4. The Y-12 National Security Complex

The Y-12 Complex, a premier manufacturing facility operated by B&W Y-12 for NNSA, plays a vital role in DOE's Nuclear Security Enterprise. While drawing on more than 60 years of manufacturing excellence, the Y-12 Complex helps ensure a safe and reliable US nuclear weapons deterrent.

The complex also retrieves and stores nuclear materials, fuels the nation's naval reactors, and performs complementary work for other government and private-sector entities.

Today's environment requires a Y-12 Complex that has a new level of flexibility and versatility. So while continuing its key role, the Y-12 Complex has evolved to become the resource the nation looks to for support in protecting America's future by developing innovative solutions in manufacturing technologies, prototyping, safeguards and security, technical computing, and environmental stewardship.

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

4.1 Description of Site and Operations

4.1.1 Mission

The Y-12 Complex is a one-of-a-kind manufacturing facility that plays an important role in US national security. The roles of the Y-12 Complex include the following:

- receipt, storage, and protection of SNMs;
- quality evaluation/enhanced surveillance of the nation's nuclear weapon stockpile;
- safe and secure storage of nuclear materials;
- dismantlement of weapon secondaries and disposition of weapon components;
- provision of technical support to the NNSA Defense Nuclear Nonproliferation Program;
- provision of fuel for the nation's naval reactors program;
- transfer of technology to private industry;
- maintenance of DOE capabilities; and
- provision of support to DOE, other federal agencies, and other national priorities.

B&W Y-12 is the NNSA management and operating contractor responsible for operation of the Y-12 Complex. Located within the city limits of Oak Ridge, the Y-12 Complex covers more than 328 ha (810 acres) in the Bear Creek Valley, stretching 4.0 km (2.5 miles) in length down the valley and nearly 2.4 km (1.5 miles) wide across it. About 6,000 people work on the site, including employees of B&W Y-12, NNSA, Wackenhut Services (NNSA's security services contractor), other DOE contractors, and subcontractors.

NNSA-related facilities located off the Y-12 Complex site but in Oak Ridge include the OST AOEC Secure Transportation Center and Training Facility and an analytical laboratory. The laboratory is a leased facility providing a wide range of routine and nonroutine analytical services for environmental and hazardous waste programs of NNSA, DOE, and other customers.

4.1.2 Transformation

"Complex Transformation" is NNSA's vision for a smaller, safer, more secure, and less expensive nuclear weapons complex that leverages the scientific and technical capabilities of its workforce and meets national security requirements.

Government-owned facilities and operations are being challenged to become smaller, more efficient, and more responsive to changing national and global challenges. Nowhere in the National Security Enterprise is transformation more evident than at the Y-12 Complex.

Some of the most striking indicators that the Y-12 Complex is undergoing an extreme makeover are seen in construction projects and a shrinking footprint. In the last 10 years, the Facilities and Infrastructure Recapitalization Program (FIRP) has demolished more than 1.4 million ft^2 of aging facilities at the Y-12 Complex and replaced them, as necessary, with new state-of-the-art facilities.

Almost 250,000 ft^2 of building space was torn down in FY 2011, including 14 facilities; 2 million ft^3 of waste material was disposed of; the security footprint was reduced; and 68% of highly enriched uranium was consolidated into the Highly Enriched Uranium Materials Facility (HEUMF). FIRP is expected to fund the demolition of between 15 and 17 facilities in FY 2012. The facilities include guard towers, warehouses, and maintenance shops.

Two new facilities, Jack Case Center and New Hope Center (Fig. 4.1), have allowed one-third of the Y-12 Complex workforce to vacate more than 50 aging facilities and relocate to offices that offer significant productivity enhancements.

An integral part of the Y-12 Complex transformation efforts and a key component of the NNSA Uranium Center of Excellence, UPF (Fig. 4.2) is one of two facilities at the Y-12 Complex whose joint mission will be to accomplish the storage and processing of all enriched uranium in one much smaller, centralized area. The second, the nation's HEUMF, came online in 2010, providing an ultrasecure warehouse for the nation's highly enriched uranium.

American Recovery and Reinvestment Act (ARRA) funding was used to expedite removal of legacy wastes and building demolition at the Y-12 Complex. These Y-12 Complex recovery act projects met or exceeded existing regulatory milestones, and as a result of efficient and effective management and supplemental ARRA funding, additional projects were added. Results and progress on each of these projects is detailed in Section 4.8, "Environmental Management and Waste Management Activities."

ORNL 2012-G00349/chj

Fig. 4.1. The New Hope Center, upper, is the Y-12 Complex's public interface. Jack Case Center, lower.

ORNL 2012-G00392/chj

Fig. 4.2. Uranium Process Facility conceptual image.

4.2 Environmental Management System

As part of B&W Y-12's commitment to environmentally responsible operations, the Y-12 Complex has implemented an EMS based on the rigorous requirements of the globally recognized ISO 14001-2004 (ISO 2004).

DOE O 436.1, *Departmental Sustainability*, provides requirements and responsibilities for managing sustainability within DOE in accordance with EO 13423, its implementing instructions, and EO 13514. The order further requires implementation of an EMS that is either certified to the requirements of ISO 14001-2004 by an accredited ISO 14001 registrar or self-declared to be in conformance to the standard in accordance with instructions issued by the Federal Environmental Executive.

In 2011 a product improvement team was chartered to determine whether there was a business viability and benefit to certifying the Y-12 Complex EMS to ISO 14001-2004. Because of the costs involved with initial registration and an absence of significant compelling benefits, the team recommended that the Y-12 Complex continue the self-declaration of conformance to ISO 14001-2004 per DOE O 436.1. The EMS requirements taken from DOE O 436.1 have been incorporated in the Environmental Protection Functional Area of the Y-12 Complex Standards/Requirements Identification Document.

4.2.1 Integration with Integrated Safety Management System

ISMS is DOE's umbrella of ES&H programs and systems that provides the necessary structure for any work activity that could potentially affect the public, a worker, or the environment. B&W Y-12's ISMS has incorporated the elements of the ISO 14001 EMS in the overall umbrella of ISMS for environmental compliance, pollution prevention, waste minimization, and resource conservation. The DOE Office of Health, Safety and Security (HSS) annual environmental progress reports on implementation of EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* (EO 2007), and the Office of Management and Budget's Environmental Stewardship Scorecard gave the Y-12 Complex an EMS scorecard rating for FY 2011 of green, indicating full implementation of EO 13423 requirements.

4.2.2 Policy

The environmental policy of B&W Y-12 and its commitment to providing sound environmental stewardship practices through the implementation of an EMS have been defined, are endorsed by top management, and have been made available to the public via company-sponsored forums and public documents such as this one. The B&W Y-12 ES&H policy is presented in Fig. 4.3.

This policy has been communicated to all employees; incorporated into General Employee Training (GET) for every employee, guest, and contractor; and made available for viewing on the internal Y-12 complex website. Y-12 Complex personnel are made aware of the commitments stated in the policies and how the commitments relate to Y-12 Complex work activities.

ORNL 2010-G00475/chj

Y-12 Environment, Safety, and Health Policy

Policy: As we work to achieve the Y-12 mission and our vision of a modernized Y-12 Complex, we will do so by ensuring the safety and health of every worker, the public, and the environment. Every employee, contractor, and visitor is expected to take personal responsibility for their actions.

- Environmental Policy: We protect the environment, prevent pollution, comply with applicable requirements, and continually improve our environment.
- Safety and Health Policy: The safety and health of our workers and the protection of public health and safety are paramount in all that we do. We maintain a safe work place and plan and conduct our work to ensure hazard prevention and control methods are in place and effective.

In support of this policy, we are committed to:

- Integration of Environment, Safety and Health (ES&H) into our business processes for w ork planning, budgeting, authorization, execution, and change control in accordance with our Integrated Safety Management System.
- Continuously improving our processes and systems by establishing, tracking, and achieving goals that drive performance excellence.
- Direct, open, and truthful communication of this policy and our ES&H performance to our employees, contractors, customers, and stakeholders.
- Strive to minimize the impact of our operations on the environment in a safe, compliant, and cost-effective manner using sustainable practices for energy efficiency, fleet management, water consumption, pollution prevention, recycling/reuse, source reduction, resource conservation, and environmentally preferable purchasing.
- Incorporate sustainable design principles into the design and construction of facility upgrades, new facilities, and infrastructure considering life-cycle costs and savings.
- Incorporate the use of engineering controls to reduce or eliminate hazards whenever possible into the design and construction of facility upgrades, new facilities, and infrastructure.
- Strive to provide a clean and efficient workplace free of occupational injuries and illnesses (Target Zero).
- Foster and maintain a work environment of mutual respect and teamwork that encourages free and open expression of ES&H concerns.

Fig. 4.3. B&W Y-12 environment, safety, and health policy.

4.2.3 Planning

4.2.3.1 Environmental Aspects

Environmental aspects may be thought of as potential environmental hazards associated with a facility operation, maintenance job, or work activity. Aspects and impacts are evaluated to ensure that the significant aspects and potential impacts continue to reflect stakeholder concerns and changes in regulatory requirements. The FY 2011 analysis of aspects identified the following as potentially having significant environmental impact:

- waste generation,
- air emissions,
- liquid discharges,
- storage/use of chemicals and radioactive materials,
- legacy contamination,
- excess/surplus materials,
- historical and cultural resources,
- natural resource consumption (energy and water), and
- natural resource conservation (positive impacts).

The EMS provides the system to ensure that environmental aspects are systematically identified, monitored, and controlled to mitigate or eliminate potential impacts to the environment.

4.2.3.2 Legal and Other Requirements

To implement the compliance commitments of the ES&H policy and to meet legal requirements, systems are in place to review changes in federal, state, or local environmental regulations and to communicate those changes to affected staff. The environmental compliance status is documented each year in this report (see Section 4.3).

4.2.3.3 Objectives, Targets, and Environmental Action Plans

B&W Y-12 continues to respond to change and pursue sustainability initiatives by establishing and maintaining environmental objectives, targets (goals), and action plans. Goals and commitments are established annually; are agreed to by the Y-12 Complex NNSA Site Office (YSO) and B&W Y-12; and are consistent with the Y-12 Complex's mission, budget guidance, ES&H work scope, site incentive plans, and continuous improvement. Targets and action plans are established for broad objectives to pursue improvement in environmental performance in five areas: clean air, energy efficiency, hazardous materials, stewardship of land and water resources, and waste reduction/recycling/buy green. Highlights of the 2011 B&W Y-12 environmental targets achieved are presented in Section 4.2.6.1.

4.2.3.4 Programs

NNSA has developed and funded several important programs to integrate environmental stewardship into all facets of Y-12 Complex missions. The programs also address the DOE order requirements for protecting various environmental media, reducing pollution, conserving resources, and helping to promote compliance with all applicable environmental regulatory requirements and permits.

4.2.3.4.1 Environmental Compliance

The B&W Y-12 Environmental Compliance Department (ECD) provides environmental technical support services and oversight for Y-12 Complex line organizations to ensure that site operations are conducted in a manner that is protective of workers, the public, and the environment; in compliance with applicable standards, DOE orders, environmental laws, and regulations; and consistent with B&W Y-12's environmental policy and site procedures. ECD serves as the B&W Y-12 interpretive authority for environmental compliance requirements and as the primary point of contact between B&W Y-12 and external environmental compliance regulatory agencies such as the city of Oak Ridge, TDEC, and EPA. ECD administers compliance programs aligned with the major environmental legislation that affects Y-12 Complex activities. Compliance status and results of monitoring and measurements conducted for these compliance programs are presented in this document.

ECD also maintains and ensures implementation of the Y-12 Complex EMS and spearheads initiatives to proactively address environmental concerns to continually improve environmental performance and go "beyond compliance."

4.2.3.4.2 Waste Management

The B&W Y-12 Waste Management Department manages and supports the full life cycle of all waste streams within the Y-12 Complex. While ensuring compliance with federal and state regulations, DOE orders, waste acceptance criteria, and Y-12 Complex procedures and policies, the Waste Management Department provides

- technical support to generators on waste management, pollution prevention, and recycling issues and
- waste certification in accordance with DOE orders and NNSS waste acceptance criteria for waste to be shipped to that site for disposition.

4.2.3.4.3 Sustainability and Stewardship

The Sustainability and Stewardship Program has two major missions. The first is to establish and maintain companywide programs and services to support sustainable waste management operations. These sustainable operations include pollution prevention and recycling programs, excess materials, waste sampling, waste generator services, and Y-12 PrYde. The Y-12 PrYde program incorporates an inspection and rating system related to the cleanliness of facilities, materials, and hazardous/unsafe conditions to help personnel maintain work areas in a clean, safe, environmentally sound, and professional manner.

The second mission is the stewardship practices, the programs that manage the legacy issues and assist in the prevention of additional problematic areas being formed. Stewardship programs include Clean Sweep and Unneeded Materials and Chemicals (UMC).

The synergistic effects of combining these programs under a single umbrella improves overall compliance with EOs, DOE orders, state and federal regulations, and NNSA expectations and also eliminates duplication of efforts while providing an overall improved appearance at the Y-12 Complex.

Additionally, the implementation of these programs directly supports EMS objectives and targets to disposition UMC, continually improve recycle programs by adding new recycle streams as applicable, improve sustainable acquisition/environmentally preferable purchasing (i.e., promoting the purchase of products made with recycled content and bio-based products, including alternative fuels such as E85 and biodiesel), meet sustainable design requirements, complete the pollution prevention reporting requirements, and implement various other related activities.

4.2.3.4.4 Energy Management

Energy management is an ongoing and comprehensive effort containing key strategies to reduce consumption of energy, water, and fuel (electricity, coal, natural gas, and gasoline/diesel). As part of Facility Management and Programs in Facilities, Infrastructure, and Services, energy management tracks federally mandated conservation initiatives at the Y-12 Complex and informs personnel about sustainability issues, particularly in relation to energy, water, and fuel conservation and efficiency.

Among other duties, the energy manager directs the site toward meeting energy management sustainability goals as defined in the site sustainability plan (SSP) (B&W Y-12 2011) issued in December 2011.

4.2.4 Implementation and Operation

4.2.4.1 Roles, Responsibility, and Authority

The safe, secure, efficient, and environmentally responsible operation of the Y-12 Complex requires the commitment of all personnel. All personnel share the responsibility for successful day-to-day accomplishment of work and the environmentally responsible operation of the Y-12 Complex. Environmental and Waste Management technical support personnel assist the line organizations with identifying and carrying out their environmental responsibilities. Additionally, an Environmental Officer Program is in place to facilitate communication of environmental regulatory requirements and to promote EMS as a tool to drive continual environmental improvement at the Y-12 Complex. Environmental officers coordinate their organizations' efforts to maintain environmental regulatory compliance and promote other proactive improvement activities.

4.2.4.2 Communication and Community Involvement

The Y-12 Complex is committed to keeping the community informed on operations, environmental concerns, safety, and emergency preparedness. The Community Relations Council, composed of 20 members from a cross section of the community, including environmental advocates, neighborhood residents, Y-12 Complex retirees, and business and government leaders, serves to facilitate communication between B&W Y-12 and the community. The council provides feedback to B&W Y-12 regarding its operations and ways to enhance community and public communications. The following paragraphs describe some of the Y-12 Complex communication and community involvement activities.

B&W Y-12 sponsored and participated in community events in 2011, including Oak Ridge Earth Day (Fig 4.4), to provide highlights of Y-12's environmental management, sustainability and stewardship, and pollution prevention activities and to provide information about the Tennessee Pollution Prevention Partnership (TP3) to more than 1,000 members of the public. B&W Y-12 also sponsored the Oak Ridge Associated Universities Science Bowl, East Tennessee Fuels Coalition, and the University of Tennessee Arboretum in 2011.

ORNL 2012-G00350/chj

Fig. 4.4. Y-12 Complex "booth" at Oak Ridge Earth Day in 2011.

As part of the Y-12 Complex America Recycles Day activities, four local charities received $200 donations from funds raised by the Y-12 Complex employee aluminum beverage can (ABC) recycling efforts. Since the ABC recycling program began in 1994, more than $80,000 has been donated to various local charities.

B&W Y-12 actively promoted the TP3 program by mentoring and sharing information with interested organizations to encourage pollution prevention and involvement in TP3. In 2011, B&W Y-12 shared information concerning the TP3 program with Eaton-Inoac, Mastermelt America, Hemlock Semiconductor, Ijams Nature Center, Y-12 Complex employees, and members of the local community.

4.2.4.3 Emergency Preparedness and Response

Local, state, and federal emergency response organizations are fully involved in the Y-12 emergency drill and exercise program. The annual drill and exercise schedule is coordinated with all organizations to ensure maximum possible participation. At a minimum, the Tennessee Emergency Management Agency (TEMA) Duty Office and the DOE headquarters Watch Office participate in all Y-12 Complex emergency response exercises.

The Y-12 Complex conducted three full-scale exercises (FSEs) in FY 2011. The focus of these FSEs included responding to a chemical spill at a transportation accident and responding to a radiological fire and release. Eight building evacuation and accountability drills and a no-notice FSE were conducted, the latter focusing on responding to a roof collapse after an unusually heavy snowfall. Additionally, a tabletop exercise was conducted focusing on the response to an active shooter event.

