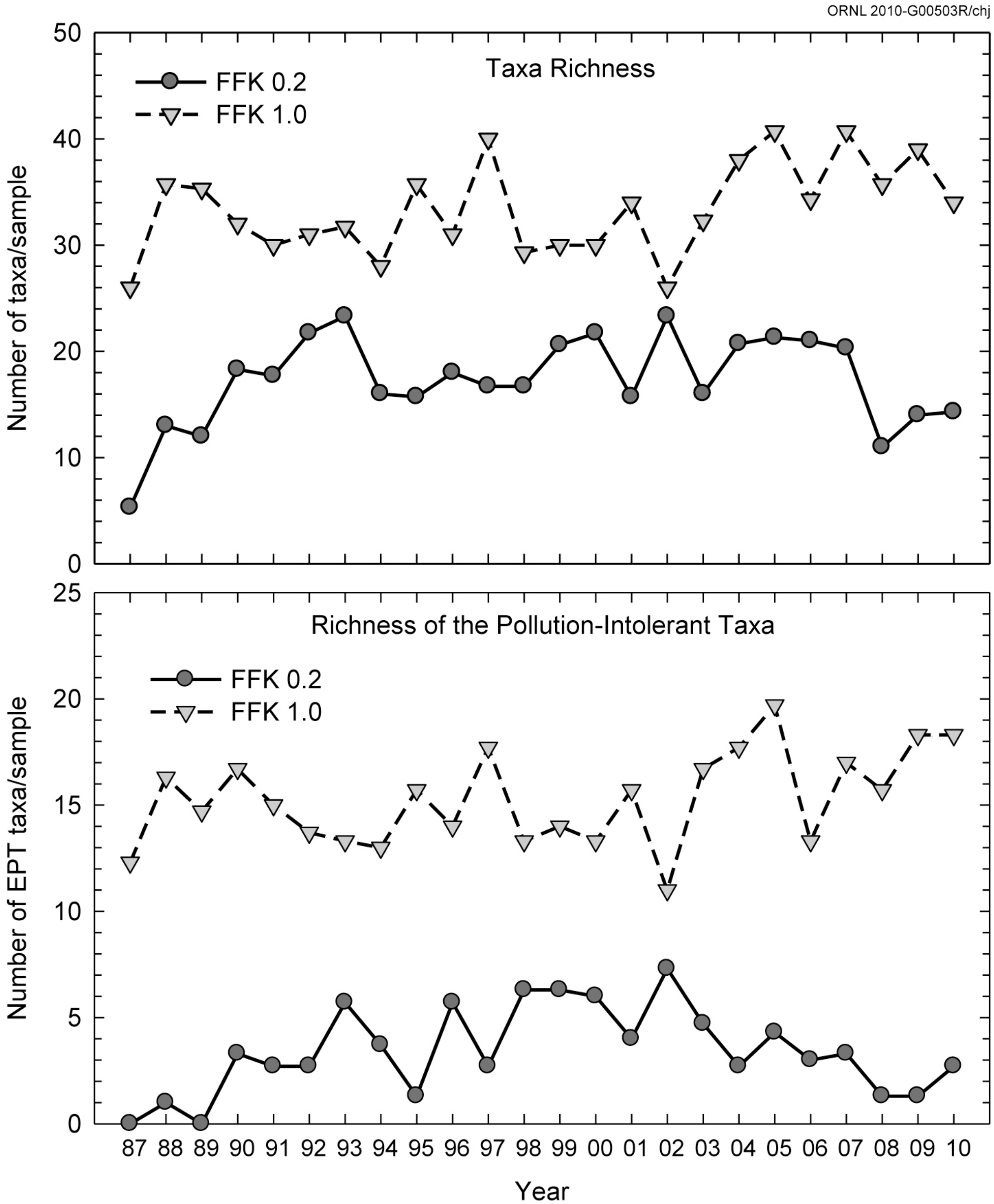

Fig. 5.35. Taxonomic richness (mean number of all taxa/sample) (top) and taxonomic richness of the *Ephemeroptera, Plecoptera,* and *Trichoptera* (mean number of EPT taxa/sample) (bottom) of the benthic macroinvertebrate community in Fifth Creek, April sampling periods, 1987−2010. FFK = Fifth Creek kilometer; EPT = Ephemeroptera, Plecoptera, and Trichoptera; FFK 1. 0 = reference site.

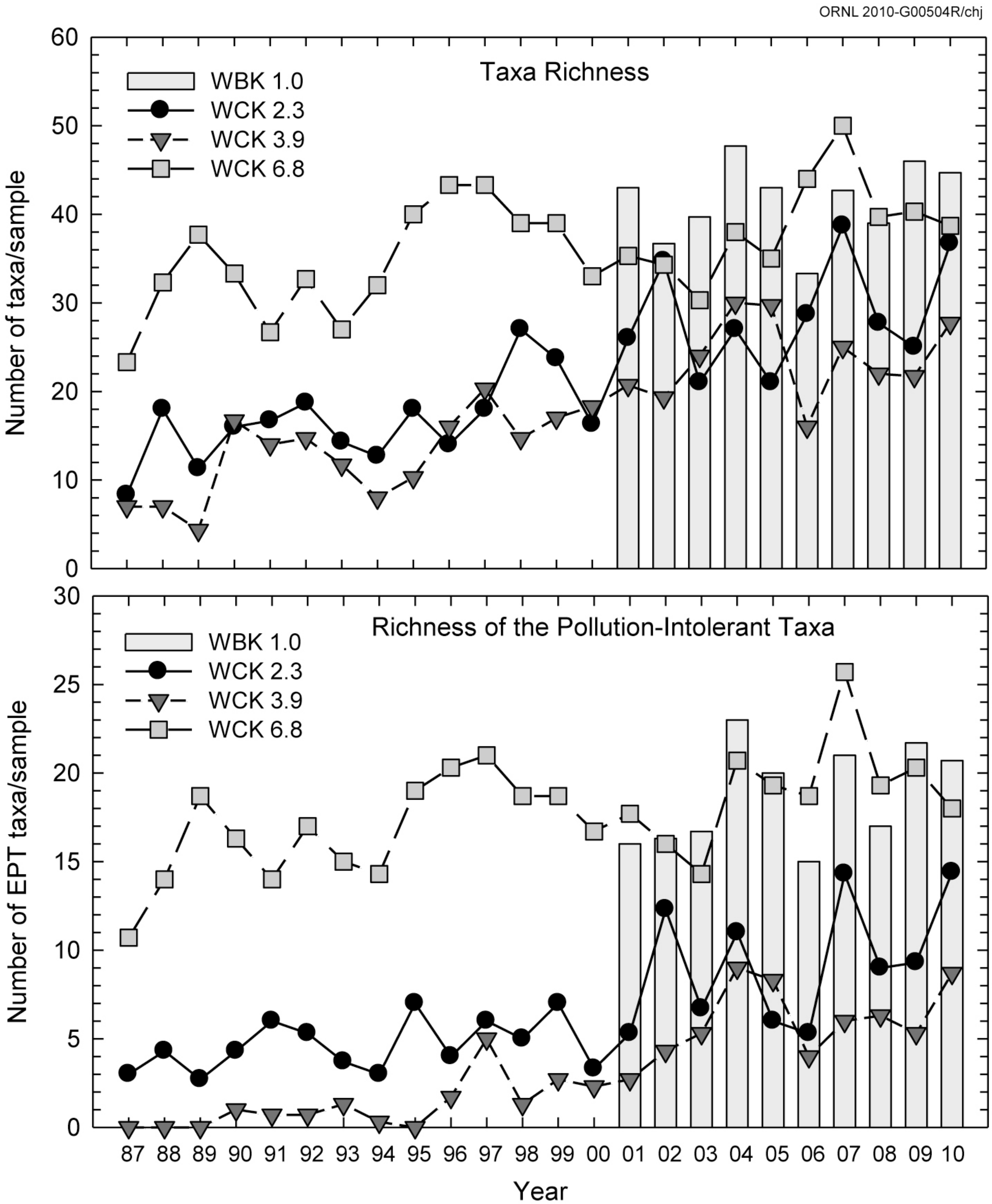

Fig. 5.36. Taxonomic richness (mean number of all taxa /sample) (top) and taxonomic richness of the *Ephemeroptera, Plecoptera*, and *Trichoptera* (mean number of EPT taxa/sample) (bottom) of the benthic macroinvertebrate communities in White Oak Creek, April sampling periods, 1987−2010. WCK = White Oak Creek kilometer; EWBK - Walker Branch kilometer; EPT = Ephemeroptera, Plecoptera, and Trichoptera; WBK 1.0 = reference site.

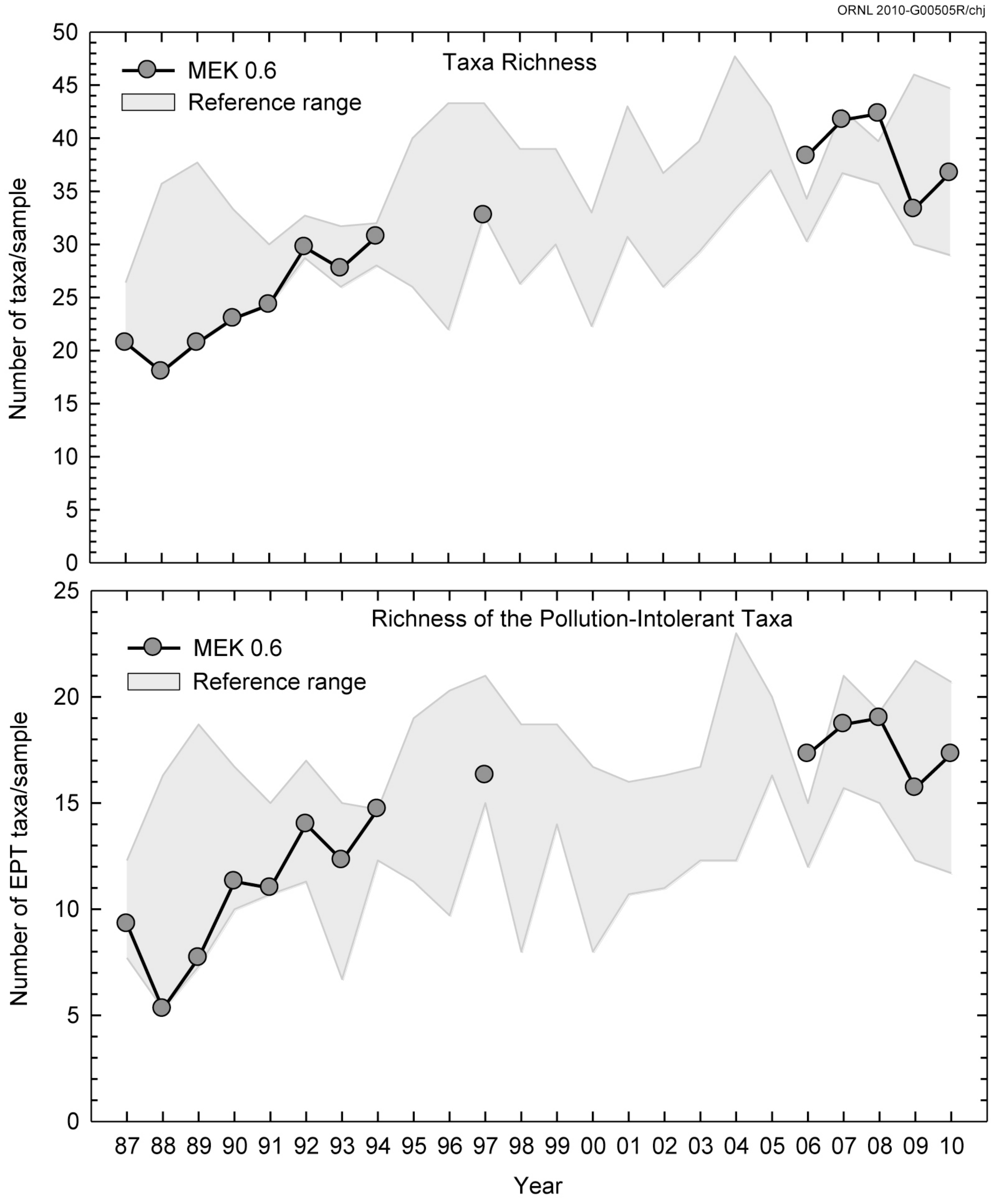

Fig. 5.37. Taxonomic richness (mean number of all taxa /sample) (top) and taxonomic richness of the *Ephemeroptera, Plecoptera*, and *Trichoptera* (mean number of EPT taxa/sample) (bottom) of the benthic macroinvertebrate communities in lower Melton Branch, April sampling periods, 1987−2010. MEK = Melton Branch kilometer; EPT = Ephemeroptera, Plecoptera, and Trichoptera; Reference range—minimum and maximum values for ORNL BMAP reference sites on upper Melton Branch (1987–1997), First Creek, Fifth Creek (1987–2010), Walker Branch (2001–2010), and White Oak Creek (1987–2000, 2007–2010).

