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 4,600 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 2009 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.

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. With more than $2 billion in new facilities completed since 2003, ORNL has one of the world's most modern campuses for the next generation of scientific discovery. 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. ORNL's Center for Computational Sciences houses the world's most powerful open science supercomputer capable of 1,600 trillion calculations per second. Each of these facilities works closely with the new Bioenergy Science Center, funded by DOE, to develop a new form of cellulosic ethanol that will not require land currently needed for the production of food.

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 others locations around the Oak Ridge vicinity.

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

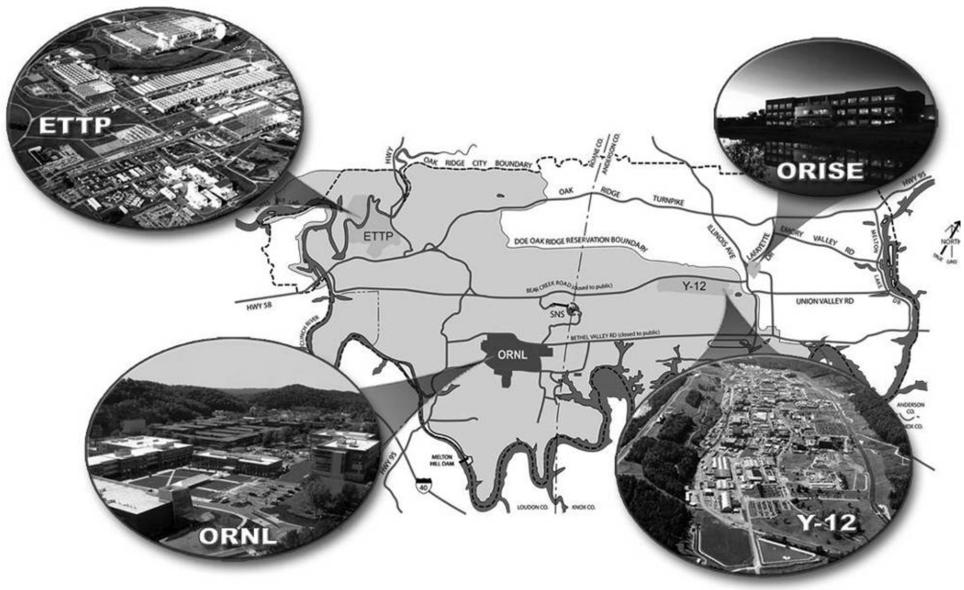

Fig. 5.1. Location of ORNL within the ORR and its relationship to other local DOE facilities.

The TWPC, managed by Wastren Advantage Inc. (WAI) for DOE, is located on the western boundary of ORNL on about 5 ha of land adjacent to the Melton Valley Storage Tanks along State Route 95. In late 2009, WAI was awarded the contract to operate the TWPC. Until this award the TWPC was operated by EnergX; henceforth WAI will be the referenced contractor for the TWPC. The TWPC's mission is to receive TRU wastes for processing, treatment, repackaging, and shipment to designated facilities for final disposal. The TWPC consists of the Waste Processing Facility, the Personnel Building, and numerous support buildings and storage areas. The TWPC began processing supernatant liquid from the Melton Valley Storage Tanks in 2002, the contact-handled debris waste in December 2005, and the remote-handled debris waste in May 2008.

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

- 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 CY 2009, 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. Isotek also completed demolition of Buildings 3074 and 3136. In CY 2009, 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 in January 2010 (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 and for the TWPC, and the discussions in this chapter include the results for the Isotek and WAI operations at ORNL.

Approximately 5 ha in the central portion of the ORNL has been leased to Halcyon, LLC, a subsidiary of the Community Reuse Organization of East Tennessee (CROET) for development into the

Oak Ridge Science and Technology Park (ORSTP). The ORSTP will provide space for 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 was leased to Halcyon, LLC, and is now known as the Halcyon Commercialization Center, continues to attract tenants. 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 S&T Park 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's environmental policy statement for ORNL is shown in Fig. 5.2.

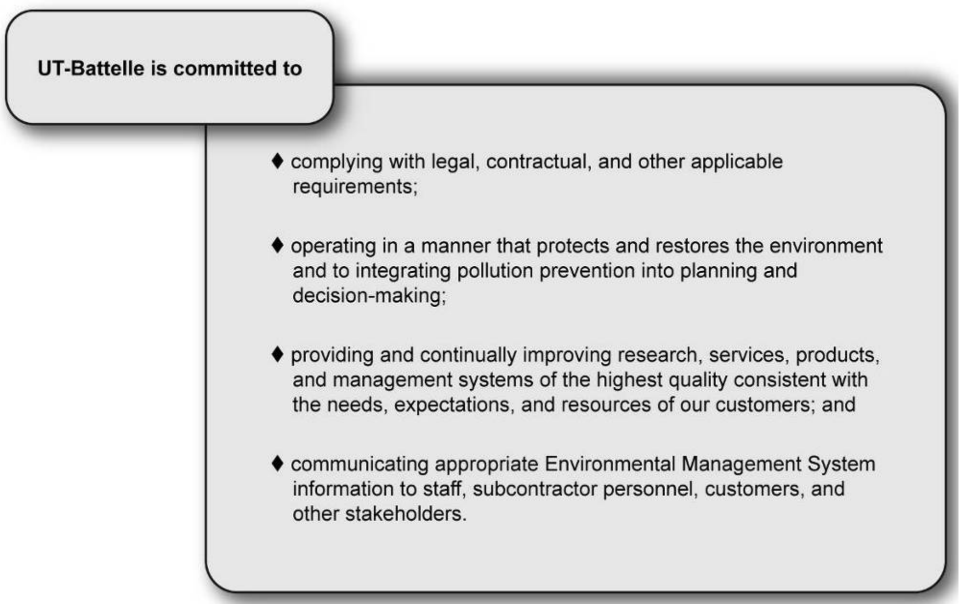

Fig. 5.2. ORNL environmental policy statements.

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), an international environmental management standard, as a tool to measure, manage, and control environmental impacts. An EMS is a continuing cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental goals. UT-Battelle's EMS was initially registered to the ISO 14001 Standard by a third-party registrar in 2004 and was reregistered in June 2007 by NSF International Strategic Registrations, Ltd. Surveillance audits were conducted in 2008 and 2009. No nonconformities were identified during the most recent surveillance 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 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 2009, and no nonconformities or issues were identified and several significant practices were noted. Section 5.2.2 describes the TWPC 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.”

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 5.3 depicts the relationship between EMS and ISMS.

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

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

Fig. 5.3. The relationship between the UT-Battelle Environmental Management System and the Integrated Safety Management System.

- internal audit; and
- management review.

5.2.1.2 UT-Battelle Policy

The UT-Battelle environmental policy statements are part of the UT-Battelle Policy for ORNL (Fig. 5.2), 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.

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

5.2.1.3.2 UT-Battelle Legal and Other Requirements

Legal and other requirements that apply to the environmental aspects identified by UT-Battelle include federal, state, and local 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.

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. These division plans focused on chemical inventory reduction, energy conservation, waste minimization, and recycling. Thirteen EMS Objectives and Targets were identified and accomplished in 2009 and are described below.

- **Objective: Reduce environmental impact associated with two division activities (450.1A)**
- **Targets:** Specific line organization targets, actions, responsible persons, and due dates. Project specifics are captured in an internal tracking system

- **Objective: Land and habitat conservation (Performance Track)**
- **Target:** Continue to remove invasive plants and establish and maintain native plants. Treat/restore/maintain 682 acres of land on the ORR by end of 2009

- **Objective: Eliminate photographic hazardous waste generation (Performance Track)**
- **Target:** Eliminate the generation of hazardous photographic waste

- **Objective: Reduced use of diesel fuel (Performance Track and 430.2B)**
- **Target:** Continue to reduce the use of diesel fuel in vehicles by converting to a biodiesel fuel supply Diesel fuel usage should be reduced by 25% by the end of 2009 (compared to 2005 usage)

- **Objective: Complete plan to implement requirements of DOE Order 430.2B**
- **Target:** Complete executable plan and submit to DOE

- **Objective: Develop measure for evaluating UT-Battelle's contribution to goals in Executive and DOE Orders 450.1A and 430.2B**
- **Target:** Develop a sustainability index that measures UT-Battelle's strategy with respect to the requirements in EO 13423, DOE Order 430.2B, and DOE Order 450.1A

- **Objective: Reduce energy intensity (430.2B)**
- **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 (430.2B)**
- **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 (430.2B)**
- **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 (450.1A).**
- **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 (430.2B)**
- **Target:** Improve HVAC control in 4500N, 4500S, 4501/4505, 4508, 5500, and 6000

- **Objective: Advance metering and energy awareness campaign (430.2B)**
- **Target:** Installation of advanced electricity metering system and implementation of Sustainable Energy Education and Communication campaign

- **Objective: Use of reclaimed Fomblin oil (Performance Track)**
- **Target:** Use 100% reclaimed Fomblin oil in nanoscience clean room facility pump

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. 5.2. Information on UT-Battelle's 2009 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 ORNL'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 ORNL site. EMPO activities include developing and implementing interface agreements applicable to multiple contractors, CERCLA Applicable or Relevant and Appropriate Requirements (ARARs), 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 2009 are discussed in the following sections. For more information see http://sustainability-ornl.org.

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 1,900,000 ft^2 of aged, expensive-to-maintain buildings has been vacated and some 1,000,000 ft^2 of new and renovated space has been constructed (see Fig. 5.4). The average age of ORNL facilities has decreased from 42 to 31 years. A combination of federal, state, and private financing has supported the construction of the new facilities (see Table 5.1).

ORNL 2010-G00432/chj

Fig. 5.4. Modernization and facilities revitalization.

Table 5.1. ORNL facilities constructed since 2000

Building number	Building name	Funding source
1521	West End Research Support Facility	DOE
7990	Melton Valley Warehouse	DOE
1060	Environmental and Life Sciences Laboratory	DOE
7972	Small-Angle Neutron Scattering Guide Hall Extension	DOE
1005	Laboratory for Comparative and Functional Genomics	DOE
7625	Multiprogram High Bay Facility	DOE
3625	Advanced Materials Characterization Laboratory	DOE
5200	Research Support Center	DOE
8610	Center for Nanophase Materials Sciences	DOE
NTRC	National Transportation Research Center	Private
5600	Computational Science Building	Private
5800	Engineering Technology Facility	Private
5700	Research Office Building	Private
5300	Multiprogram Research Facility	Private
5100	Joint Institute for Computational Sciences & Oak Ridge Center for Advanced Technologies	State
1520	Joint Institute for Biological Sciences	State
7880	TRU Waste Process Building	DOE
7880A	Contact-Handled Staging Area Building	DOE
7880B	Personnel Support Building	DOE
7880HH	Macroencapsulation Building	DOE
7880BB	Contact-Handled Marshalling Building	DOE
7880AA	Drum Venting Building	DOE

During FY 2009, modernization and revitalization efforts at ORNL provided new facilities, enhanced staff interaction and space utilization, upgraded utility systems, and demolished old, expensive-to-maintain facilities. During the year, ORNL expended approximately $7 million to decrease the backlog of deferred maintenance in mission-critical facilities, to vacate substandard facilities, and to improve the quality of remaining facilities.

Bethel Valley East Campus

Construction of the Multiprogram Laboratory Facility (MLF) building began in 2009. The new MLF is located in Bethel Valley on ORNL's East campus, and consists of a three-story building housing 160,000 ft^2 of research laboratory and support space, thereby enabling relocation of key research capabilities from aged facilities. MLF occupancy is scheduled for summer 2011.

Critical parking and utility infrastructure projects for the Bethel Valley East Campus were also initiated in 2009. An unprecedented demand for automobile parking, fueled by staffing and subcontractor increases associated with receipt of American Recovery and Reinvestment Act funding, mandates early completion of planned parking lot expansions and construction of a new parking structure.

Other FY 2009 modernization efforts in the Bethel Valley East Campus included initiating the replacement of the 0902 Water Reservoir. This 3 million gallon capacity reservoir that provides potable and fire water to ORNL has been in continuous operation since 1948, and extensive degradation has occurred. In addition, projects to upgrade the 6001 Cooling Tower, replace switchgear in Building 4509, and install new smoke detectors in Building 4500 North and South were completed in 2009.

Bethel Valley Central Campus

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. During 2009 construction of an adjoining expansion (to Building 3625) was initiated. The expansion to the Advanced Microscopy Laboratory is located on the southwest side of the existing building to house a number of vibration-sensitive instruments used for materials characterization. UT-Battelle also vacated Building 3025M in support of DOE-EM Program plans for eventual building demolition.

Bethel Valley West Campus

Renovations to existing West Campus facilities continued in 2009 with the construction of a quadrangle, renovation to the Buildings in the 1500 series, and initiation of the construction of several greenhouses (Fig. 5.5). During the year the West End Research Support Facility was completed and placed into service.

ORNL 2010-G00434/chj

Fig. 5.5. Greenhouses.

Chestnut Ridge Campus

Chestnut Ridge infrastructure investment continued in 2009, including approval of a Guest House, construction of three parking areas that provide a total of approximately 240 finished parking spaces, and construction of a cafeteria on the first floor of the Central Laboratory and Office building. The state of Tennessee continued construction of the Joint Institute for Neutron Sciences building.

Melton Valley Campus

Construction of the Melton Valley warehouse was completed in 2009. This facility will provide space to consolidate storage of equipment and materials formerly stored across the ORNL site. In addition, in 2009 construction began on an 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 that will enable ongoing modernization efforts at ORNL and the Y-12 National Security Complex. The IFDP will reduce risk to workers and the public, minimize ORNL and Y-12 mission risks resulting from the presence of deteriorating facilities and excess “legacy” materials, and provide valuable real estate for continued modernization (see Fig. 5.6). DOE approved the Alternative Selection and Cost Range Critical Decision-1 for the project in November 2008, and work on the 26-year project continued in 2009 with development of the Critical Decision-2/3 package.

ORNL 2010-G00491/chj

Fig. 5.6. Demolition activities at ORNL.

5.2.1.4.2 Energy Management

The UT-Battelle Energy Management Program seeks to advance continuous improvements in energy efficiency in UT-Battelle facilities, coordinates energy-related efforts across UT-Battelle organizations, and promotes employee awareness of energy conservation programs and opportunities. The *Oak Ridge National Laboratory Executable Plan* (Palko 2008) outlines the general strategy for managing and implementing energy and energy-related activities at ORNL. The plan also addresses activities related to the accomplishment of the goals of Executive Order 13423, “Strengthening Federal Environmental, Energy, and Transportation Management” and the DOE Transformational Energy Action Management (TEAM) initiative.

Energy Intensity Reduction Performance in Subject Buildings

The Energy Policy Act (EPACT) of 2005 established ambitious goals for reducing building energy intensity using 2003 as the baseline year. Executive Order 13423 sets a more stringent reduction goal of 3% per year for the same time period, resulting in a planned 30% reduction over 10 years with FY 2006 defined as the first performance year. Buildings that have been excluded from these goals at ORNL include the HFIR, the Computational Sciences Building's computer center, the Holifield Heavy Ion Research Facility, and the process buildings at the SNS project.

In FY 2003, ORNL's energy intensity was 364,539 Btu per gross square foot (GSF), as shown in Fig. 5.7, and after a brief plateau has trended downward. ORNL's energy intensity decreased by 5.78% between FY 2005 and FY 2006, 6.31% between FY 2006 and FY 2007, and 1.54% between FY 2007 and FY 2008. The cumulative progress between FY 2003 and FY 2009 represents a 12.8% Btu/GSF reduction in energy intensity. The FY 2009 target reduction was 12%; therefore, ORNL is currently ahead of the pace for meeting the FY 2015 goal of a 30% reduction. Various factors affect the results each quarter and each year, and fluctuations or plateaus are not uncommon. Variables include the addition of new, efficient buildings; the shutdown or demolition of inefficient buildings; the implementation of new energy efficiency projects; the operation and management of systems that use energy; and weather conditions. Overall, ORNL's energy use trend is downward and currently on pace to meet the Presidential goal.

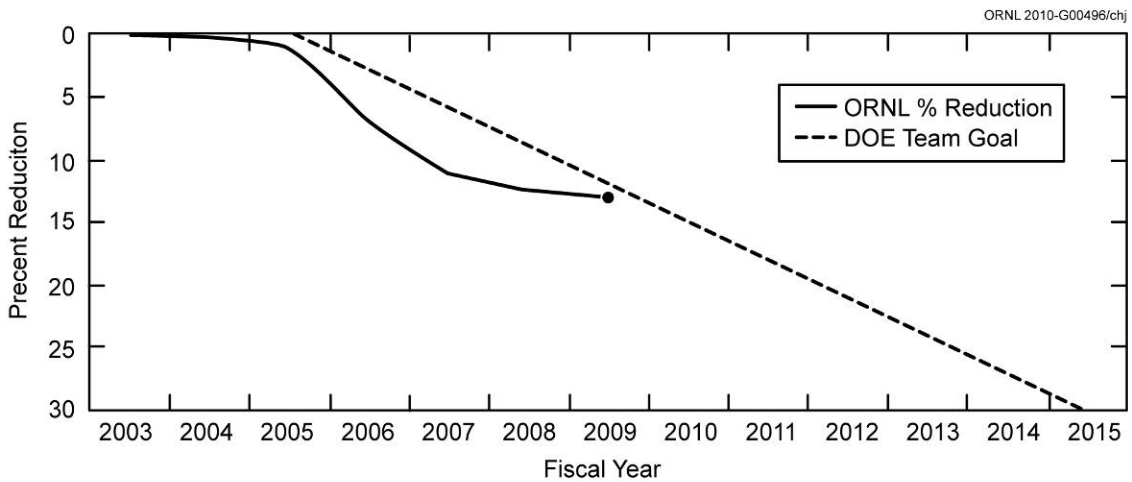

Fig. 5.7. ORNL building energy reduction versus the DOE Transformational Energy Action Management (TEAM) goal.

Energy Savings Performance Contracting

On July 30, 2008, Johnson Controls, Inc. was awarded an Energy Savings Performance Contract (ESPC) at ORNL in support of the DOE TEAM Initiative. Recognizing that the core mission and responsibility of DOE is to lead the nation in promoting and using the best available energy management technologies and practices, the TEAM Initiative executes programs to meet, exceed, and lead in the implementation of the Executive Order 13423 energy, environmental, and transportation goals.

In addition to meeting the goals of the TEAM Initiative, the ESPC supports and modernizes facility infrastructure, provides utility support and capacity, and ensures that mission-related activities can be performed without interruption. ORNL will receive the following specific benefits from this contract.

- Significant infastructure improvements to the existing steam plant and distribution system to create a world-class combined heat and power system fueled by renewable energy
- Improved chilled water system efficiency and reliability as a result of expanding and automating the plant
- Installation of advanced metering technology to continue ORNL's path toward meeting Section 103 of EPACT 2005

- Expansion of the Building Management System to provide automation in key areas and critical systems
- Extensive upgrades to heating, ventilating, and air-conditioning systems to improve comfort and meet facility consolidation needs
- Approximately $65 million in necessary deferred infrastructure improvements funded through energy savings
- Annual energy savings of 768,061 million Btu
- Water use reduction of about 170 million gal per year
- Carbon sequestration equivalent to 1,325,744 tree seedlings grown in an urban environment for 10 years or 11,751 acres of pine forests
- Emission reductions equivalent to the reduction of 9,470 passenger vehicles; 120,242 barrels of oil; the energy used by 4,563 homes annually; or 270 coal rail cars

Table 5.2 demonstrates that the ESPC goals meet or exceed TEAM goals. The status of the energy conservation measures (ECMs) is outlined in Table 5.3.

Table 5.2. Energy savings performance contracting goals, 2009

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

[a]TEAM=Transformational Energy Action Management Initiative

Table 5.3. Energy conservation measures status, 2009

Central Steam Plant biomass solution	Design and procurements are being finalized with construction to begin late FY 2009. Construction will be completed in mid-FY 2011
Select steam decentralization for remote buildings	Design and procurements are nearly complete; installation of equipment in the 7000 area is complete; and construction 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	Design and procurement is complete, and installation of equipment is at 90%
Comprehensive HVAC upgrade	Design is being finalized and procurements have begun
Energy-efficient lighting upgrade	Design, procurements, and construction are complete.
Water conservation	Domestic water projects are complete. The once-through cooling project is designed with completion scheduled for FY 2010

Electric Metering

The EPACT 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.

UT-Battelle has had a policy of metering for electricity at the building or substation level for many years. There are currently about 350 standard electric meters installed at ORNL (Table 5.4). Almost all buildings that use electricity have at least a standard meter. While the site has approximately 450 structures identified as buildings, many of them are warehouses and equipment sheds that use little, if any, electricity. Of this total, approximately 120 buildings represent 70% of the space and 80% of the electricity use. Based on the criteria established in *Guidance for Electric Metering in Federal Buildings* (DOE 2006), 38 buildings at ORNL, which use over $32,000 in electricity each year, require advanced metering. When complete, buildings that account for 65% of UT-Battelle's total electrical consumption will have advanced metering and all buildings will have at least a standard meter.

Table 5.4. Electrical metering status

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

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

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

UT-Battelle Employee Energy Conservation Education and Involvement Opportunities

During 2009, UT-Battelle sponsored several events to promote employee awareness of opportunities to conserve energy and promote energy efficiency.

ORNL's Earth Day 2009 celebration, held on Thursday, April 16, 2009, included a slate of activities headlined with a talk by Dr. Mike Sale entitled "Energy, Water, Sustainability, and Responsibility." Other activities included an East Campus Pond tour and an opportunity for staff to exchange a plastic bag for a hot/cold insulated reusable bag. The plastic bags collected were picked up and recycled at no charge by the Knoxville Recycling Coalition. More than 2,000 people attended this event (Fig. 5.8).

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Fig. 5.8. 2009 Earth Day.

UT-Battelle sponsored several events in October in recognition of National Energy Awareness Month, which is billed as a time to promote wise and efficient use of our nation's energy and a time to emphasize the commitment to a more secure energy future. This year's Energy Awareness Month theme was "A Sustainable Energy Future: Putting All the Pieces Together."

UT-Battelle and Johnson Controls, Inc., sponsored the 2009 Energy Awareness Celebration on Thursday, January 22 on ORNL's Main Street with information on how to improve energy efficiency in workplaces, homes, and communities. As a part of this celebration, the Sustainable Campus Initiative dedicated a solar array on Bethel Valley Road.

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. One million square feet of 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 17 acres at ORNL (see Fig. 5.9) and 307 acres across the ORR and removal of invasive plants from 140 acres at ORNL and 500 acres across the ORR.

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Fig. 5.9. Plants and natural landscaping.

Three solar collectors 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. The third, most recently installed collector is a single-axis tracking 700-watt total energy concentrator with low-cost, flat, aluminum mirrors that reflect sunlight onto the smaller solar cells in the concentrator. Since only one-third of the area of this array consists of solar cells, the concentrator can produce more energy with fewer expensive solar cells. Research is under way at ORNL to determine how well the array will perform in the naturally hazy atmosphere of East Tennessee.

The large 88 m by 3 m (288 ft by 10 ft) solar collector specifically supports ORNL'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. ORNL accomplished the first step in meeting this goal on October 1, 2009, when ORNL self-declared Building 3156 to be a maximum energy-efficient building with plans under way to transform the remaining buildings. Due to aggressive implementation of energy efficiency measures, Building 3156 decreased its consumption from about 100 MWh/yr to 60 MWh/yr, which is offset by solar power.

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 E-85, 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 476 vehicles in 2009.

In FY 2009, UT-Battelle had a vehicle fleet that included 17 electric vehicles and 41 hybrid cars (see Fig. 5.10). There were also 232 flex fuel vehicles in the fleet (49%) and 66% of new vehicle procurements during the year were flex fuel vehicles. During 2009 a reduction in vehicle emissions was achieved in part due to the use of 50,503 gal of E85 to fuel the ORNL fleet, which is up from 39,366 gal in 2008. In addition there are 86 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 also pursuing the potential use and support of PHEVs in combination with solar-covered parking.

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Fig. 5.10. Vehicle fleet.

5.2.1.4.3 Pollution Prevention

UT-Battelle implemented 33 new pollution prevention projects at ORNL during 2009, eliminating more than 255 million kg (~562,000,000 lb) of waste and leading to cost savings/avoidance of more than $8 million (including ongoing reuse/recycle projects). Major 2009 pollution prevention successes at ORNL included source reduction projects such as the elimination of photo processing chemicals, water conservations efforts, and recycling (including radioactive lead, Tyvek, and electronics).

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 FY 2009, the use and discharge of water at ORNL was reduced through a variety of water-saving options including (1) replacement of standard-flow plumbing fixtures with low-flow products to reduce domestic water use, (2) replacement and repair of steam traps, (3) aggressive identification and repair of water leaks, (4) the Physics Division's cooling water flow reduction pilot, and (5) the Biological and Environmental Sciences Directorate's ultraviolet (UV) dechlorinator project.

Future identified water reduction projects include the ESPC-funded projects to eliminate once-through cooling water and to install a biomass gasification steam plant (BGSP) at the ORNL steam plant, as well as the expansion of the Physic's Division cooling-water flow reduction pilot. Furthermore, to enhance water use and quality awareness, UT-Battelle holds on-site, Laboratory-wide awareness activities such as Earth Day celebrations and Fix-a-Leak Week and sponsors related educational community outreach activities.