The Y-12 Complex's expertise in emergency management continues to be recognized within DOE. A member of the Y-12 Complex Emergency Management Program Office (EMPO) staff attended the Nuclear Security Information Exchange Active Aggressor (Shooter) meeting in Albuquerque, New Mexico, on December 2, 2010. Most DOE NNSA sites were represented. Topics included necessary training, drills, and exercises for employees, security personnel, and emergency response personnel. EMPO staff members also performed an evaluation of the NNSS Annual Exercise in April 2011. Members of the EMPO staff participated in the DOE Emergency Management Issues Special Interest Group Conference held in Charleston, South Carolina, in May 2011. The Y-12 Complex made presentations, participated in steering committee meetings, and distributed Y-12 Complex Emergency Management Program information to other DOE facility emergency management professionals.

4.2.5 Checking

4.2.5.1 Monitoring and Measurement

The Y-12 Complex maintains procedures to monitor overall environmental performance and to monitor and measure key characteristics of its operations and activities that can have a significant environmental impact. Environmental effluent and surveillance monitoring programs are well-established, and the results of the 2011 program activities are reported elsewhere in this document. Progress achieving environmental goals is reported as a monthly metric on the senior management web portal, Performance Track, that consolidates and maintains Y-12 Complex site-level performance measures. Progress is reviewed in periodic meetings with senior management and the NNSA YSO.

4.2.5.2 Environmental Management System Assessments

To periodically verify that EMS is operating as intended, assessments are conducted as part of the Y-12 Complex's assessment program. The assessments are designed to ensure that nonconformities with the ISO 14001 standard are identified and addressed. The Y-12 Complex's EMS assessment program consists of a three-pronged approach that includes focused EMS assessments; routine surveillances, inspections, and data reviews; and environmental multimedia assessments integrated with regularly scheduled facility evaluations led by the Independent Assessment Organization.

Three EMS assessments and three facility evaluations using an environmental multimedia approach were conducted in 2011. As a result of the EMS assessments procedures are being improved for planning and initiating environmental and EMS assessments, trending results, and initiating and finalizing effective corrective and preventive actions (i.e., issues management). The facility evaluations confirmed EMS is being adequately implemented across the site.

EO 13423 requires that federal facility EMSs be audited by a qualified party outside of the control or scope of the EMS at least every 3 years from the date of the initial declaration. The last external, independent assessment of the Y-12 Complex EMS was conducted April 13–16, 2009, and the EMS was found to be in conformance. The next external independent assessment of the Y-12 Complex EMS is planned for April 2012.

4.2.6 Performance

The EMS objectives and targets and other plans, initiatives, and successes that work together to accomplish DOE goals and reduce environmental impacts are discussed in this section. The Y-12 Complex used a number of DOE's reporting systems, including the following, to report performance.

- Pollution Prevention Tracking and Reporting System, which collects environmental, sustainable acquisition and product purchases, and best practices data.
- Federal Automotive Statistical Tool, which collects fleet inventory and fuel use.
- Consolidated Energy Data Report, which collects additional data on metering requirements, water use, renewable energy generation and purchases, training, and sustainable buildings.
- Site Sustainability Plan Performance Reporting, which collects data on site-identified sustainability projects and supports Energy Independence and Security Act (EISA) Section 432 compliance.

The DOE HSS annual environmental progress reports on implementation of EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* (EO 2007), and Office of Management and Budget's Environmental Stewardship Scorecard gave the Y-12 Complex an EMS scorecard rating for FY 2011 of green, indicating full implementation of EO 13423 requirements.

4.2.6.1 Environmental Management System Objectives and Targets

At the end of FY 2011 B&W Y-12 had achieved 10 of 12 targets that had been established the year before. Overall, 48 actions were completed versus 43 planned for completion through September. Highlights included the following, with additional details and successes presented in other sections of this report.

- Clean Air—Compiled and reported data necessary to calculate Scope 3 GHG emissions for employee commuting, in accordance with federal guidance.
- Energy Efficiency—Continued construction for Phase 1 of Energy Savings Performance Contract (ESPC) projects. Completion of the ESPC projects will reduce site energy intensity by 4%, reduce potable water use by 5%, and reduce GHG emissions. An analysis of the Y-12 Complex metering system was completed and a metering plan developed and implemented. A Y-12 Complex SSP was developed and issued, and resource and training needs to establish an Energy Audit Team were identified.
- Hazardous Materials—Completed ARRA projects to remove and disposition legacy materials in Buildings 9201-5 and 9204-4; completed cleanup of the 1.5-acre Just-in-Case storage yard; completed cleanup of the Old Salvage Yard (7 acres) by removing more than 31,000 yd^3 of scrap material.
- Land/Water Conservation—Eliminated a significant source of off-site mercury transport by remediating the storm drain in the West End Mercury Area (WEMA); continued progress to identify and correct inflow/infiltration (I/I) into the Y-12 Complex sanitary sewer by smoke testing throughout the Y-12 Complex and making more than 20 repairs.
- Reduce/Reuse/Recycle/Buy Green—Developed and implemented a "green cleaning only" initiative for custodial services.

4.2.6.2 Sustainability and Stewardship

Numerous efforts at the Y-12 Complex have reduced its impact on the environment. Efforts include increased use of environmentally friendly products and processes and reductions in waste and emissions. During the past few years, these efforts have been recognized by our customers, our community, and other stakeholders (see Section 4.2.7). Not only have the pollution prevention efforts at the Y-12 Complex benefited the environment, they have also resulted in avoided costs (Fig. 4.5).

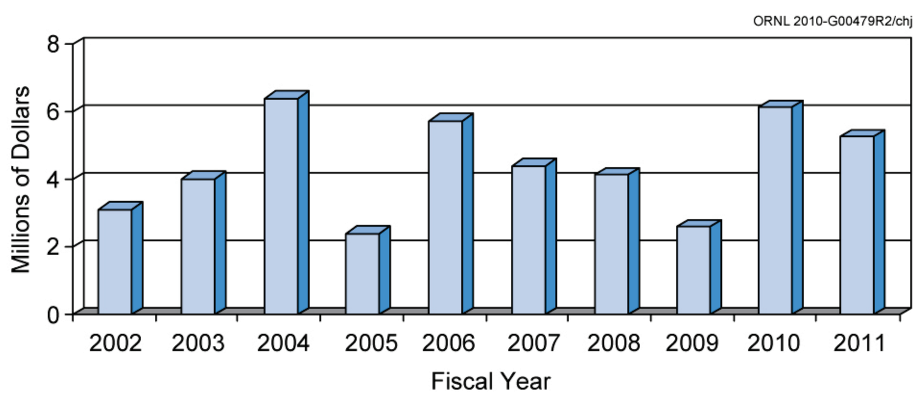

Fig. 4.5. Cost savings from Y-12 Complex pollution prevention activities.

In FY 2011 the Y-12 Complex implemented 112 pollution prevention initiatives (Fig. 4.6), with a reduction of more than 10.4 million kg (23 million lb) of waste and cost savings of more than \$5.2 million. The completed projects include the activities described below.

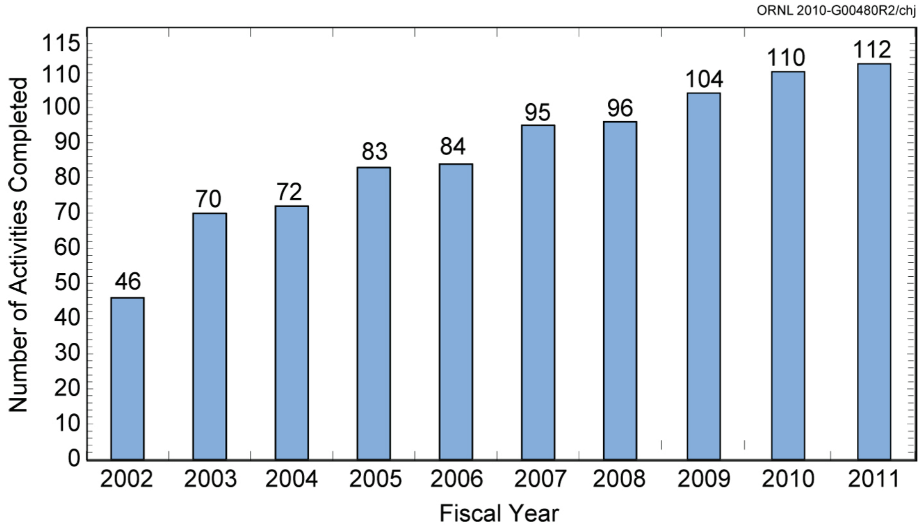

Fig. 4.6. Y-12 Complex pollution prevention initiatives.

Initiatives with Pollution Prevention Benefits and Source Reduction. Sustainable initiatives have been embraced across the Y-12 Complex to reduce the impact of pollution on the environment and to increase operational efficiency. Many of the Y-12 Complex's sustainable initiatives have pollution prevention benefits or targets eliminating the source of pollution, including the 2011 activities highlighted in this section.

Sustainable Acquisition/Environmentally Preferable Purchasing. Sustainable products, including recycled-content materials, are procured for use across the Y-12 Complex. In 2011, B&W Y-12 procured recycled-content materials valued at more than $3.0 million for use at the site (Fig. 4.7).

Fig. 4.7. Y-12 Complex sustainable acquisition billboard.

Unneeded Materials and Chemicals. The UMC initiative was implemented to assist in the potential use and ultimate disposition of resources that were not being used. The overall goal of the UMC initiative is reuse of existing resources while providing a cleaner/safer facility and improved compliance. The UMC disposition process (Fig. 4.8) does not simply manage all UMC as waste but first tries to find another outlet using a systematic process. The steps of this process are to first try to identify another use (1) within the Y-12 Complex, (2) within DOE, (3) within the government, (4) through sale to the public, (5) through recycle, and finally (6) through disposal as waste. Since 2006, the UMC program at the Y-12 Complex has dispositioned more than 11,500 items.

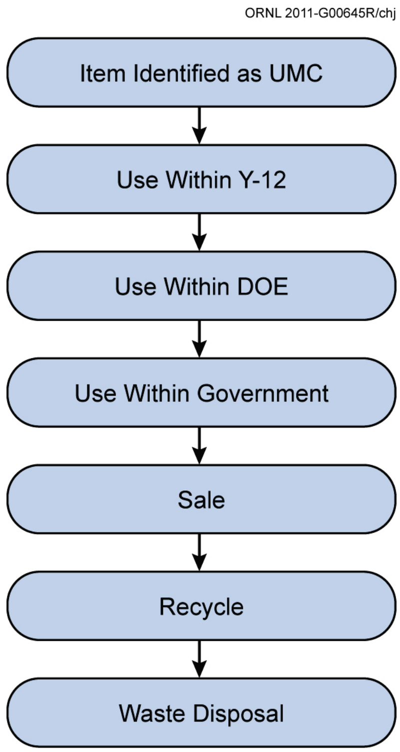

Fig. 4.8. Unneeded materials and chemicals disposition process at the Y-12 Complex.

Environmentally Friendly Solvent. The Y-12 Complex is committed to reducing the use of toxic and hazardous chemicals and minimizing the volume of hazardous waste generated by site operations. Traditionally solvents such as methylene chloride, toluene, and methanol were used for removing epoxy and polyurethane adhesives and for stripping paint. A Y-12 Complex research chemist and laboratory assistant developed a new solvent blend called RonJohn. RonJohn is a versatile, environmentally friendly solvent blend that has replaced traditional solvents in various site operations. The nonflammable, water-soluble solvent has gained sitewide acceptance due to its lower safety hazard rating and ability to quickly dissolve coatings and other materials. Spent RonJohn is not considered a hazardous waste. RonJohn has been licensed to RockinBoat LLC and is now available for commercial use.

Recycling Initiatives. B&W Y-12 has a well-established recycling program and continues to identify new material streams and to expand the types of materials that can be recycled by finding new markets and outlets for the materials. As shown in Fig. 4.9, more than 950,000 kg (2.1 million lb) of materials was diverted from landfills and into viable recycle processes during 2011. Currently recycled materials range from office-related materials to operations-related materials such as scrap metal, tires, and batteries. The recycling program was expanded in 2011 to include pagers and exit lights.

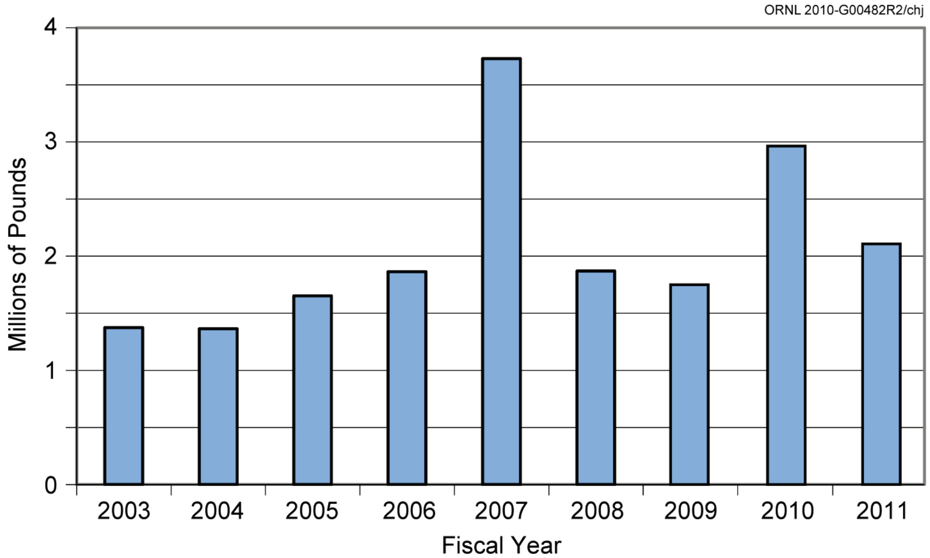

Fig. 4.9. Y-12 Complex recycling results.

Personal Electronic Equipment Collection Event. On September 30, 2011, the Y-12 Complex Sustainability and Stewardship Organization hosted a personal electronics collection event for Y-12 Complex employees and subcontractors (Fig. 4.10). An off-site recycling vendor collected the equipment from the employees in the New Hope Center Parking Lot. About 82 employees and subcontractors participated in the collection event. More than 645 electronic items, weighing a total of 6,147 lb, were collected during the 4 h event. Examples of the types of items collected include CPUs, CRT monitors, LCD monitors, cell phones, printers, etc. Government-owned equipment was not collected during the event.

Fig. 4.10. Y-12 Complex Personal Electronic Equipment Collection Event.

Sustainable Paving. Personnel at the Y-12 Complex continually search for ways to implement sustainable practices to reduce the potential environmental impacts of complex operations. There are more than 33 miles of roads and more than 71 acres of parking lots on the Y-12 Complex. Y-12 Complex roads and parking lots must be maintained to ensure safe completion of mission activities. Because paved surfaces have an impact on the environment, sustainable paving practices have been implemented to mitigate those impacts. The site reused mulch in sediment control devices to prevent erosion concerns during the construction of a new bypass road. Warm mix asphalt, milled asphalt, and roller compacted concrete were used to pave and maintain roads and parking lots. Y-12 Complex sustainable paving practices have prevented the generation of about 15 million lb of waste, reduced GHG emissions from asphalt production, facilitated the use of recycled content materials, and prevented the use of new raw materials.

4.2.6.3 Energy Management

The DOE sites' "executable plans," previously developed annually to update and report energy use, were renamed "SSPs" (site sustainability plans) and expanded to cover the requirements of EOs 13423 and 13514 and DOE's strategic sustainability performance plan (SSPP) (DOE 2011b). The *FY 2012 Y-12 Site Sustainability Plan* (B&W Y-12 2011) serves as a deliverable to fulfill the planning and reporting requirements of the EOs and SSPP. The DOE sustainability goals and Y-12 status and plans for these goals are summarized in Table 4.1.