5.5.8.2 Fish Communities

Monitoring fish communities in WOC and major tributaries continued in 2010. 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 2010 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. A project to introduce missing fish species into the watershed was initiated in 2008 by stocking five native species. Reproduction was noted for three of the species, and several species expanded their range beyond initial introduction sites. Increased richness was observed in most of WOC during 2010, with the highest ever values seen at WCK 2.3 and WCK 3.9. The initial success of the introductions in much of WOC suggests that overall water quality has improved in the watershed over the past 2 decades, and further sites were selected for introductions in 2011.

Generally, the fish communities in tributary sites adjacent to and downstream of ORNL outfalls remained impacted in 2010 relative to reference streams or upstream sites. Some recovery was seen in Fifth Creek where the fish community improved in fall sampling (Fig. 5.38).

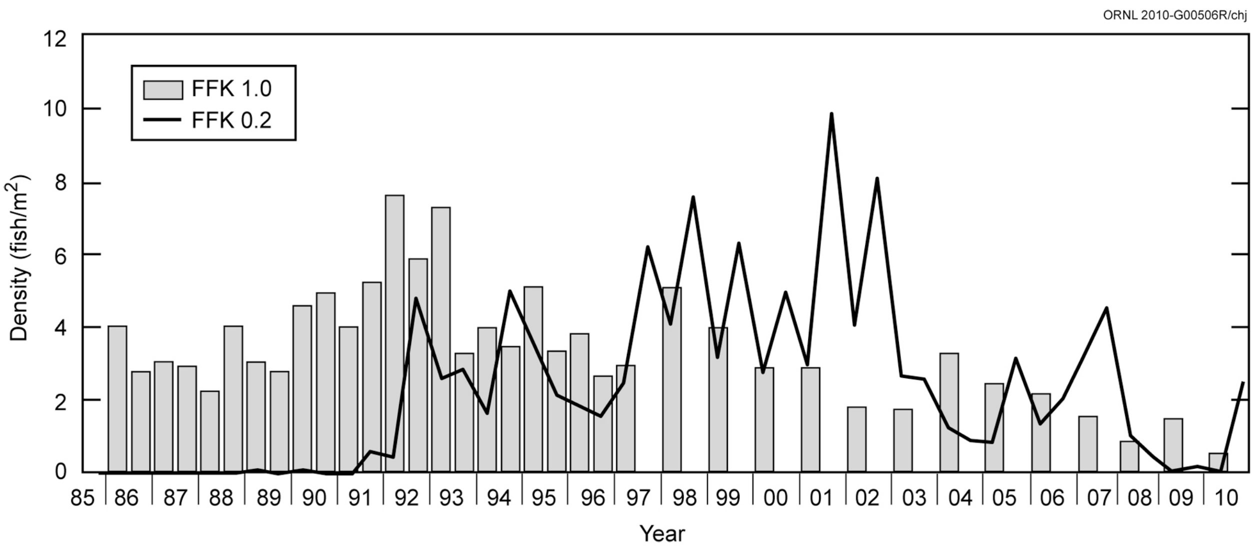

Fig. 5.38. Density estimates of fish communities in Fifth Creek, 1985–2010.

5.5.9 PCBs in the WOC Watershed

Past monitoring has shown that while PCBs are present in the watershed, they are not discharged from ORNL outfalls into the WOC watershed at levels detected by standard analytical methods. Largemouth bass collected from White Oak Lake continue to have tissue PCB concentrations higher than those recommended by TDEC and EPA for frequent consumption. While past monitoring efforts were instrumental in establishing a baseline for PCBs, the focus has historically been on relating PCB levels in fish to safe levels for consumption. These studies were not designed to identify specific stream reaches or sources contributing to PCB bioaccumulation.

The mobility of the fish populations used in traditional bioaccumulation monitoring studies precludes the possibility of source identification. Therefore, the source identification task involved the use of semipermeable membrane devices (SPMDs) to assess the chronic, low-level sources of PCBs at critical sites on the reservation. SPMDs are thin, plastic sleeves filled with oil in which PCBs are soluble.

Because SPMDs remain submerged at a given site for 4 weeks and have a high affinity for PCBs, a time-integrated, semi-quantitative index of the mean PCB concentration in the overlying water during the deployment period is provided. SPMDs also have advantages over "snapshot" water concentration analyses. The long deployment period enables the distinction between the relative PCB inputs at sites whose aqueous PCB concentrations are below detection limits in water.

In 2010, ORNL's PCB monitoring continued the identification of the stream reaches in the WOC watershed where PCB sources are likely to contribute to bioaccumulation in fish. The key integration points and reference sites within the watershed that were identified and monitored in 2009 were resampled to assess bioaccumulation potential.

The SPMD results in this study provide information on the relative contributions of various stream reaches within the ORNL campus (Fig. 5.39). The 2010 results confirm the 2009 results which show the influence of ORNL activities. SPMDs deployed at reference sites upstream and downstream of the plant had background levels of PCBs, while all sites within the plant were above background levels. The highest levels, which were observed in First Creek, were confirmed in 2010, indicating that this creek may be critical in introducing PCBs to White Oak Creek (Table 5.21).

In 2010, the PCB source evaluation was narrowed to better understand PCB sources in First Creek. In addition to SPMDs, clams were deployed in selected sites in and downstream of First Creek (Fig. 5.40). Clams feed on plankton and other fine particles and provide a relative measure of the total PCB levels in these sites, whereas SPMDs provide a relative measure of dissolved PCBs. The results from this study indicate that the central reach of First Creek is where PCBs are most available for bioaccumulation (Table 5.22).

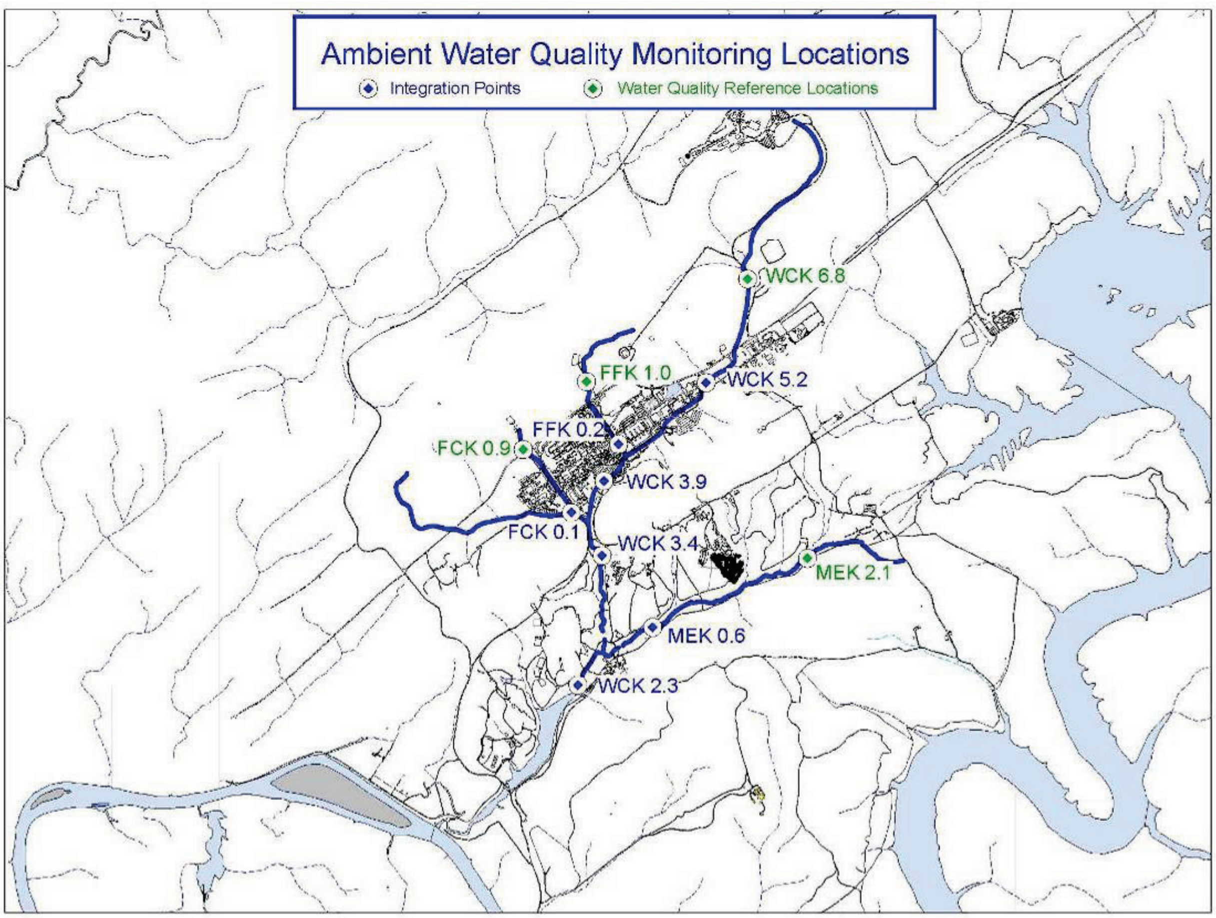

Fig. 5.39. Locations of ambient water quality monitoring integration points and reference locations at ORNL.

Table 5.21. PCB concentrations in semipermeable membrane devices at monitoring locations in the White Oak Creek watershed

Samples recovered in April 2010, after 4 weeks

ORNL stream	Location name	Location type	Total PCBs (ppm)
White Oak Creek	WCK 5.2	Integration point	Sample lost
White Oak Creek	WCK 3.9	Integration point	2350
White Oak Creek	WCK 3.4	Integration point	5800
White Oak Creek	WCK 2.3	Integration point	940
White Oak Creek	WCK 4.1	Integration point	3900
First Creek	FCK 0.1	Integration point	24000
Fifth Creek	FFK 0.2	Integration point	1510
Melton Branch	MEK 0.6	Integration point	87
White Oak Creek	WCK 6.8	Reference site	59
Fifth Creek	FFK 1.0	Reference site	58
First Creek	FCK 0.9	Reference site	82
Melton Branch	MEK 2.1	Reference site	59