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 2009 alone, water conservation efforts reduced water usage and the associated waste water generation by more than 238 million liters (63 million gal) per year with an associated cost avoidance of more than $104,700. In the last two fiscal years, UT-Battelle has reduced water usage by 295 million liters (78 million gal) per year with an associated cost avoidance of more than $342,000. When all identified water conservation efforts are complete, a total of 1 billion liters (273 million gal) per year of water usage and associated waste water generation will be eliminated with an associated cost avoidance of more than $5 million, which includes all cost avoidance associated with the BGSP.

During the year UT-Battelle expanded the scope of the recycling program at ORNL with more than 78% of FY 2009–generated materials being diverted for recycle or beneficial use. One successful activity involved "dumpster dives" (see Fig. 5.11) performed by the Sustainable Campus Initiative team during the year to identify viable opportunities for further reductions in waste streams at ORNL. This involves detailed hand sorting and categorization of the contents of dumpsters from targeted buildings. Based on this effort, UT-Battelle targeted recycling and/or reduction of office waste as an area where the diversion of materials from waste streams to beneficial reuse or recycle programs could result in significant reductions in the volume of waste being sent to landfills or disposal facilities. To address this waste stream, centralized recycling locations in hallways and common areas have been replaced by individual containers within offices. Preliminary results indicate this approach has been successful, and similar efforts in other areas will be undertaken during 2010 to further reduce sanitary industrial waste at ORNL.

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Fig. 5.11. Pollution prevention.

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

ORNL Site P2 Awards

- DOE's Environmental Sustainability (EStar) Awards—received for the Sustainable Campus Team and maximum energy-efficient building (Building 3156). The EStar Awards recognize exemplary environmental sustainability and stewardship practices and excellence in pollution prevention across DOE.

- DOE Office of Science Best in Class Award—On December 31, 2009, ORNL received notification that DOE Office of Science awarded ORNL an Office of Science "Best in Class" Award for environmental sustainability and recognized three other initiatives with "Noteworthy Practices" Awards. Best in Class and Noteworthy Practices Awards were received for accomplishments associated with ORNL's maximum energy-efficient building (Building 3156), Sustainable Campus Initiative, Information Technology Green IT Initiative, and Green Fleet Program.

- Tennessee Department of Environment and Conservation (TDEC) Tennessee Pollution Prevention Partnership (TP3) Performer Member Flag—UT-Battelle completed the five-project TP3 plan that demonstrates a commitment to preventing pollution of air, land, and water while conserving natural resources.

- Tennessee Chamber of Commerce & Industry Award for Outstanding Achievement in Water Quality and achievement certificate for environmental excellence for the successful completion of several environmental activities at ORNL.

5.2.1.5 Implementation and Operation

5.2.1.5.1 Structure and Responsibility

The UT-Battelle Environmental Policy (Fig. 5.2) 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 ORNL 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 2009, an internal audit and an external surveillance audit were conducted and verified that the EMS continued to conform to ISO 14001:2004. In addition the Office of Management and Budget’s Environmental Stewardship Program gave UT-Battelle a green EMS scorecard rating on implementation of EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management, indicating full implementation of EO 13423 requirements. 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 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 2009, 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 TWPC subject area documents (procedures and guidelines). Through environmental program personnel and EMS representatives, the EMS assists the line organizations in identifying and addressing environmental issues in accordance with the EMS requirements.

Environmental aspects are elements of an organization's activities, products, or services that can interact with the environment. 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, and pollution prevention as potentially having significant environmental impacts. Activities that are relative to any of those aspects are carefully controlled to minimize or eliminate impacts to the environment.

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.

"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 2009, WAI procured environmentally preferable materials totaling approximately $131,000 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 2009 UT-Battelle, 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 (NPDES) permit discharge limits. There were no notices of violation or penalties issued by the regulatory agencies. Table 5.5 contains a list of environmental permits that were effective in 2009 at ORNL. Table 5.6 presents a summary of environmental audits conducted at ORNL in 2009.

ORNL does not operate any Resource Conservation and Recovery Act (RCRA) Subtitle D disposal facilities. ORNL's 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 2009 and provide an overview of compliance status for the year.

5.3.1 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 5.7 summarizes NEPA activities conducted at ORNL during 2009.

Table 5.5. ORNL environmental permits, 2009

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	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
CWA	ORNL NPDES Permit (ORNL sitewide wastewater discharge permit)	TN0002941	07/01/08	07-30-13	DOE	DOE	UT-B, BJC

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—SNS	TNR139975	09-30-00	NA	DOE	DOE	UT-B
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—ORNL Research Support Center	TNR130471	06-02-03	02-07-08	DOE	DOE	UT-B
CWA	General Permit For Construction & Removal of Minor Road Crossings-ORNL West Campus Improvements	NR0803.058	04-07-08	04-07-09	DOE	DOE	UT-B
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—ORNL 24-Inch Water Line Replacement	TNR132022	06-23-06	02-07-08	DOE	DOE	UT-B
CWA	Tennessee General Permit No. TNR10-0000, Stormwater Discharges from Construction Activity—ORNL Decommissioning & Demolishing Buildings	TNR1301343	05-26-05	NA	DOE	DOE	UT-B
CWA	Tennessee General Permit No. TNR10-0000, Stormwater Discharges from Construction Activity—ORNL West Campus Improvements	TNR132878	12-04-07	NA	DOE	DOE	UT-B
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—Pro2Serve National Security Engineering Center		10-06	NA	DOE	DOE	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
RCRA	Hazardous Waste Transporter Permit	TN1890090003	01-21-10	01-31-11	DOE	DOE	UT-B, BJC

Table 5.5 (continued)

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
RCRA	Hazardous Waste Corrective Action Permit	TNHW-121	09-28-04	09-28-14	DOE	DOE/all[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-097	09-30-97	09-30-07	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 compliance regulations when timely renewal or conversion 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.

Table 5.6. Summary of regulatory environmental audits and assessments conducted at ORNL

Date	Reviewer	Subject	Issues
		UT-Battelle	
May 11–14	TDEC	TDEC Annual RCRA Inspection	0
July 23	USDA/TNDA	USDA Compliance Inspection	0
September 22	TDEC	CWA NPDES program Inspection	0
September 25	TDEC	RATA for Predictive Emissions	0
November 2–4	TDEC	Annual RCRA inspection at Y-12 Complex	0
December 17	TDEC	Annual CAA inspection	0
		TWPC (WAI)	
May 14	TDEC	TDEC Annual RCRA Inspection	0

Abbreviations

CAA	Clean Air Act
NPDES	National Pollutant Discharge Elimination System
ORNL	Oak Ridge National Laboratory
RATA	Relative Accuracy Test Audit
RCRA	Resource Conservation and Recovery Act
TDEC	Tennessee Department of Environment and Conservation
TNDA	Tennessee Department of Agriculture
TWPC	Transuranic Waste Processing Center
USDA	United States Department of Agriculture

During 2009, 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.

Table 5.7. National Environmental Policy Act (NEPA) activities, 2009

Types of NEPA documentation	Number of instances
ORNL	
Categorical exclusions (CXs) approved	1
Approved under general actions or generic CX documents	59[a]
WAI	
Approved under general actions or generic CX documents	5[a]
Isotek	
Environmental assessment	1

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

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 2009, an environmental assessment for the Isotek-managed U-233 Material Downblending and Disposition Project (Building 3019 Complex) (DOE 2010) was completed, and a Finding of No Significant Impact under the NEPA process was issued in January 2010.

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). A Section 106 consultation of the Act was completed for the demolition of Buildings 3008, 3012, 3044, 3503, 3504, 3508 and 3592. The State Historic Preservation Officer had no objection to implementing actions for the demolition of these buildings (letter to DOE-ORO, August 20, 2009).

5.3.2 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 was issued its first sitewide operating air permit 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.). TDEC personnel performed an inspection of ORNL on December 17, 2009, to verify compliance with applicable regulations and permit conditions. There were no compliance issues identified. Also, a Knox County Air Quality permit is maintained for the offsite NTRC. In 2009, an annual compliance report was submitted for this permit. In summary, there were no UT-Battelle, Isotek, or WAI CAA violations or exceedances in 2009. Section 5.4 provides detailed information on 2009 activities conducted at ORNL in support of the CAA.

5.3.3 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 2009, 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 2009 was nearly 100%, with only one measurement exceeding numeric NPDES permit limits by exceeding a daily-maximum total residual oxidant (TRO) limit. The noncompliance occurred at an instream monitoring point on Fifth Creek, where on February 16, 2009, 0.12 mg/L TRO (chlorine) was measured. The measurement resulted in calculated exceedance of a second, monthly average TRO limit. A dechlorination system at Outfall 265 was repaired to guard against recurrence. Information on the exceedances is provided in Appendix E, Section E.3. The exceedance did not result in any discernable ecological impact. Section 5.5 contains detailed information on the activities and programs carried out in 2009 by UT-Battelle in support of the CWA.

5.3.4 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),
- lead and copper, and
- disinfectant by-products (trihalomethanes and haloacetic acids).

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

In 2009, sampling results for ORNL's water system chlorine residual levels, bacterial constituents, disinfectant by-products, and lead and copper 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.

5.3.5 RCRA Compliance Status

DOE and the DOE contractors at ORNL were jointly regulated as a large-quantity generator of hazardous waste in 2009 (EPA ID No. TN1890090003), because collectively more than 1,000 kg of hazardous waste per month was generated. This includes hazardous waste that is generated under permitted activities (including repackaging or treatment residuals). At the end of 2009, there were approximately 400 generator accumulation areas for hazardous or mixed waste serving various contractor organizations at ORNL, including UT-Battelle, BJC, Energy Solutions, Isotek, and WAI. DOE and the DOE contractors at ORNL were also jointly regulated as a large quantity handler of universal waste (e.g., fluorescent lamps, batteries, etc.) under the universal waste management standards as more than 5,000 kg of total universal waste was collectively accumulated prior to off-site recycle at any time during 2009. Similarly, DOE and ORNL contractors were collectively regulated as a used oil generator under the used oil management standards in 2009. At the end of 2009, there were approximately 100 used oil areas for management of used oil prior to off-site recycle or disposal.

UT-Battelle and BJC were permitted to transport hazardous wastes and UT-Battelle was registered to operate a transfer facility for temporary (less than 10-day) storage of hazardous wastes transported from off-site locations (such as NTRC). DOE, UT-Battelle, BJC, and WAI were permitted to operate RCRA-permitted hazardous waste treatment and storage facilities (or units). During 2009, 24 units operated as permitted units; another 6 units were permitted as proposed units (but will not be built and have been eliminated in a permit renewal application submitted in 2007 for TNHW-097).

The RCRA units operate under three permits at ORNL: TNHW-097 (TNHW-145 was issued in early 2010 and replaces the TNHW-097 permit), TNHW-134, and TNHW-121. TNHW-121 is the existing RCRA Hazardous and Solid Waste Amendments permit for the ORR (see Table 5.8). The permits are modified when necessary. Five permit modifications and two temporary authorizations were approved by TDEC in 2009. Two modifications to permit TNHW-134 included removal of Portable Unit 1 and minor changes to the waste analysis plan, training, and inspection logs. Three permit modifications and two temporary authorizations to TNHW-097 were approved by TDEC in 2009. The modifications included removal of WESKEM, LLC as permit co-operator; addition of Portable Unit 1; and for the TWPC, approval of a staging area for loaded and sealed 72-B casks, addition of storage capacity, and addition of size reduction treatment. The temporary authorizations included adding additional storage capacity to four

TWPC permitted units and allowing macroencapsulation at an additional location at the TWPC. The renewal application for the TNHW-097 permit submitted in March 2007 was still pending throughout 2009.

TDEC conducted an annual RCRA inspection in May 2009 of ORNL generator areas, battery collection areas, RCRA-permitted areas, and RCRA records including required training, generator inspections, permitted facility records, shipments, transfer facility log, the 2008 RCRA Annual Report of Hazardous Waste Activities, and the 2008 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.

DOE and associated contractors at the NTRC were regulated as a conditionally exempt small-quantity generator in 2009, meaning that less than 100 kg of hazardous waste per month was generated collectively. At the end of 2009, there were three generator accumulation areas in support of operations that generate hazardous wastes and one used oil area for management of recyclable used oil.

There were no hazardous wastes or used oil generated by DOE and contractors at the 0800 Area, the DOE Office of Scientific and Technical Information, ORNL Records, or the Freels Bend Area in 2009.

5.3.6 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.

Table 5.8. ORNL Resource Conservation and Recovery Act operating permits, 2009

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-097	Portable Unit 1 Storage & Treatment Unit
	Building 7574 Container Storage Unit
	Building 7576 Container Storage Unit
	Building 7577 Container Storage Unit
	Building 7580 Container Storage Unit
	Building 7823 Container Storage Unit
	Building 7842 Container Storage Unit
	Building 7855 Container Storage Unit
	Building 7860A Container Storage Unit
	Building 7878 Container Storage Unit
	Building 7879 Container Storage Unit
	Building 7883 Container Storage Unit
	Building 7884 Container Storage Unit
	Building 7880 Waste Processing Facility (WPF) 2 Container Storage Unit
	Building 7880 WPF 4 Container Storage Unit
	Building 7880A WPF 1 (Contact-Handled Storage Area) Container Storage Unit
	WPF 3 (Drum Aging Criteria) Container Storage Unit
	WPF 5 (Container Storage Area) Container Storage Unit
	Building 7880BB WPF 6 (Contact-Handled Marshaling Building) Container Storage Unit
	Building 7880AA WPF 7 (Drum Venting Building) Container Storage Unit
	Macroencapsulation T-1 Treatment Unit
	Amalgamation T-2[a] Treatment Unit
	Solidification/Stabilization T-3 and 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.

5.3.7 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.

5.3.7.1 ORNL RCRA-CERCLA Coordination

The ORR Federal Facility Agreement is intended to coordinate the corrective action processes of RCRA required under the Hazardous and Solid Waste Amendments permit with CERCLA response actions. Annual updates for 2009 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 2010.

In May 2005 ORNL applied for, but has not yet received, a RCRA postclosure permit for SWSA 6. RCRA groundwater monitoring data is reported yearly to TDEC and EPA in the annual CERCLA *Remediation Effectiveness Report* (DOE 2010a) 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.

5.3.8 Toxic Substances Control Act Compliance Status

PCB waste generation, transportation, and storage at ORNL are regulated under the EPA ID number TN1890090003. In 2009, UT-Battelle operated approximately 11 PCB waste storage areas in generator buildings and RCRA-permitted storage buildings at ORNL for longer-term storage of PCB/radioactive wastes when necessary. Two PCB waste storage areas were operated at 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 2009, there were no discoveries of unauthorized uses of PCBs.

5.3.9 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 5.9 describes the main elements of the act. UT-Battelle complied with these requirements in 2009 through the submittal of reports under EPCRA Sections 302, 303, 311, and 312.

ORNL had no releases of extremely hazardous substances, as defined by EPCRA, in 2009.

Table 5.9. 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

5.3.9.1 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 CY 2009 on the ORR, 20 were located at ORNL.

Private-sector lessees associated with the reindustrialization effort were not included in the 2009 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.

5.3.9.2 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 off-site transfers were calculated for each chemical that exceeded one or more of the thresholds.

For CY 2009, ORNL reported releases of 52,762 lb of nitric acid and 73,041 lb of nitrate compounds (Table 5.10). Of this, 52,668 lb of the nitric acid was not actually released but rather was used for waste treatment at the Process Waste Treatment Complex (PWTC). This use is considered a "release" under Toxic Release Inventory regulations. The remaining 94 lb was sent off site for disposition. Nitrate compounds are coincidentally manufactured as by-products of neutralizing nitric acid waste and as by-products of sewage treatment. The neutralized nitric acid is not released; it is stored for future disposal as radiological waste because it becomes radioactive during the treatment process. The nitrate compounds from the sewage treatment plant (STP) are released into the environment. The discharge of nitrate compounds is not regulated in the NPDES permit for the sewage plant.

Table 5.10. Emergency Planning and Community Right-to-Know Act Section 313 toxic chemical release and off-site transfer summary[a] for ORNL, 2008 and 2009

Chemical	Year	Quantity (lb)
Nitrate compounds	2008	47,000
	2009	73,041
Nitric acid	2008	25,739
	2009	52,762
Total	2008	72,739
	2009	125,803

[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.

5.4 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 (non-radiological). 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.

At the beginning of 2009, the primary emission points of nonradioactive emissions at ORNL included the steam plant, boilers 1–6 on the main ORNL site, two boilers located at the 7600 complex, and four boilers located at the SNS site. During 2009, steam plant boilers 1–4 were permanently shut down. All of these units use fossil fuels; therefore, criteria pollutants are emitted. Actual and allowable emissions from the sources are compared in Table 5.11. Actual emissions were calculated from fuel use and EPA emission factors. Boiler 6, a 125-MBtu/h boiler, is subject to the new source performance standards of 40 CFR 60 Subpart Db with continuous emission monitoring requirements for NO_x and opacity. All UT-Battelle emission sources operated in compliance with Title V permit conditions during 2009.

Table 5.11. Actual versus allowable air emissions from ORNL steam production, 2009

Pollutant	Emissions (tons per year)[a]		Percentage of allowable (%)
	Actual	Allowable	
Sulfur dioxide	9	1277	0.7
Particulate matter	3	71	4.2
Carbon monoxide	35	196	17.9
Volatile organic compounds	2	14	14.3
Nitrogen oxides	74	380	19.5

[a]1 ton = 907.2 kg.

The permitting and start of construction of the Energy Conservation Measures Project, with the goal of energy savings, was a significant event in 2009. This project includes replacing the existing natural gas/fuel oil fired boilers 1–4 with a biomass gasification system at the ORNL Steam Plant, the installation of additional boilers in remote locations to eliminate the need for steam distribution to those areas, and modifications to the existing natural gas/fuel oil fired boilers 5 and 6. The biomass gasification system, a main component of the overall project, will gasify wood fuel to provide a clean source of steam and will significantly displace fossil fuels used by the existing steam plant and reduce the fossil fuel consumption at ORNL. Also, during 2009, there were three minor modification and two administrative amendment requests pending for the Title V permit.

The minor modification requests were to include the SNS Central Exhaust Facility under the UT-Battelle Title V permit, to transfer ownership of the Radiochemical Development Facility, and to allow an alternative monitoring system for nitrogen oxides.

For state fiscal year 2009, UT-Battelle paid $7,331 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 2009, 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). ORNL's Asbestos Management Program manages the compliance of work activities involving the removal and disposal of ACM, which includes 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 CY 2009.

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. 5.12):

- 2026 Radioactive Materials Analytical Laboratory;
- 3020 Radiochemical Development Facility;
- 3039 central off-gas and scrubber system, which includes the 3500 and 4500 areas' cell ventilation system, isotope solid-state ventilation system, 3025 and 3026 areas' cell ventilation system, 3042 ventilation system, and 3092 central off-gas system;
- 7503 Molten Salt Reactor Experiment Facility;
- 7880 TWPC;
- 7911 Melton Valley complex, which includes HFIR and the Radiochemical Engineering Development Center (REDC); and
- 8915 SNS Central Exhaust Facility stack.

In 2009, there were 17 minor point/group sources, and emission calculations/estimates were made for each of them.

5.4.3.1 Sample Collection and Analytical Procedure

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

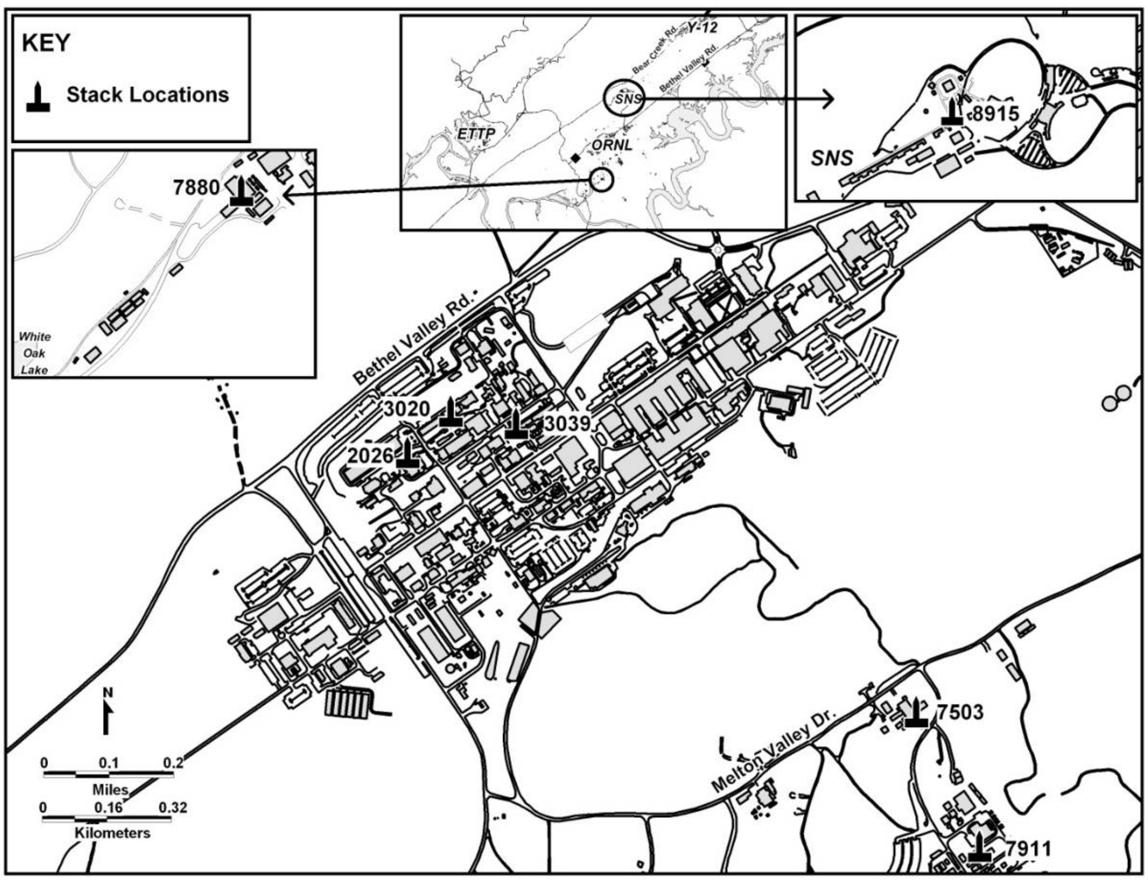

Fig. 5.12. Locations of major radiological emission points at ORNL.

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 annually.

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 2009 are presented in Table 5.12. 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.