Table 4.1. Y-12 Site Sustainability Plan Goal Performance and Review for 2011

SSPP	DOE Goal	Performance Status	Planned Actions and Contributions	Risk of Nonattainment
1.1	28% Scope 1 and 2 GHG reduction by FY 2020 from an FY 2008 baseline	**At risk**—Scope 1 and 2 emissions decreased by 12%, (Scope 1 decreased 27%, but Scope 2 actually increased by .01% due to the mission factor revision).	Continue to identify methods for reduction of GHG; further emphasize energy reductions.	Medium
1.2	30% energy intensity reduction by FY 2015 from an FY 2003 baseline	**On track**—the site has achieved a 22.8% reduction from the 2003 baseline.	Continue implementation of planned reduction initiatives.	Low
1.3	Individual buildings or processes metering for 90% of electricity (by October 1, 2012); for 90% of steam, natural gas, and chilled water (by October 1, 2015)	**Making progress**—EMIP project will provide metering for electricity, natural gas, and steam.	Complete analysis of chilled water system; develop plan for installation of CW and PW meters.	Electricity: Low Steam: Medium Natural Gas: Low Chilled Water: Medium
1.4	Cool roofs, when economical, for roof replacements unless project already has CD-2 approval (new roofs must have thermal resistance of at least R-30)	**On track**—Investments in roofing have resulted in cool-roof technology since 2008.	Future roofing projects will continue to use cool roofs where practical, with 181,739 ft^2 planned for FY 2012.	Low
1.5	7.5% of a site's annual electricity consumption from renewable sources by FY 2013 and thereafter (5% in FY 2010-2012)	**On track**—Y-12 purchased Green-e certified RECs in the amount of 21,000 MWh per year. **At risk**—if it is determined RECs are not suitable, Y-12 will not meet this goal.	If an agreement is reached that sites can use RECs to satisfy this goal, Y-12 will make the purchase and the goal will be blue. The site is investigating the feasibility of installing solar arrays and also a vertical-axis wind turbine. Although these systems will not meet the 7.5% requirement, they are a step forward.	Without RECs: High With RECs: Low
1.6	10% annual increase in fleet alternative fuel consumption by FY 2015 relative to an FY 2005 baseline	**Goal has been met**—Y-12 has achieved a 342% increase in alternative fuel consumption within 6 years.	Additional measures are being evaluated for continued improvement beyond the goals.	Low

Table 4.1. (continued)

SSPP	DOE Goal	Performance Status	Planned Actions and Contributions	Risk of Nonattainment
1.7	2% annual reduction in fleet petroleum consumption by FY 2020 relative to an FY 2005 baseline	**Goal has been met**—Y-12 has achieved the petroleum reduction goal with a 48% reduction within 6 years.	Additional measures are being evaluated for continued improvement beyond the goals.	Low
1.8	75% of light-duty vehicle purchases must consist of AFVs by FY 2015 and thereafter	**Goal has been met**—Y-12 purchases only AFVs for the on-site fleet.	Future vehicle purchases will only include AFVs.	Low
1.9	Reduce fleet inventory by 35% within the next three years relative to an FY 2005 baseline	**Making progress**—NNSA has implemented a 4%-per-year reduction target for the complex.	Based on revised goal, Y-12 will evaluate the existing inventory and develop a path forward.	Low
2.1	13% Scope 3 GHG reduction by FY 2020 from an FY 2008 baseline	**At risk**—Site Scope 3 emissions have increased by 3%.	Site will improve teleconference and webinar capabilities to reduce business travel and benchmark other sites.	Medium
3.1	15% of existing buildings larger than 5,000 GSF compliant with the GPs of HPSB by FY 2015	**Making progress**—the site focused on meeting HPSB compliance for JCC—although the facility gets us yellow for gross square footage, still red for building count.	Y-12 will continue to implement initiatives to meet HPSB compliance as funding and resources allow.	Medium
3.2	All new construction, major renovations, and alterations of buildings greater than 5,000 GSF must comply with the GPs and, where the work exceeds $5 million, each are LEED-NC Gold certification or equivalent	**On track**—the UPF project is seeking LEED certification for the new construction projects.	The UPF project team will continue efforts toward LEED certification.	Medium
4.1	26% water intensity reduction by FY 2020 from an FY 2007 baseline	**Goal has been met**—the site has achieved a 33.8% reduction from the baseline.	Water conservation measures will continue to be implemented on a building-by-building basis in support of the HPSB initiative.	Low
4.2	20% water consumption reduction of industrial, ILA water by FY 2020 from an FY 2010 baseline	**On track**—Y-12 will be implementing efforts to eliminate ILA water usage prior to FY 2013.	Y-12 recently recognized that both the Jack Case and New Hope Centers consume potable water for irrigation purposes. Both of these practices are easily correctable, and efforts are under way to eliminate the ILA usage.	Low
5.1	Divert at least 50% of nonhazardous solid waste, excluding construction and demolition debris by FY 2015	**Goal has been met**—More than 50% of nonhazardous waste diverted from landfill.	At least one new recycle material stream is added to the recycling program each fiscal year to further increase the diversion rate.	Low
5.2	Divert at least 50% of construction and demolition materials and debris by FY 2015	**Goal has been met**—More than 57% of construction and demolition waste diverted from landfill.	At least one new recycle material stream is added to the recycling program each fiscal year to further increase the diversion rate.	Low

Table 4.1. (continued)

SSPP	DOE Goal	Performance Status	Planned Actions and Contributions	Risk of Nonattainment
6.1	Procurements meet sustainability requirements and include sustainable acquisition clause (95% each year)	**Goal has been met**—Sustainable acquisition clause has been included in procurements.	Site will continue to evaluate new sustainable products for use.	Low
7.1	All data centers are metered to measure a monthly PUE (100% by FY 2015)	**Making progress**—electric meter installations are planned for these facilities in FY 2012.	Data centers are currently planned for consolidation. The site will monitor each consolidation to ensure metering is effectively measuring PUE.	Low
7.2	Maximum annual weighted average PUE of 1.4 by FY 2015	**At Risk**—The PUE is currently estimated at lower than 1.4. However, this value is based solely on electricity usage and does not account for chilled water energy intensity.	Chilled water and electrical metering are planned for this facility. These data will verify PUE; it is not known at this time what actions are required.	High
7.3	Electronic stewardship—100% of eligible personal computers, laptops, and monitors with power management actively implemented and in use by FY 2012	**Goal has been met**—The Y-12 Complex IT organization has taken aggressive steps to implement power management for all eligible devices (except those that must be excluded for legitimate business reasons like cyber-security, machine controllers, etc.).	Continue active implementation of power management of computing devices.	Low

Abbreviations

AFV = alternative fuel vehicle
CD = Critical Decision
CW = chilled water
DOE = US Department of Energy
EMIP = Energy Modernization Implementation Program
FY = fiscal year
GHG = greenhouse gas
GP = guiding principle
GSF = gross square feet
HPSB = high-performance sustainable building
ILA = industrial, landscaping, and agriculture
IT = information technology
JCC = Jack Case Center
LEED = Leadership in Energy and Environmental Design
NC = new construction
NNSA = National Nuclear Security Administration
PUE = power utilization effectiveness
PW = potable water
REC = renewable energy certificate
SSPP = Strategic Sustainability Performance Plan (DOE)
UPF = Uranium Processing Facility
Y-12 Complex = Y-12 National Security Complex

Energy Performance. Based on FY 2011 data, energy use at the Y-12 Complex is 2.14 × 1,012 Btu. The square footage is 7,143,781; therefore the FY 2011 estimated energy intensity is 323,004 Btu/GSF (Fig. 4.11), which represents a 6.7% reduction compared to FY 2010. When compared to the baseline year, FY 2003, this represents a 22.8% reduction. The site has made good progress in implementing several energy reduction initiatives. Night setbacks were implemented on heating, ventilating, and air-conditioning (HVAC) systems in several buildings last year. Energy use reflected the reductions related to this effort almost immediately. Several of these same HVAC systems also underwent refurbishment, including new variable frequency drives and filter change-outs. Lighting upgrades also were installed in several locations. Although light-emitting diode (LED) lighting is planned for more locations, several recent installations of the more efficient T-8 lighting have proven beneficial. Incandescent lighting is also being replaced with compact fluorescent lamps in several locations. A parking lot pilot project was initiated to study LED, induction, and high-pressure sodium lighting applications. Results so far indicate that LED lighting is the most efficient, followed closely by induction lighting. Additional data will be forthcoming, but the site is looking at increasing use of LED lighting in many applications.

To attain high-performance sustainable building (HPSB) compliance, occupant sensors and WattStopper smart strips were installed in the Jack Case Center. The facility achieved HPSB status on March 16, 2012, becoming the Y-12 Complex's first HPSB facility after achieving a 21.4% reduction in energy from a 2007 baseline. Similar measures will be implemented in Buildings 9113 and 9119 during FY 2012–2013.

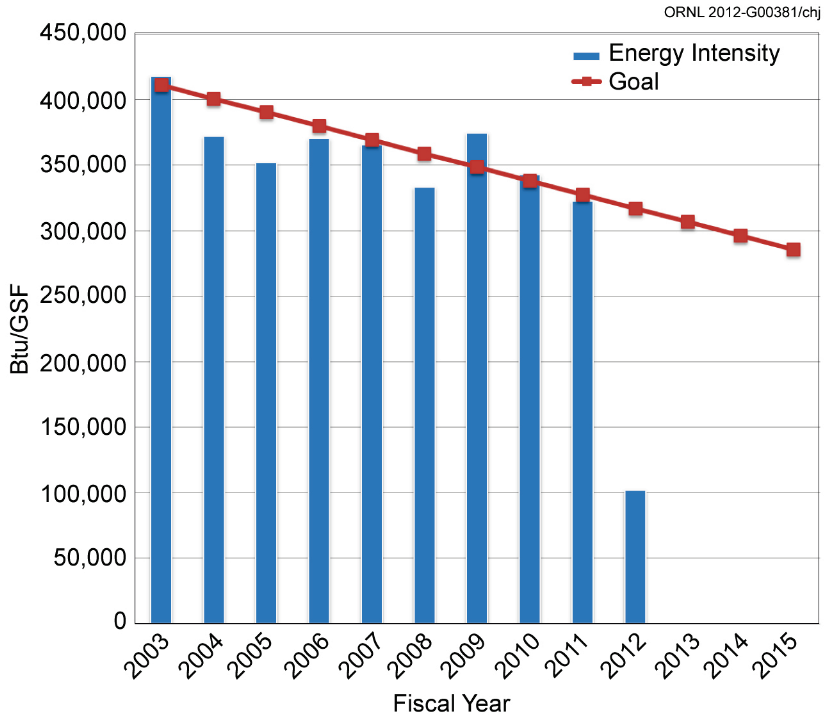

Fig. 4.11. Y-12 Complex energy intensity vs goal: FY 2003 vs FY 2011. (GSF = gross square footage.)

4.2.6.4 Water Conservation

By the end of FY 2011, the site had achieved a 33.8% reduction in potable water use since the baseline was established (Fig. 4.12). During FY 2011, the site noted a reduction of 7%. Actions that contributed to the reduction included the following.

- Cooling tower retrofits included in the ESPC contract.
- Steam trap repairs and improvements.
- Condensate return repairs and reroutes.
- Cleanout and shutdown of Buildings 9201-05, 9204-04, and 9401-03.

Continued reductions in water use will be incorporated into ongoing facility repairs and renovations as funding becomes available. These efforts will include the following.

- Upgrading toilets and urinals to low-flow, hands-free units.
- Installing flow restrictors on faucets and shower heads.
- Modifying cafeteria components including high-efficiency dishwasher with Opti-Rinse technology and in-line flow restrictors on garbage disposal and tray conveyor trough nozzle supply lines.
- Repairing condenser loop connections so that all condenser water is returned to the cooling towers.
- Replacing existing water-cooled air conditioning systems with air-cooled equivalents.
- Installing advanced potable water meters.
- Incorporating additional condensate recovery projects to include further end-use capture sites for condensate return; domestic upgrades are identified for future implementation on a building-by-

building basis as funding allows. Similarly, many of the cooling tower upgrades are prioritized and will be evaluated accordingly for implementation as funding permits.

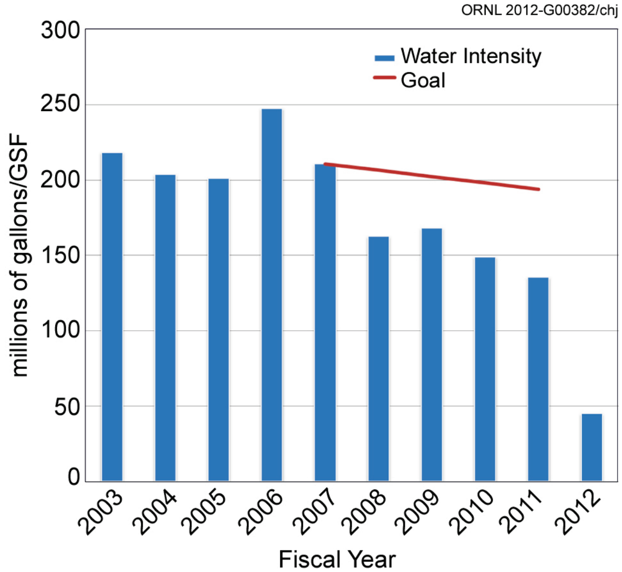

Fig. 4.12. Y-12 Complex water intensity vs goal: FY 2007 vs FY 2011.(GSF = gross square footage.)

4.2.6.5 Fleet Management

The Y-12 Complex has already surpassed the petroleum reduction goal by achieving a 48% reduction within 5 years. Furthermore, the site has achieved a 342% increase in alternative fuel use from the 2005 baseline. The site continues to assess ways to reduce fuel consumption, and the use of hybrid and electric vehicles is being evaluated.

The following actions are planned for continued progress in fleet management.

- Increase the use of hybrid electric vehicles as they become available (Fig. 4.13).
- Develop and implement a plan for installing electric charging stations throughout the plant.
- Evaluate a “preferred parking” initiative for energy-efficient and/or electric vehicles.

Fig. 4.13. Electric carts are used within the protected area of the Y-12 Complex.

As there is a ready supply of E-85 fuel on the site, all alternative fuel vehicles use the fuel 100% of the time. Biodiesel was introduced to the site in 2007. In 2008 the increase in the cost of biodiesel prompted an evaluation of the benefits of biodiesel use vs the costs, and it was determined that biodiesel was no longer cost-effective. Therefore, ultra-low diesel was purchased and used throughout 2011. All diesel vehicles were required to use the ultra-low fuel. Table 4.2 is a Y-12 Complex fuel statistic pulled from the Flow and Analysis System for Transportation Data Consistency Report showing the goal will be reached through 2018.

Table 4.2. Summary of petroleum and alternative fuel use over a 5-year period

	2005 Baseline	2011	Increase/ decrease	EO 13423 goal	Actual increase/ decrease
Petroleum (Nonfleet)	14,378 gal	9,844 gal	32% decrease	2% per year decrease	5% per year decrease
Petroleum (Fleet)	160,126 gal	82,928 gal	48% decrease	2% per year decrease	8% per year decrease
E85 fuel + biodiesel	4,801 gal	21,236 gal	342% increase	10% per year increase	57% per year increase

To track the continued success of the fuel-saving measures, the fleet manager monitors gasoline, E85, and B20 fuel consumption by both Y-12 Complex and General Services Administration (GSA) vehicles and maintains monthly reporting metrics. Future fleet management energy savings will be achieved by continued strict monitoring of vehicle use. Increasing the use of alternative fuels and replacing gasoline-fueled vehicles with E85-fueled vehicles will occur as funding permits. Goals in support of alternative fuel use have been achieved such as procuring a hybrid bus and pickup truck for the Y-12 Complex fleet in addition to the E85 replacements.

4.2.6.6 Electronic Stewardship

The Y-12 Complex committed to the Federal Electronics Challenge (FEC) pledge in 2008 to improve the management of electronic assets during all life-cycle phases: acquisition, operation and maintenance, and end-of-life management. In 2011, as an FEC Partner, B&W Y-12 completed all FEC annual reporting to account for acquisition and procurement of electronics and implementation of other practices to maximize Y-12 Complex energy efficiency, reduce electronic-related wastes, and improve end-of-life management. B&W Y-12 received a 2011 FEC Silver Level Award in September 2011 (see Section 4.2.7).

4.2.6.7 Greenhouse Gases

The Y-12 Complex developed a preliminary GHG inventory in August 2009. The inventory was developed for FY 2008 with an FY 2003 baseline year. Based on the requirements of EO 13514, the baseline year was changed to FY 2008. Table 4.3 provides a summary of Y-12 Complex GHG emissions for FY 2008 and FY 2011.

The Y-12 Complex reduced Scope 1 and 2 GHG emissions by 12% in FY 2011, primarily as a result of decreases in GHG emissions related to steam generation. Scope 3 GHG emissions have increased by 3% since the 2008 baseline year. Employee commuting GHG emissions account for 55% of the Scope 3 emissions. It will be difficult for the Y-12 Complex to meet the reduction goal for Scope 3 GHG emissions without the addition of public transit to the Oak Ridge area and/or a telecommuting program. To further reduce employee commuting emissions, the Y-12 Complex will continue to encourage use of the Y-12 Complex carpooling and rideshare programs.

Table 4.3. Y-12 National Security Complex greenhouse gas emissions summary

GHG Emission Source	FY 2008 Baseline (Metric Ton CO_2e/year)	FY 2011 (Metric Ton CO_2e/year)
Scope 1		
Steam (Coal, Natural Gas, Fuel Oil)	128,654	78,404
Industrial Fugitive Emissions	22,549	32,097
Scope 2		
Electricity	184,995	185,021
Total Scope 1 (without fleet data) and 2	**336,198**	**295,523**
Scope 3		
T&D Losses	12,185.8	12,122.2
Off-Site Municipal Wastewater Treatment	30.4	31.4
Employee Commute	17,447	18,209
Business Ground and Air Travel	2,251	2,517.5
Total Scope 3	**31,914.2**	**32,880.1**
TOTAL GHG Emissions	**368,122.2**	**328,403.1**

Abbreviations
CO_2e = CO_2 equivalent
FY = fiscal year
GHG = greenhouse gas
T&D = transmission and distribution

4.2.7 Awards and Recognition

Since November 2000, the Y-12 Complex commitment to environmentally responsible operations has been recognized with more than 76 external environmental awards from local, state, and national agencies. The awards received in 2011 are summarized below.

DOE E-Star Award. The “Waste Not Want Not, Y-12 Comprehensive, Cost-Effective Recycling Program” was selected by DOE headquarters to receive an E-Star Award. Additionally, the Y-12 Complex Clean Steam Team was selected for an E-Star Honorable Mention Award. The E-Star Awards recognize innovation and/or excellence in pollution prevention and environmental sustainability stewardship efforts within DOE, and recipients are selected by an independent panel. The award winners were selected from about 186 nominations made by pollution prevention representatives from the US Department of Health and Human Services, EPA, GSA, and USACE.