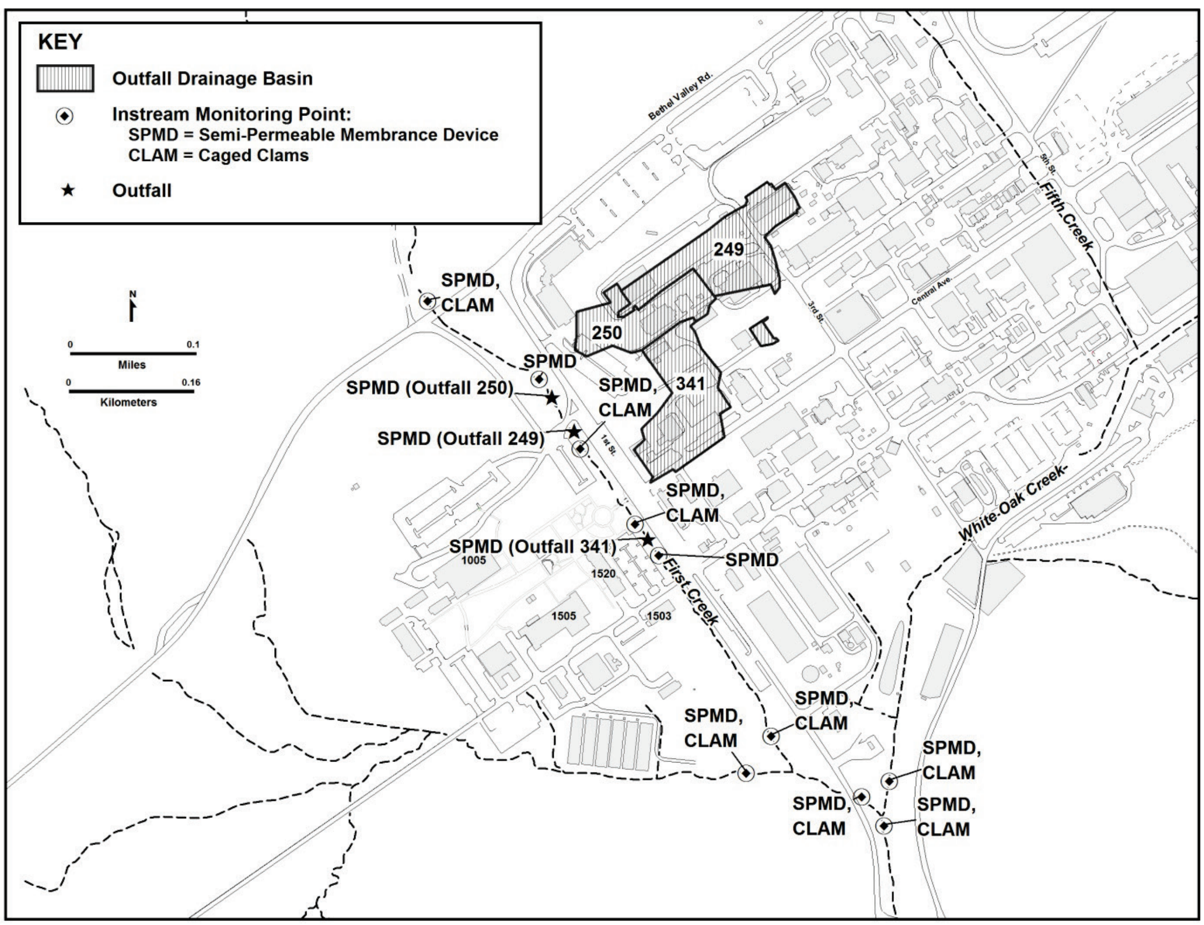

Fig. 5.40. Locations of monitoring points for First Creek source investigation.

Table 5.22. First Creek PCB source assessment, June 2010
Total PCBs (parts per billion)

Location Name	Location Type	SPMD	Clams
FCK 0.9	Reference site	69	9.4
Upstream Outfall 250	Instream	400	
Outfall 250	End of Pipe	14100	
Outfall 249	End of Pipe	364	
Downstream Outfall 249	Instream	8200	192.5
Upstream Outfall 341	Instream	26540	1945
Outfall 341	End of Pipe	3200	
Downstream Outfall 341	Instream	17700	
FCK 0.1	Instream	11480	2550
Northwest Tributary upstream of confluence with First Creek	Reference site	71	189.5
Northwest Tributary downstream of confluence with First Creek	Instream	5180	1285
White Oak Creek downstream of confluence with Northwest Tributary	Instream	1980	189.5
White Oak Creek upstream confluence with Northwest Tributary	Instream	1520	163.5

5.5.10 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 spill prevention, control, and countermeasures (SPCC) plans to minimize the potential for oil discharges. Each facility on the ORR implements a site-specific SPCC plan. The NTRC, which is located off the ORR, also has a SPCC plan covering the oil inventory at its location. There were no regulatory or permitting actions related to oil pollution prevention at ORNL in 2010. In 2011, ORNL will be implementing new SPCC training requirements that are required to be in place by November 2011.

5.5.11 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 (Fig. 5.41).

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 White Oak Lake at WOD are also checked for volatile organic compounds (VOCs), PCBs, and metals. Table 5.23 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. 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.

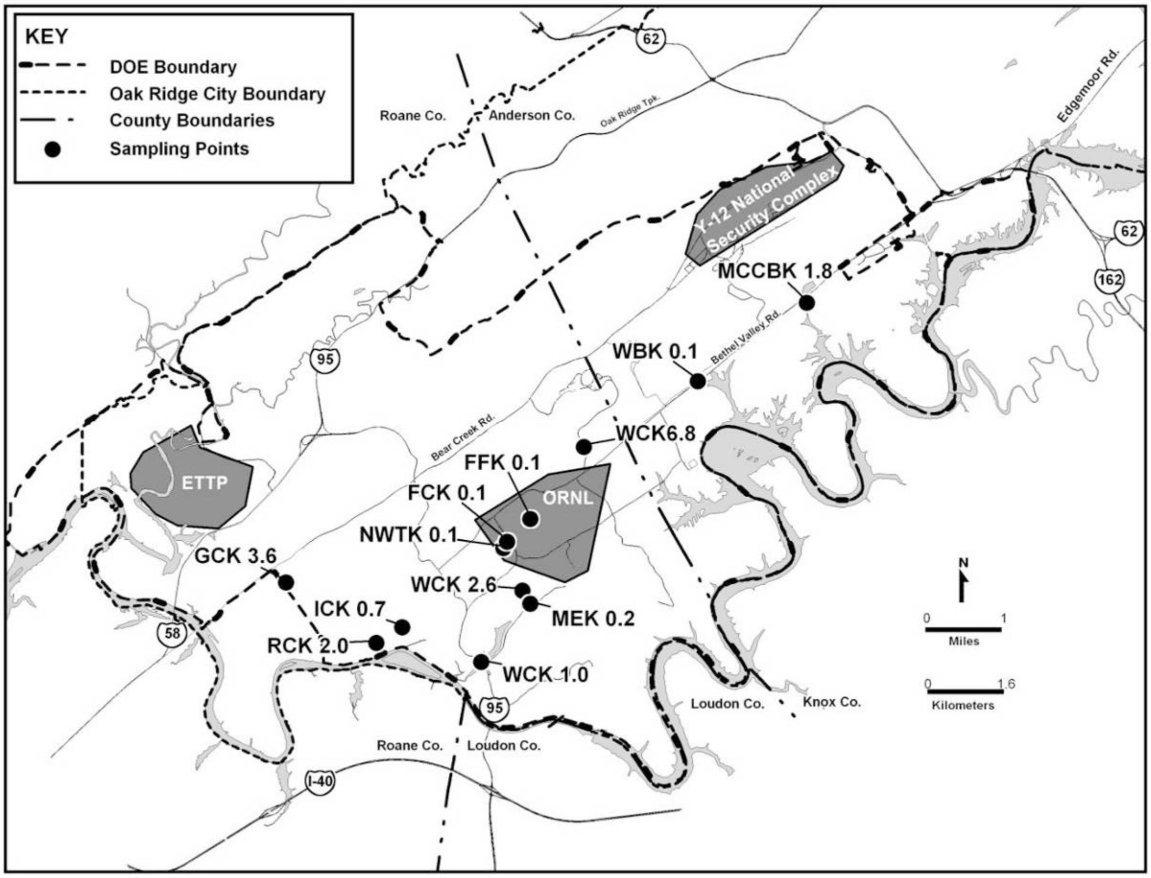

Fig. 5.41. ORNL surface water sampling locations.

Table 5.23. ORNL surface water sampling locations, frequencies, and parameters, 2010

Location[a]	Description	Frequency	Parameters[b]
MEK 0.2	Melton Branch downstream from ORNL	Bimonthly (Jan., March, May, July, Sept., Nov.)	Gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, field measurements
WCK 1.0	White Oak Lake at White Oak Dam	Monthly	Volatiles, metals, PCBs, gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, field measurements
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, tritium, field measurements
WCK 6.8	WOC upstream from ORNL	Quarterly (Feb., May, Aug., Nov.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements
WBK 0.1	Walker Branch prior to entering CRK 53.4	Semiannually (April, Oct.)	Gross alpha, gross beta, gamma scan, field measurements
GCK 3.6	Grassy Creek upstream of Energy Solutions and IT Corp. at CRK 23	Semiannually (April, Oct.)	Lead, gross alpha, gross beta, gamma scan, field measurements
ICK 0.7	Ish Creek prior to entering CRK 30.8	Semiannually (April, Oct.)	Gross alpha, gross beta, gamma scan, field measurements

Table 5.23 (continued)

Location[a]	Description	Frequency	Parameters
MCCBK 1.8	McCoy Branch prior to entering CRK 60.3	Semiannually (April, Oct.)	Gross alpha, gross beta, gamma scan, field measurements
RCK 2.0	Raccoon Creek sampling station prior to entering CRK 31	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements
NWTK 0.1	Northwest Tributary prior to the confluence with First Creek	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements
FCK 0.1	First Creek prior to the confluence with Northwest Tributary	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements
FFK 0.1	Fifth Creek just upstream of WOC (ORNL)	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements

[a]Locations identify bodies of water and locations on them (e.g., WCK 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	Raccoon Creek kilometer
WBK	Walker Branch kilometer
WCK	White Oak Creek (WOC) kilometer

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

For comparison purposes, the ORR upstream reference site (CRK 66) can be compared with results from this program as applicable (Sect. 6.4.1).

Radionuclides were detected above MDAs at most of the 12 surface water locations in 2010; the locations with no detected radionuclides were Ish Creek (ICK 0.7) and Walker Branch (WBK 0.1).

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. During 2009 and 2010 ^{90}Sr discharges from Bethel Valley increased because of increased discharges of contaminated groundwater from the Core Hole 8 plume to First Creek. During FY 2011 the EM program started a project to improve groundwater capture and refurbish the existing plume collection system. Future remedial actions in contaminated soil areas are planned, and until completion, little change in surface water contaminant conditions is expected. The results from 2010 sampling at these locations are consistent with historical data and with the processes or legacy activities nearby or upstream from these locations. Volatile organic compounds continue to be detected at WOC at WOD; toluene and chloroform were detected at estimated levels during most sampling events. 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 SWSA 3. Raccoon Creek sampling results continue to demonstrate seasonal variability. Grassy Creek and Ish Creek had fewer detected radionuclides than in previous years, which may be a result of remedial actions in SWSA 3. Remediation activities at the SWSA 3 Area including Contractor's Landfill and the Closed Scrap Metal Area (CSMA) started in FY 2010 and should be completed in summer 2011. SWSA 3 and the CSMA are getting a RCRA cap with drainage for diversion of surface water away from the cap, while the contractor's landfill received 2 ft of soil cover (this portion was completed in November 2010).

5.5.12 Sediment Monitoring

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. 5.42). 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. 5.42). These samples are filtered, and the residue (settleable solids) is analyzed for gross alpha, gross beta, and gamma emitters.

Potassium-40, a naturally occurring radionuclide, was detected in sediments at all three locations. The only man-made radionuclide detected in sediments was ^{137}Cs downstream from ORNL at CRK 32. Figure 5.43 shows 7 years of ^{137}Cs results in sediment.

Sampling for heavy-rain-event settleable solids took place in January and December 2009. Radionuclide concentrations for alpha, beta, and ^{137}Cs were higher at the downstream location, WCK 1.0, than those observed at upstream locations.