Historical trends for ^{3}H and ^{131}I are presented in Figs. 5.13 and 5.14, respectively. For 2009, ^{3}H emissions totaled approximately 152.6 Ci (Fig. 5.13), an increase from 2008; ^{131}I emissions totaled 0.17 Ci (Fig. 5.14), a significant increase over the past 5 years. The ^{3}H and ^{131}I increases were due to research activities in 2009 in the REDC involving the processing of heavy element targets. (REDC emissions discharge through the 7911 Melton Valley complex stack.) Additional sources of ^{3}H

Table 5.12. Radiological airborne emissions from all sources at ORNL, 2009 (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								2.50E–10	2.50E–10
^{228}Ac	M								7.49E–06	7.49E–06
^{110m}Ag	M								1.59E–9	1.59E–09
^{110m}Ag	S					2.25E–06				2.25E–06
^{241}Am	F				5.70E–09	1.15E–06			2.49E–09	1.16E–06
^{241}Am	M	7.68E–08	1.68E–07				1.22E–08		4.34E–08	3.00E–07
^{243}Am	M								6.38E–10	6.38E–10
^{41}Ar	G						8.40E+02	9.53E+00		8.50E+02
^{139}Ba	M						1.01E+00			1.01E+00
^{140}Ba	M						2.56E–04		1.96E–10	2.56E–04
^{140}Ba	S					1.44E–05				1.44E–05
^{7}Be	S			8.29E–06	4.36E–08	1.76E–05			4.62E–07	2.64E–05
^{7}Be	M		9.98E–08						6.01E–03	6.01E–03
^{212}Bi	M								1.58E–08	1.58E–08
^{214}Bi	M								2.61E–06	2.61E–06
^{11}C	G							7.66E+02		7.66E+02
^{14}C	M								1.38E–09	1.38E–09
^{45}Ca	M								8.55E–14	8.55E–14
^{141}Ce	M								9.35E–09	9.35E–09
^{144}Ce	M								2.97E–08	2.97E–08
^{252}Cf[b]	M						7.31E–09		1.67E–11	7.33E–09
^{242}Cm	M								5.65E–08	5.65E–08
^{243}Cm	F					6.30E–07			1.36E–09	6.31E–07
^{243}Cm	M								8.61E–12	8.61E–12
^{244}Cm	F			1.29E–07	3.32E–08	6.30E–07			1.34E–06	2.13E–06
^{244}Cm	M	4.32E–07	2.54E–08				1.12E–08		2.51E–09	4.71E–07
^{245}Cm	M								6.37E–11	6.37E–11
^{248}Cm	M								9.28E–19	9.28E–19
^{57}Co	M								2.09E–06	2.09E–06
^{58}Co	M								3.37E–07	3.37E–07
^{60}Co	M								1.52E–04	1.52E–04
^{60}Co	S			1.57E–06		2.67E–06				4.24E–06

Table 5.12 (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{51}Cr	M								7.58E–10	7.58E–10
^{134}Cs	F								2.17E–08	2.17E–08
^{134}Cs	S					2.07E–06				2.07E–06
^{135}Cs	F								2.18E–13	2.18E–13
^{137}Cs	F	1.53E–06	1.12E–06				7.77E–06		3.80E–04	3.91E–04
^{137}Cs	S			2.26E–04	7.70E–09	2.46E–06			2.82E–04	5.11E–04
^{138}Cs	F						1.62E+03			1.62E+03
^{253}Es	M								5.35E–11	5.35E–11
^{152}Eu	M								4.28E–09	4.28E–09
^{154}Eu	M								3.94E–09	3.94E–09
^{155}Eu	M								7.25E–10	7.25E–10
^{156}Eu	M								1.38E–16	1.38E–16
^{55}Fe	M								2.30E–07	2.30E–07
^{59}Fe	M								1.17E–10	1.17E–10
^{153}Gd	M								1.06E–13	1.06E–13
^{3}H	S								3.59E–01	3.59E–01
^{3}H	V	1.01E+00		8.37E+00	1.75E+00		7.42E+01	6.61E+01	1.17E+00	1.53E+02
^{181}Hf	M								2.37E–12	2.37E–12
^{203}Hg	M								9.28E–07	9.28E–07
^{166}Ho	M								2.00E–10	2.00E–10
^{124}I	F								5.63E–16	5.63E–16
^{125}I	F							1.53E–01	1.08E–09	1.53E–01
^{126}I	F								6.45E–10	6.45E–10
^{129}I	F								1.07E–03	1.07E–03
^{131}I	F					6.69E–06	1.73E–01		4.95E–07	1.73E–01
^{132}I	F						7.48E–01			7.48E–01
^{133}I	F						5.91E–01			5.91E–01
^{134}I	F						1.00E+00			1.00E+00
^{135}I	F						1.33E+00			1.33E+00
^{192}Ir	M								1.01E–06	1.01E–06

Table 5.12 (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{40}K	M								3.54E–05	3.54E–05
^{79}Kr	G							1.77E+01		1.77E+01
^{81}Kr	G								5.48E–15	5.48E–15
^{85}Kr	G						1.05E+03		5.53E–07	1.05E+03
^{85m}Kr	G						8.34E+00	5.45E+01		6.28E+01
^{87}Kr	G						8.61E+01	2.36E+01		1.10E+02
^{88}Kr	G						4.78E+01	9.62E+00		5.74E+01
^{89}Kr[c]	G						3.35E+01			3.35E+01
^{140}La	M						1.65E–02		5.89E–10	1.65E–02
^{140}La	S					6.54E–06				6.54E–06
^{54}Mn	S					2.31E–06				2.31E–06
^{54}Mn	M								3.48E–08	3.48E–08
^{93}Mo	M								9.49E–10	9.49E–10
^{99}Mo	M								2.33E–10	2.33E–10
^{13}N	G							1.67E+01		1.67E+01
^{22}Na	M								3.72E–14	3.72E–14
^{92}Nb[d]	M								6.27E–09	6.27E–09
^{93m}Nb	M								2.41E–11	2.41E–11
^{95}Nb	M								5.97E–08	5.97E–08
^{95m}Nb	M								1.84E–12	1.84E–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								2.74E–13	2.74E–13
^{191}Os	S			7.42E–04						7.42E–04
^{32}P	M								4.24E–10	4.24E–10
^{33}P	M								5.85E–13	5.85E–13
^{212}Pb	M	4.58E–01	5.45E–01				2.27E–02		9.45E–06	1.03E+00
^{212}Pb	S			9.53E–01	8.74E–02				1.67E–02	1.06E+00
^{210}Po	M								3.00E–14	3.00E–14

Table 5.12 (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{238}Pu	F			3.40E–08	2.75E–09	1.57E–06			8.98E–10	1.61E–06
^{238}Pu	M	2.92E–08	1.40E–08				2.23E–09		3.30E–07	3.76E–07
^{239}Pu	F			9.30E–07	8.28E–09	6.95E–07			8.60E–10	1.63E–06
^{239}Pu	M	8.14E–08	1.34E–07				2.93E–09		1.98E–09	2.20E–07
^{240}Pu	F					6.95E–07			4.88E–10	6.95E–07
^{240}Pu	M								1.30E–09	1.30E–09
^{241}Pu	M								1.78E–07	1.78E–07
^{242}Pu	M								1.45E–14	1.45E–14
^{228}Ra	M								7.49E–06	7.49E–06
^{88}Rb	M							3.20E+00		3.20E+00
^{188}Re	M								4.15E–07	4.15E–07
^{103}Ru	M								3.50E–09	3.50E–09
^{106}Ru	M								1.01E–05	1.01E–05
^{106}Ru	S					1.97E–05			3.20E–04	3.40E–04
^{35}S	M								1.35E–08	1.35E–08
^{124}Sb	M								1.01E–07	1.01E–07
^{125}Sb	M								2.63E–07	2.63E–07
^{46}Sc	M								6.40E–11	6.40E–11
^{75}Se	F								1.41E–11	1.41E–11
^{75}Se	S			9.19E–05		1.95E–06				9.39E–05
^{113}Sn	M								1.60E–11	1.60E–11
^{119m}Sn	M								1.43E–10	1.43E–10
^{89}Sr	S			1.56E–05	6.90E–09				3.36E–05	4.92E–05
^{89}Sr	M	1.61E–07	8.25E–07				4.31E–06		6.99E–09	5.30E–06
^{90}Sr	M	1.61E–07	8.25E–07				4.31E–06		8.02E–04	8.07E–04
^{90}Sr	S			1.56E–05	6.90E–09	7.86E–06			3.36E–05	5.71E–05
^{179}Ta	M								5.95E–14	5.95E–14
^{182}Ta	M								5.80E–11	5.80E–11
^{99}Tc	M								1.03E–10	1.03E–10
^{99}Tc	S					9.85E–06				9.85E–06

Table 5.12 (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{99m}Tc	M								2.98E–08	2.98E–08
^{129}Te	M								9.92E–12	9.92E–12
^{129m}Te	M								3.76E–07	3.76E–07
^{228}Th	S	8.59E–09	6.64E–09	2.32E–09	1.02E–09		8.86E–09		5.05E–10	2.79E–08
^{230}Th	F			8.75E–09	4.93E–10				1.08E–09	1.03E–08
^{230}Th	S	4.93E–09	2.46E–09				8.88E–09		1.38E–11	1.63E–08
^{232}Th	F			3.47E–09	2.56E–10				2.14E–10	3.94E–09
^{232}Th	S	1.09E–09	1.87E–09				5.89E–09		1.98E–11	8.87E–09
^{234}Th	S								3.49E–05	3.49E–05
^{232}U	M								2.82E–12	2.82E–12
^{233}U	M								4.62E–10	4.62E–10
^{233}U	S					4.48E–07			2.00E–05	2.05E–05
^{234}U	M	1.10E–07	9.55E–08				6.67E–08		7.16E–10	2.73E–07
^{234}U	S			1.45E–07	1.40E–08	4.48E–07			2.00E–05	2.06E–05
^{235}U	M	9.74E–09	7.97E–09				1.22E–08		1.00E–07	1.30E–07
^{235}U	S			1.43E–08	1.02E–09	9.69E–07			1.16E–06	2.15E–06
^{236}U	M								2.10E–14	2.10E–14
^{236}U	S								1.29E–06	1.29E–06
^{238}U	S			2.56E–08	8.50E–10	9.02E–07			1.94E–06	2.87E–06
^{238}U	M	4.45E–09	9.18E–09				2.53E–08		4.34E–05	4.35E–05
^{181}W	M								1.19E–11	1.19E–11
^{185}W	M								3.57E–08	3.57E–08
^{188}W	M								8.38E–08	8.38E–08
^{125}Xe	G							1.32E+01		1.32E+01
^{127}Xe	G							1.30E+01	6.86E–11	1.30E+01
^{129m}Xe	G								1.45E–10	1.45E–10
^{131m}Xe	G						1.12E+02		9.50E–08	1.12E+02
^{133}Xe	G						1.05E+01		8.92E–09	1.05E+01
^{133m}Xe	G						2.26E+01		5.43E–16	2.26E+01
^{135}Xe	G						5.57E+01			5.57E+01

Table 5.12 (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total minor source	ORNL total
^{135m}Xe	G						4.08E+01			4.08E+01
^{137}Xe[e]	G						1.17E+02			1.17E+02
^{138}Xe	G						2.18E+02			2.18E+02
^{88}Y	F					3.38E–06				3.38E–06
^{88}Y	M								1.35E–13	1.35E–13
^{91}Y	M								1.60E–08	1.60E–08
^{65}Zn	F					5.22E–06				5.22E–06
^{65}Zn	M								2.35E–10	2.35E–10
^{88}Zr	M								1.08E–13	1.08E–13
^{95}Zr	S					4.47E–06				4.47E–06
^{95}Zr	M								2.67E–08	2.67E–08

[a] 1 Ci = 3.7E+10.
[b] Cf-248 was used as a surrogate for Cf-252.
[c] Kr-88 was used as a surrogate for Kr-89.
[d] Nb-94 was used as a surrogate for Nb-92.
[e] Xe-135 was used as a surrogate for Xe-137.

F - Fast absorption of particulate aerosols to blood
M - Medium absorption particulate aerosols to blood
S - Slow absorption particulate aerosols to blood
G - Gaseous form
V - Vapor form

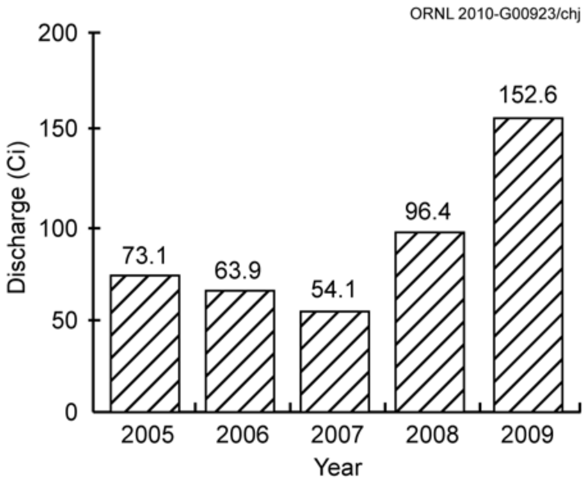

Fig. 5.13. Total discharges of ^{3}H from ORNL to the atmosphere, 2005–2009.

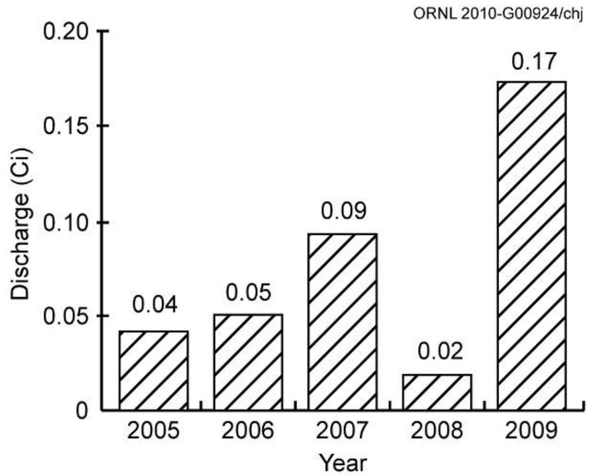

Fig. 5.14. Total discharges of ^{131}I from ORNL to the atmosphere, 2005–2009.

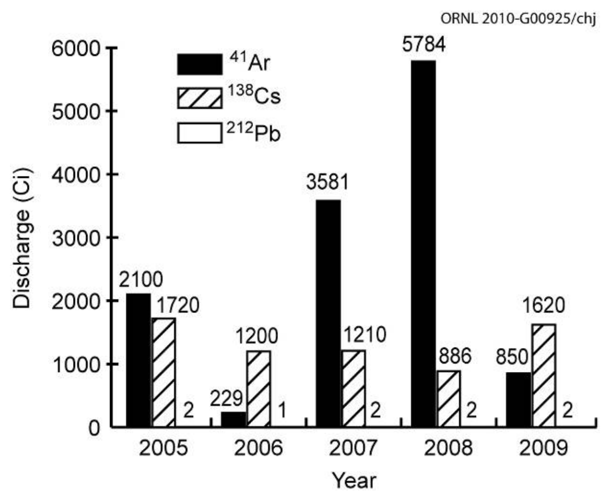

Fig. 5.15. Total discharges of ^{41}Ar, ^{138}Cs, and ^{212}Pb from ORNL to the atmosphere, 2005–2009.

increases were research activities in building 4501 and operations at the SNS. For 2009, the major contributors to the offsite dose at ORNL were ^{138}Cs, ^{212}Pb, and ^{41}Ar (contributions of approximately 34%, 32%, and 11%, respectively). Emissions of ^{138}Cs result from research activities in the REDC. The radioactive decay of onsite legacy material and contamination areas containing isotopes of ^{228}Th, ^{232}Th, and ^{232}U results in ^{212}Pb emissions. In 2009, ^{212}Pb was emitted from the following stacks: 2026, 3020, 3039, 7503, 7856, 7877, 7911, and the STP Sludge Drier. HFIR operations and research activities result in ^{41}Ar emissions, which emit as a nonadsorbable gas from the 7911 Melton Valley complex stack. For 2009, ^{138}Cs emissions totaled 1620 Ci, ^{212}Pb emissions totaled 2 Ci, and ^{41}Ar emissions totaled 850 Ci (Fig. 5.15). Emissions of ^{41}Ar decreased in 2009 due to the removal of an experiment requiring argon as a coolant in late 2008. Emissions of ^{138}Cs increased due to the processing of seven heavy element targets in 2009 to recover and purify ^{252}Cf. (The spontaneous fission decay of ^{252}Cf is the source of ^{138}Cs. This was the first processing campaign in a number of years.)

The calculated radiation dose to the maximally exposed off-site individual from all radiological airborne release points at ORNL during 2009 was 0.3 mrem. This dose is well below the NESHAP standard of 10 mrem and is less than 0.10 % 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.)

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 with no disruption of service.

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 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. 5.16) 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 5.13).

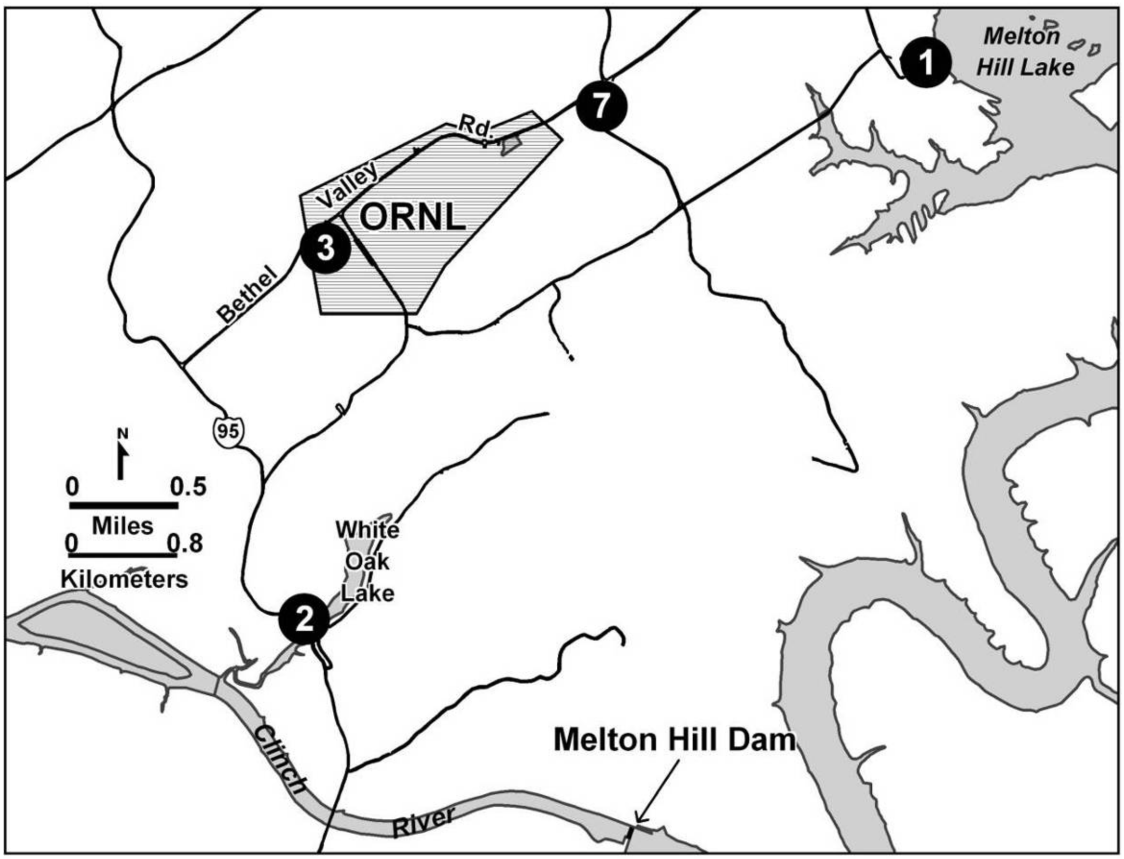

Fig. 5.16. Locations of ambient air monitoring stations at ORNL.

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 bi-weekly. A silica-gel column is used for collection of tritium as tritiated water. These samples are collected biweekly or weekly, depending on ambient humidity levels, and composited quarterly for tritium analysis.

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 5.13) 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 2009, 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 initial rounds of WQPP monitoring were conducted 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 a Radiological Monitoring Plan. The WQPP will be reviewed, and if appropriate, 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. 5.17. 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.

The first two steps of the stressor identification process were initiated in 2009; focusing first on mercury impairment (Fig. 5.18), 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.

Table 5.13. Radionuclide concentrations (pCi/mL)[a] measured at ORNL perimeter air monitoring stations, 2009

Parameter	No. detected/ sampled	Concentration		
		Average	Minimum	Maximum
		Station 1		
Alpha	1/1	4.08E–09	*b*	*b*
^{7}Be	1/1	2.48E–08	*b*	*b*
Beta	1/1	1.70E–08	*b*	*b*
^{3}H	2/4	3.26E–05	5.97E–07	1.25E–04[c]
^{40}K	27/27	2.14E–07	1.39E–07	3.4E–07
^{234}U	1/1	5.61E–12	*b*	*b*
^{235}U	0/1	1.65E–13	*b*	*b*
^{238}U	1/1	5.32E–12	*b*	*b*
		Station 2		
Alpha	1/1	4.46E–09	*b*	*b*
^{7}Be	1/1	2.30E–08	*b*	*b*
Beta	1/1	1.75E–08	*b*	*b*
^{3}H	2/4	5.45E–06	1.01E–06	7.77E–06
^{40}K	27/27	2.26E–07	1.04E–07	3.46E–07
^{234}U	1/1	5.78E–12	*b*	*b*
^{235}U	0/1	–1.95E–13	*b*	*b*
^{238}U	1/1	6.79E–12	*b*	*b*
		Station 3		
Alpha	1/1	3.82E–09	*b*	*b*
^{7}Be	1/1	2.31E–08	*b*	*b*
Beta	1/1	1.74E–08	*b*	*b*
^{3}H	2/4	3.73E–06	-6.10E–07	7.64E–06
^{40}K	27/27	2.66E–07	1.81E–07	4.03E–07
^{234}U	1/1	9.81E–12	*b*	*b*
^{235}U	0/1	1.72E–13	*b*	*b*
^{238}U	1/1	1.33E–11	*b*	*b*
		Station 7		
Alpha	1/1	6.12E–09	*b*	*b*
^{7}Be	1/1	2.35E–08	*b*	*b*
Beta	1/1	1.77E–08	*b*	*b*
^{3}H	1/4	3.64E–06	3.67E–07	6.45E–06
^{40}K	27/27	2.53E–07	1.78E–07	3.66E–07
^{234}U	1/1	7.95E–12	*b*	*b*
^{235}U	0/1	3.69E–13	*b*	*b*
^{238}U	1/1	7.53E–12	*b*	*b*

[a]1 pCi = 3.7×10^{-2} Bq.

[b]Not applicable.

[c]High bias to analytical results exists due to analytical issues encountered. However, biased value was reported.

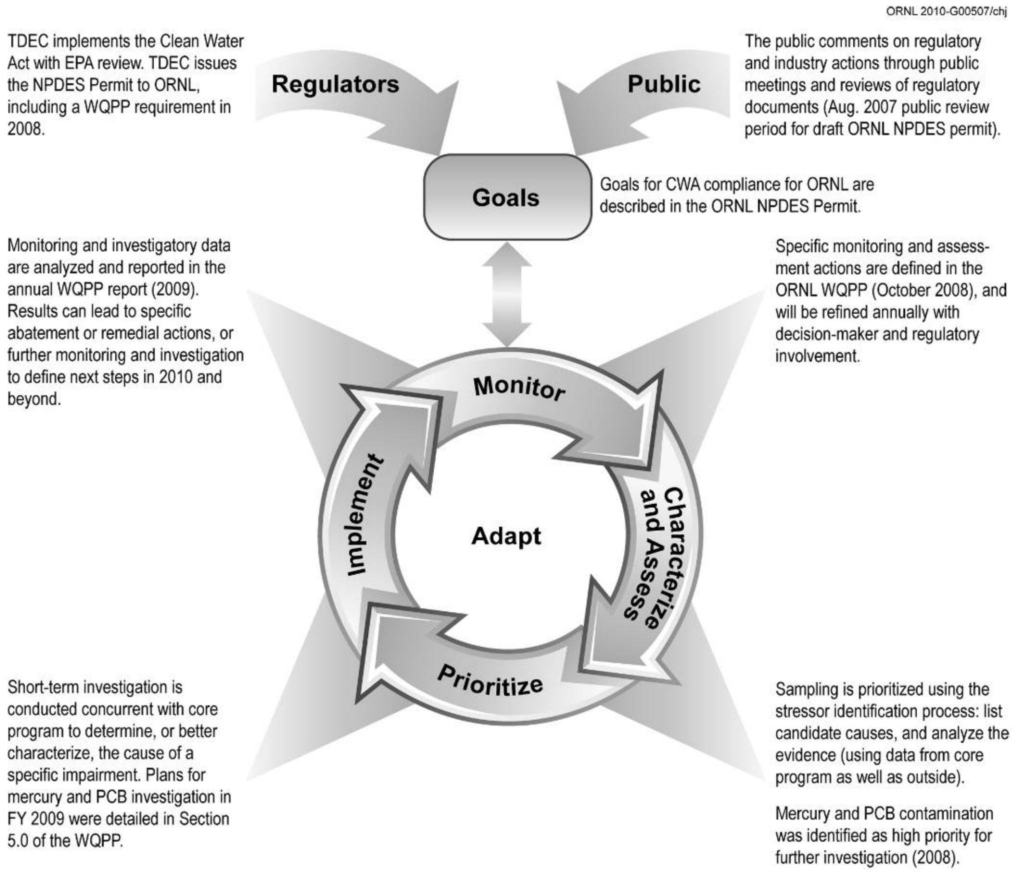

Fig. 5.17. Diagram of the adaptive management framework, with step-wise planning specific to the ORNL Water Quality Protection Plan. Adapted from EPA.

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.

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 (See Table 5.14 below and Table 2.8 in *Environmental Monitoring on the Oak Ridge Reservation: 2009 Results* (DOE 2010b).

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 5.14. The three ORNL wastewater treatment facilities achieved 100% compliance with permit limits and conditions in 2009.

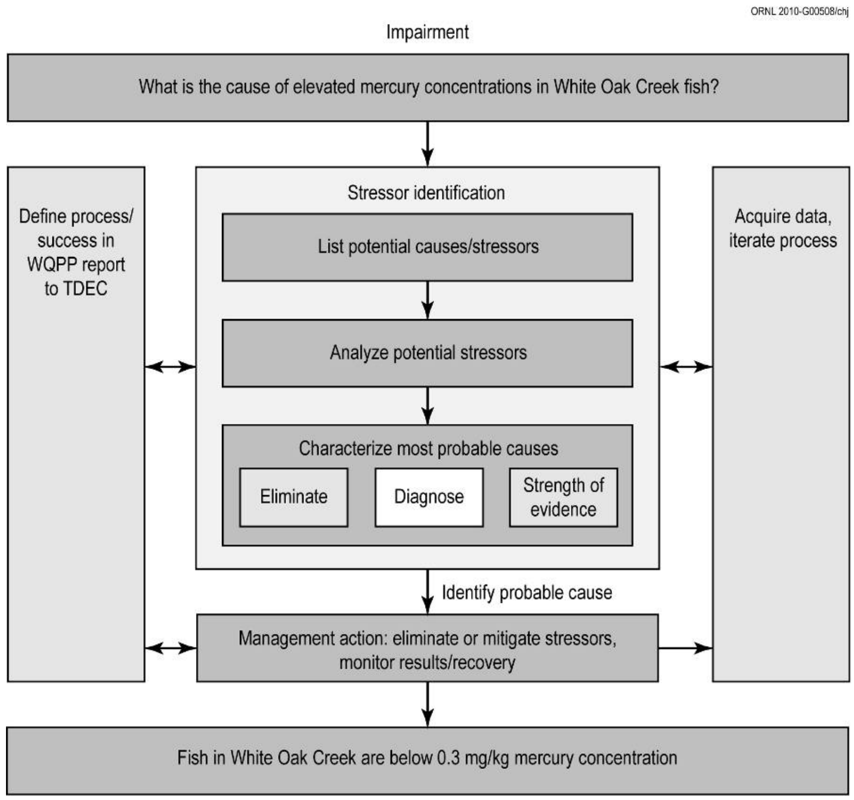

Fig. 5.18. Application of stressor identification guidance to address mercury impairment in the White Oak Creek watershed. Diagram modified from EPA.