Tennessee Chamber of Commerce and Industry. B&W Y-12 was recognized in four areas at awards ceremonies at the 29th Annual Tennessee Chamber of Commerce and Industry Environmental Conference in October 2011 (Fig. 4.14). Award winners were selected by a panel of state officials who reviewed the nominations, accomplishments, and compliance records of the respective environmental programs. B&W Y-12 received the following two awards.

- Hazardous Waste Management Award for “Y-12’s Environmentally Friendly Solvent Blend”
- Water Quality Award for “Y-12’s Sustainable Design Practices Reduce Environmental Impacts”

Additionally, B&W Y-12 received achievement certificates for the following activities.

- Solid Waste Management Certificate for “Y-12’s Comprehensive, Cost-Effective Recycling Program”
- Air Quality Certificate for “Y-12’s American Recovery and Reinvestment Act (ARRA) Initiatives Reduce Greenhouse Gas Emissions”

ORNL 2012-G00353/chj

Fig. 4.14. Presentation of the Water Quality award to B&W Y-12 at the 29th Annual Tennessee Chamber of Commerce and Industry Environmental Conference.

NNSA Awards. In 2011 the Y-12 Complex received four NNSA Pollution Prevention/Sustainability Best in Class Awards. This is the eighth consecutive year that the Y-12 Complex has been recognized by NNSA for award-winning activities. These awards recognize innovation and/or excellence in pollution prevention and environmental sustainability stewardship efforts within NNSA and DOE, and recipients are selected by an independent panel.

Tennessee Pollution Prevention Partnership. In 2011**,** the Y-12 Complex was awarded Performer Level status in the TP3 Program for another year. To maintain Performer Level status in the TP3 Program, the Y-12 Complex must illustrate ongoing commitment to pollution prevention through the completion of a success story and mentoring and outreach activities. Activities are reviewed annually by the members of the TDEC TP3 Program Review Panel.

Federal Electronics Challenge. B&W Y-12 received a 2011 FEC Silver Level Award in September 2011. FEC awards recognize the achievements of FEC partners and their leadership in federal electronics stewardship. B&W Y-12 was one of 12 Silver Level Award winners. This FEC Silver Award was specifically for B&W Y-12's accomplishments in electronics acquisition and end-of-life management activities.

4.2.7.1 Storm Water Management and the Energy Independence and Security Act of 2007

Although the Y-12 Complex NPDES permit regulates discharges of storm water runoff, storm water management practices at the Y-12 Complex also consider requirements of EISA Section 438. Under Section 438 federal agencies have requirements to reduce storm water runoff from development and redevelopment projects to protect water resources. The Y-12 Complex complies with these requirements using a variety of storm water management practices, often referred to as "green infrastructure" or "low impact development" practices, including for example, reducing impervious surfaces, using vegetative practices, and porous pavements. During the planning and design stages of development and redevelopment projects at the Y-12 Complex consideration is given to the techniques identified in the technical guidance prepared by EPA to assist federal agencies in implementing EISA Section 438 (EPA 2009). Recent examples of projects that used techniques to reduce the rate and volume of storm water runoff include the regrading and stabilization of a 1.214 ha (3-acre) former coal storage area and the revegetation of previously paved areas due to roadway relocation or elimination. The areas have been reseeded and allowed to return to natural grass plantings. Pervious concrete is included in the design of a new parking surface due to be completed during FY 2012 and will be included in the design and construction planning for relocated parking areas associated with modernization efforts at the Y-12 Complex. Additionally, low-maintenance plantings are being incorporated into the landscaping at the entrance and around facilities within the plant. This effort will be continued and expanded in future development of the site.

4.3 Compliance Status

4.3.1 Environmental Permits

Table 4.4 lists environmental permits in force at the Y-12 Complex during 2011. More detailed information can be found in the following sections.

4.3.2 National Environmental Policy Act/National Historic Preservation Act Assessments

NNSA adheres to NEPA regulations, which require federal agencies to evaluate the effects of proposed major federal activities on the environment. The prescribed evaluation process ensures that the proper level of environmental review is performed before an irreversible commitment of resources is made.

During 2011, environmental evaluations were completed for 35 proposed actions, all of which were determined to be covered by a CX.

4.3.2.1 Sitewide Environmental Impact Statement for Y-12 Complex

The NEPA implementing procedures, 10 CFR 1021 (DOE 2011), require a 5-year evaluation of the current Y-12 Complex sitewide environmental impact statement (SWEIS). A new SWEIS is being prepared to evaluate the new modernization proposals and to update the analyses presented in the original Y-12 Complex SWEIS (issued in November 2001). The notice of intent was published in the *Federal Register* on November 28, 2005, and a public scoping meeting was held December 15, 2006, in Oak Ridge.

The draft SWEIS was issued in October 2009 (NNSA 2009), and a notice of availability was published in the *Federal Register* on October 30, 2009. Two public hearings for the draft SWEIS were held on November 17, and 18, 2009. These hearings allowed members of the public to provide comments on the draft SWEIS. The meetings were attended by about 350 members of the public. The public comment period for the draft SWEIS ended on January 29, 2010. The final SWEIS was issued February 2011, and the notice of availability was published March 4, 2011. The final SWEIS is available on the internet at www.y12sweis.com.

Table 4.4. Y-12 National Security Complex environmental permits, 2011

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	New Steam Plant Package Boilers (Construction)	960947	9/06/2007	2/01/2009[a]	DOE	DOE	B&W Y-12
CAA	Chip Oxidizer Operating Permit	554594	10/21/2004	10/21/2009[b]	DOE	DOE	B&W Y-12
CAA	Operating Permit (Title V)	554701	10/21/2004	10/21/2009[b]	DOE	DOE	B&W Y-12
CAA	Steam Plant (existing) Clean Air Interstate Rule NO_X Permit	861316	6/9/2008	Upon renewal of Title V permit[b]	DOE	DOE	B&W Y-12
CAA	Disassembly and Storage Operation (Construction)	963891P	9/29/2010	10/01/2011[b]	DOE	DOE	B&W Y-12
CAA	Title V Major Source Operating Permit	562767	1/8/2012	1/8/2017[b]	DOE	DOE	B&W Y-12
CWA	Industrial & Commercial User Wastewater Discharge (Sanitary Sewer Permit)	No. 1-91	4/1/2010	3/31/2015	DOE	DOE	B&W Y-12
CWA	NPDES Permit	TN0002968	3/13/2006	12/31/2008[d]	DOE	DOE	B&W Y-12
CWA	NPDES Permit	TN0002968	10/31/2011	11/30/2016	DOE	DOE	B&W Y-12
CWA	401 Water Quality Certification/ ARAP Access/Haul Road	NRS10.083	6/10/2010	6/09/2015	B&W Y-12	B&W Y-12	B&W Y-12
CWA	Department of Army Permit	2010-00366	9/02/2010	9/02/2015	DOE, B&W Y-12	B&W Y-12	B&W Y-12
CWA	General Storm Water Permit Coal Storage Area Stabilization Project	TNR 133949	6/7/2011	5/23/2016 (Project is complete)	DOE	B&W Y-12	B&W Y-12
CWA	General Storm Water Permit Y-12 Complex (103 acres)	TNR 134022	10/27/2011	5/23/2016	DOE	B&W Y-12	B&W Y-12
RCRA	Hazardous Waste Transporter Permit	TN3890090001	1/4/2012	1/31/2013	DOE	DOE	B&W Y-12

Table 4.4. (continued)

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
RCRA	Hazardous Waste Corrective Action Permit	TNHW-121	9/28/2004	9/28/2014	DOE	DOE, NNSA, and all ORR cooperators of hazardous waste permits	UCOR
RCRA	Container Storage Units	TNHW-122	8/31/2005	8/31/2015	DOE	DOE/B&W Y-12	B&W Y-12/ Navarro cooperator
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-127	10/06/2005	10/06/2015	DOE	DOE/B&W Y-12	B&W Y-12 cooperator
RCRA	RCRA Post-Closure Permit for the Chestnut Ridge Hydrogeologic Regime	TNHW-128	9/29/2006	9/29/2016	DOE	DOE/UCOR	UCOR
RCRA	RCRA Post-Closure Permit for the Bear Creek Hydrogeologic Regime	TNHW-116	12/10/2003	12/10/2013	DOE	DOE/UCOR	UCOR
RCRA	RCRA Post-Closure Permit for The Upper East Fork Poplar Creek Hydrogeologic Regime	TNHW-113	9/23/2003	9/23/2013	DOE	DOE/UCOR	UCOR
Solid Waste	Industrial Landfill IV (Operating, Class II)	IDL-01-103-0075	Permitted in 1988—most recent modification approved 1/13/1994	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Industrial Landfill V (Operating, Class II)	IDL-01-103-0083	Initial permit 4/26/1993	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Construction and Demolition Landfill (Overfilled, Class IV Subject to CERCLA ROD)	DML-01-103-0012	Initial permit 1/15/1986	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Construction and Demolition Landfill VI (Postclosure care and maintenance)	DML-01-103-0036	Permit terminated by TDEC 3/15/2007	N/A	DOE	DOE/UCOR	UCOR

Table 4.4. (continued)

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
Solid Waste	Construction and Demolition Landfill VII (Operating, Class IV)	DML-01-103-0045	Initial permit 12/13/1993	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Centralized Industrial Landfill II (Postclosure care and maintenance)	IDL-01-103-0189	Most recent modification approved 5/8/1992	N/A	DOE	DOE/UCOR	UCOR

[a]A request for extension was submitted to TDEC on January 7, 2009. This source was addressed in the Title V renewal application.

[b]The Title V renewal operating air permit from TDEC was issued January 8, 2012, and incorporates all the change requests that were previously submitted to TDEC. The new permit is numbered 562767 and replaces Title V permits 554701 and 554594.

[c]This source was addressed in the Title V renewal application and is incorporated in the Title V renewal operating air permit issued by TDEC on January 8, 2012.

[d]An application for reissuance of the NPDES permit was submitted to TDEC, Division of Water Pollution Control, on July 1, 2008. The permit expired December 31, 2008, and Y-12 Complex discharges continued under the requirements of this permit until the renewed permit was issued on October 31, 2011, and became effective December 1, 2011.

Abbreviations

ARAP = Aquatic Resource Alteration Permit
B&W Y-12 = B&W Technical Services Y-12 L.L.C.
CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CWA = Clean Water Act
DOE = US Department of Energy
Navarro = Navarro Research and Engineering, Inc.
NNSA = National Nuclear Security Administration
NPDES = National Pollutant Discharge Elimination System
ORR = Oak Ridge Reservation
RCRA = Resource Conservation and Recovery Act
ROD = record of decision
TDEC = Tennessee Department of Environment and Conservation
UCOR = URS | CH2M Oak Ridge LLC
Y-12 Complex = Y-12 National Security Complex

4.3.2.2 Preserving the Y-12 Site's History for Future Generations

In accordance with NHPA, NNSA is committed to identifying, preserving, enhancing, and protecting its cultural resources. The compliance activities in 2011 included completing an NHPA Section 106 review on 35 proposed projects and participating in various outreach projects with local organizations and schools.

Thirty-five proposed projects were evaluated to determine whether any historic properties eligible for inclusion in the *National Register of Historic Places* would be adversely impacted. Of the 35 proposed projects, it was determined that 34 would have no adverse effects on historic properties eligible for listing in the *National Register* and that no further Section 106 documentation was required. Only one of the projects would have an adverse effect on historic properties eligible for listing in the *National Register*, and the appropriate Section 106 documentation was prepared and submitted to the State Historic Preservation Office for concurrence.

The Y-12 Oral History Program continues efforts to conduct oral interviews of current and former employees to document the knowledge and experience of those who worked at the Y-12 Complex during World War II and the Cold War era. The interviews provided information on day-to-day operations of the Y-12 Complex, the use and operation of significant components and machinery, and how technological innovations occurred over time. Some of the information collected from the interviews will be available in various media, including DVDs shown in the Y-12 History Center.

The Y-12 History Center, located in The New Hope Center, continues to be a work in progress. It was closed September 2011 for major renovations and will reopen in May 2012. It will feature new exhibits, artifacts, photographs, pop-up signs, brochures, DVDs, and other information associated with the history of the Y-12 site and the New Hope Community. Once the Y-12 History Center reopens to the public, it will resume its normal schedule, Monday through Thursday from 8:00 a.m. to 5:00 p.m. and on Fridays by special request. A selection of materials, including DVDs, books, pamphlets, postcards, and fact sheets will continue to be available free to the public. While the History Center was closed in 2011, a temporary location with limited exhibits was set up in the New Hope Center for tours by various organizations, local schools, and other visitors.

Outreach activities in 2011 consisted of B&W Y-12 partnering with the city of Oak Ridge, the Convention and Visitor's Bureau, and the Arts Council of Oak Ridge, which sponsors the annual Secret City Festival. The Secret City Festival promoted the history of the Manhattan Project by providing guided tours of the Y-12 Complex in June. The American Museum of Science and Energy ran shuttles continuously to the Y-12 Complex New Hope Visitor Center. The Y-12 Complex conducted a total of 36 tours. About 639 people from 22 states visited the Y-12 History Center and toured the Y-12 Complex's historic facility, Building 9731, known as the "Pilot Plant" (Fig 4.15). Tour participants had an opportunity to tour the east end of the Y-12 Complex, with a stopover at Building 9731, a stopover at the overlook on Chestnut Ridge to get a view of the Y-12 Complex, and a "windshield tour" of HEUMF as they returned to the New Hope Center. The tour participants were greeted at Building 9731 by a plant retiree who had worked at the Y-12 Complex from 1946 to 1950 conducting tests of the calutrons. He also helped design the display on how to operate the calutrons.

B&W Y-12 also partnered with the American Museum of Science and Energy by providing guided public tours from June through September. Other outreach activities included visiting local schools and conducting presentations on the history of the Y-12 Complex and Oak Ridge.

ORNL 2011-G00651/chj

Fig. 4.15. Building 9731 between two images of calutrons.

4.3.3 Clean Air Act

This section contains a review of the major elements of the Clean Air Program at the Y-12 Complex including program highlights for 2011.

DOE was issued Title V Major Source Operating Permits 554701 and 554594 in 2004 for the Y-12 Complex, and required compliance implementation began April 1, 2005. More than 3,000 data points are obtained and reported yearly under the Title V operating permit, and there are five continuous monitors for criteria pollutants and numerous continuous samplers for radiological emissions. There was no noncompliance as a result of monitoring activities during 2011.

On January 13, 2011, a minor permit modification to the construction air permit for the new steam plant was submitted to TDEC for review and documentation. The modification was for a change to the total usage limit of Number 2 fuel oil. Y-12 Complex personnel requested that the total usage condition be removed from the construction air permit and not included in the Title V renewal operating permit for the Y-12 Complex.

Updates to the Title V renewal application, Permit 554701, were submitted to TDEC on March 16, 2011, for its records. The updates to the renewal permit application (1) identify new regulatory requirements, both current and future applicable requirements, that have been issued in the 22 months since the renewal permit application and (2) provide updated complex-wide general application forms for changes that have taken place in the last 22 months.

Historically, more than 90% of the Y-12 Complex pollutant emissions to the atmosphere were attributed to the operation of the old coal-fired and natural gas–fired steam plant. Emissions from the new steam plant will be significantly lower than those from the old steam plant, resulting in an overall air quality improvement. The new steam plant burns primarily natural gas and will have a Number 2 fuel oil backup. The clean air construction permit for this project included a Best Available Control Technology analysis for certain criteria pollutants and a case-by-case Maximum Achievable Control Technology (MACT) analysis for hazardous air pollutants.

A written notification of change of B&W Y-12 “responsible official” was submitted to TDEC on January 13, 2011; August 8, 2011; and September 27, 2011 for TDEC information and records. At this time, there was no change to the DOE NNSA responsible official designated on the air permits.

A public notice for the Y-12 Complex’s Title V Renewal Air Permit (draft permit 562767) ran in The Oak Ridger on Friday, November 25, 2011, in accordance with TDEC, Division of Air Pollution Control, guidance. The public notice is required to be put in the newspaper for a 30-day public comments period in accordance with Tennessee Air Pollution Control Regulations Rule 1200-3-9-.02(11)(f)8.

In 2011, TDEC personnel performed an inspection of the Y-12 Complex on August 3 and 4 to verify compliance with applicable regulations and permit conditions. No compliance issues were identified.

4.3.4 Clean Water Act and Aquatic Resources Protection

The Y-12 NPDES permit (TN0002968) in effect during 2011 was issued on March 13, 2006, and became effective on May 1, 2006. An application for reissuance of the NPDES permit was submitted to TDEC, Division of Water Pollution Control, on July 1, 2008.

The permit expired December 31, 2008, and Y-12 Complex discharges are continuing under the requirements of this permit pending TDEC action on the renewal application. The effluent limitations contained in the permit are based on the protection of water quality in the receiving streams. The permit emphasizes storm water runoff and biological, toxicological, and radiological monitoring.