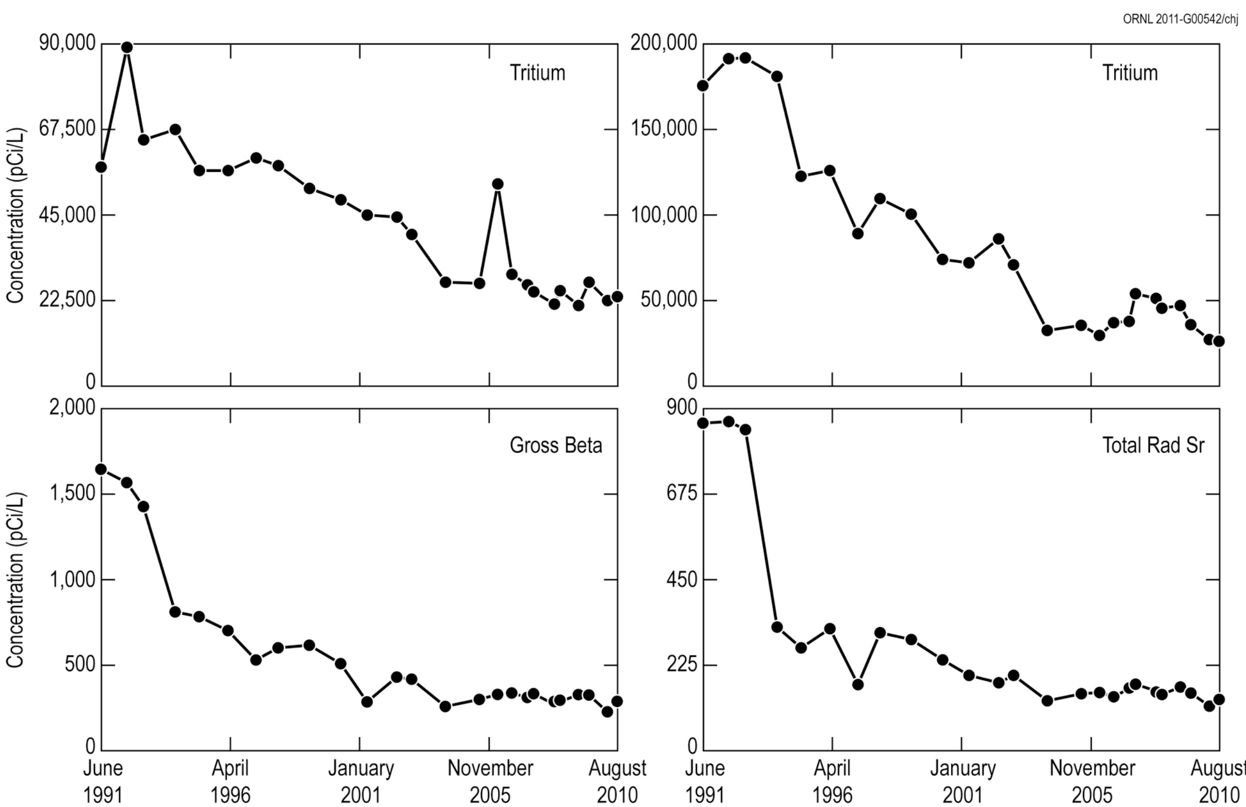

Fig. 5.42. ORNL sediment sampling locations.

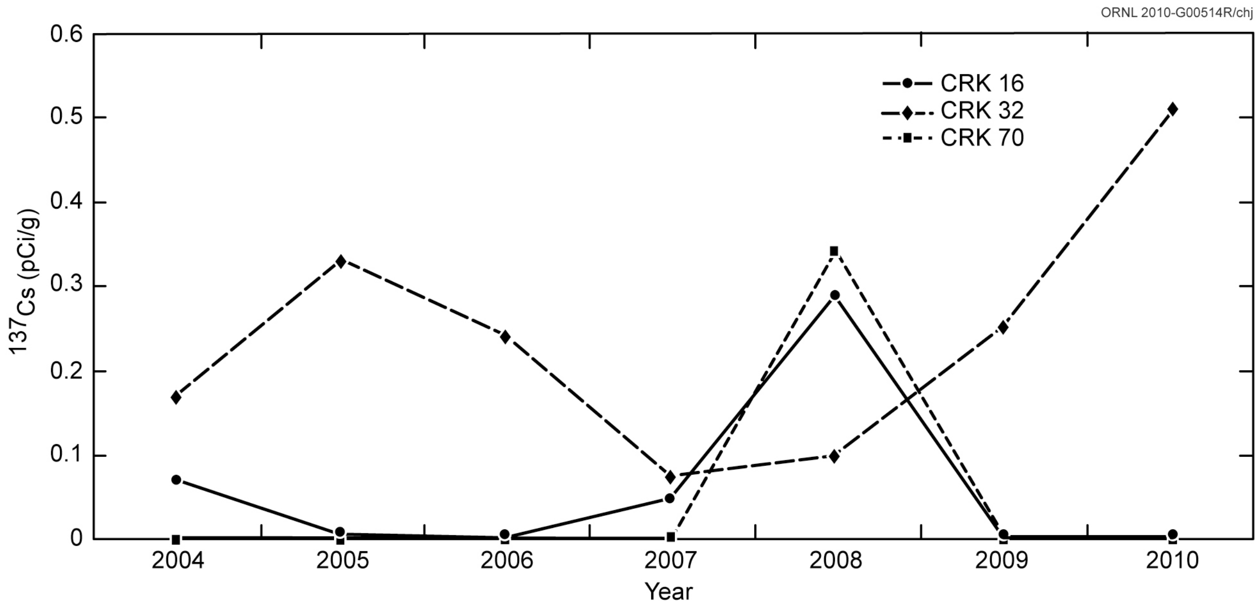

Fig. 5.43. ORNL sediment sampling results for ^{137}Cs, 2004–2010.

5.6 Groundwater Protection Program

As in years past, groundwater monitoring at ORNL was conducted under two sampling programs in 2010: DOE Environmental Management (EM) monitoring and DOE Office of Science (SC) surveillance monitoring. The EM groundwater monitoring program was performed by BJC. The SC groundwater monitoring surveillance program was conducted by UT-Battelle.

Contaminant concentrations in groundwater observed in other watershed or sub-watershed discharge areas were generally consistent with observations described in past annual site environmental reports (ASERs). Several polycyclic aromatic hydrocarbon (PAH) compounds were identified in samples collected from Northwestern and White Oak Creek Discharge Area wells. The sources of these PAH compounds are unknown, but it is hypothesized that they originate in legacy contamination within the main campus area or the burial grounds in Melton Valley. PAH compounds were also identified in samples associated with laboratory or trip blanks. Based on the results of the 2010 monitoring effort, there is no indication that current SC operations are significantly impacting groundwater at ORNL.

5.6.1 DOE-EM Groundwater Monitoring

Monitoring was performed as part of an ongoing comprehensive CERCLA cleanup effort in Bethel and Melton Valleys at ORNL, the two administrative watersheds at the ORNL site. Groundwater monitoring for baseline and trend evaluation in addition to measuring effectiveness of completed CERCLA remedial actions is conducted by the Water Resources Restoration Program (WRRP). The WRRP has been managed by BJC for the DOE-EM program since its inception and is the vehicle for the EM program to carry out the monitoring requirements outlined in CERCLA decision documents. The results of CERCLA monitoring for the ORR for fiscal year 2010, including the monitoring at ORNL, are evaluated and reported in the *2011 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE 2011a) as required by the Federal Facilities Agreement for the ORR. The monitoring results and remedy effectiveness evaluations for Bethel and Melton Valley are reported in Sections 2 and 3, respectively, in this report.

The WRRP also conducts groundwater monitoring at SWSA 6 and submits the required annual groundwater monitoring report to TDEC in response to RCRA Permit.

Groundwater monitoring conducted by the EM program at ORNL includes routine sampling and analysis of groundwater from 27 wells in Bethel Valley. In Melton Valley, where CERCLA remedial actions were completed in 2006 for the extensive waste management areas, the groundwater monitoring program includes monitoring groundwater levels in 80 wells to evaluate the effectiveness of hydrologic isolation of buried waste units. Additionally, groundwater is sampled and analyzed for a wide range of general chemical and contaminant parameters in 46 wells within the interior portion of the closed waste management area.

DOE initiated activities on a groundwater treatability study at the Bethel Valley 7000 Services Area VOC plume. This plume contains trichloroethene and its transformation products cis-1,2-dichloroethene and vinyl chloride, all at concentrations greater than EPA primary drinking water standards. The treatability study is a laboratory and field demonstration that microbes inherent to the existing subsurface microbial population can fully degrade the VOCs to nontoxic end products.

During FY 2010 baseline groundwater sampling and analysis was conducted at two former Low-Level Solid Waste Storage Areas in Bethel Valley—SWSA 1 and SWSA 3. Remedial actions and monitoring were specified in a CERCLA Remedial Action Work Plan that was developed by DOE and was approved by EPA and TDEC prior to project initiation.

During FY 2010 the EM Program installed an offsite groundwater monitoring well array west of the Clinch River adjacent to Melton Valley. During FY 2010 monitoring was initiated in those wells. In addition to monitoring offsite groundwater quality near Melton Valley, exit pathway groundwater monitoring conducted by the EM program in Melton Valley includes sampling at six multiport monitoring wells in western Melton Valley (wells 4537, 4538, 4539, 4540, 4541, 4542).

5.6.1.1 Summary of EM Groundwater Monitoring

5.6.1.1.1 Bethel Valley

During FY 2010, design work was completed and construction was initiated for remedial actions at two former waste storage sites, SWSA 1 and SWSA 3, that were used for disposal of radioactively contaminated solid wastes between 1944 and 1950. The Bethel Valley Record of Decision (DOE 2002) selected hydrologic isolation using multi-layer caps and groundwater diversion trenches as the remedial action for the waste burial grounds and construction of soil covers over the former contractor's landfill and contaminated soil areas near SWSA 3. The baseline monitoring included measurement of groundwater levels to obtain baseline data to allow evaluation of post-remediation groundwater-level suppression. Sampling and analysis of groundwater quality and contaminants were also conducted. Also during FY 2010 the EM Program installed three new groundwater monitoring wells in Bethel Valley to the west of TN Highway 95 to detect and monitor contamination from the SWSA 3 area. These three wells supplement data being collected from a multiport well (4579) near SWSA 3 for exit pathway groundwater monitoring in western Bethel Valley. Groundwater monitoring near SWSA 3, along with the exit pathway, and groundwater monitoring and surface water monitoring at the Northwest Tributary of White Oak Creek and in the headwaters of Raccoon Creek allow integration of data concerning SWSA 3 contaminant releases as presented in the 2011 Remediation Effectiveness Report (DOE 2011a).

The other principal element of the Bethel Valley Record of Decision (DOE 2002) remedy that requires groundwater monitoring is the containment pumping to control and treat discharges from the Core Hole 8 plume in the central campus area of ORNL. The original action for this plume was a CERCLA Removal Action that was implemented in 1995. The remedy had performed well until the latter portion of FY 2008 when conditions changed and ^{90}Sr and $^{233/234}$U concentrations in monitoring wells and the groundwater collection system began increasing. Leaking utility waterlines near the source area are suspected to have increased the mass of contaminants feeding the plume. Increased infiltration of plume water into storm drains has allowed increased contaminant flux to First Creek, a tributary of White Oak Creek. During FY 2009 the remedy did not meet its performance goal, which is a reduction of ^{90}Sr in White Oak Creek. DOE is in the process of modifying the groundwater collection system to increase the plume containment effectiveness. During FY 2010 DOE initiated a project to install additional plume contaminant collection wells and a refurbishment of the existing plume collection infrastructure, which had become unreliable because of its age.

Monitoring of groundwater contaminants in other areas of Bethel Valley showed that contaminant levels are generally stable.

5.6.1.1.2 Melton Valley

The *Record of Decision for Interim Actions in Melton Valley* (DOE 2000) established goals for a reduction of contaminant levels in surface water, groundwater-level fluctuation reduction goals within hydrologically isolated areas, and minimization of the spread of groundwater contamination. Remedy effectiveness groundwater monitoring in Melton Valley includes groundwater-level monitoring in wells within and adjacent to hydrologically isolated shallow waste burial areas and groundwater quality monitoring in selected wells adjacent to buried waste areas.

Groundwater-level monitoring is showing that the hydrologic isolation component of the Melton Valley remedy is effectively minimizing the infiltration of percolation water from contacting buried waste and is reducing contaminated leachate formation. FY 2010 was the second consecutive year to experience above-average annual rainfall since the remedy was completed in 2006, which provided a good stress test on the hydrologic isolation remedy components. In a few areas, groundwater levels within capped areas continue to respond to groundwater fluctuations imposed from areas outside the caps, but contact of groundwater with buried waste is minimal. Overall the hydrologic isolation systems are performing as designed; however, groundwater level control at the SWSA 4 downgradient collection trench was challenged following large rain events. DOE proposes to conduct maintenance actions on that element of the remedy to improve its performance.

Groundwater quality monitoring in the interior of Melton Valley shows that in general groundwater contaminant concentrations are declining or are stable following remedial actions.