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 non-toxic. The STP has shown isolated indications of effluent toxicity, but confirmatory tests conducted as required by the permit have confirmed 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 2009, 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 (see Table 5.14).

Table 5.14. National Pollutant Discharge Elimination System (NPDES) compliance at ORNL, 2009
(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		0	52	100
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 (Coal Yard Runoff Treatment Facility)								
pH (standard units)				9.0	6	0	51	100
Total suspended solids				50		0	6	100
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

Table 5.14 (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]
Oil and grease	66.7	100	10	15		0	12	100
pH (standard units)				9.0	6.0	0	52	100
Temperature (ºC)				30.5		0	52	100
Instream chlorine monitoring points								
Total residual oxidant			0.011	0.019		2[b]	288	99.3

[a]Percentage compliance 100 – [(number of noncompliances/number of samples) × 100].
[b]Two exceedances at X19 in February 2009.

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.

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 TRO, by limiting the TRO mass loading from outfalls and the TRO concentration instream. 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. Instream 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, staff investigates and implements treatment and reduction measures. TRO is also monitored at instream points twice per month to verify that releases are not creating adverse conditions for fish and other aquatic life.

Thirty-one individual outfalls were checked for TRO either semiannually, quarterly, monthly, or bimonthly, throughout the year for a total of 259 attempts. Flow was detected 233 times. Table 5.15 lists instances in 2009 where outfalls were found to be in excess of the TRO action level. All cases have been investigated and determined to be from aging, underground water pipes that are leaking drinking water. Two outfalls, 265 and 368, on Fifth Creek exceeded the action level during 2009. There are water line leaks that contributed to a February 2009 exceedance of the TRO limit at X19, an instream monitoring point downstream of the outfalls. The limit is 0.05 mg/L and the measured value was 0.12 mg/L. Four outfalls on WOC exceeded the action level but did not lead to any instream TRO concentration exceedances.

5.5.3 Cooling Tower Blowdown Monitoring

In 2009, as part of the WQPP at ORNL, cooling tower blowdown effluents were monitored twice (in February and August) for field parameters (pH, conductivity, temperature, and dissolved oxygen) and were monitored once (in August) for chemical oxygen demand, total suspended solids, and total metals. All samples were grab samples.

Table 5.15. Outfalls exceeding total residual oxidant (TRO) action level[a] in 2009

Sample date	Outfall	TRO concentration (mg/L)	Flow (gpm)	Load (grams/ day)	Receiving stream	Downstream integration point	Instream TRO point
2/9/2009	265	0.85	20	92.7	Fifth Creek	FFK 0.2	X19
2/9/2009	368	0.8	15	65.4	Fifth Creek	FFK 0.2	X19
4/2/2009	368	0.7	14	53.4	Fifth Creek	FFK 0.2	X19
7/9/2009	368	1.25	9	61.3	Fifth Creek	FFK 0.2	X19
10/5/2009	368	0.85	5	23.2	Fifth Creek	FFK 0.2	X19
2/9/2009	207	0.35	8	15.3	White Oak Creek	WCK 3.9	X21
4/2/2009	207	0.6	3	9.8	White Oak Creek	WCK 3.9	X21
2/16/2009	227	0.85	4	18.5	White Oak Creek	WCK 3.9	X25
2/9/2009	304	0.15	8	6.5	White Oak Creek	WCK 3.9	X21
2/9/2009	312	0.35	4.5	8.6	White Oak Creek	WCK 3.9	X25
4/2/2009	312	0.3	4	6.5	White Oak Creek	WCK 3.9	X25
10/5/2009	312	0.35	5	9.5	White Oak Creek	WCK 3.9	X25

[a]1.2 grams per day.

Fourteen cooling tower/cooling tower systems (Table 5.16) were targeted for monitoring. Of those, three towers (2026, 2535, and 3047) were not operating during any sampling attempts and therefore were not sampled. Three towers (3517, 7902 and 7923) were not operating during the February sampling event but were operating and were sampled during the August sampling event.

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. In some cases, outfall pipes could not be sampled because they were submerged by the receiving stream. Field measurements are presented in Table 5.17. Results for laboratory analyses are presented in Table 5.18.

Table 5.16. Cooling tower/cooling tower systems monitored at ORNL

Cooling tower/ tower system	NPDES outfall receiving blowdown	Sampled location
2026	249	N/A (tower not operating during sampling attempts)
2535	204	N/A (tower not operating during sampling attempts)
2539	204	Tower Basin
3047	367	N/A (tower not operating during sampling attempts)
3517	304	Tower Basin
4510/4521	014	Outfall
5300	363	Outfall
5600	227	Outfall
6001	314	Tower Basin
7619	291	Outfall
7626	191	Outfall
7902	281	Outfall
7923	481	Outfall
8913	435	Outfall

Table 5.17. 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)
2539	2539 basin	2/12/2009	Unknown	0.62	6.1	7.9	12.2
2539	2539 basin	8/18/2009	Unknown	0.69	9	7.9	24.2
3517	3517 basin	2/12/2009	Tower was not operating during Feb. sampling attempt				
3517	3517 basin	8/18/2009	Unknown	0.357	8.2	8.1	26.3
5300	Outfall 363	2/12/2009	6	0.71	6.4	8	12
5300	Outfall 363	8/18/2009	6.5	0.838	6.9	8.4	26
5600	Outfall 227	2/12/2009	10	0.83	6.8	8	14.7
5600	Outfall 227	8/18/2009	20	0.49	7	8.4	31.7
6001	6001 basin	2/12/2009	Unknown	1.2	5.9	8.2	23.9
6001	6001 basin	8/18/2009	Unknown	1.19	7.8	8.1	26.2
7619	Outfall 291	2/12/2009	65	0.329	6.8	8.3	8.8
7619	Outfall 291	8/18/2009	0.5	0.271	7	7.6	22.6
7626	Outfall 191	2/12/2009	130	0.407	7.2	7.8	8.8
7626	Outfall 191	8/18/2009	4	0.387	7.1	7.8	23.7
7902	Outfall 281	2/12/2009	Tower was not operating during Feb. sampling attempt				
7902	Outfall 281	8/18/2009	95	1.59	7.3	7.9	27.1
7923	Outfall 481	2/12/2009	Tower was not operating during Feb. sampling attempt				
7923	Outfall 481	8/18/2009	Unknown	1.06	7.7	8.9	28.8
8913	Outfall 435	2/12/2009	90	0.05	6.8	7.3	10.3
8913	Outfall 435	8/18/2009	75	0.419	7.9	8	20.1
4510/4521	Outfall 014	2/12/2009	15	0.98	5.9	9	23.2
4510/4521	Outfall 014	8/18/2009	50	1.17	9	8.2	28

[a]Cooling Towers 2026, 2535, 3047 were not operating during either the February 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.

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 17, 2009. 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. Four rounds of grab sample measurements for temperature were collected on the day of monitoring both upstream and downstream of the cooling tower discharges. Individual temperature measurements are presented in Table 5.19. No instream temperature measurement exceeded the maximum criteria of 30.5°C. Upstream to downstream temperature change for the monitored stream reaches were calculated for each of the four rounds of measurements (see Table 5.20). For all rounds, the measured temperature changes across all monitored stream reaches were less than the maximum change criteria of 3°C. The rates of instream temperature change between rounds of measurements were also calculated for each stream reach. No rates of change exceeded the criteria of 2°C per hour (see Table 5.20).

Table 5.18. Results (in mg/L) from laboratory analyses of blowdown from ORNL cooling towers[a,b]
Date sampled: August 18, 2009

	Cooling tower (sampled location)										
	2539 (2539 basin)	**3517 (3517 basin)**	**5300 (OF 363)**	**5600 (OF 227)**	**6001 (6001 basin)**	**7619 (OF 291)**	**7626 (OF 191)**	**7902 (OF 281)**	**7923 (OF 481)**	**8913 (OF 435)**	**4510/4521 (OF 014)**
Chemical oxygen demand	25.5	J 14.7	30.9	J 12	90.4	J 14.7	J 12	30.9	52.5	J 6.59	174
Total suspended solids	<2	<2	13	2	8	3	<2	<2	<2	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
As	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	0.00371
Be	<0.000686	<0.000686	<0.000686	<0.000686	<0.000686	<0.000686	<0.000686	<0.000686	<0.000686	<0.000686	<0.000686
Ca	88.1	45.8	133	57	156	38	52	239	162	40.3	167
Cd	<0.000782	<0.000782	<0.000782	<0.000782	<0.000782	<0.000782	<0.000782	<0.000782	<0.000782	<0.000782	<0.000782
Cr	<0.001	<0.001	0.00109	<0.001	0.132	<0.001	<0.001	0.00135	0.00112	<0.001	<0.001
Cu	0.00594	0.0186	0.0961	0.109	0.428	<0.001	<0.001	0.00271	0.11	<0.001	0.00608
Fe	0.562	<0.0206	0.393	0.0603	0.126	1.19	0.151	0.15	0.146	0.142	0.0207
Mg	24.7	13.5	35.4	15	46.9	10.2	9.69	65.7	47	11	48.2
Mn	0.00719	<0.000953	0.0241	0.00831	0.00943	4.72	0.0355	0.00269	0.0112	0.113	0.0032
Mo	0.795	<0.000931	0.346	1.89	0.67	<0.000931	0.0036	0.00335	0.00187	0.00326	0.819
Ni	0.00278	<0.00138	0.00345	0.00159	0.00489	0.0027	0.00187	0.00558	0.00384	<0.00138	0.00405
Pb	<0.001	<0.001	<0.001	<0.001	0.00223	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sb	<0.00081	<0.00081	<0.00081	<0.00081	<0.00081	<0.00081	<0.00081	0.00223	<0.00081	<0.00081	0.00279
Se	<0.0406	<0.0406	<0.0406	<0.0406	0.0621	<0.0406	<0.0406	<0.0406	<0.0406	<0.0406	<0.0406
Zn	0.158	0.145	0.202	0.0657	0.278	< 0.02	0.0342	0.0742	0.167	0.12	0.218

[a]Towers 2026, 2535, and 3047 were not operating during the time that analytical samples were collected.

[b]Prefix "J" indicates that the value was estimated at or below the analytical detection limit by the laboratory, and prefix "<" indicates that the value was undetected at the analytical detection limit.

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Table 5.19. Field measurements from 2009 instream temperature assessment
Monitoring date: August 17, 2009

Monitoring location	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	23.3	09:15	24.0	10:58	24.5	13:14	25.2	14:45
Downstream of Outfall 014	23.3	09:13	24.1	10:59	24.5	13:15	25.3	14:46
Upstream of Outfall 227	23.2	09:20	23.2	11:04	24.0	13:11	24.1	14:40
Downstream of Outfall 227	23.1	09:18	23.2	11:05	26.0	13:12	24.7	14:41
Upstream of Outfall 281	21.6	09:40	22.0	10:49	23.2	13:35	23.8	15:15
Downstream of Outfall 281	23.8	09:38	24.0	10:46	25.5	13:36	26.0	15:16
Upstream of Outfall 314	20.0	09:31	20.6	11:12	21.0	13:29	21.8	14:56
Downstream of Outfall 314	22.7	09:30	22.6	11:13	22.8	13:30	23.2	14:58
Upstream of Outfall 363	17.9	09:28	18.1	10:55	18.8	13:20	19.0	14:48
Downstream of Outfall 363	18.0	09:26	18.6	10:54	19.2	13:18	19.2	14:50
Upstream of Outfall 435	16.6	09:31	16.9	11:18	18.0	13:24	18.9	15:04
Downstream of Outfall 435	16.9	09:30	17.5	11:20	18.6	13:25	19.4	15:06

5.5.4 Radiological Monitoring

Beginning in 2009, monitoring of effluents and instream locations for radioactivity that was previously conducted under the ORNL Radiological Monitoring Plan was reorganized under the ORNL WQPP. Monitoring established under the former Radiological Monitoring Plan for instream locations X13, X14, and X15 and the three major treatment facility discharges (Outfalls X01, X02, and X12) continued unchanged under the WQPP, with the exception that an analysis for $^{89/90}$Sr was added to the monthly monitoring requirements for Outfall X02, the discharge from the SPWTF. Monitoring was adjusted for some category outfalls based on a review of data collected under the previous Radiological Monitoring Plan. Category outfalls are outfalls that discharge effluents with relatively minor constituents that receive little or no treatment prior to discharge. Those adjustments resulted in a net increase in analyses for dry-weather discharges from category outfalls. Sampling of radioactivity in stormwater from individual category outfalls was not conducted in 2009. Table 5.21 details the monitoring frequency and target analyses for the three treatment facility outfalls, three instream monitoring locations, and 22 category outfalls.

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 direct infiltration. In 2009, 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.

The three treatment facilities monitored were the STP, the SPWTF and the PWTC. Three instream monitoring locations were: X13 on Melton Branch, X14 on White Oak Creek, and X15 at White Oak Dam (WOD) (Fig. 5.19). 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 applicable (there are no DCGs for gross alpha and gross beta activities) and when at least one individual measurement indicated detectable activity

Table 5.20. Measurements of instream temperature change for stream reaches receiving cooling tower blowdown at ORNL

Monitoring date: August 17, 2009

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/h)	Round 2 to Round 3 (°C/h)	Round 3 to Round 4 (°C/h)
OF 014/ 4510&4521 Cooling System	0.0	0.1	0.0	0.1	0.5	0.2	0.5
OF 227/ 5600 Cooling System	–0.1	0.0	2.0	0.6	0.1	1.3	–0.9
OF 281/ 7902 Cooling System	2.2	2.0	2.3	2.2	0.2	0.5	0.3
OF 314/ 6001 Cooling System	2.7	2.0	1.8	1.4	–0.1	0.1	0.3
OF 363/ 5300 Cooling System	0.1	0.5	0.4	0.2	0.4	0.2	0.0
OF 435/ 8913 Cooling System	0.3	0.6	0.6	0.5	0.3	0.5	0.5

Table 5.21. ORNL National Pollutant Discharge Elimination System Radiological Monitoring Plan

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	
Coal Yard Runoff 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.

(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 comparisons. DCGs are not intended to be thresholds for instream values as they are for effluents, but are nonetheless useful as a frame of reference. Effluents and instream concentrations are compared to DCGs that were calculated 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.

In 2009, there were no measured annual average concentrations of radioactivity that exceeded 100% of DCG concentrations. The annual average concentration of at least one radionuclide exceeded 4% of the relevant DCG concentration in dry-weather discharges from eight NPDES outfalls (080, 085,204, 241, 302, 304, X01, and X12) and at instream sampling locations X13, X14, and X15. Four percent of the

DCG is roughly equivalent to the 4-mrem dose limit on which the EPA radionuclide drinking water standards are based (4% of a DCG is a convenient comparison point, but it should not be concluded that ORNL effluents or ambient waters are direct sources of drinking water) (Fig. 5.20).

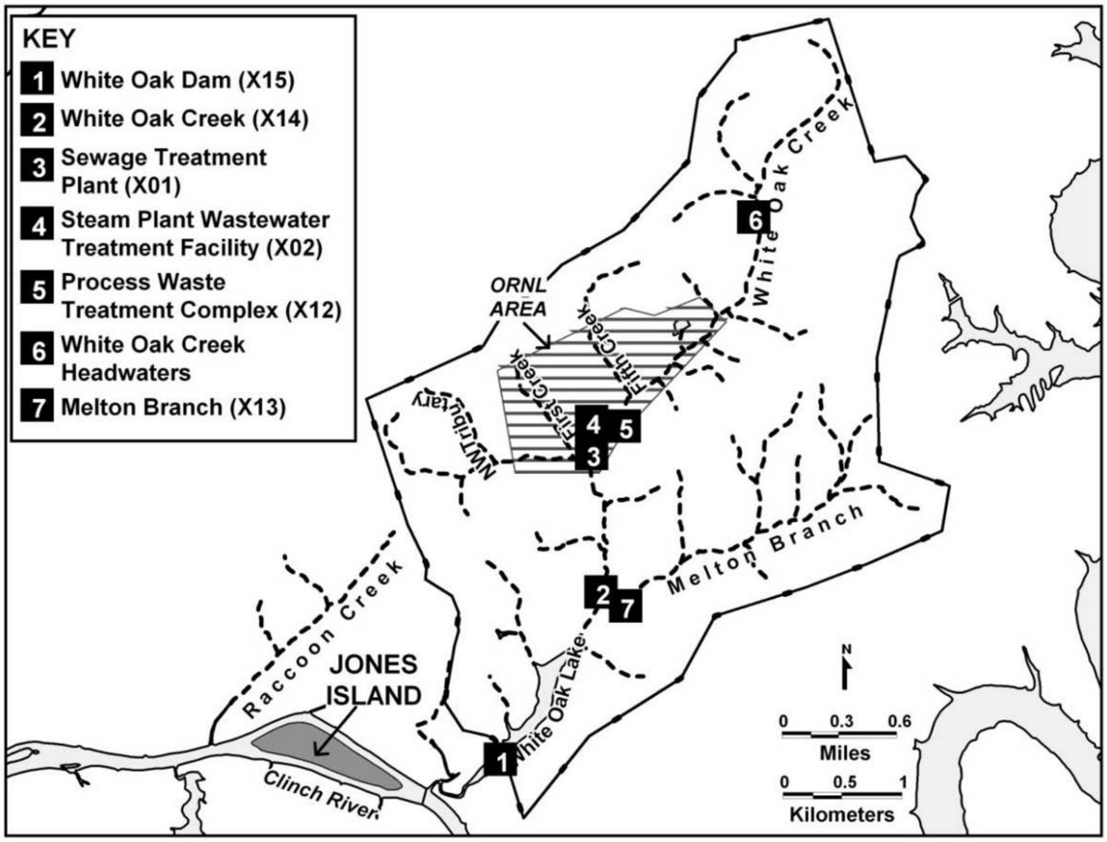

Fig. 5.19. ORNL surface water, National Pollutant Discharge Elimination System, and reference sampling locations.

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. 5.21 through 5.25. CY 2009 discharges at White Oak Dam continue to be generally decreased in comparison to years preceding completion of the waste area caps in Melton Valley, though they were somewhat higher than the previous two years, most likely as a result of higher instream flow volume in 2009 as compared to those years (see Fig. 5.26).

5.5.5 Total Mercury and Methylmercury

Legacy mercury environmental contamination exists at ORNL, due largely to spills and releases that occurred in the 1950s during isotope separation pilot-scale work. Four ORNL facilities were involved, Buildings 3503, 3592, 4501, and 4505, and as a result, mercury is present in soils and groundwater in and around these 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.

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

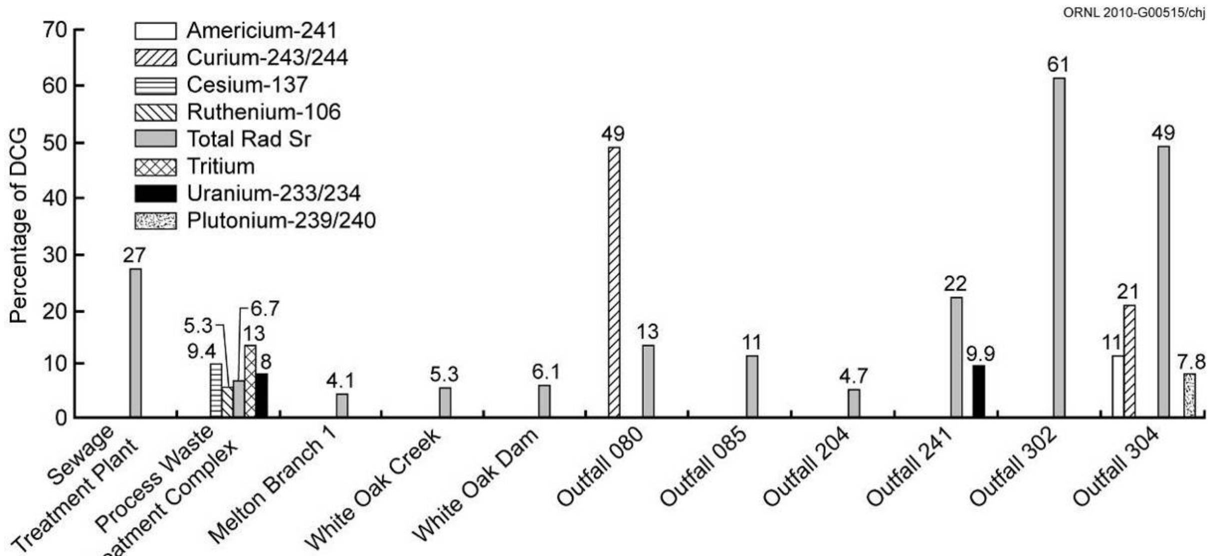

Fig. 5.20. Radionuclides at ORNL sampling sites having average concentrations greater than 4% of the relevant derived concentration guides in 2009.

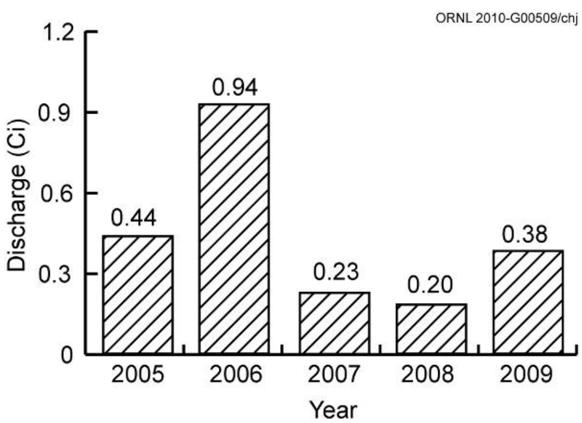

Fig. 5.21. Cesium-137 discharges at White Oak Dam, 2005–2009.

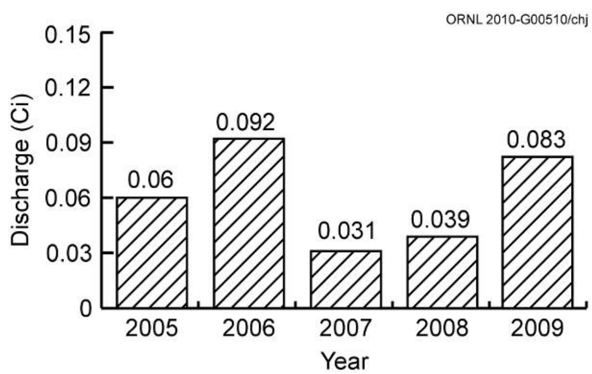

Fig. 5.22. Gross alpha discharges at White Oak Dam, 2005–2009.

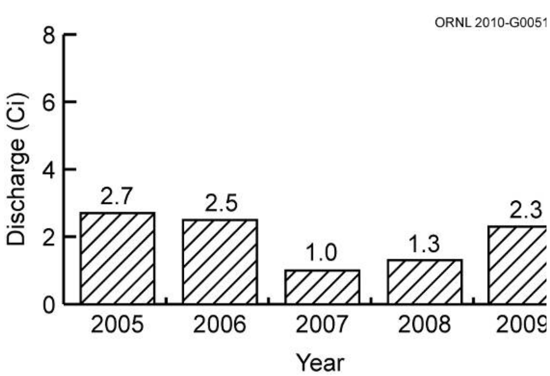

Fig. 5.23. Gross beta discharges at White Oak Dam, 2005–2009.

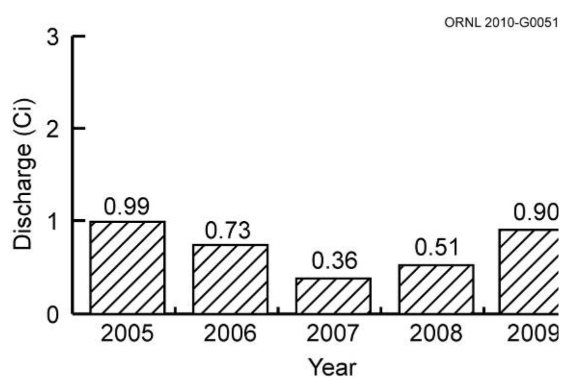

Fig. 5.24. Total radioactive strontium discharges at White Oak Dam, 2005–2009.

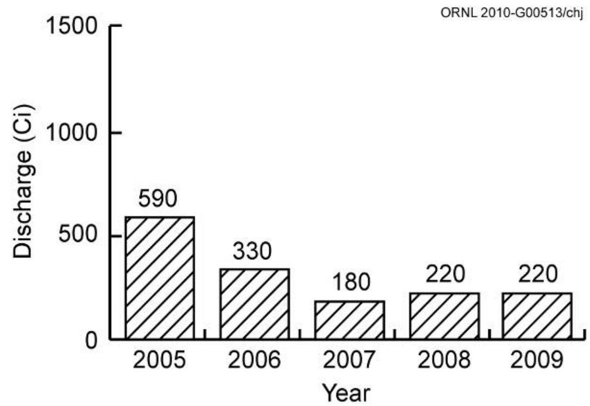

Fig. 5.25. Tritium discharges at White Oak Dam, 2005–2009.