During 2011 the Y-12 Complex continued its excellent record for compliance with the NPDES water discharge permit. About 5,000 data points were obtained from sampling required by the NPDES permit; only one noncompliance was reported. Some of the key requirements in the permit are summarized below (additional details are provided in Section 4.5, "Water Quality Program"):

- chlorine limitations based on WQC at three outfalls located near the headwaters of East Fork Poplar Creek (EFPC), which are controlled by dechlorination systems;
- reduction of the measurement frequency for pH and chlorine at EFPC outfalls with the additional requirement for measurements instream at two locations (Station 17 and monitoring location C11);
- a radiological monitoring plan requiring monitoring and reporting of uranium and other isotopes at pertinent locations (see Section 4.5.2);
- implementation of a storm water pollution prevention plan requiring sampling and characterization of storm water (see Section 4.5.3);
- storm water sampling of stream baseload sediment at four instream EFPC locations (see Section 4.5.3);
- a requirement for an annual storm water monitoring report, an annual report of the BMAP data;
- a requirement to manage the flow of EFPC such that a minimum flow of 19 million L/day (5 million gal/day) is guaranteed by adding raw water from the Clinch River to the headwaters of EFPC; and
- whole effluent toxicity testing limitation for the three outfalls of EFPC (see Section 4.5.8).

A notice of appeal of certain permit terms and limits for legacy constituents of mercury and PCBs was filed by NNSA in April 2006. The permit limits for toxicity at three outfalls were appealed because legacy contamination may adversely affect toxicity and their cleanup is addressed under CERCLA. Chlorine limits at the headwaters of the creek were also appealed, and a compliance schedule was requested so that a dechlorination unit could be put in place to handle a more stringent chlorine limit at Outfall 109. The dechlorination unit has since been installed in accordance with the compliance schedule. Issues associated with the appeal were not resolved before expiration of the permit.

An application for renewal of the NPDES permit was completed in June 2008 and was submitted to TDEC on July 1, 2008. This work effort included special sampling needed to fully characterize effluents and to properly complete permit application forms.

In early 2011 the TDEC Water Pollution Control NPDES permit writer assigned to the Y-12 Complex requested an update of monitoring data and began the process of permit review and renewal. A two volume summary of NPDES data was provided in February 2011. The new permit was issued on October 31, 2011, and became effective December 1, 2011.

The Industrial and Commercial User Wastewater Discharge Permit (1-91) was issued by the city of Oak Ridge to the Y-12 National Security Complex National Nuclear Security Administration on April 1, 2010. The permit, which expires on March 31, 2015, provides requirements for the discharge of wastewaters to the sanitary sewer system and prohibitions for certain types of wastewaters. There were six exceedances of the permit in 2011. All were the result of exceeding the maximum daily allowable flow limit. During the year, the city of Oak Ridge conducted two inspections under the Industrial Pretreatment Program (February 3, 2011, and August 25, 2011). The city of Oak Ridge requested, and NNSA has delivered, an action plan to address I/I into the sanitary sewer system. Members of the Clean Water Program continued to work on surface water programs such as Storm Water Pollution Prevention, including storm water sampling and site inspections, BMAP, and development of best management practice plans for projects and site activities. Work continued on streamlining data management for compliance reporting, review, approval, and tracking of water discharges and connections to the storm and sanitary sewer systems.

4.3.5 Safe Drinking Water Act

The City of Oak Ridge supplies potable water to the Y-12 Complex that meets all federal, state, and local standards for drinking water. The water treatment plant, located north of the Y-12 Complex, is owned and operated by the city of Oak Ridge.

The Tennessee Regulations for Public Water Systems and Drinking Water Quality, Chap.1200-5-1, sets limits for biological contaminants and for chemical activities and chemical contaminants. Sampling for total coliform, chlorine residuals, lead, copper, disinfectant by-product, and propylene glycol is conducted by the Y-12 Utilities Management Organization.

In 2011, the Y-12 Complex potable water system retained its approved status for potable water with TDEC. TDEC instituted a requirement for sampling the site potable water system for propylene glycol in 2007 after learning that an unapproved cross-connection exists between the Y-12 potable water system and the antifreeze fire sprinkler systems containing propylene glycol. Sampling of the potable water system for propylene glycol was continued in 2011. Laboratory results for all of the samples collected during 2011 were below the detection limits. There are future plans to eliminate these cross-connections.

All total coliform samples collected during 2011 were analyzed by the State of Tennessee laboratory, and the results were negative. Analytical results for disinfectant by-products (total trihalomethanes and haloacetic acids) for Y-12 Complex water systems were below TDEC and Safe Drinking Water Act (SDWA) limits. The Y-12 Complex potable water system is currently sampled triennially for lead and copper, and the system sampling was last completed in 2011. These results were below TDEC and SDWA limits and met the established requirements

4.3.6 Resource Conservation and Recovery Act

RCRA regulates hazardous wastes that, if mismanaged, could present risks to human health or the environment. The regulations are designed to ensure that hazardous wastes are managed from the point of generation to final disposal. In Tennessee, EPA delegates the RCRA program to TDEC, but EPA retains an oversight role. The Y-12 Complex is considered a "large-quantity generator" because it may generate more than 1,000 kg (2,205 lb) of hazardous waste in a month and because it has RCRA permits to store hazardous wastes for up to 1 year before shipping off the site to licensed treatment and disposal facilities. The Y-12 Complex also has a number of satellite accumulation areas (SAAs) and 90-day waste storage areas.

Mixed wastes are materials that are both hazardous (under RCRA guidelines) and radioactive. The Federal Facilities Compliance Act (1992) requires that DOE work with local regulators to develop a site treatment plan to manage mixed waste. Development of the plan has two purposes: to identify available treatment technologies and disposal facilities (federal or commercial) that are able to manage mixed waste produced at federal facilities and to develop a schedule for treating and disposing of the waste streams.

The ORR site treatment plan (TDEC 2011) is updated annually and submitted to TDEC for review. The October 2011 plan documents the mixed-waste inventory and describes efforts undertaken to seek new commercial treatment and disposal outlets for various waste streams. NNSA has developed a disposition schedule for the mixed waste in storage and will continue to maintain and update the plan as a reporting mechanism as progress is made. The Y-12 Complex is reducing its inventory of legacy mixed waste as part of the plan (Fig. 4.16).

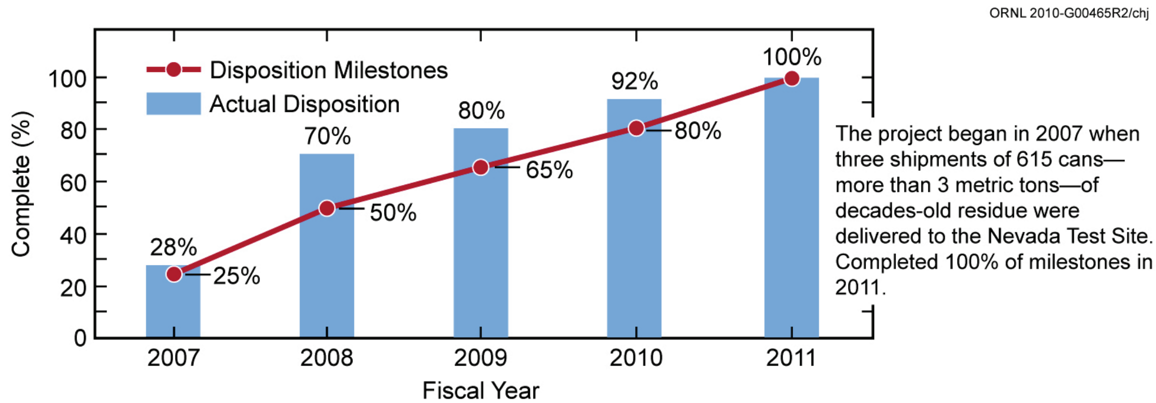

Fig. 4.16. Reducing inventory of legacy mixed waste as part of the Oak Ridge Reservation site treatment plan.

The quantity of hazardous and mixed wastes generated by the Y-12 Complex decreased in 2011 (Fig. 4.17). Repackaging and disposal of legacy mixed waste resulted in 100% completion of the milestones in the ORR site treatment plan. Ninety-five percent of the total hazardous and mixed waste generated in 2011 was generated as contaminated leachate from legacy operations. The Y-12 Complex currently reports waste on 110 active waste streams. The Y-12 Complex is a state-permitted treatment, storage, and disposal facility. Under its permits, the Y-12 Complex received 1,368 kg (3,016 lb) of hazardous and mixed waste from the off-site Union Valley analytical chemistry laboratory in 2011. In addition, 330,931 kg (729,537 lb) of hazardous and mixed waste was shipped to DOE-owned and commercial treatment, storage, and disposal facilities. More than 8 million kg (18 million lb) of hazardous and mixed wastewater was treated at on-site wastewater treatment facilities.

TDEC conducted a comprehensive inspection of the Y-12 Complex hazardous waste program in November 2011, including permitted storage facilities, SAAs, and 90-day accumulation areas. No violations were noted during the inspection.

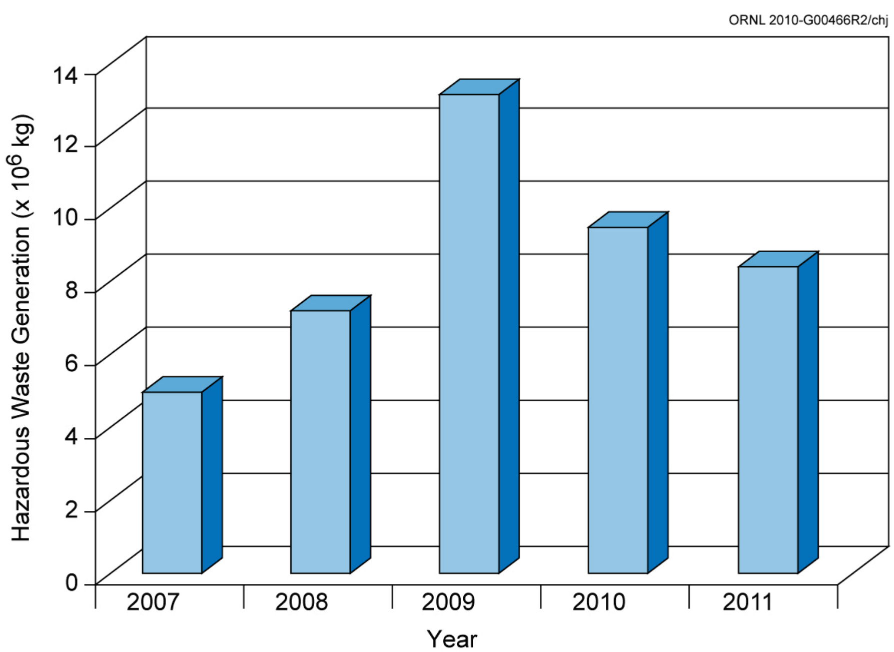

Fig. 4.17. Hazardous waste generation, 2007–2011.

4.3.6.1 Resource Conservation and Recovery Act Underground Storage Tanks

TDEC regulates the active petroleum USTs at the Y-12 Complex. Existing UST systems that are to remain in service at the Y-12 Complex must comply with performance requirements described in TDEC UST regulations (TN 1200-1-15). Three specific requirements are considered:

- release detection for both the tank and piping,
- corrosion protection for both the tank and piping, and
- spill/overfill prevention equipment.

The Y-12 Complex UST Program includes two active petroleum USTs that meet current regulatory compliance requirements. The UST registration fees for the tanks are current, enabling fuel delivery until March 31, 2012. All legacy petroleum UST sites at the Y-12 Complex have either been granted final closure by TDEC or have been deferred to the CERCLA process for further investigation and remediation. Plans are to close and remove these tanks in 2012.

4.3.6.2 Resource Conservation and Recovery Act Subtitle D Solid Waste

The ORR landfills operated by the DOE Office of Environmental Management program are located within the boundary of the Y-12 Complex. The facilities include two Class II operating industrial solid waste disposal landfills and one operating Class IV construction demolition landfill. The facilities are permitted by TDEC and accept solid waste from DOE operations on ORR. In addition, one Class IV facility (Spoil Area 1) is overfilled by 8,945 m^3 (11,700 yd^3) and has been the subject of a CERCLA RI/FS. A CERCLA ROD for Spoil Area 1 was signed in 1997. One Class II facility (Landfill II) has been closed and is subject to postclosure care and maintenance. Associated TDEC permit numbers are noted in Table 4.4. Additional information about the operation of these landfills is addressed in Section 4.8.3., "Waste Management."

4.3.7 Resource Conservation and Recovery Act-Comprehensive Environmental Response, Compensation, and Liability Act Coordination

The ORR FFA is intended to coordinate the corrective action processes of RCRA required under the Hazardous Waste Corrective Action permit (formerly known as the Hazardous and Solid Waste Amendments permit), with CERCLA response actions.

Three RCRA postclosure permits, one for each of the three hydrogeologic regimes at the Y-12 Complex, have been issued to address the eight major closed waste disposal areas at the Y-12 Complex. Because it falls under the jurisdiction of two postclosure permits, the S-3 Pond Site is described as having two parts, eastern and former S-3 (Table 4.5). Groundwater corrective actions required under the postclosure permits have been deferred to CERCLA. RCRA groundwater monitoring data were reported to TDEC and EPA in the annual groundwater monitoring report for the Y-12 Complex (UCOR 2012).

Table 4.5. Y-12 National Security Complex RCRA postclosure status for former treatment, storage, and disposal units on ORR

Unit	Major components of closure	Major postclosure requirements
	Upper East Fork Poplar Creek Hydrogeologic Regime (RCRA Postclosure Permit No. TNHW-113)	
New Hope Pond	Engineered cap, Upper East Fork Poplar Creek distribution channel	Cap inspection and maintenance. No current groundwater monitoring requirements in lieu of ongoing CERCLA actions in the eastern portion of Y-12 Complex
Eastern S-3 Ponds Groundwater Plume	None for groundwater plume, see former S-3 Ponds (S-3 Site) for source area closure	Postclosure corrective action monitoring. Inspection and maintenance of monitoring network

Table 4.5. (continued)

Unit	Major components of closure	Major postclosure requirements
	Chestnut Ridge Hydrogeologic Regime (RCRA Postclosure Permit No. TNHW-128)	
Chestnut Ridge Security Pits	Engineered cap	Cap inspection and maintenance. Postclosure corrective action monitoring. Inspection and maintenance of monitoring network and survey benchmarks
Kerr Hollow Quarry	Waste removal, access controls	Access controls inspection and maintenance. Postclosure detection monitoring. Inspection and maintenance of monitoring network and survey benchmarks
Chestnut Ridge Sediment Disposal Basin	Engineered cap	Cap inspection and maintenance. Postclosure detection monitoring. Inspection and maintenance of monitoring network and survey benchmarks
East Chestnut Ridge Waste Pile	Engineered cap	Cap inspection and maintenance. Postclosure detection monitoring. Inspection and maintenance of monitoring network, leachate collection sump, and survey benchmarks. Management of leachate
	Bear Creek Hydrogeologic Regime (RCRA Postclosure Permit No. TNHW-116)	
Former S-3 Ponds (S-3 Site)	Neutralization and stabilization of wastes, engineered cap, asphalt cover	Cap inspection and maintenance. Postclosure corrective action monitoring. Inspection and maintenance of monitoring network and survey benchmarks
Oil Landfarm	Engineered cap	Cap inspection and maintenance. Postclosure corrective action monitoring. Inspection and maintenance of monitoring network and survey benchmarks
Bear Creek Burial Grounds A-North, A-South, and C-West and the walk-in pits	Engineered cap, leachate collection system specific to the burial grounds	Cap inspection and maintenance. Post-closure corrective action monitoring. Inspection and maintenance of monitoring network and survey benchmarks

Abbreviations
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
RCRA = Resource Conservation and Recovery Act
Y-12 Complex = Y-12 National Security Complex

Periodic updates of proposed construction and demolition activities at the Y-12 Complex (including alternative financing projects) 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 that warrant CERCLA oversight. The goal is to ensure that modernization efforts do not impact the effectiveness of previously completed CERCLA environmental remediation actions and that they do not adversely impact future CERCLA environmental remediation actions.

4.3.8 Toxic Substances Control Act

The storage, handling, and use of PCBs are regulated under TSCA. Capacitors manufactured before 1970 that are believed to be oil filled are handled as though they contained PCBs, even when that cannot be verified from manufacturer records. Certain equipment containing PCBs and PCB waste containers must be inventoried and labeled. The inventory is updated by July 1 of each year. The 2011 annual PCB inventory was submitted June 16, 2011.

Given the widespread historical uses of PCBs at the Y-12 Complex and fissionable material requirements that must be met, an agreement between EPA and DOE was negotiated to assist ORR facilities in becoming compliant with TSCA regulations. This agreement, known as the Oak Ridge Reservation Polychlorinated Biphenyl Federal Facilities Compliance Agreement (ORR PCB FFCA), which became effective in 1996, provides a forum with which to address PCB compliance issues that are truly unique to these facilities. Y-12 Complex operations involving TSCA-regulated materials were conducted in accordance with TSCA regulations and the ORR PCB FFCA.

The final shipment of legacy PCB waste occurred on August 22, 2011. This completes the removal of legacy PCB waste, some of which has been stored since 1997, in accordance with the terms of the ORR PCB FFCA.

4.3.9 Preventing Spills and Reporting Spills/Releases

4.3.9.1 Preventing Oil Pollution and Spills

The Y-12 Complex maintains its *Spill Prevention, Control, and Countermeasures Plan* (SPCC Plan) (B&W Y-12 2010?) to prevent spills of oil and hazardous constituents and document the countermeasures to be invoked should a spill occur. A revision to the SPCC Plan was issued in 2010. This revision updated general Y-12 Complex spill prevention techniques and, in particular, reflected the addition of a fuel oil storage tank and dike system built and operated as part of the new Y-12 Complex Steam Plant.