Monitoring of groundwater in the Melton Valley exit pathway has detected the presence of site-related contaminants in groundwater near the Clinch River. Low concentrations of ^{90}Sr, ^{3}H, uranium, and VOCs have been detected in a number of the multizone sampling locations. Groundwater in the exit pathway wells has high alkalinity and sodium and exhibits elevated pH. During FY 2010 the EM Program installed an offsite groundwater monitoring well array west of the Clinch River adjacent to Melton Valley. During FY 2010 monitoring was initiated in those wells. Monitoring included groundwater-level monitoring to evaluate potential flowpaths near the river as well as sampling and analysis for a wide array of metals, anions, radionuclides, and volatile organic compounds. Monitoring is planned to continue into 2011 before conclusions are drawn concerning groundwater conditions offsite.

5.6.2 Office of Science Groundwater Monitoring

During 2010 DOE Order 450.1A was the primary requirement for a site-wide groundwater protection program at ORNL. As part of the groundwater protection program, and to be consistent with UT-Battelle management objectives, groundwater surveillance monitoring was performed in order to monitor ORNL groundwater exit pathways and UT-Battelle facilities ("active sites") potentially posing a risk to groundwater resources at ORNL. Results of the SC groundwater surveillance monitoring program are reported in the following sections.

Exit pathway and active-sites groundwater surveillance monitoring points sampled during 2010 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 SC, federal drinking water standards and Tennessee water quality criteria for domestic water supplies (TDEC 2009) were used as reference standards in the following discussions. Four percent of the derived concentration guide (DCG) found in DOE Order 5400.5 were used if no federal or state standards have been established for a particular 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.

5.6.2.1 Exit Pathway Monitoring

During 2010, exit pathway groundwater surveillance monitoring was performed in accordance with the *UT-Battelle Sampling and Analysis Plan for Surveillance Monitoring of Exit Pathway Groundwater at Oak Ridge National Laboratory* (Bonine 2010). Groundwater exit pathways at ORNL include areas from watersheds or sub-watersheds 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 interval depths (for wells), and locations relative to discharge areas proximate to DOE facilities operated by, or under the control of, UT-Battelle. The groundwater exit pathways at ORNL include four discharge zones identified by a data quality objectives process. One of the original exit pathway zones was split into two zones for geographic expediency. The Southern Discharge Area Exit Pathway was carved from the East End Discharge Area Exit Pathway.

The five zones are as follows:

- the WOC Discharge Area Exit Pathway,
- the 7000/Bearden Creek Watershed Discharge Area Exit Pathway,
- the East End Discharge Area Exit Pathway,
- the Northwestern Discharge Area Exit Pathway, and
- the Southern Discharge Area Exit Pathway.

Figure 5.44 shows the locations of the exit pathway monitoring points sampled in 2010. Unfiltered samples collected from the UT-Battelle exit pathway groundwater surveillance monitoring points in 2010 were analyzed for VOCs, semi-volatile organic compounds (SVOCs), metals (including mercury), and radionuclides (including gross alpha/gross beta activity, gamma emitters, total radioactive strontium, and ^{3}H). Under the monitoring strategy outlined in the Exit Pathway Sampling and Analysis Plan, samples were collected semiannually during the wet (May) and dry (August) seasons.

5.6.2.1.1 Exit-Pathway Monitoring Results

Statistical trend analyses were performed on 2010 exit pathway monitoring data sets containing data exceeding reference standards. The bases used for the trend analyses were the historical data collected from the late 1980s through 2009. Trend analyses were not performed on data sets that were reported as being “undetected” by the laboratory, even when minimum detection limits exceeded reference standards (semivolatile organic compounds atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol) and were not performed on parameters for which there are no reference standards or where data densities were insufficient. Trends for those parameters that exhibited statistically significant (80% to 99% confidence levels) upward or downward trends are reported. Samples were not collected at EE-02 or S-01 during the dry season due to a lack of water flow at these locations. Samples were collected at all other monitoring points during both the wet and dry seasons. Monitoring results are available in the Oak Ridge Environmental Information System (OREIS). Access to this system can be requested via email (oreis@ettp.doe.gov) or by telephone at 865-574-3257.

Exit-Pathway Results for WOC Discharge Area

Monitoring wells 857, 858, 1190, 1191, and 1239 were sampled during May and August 2010. As in past years, radiological constituents were 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 the WOC Discharge Area wells. A statistically significant downward trend exists for all three radiological constituents at both sampling locations. Figure 5.45 shows the downward trends for all three radiological constituents in both wells. Aside from the radionuclides that were detected above reference standard concentrations, the following

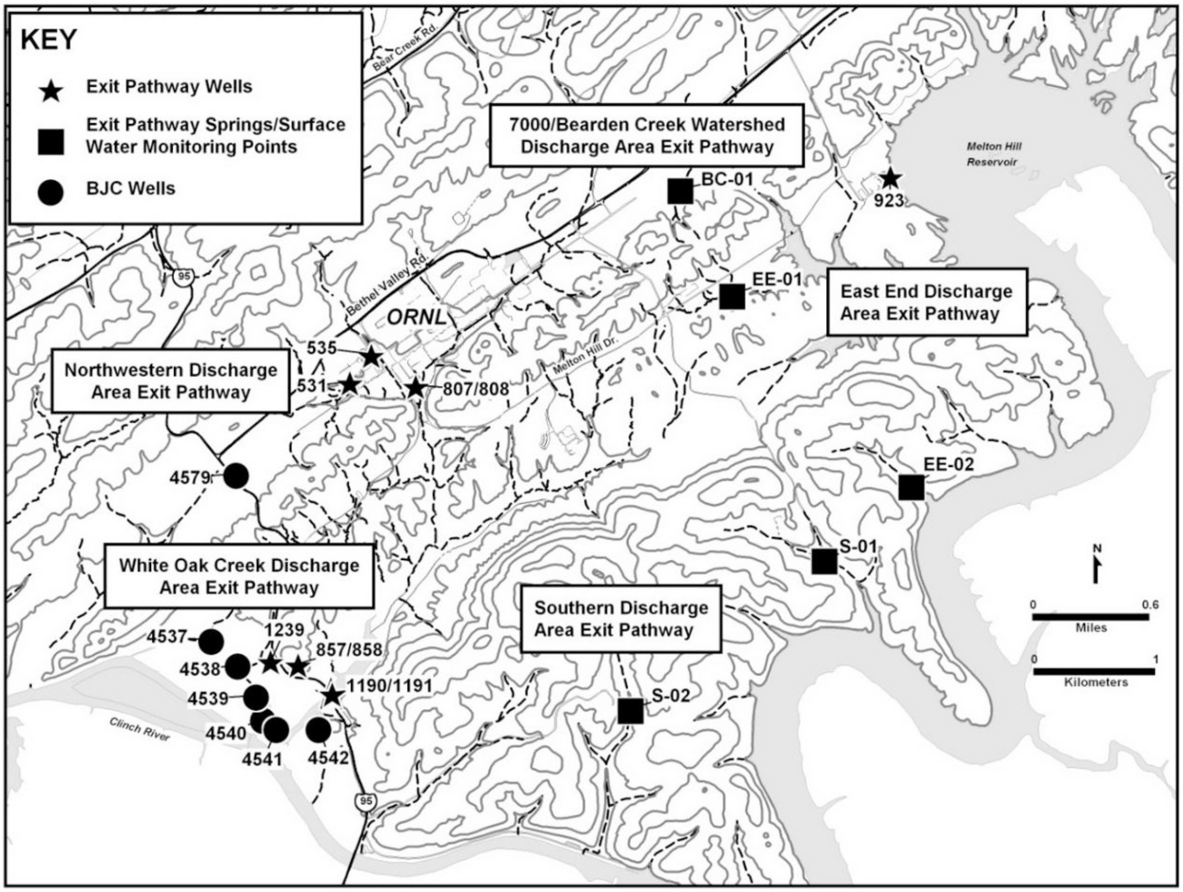

Fig. 5.44. UT-Battelle exit pathway groundwater monitoring locations at ORNL, 2010.

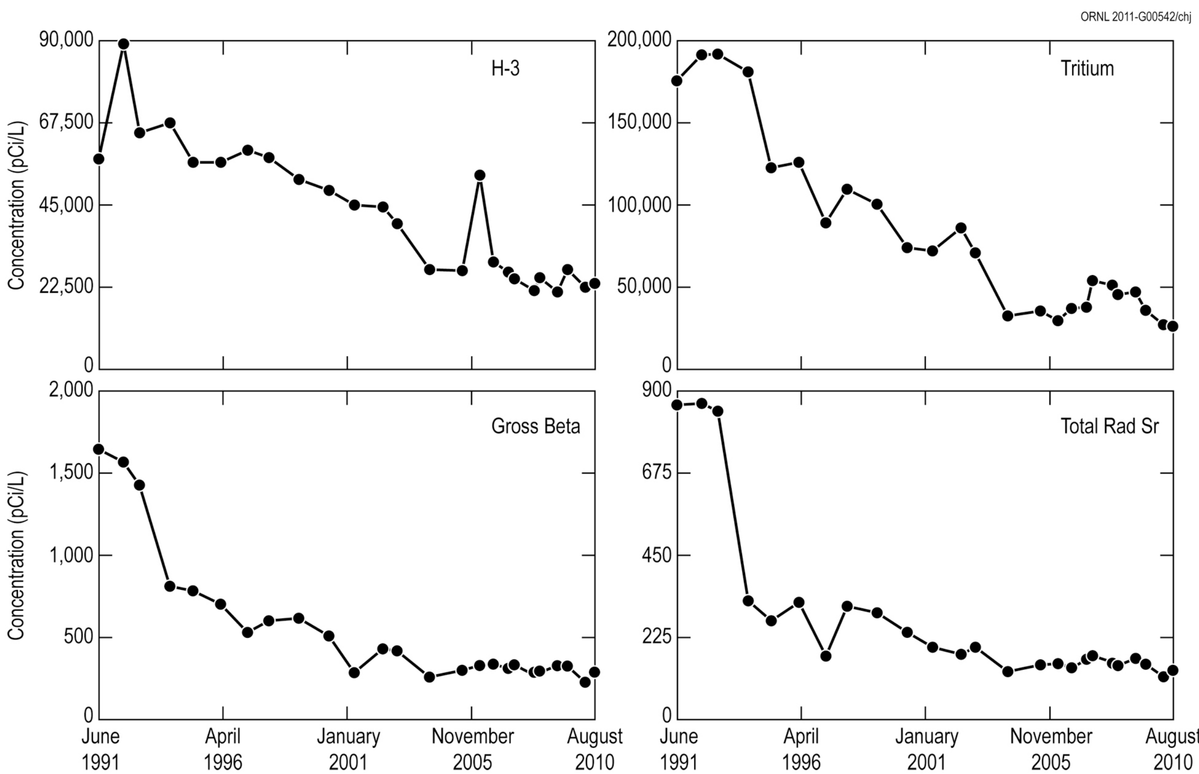

Fig. 5.45. Time series of radionuclides exceeding reference standards at Wells 1190 and 1191.

radionuclides were detected at low levels in WOC Discharge Area wells: gross beta activity and ^{3}H in well 857; gross beta activity in well 1190; and gross alpha and beta activity in well 1239. The source of these radiological contaminants is most likely from the burial grounds located within Melton Valley.

As in past years, iron, manganese, and aluminum exceeded reference standards in WOC Discharge Area wells during 2010. Aluminum and iron were found to exceed their reference standards in well 857 in addition to iron and manganese in wells 1190 and 1191. Statistical analyses of metals data for these wells show a statistically significant increase in trend for aluminum in well 857 and manganese in well 1191. Statistically significant downward trends exist for manganese and iron in well 1190 in addition to iron in wells 857 and 1191. It is possible that the metals are sorbed onto suspended solids in the groundwater samples collected, contributing to the exceedance of the reference standards used for comparison. Other metals were detected at low concentrations in groundwater samples collected from WOC Discharge Area wells. Monitoring results are available in the Oak Ridge Environmental Information System (OREIS). Access to this system can be requested via email (oreis@ettp.doe.gov) or by telephone at 865-574-3257.