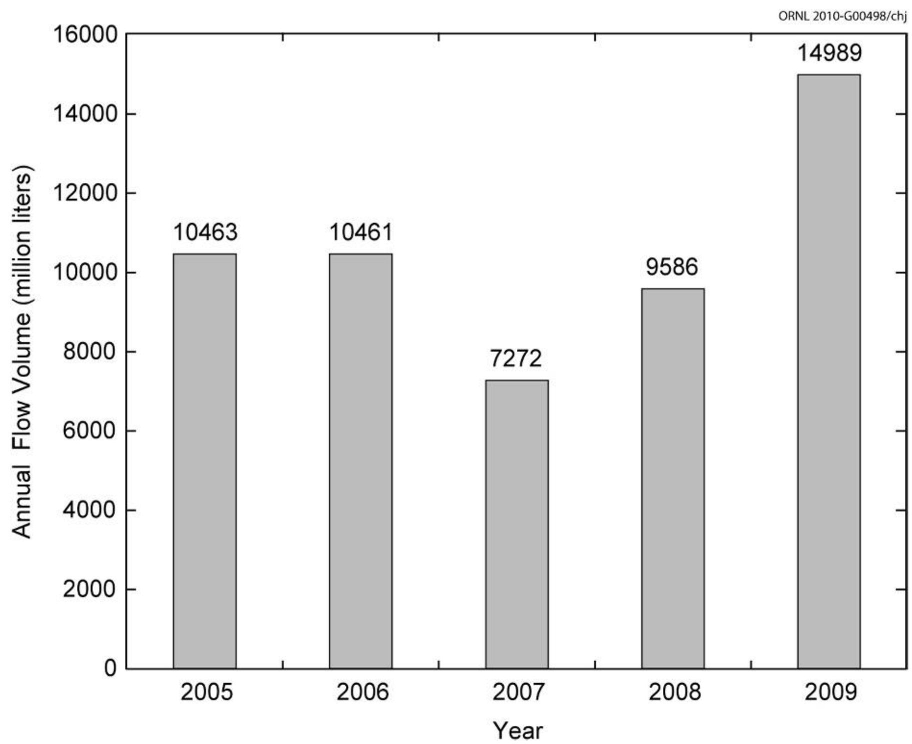

Fig. 5.26. Annual flow volume at White Oak Dam, 2005–2009.

Creek. In 2007, another groundwater sump in Building 4501 that had been found to accumulate 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 before its 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 (see Fig. 5.27).

For the mercury-investigation component of the WQPP, data collected during initial monitoring may lead to effluent sampling at additional outfalls in future WQPP revisions and are expected to help prioritize future abatement actions and help delineate mercury sources. Depending on the results of the 2009 characterization, follow-up efforts would be narrower in scope, focusing on more precise source identification, mechanism of mercury mobilization, or temporal variability of inputs from the most significant sources.

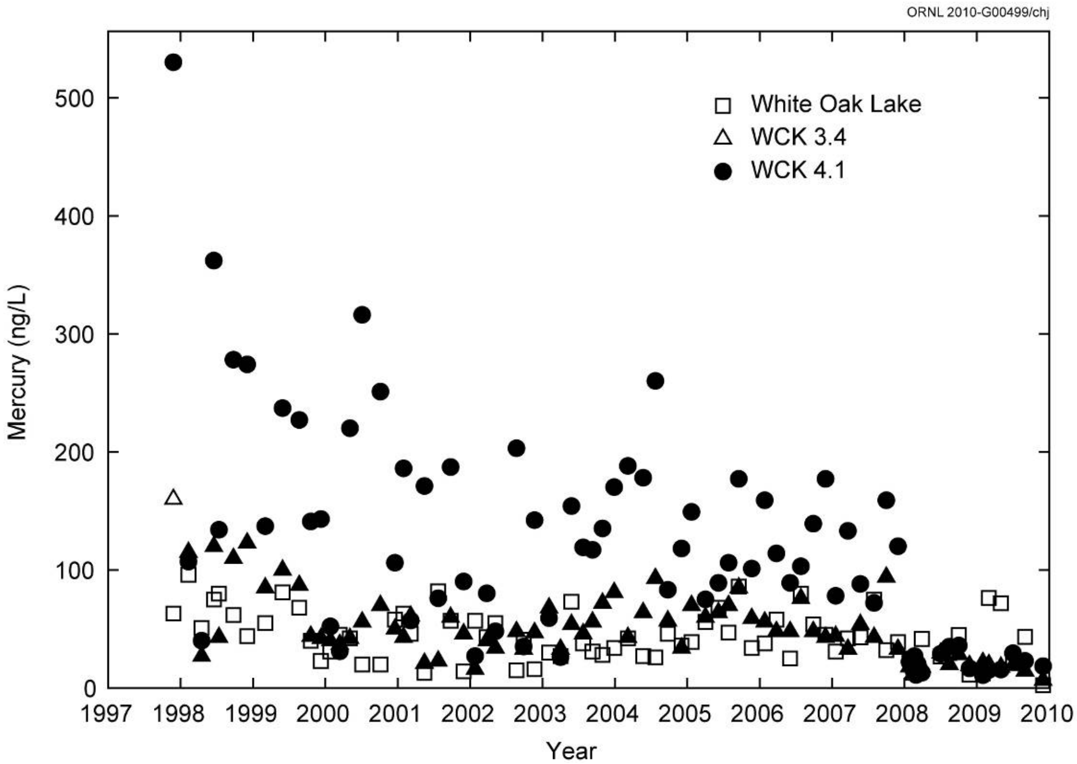

Fig. 5.27. Total aqueous mercury concentrations at sites in White Oak Creek downstream from ORNL, 1998–2009.

In 2009, monitoring conducted under the WQPP included spring and fall rounds of dry-weather samples collected and analyzed from a number of instream points in the White Oak Creek watershed upstream, within, and downstream from the ORNL facilities complex and from certain 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, and analyses were conducted for total mercury, dissolved total mercury, methylmercury, and dissolved methyl mercury. Concentration and flux values were measured and calculated. Selected results of the 2009 monitoring are shown in Figs. 5.28 through 5.31, and complete mercury monitoring results can be found in the 2009 Environmental Monitoring Results (DOE 2010b).

Monitoring results for 2009 indicated that mercury concentrations at all instream locations were below the Tennessee water quality criterion for recreational use, 51 ng/L (parts per trillion), with a few stream reaches showing higher mercury concentrations and/or fluxes than the rest (Fig. 5.28 and Fig. 5.30). These areas of interest included Outfall 211 and the area downstream from that outfall in White Oak Creek; a particular reach of Fifth Creek; and White Oak Creek downstream of its confluence with Fifth Creek (Fig. 5.29 and Fig. 5.31).

Methylmercury values were typically less than 1% of the total mercury concentrations and fluxes monitored in the same locations. Dissolved methylmercury was only detected at a few of the monitoring locations; overall much less methylmercury than total mercury, both in dissolved and undissolved analyses, was detected.

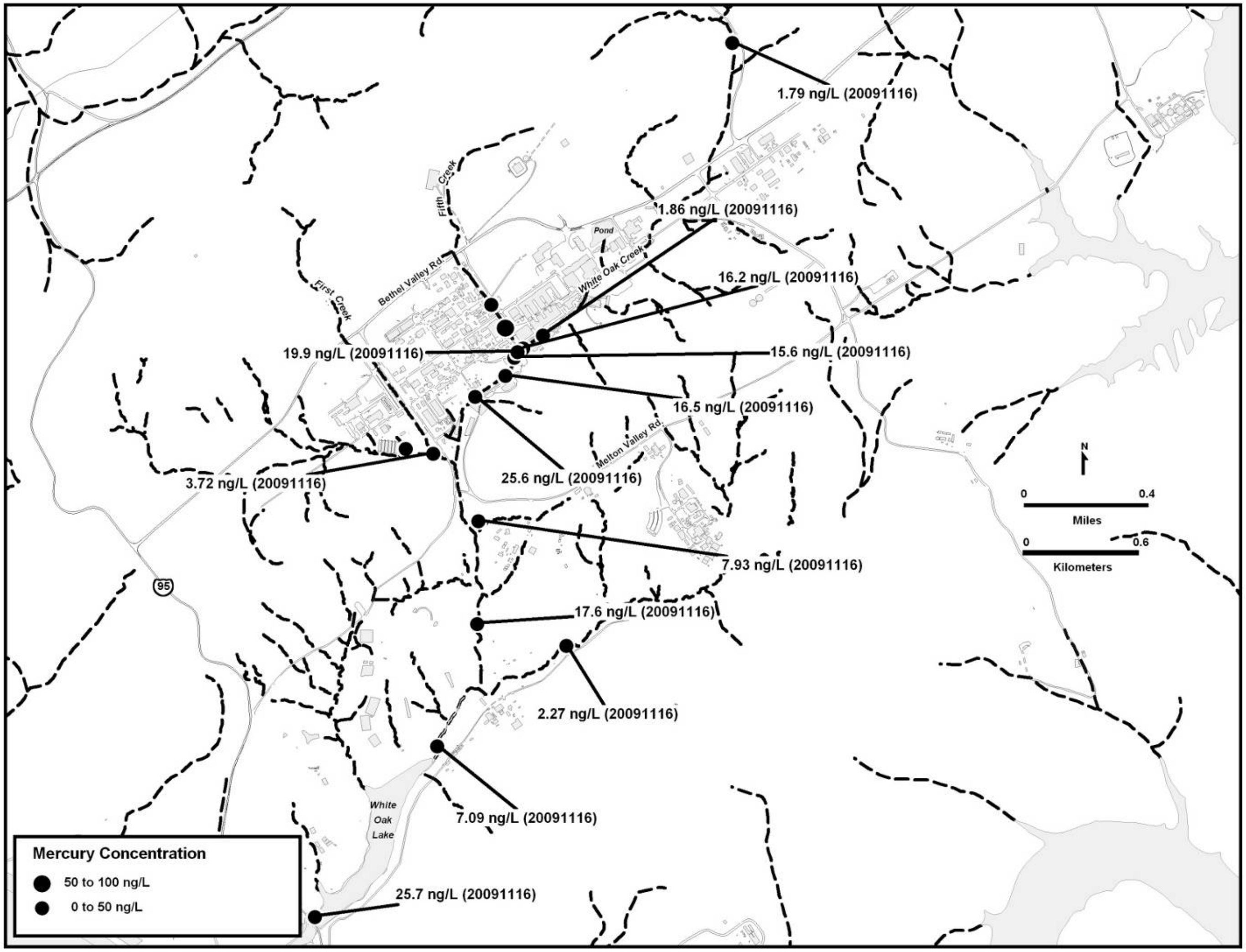

Fig. 5.28. Concentrations of total mercury in the White Oak Creek watershed, November 2009.

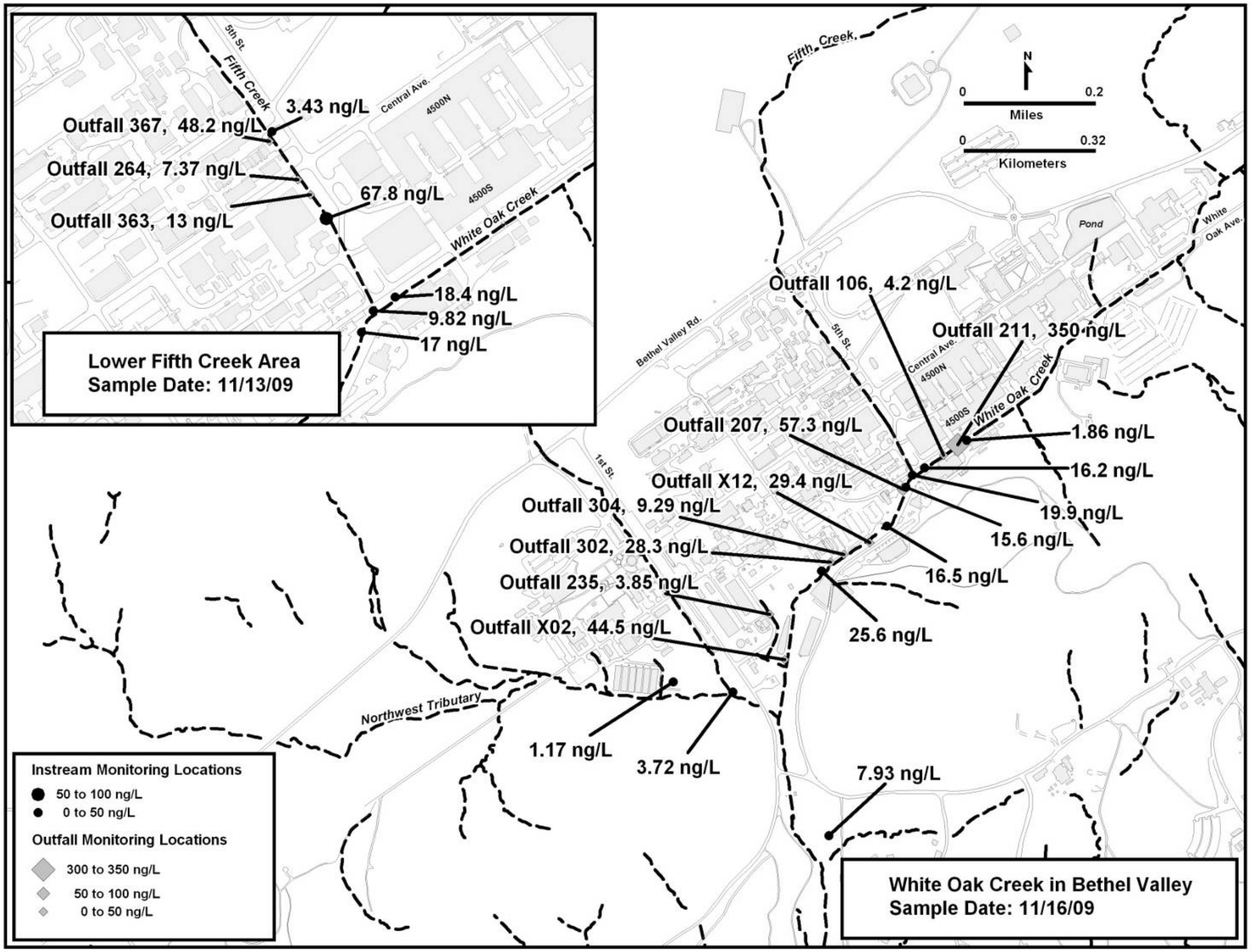

Fig. 5.29. Concentrations of total mercury in Bethel Valley reaches of White Oak Creek, November 2009.

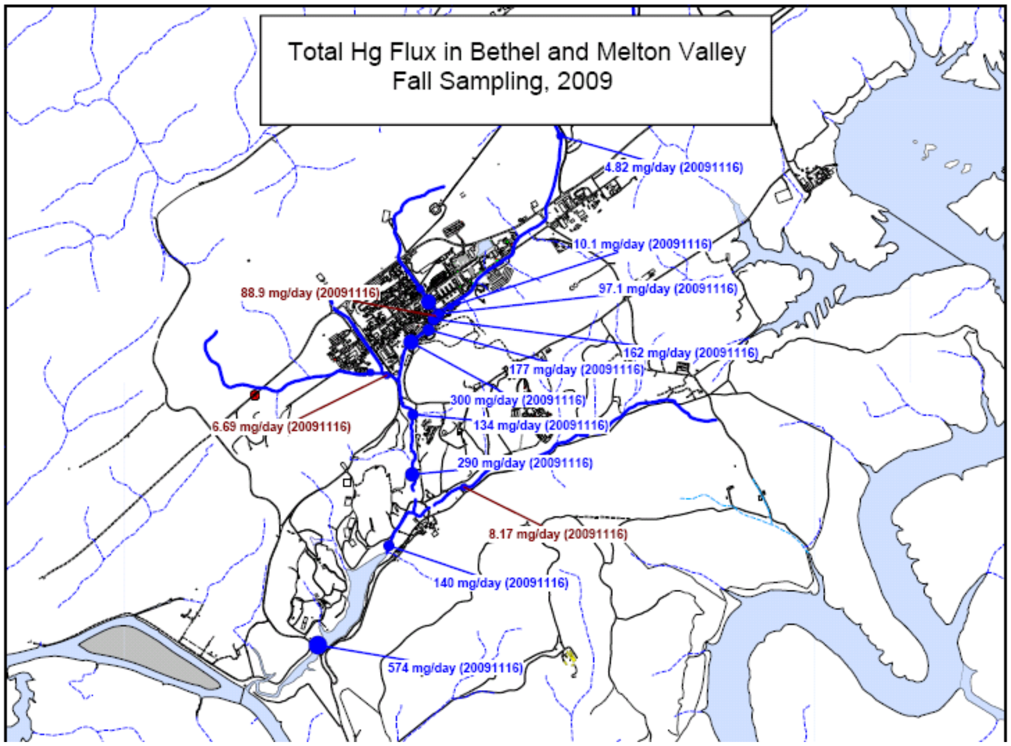

Fig. 5.30. Flux of total mercury in the White Oak Creek watershed, November 2009.

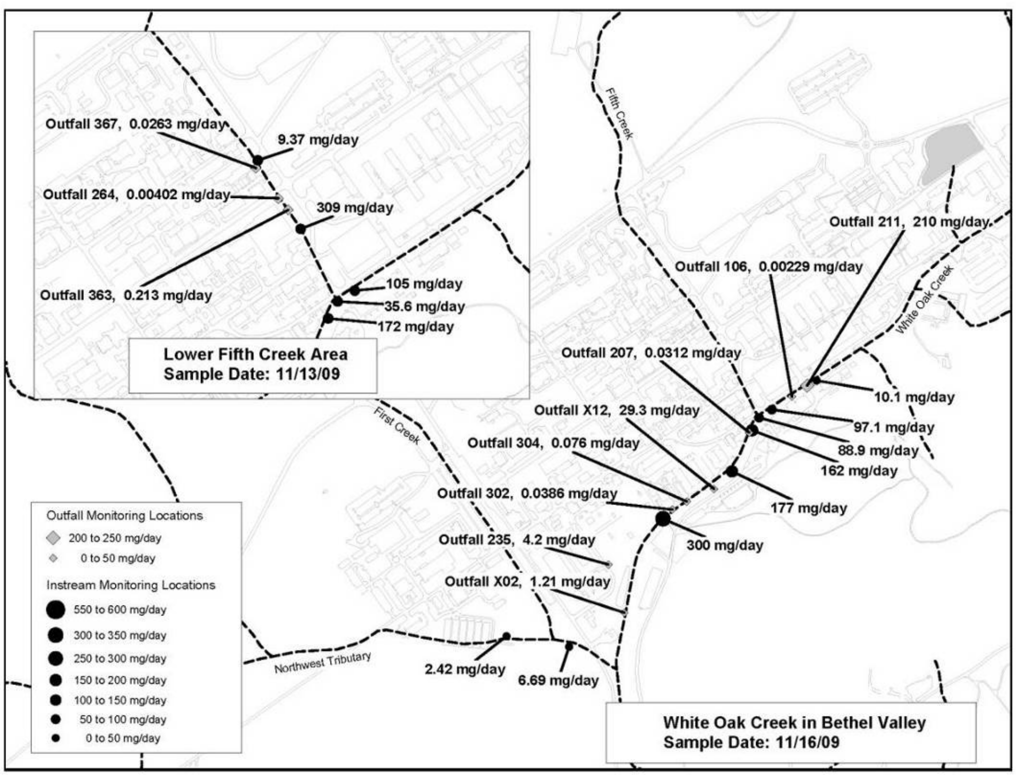

Fig. 5.31. Flux of total mercury in Bethel Valley reaches of White Oak Creek, November 2009.

For 2010, WQPP mercury investigative efforts will focus on one or more of the areas of interest that were identified in the 2009 monitoring. A subset of the 2009 characterization-monitoring protocol will also be conducted in 2010, to maintain ongoing data on the presence of mercury in the White Oak Creek watershed.

5.5.6 Ambient Dry and Wet Weather Monitoring

In 2009, the ORNL WQPP included an objective to characterize water quality at some of the same instream locations where biological communities (fish and benthic macroinvertebrates) are monitored. These locations, where both biological and water quality data were collected, are referred to in the WQPP as integration points. Monitoring sites included seven integration points within or downstream of industrialized areas and four water quality reference locations upstream of the majority of process and stormwater discharges from those industrialized areas (see Fig. 5.32). The purpose of generating a database of water quality conditions at locations where biological community health is monitored 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.

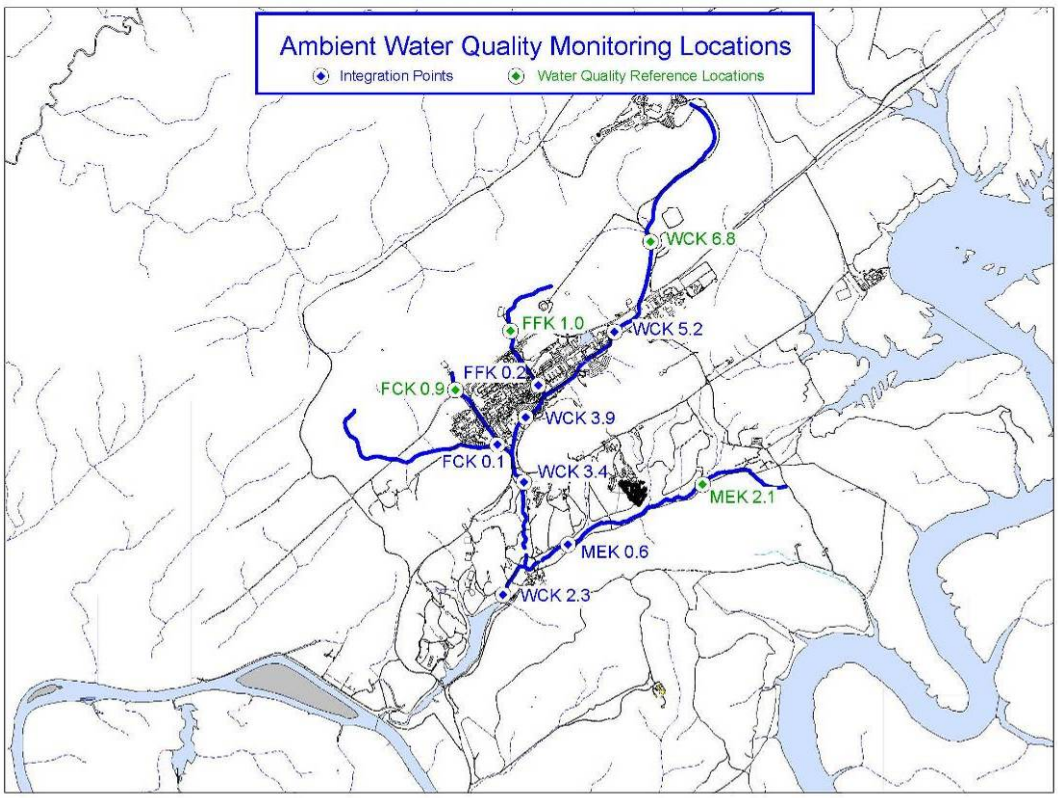

Fig. 5.32. Locations of ambient water quality monitoring integration points and reference locations at ORNL.

In 2009, each location was monitored four times during dry-weather baseflow conditions and two times during wet-weather storm runoff conditions. Samples were collected for solids (suspended and dissolved) and metals (total and dissolved). Nutrients (total phosphorus, Kjeldahl nitrogen, nitrate+nitrite nitrogen, and ammonia) were collected for the sampling events within the growing season (two of the dry-weather sampling events and one of the wet-weather sampling events). Dry-weather samples were 24-h time-proportional composite samples, and wet-weather samples were flow-proportional composite samples of up to 6 h duration. Field measurements (conductivity, dissolved oxygen, flow, pH, and temperature) were performed on grab samples during each sampling event. Results are presented in the

2009 Environmental Monitoring Results (DOE 2010b). These results are being used to guide future efforts under the WQPP, and along with data from future sampling, should prove useful in determining causes of biological community impairments in the WOC watershed. The data suggest that areas warranting additional study under the WQPP are instream concentrations of nutrients and metals, and additional sampling of those parameters is planned for 2010.

5.5.7 Stormwater Surveillances and Construction Activities

Figure 5.33 depicts the location of construction sites that were considered significant in 2009 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). Three of these sites were inspected in 2009 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.

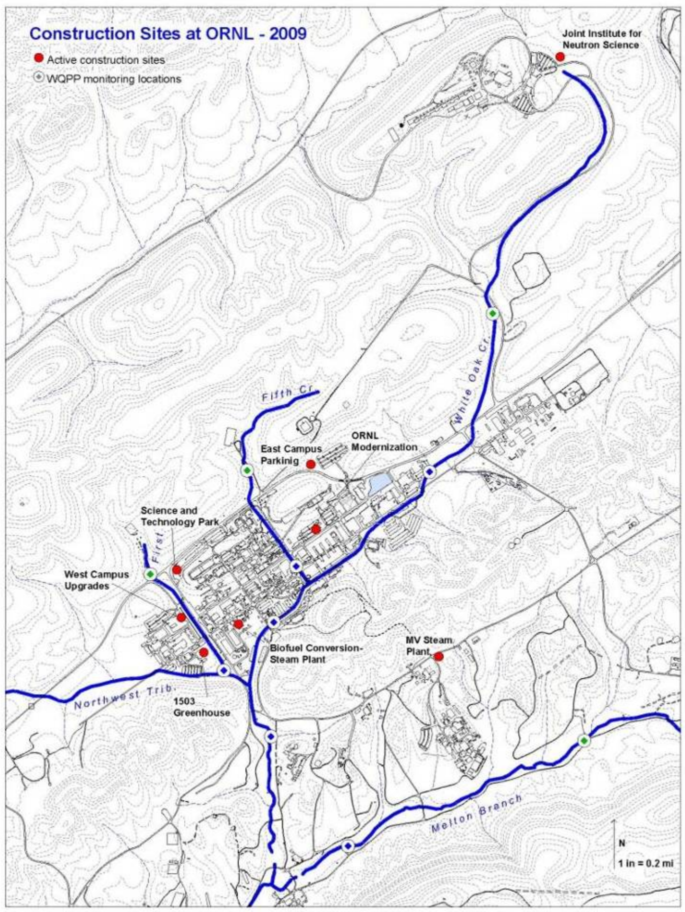

Fig. 5.33. Active construction sites and WQPP monitoring locations at ORNL, 2009.