In general, the first response of an individual discovering a spill is to call the plant shift superintendent. Spill response materials and equipment are stored near tanks and drum storage areas and other strategic areas of the Y-12 Complex to facilitate spill response. All Y-12 Complex personnel and subcontractors are required to have initial spill and emergency response training before they can work on the site. This training is received as part of the GET program.

4.3.9.2 Emergency Reporting Requirements

EPCRA and SARA Title III require that facilities report inventories (i.e., Tier II Report sent to the local emergency planning committees and the state emergency response commission) and releases (i.e., Toxic Release Inventory Report submitted to state and federal environmental agencies) of certain chemicals that exceed specific release thresholds. The Y-12 Complex complied with those requirements in 2011 through the submittal of reports under EPCRA Sections 302, 303, 311, 312, and 313. The Y-12 Complex had no releases of extremely hazardous substances as defined by EPCRA in 2011.

One Section 311 notification was made in 2011 because a chemical exceeded the reporting threshold. This chemical was not new to Y-12 operations, but it was the first time it had exceeded the reporting threshold. 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 Section 312. Y-12 reported 59 chemicals in inventory that were over threshold during the 2011 reporting year.

Each ORR facility evaluates its respective operations to determine applicability for submittal of annual toxic release inventory reports (Section 313) to EPA and TEMA 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 these chemicals are evaluated to determine which chemicals exceeded the reporting thresholds based on amounts manufactured, processed, or otherwise used at each facility. After threshold determinations are made, releases and off-site transfers are calculated for each chemical that exceeded one or more of the thresholds.

Total 2011 reportable toxic releases to air, water, and land and waste transferred off the site for treatment, disposal, and recycling were 29,312 kg (64,623 lb). Table 4.6 lists the reported chemicals for the Y-12 Complex for 2010 and 2011 and summarizes releases and off-site transfers for those chemicals exceeding reporting thresholds.

Table 4.6. Emergency Planning and Community Right-to-Know Act Section 313 toxic chemical release and off-site transfer summary for the Y-12 Complex, 2010 and 2011

Chemical	Year	Quantity[a] (lb)[b]
Chromium	2010	*c*
	2011	*c*
Cobalt	2010	*c*
	2011	*c*
Copper	2010	4,265
	2011	7,043
Lead compounds	2010	73,412
	2011	8,467
Manganese	2010	*c*
	2011	*d*
Mercury	2010	*d*
	2011	3,322
Mercury compounds	2010	13
	2011	*d*
Methanol	2010	52,709
	2011	43,505
Nickel	2010	*c*
	2011	2,286
Silver	2010	*c*
	2011	*c*
Total	2010	130,399
	2011	64,623

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

[b]1 lb = 0.45359237 kg.

[c]Not applicable because releases were less than 500 lb; hence, a Form A was submitted.

[d]Not reported for the year (i.e., below threshold).

4.3.9.3 Spills and Releases

The Y-12 Complex has procedures for notifying off-site authorities for categorized events at the Y-12 Complex. Off-site notifications are required for specified events according to federal statutes, DOE orders, and the Tennessee Oversight Agreement. As an example, any observable oil sheen on EFPC and any release impacting surface water must be reported to the EPA National Response Center in addition to other reporting requirements. Spills of CERCLA RQ limits must be reported to the EPA National Response Center, DOE, TEMA, and the Anderson County Local Emergency Planning Committee.

There were no releases of hazardous substances exceeding an RQ. There was one reported oil sheen and one release into upper EFPC that resulted in a fish kill (see Section 4.3.9.4).

4.3.9.4 Environmental Occurrences

The Y-12 occurrence reporting program provides timely notification to the DOE community of Y-12 Complex events and site conditions that could adversely affect the public or worker health and safety, the environment, national security, DOE's safeguards and security interests, functioning of DOE facilities, or the department's reputation.

Y-12 Complex occurrences are categorized and reported through the Occurrence Reporting and Processing System (ORPS). ORPS provides NNSA and the DOE community with a readily accessible database of information about occurrences at DOE facilities, causes of those occurrences, and corrective actions to prevent recurrence of the events. DOE analyzes aggregate occurrence information for generic implications and operational improvements.

Regulatory agencies were notified on June 28, 2011, of an oil sheen on EFPC. The duration was around 2 h, and the volume of the release was estimated to be less than 1 gal. This was the Y-12 Complex's first reportable release since 2009. Occurrence report NA--YSO-BWXT-Y12SITE-2011-0016, Visible Oil Sheen on East Fork Poplar Creek, was filed. A search was initiated to determine a potential source for the material. Construction activities and Fire Department flushing operations were reviewed, but a definitive source could not be confirmed.

The TDEC Division of Underground Storage Tanks issued an NOV (Occurrence NA--YSO-BWXT-Y12SITE-2011-0017) on June 29, 2011, for failure to report a suspected release from a UST system within 72 h. The NOV was based on the January 25, 2011, failure of an annual line tightness test of two regular unleaded gasoline lines serving a UST system at the Y-12 Complex. Upon failing the test, the lines were taken out of service and fuel dispensing was discontinued as a protective measure. Examination of the system found an automatic line leak detector to be malfunctioning thus preventing fuel from entering a line. The leak detector was replaced and the line tightness test was passed on June 27, 2011. Examination of the second line found a malfunctioning ball valve which prevented the line from holding fuel. The valve was replaced and the line tightness test was passed on July 12, 2011. Based on the type of malfunctions of the system, which did not allow fuel in the lines, no release occurred or was suspected. In addition, this UST system is equipped to perform statistical analysis of the inventory. Data from this system confirmed that no release of fuel occurred from the system.

A fish kill was discovered on July 21, 2011, in the upper portions of EFPC inside the boundaries of the Y-12 Complex, and TDEC was notified. Occurrence report NA--YSO-BWXT-Y12SITE-2011-0019, Fish Kill Event in Upper East Fork Poplar Creek, was filed. Over a 3-day period, a survey of the creek recovered a total of 650 minnow-sized fish (mostly stonerollers), crayfish, and clams. Surveys conducted July 23 identified living fish throughout the creek, and the overall impact to the creek was determined to be localized and insignificant. Follow-up checks of EFPC confirmed that aquatic life was doing well. A combination of a number of factors is believed to have caused the fish to die. These include stream conditions such as low flow, elevated water temperatures, depressed dissolved oxygen as the result of flow management water being off, and a discharge of cloudy water which occurred on the afternoon of July 20. The discharge, which lasted about 1.5 h, was from the storm drain system upstream of Outfall 200 and likely associated with discharges from the WEMA Storm Sewer Remediation Project (see Section 4.8.2.) among other factors (see Section 4.5.1).

4.3.9.5 Mercury Removal from Storm Drain Catch Basins

In May 2003, metallic mercury was observed in two storm drain catch basins located in the west end of the Y-12 Complex. The storm drain line on which the catch basins are located flows into EFPC at Outfall 200. Mercury tends to collect at those low spots in the drain system following heavy rains. During 2011, spill response and waste services personnel conducted six removals and recovered an estimated 5.4 kg (12.0 lb) of mercury. About 38.3 kg (84.5 lb) have been recovered since 2003.

4.3.10 Audits and Oversight

A number of federal, state, and local agencies oversee Y-12 Complex activities. In 2011, the Y-12 Complex was inspected by federal, state, or local regulators on five occasions. The TDEC Department of Energy Oversight Division maintained a part-time regulator on-site who provided periodic oversight of Y-12 Complex activities. Except for work completed under the ORR FFA, TDEC DOE oversight work is nonregulatory. This clarification is made to avoid any misunderstanding of the TDEC DOE Oversight

Division's role at the Y-12 Complex. Most other matters such as CAA, CWA, and RCRA are regulated by TDEC's Knoxville Basin Office, not the TDEC DOE Oversight Division. The Environmental Restoration Section at the TDEC DOE Oversight Division handles CERCLA matters at the Y-12 Complex. In addition to external audits and oversight, the Y-12 Complex has a comprehensive self-assessment program.

An inspector from TDEC conducted an unannounced hazardous waste compliance inspection at the Analytical Chemistry Organization's Union Valley Facility on April 12, 2011. There were no findings or concerns. TDEC inspectors completed their annual compliance inspection of the Y-12 Complex's hazardous waste management practices November 1. The five member audit team inspected more than 40 RCRA-permitted storage and accumulation areas and examined RCRA annual reports, training records, spill control equipment, waste characterization records, hazardous waste manifests, and waste reduction reports. This year is the fourth consecutive year that no noncompliance findings were identified.

Table 4.7 provides a summary of external regulatory audits and reviews for 2011.

Table 4.7. Summary of external regulatory audits and reviews, 2011

Date	Reviewer	Subject	Issues
February 3	City of Oak Ridge	Semiannual Industrial Pretreatment Compliance Inspection	0
April 12	TDEC	RCRA Inspection of the Union Valley Facility	0
August 3–4	TDEC	Annual Clean Air Compliance Inspection	0
August 25	City of Oak Ridge	Semiannual Industrial Pretreatment Compliance Inspection	0
October 31–November 1	TDEC	Annual RCRA Inspection	0

Abbreviations
TDEC = Tennessee Department of Environment and Conservation
RCRA = Resource Conservation and Recovery Act

4.4 Air Quality Program

Permits issued by the State of Tennessee are the primary vehicle used to convey the clean air requirements that are applicable to the Y-12 Complex. New projects are governed by construction permits, and eventually, the requirements are incorporated into the sitewide Title V operating permit. Sections of the Title V permit contain requirements that are generally applicable to most industrial sites. Examples include requirements associated with asbestos controls, control of stratospheric ozone-depleting chemicals, control of fugitive emissions, and general administration of the permit. The Title V permit also contains a section of specific requirements directly applicable to individual sources of air emissions at the Y-12 Complex. Major requirements in that section include the Rad-NESHAP (40 CFR 61) requirements and the numerous requirements associated with emissions of criteria pollutants and other hazardous air pollutants (nonradiological). In addition, a number of sources that are exempt from permitting requirements under state rules but subject to listing on the Title V permit application are documented, and information about them is available upon request from the state.

Ambient air monitoring, while not specifically required by any permit condition, is conducted at the Y-12 Complex to satisfy DOE order requirements, as a best management practice, and/or to provide evidence of sufficient programmatic control of certain emissions. Ambient air monitoring conducted specifically for the Y-12 Complex (i.e., mercury monitoring) is supplemented by additional monitoring conducted for ORR and by both on-site and off-site monitoring conducted by TDEC. In addition, the overall effectiveness of the CAA compliance program is ensured by internal audits and external audits such as the annual inspection conducted by State of Tennessee personnel.

4.4.1 Construction and Operating Permits

In 2011, the Y-12 Complex had two construction air permits: one for the replacement steam plant, the other for machining beryllium and/or beryllium compounds.

The DOE NNSA and Y-12 Complex Title V permits in 2011, two permits with a request to combine them into one permit, included 35 air emission sources and more than 100 air emission points. All remaining emission sources are categorized as insignificant and exempt from permitting. The Tennessee Air Pollution Control Board issued a minor modification to the Title V Major Source Operating Permit 554701 on April 5, 2009. The minor modification was to align permit conditions with site transformation activities. Permit change requests at the end of 2011 included

- a request to convert one construction permit to an operating permit;
- a request to combine permit 554594 (which only has one emission source) into the existing Y-12 Complex sitewide permit;
- a request to add the new steam plant to the operating permit;
- a request to add Fuel Station Stage 1 emission control requirements to the permit;
- a request to change a condition in a construction permit to add beryllium to the process;
- a request to convert the machining operation for adding beryllium to an operating permit;
- a request for an operational flexibility change for the metal working operation;
- an update to the major source (Title V) operating air permit renewal application; and
- a request to change a condition in a construction permit to delete fuel oil limit from the permit.

The Y-12 Complex major source (Title V) operating air permit renewal application was prepared and hand-delivered to TDEC personnel in April 2009. As part of the permit application renewal, it was requested that TDEC combine Air Permit 554594 into Air Permit 554701 followed by cancellation of Air Permit 554594. The complete permit application consists of four volumes. The complete, unedited application consists of Volumes 1, 2, 3.2, and 4.3. Volumes 3.1, 4.1, and 4.2, which are edited for classification reasons, were provided to TDEC for review and approval. Any classified information is held on-site at the Y-12 Complex for the appropriately Q-cleared TDEC personnel to review as needed. The Title V renewal operating air permit from TDEC was issued January 8, 2012, and incorporates all the change requests that were previously submitted to TDEC.

Permit administration fees in excess of $70,000 per year are paid to TDEC in support of the Title V program. B&W Y-12 has chosen to pay the fees based on a combination of actual emissions (steam plant, methanol, solvent 140 VOC) and allowable emissions (balance of plant). In years when a detailed air emission inventory is not required to be compiled for Y-12 Complex operations, the emissions ledger compiled to support the annual fee payment is the most comprehensive presentation of total site emissions. In 2011, emissions categorized as actual emissions totaled 60,011 kg (66.15 tons), and emissions calculated by the allowable method totaled 642,316 kg (708.02 tons). The total emissions fee paid was $19,661.63.

Demonstrating compliance with the conditions of air permits is a significant effort at the Y-12 Complex. Key elements of maintaining compliance are maintenance and operation of control devices, monitoring, record keeping, and reporting. High-efficiency particulate air (HEPA) filters and scrubbers are control devices used at the Y-12 Complex. HEPA filters are found throughout the complex, and in-place testing of HEPA filters to verify the integrity of the filters is routinely performed. Scrubbers are operated and maintained in accordance with source-specific procedures. Monitoring consists of tasks such as continuous stack sampling, one-time stack sampling, and monitoring the operation of control devices. Examples of continuous stack sampling are the radiological stack monitoring systems on numerous sources throughout the complex.

The Y-12 Complex sitewide permit requires annual and semiannual reports. One report is the overall ORR radiological NESHAP report (CFR 2009a), which includes specific information regarding Y-12 Complex emissions; the second is an annual Title V compliance certification report indicating compliance status with all conditions of the permit. Table 4.8 gives the actual emissions verses allowable emissions for the Y-12 Complex Steam Plant.

Table 4.8. Actual versus allowable air emissions from the Y-12 Complex Steam Plant, 2011

Pollutant	Emissions (tons/year)[a]		Percentage of allowable
	Actual	Allowable	
Particulate	5	41	12.2
Sulfur dioxide	0.4	39	1.0
Nitrogen oxides[b]	21	81	25.9
Volatile organic compounds[b]	3	9.4	31.9
Carbon monoxide[b]	51	139	36.7

NOTE: The emissions are based on fuel usage data for May through December 2011. The emissions also included the fuel used during testing.

[a]1 ton = 907.2 kg.

[b]When there is no applicable standard or enforceable permit condition for some pollutants, the allowable emissions are based on the maximum actual emissions calculation as defined in Tennessee Department of Environment and Conservation Rule 1200-3-26-.02(2)(d)3 (maximum design capacity for 8,760 h/year). The emissions for both the actual and allowable emissions were calculated based on the latest US Environmental Protection Agency compilation of air pollutant emission factors (EPA 1995 and 1998. *Compilation of Air Pollutant Emission Factors AP-42, Fifth Edition, Volume 1: Stationary Point and Area Sources*. Environmental Protection Agency, Research Triangle Park, N.C., January 1995 and September 1998).

4.4.1.1 Generally Applicable Permit Requirements

The Y-12 Complex, like many industrial sites, has a number of generally applicable requirements that require management and control. Asbestos, ODSs, and fugitive particulate emissions are notable examples.

4.4.1.1.1 Control of Asbestos

The Y-12 Complex has numerous buildings and equipment that contain asbestos-containing materials. The compliance program for management of removal and disposal of asbestos-containing materials includes demolition and renovation notifications to TDEC and inspections, monitoring, and prescribed work practices for abatement and disposal of asbestos materials. There was no reportable release of asbestos in 2011. There were three notifications of asbestos demolition or renovation submitted to TDEC in 2011; all were for demolitions. All have been completed.

4.4.1.1.2 Stratospheric Ozone Protection

The *Y-12 Complex Ozone Depleting Substances (ODS) Phase-Out and Management Plan* (B&W Y-12 2009a) provides a complete discussion of requirements and compliance activities at the Y-12 Complex. Past ODS reduction initiatives began in the early 1980s and focused on Class I ODS use in refrigerants and solvent cleaning operations. Only one small chiller remains at the Y-12 Complex which contains Class I ODSs. This system has a 454 kg (1,000 lb) charge of refrigerant and was manufactured in 1990. If it is determined to be economically practicable, this system will be retrofitted with a non-Class I ODS refrigerant.

Y-12 Complex initiatives have also involved elimination of ODS solvents in cleaning processes. Operations personnel developed and implemented changes in one process which eliminated ODS solvent from that process. Evaluation of ODS reduction opportunities continue for another solvent cleaning operation. Future actions related to this process will be dependent on ongoing efforts to identify a safe and viable replacement chemical or to identify practical and cost-effective modifications to process equipment.

All Class I and Class II substitutions are made in accordance with EPA's Significant New Alternatives Program (SNAP). Y-12 Complex personnel are notified as EPA issues regulations detailing SNAP replacement chemicals which may be applicable to Y-12 Complex operations. To prevent ODSs from coming on-site, procurement documents are written to ensure that no additional equipment or processes using Class I ODSs are brought onsite, and Class II ODS usage is limited wherever possible.