Detection limits for several semivolatile organic compounds (atrazine, benzo(a)pyrene, hexa-chlorobenzene, and pentachlorophenol) 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, several PAH compounds (i.e., fluroanthene, naphthalene, and phenanthrene) were detected at low estimated concentrations in well 857. Additionally, PAH compounds benzo(a)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene were detected in low estimated concentrations in well 1239. The source of the PAH compounds is unknown, but it is possible that these PAH compounds are legacy contaminants from the main campus area of ORNL or the burial grounds in Melton Valley. Departing from past year observations, plasticizers bis (2-ethylhexyl) phthalate and diethyl phthalate were not detected in samples collected from WOC Discharge Area wells.

Low concentrations of acetone were detected in groundwater samples collected from all of the WOC Discharge Area wells in 2010. Acetone was detected in low estimated concentrations in all of the laboratory blanks associated with dry season samples collected from WOC Discharge area wells. Acetone was also found at low concentrations in trip blanks that accompanied dry season samples collected from wells 1190, 1191, and 1239.

Exit-Pathway Results for 7000/Bearden Creek Watershed Discharge Area

Because of sporadic flow at spring/seep BC-01, a new spring was chosen within the same discharge sub-area. A new spring was located downstream of the original location of BC-01 within the same tributary to Bearden Creek, allowing sampling to occur in May and August 2010.

No radionuclides were detected in BC-01 in 2010; however, iron, manganese, and aluminum were detected at concentrations greater than reference standards. None of these metals exhibit a discernable upward or downward trend. Other metals were detected at low concentrations in groundwater samples collected from this discharge area in 2009. Monitoring results are available in the Oak Ridge Environmental Information System (OREIS). Access to this system can be requested via email (oreis@ettp.doe.gov) or by telephone at 865-574-3257. Detection limits for the semivolatile organic compounds (atrazine, benzo(a)pyrene, hexa-chlorobenzene, and pentachlorophenol) exceeded reference standards. Iodomethane (also known as methyl iodide) was found at a very low estimated concentration in the groundwater sample collected from BC-01 in May 2010. Iodomethane is primarily used as a component of a pesticide. There are no records indicating that an iodomethane-based pesticide has been used at ORNL; consequently, the source of this compound is not known. No other VOCs were detected in BC-01 in 2010.

Exit-Pathway Results for East End Discharge Area

Well 923 and monitoring point EE-01 were sampled in May and August 2010. Well EE-02 was sampled only during the wet season (May 2010), as there was no flow present at this 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. Iron and manganese exceeded reference standards in well 923 and EE-01, while manganese exceeded its reference standard at EE-02. No statistically significant trend was detected in the iron and manganese data sets at well 923. Likewise, no trend was detected in the manganese data set for EE-02; however, a statistically significant increase in trend is observable in the manganese data set for EE-01. Other metals were detected at low concentrations in groundwater samples collected from East End Discharge Area in 2010. Monitoring results are available in the Oak Ridge Environmental Information System (OREIS). Access to this system can be requested via email (oreis@ettp.doe.gov) or by telephone at 865-574-3257.

Detection limits for several undetected semivolatile organic compounds (atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol) exceeded reference standards. Acetone was detected at a low concentration in a sample collected in August 2010 from well 923. Acetone was also detected in the trip blank accompanying that sample. Methylene chloride was found in a laboratory blank and trip blank associated with a sample collected in May 2010 from well 923. In addition, methylene chloride was detected at a low estimated concentration in a sample collected from EE-01 in August 2010.

Exit-Pathway Results for Northwestern Discharge Area

Wells 531, 535, 807, and 808 were sampled in May and August 2010. No radiological parameters exceeded their reference standards at any Northwestern Discharge Area monitoring point. However, gross alpha and beta activity and ^{3}H were detected in low concentrations in well 535. In addition, low concentrations of gross beta activity, total radioactive strontium, and ^{3}H were detected in groundwater samples collected from well 807.

Iron and aluminum concentrations exceeded reference standards in samples collected from well 531. No discernable trend was detected in the data sets for either parameter. Iron and manganese also exceeded reference standards in well 535. Analyses of the historical data sets for iron and manganese indicate the presence of statistically significant increasing trends for both parameters. Additionally, iron and manganese exceeded reference standards in well 807, but trend analyses of the historical data sets for these parameters indicate no discernable trends. Other metals were detected at low concentrations in groundwater samples collected from Northwestern Discharge Area in 2010. Monitoring results are available in the Oak Ridge Environmental Information System (OREIS). Access to this system can be requested via email (oreis@ettp.doe.gov) or by telephone at 865-574-3257.

Detection limits for several undetected semivolatile organic compounds (atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol) exceeded reference standards. As a departure from 2009, diethyl phthalate and toluene were not detected in samples collected from well 535. PAH compounds benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and ideno(1,2,3-cd) pyrene were detected at low estimated concentrations in well 807, while benzo(a)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene were detected at low estimated concentrations in well 808. Benzo(a)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene were also found in laboratory blanks associated with samples collected from wells 807 and 808. The PAH compound naphthalene was detected at a low estimated concentration in well 535 in 2010. The source of naphthalene, dibenzo(a,h)anthracene, and ideno(1,2,3-cd) pyrene is unknown; however, it is possible that these compounds are legacy soil contaminants found in the main campus of ORNL.

Volatile organics identified in samples collected from Northwest Discharge Area wells included methylene chloride and acetone. Methylene chloride was detected at a low estimated concentration in a groundwater sample collected from well 531. The same compound was also detected in the laboratory and trip blanks associated with the sample. Acetone was detected at a low estimated concentration in well 807 and detected in well 808 during dry season sampling. Acetone was also detected in the trip blanks associated with these samples. Acetone was also identified in the method blank associated with a sample collected from well 535.

Exit-Pathway Results for Southern Discharge Area

Monitoring point S-01 was sampled by UT-Battelle in May 2010, but no samples were collected during the dry season sampling event (August 2010) because the monitoring point was dry. Monitoring point S-02 was sampled in May and August 2010.

No radiological parameters exceeded reference standards at either monitoring point; however, low concentrations of gross alpha and ^{40}K were detected in samples collected from S-02.

Concentrations reported for aluminum and iron exceeded reference standards at S-01. Likewise, iron, aluminum, and manganese concentrations exceeded reference standards at S-02. Trend analyses of the data sets for these metals indicate no discernable trends. Lead was detected in 2009 in samples collected from S-02 in 2009 but was not detected in samples collected in 2010. Other metals were detected at low concentrations in groundwater samples collected from Southern Discharge Area in 2009. Monitoring results are available in the Oak Ridge Environmental Information System (OREIS). Access to this system can be requested via email (oreis@ettp.doe.gov) or by telephone at 865-574-3257.

Detection limits for several undetected semivolatile organic compounds (atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol) exceeded reference standards. Unlike 2009, volatile organic compounds were not detected in groundwater samples collected.

5.6.2.2 Active Sites Monitoring

5.6.2.2.1 Active Sites Monitoring—HFIR

Surveillance monitoring of the HFIR site detected a subsurface release of ^3H from a process waste drain in the autumn of 2000. At that time, reactor systems were shut down so that the release site could be identified and repaired. The process waste drain was found to be the source of the release and was repaired, ending the release of the ^3H to the subsurface. From 2000–2007, monitoring of HFIR-site wells and subsurface drains was conducted to determine the size and scope of the ^3H plume that was created by the release. This groundwater monitoring approach was conducted by the UT-Battelle Research Reactor Division (RRD). The main mass of the ^3H plume was observed to move from the release area to the south–southeast toward a tributary to Melton Branch and Melton Branch itself. RRD discontinued routine monitoring in 2007 based on a history of zero detectable subsurface releases of ^3H from the process waste drain and observations of steep downward trends in ^3H concentration reductions in samples collected from monitoring sites down gradient of the release site. The expectation is that ^3H concentrations should continue to decrease with the possibility of additional precipitation-driven concentration spikes or drought-induced ^3H concentration stagnation. Although RRD has ceased monitoring the ^3H plume, ^3H monitoring at HFIR has continued under the auspices of the *Oak Ridge National Laboratory NPDES Water Quality Protection Plan*, October 2008 (unpublished). Please refer to Sect. 5.5 of that document for requirements of 2010 ^3H monitoring at HFIR. All wells used in the RRD groundwater monitoring program are being maintained for future use as needed.

5.6.2.2.2 Active Sites Monitoring—SNS

Active sites groundwater surveillance monitoring was performed in 2010 at the SNS site. The 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 2010 under the draft *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 and 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 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 that break out 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 the following: (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. Locations were chosen based on hydrogeological factors and proximity to the beam line. Figure 5.46 shows the locations of the specific monitoring points sampled during 2010.

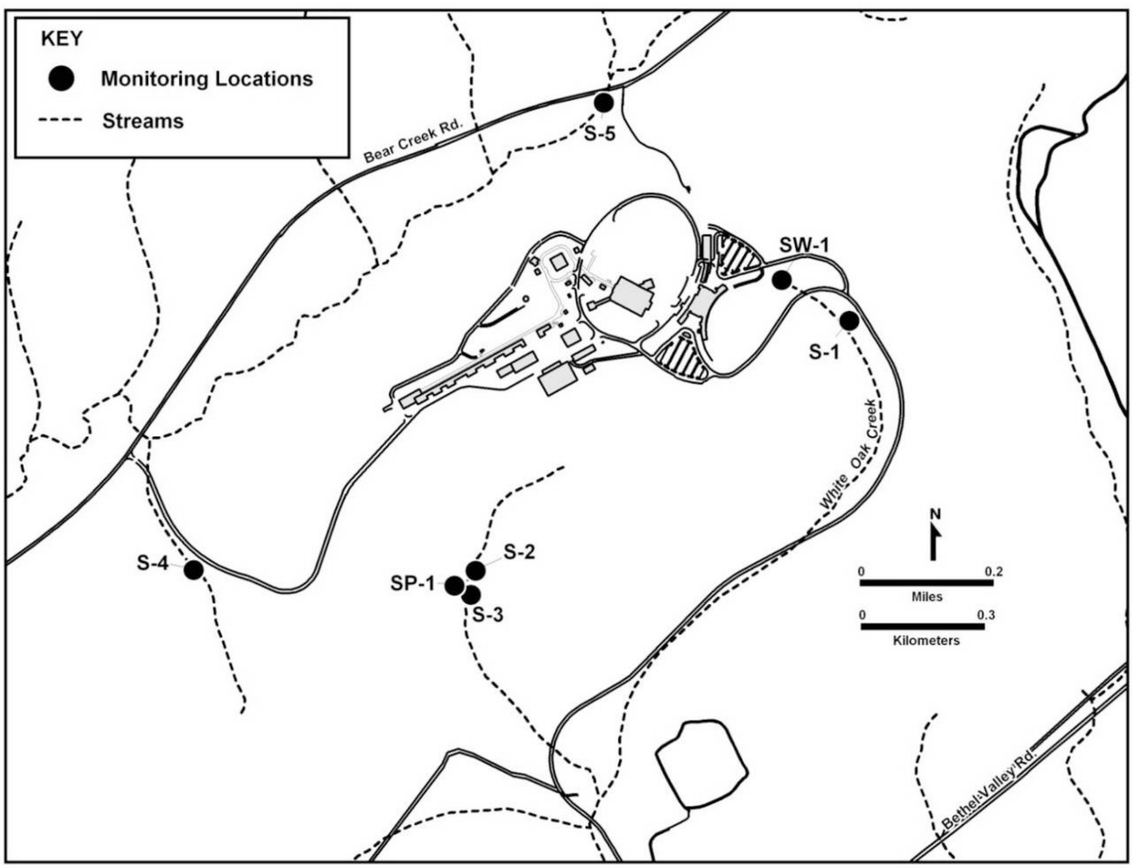

Fig. 5.46. Groundwater monitoring locations at the Spallation Neutron Source, 2010.