NPDES outfall drainage areas were also inspected twice in 2009. 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 de-icer 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.

Instream locations identified under the WQPP were monitored twice in 2009 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 2009. 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 2009. Long-term trends in waterborne mercury in the WOC system downstream of ORNL are shown in Fig. 5.27. Waterborne mercury downstream of ORNL declined abruptly in 2008 and remained low in 2009 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 18.6 ± 2.7 ng/L in 2009 compared with 108 ± 33 ng/L in 2007. The decrease was also apparent but less pronounced at WCK 3.4, with mercury averaging 16.6 ± 2.2 ng/L in 2009 versus 49 ± 23 ng/L in 2007. In addition to being significantly lower than levels in 2007, mercury levels at these two sites were also slightly lower than in 2008. A pretreatment system for the sump water started operation on October 22, 2009, which removes 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 38.0 ± 12.7 ng/L in 2009, a level similar to results reported in recent years.

Bioaccumulation in Fish. In WOC, mercury and PCB concentrations in fish are at or near human health risk thresholds (e.g., EPA ambient water quality criteria [AWQC], TDEC fish advisory limits). Mercury concentrations in fish collected in the WOC system (WCK 2.9, WCK 1.5) remained within historical ranges in 2009 (Fig. 5.34). Mercury concentrations in redbreast sunfish at WCK 3.9 (a site sampled for the first time in 2007) averaged 0.38 µg/g in 2009, significantly lower than in previous years. Mean PCB concentrations in redbreast sunfish at WCK 3.9 were also significantly lower in 2009 (0.30 µg/g) than in 2008 (0.66 µg/g). This apparent decrease may be because the fish collected in 2009 were significantly (approximately 20% by weight) smaller than in 2008. In contrast, mean PCB concentrations in fish from WCK 2.9 increased from 0.26 in 2008 to 0.43 µg/g in 2009 despite no difference in the average size of the fish collected between the two years (Fig. 5.35).

Benthic Macroinvertebrate Communities. Monitoring of benthic macroinvertebrate communities in WOC, First Creek, and Fifth Creek continued in 2009. Additionally, monitoring of the macroinvertebrate community in lower Melton Branch continued under the Water Resources Restoration Program. Benthic macroinvertebrate samples are collected at sites upstream and downstream of the influence of ORNL operations; reference sites for WOC, First Creek, and Fifth Creek are used as references for the Melton Branch site (Melton Branch kilometer [MEK] 0.6). 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. 5.36, 5.37, and 5.38). Relative to reference sites, the metrics total taxonomic richness (i.e., the number of different species per sample) and richness of the pollution-intolerant taxa (i.e., mayflies, stoneflies, and caddisflies or *Ephemeroptera*, *Plectoptera*, and *Trichoptera* [EPT] richness) continue to be lower at sites adjacent to and downstream of the main ORNL campus. Reductions in metric values observed at FFK 0.2 in 2008 persisted in 2009, providing stronger evidence that an additional stress (or stresses) occurred after April 2007. In 2008, FCK 0.1 had exhibited reductions in metric values comparable to those at FFK 0.2, but increases in metric values in 2009 indicate that the change in 2008 was either a response to a limited but significant disturbance associated with facility operations or just natural annual variation. Changes in the macroinvertebrate communities in WOC (WCK 3.9 and WCK 2.3, Fig. 5.38) and lower Melton Branch (MEK 0.6, Fig. 5.39) suggest that conditions remain stable in these streams. The benthic macroinvertebrate community in lower Melton Branch (MEK 0.6) continues to show no evidence of discernible degradation based on total and EPT richness. However, abundances of invertebrates at that site are somewhat elevated compared with reference sites, which is a common characteristic of streams with elevated concentrations of nutrients (i.e., nitrogen and phosphorus), either from direct (e.g., from effluent discharges or stormwater runoff from fertilized land) or indirect (e.g., inputs from nutrients naturally present in freshly disturbed soils) sources.

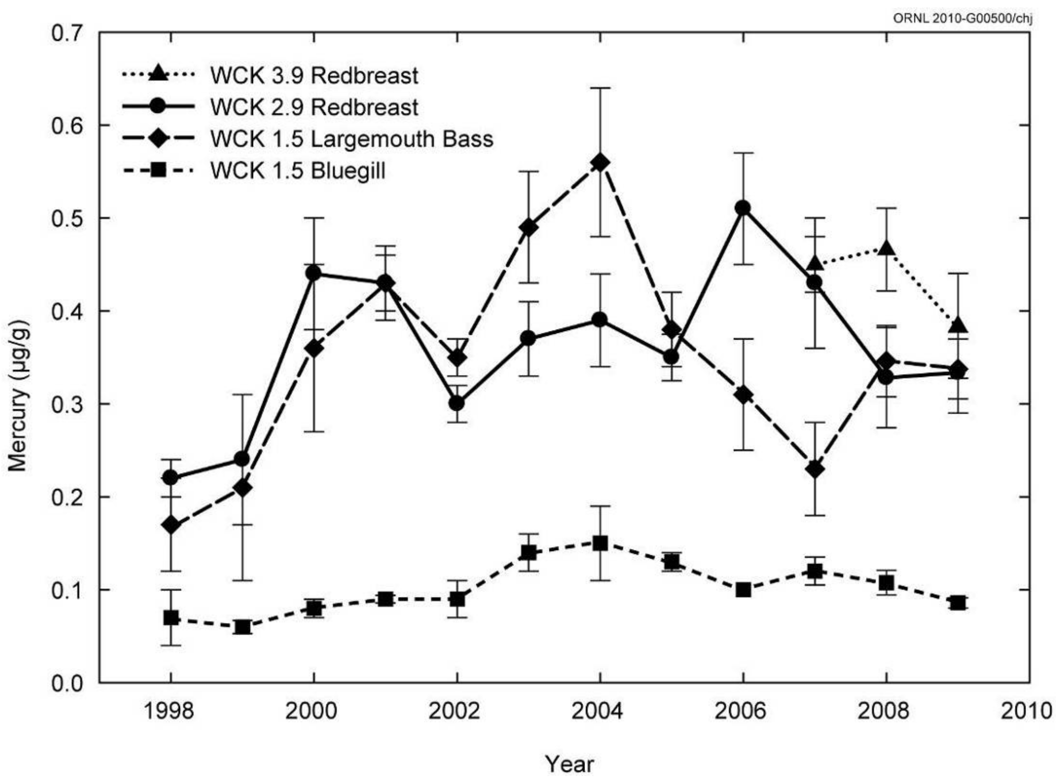

Fig. 5.34. Mean concentrations of mercury (µg/g, ± standard error, N = 6) in muscle tissue of sunfish and bass from White Oak Creek (WCK 3.9, WCK 2.9) and White Oak Lake (WCK 1.5), 1998–2009. WCK = White Oak Creek kilometer

5.5.8.2 Fish Communities

Monitoring fish communities in WOC and major tributaries continued in 2009. 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 2009 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 species into the watershed was initiated in 2008 and increased richness was observed in most of WOC during 2009, except a section where episodic fish kills occurred in 2008 as a result of several acute toxic releases over a few months. The mortality in 2008 impacted richness values in 2009, as the site is isolated from downstream areas of colonization, and richness often takes several years to rebound. The initial success of the introductions in much of WOC suggests that overall water quality has improved in the watershed over the past two decades.

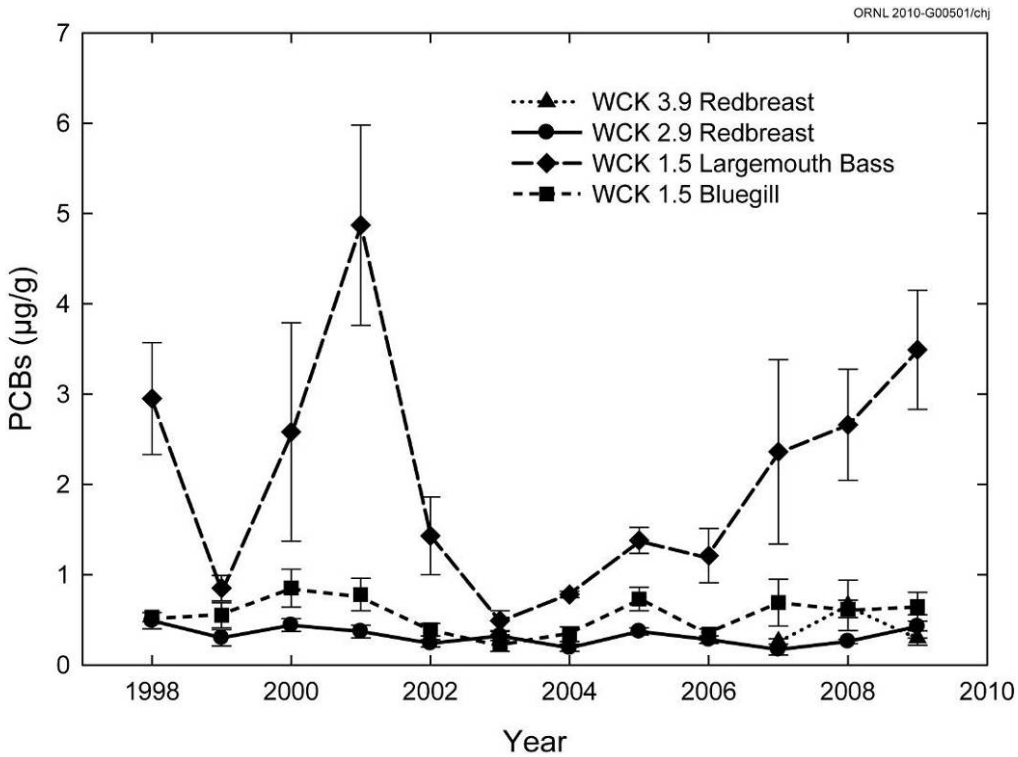

Fig. 5.35. Mean polychlorinated biphenyl (PCB) concentrations (µg/g, ± standard error N=6) in fish fillet collected from the White Oak Creek watershed, 1998–2009. WCK = White Oak Creek kilometer.

Generally, the fish communities in tributary sites adjacent to and downstream of ORNL outfalls remained impacted in 2009 relative to reference streams or upstream sites, especially in Fifth Creek where the fish community decreased from multiple species down to limited richness at very low abundances (Fig. 5.40).

5.5.9 PCBs in the WOC Watershed

Bioaccumulation monitoring has shown that PCBs are not discharged from ORNL outfalls into the WOC watershed at levels detected by standard analytical methods, but 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, focus has historically been on PCB levels in fish related to consumption advisories. These studies were not designed to identify specific stream reaches contributing to PCB bioaccumulation.

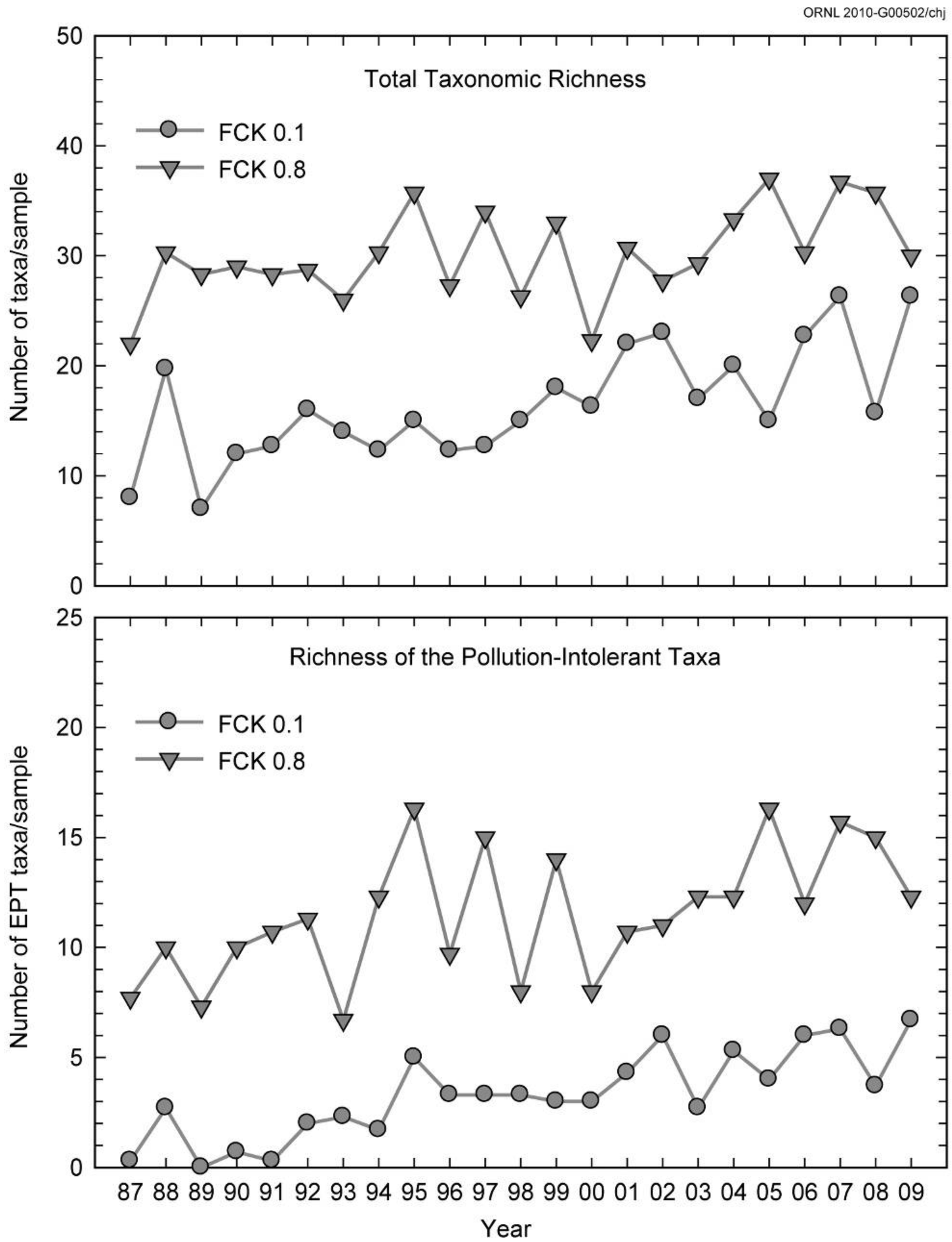

Fig. 5.36. Taxonomic richness (top) and richness of the pollution-intolerant taxa (bottom) of the benthic macroinvertebrate community in First Creek, April sampling periods, 1987−2009. FCK = First Creek kilometer; EPT = *Ephemeroptera, Plecoptera*, and *Trichoptera*; FCK 0.8 = reference site.

In 2009, the focus of PCB monitoring at ORNL under the BMAP was on the identification of the stream reaches in the White Oak Creek watershed where PCB sources are likely to contribute to bioaccumulation in fish. Key integration points within the watershed were identified and monitoring results from impacted sites were compared to reference sites in each of the streams on the main ORNL campus and Melton Valley to assess bioaccumulation potential.

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 semi-permeable membrane devices (SPMDs) to assess the chronic, low-level discharges of PCBs at critical sites on the reservation. SPMDs are essentially oil-filled plastic sleeves in which PCBs are soluble.

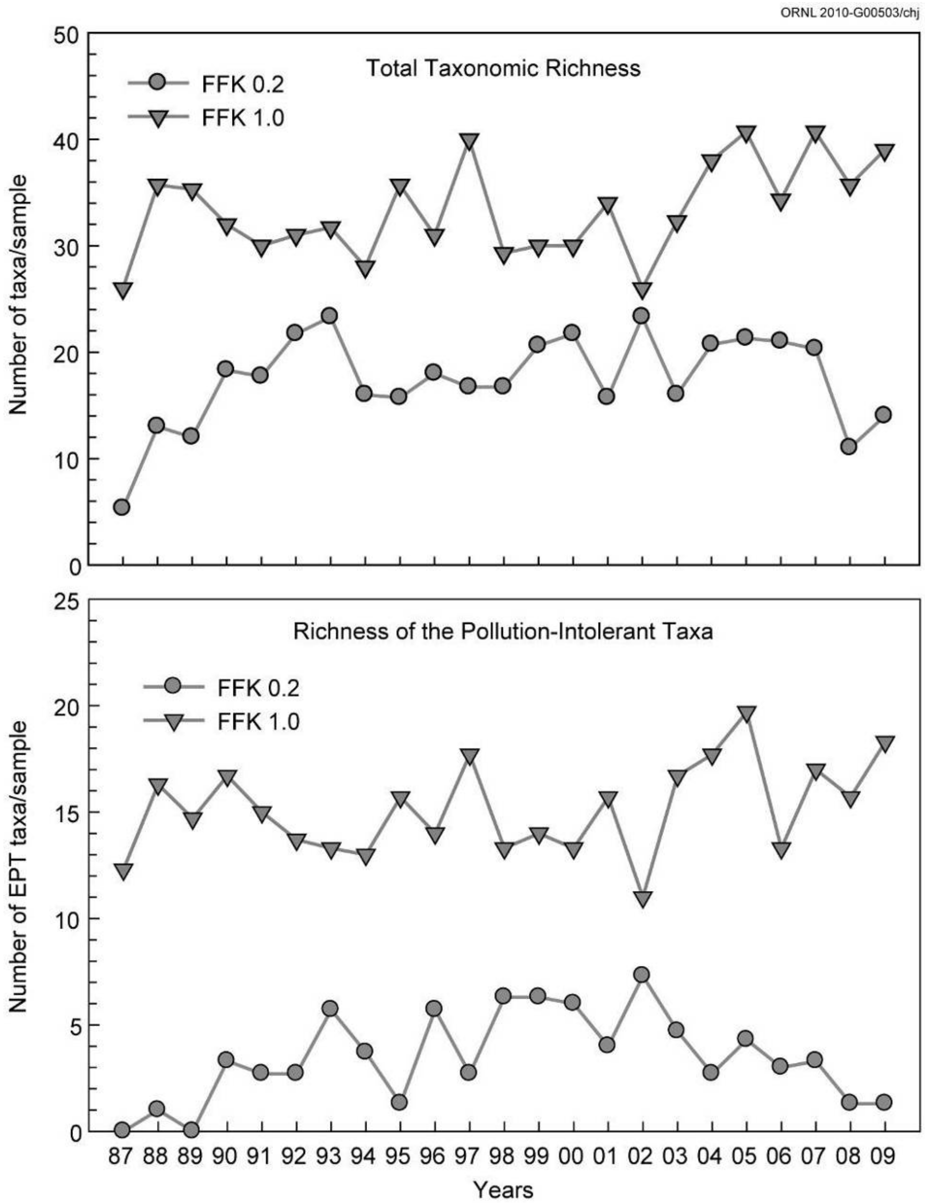

Fig. 5.37. Taxonomic richness (top) and richness of the pollution-intolerant taxa (bottom) of the benthic macroinvertebrate community in Fifth Creek, April sampling periods, 1987−2009. FFK = Fifth Creek kilometer; EPT = *Ephemeroptera, Plecoptera,* and *Trichoptera*; FFK 1.0 = reference site.

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 (Fig. 5.41).

The SPMD results in this study provide information on the relative contributions of various stream reaches within the ORNL campus. Results clearly show the influence of ORNL activities, as SPMDs deployed at reference sites upstream and downstream of the plant had background levels of PCBs, while all sites within the plant had elevated levels. By far, the highest levels were seen at First Creek, indicating that this creek may be critical in introducing PCBs to White Oak Creek, exacerbating bioaccumulation in fish in this watershed (Table 5.22). Future source identification studies will therefore be refined to focus on First Creek inputs.

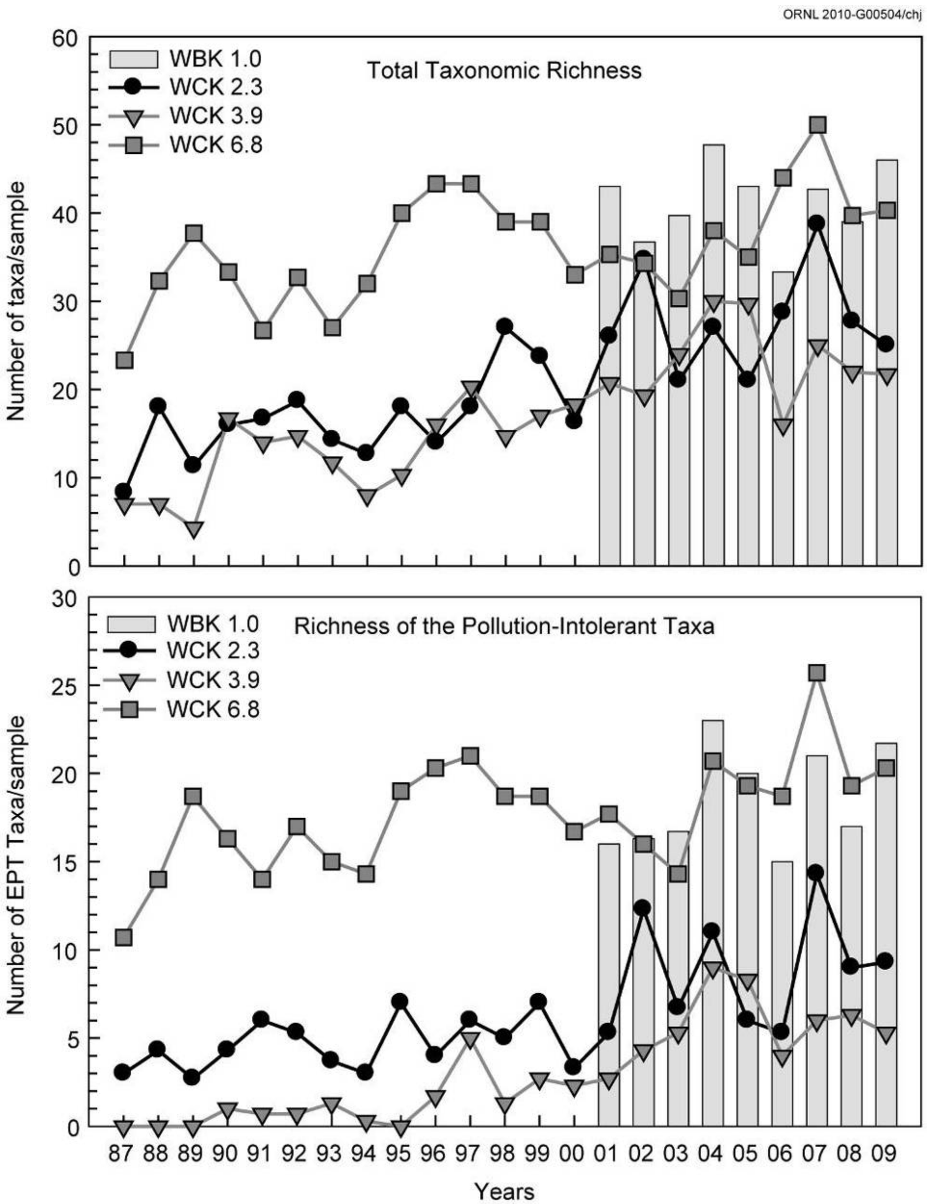

Fig. 5.38. Taxonomic richness (top) and richness of the pollution-intolerant taxa (bottom) of the benthic macroinvertebrate communities in White Oak Creek, April sampling periods, 1987−2009. WCK = White Oak Creek kilometer; WBK = Walker Branch kilometer; EPT = *Ephemeroptera, Plecoptera*, and *Trichoptera*; WBK 1.0 = reference site.

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) plan 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 2009.