Infrastructure reduction activities also led to the reduction of ODS substances on site. All refrigerants and solvents must be removed from equipment before disposal. Recovered ODSs are typically recycled/reused in other equipment in the Y-12 Complex. However, Class I ODSs deemed excess must be transferred to the Defense Logistics Agency as needed. Remaining ODSs are offered to other DOE sites or government agencies, sold, or properly disposed if not useable.

4.4.1.1.3 Fugitive Particulate Emissions

As modernization and infrastructure reduction efforts increase at the Y-12 Complex, the need also increases for good work practices and controls to minimize fugitive dust emissions from construction and demolition activities. Y-12 Complex personnel continue to use a mature project planning process to review, recommend, and implement appropriate work practices and controls to minimize fugitive dust emissions.

4.4.1.2 National Emission Standards for Hazardous Air Pollutants for Radionuclides

The release of radiological contaminants, primarily uranium, into the atmosphere at the Y-12 Complex occurs almost exclusively as a result of plant production, maintenance, and waste management activities. The major radionuclide emissions contributing to the dose from the Y-12 Complex are ^{234}U, ^{235}U, ^{236}U, and ^{238}U, which are emitted as particulates. The particle size and solubility class of the emissions are determined based on review of the operations and processes served by the exhaust systems to determine the quantity of uranium handled in the operation or process, the physical form of the uranium, and the nature of the operation or process. The four categories of processes or operations that are considered when calculating the total uranium emissions are

- those that exhaust through monitored stacks;
- unmonitored processes for which calculations are performed per Appendix D of 40 CFR 61 (CFR 2009b);
- processes or operations exhausting through laboratory hoods, also involving Appendix D calculations; and
- emissions from room ventilation exhausts (calculated using radiological control monitoring data from the work area).

Continuous sampling systems are used to monitor emissions from a number of process exhaust stacks at the Y-12 Complex. In addition, a probe-cleaning program is in place, and the results from the probe cleaning at each source are incorporated into the respective emission point source term. In 2011, 40 process exhaust stacks were continuously monitored, 34 of which were major sources; the remaining 6 were minor sources. The sampling systems on these stacks have been approved by EPA Region 4.

During 2011, unmonitored uranium emissions at the Y-12 Complex occurred from 37 emission points associated with on-site, unmonitored processes and laboratories operated by B&W Y-12. Emission estimates for the unmonitored processes and laboratory stacks were made using inventory data with emission factors provided in 40 CFR Part 61, Appendix D (CFR 2009b). The Y-12 Complex source term includes an estimate of those unmonitored emissions.

The B&W Y-12 Analytical Chemistry Organization operates out of two main laboratories. One is located on the site in Building 9995 and is included in the discussion above. The other is located in a leased facility on Union Valley Road, about 0.3 miles east of the Y-12 Complex, and is not within the ORR boundary. In 2011, there were no emission points (or sources) in the off-site laboratory facility.

Additionally, estimates from room ventilation systems are considered using radiological control data on airborne radioactivity concentrations in the work areas. Where applicable, exhausts from any area where the monthly concentration average exceeds 10% of the derived air concentration (DAC) as defined in the ORR radionuclide compliance plan (DOE 2005) are included in the annual source term. Annual average concentrations and design ventilation rates are used to arrive at the annual emission estimate for those areas. Two emission points from room ventilation exhausts were identified in 2011 where emissions exceeded 10% of DAC. These emission points feed to monitored stacks, and any radionuclide emissions are accounted for as noted for monitored emission points.

The Y-12 Complex Title V Major Source Operating Permits contain a sitewide, streamlined alternate emission limit for enriched and depleted uranium process emission units. A limit of 907 kg (2,000 lb) per year of particulate was set for the sources for the purposes of paying fees. The compliance method defined for Permit 554701, Condition E3, and Permit 554594, Condition E4, requires the annual actual mass emission particulate emissions to be generated using the same monitoring methods required for Rad-NESHAP compliance. An estimated 4.9E-3 Ci (0.53 kg) of uranium was released into the atmosphere in 2011 as a result of Y-12 Complex process and operational activities (Figs. 4.18 and 4.19).

The calculated radiation dose to the maximally exposed off-site individual from airborne radiological release points at the Y-12 Complex during 2011 was 0.1 mrem. This dose is well below the NESHAP standard of 10 mrem and is less than 0.04% of the roughly 300 mrem that the average individual receives from natural sources of radiation. (See Section 7.1.2. for an explanation of how the airborne radionuclide dose was determined.)

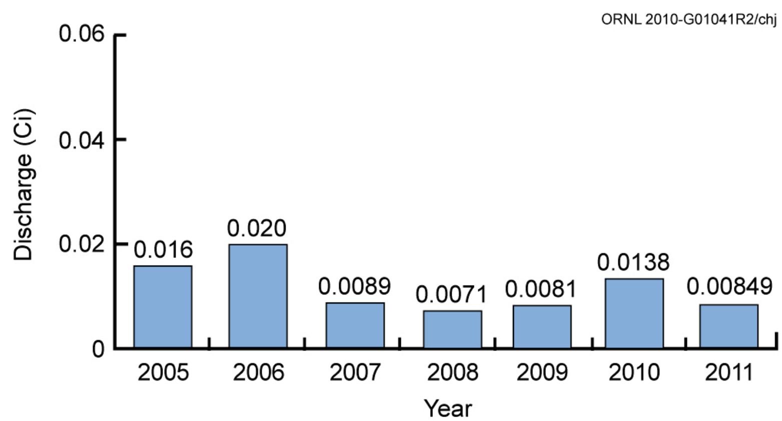

Fig. 4.18. Total curies of uranium discharged from the Y-12 Complex to the atmosphere, 2005–2011.

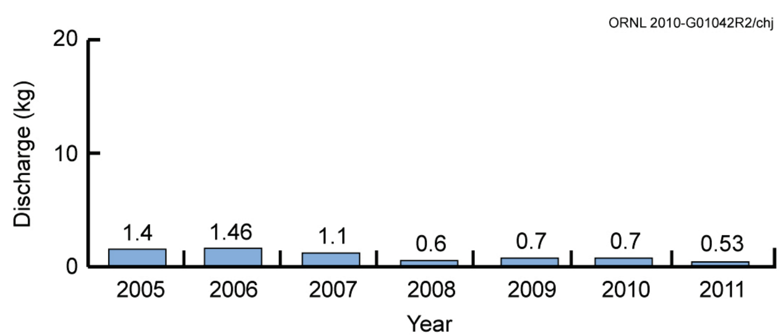

Fig. 4.19. Total kilograms of uranium discharged from the Y-12 Complex to the atmosphere, 2005–2011.

4.4.1.3 Quality Assurance

QA activities for the Rad-NESHAP program are documented in *Y-12 National Security Complex Quality Assurance Project Plan for National Emission Standards for Hazardous Air Pollutants (NESHAP) for Radionuclide Emission Measurements* (B&W Y-12 2010a). The plan satisfies the QA requirements in 40 CFR Part 61, Method 114 (CFR 2007), for ensuring that the radionuclide air emission measurements from the Y-12 Complex are representative to known levels of precision and accuracy and that administrative controls are in place to ensure prompt response when emission measurements indicate an increase over normal radionuclide emissions. The requirements are also referenced in TDEC regulation 1200-3-11-.08. The plan ensures the quality of the Y-12 Complex radionuclide emission measurements data from the continuous samplers, breakthrough monitors, and minor radionuclide release points. It specifies the procedures for management of activities affecting the quality of data. QA objectives for completeness, sensitivity, accuracy, and precision are discussed. Major programmatic elements addressed in the QA plan are the sampling and monitoring program, emissions characterization, analytical program, and minor source emission estimates.

4.4.1.4 Source-Specific Criteria Pollutants

Proper maintenance and operation of a number of control devices (e.g., HEPA filters and scrubbers) are key to controlling emissions of criteria pollutants. The primary source of criteria pollutants at the Y-12 Complex is the steam plant, where natural gas and Number 2 fuel oil were burned in 2011. Information regarding actual vs allowable emissions from the steam plant is provided in Table 4.8.

Particulate emissions from point sources result from many operations throughout the Y-12 Complex. Compliance demonstration is achieved via several activities, including monitoring the operations of control devices, limiting process input materials, and using certified readers to conduct stack-visible emission evaluations.

Use of Solvent 140 and methanol throughout the complex and use of acetonitrile at a single source are primary sources of VOC emissions. Material mass balances and engineering calculations are used to determine annual emissions.

The results of monitoring a number of process parameters and the results of stack monitoring are provided in reports to TDEC quarterly, semiannually, and annually. All monitored results, including stack-monitoring results, were provided in reports in 2011 and were in compliance with the Title V permit.

4.4.1.5 Mandatory Reporting of Greenhouse Gas Emissions under 40 CFR 98

Title 40 of the Code of Federal Regulations Part 98, "Mandatory Greenhouse Gas Reporting," establishes mandatory GHG reporting requirements for owners and operators of certain facilities that directly emit GHGs and for certain fossil fuel suppliers and industrial GHG suppliers. The purpose of the rule is to collect accurate and timely data on GHG emissions that can be used to inform future policy decisions.

The mandatory reporting of GHGs rule requires reporting of annual emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons, perfluorochemicals, and other fluorinated gases (e.g., nitrogen trifluoride and hydrofluorinated ethers). These gases are often expressed in metric tons of CO_2 equivalent (CO_2e).

The Y-12 Complex is subject only to the Subpart A general provisions and reporting from stationary fuel combustion sources covered in Subpart C, General Stationary Fuel Combustion. Currently the rule does not require control of GHGs; rather, it requires only that sources emitting above the 25,000 CO_2e threshold level monitor and report emissions.

The Y-12 Complex Steam Plant is subjected to this rule. The steam plant consists of four boilers. The maximum heat input capacity of each boiler shall not exceed 99 MM Btu/h. Natural gas is the primary fuel source for these boilers with Number 2 fuel oil as a backup source of fuel. Other limited stationary combustion sources are metal forming operations and production furnaces that use natural gas. In Building 9212, a gas-fired furnace used for drying wet residues and burning solids in a recovery process has a maximum heat input of 700,000 Btu/h. In Building 9215, 10 natural gas torches, each at 300 standard ft^3/h, are used to preheat tooling associated with a forging and forming press. In Building 9204-2, natural gas is used to heat two electrolytic cells. The maximum rated heat input to the burners on each cell is 550,000 Btu/h.

All of the combustion units burning natural gas are served through the fuel supply and distribution system and are reported as combined emissions consistent with the provisions of 40 CFR 98.36(c)(3). The Tier 1 Calculation Method was used to calculate GHGs from the Y-12 Complex. The amount of natural gas supplied to the site, along with the fuel usage logs provides the basic information for calculation of the GHG emissions.

The emission report is submitted electronically in a format specified by the EPA administrator. Each report is signed by a designated representative of the owner or operator, certifying under penalty of law that the report has been prepared in accordance with the requirements of the rule. The total amount of GHGs, subject to the mandatory reporting rule, emitted from the Y-12 Complex in 2010 was 97,609.8 metric tons CO_2e. In 2011, the Y-12 Complex emitted 70,186.7 metric tons CO_2e. The decrease in emissions is associated with the fact that coal is no longer burned since the natural-gas-fired steam plant came online.

4.4.1.6 Hazardous Air Pollutants (Nonradiological)

Beryllium emissions from machine shops are regulated under a state-issued permit and are subject to a limit of 10 g/24 h. Compliance is demonstrated through a one-time stack test and through monitoring of control device operations. Hydrogen fluoride is used at one emission source, and emissions are controlled through the use of scrubber systems. The beryllium control devices and the scrubber systems were monitored during 2011 and found to be operating properly.

Methanol is released as fugitive emissions (e.g., pump and valve leaks) as part of the brine/methanol system. Methanol is subject to state air permit requirements; however, due to the nature of its release (fugitive emissions only), there are no specific emission limits or mandated controls. Mercury is a significant legacy contaminant at the Y-12 Complex, and cleanup is being addressed under the environmental remediation program. Like methanol emissions, mercury air emissions from legacy sources are fugitive in nature and therefore are not subject to specific air emission limits or controls. On-site monitoring of mercury is conducted and is discussed under Section 4.4.2, “Ambient Air.”

In 2007 EPA vacated a proposed MACT which was intended to minimize hazardous air pollution emissions. At that time a case-by-case MACT review was conducted as part of the construction permitting process for the Y-12 Complex replacement steam plant. The new natural-gas-fired steam plant came online on April 20, 2010, and coal is no longer combusted. Specific conditions aimed at minimizing hazardous air pollutant emission from the new steam plant were incorporated into the operating permit issued January 8, 2012 (see Section 4.4.1).

Unplanned releases of hazardous air pollutants are regulated through the Risk Management Planning regulations. Y-12 Complex personnel have determined there are no processes or facilities containing inventories of chemicals in quantities exceeding thresholds specified in rules pursuant to CAA, Title III, Sect.112(r), “Prevention of Accidental Releases.” Therefore, the Y-12 Complex is not subject to that rule. Procedures are in place to continually review new processes and/or process changes against the rule thresholds.

4.4.2 Ambient Air

To understand the complete picture of ambient air monitoring in and around the Y-12 Complex, data from monitoring conducted on- and off-site specifically for the Y-12 Complex, DOE reservationwide monitoring, and on- and off-site monitoring conducted by TDEC personnel must be considered. No federal regulations, state regulations, or DOE orders require ambient air monitoring within the Y-12 Complex boundary; however, on-site ambient air monitoring for mercury and radionuclides is conducted as a best management practice. With the reduction of plant operations and improved emission and administrative controls, levels of measured pollutants have decreased significantly during the past several years. In addition, major processes that result in emission of enriched and depleted uranium are equipped with stack samplers that have been reviewed and approved by EPA to meet requirements of the NESHAP regulations.

4.4.2.1 Mercury

The Y-12 Complex ambient air monitoring program for mercury was established in 1986 as a best management practice. The objectives of the program have been to maintain a database of mercury concentration in ambient air, to track long-term spatial and temporal trends in ambient mercury vapor, and to demonstrate protection of the environment and human health from releases of mercury to the atmosphere at the Y-12 Complex. Originally, four monitoring stations were operated at the Y-12 Complex, including two within WEMA (i.e., the former west end mercury-use area at Y-12). The two atmospheric mercury monitoring stations currently operating at the Y-12 Complex, Ambient Air Station No. 2 (AAS2) and AAS8, are located near the east and west boundaries of the Y-12 Complex, respectively (Fig. 4.20). Since their establishment in 1986, AAS2 and AAS8 have monitored mercury in ambient air continuously with the exception of short intervals of downtime because of electrical or equipment outages. In addition to the monitoring stations located at the Y-12 Complex, two additional monitoring sites were operated: a reference site (Rain Gauge No. 2) was operated on Chestnut Ridge in the Walker Branch Watershed for a 20-month period in 1988 and 1989 to establish a reference concentration (RfC), and a site was operated at New Hope Pond for a 25-month period from August 1987 to September 1989.

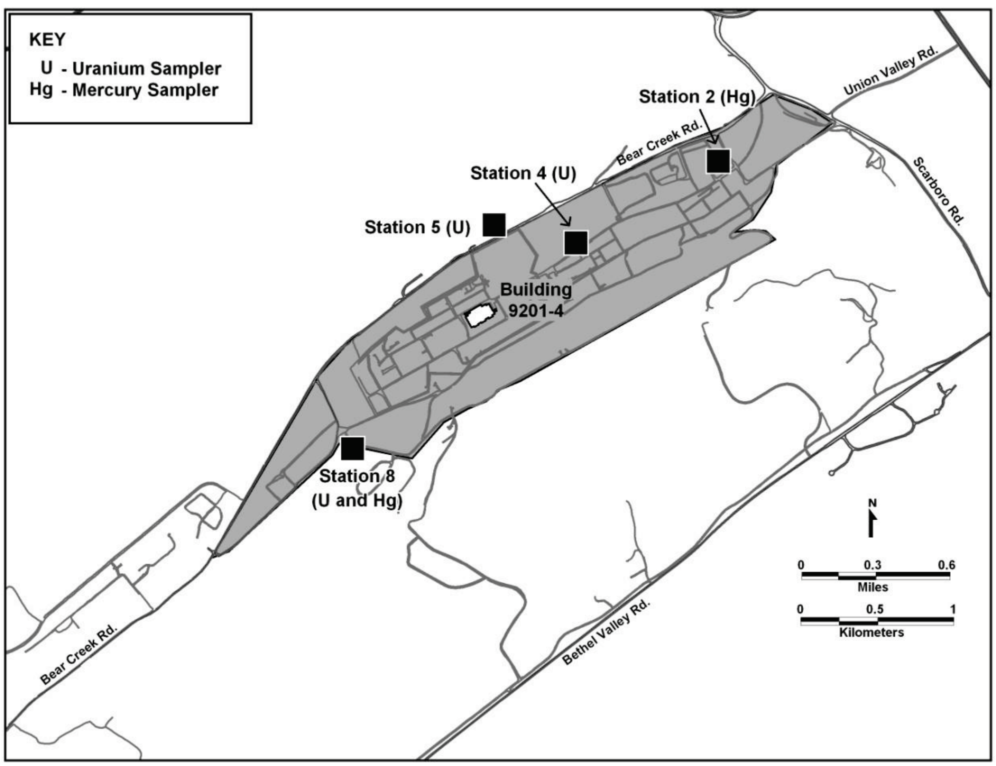

Fig. 4.20. Locations of ambient air monitoring stations at the Y-12 Complex.