Because of the presence of karst geomorphic features at the SNS site (and the lack of groundwater wells at the SNS site), sampling of the seeps/springs was performed quarterly to characterize the radionuclide content of the water throughout the expected range of flow at each monitoring locations. Three grab samples were collected from each seep/spring: one sample to represent base flow (collected during dry periods between rainfall events) and two samples collected during rainfall events representing higher stage/flow rates [i.e., one representing the rising limb of the storm hydrograph (water flow induced by the initial pulse of rainfall percolating through the system) and one representing the falling limb of the storm hydrograph (water flowing in the system after peak flow induced by rainfall has occurred)], as shown in Fig. 5.47. Given their fate and transport characteristics, ^{3}H and ^{14}C are the principal groundwater constituents of concern at the SNS site. In 2010, 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.

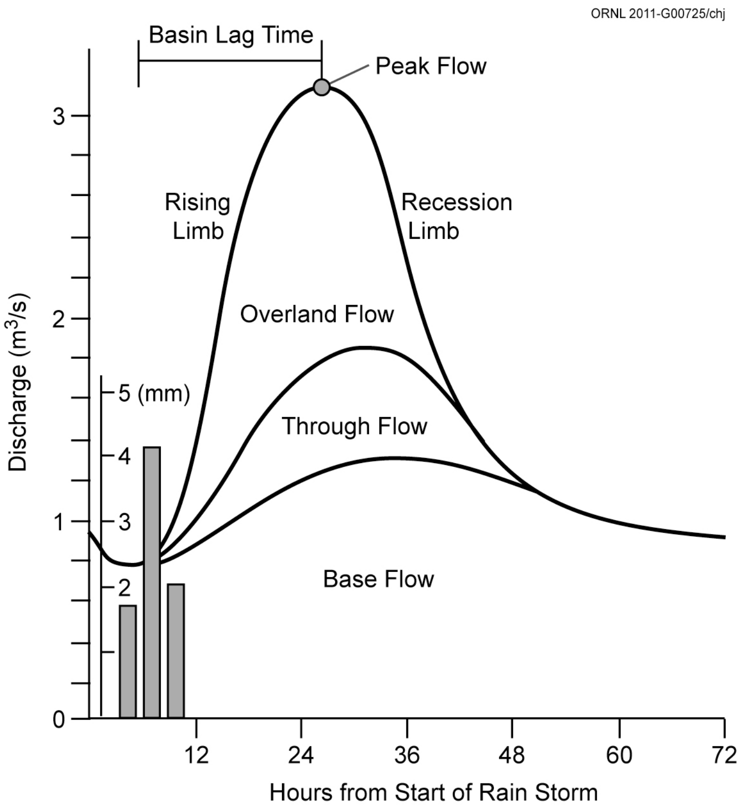

Fig. 5.47. Simple hydrograph of spring discharge vs. time after initiation of rainfall.

SNS Site Results

Sampling at the SNS site occurred during March, June, August, and November 2010, and the sampling results were compared to reference standards. No SNS sample results exceeded reference standard thresholds in 2010. Low concentrations of gross alpha and beta activity were detected in samples collected from S-5 during base flow conditions in March. Carbon-14 and gamma-emitting radionuclides were not detected in samples collected at the SNS site during 2010. Low concentrations of ^{3}H were detected numerous times during 2010. None of the ^{3}H concentrations exceeded the corresponding reference standard. The following is a summary of the locations, flow conditions, and sampling events for ^{3}H detections observed during 2010:

1. S-1 – (a) during base flow conditions in August and November and (b) during rising and falling limb conditions in March, June, August, and November.
2. S-2 – (a) during base flow conditions in August and November and during rising and falling limb conditions in March, June, August, and November.
3. S-3 – (a) during base flow conditions in August; (b) during rising limb conditions in March, June, and November; and (c) during falling limb conditions in March, August, and November.
4. S-4 – (a) during base flow conditions in August; (b) during rising limb flow conditions in November; and (c) during falling limb conditions in June and November.

5. S-5 – (a) during base flow conditions in August and November and (b) during rising limb and falling limb conditions in November.
6. SW-1 – ^{3}H was detected in samples collected during all flow conditions and all sampling events (March, June, August, and November).
7. SP-1 – (a) during rising limb flow conditions in March and (b) during falling limb conditions in June.

SNS groundwater monitoring results are found in Table 5.24.

Table 5.24. Constituents detected in SNS groundwater, 2010[a]

Parameter	N det/N total	Min[b]	Max	Avg	Standard error[c]
Spring S-1 - Discharge point east-southeast of SNS site					
Field measurements					
Conductivity (mS/cm)	12/12	0.22	0.63	0.34	0.042
Dissolved Oxygen (ppm)	12/12	4.5	10	8.1	0.54
pH (Std Unit)	12/12	5.7	7.8	n/a	n/a
Temperature (°C)	12/12	13	25	18	1.4
Turbidity (NTU)	12/12	2.0	180	56	19
Radionuclides (pCi/L)[d]					
Tritium	10/12	U81*	3,600*	~950*	380
Spring S-2 - Discharge point south of SNS site					
Field measurements					
Conductivity (mS/cm)	12/12	0.31	0.44	.037	0.013
Dissolved Oxygen (ppm)	12/12	2.1	8.0	4.7	0.52
pH (Std Unit)	12/12	6.0	7.8	n/a	n/a
Temperature (°C)	12/12	12	19	15	0.72
Turbidity (NTU)	12/12	1.0	49	10	3.8
Radionuclides (pCi/L)[d]					
Tritium	10/12	U81*	1,400*	~590*	140
Spring S-3 - Discharge point south of SNS site					
Field measurements					
Conductivity (mS/cm)	12/12	0.28	.039	0.35	0.0085
Dissolved Oxygen (ppm)	12/12	3.5	7.4	5.6	0.36
pH (Std Unit)	12/12	6.4	7.5	n/a	n/a
Temperature (°C)	12/12	14	15	15	0.14
Turbidity (NTU)	12/12	1.0	27	7.2	2.0
Radionuclides (pCi/L)[d]					
Tritium	7/12	U35	520*	~170*	38
Spring S-4 - Discharge point west-southwest of SNS site					
Field measurements					
Conductivity (mS/cm)	12/12	0.1	0.24	0.18	0.013
Dissolved Oxygen (ppm)	12/12	6.9	9.8	8.6	0.26
pH (Std Unit)	12/12	5.9	7.7	n/a	n/a
Temperature (°C)	12/12	11	21	16	0.97
Turbidity (NTU)	12/12	0.0	10	2.5	0.81
Radionuclides (pCi/L)[d]					
Tritium	4/12	U24	220*	~110*	17

Table 5.24 (continued)

Parameter	N det/N total	Min[b]	Max	Avg	Standard error[c]
Spring S-5 - Discharge point north-northeast of SNS site					
Field measurements					
Conductivity (mS/cm)	12/12	0.42	0.63	0.55	0.022
Dissolved Oxygen (ppm)	12/12	1.8	7.5	5.0	0.58
pH (Std Unit)	12/12	5.5	7.6	n/a	n/a
Temperature (°C)	12/12	13	20	15	0.54
Turbidity (NTU)	12/12	0.0	9.0	2.5	0.81
Radionuclides (pCi/L)[d]					
Alpha activities[e]	1/1	8.6*	8.6*	n/a	n/a
Beta activities[e]	1/1	14*	14*	n/a	n/a
Tritium	4/12	U22	230*	~150*	20
Spring SP-1 - Discharge point south of SNS site					
Field measurements					
Conductivity (mS/cm)	12/12	0.28	0.33	0.3	0.0056
Dissolved Oxygen (ppm)	12/12	7.2	11	8.7	0.32
pH (Std Unit)	12/12	6.3	8.1	n/a	n/a
Temperature (°C)	12/12	12	21	16	0.8
Turbidity (NTU)	12/12	0.0	21	3.3	1.8
Radionuclides (pCi/L)[d]					
Tritium	12/12	U-100	250*	~73*	26
Surface Water Point SW-1 - Discharge point east-southeast of SNS site					
Field measurements					
Conductivity (mS/cm)	12/12	0.26	0.45	0.34	0.021
Dissolved Oxygen (ppm)	12/12	1.4	8.6	5.1	0.74
pH (Std Unit)	12/12	5.7	7.3	n/a	n/a
Temperature (°C)	12/12	12	20	16	0.95
Turbidity (NTU)	12/12	0.0	43	11	4.2
Radionuclides (pCi/L)[d]					
Tritium	12/12	160*	940*	500*	86

[a]All values were included in the calculations. Only parameters that have detections in one or more samples are listed in the table. The sampling and analysis plan contains a complete list of analyses performed.

[b]Prefix “U” indicates that the radionuclide was undetected at the MDA.

[c]Standard error of the mean.

[d]Individual and average radionuclide concentrations significantly greater than zero are identified by an *. Detected radionuclides are those detected at or above MDA.

[e]Gross activity (gross alpha and gross beta) performed as part of March 2010 sampling at all locations. Activity detected only at location S-5.

5.7 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.

5.7.1 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;
- perform work planning—analyze hazards and define controls;
- execute work; and
- provide feedback.

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

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.

5.7.2 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.

Likewise, the TWPC Training and Qualification program provides employees 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.

5.7.3 Equipment and Instrumentation

5.7.3.1 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.

5.7.3.2 Standardization

EP&WSD sampling procedures, maintained in the Integrated Document Management System, 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. Standard operating procedures for sampling also include instructions for designating nonconforming instruments as "out-of-service" and initiating requests for maintenance.

5.7.3.3 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.

5.7.4 Assessment

Independent audits, surveillance, and internal management assessments are performed to verify that requirements have been accurately specified and activities that have been performed conform to expectations and requirements. External assessments are scheduled based on requests from auditing agencies. Table 2.1 presents a listing of environmental audits and assessments performed at ORNL in 2010 and information on the number of findings identified. 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.

The TWPC performs independent audits, surveillances, and internal management assessments to verify that requirements have been accurately specified and activities that have been performed conform to expectations and requirements. Environmental personnel conduct internal assessments of TWPC procedural compliance, environmental compliance, and EMS implementation. Corrective actions, if required, are documented and tracked in the TWPC Issues Management Database.

5.7.5 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. UT-Battelle uses a competitive award system to select laboratories that are contracted under basic ordering agreements to perform analytical work to characterize ORNL environmental samples. The DOE Environmental Management Consolidated Audit Program performs oversight of subcontracted commercial laboratories. 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 that monitor the performance of all subcontracted laboratories and verify that 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.

5.7.6 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.

5.7.7 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 office areas and the ORNL Inactive Records Center, and destroying records.

The TWPC maintains all 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.

5.8 Environmental Management and Waste Management Activities at ORNL

Because of past waste disposal practices and unintentional releases, portions of land and facilities on the ORR are contaminated with radioactive elements, mercury, asbestos, polychlorinated biphenyls, and industrial wastes. DOE EM conducts cleanup programs across the reservation to correct the contamination remaining from years of energy research and weapons production.

ORNL has become one of the world's most modern campuses for scientific discovery in materials and chemical sciences, nuclear science, energy research, and super-computing. However, the site also includes large contaminated areas that resulted from past operations and waste disposal practices. The Environmental Management Program has divided ORNL into two major cleanup areas: Bethel Valley and Melton Valley. The Bethel Valley area includes reactors and the principal research facilities, and the Melton Valley Area was used for reactors and waste management. The following sections summarize some of the 2010 EM activities undertaken at ORNL. More detailed information is available in the FY 2010 Cleanup Progress Annual Report to the Oak Ridge Community (DOE 2010a).

5.8.1 Demolition Completed at 3026 C&D

In February 2010 demolition and stabilization were completed on the wooden superstructure of one of the highest hazard excess facilities at ORNL—the 3026 C&D Radioisotope Development Laboratory. This building, one of the original Manhattan Project facilities, had a footprint of approximately 24,000 ft^2 and contained several hot cells and associated pipes and ducts that were highly contaminated. The wooden structure in which the hot cells were located had deteriorated significantly over the years due to age and roof leaks. A roof failure in 2007 damaged the fire suppression sprinkler system, requiring it to be deactivated. This deactivation presented potential fire hazards to nearby facilities and the potential for contaminant release if a fire occurred in the facility.

DOE determined that the resulting risks warranted implementing a time-critical Removal Action to remove the 3026 C&D wooden structure and stabilize the hot cells.