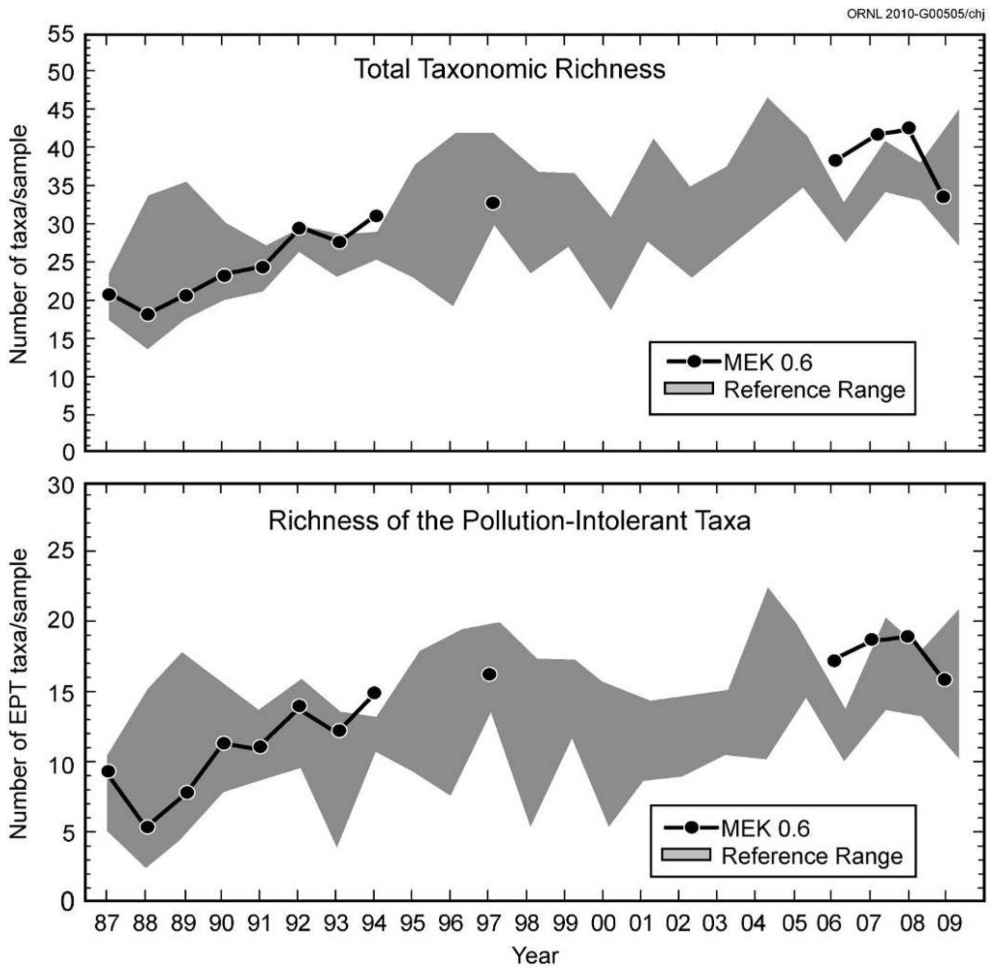

Fig. 5.39. Taxonomic richness (top) and richness of the pollution-intolerant taxa (bottom) of the benthic macroinvertebrate community in lower Melton Branch, April sampling periods, 1987−2009. MEK = Melton Branch kilometer; EPT = *Ephemeroptera*, *Plecoptera*, and *Trichoptera*. Reference range is between minimum and maximum values for ORNL Biological Monitoring and Abatement Plan reference sites on First Creek, Fifth Creek, Melton Branch (1987–1997), Walker Branch (2001–2008), and White Oak Creek (1987–2000).

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. 5.42).

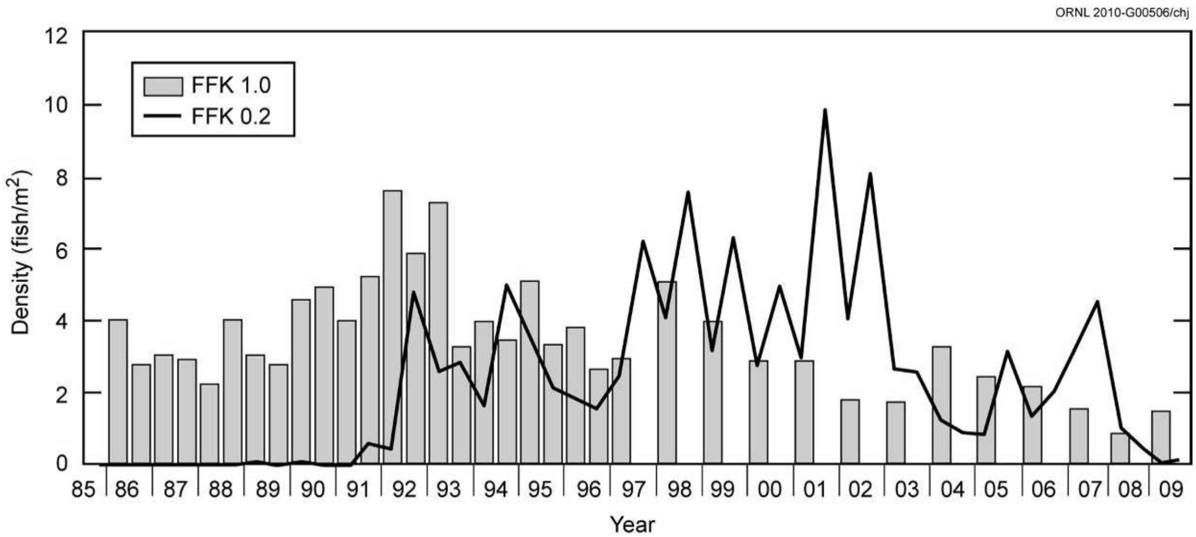

Fig. 5.40. Density estimates of fish communities in Fifth Creek, 1985–2009.

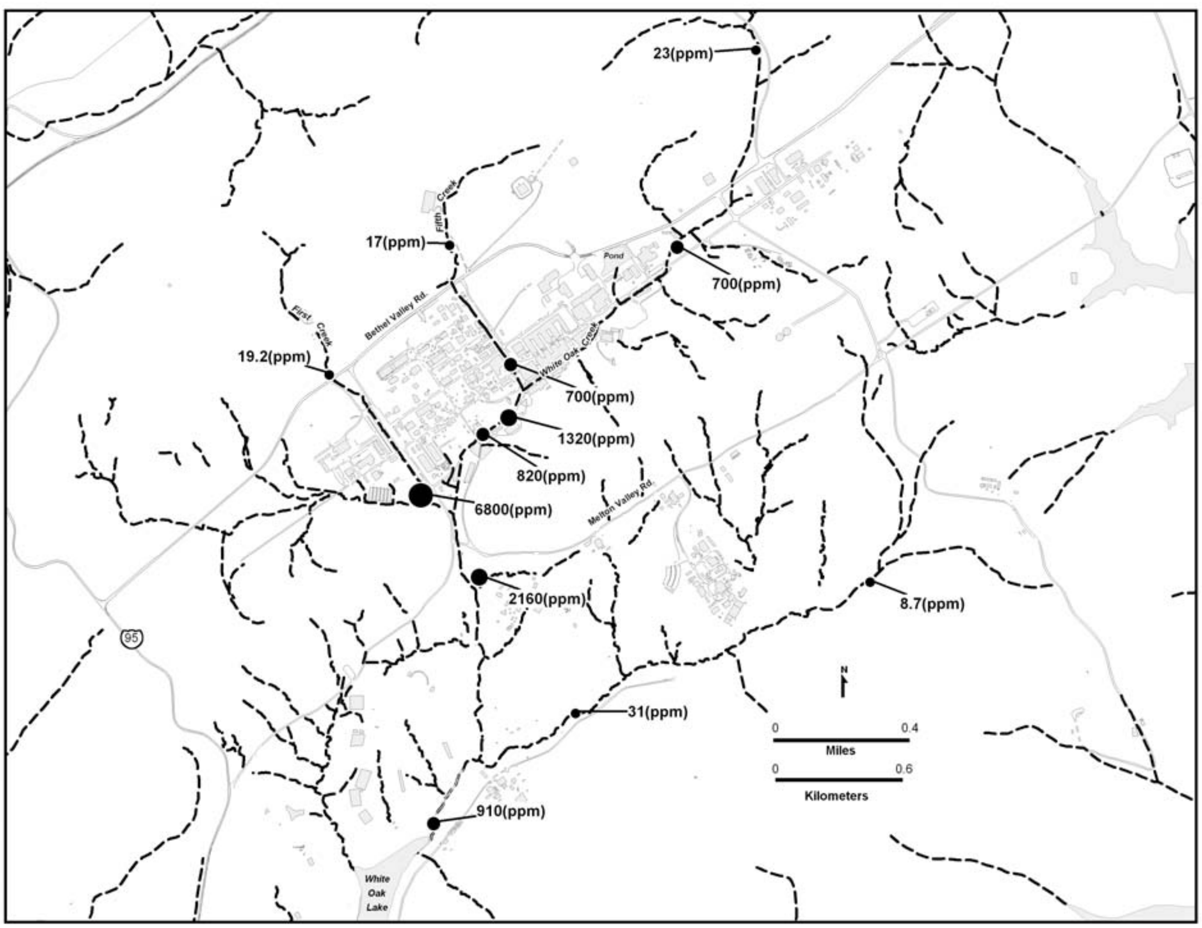

Fig. 5.41. Total polychlorinated biphenyl concentrations (parts by million) by semi-permeable membrane devices, sample collection date: July 14, 2009.

Table 5.22. PCB concentrations in semi-permeable membrane devices at monitoring locations in the White Oak Creek watershed

Samples recovered on July 14, 2009, after 4 weeks

ORNL stream	Location name	Location type	Total PCBs (ppm)
White Oak Creek	WCK 5.2	Integration point	700
White Oak Creek	WCK 3.9	Integration point	820
White Oak Creek	WCK 3.4	Integration point	2160
White Oak Creek	WCK 2.3	Integration point	910
White Oak Creek	WCK 4.1	Integration point	1320
First Creek	FCK 0.1	Integration point	6800
Fifth Creek	FFK 0.2	Integration point	700
Melton Branch	MEK 0.6	Integration point	31
White Oak Creek	WCK 6.8	Reference site	23
Fifth Creek	FFK 1.0	Reference site	17
First Creek	FCK 0.9	Reference site	19.2
Melton Branch	MEK 2.1	Reference site	8.7

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.

Radionuclides were detected above MDAs at all of the 12 surface water locations in 2009. The locations with the highest radionuclide levels are in the ORNL main plant area or at locations downstream of the main plant. These locations are near or downstream of CERCLA sites. Over the past few years, several remedial actions have been completed within the main plant area, which have resulted in observed decreases in radionuclide concentrations in surface water samples as compared to concentrations observed in mid-1990s; future remedial actions in those areas are planned and, until completion, little change in surface water contaminant conditions is expected. The results from 2009 sampling at those locations are consistent with historical data and with the processes or legacy activities nearby or upstream from these locations. The VOC chloroform continues to be detected at WOC at WOD. Sampling locations west, southwest of ORNL [Raccoon Creek (RCK 2.0), Grassy Creek (GCK 3.6), and Ish Creek (ICK 0.7)] are impacted by contaminated groundwater from Solid Waste Storage Area 3. Future remedial actions should decrease these levels of radionuclides.

5.5.12 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. 5.43). 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. 5.44). These samples are filtered, and the residue (settleable solids) is analyzed for gross alpha, gross beta, and gamma emitters.

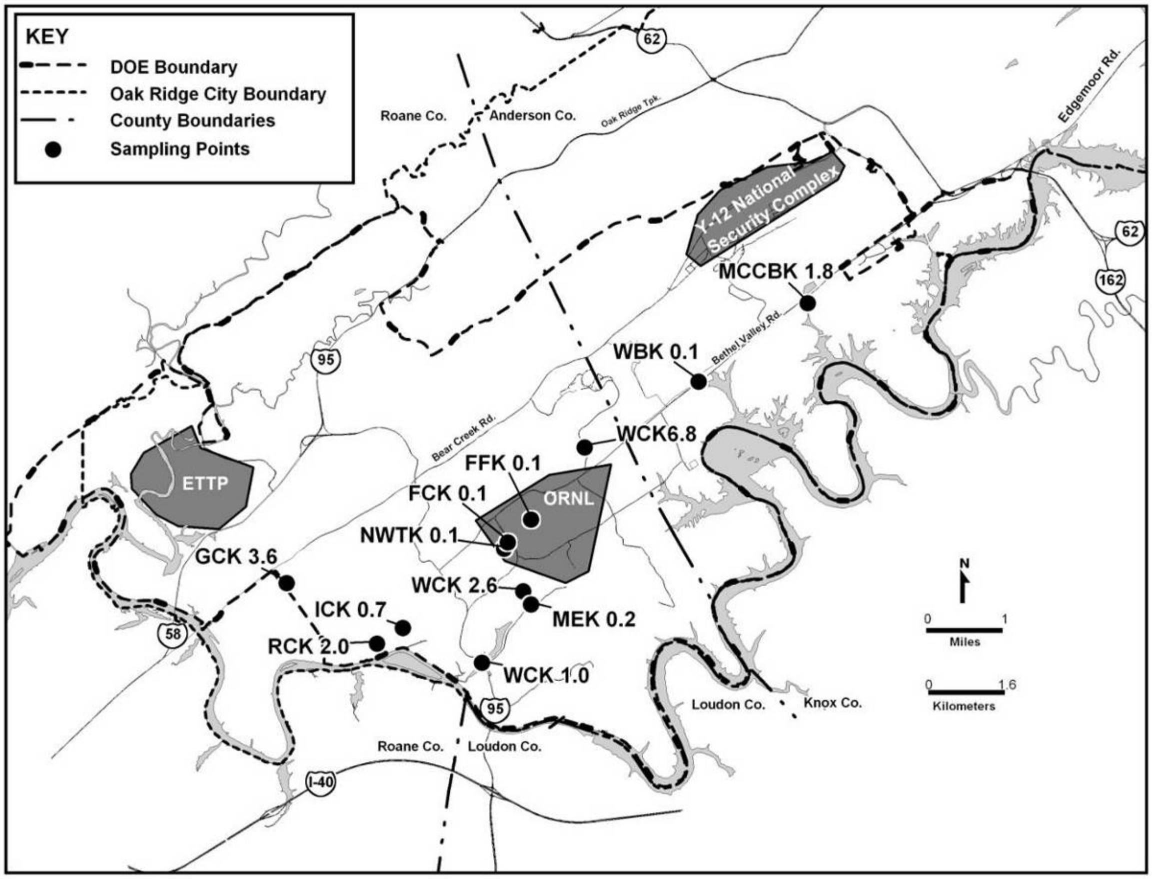

Fig. 5.42. ORNL surface water sampling locations.

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 5.44 shows 6 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.

5.6 Groundwater Protection Program

As in years past, groundwater monitoring at ORNL was conducted under two sampling programs in 2009: DOE Environmental Management (EM) monitoring and DOE Office of Science (OS) surveillance monitoring. The EM groundwater monitoring program was performed by BJC. The OS groundwater monitoring surveillance program was conducted by UT-Battelle.

Results from the 2009 surveillance monitoring effort at exit pathway monitoring points indicate a continued decrease in trend in concentrations of radionuclides such as ^{3}H, total radioactive strontium, and gross beta activity at WOC Area Discharge wells. Where comparisons could be performed, upper tolerance limits estimated for metals such as iron, manganese, and aluminum are within range or below those upper tolerance limits estimated for groundwater in similar bedrock environments at ORNL. Where

Table 5.23. ORNL surface water sampling locations, frequencies, and parameters, 2009

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

[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.

these metals are present, it is likely that they are sorbed onto suspended solids in the groundwater samples collected given that groundwater samples are not filtered prior to analysis. Overall, 2009 contaminant concentrations in groundwater observed in other watershed or sub-watershed discharge areas were consistent with observations described in past ASERs. Similar conclusions can be drawn for 2009 SNS results. Based on the results of the 2009 monitoring effort, there is no indication that current OS operations are significantly impacting groundwater at ORNL.

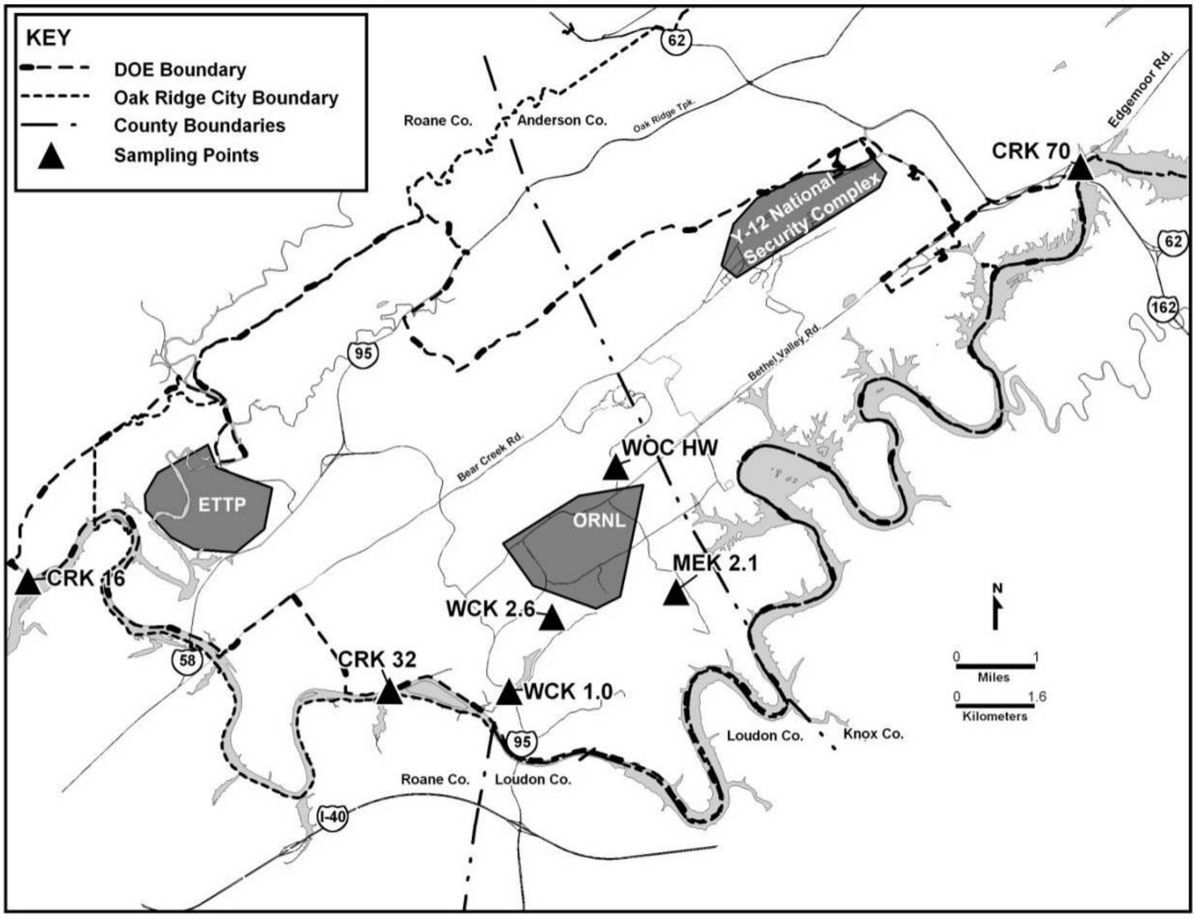

Fig. 5.43. ORNL sediment sampling locations.

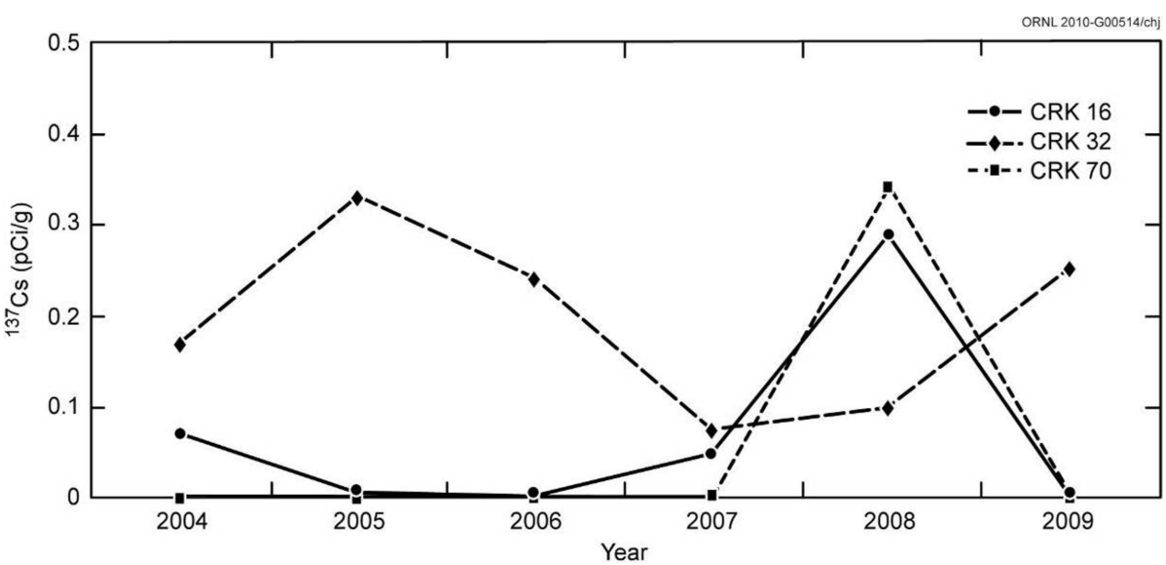

Fig. 5.44. ORNL sediment sampling results for ^{137}Cs, 2004–2009.

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 2009, including the monitoring at ORNL, are evaluated and reported in the *2010 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE 2010a) 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 the 2010 Remediation Effectiveness 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.

Exit pathway groundwater monitoring conducted by the EM program includes sampling at six multiport monitoring wells in western Melton Valley (wells 4537, 4538, 4539, 4540, 4541, 4542) and 1 multiport well (4579) in western Bethel Valley.

5.6.1.1 Summary of EM Groundwater Monitoring

5.6.1.1.1 Bethel Valley

The only element of the Bethel Valley Record of Decision (DOE 2002) remedy that requires groundwater monitoring that was complete prior to FY 2009 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 water lines 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.

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

Monitoring of well 4579 in the western exit pathway of Bethel Valley detected ^{90}Sr in bedrock at levels greater than the MCL effective dose equivalent (8 Ci/L). The multizone monitoring well was installed to monitor a known seepage pathway between Solid Waste Storage Area 3 and the headwater of Raccoon Creek. Monitoring of surface water in Raccoon Creek has been conducted for many years and ^{90}Sr activity in the stream have fluctuated. In FY 2009 the average ^{90}Sr activity in the Raccoon Creek surface water was less than MCL effective dose equivalent.

5.6.1.1.2 Melton Valley

The Record of Decision for Interim Actions in Melton Valley (DOE 2000) established goals for 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 2009 was the first 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 level within capped areas continue to respond to groundwater fluctuations imposed from areas outside the caps however the contact of groundwater with buried waste is minimal. Overall the hydrologic isolation systems are performing as designed.

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, U, 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. Because of the detection of site related contaminants near the DOE site boundary additional groundwater monitoring wells are being installed offsite, on the western side of the Clinch River to enable sampling and analysis of groundwater to determine if site related contaminants have migrated beneath the river.

5.6.2 Office of Science Groundwater Monitoring

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

Exit pathway and active sites groundwater surveillance monitoring points sampled during 2009 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 OS, federal drinking water standards and Tennessee water quality criteria for domestic water supplies (TDEC 2009) are used as reference standards in the following discussions. Four percent of the DOE DCGs are used if no federal or state standards have been established for a radionuclide. Although drinking water standards and DOE DCGs are used for comparative purposes, it is important to note that no members of the public consume groundwater from ORNL wells, nor do any groundwater wells furnish drinking water to personnel at ORNL.

5.6.2.1 Exit Pathway Monitoring

During 2009, 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 2009). 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 intervals (for wells), and locations relative to discharge areas proximate to the ORNL main campus. The groundwater exit pathways at ORNL include four discharge zones identified by the groundwater data quality objectives process carried out in 2004. One of the original exit pathway zones was split into two zones for geographic expediency. The Southern Discharge Area Exit Pathway was carved from the East End Discharge Area Exit Pathway. Figure 5.45 shows the locations of the exit pathway monitoring points sampled in 2009.

The five zones include the following:

- 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.

Unfiltered samples collected from the UT-Battelle exit pathway groundwater surveillance monitoring points in 2009 were analyzed for VOCs, semi-volatile organic compounds, metals (including mercury), and radionuclides (including gross alpha/gross beta activity, gamma emitters, total radioactive strontium, and tritium). Under the monitoring strategy outlined in the Exit Pathway Sampling and Analysis Plan (Bonine 2009), samples were collected semiannually during the wet and dry seasons in 2009.

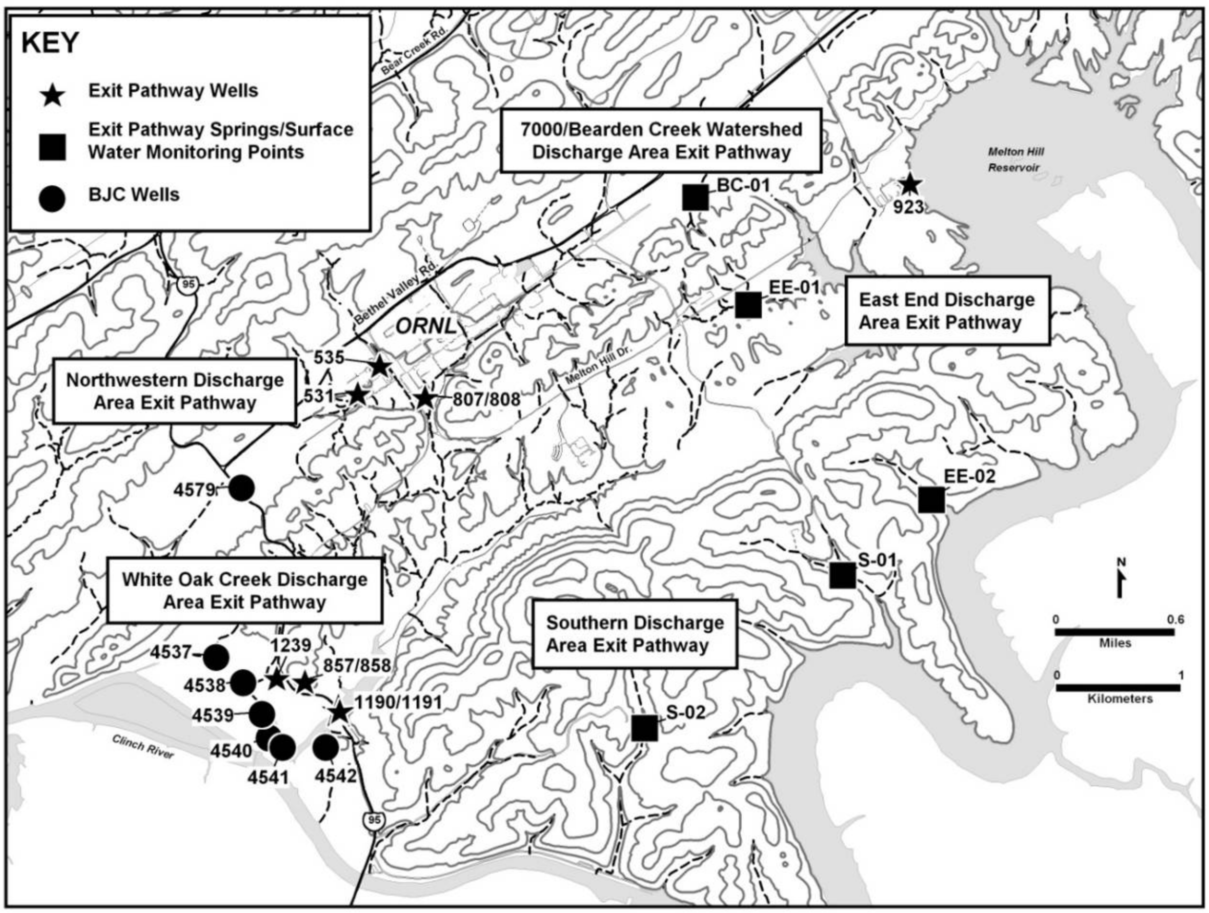

Fig. 5.45. UT-Battelle exit pathway groundwater monitoring locations at ORNL, 2009.