More than 160 shipments of building debris, representing 1.7 million pounds of waste, were sent to EMWMF as a result of the 3026 C&D demolition activities. An additional 25 yd^3 of waste was processed and dispositioned via alternative pathways. Of special note was that for personnel safety, a portion of the building had to be demolished with friable asbestos in place. This required the use of supersacks for debris packaging.

As a final step in this phase of the 3026 C&D work, the entire remaining hot cell structures and building slab were coated with polyurea. Polyurea's properties of fast reactivity and relative insensitivity to moisture make it useful for large-surface-area projects. With this final stabilization coating in place, the 3026 C&D area was transitioned on September 23, 2010, to the DOE contractor responsible for removing the hot cells.

5.8.2 2000 Complex Demolition Activities

Demolition was completed on six facilities in the 2000 Complex at ORNL during 2010. The complex, located in the northwest corner of the ORNL central campus, included eight facilities and structures totaling 58,000 ft^2.

The Complex was constructed in the late 1940s to support various ORNL research projects, and included Buildings 2000, 2001, and 2024, and the ancillary support facilities 2019, 2034, 2087, 2088, and 2092. All of these buildings were in severe disrepair and had been vacant for approximately 6 years.

The specific hazards associated with the 2000 Complex include the extremely poor physical condition of the structures, constant flaking of PCB-containing paint, extensive quantities of friable and non-friable asbestos in restricted attic areas, and radiologically contaminated ductwork and fume hoods. The demolition project was divided into two phases.

In FY 2010, demolition of the first phase (2000 Complex East) was completed. This phase consisted of the demolition of six buildings (2001, 2019, 2024, 2087, 2088 and 2092) with a combined area of approximately 35,000 ft^2. Also in FY 2010, the contract was awarded, contractor mobilized, and hazardous material abatement commenced on the second and final phase (2000 Complex West), which consisted of the Buildings 2000 and 2034, with a combined area of 23,200 ft^2.

2010 Phase 1 demolition work resulted in 278 shipments of building debris, representing more than 5700 yd^3 of waste shipped to the Y-12 landfill and 75 yd^3 to EMWMF.

5.8.3 Bethel Valley Burial Grounds Remediation

The Bethel Valley Burial Grounds Project includes capping SWSA 1 in Central Bethel Valley and SWSA 3 in West Bethel Valley, remediation of contaminated hot spots, and placing a cover over disposal areas in the vicinity of the two SWSAs.

Work in the vicinity of SWSA 1 was completed in October 2010. Capping of SWSA 1 involved placement of several layers of cap material to prevent migration of contaminants as a result of infiltration of water. SWSA 1 is divided by a road that required reconstruction as part of the placement of the cap.

Two disposal areas near SWSA 1—the Former Waste Pile Area and the Nonradioactive Wastewater Treatment Plant Debris Pile—were covered with additional soil and re-seeded during FY 2010.

Work in the vicinity of SWSA 3 is ongoing. Activities to place some of the miscellaneous debris recovered and generated during remedial action operations on SWSA 3 are under way, and vegetation in the area adjacent to SWSA 3 and the Closed Scrap Metal Area has been cleared.

The adjacent contractor's landfill east and west have been cleared, and placement of additional soil is under way. Hot spots have been sampled, and the data are being evaluated. Ancillary activities include surveying, geophysical investigations, well investigations, well plugging and abandonment, and well installation. These ancillary activities have been completed in the vicinity of SWSA 1 and are ongoing in the vicinity of SWSA 3.

5.8.4 Tank W1A Remediation Under Way

A groundwater plume of contamination emanates from contaminated soil surrounding Tank W-1A in the central portion of ORNL and migrates to a nearby creek.

The principal plume contaminants are ^{90}Sr and uranium isotopes. Since late 1994, DOE has been implementing various actions to minimize the release of groundwater contaminants into First Creek.

During 2010 installation of a weather enclosure, soil sampling, and characterization along a Tank W-1A feed pipeline were completed. Field work is expected to be completed in fall 2011.

5.8.5 Uranium-233 Downblending and Disposition Project

Uranium-233, a special nuclear material that requires strict safeguards and security controls, is stored at ORNL in Building 3019A. During 2010, demolition and disposition of related waste for Buildings 3136 and 3074 was completed to allow for construction of an annex facility to Building 3019A. Building 3136 was a wood framed structure with sheet metal siding. Constructed in 1984 and operated as a document storage facility, the 600-ft^2 single-story building was the first of two facilities to be dismantled.

Building 3074 was constructed in 1951 and operated as the hot-cell-manipulator repair and maintenance shop. The 3,500-ft^2 single-story facility contained asbestos material, lead-based paint, polychlorinated biphenyl–containing material, and radioactive contamination. Building debris meeting the definition of mixed low-level waste was sent to the Nevada National Security Site for disposal, while the debris meeting the definition of low-level waste was disposed at Clive, Utah.

5.8.6 Soils and Sediment Remediation

The objective of the Bethel Valley Soils and Sediment Project is to characterize, scope, and complete remediation of contaminated soils and sediments to protect workers and groundwater in the area.

The RAWP for the project outlines the approach that will be followed to characterize and evaluate soils and sediments, ensuring that the soil cleanup requirements for Bethel Valley are met. The work plan was approved by the regulators in early FY 2010 and field assessment activities, which focused on portions of Bethel Valley west of the ORNL main campus, have been completed. Soils in these areas, which surround the SWSA 3 Burial Ground, have been sampled, and analytical results are being validated and assessed to determine if additional sampling will be necessary.

These efforts have resulted in more than 197 ha (487 acres) of the Raccoon Creek area being identified as requiring no action.

5.8.7 Bethel Valley Groundwater Projects

Several activities were initiated in 2010 to address Bethel Valley groundwater plumes.

5.8.7.1 7000 Area Groundwater Treatability Study

The 7000 Area includes the maintenance facilities on the east end of ORNL and the treatability study will allow the determination of the feasibility of using bacteria to eliminate trichloroethylene in groundwater.

Field activities during 2010 included sampling and analyzing groundwater to determine the presence of naturally occurring DE chlorinating microbes, evaluation of the degradation capacity of indigenous microbes, and dye studies at several wells to determine the groundwater transport characteristics. DOE will perform a pilot study at four wells in the 7000 area to determine if full-scale bioremediation is feasible.

5.8.7.2 Corehole 8 Intercept Extraction System

Surface water monitoring in First Creek has indicated the ^{90}Sr in groundwater is bypassing the Corehole 8 intercept extraction system and surfacing at First Creek on the west side of ORNL. A groundwater engineering study concluded that the Corehole 8 plume is moving along the bedrock deeper than the current interceptor extraction system components, and deeper extraction wells to intercept the deep groundwater are needed.

A sampling campaign was initiated in the summer of 2010 to determine the best location for new extraction wells. Drilling activities were initiated, and two wells will be connected to the extraction system in FY 2011. In addition the system will be upgraded with larger pumps and controllers for the multiple extraction components.

5.8.7.3 SWSA 3 Exit Pathway Monitoring

Three new monitoring wells were installed west of Highway 95 along Raccoon Creek during 2010 to monitor a ^{90}Sr plume that originates at the SWSA 3 landfill. Strontium-90 in the groundwater has been shown to flow both to the west, under Highway 95, surfacing in the Raccoon Creek headwaters, and to the east, surfacing in a tributary flowing to First Creek within the ORNL campus.

5.8.7.4 Off-Site Monitoring Wells

DOE has completed installation of monitoring wells across the Clinch River from ORNL to monitor for potential ORNL site-related contaminants.

Sixteen new monitoring wells were installed during 2010. These wells are now included in the Melton Valley monitoring network and were also incorporated into the recently proposed Melton Valley Monitoring Plan. The 16 new wells and five nearby residential wells will be sampled quarterly with initial results to be published in the FY 2011 Remedial Effectiveness Report (DOE 2011a).

5.8.8 ORNL Waste Management

5.8.8.1 ORNL Wastewater Treatment

At ORNL, 118 million gallons of wastewater were treated and released at the PWTC in 2010. In addition, the LLW evaporator at ORNL treated 120,000 gallons of waste. The waste treatment activities supported both EM and Office of Science mission activities, ensuring that wastewaters for both programs' activities are managed in a safe and compliant manner.

5.8.8.2 ORNL Newly Generated Waste Management

ORNL is the largest, most diverse Office of Science Laboratory in the DOE Complex. Although much effort is expended to prevent pollution and eliminate waste generation, some waste streams are generated as a by-product of performing research and operational activities and must be managed to ensure that the environment is protected from associated hazards. UT-Battelle, LLC, as the prime contractor for the management of ORNL, is responsible for the management of wastes generated from research and development activities as well as the wastes generated from the operations of the R&D facilities.

Wastes generated from ongoing research and operational activities are termed "newly generated waste." At ORNL, newly generated wastes consist of chemical waste streams, waste containing or contaminated with radioactivity, and chemical waste that also contains radioactivity (known as mixed waste). The majority of ORNL's newly generated radioactive waste meets the definition of low-level radioactive waste, but ORNL does generate a small quantity of waste classified as TRU waste. Most of ORNL's newly generated radioactive waste contains very small quantities of radioactivity and can be handled without special-handling protocols. [This waste is known as contact-handled (CH) waste.] However, some wastes generated in the ORNL's nuclear facilities contain enough radioactivity to require special-handling procedures such as transport in special casks that provide shielding of the radioactivity. [This waste is known as remote-handled (RH) waste.] Less than 5% of the ORNL's newly generated radioactive waste meets the criteria of being RH waste.

Beginning October 1, 2008, ORNL became fully responsible for disposition of almost all of its newly generated waste. Prior to that date, waste management responsibilities at ORNL were a shared responsibility between the DOE Office of Science (and its prime contractor, UT-Battelle) and DOE-EM (and its prime contractor, BJC). DOE initiated the transfer of most waste management responsibilities back to ORNL on October 1, 2008, to give waste generators across ORNL incentive to find new ways of doing business to eliminate and/or reduce waste generation. When 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. Waste management responsibility is shared only for those waste streams that are still both being generated by

DOE-SC and DOE-EM activities at ORNL (e.g., TRU waste and certain liquid and gaseous waste streams that can be treated by the on-site ORNL liquid and gaseous waste system operated by DOE-EM and its contractors).

The transition of waste management responsibilities at ORNL that took effect the beginning of FY 2009 went smoothly, and ORNL newly generated waste continues to be safely and effectively dispositioned using a combination of commercial waste vendors and government-owned waste disposal sites. ORNL maintains contracts with a variety of commercial waste vendors to provide for the required transport, treatment, and safe disposal of hazardous, mixed, and some radioactive waste streams. The other radioactive waste streams from ORNL are dispositioned at the National Nuclear Security Administration’s (NNSA’s) Nevada National Security Site (formerly known as the Nevada Test Site), for which ORNL is an approved waste generator. Standard industrial waste generated by ORNL is dispositioned in DOE’s ORR industrial waste landfills located near Y-12. Finally, certain waste streams generated from environmental remediation projects at ORNL may also be dispositioned in the Oak Ridge EMWMF located near Y-12, if approved by regulatory agencies in accordance with the Oak Ridge Federal Facilities Agreement.

ORNL management of newly generated waste is fully regulated by a number of federal and state laws and associated regulations. In Oak Ridge, most of these regulations are implemented by the state of Tennessee, with TDEC overseeing waste management activities. ORNL waste management officials routinely meet with TDEC DOE Oversight Division staff to brief them on the status of waste management activities, and compliance audits of waste management activities are routinely performed by TDEC. ORNL’s radioactive waste activities are performed under the authority of DOE’s Radioactive Waste Management Order (DOE Order 435.1), with which ORNL fully complies. Radioactive waste activities are routinely reviewed with DOE officials to ensure the requirements of the radioactive waste order are being met.

5.8.8.3 Transuranic Waste Processing Center

Transuranic waste-processing activities carried out for DOE in 2010 by WAI address the three remaining waste streams stored at ORNL—CH solids/debris, 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 of 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 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 in December 2005, and RH-TRU processing started in May 2008. During CY 2010, 284.9 m^3 of CH waste and 54.2 m^3 of RH waste was processed. In CY 2010, 353.5 m^3 of CH waste and 32.4 m^3 of RH waste was shipped off-site.

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