5.6.2.1.1 Exit Pathway Monitoring Results

Statistical trend analyses were performed on exit pathway monitoring data sets containing data exceeding reference standards in 2009. 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 (i.e., semi-volatile 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. Only those parameters that exhibited statistically significant (80% to 99% confidence levels) upward or downward trends are reported. Where data densities for monitoring points were sufficient, 95% upper tolerance limits (UTLs) were estimated for specific metal data sets that have historically exceeded reference standards. These UTLs were compared against UTLs estimated for those metals in the different groundwater regimes identified for ORNL. Where data densities were insufficient to estimate UTLs, no comparison was made. Samples were not collected at BC-01 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. Groundwater sampling results that exceeded reference standards as well as those that were detected in 2009 may be found in the 2009 Environmental Monitoring Results (DOE 2010b).

WOC Discharge Area Exit Pathway Results

Monitoring wells 857, 858, 1190, 1191, and 1239 were sampled during April as well as in August and September 2009. Radiological constituents continued to be detected in two wells at concentrations greater than the reference standards: ^{3}H in well 1190 and gross beta activity, total radioactive strontium, and ^{3}H in well 1191. No other radionuclides exceeded reference standards in the WOC Discharge Area wells. A statistically significant downward trend exists for all three radiological constituents at both sampling locations. Aside from the radionuclides that were detected above reference standard concentrations, the following radionuclides were detected at low levels in WOC Discharge Area wells: gross beta activity, ^{214}Bi, and ^{3}H in well 857; gross beta activity and ^{40}K in well 858; ^{214}Bi and ^{214}Pb in well 1190; and gross alpha activity, ^{214}Bi, and ^{214}Pb in well 1191.

As in past years, iron, manganese, and aluminum exceeded reference standards in WOC Discharge Area wells during 2009. Aluminum was found to exceed its reference standard in well 857 in addition to iron and manganese in wells 1190 and 1191. Statistical trend analyses of metals data for these wells show a statistically significant historical increase in aluminum and manganese in wells 857 and 1191, respectively and a statistically significant historical decrease in manganese and iron in wells 1190 and 1191, respectively. Further statistical analyses of historical iron, manganese, and aluminum data from these wells indicate the 95% UTLs are within the range or below those estimated for the transition limestone-shale/shale-dominated groundwater clusters established for ORNL (Wolf et al. 1996). The transition limestone-shale/shale-dominated groundwater clusters were used for comparison because the WOC Discharge Area wells are screened in strata dominated by shale but interbedded with limestones. Table 5.24 provides a comparison for these UTLs.

Table 5.24. Comparison of WOC discharge area groundwater and shale-dominated groundwater upper tolerance limits (UTLs)

Metal	WOC discharge area estimated 95th UTL (mg/L)	Transition limestone-shale groundwater estimated 95th UTL (mg/L)	Shale-dominated groundwater estimated 95th UTL (mg/L)
Iron	9.19	8.0	50
Manganese	0.35	2.6	16
Aluminum	1.11	3.2	2.8

It is likely 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; these results can be found in the 2009 Environmental Monitoring Results (DOE 2010a).

Detection limits for several semi-volatile organic compounds (atrazine, benzo(a)pyrene, hexachlorobenzene, 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, a common plasticizer [bis(2-ethylhexyl) phthalate] was detected at low, estimated concentrations in wells 858, 1190, and 1191 and was detected in well 1239. Bis(2-ethylhexyl) phthalate was also found in laboratory blank samples from wells 857, 858, and 1239. Given its presence in laboratory blanks, the source of bis(2-ethylhexyl) phthalate may have been due to laboratory cross-contamination of sample aliquots collected from wells 1190, 1191, and 1239. Departing from past year observations, diethyl phthalate was not detected in samples collected from WOC Discharge Area wells in 2009.

Low concentrations of VOCs were also detected in WOC Area Discharge wells in 2009. Low levels of acetone were detected in wells 1190 and 1191, while a low estimated concentration of carbon disulfide was reported for a sample collected from well 1190. Subsequent to collection of the 2009 groundwater samples, acetone was found to be present in the deionized water used in preparing blank samples. This source of deionized water is no longer used for blank samples or for decontamination of sampling equipment.

7000/Bearden Creek Watershed Discharge Area Exit Pathway Results

Wells 1198 and 1199 were not sampled during 2009 because detailed geotechnical and environmental characterization of the Multiprogram Computational and Data Center site located east of the 7000 area revealed that neither is located in the groundwater discharge zone for the 7000/Bearden Creek Watershed Discharge Area.

Spring/seep BC-01 was sampled during the wet season in March 2009, but could not be sampled during the dry season due to the lack of water flow from the spring/seep.

No radionuclides were detected in BC-01. Iron and aluminum were detected at concentrations greater than reference standards in 2009. These metals are most likely sorbed onto suspended solids in the groundwater samples collected contributing to the exceedance of the reference standards. Other metals were detected at low concentrations in groundwater samples collected from this discharge area in 2009 and results are provided in the 2009 Environmental Monitoring Results (DOE 2010b).

Detection limits for the semi-volatile organic compounds (atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol) exceeded reference standards. No VOCs were detected in BC-01.

East End Discharge Area Exit Pathway Results

Well 923 was sampled in April and August 2009. Wells EE-01 and ED-02 were sampled in March and August 2009. 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, EE-02, and well 923. Additionally, low concentrations of ^{214}Bi and ^{214}Pb were detected in EE-02.

Iron, manganese, and aluminum exceeded reference standards in EE-01 and EE-02, and iron and manganese exceeded reference standards in well 923. A statistically significant historical increase in manganese is observable in the EE-01 data set. It is likely that iron, manganese, and aluminum are sorbed onto suspended solids in the groundwater samples collected contributing to the exceedance of the reference standards. Other metals were detected at low concentrations in groundwater samples collected from East End Discharge Area in 2009; these results can be viewed in the 2009 Environmental Monitoring Results (DOE 2010b).

Detection limits for several undetected semi-volatile organic compounds (atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol) exceeded reference standards. Bis(2-ethylhexyl) phthalate was detected in one sample collected from well 923. Plastic well casing materials used in the construction of the well may explain the presence of the phthalate in the sample. A low estimated concentration of bis(2-ethylhexyl) phthalate was also detected in a sample collected from EE-01 during 2009. No other organic compounds were detected in samples collected from the East End Discharge Area.

Northwestern Discharge Area Exit Pathway Results

Wells 807 and 808 were added to the Northwest Discharge Area Exit Pathway in 2009. These wells are located down gradient of many of the facilities located in the ORNL Main Campus. They are also located near the water gap through Haw Ridge and are used to monitor a localized groundwater exit pathway from the ORNL Main Campus into Melton Valley.

Wells 807 and 808 were sampled in April and August 2009 as was well 531. Well 535 was sampled in early June and September 2009 due to continued access restrictions associated with construction activities related to ORNL campus upgrades.

No radiological parameters exceeded their reference standards at any Northwestern Discharge Area monitoring point in 2009. However, gross beta activity was detected in low concentrations in well 531 and ^{214}Bi, ^{214}Pb, and ^{3}H were detected in well 535. Gross beta activity, total radioactive strontium, ^{3}H, and ^{214}Bi were detected in well 807 while gross beta activity and ^{40}K were detected in low concentrations in well 808.

Iron and aluminum concentrations exceeded reference standards in well 531. However, statistical analyses of historical data for both metals exhibit statistically significant decreasing trends in concentrations. Iron, manganese, and aluminum also exceeded reference standards in well 535, and analyses of historical data for iron and manganese exhibit statistically significant increasing trends at well 535. Additionally, iron and manganese exceeded reference standards in well 807 with historical concentration data for iron exhibiting a statistically significant increasing trend. It is likely that these metals are sorbed onto suspended solids in the samples contributing to the exceedance of the reference standards. Other metals were detected at low concentrations in groundwater samples collected from Northwestern Discharge Area in 2009 and results are provided in the 2009 Environmental Monitoring Results (DOE 2010b). Detection limits for several undetected semi-volatile organic compounds (atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol) exceeded reference standards. Diethyl phthalate was detected at a low, estimated concentration in a sample collected from well 535. Plastic well casing materials used in the construction of the well may explain the presence of the phthalate in the sample. Toluene was also detected at low, estimated concentrations in samples collected from well 535 in 2009.

Southern Discharge Area Exit Pathway Results

Monitoring point S-01 was sampled by UT-Battelle in March 2009, but no samples were collected during the dry season sampling event (August 2009) because the monitoring point was dry. Monitoring point S-02 was sampled in March and August 2009.

No radiological parameters exceeded reference standards at either monitoring point; however, low concentrations of ^{214}Bi and ^{214}Pb were detected in the sample collected from S-01, and gross alpha and beta were detected in samples collected from S-02.

Concentrations reported for iron, aluminum, manganese, and lead concentrations exceeded reference standards at S-02 during 2009. It is likely that these metals are sorbed onto suspended solids in the groundwater samples collected contributing to the exceedance of the reference standards. Other metals were detected at low concentrations in groundwater samples collected from Southern Discharge Area in 2009; these results can be viewed in the 2009 Environmental Monitoring Results (DOE 2010b).

Detection limits for several undetected semi-volatile organic compounds (atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol) exceeded reference standards. Acetone was detected in a blank sample associated with samples collected from S-02. Subsequent to collection of the 2009 groundwater samples, acetone was found to be present in the deionized water used in preparing blank samples. This source of deionized water is no longer used for blank samples or for decontamination of sampling equipment.

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 ^{3}H 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 ^{3}H to the subsurface. From 2000–2007, monitoring of HFIR-site wells and subsurface drains was conducted to determine the size and scope of the ^{3}H 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 ^{3}H 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 ^{3}H from the process waste drain and observations of steep downward trends in ^{3}H concentration reductions in samples collected from monitoring sites down gradient of the release site. The expectation is that ^{3}H concentrations should continue to decrease with the possibility of additional precipitation-driven concentration spikes or drought-induced ^{3}H concentration stagnation. Although RRD has ceased monitoring the ^{3}H plume, ^{3}H monitoring at HFIR has continued under the auspices of the *ORNL Radiological Monitoring Plan*. Please refer to Sect. 5.5 of that document for requirements of 2009 ^{3}H 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 2009 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 2009 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 (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 2009.

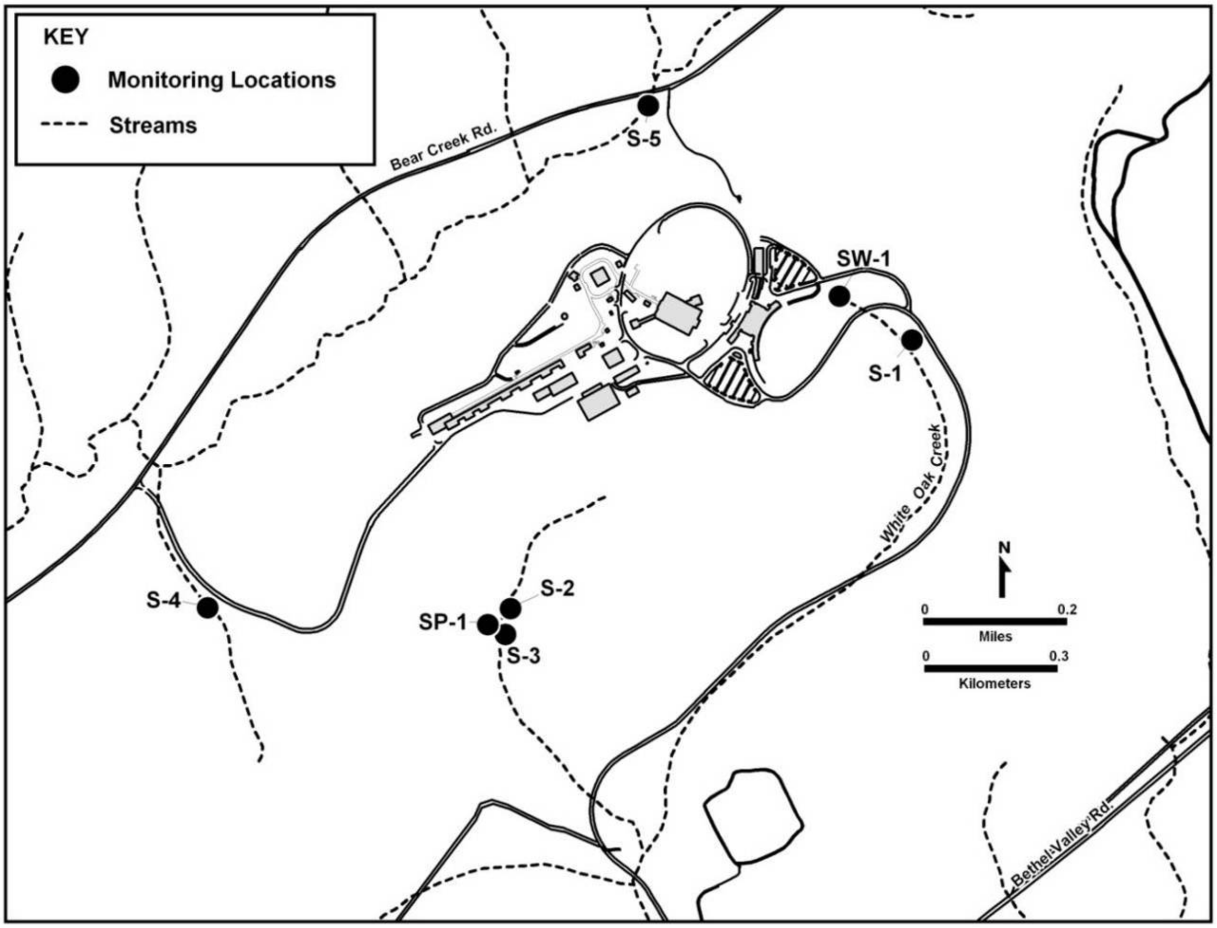

Fig. 5.46. Groundwater monitoring locations at the Spallation Neutron Source, 2009.

Because of the presence of karst geomorphic features at the SNS site, sampling of the seeps/springs was performed quarterly to characterize water quality throughout the expected range of flow observed at the selected monitoring locations. Three grab samples were collected from each seep/spring: one sample to represent base flow and two samples to represent higher stage/flow rates (i.e., one representing the rising limb of the storm hydrograph and one representing the recession [falling] limb of the storm hydrograph). Given their fate and transport characteristics, ^{3}H and ^{14}C are the principal groundwater constituents of concern at the SNS site. In 2009, samples were collected on a quarterly basis for ^{3}H and ^{14}C analyses. Additionally, samples were collected during wet season base flow conditions for gross activity (alpha and beta) and for selected gamma spectroscopic parameters.

SNS Site Results

Sampling at the SNS site occurred during March, June, September, and November 2009, and the sampling results were compared to reference standards. Gross alpha activity was detected above the applicable reference standard in the base flow sample collected from S-5 in March 2009. No other SNS sample results exceeded reference standard values in 2009. Low concentrations of gross alpha activity were detected in samples collected from S-1 and SW-1 during base flow conditions in March. In addition, low concentrations of gross beta activity were detected in samples collected from S-2 and S-5 during base flow conditions in March 2009. Carbon-14 was detected in a sample collected during base flow condition at monitoring point S-4 in March 2009. Low concentrations of ^{3}H were detected numerous times during 2009. The following is a summary of the locations, flow conditions, and dates for the ^{3}H detections.

1. S-1 – (a) during falling limb flow conditions in March; (b) during base flow, rising limb, and falling limb flow conditions in September; and c) during rising limb flow conditions in November
2. S-2 – (a) during base flow, rising limb, and falling limb flow conditions in September and (b) during rising limb flow conditions in November
3. S-4 – during rising limb flow conditions in November
4. S-5 – (a) during base flow and rising limb flow conditions in September and (b) during rising limb flow conditions in November
5. SW-1 – during rising limb flow conditions in September and November

SNS groundwater monitoring results are found in the 2009 Environmental Monitoring Results (DOE 2010b).

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

In 2009, UT-Battelle personnel had 10 domestic soil agreements for receipt of or movement of quarantined soils, two soil permits for receipt of or movement of nondomestic soils (from outside the continental United States), and six 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.

5.8 Quality Assurance Program

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

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

5.8.1 Work/Project Planning and Control

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

- define scope of work;
- 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.

5.8.2 Personnel Training and Qualifications

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

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.

5.8.3 Equipment and Instrumentation

5.8.3.1 Calibration

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

5.8.3.2 Standardization

EP&WSD sampling procedures, maintained in 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.

5.8.3.3 Visual Inspection, Housekeeping, and Grounds Maintenance

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

5.8.4 Assessment

Independent audits, surveillance, and internal management assessments are performed to verify that requirements have been accurately specified and 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

2009 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.

5.8.5 Analytical Quality Assurance

The contract laboratories that perform analyses of environmental samples from the ORR environmental monitoring programs are required to have documented QA/QC programs, trained and qualified staff, appropriately maintained equipment and facilities, and applicable certifications. 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.

5.8.6 Data Management and Reporting

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

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

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

5.8.7 Records Management

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

5.9 Environmental Management Activities at ORNL

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

ORNL has become one of the world's most modern campuses for scientific discovery in materials and chemical sciences, nuclear science, energy research, and supercomputing. However, among all this modern infrastructure are large contaminated areas that resulted from years of former operations and waste storage. The EM Program has divided ORNL into two major cleanup areas: Bethel Valley and Melton Valley. The Bethel Valley area includes the principal research facilities, and the Melton Valley area was used for reactors and waste management. The following sections summarize some of the 2009 EM activities undertaken at ORNL. More detailed information is available in the *FY 2009 Cleanup Progress Annual Report to the Oak Ridge Community* (DOE 2009).

5.9.1 Tank W1-A Remediation Planned

An area of groundwater contamination resulting from Tank W-1A, called the Core Hole 8 plume, has been the focus of DOE coordinated actions to minimize the release of contaminants since late 1994.

Remediating Tank W-1A has been on hold pending funding, but in FY 2009 it was identified as a project that would receive ARRA funds.

The Core Hole 8 plume, located in the central portion of the ORNL main plant area, emanates from contaminated soil surrounding Tank W-1A in the North Tank Farm and migrates westward to a nearby creek. The principal plume contaminants are strontium-90 and uranium isotopes.

Planning activities in 2009 focused on characterizing the extent and types of contamination as well as excavation, packaging, and waste transportation considerations. The project is scheduled to be completed in 2011.

5.9.2 Decommissioning of Non-Reactor Facilities

In FY 2009, DOE prepared a remedial design report/remedial action work plan (RDR/RAWP) (DOE 2006a) for decontamination and decommissioning (D&D) of non-reactor facilities and legacy material removal in the Bethel Valley Watershed at ORNL. The RDR/RAWP addresses D&D of approximately 180 facilities including:

- near-term projects funded by ARRA that are planned for completion in 2011, and
- other (non-ARRA-funded) facility D&D and legacy material removal scope planned for implementation during a 20-plus-year period.

5.9.3 Initiation of Demolition Plans for Building 3026 C&D

In 2009, demolition was initiated on 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 20,000 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, and a roof failure in 2007 damaged the fire suppression sprinkler system, requiring deactivation. This 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 for the 3026 C&D wooden structure.

In 2009, a high-priority, accelerated project plan was developed by UT-Battelle and approved by DOE to prepare for demolition of the wooden structure. The waste handling plan and associated sampling and analysis/quality assurance project plans were prepared, reviewed, and approved by EPA and TDEC (DOE 2009a, 2009b; see Appendixes). The facility's structural condition was assessed, and shoring was installed to ensure safe access for workers to most areas of the facility. The facility was surveyed to establish baseline hazardous material conditions so that appropriate worker protection measures could be identified and implemented. Samples and analytical data were developed, and a waste profile was prepared and approved for disposal of the majority of demolition debris at the EMWMF as well as disposal of selected items off-site. Associated cell piping and ductwork were treated with stabilizing agents to minimize the potential for release of contaminants during the demolition process. The facility was disconnected from utility systems (water, steam, air, and ventilation). A subcontract was established with Clauss Construction, LLC, to demolish the wooden structure. The activities required to prepare for final demolition were initiated and included removal of asbestos-containing materials (floor tile, transite, thermal insulation); removal of hazardous materials, such as lead shielding, light bulbs, mercury switches, and oils; and removal of hot cell piping and ductwork. At the end of FY 2009, final preparations were in progress to begin shipping and disposing of asbestos-containing debris at the EMWMF. Demolition of the 3026 C&D wooden structure was completed in early FY 2010. A follow-on project is planned to be initiated later in FY 2010 to demolish the remaining 3026 hot cell structures.

5.9.4 Planning for Demolition of "2000 Complex" Facilities

In 2009, planning began for the demolition of the 2000 Complex at ORNL, located in the northwest corner of the central campus area. The complex consisted of 8 facilities encompassing about 60,000 ft^2 used to support ORNL research projects in the late 1940s. The complex is in severe disrepair and has been vacant for approximately 6 years. A high-priority, accelerated project plan was developed by UT-Battelle in 2009 and approved by DOE. The demolition will be conducted in two phases with the first phase (2000 Complex East) consisting of six buildings (2001, 2019, 2024, 2087, 2088, and 2092) and the second phase (2000 Complex West) consisting of the 2000 and 2034 buildings.

The Waste Handling Plan and associated Sampling and Analysis Plan/Quality Assurance Project Plan are in development, with approval anticipated in early FY 2010. Demolition of the 2000 Complex East buildings is expected to be completed by the spring of 2010. Demolition of the 2000 Complex West facilities is expected to be completed in the late fall of 2010.

5.9.5 Bethel Valley Burial Grounds Remediation

In 2009, DOE prepared a RDR/RAWP that presents the design for hydrologic isolation of buried waste at the Bethel Valley Burial Grounds at ORNL. The RDR/RAWP addresses remediation of two former waste sites that are sources of contaminant release: Solid Waste Storage Area (SWSA) 1 in Central Bethel Valley and SWSA 3 in West Bethel Valley.

The RDR/RAWP also addresses contaminated areas in the vicinity of the two SWSAs. The Bethel Valley Burial Grounds remediation project is planned to be performed with ARRA funding and completed in 2011.

5.9.6 Soil and Sediment Remediation

The ORNL Soils and Sediment Project will complete removal of contaminated soils and sediments to protect workers and groundwater as specified in the Bethel Valley Interim Record of Decision (DOE 2002).

The RAWP for the project provides the approach that will be followed to characterize soils and sediments to ensure that the soil cleanup requirements for Bethel Valley are met. The initial draft of the RAWP was submitted to the regulators in 2008, and a revised draft was submitted in 2009. Officials are working to resolve regulator comments and finalize the RAWP by early FY 2010.

Field sampling activities for this area are planned to be started in FY 2010. Additional workshops on the remaining areas will also be conducted in FY 2010.

5.10 ORNL Waste Management

5.10.1 ORNL Wastewater Treatment

At ORNL, approximately 131 million gal of wastewater were treated and released at the PWTC in 2009. In addition, the liquid low-level waste (LLW) evaporator at ORNL treated 141,000 gal 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.

5.10.2 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 byproduct of performing research and operational activities and must be managed to ensure 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 currently 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 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.

5.10.3 TRU Waste Processing Center

TRU waste-processing activities carried out for DOE in 2009 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 900 m^3 of RH sludge, 550 m^3 of RH-TRU/alpha LLW solids, 1,600 m^3 of RH LLW supernate, and 1,000 m^3 of CH TRU/alpha LLW solids currently stored in Melton Valley. The forecast for waste quantities to be processed at the TWPC has been updated to include the latest estimates: 2,000 m^3 of RH sludge, 700 m^3 of RH-TRU solids, and 1,500 m^3 of CH-TRU solids. CH-TRU processing started in December 2005, and RH-TRU processing started in May 2008. During CY 2009, 380 m^3 of CH waste and 18.8 m^3 of RH waste was processed. In CY 2009, 102.7 m^3 of CH waste and 5.5 m^3 of RH waste was shipped off-site.

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