To determine mercury concentrations in ambient air, airborne mercury vapor is collected by pulling ambient air through a sampling train consisting of a Teflon filter and an iodinated-charcoal sampling trap. A flow-limiting orifice upstream of the sampling trap restricts airflow through the sampling train to ~1 L/min. Actual flows are measured weekly with a calibrated Gilmont flowmeter in conjunction with the weekly change-out of the sampling trap. The charcoal in each trap is analyzed for total mercury using cold vapor atomic fluorescence spectrometry after acid digestion. The average concentration of mercury vapor in ambient air for each 7-day sampling period is then calculated by dividing the total mercury per trap by the volume of air pulled through the trap during the corresponding 7-day sampling period.

As reported previously, average mercury concentration at the ambient air monitoring sites has declined significantly since the late 1980s. Recent average annual concentrations at the two boundary stations are comparable to concentrations measured in 1988 and 1989 at the Chestnut Ridge reference site (Table 4.9). Average mercury concentration at the AAS2 site for 2011 is 0.0040 µg/m^3 (N = 51) and comparable to averages measured since 2003. After noting an increase in average concentration at AAS8 for the period 2005 through 2007, thought to be possibly due to increased D&D work on the west end, the average concentration at AAS8 for 2011 was 0.0050 µg/m^3 (N=51) or similar to levels reported for 2008 and the early 2000s.

Table 4.9. Summary of data for the Y-12 National Security Complex ambient air monitoring program for mercury for CY 2011 (The averages for 1986 through 1988, a period of elevated mercury concentration, are also shown for comparison.)

Ambient air monitoring stations	Mercury vapor concentration (µg/m^3)			
	2011 Minimum	2011 Maximum	2011 Average	1986-1988[a] Average
AAS2 (east end of the Y-12 Complex)	0.0006	0.0096	0.0040	0.010
AAS8 (west end of the Y-12 Complex)	0.0003	0.012	0.0053	0.033
Reference Site, Rain Gauge No.2 (1988[b])	N/A	N/A	N/A	0.006
Reference Site, Rain Gauge No.2 (1989[c])	N/A	N/A	N/A	0.005

[a]Period in late ’80s with elevated ambient air Hg levels.
[b]Data for period from February 9 through December 31, 1988.
[c]Data for period from January 1 through October 31, 1989.

Abbreviations
Y-12 Complex = Y-12 National Security Complex
AAS = ambient air station

Table 4.9 summarizes the 2011 mercury results and results from the 1986 through 1988 period for comparison. Figure 4.21 illustrates temporal trends in mercury concentration for the two active mercury monitoring sites since the inception of the program in 1986 through 2011 (plots 1, 2) and seasonal trends at AAS8 from 1993 through 2011 (plot 3). The dashed line superimposed on plots 1 and 2 is the EPA RfC of 0.3 µg/m^3 for chronic inhalation exposure. The large increase in mercury concentration at AAS8 observed in the late 1980s (see plot 2) was thought to be related to disturbances of mercury-contaminated soils and sediments during the Perimeter Intrusion Detection Assessment System installation and storm drain restoration projects under way at that time within WEMA. In plot 3, a monthly moving average has been superimposed over the AAS8 data to highlight seasonal trends in mercury at AAS8 from January 1993 through 2011.

In conclusion, 2011 average mercury concentrations at the two mercury monitoring sites are comparable to reference levels measured for the Chestnut Ridge reference site in 1988 and 1989. More importantly, measured concentrations continue to be well below current environmental and occupational health standards for inhalation exposure to mercury vapor [i.e., the National Institute for Occupational Safety and Health recommended exposure limit of 50 µg/m3, time-weighted average (TWA) for up to a 10 h workday, 40 h workweek; the American Conference of Governmental Industrial Hygienists workplace threshold limit value of 25 µg/m3 as a TWA for a normal 8 h workday and 40 h workweek; and the current EPA RfC of 0.3 µg/m3 for elemental mercury for a continuous inhalation exposure to the human population without appreciable risk of harmful effects during a lifetime].

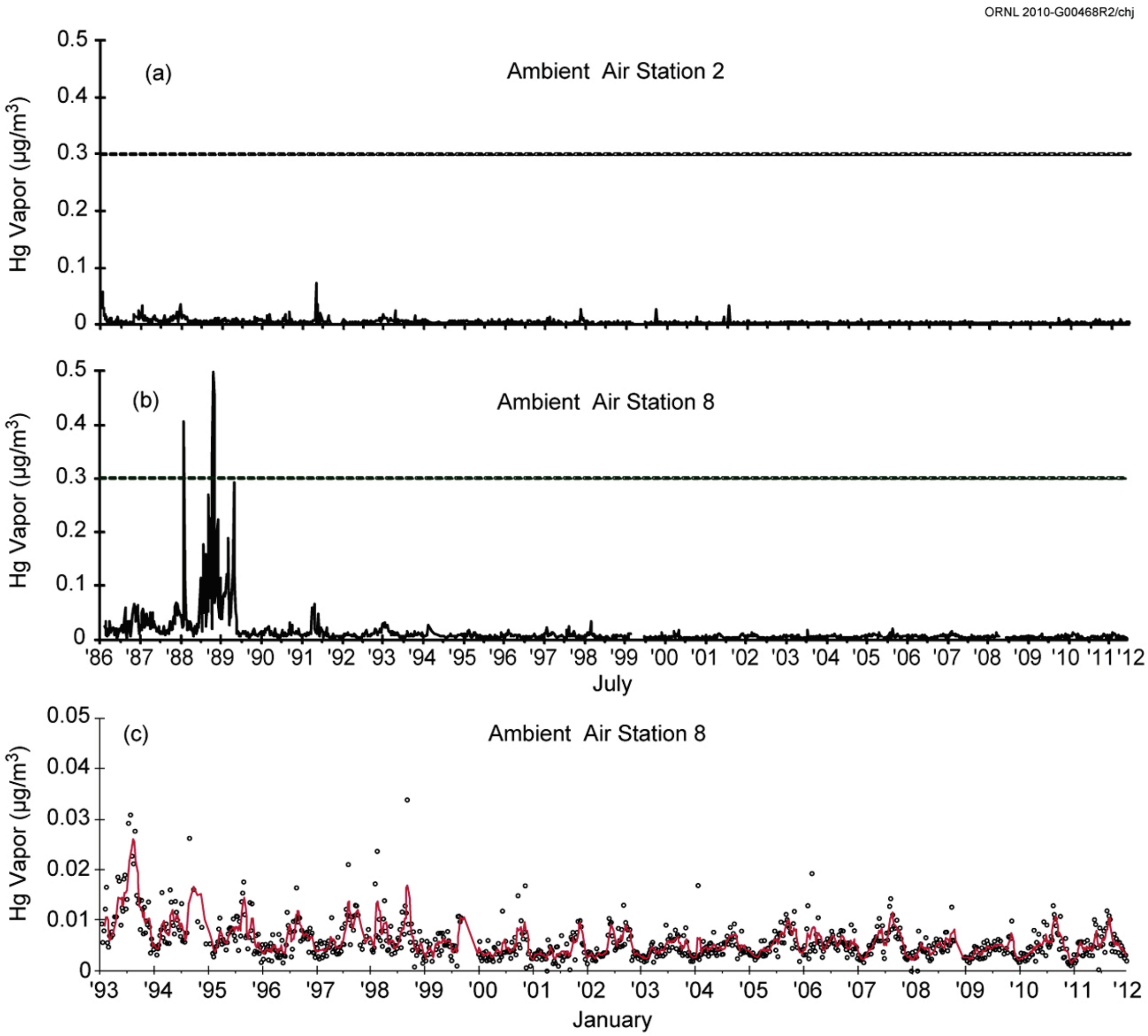

Fig. 4.21. Temporal trends in mercury vapor concentration for the boundary monitoring stations at the Y-12 Complex, July 1986 to January 2012 (plots 1 and 2) and January 1993 to January 2012 for AAS8 (plot 3). The dashed line superimposed on plots 1 and 2 represents the EPA reference concentration of 0.3 µg/m^3 for chronic inhalation exposure. In plot 3 (note different concentration scale), a monthly moving average has been superimposed over the data to highlight seasonal trends in mercury at AAS8 from January 1993 to January 2012 with higher concentrations generally measured during the warm weather months.

4.4.2.2 Quality Control

A number of QA/QC steps are taken to ensure the quality of the data for the Y-12 Complex mercury in ambient air monitoring program.

An hour meter records the actual operating hours between sample changes. This allows for correction of total flow in the event of power outages during the weekly sampling interval.

A new Gilmont correlated flowmeter, used for measuring flows through the sampling train, is purchased annually or, if not new, shipped back to the manufacturer annually for calibration in accordance with standards set by the National Institute of Standards and Technology (NIST).

A minimum of 5% of the samples in each batch submitted to the analytical laboratory are blank samples. The blank sample traps are submitted "blind" to verify trap blank values and to serve as a field blank for diffusion of mercury vapor into used sample traps during storage before analysis.

To verify the absence of mercury breakthrough, 5% to 10% of the field samples have the front (upstream) and back segments of the charcoal sample trap analyzed separately. The absence of mercury above blank values on the back segment confirms the absence of breakthrough.

Chain-of-custody forms track the transfer of sample traps from the field technicians all the way to the analytical laboratory.

A field performance evaluation is conducted annually by the project manager to ensure that proper procedures are followed by the sampling technicians. No issues were identified in the last evaluation conducted April 6, 2011.

Analytical QA/QC requirements include

- use of prescreened and/or laboratory purified reagents,
- analysis of at least two method blanks per batch,
- analysis of standard reference materials,
- analysis of laboratory duplicates [one per 10 samples; any laboratory duplicates differing by more than 10% at five or more times the detection limit are to be rerun (third duplicate) to resolve the discrepancy], and
- archiving of all primary laboratory records for at least 1 year.

4.4.2.3 Ambient Air Monitoring Complementary to the Y-12 Complex Ambient Air Monitoring

Ambient air monitoring is conducted at multiple locations near ORR to measure radiological and other selected parameters directly in the ambient air. These monitors are operated in accordance with DOE orders. Their locations were selected so that areas of potentially high exposure to the public are monitored continuously for parameters of concern. This monitoring provides direct measurement of airborne concentrations of radionuclides and other hazardous air pollutants, allows facility personnel to determine the relative level of contaminants at the monitoring locations during an emergency, verifies that the contributions of fugitive and diffuse sources are insignificant, and serves as a check on dose-modeling calculations. As part of the ORR network, an ambient air monitoring station located in the Scarboro Community of Oak Ridge (Station 46) measures off-site impacts of Y-12 Complex operations. This station is located near the theoretical area of maximum public pollutant concentrations as calculated by air-quality modeling. ORR network stations are also located at the east end of the Y-12 Complex (Station 40) and just south of the Country Club Estates neighborhood (Station 37).

The State of Tennessee is primarily responsible for ambient air monitoring to characterize the region in general and to characterize and monitor DOE operations specifically. This is accomplished in numerous ways. Specific to Y-12 Complex operations, there are three uranium ambient air monitors within the Y-12 Complex boundary that, since 1999, have been used by TDEC personnel in their environmental monitoring program. Each of the monitors uses 47 mm borosilicate glass-fiber filters to collect particulates as air is pulled through the units. The monitors control airflow with a pump and rotometer set to average about 2 standard ft^3/min.

In addition, TDEC DOE Oversight Division air quality monitoring includes several other types of monitoring on ORR, for example,

- RADNet air monitoring,
- fugitive radioactive air emission monitoring,
- ambient VOC air monitoring,
- perimeter air monitoring,
- real-time monitoring of gamma radiation,
- ambient gamma radiation monitoring using external dosimetry, and
- program-specific monitoring associated with infrastructure-reduction activities.

Results of these activities are summarized in annual status reports, which are issued by the TDEC DOE Oversight Division.

The State of Tennessee also operates a number of regional monitors to assess ambient concentrations of criteria pollutants such as sulfur dioxide, particulate (various forms), and ozone for comparison against ambient standards. The results are summarized and available through EPA and state reporting mechanisms.

4.5 Water Quality Program

4.5.1 National Pollutant Discharge Elimination System Permit and Compliance Monitoring

The current Y-12 Complex NPDES permit (TN0002968) requires sampling, analysis, and reporting for about 65 outfalls. Major outfalls are noted in Fig. 4.22. The number is subject to change as outfalls are eliminated or consolidated or if permitted discharges are added. Currently, the Y-12 Complex has outfalls and monitoring points in the following water drainage areas: EFPC, Bear Creek, and several tributaries on the south side of Chestnut Ridge, all of which eventually drain to the Clinch River.

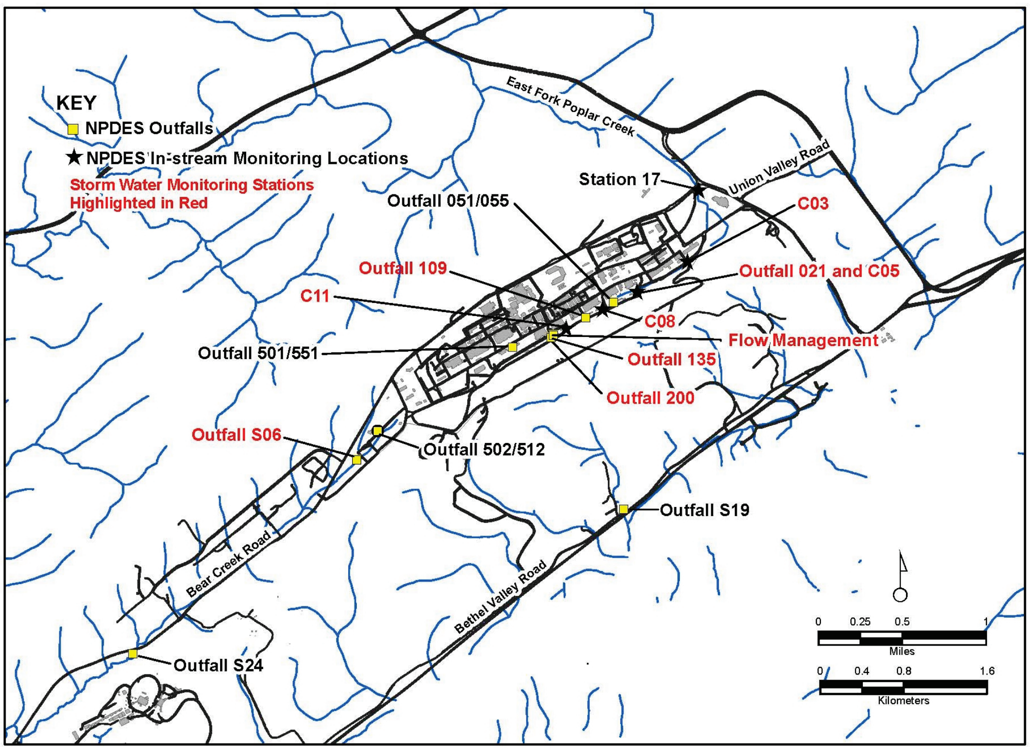

Fig. 4.22. Major Y-12 Complex National Pollutant Discharge Elimination System (NPDES) outfalls and storm water monitoring locations.

Discharges to surface water allowed under the permit include storm drainage, cooling water, cooling tower blowdown, steam condensate, and treated process wastewaters, including effluents from wastewater treatment facilities. Groundwater inflow into sumps in building basements and infiltration to the storm drain system are also permitted for discharge to the creek. The monitoring data collected by the sampling and analysis of permitted discharges are compared with NPDES limits where applicable for each parameter. Some parameters, defined as "monitor only," have no specified limits.

The water quality of surface streams in the vicinity of the Y-12 Complex is affected by current and legacy operations. Discharges from Y-12 Complex processes flow into EFPC before the water exits the Y-12 Complex. EFPC eventually flows through the city of Oak Ridge to Poplar Creek and into the Clinch River. Bear Creek water quality is affected by area source runoff and groundwater discharges. The NPDES permit requires regular monitoring and storm water characterization in Bear Creek and several of its tributaries.

Requirements of the NPDES permit for 2011 were satisfied, and monitoring of outfalls and instream locations indicated excellent compliance. Data obtained as part of the NPDES program are provided in a monthly report to TDEC. The percentage of compliance with permit requirements for 2011 was >99.9%.

There were three NPDES permit limit excursions for cadmium (monthly average permit limit 0.001 mg/L and daily average permit limit 0.025 mg/L). At the time of these readings, there were no observed adverse effects on the receiving stream.

- At Outfall 125 on 1/12/2011 measured monthly average cadmium was 0.00186 mg/L.
- At Outfall 200 on 1/19/2011 measured monthly average cadmium was 0.00104 mg/L.
- At Outfall 200 on 12/5/2011 measured monthly average cadmium was 0.00118 mg/L.

Elevated levels of mercury, above the proposed daily maximum limit of 0.004 mg/L, were reported on seven occasions for Outfall 55 that drains areas of Building 9201-2.

- 2/08/2011 measured mercury was 0.00535 mg/L
- 3/22/2011 measured mercury was 0.00742 mg/L
- 4/26/2011 measured mercury was 0.00535 mg/L
- 5/02/2011 measured mercury was 0.00602 mg/L
- 5/10/2011 measured mercury was 0.0202 mg/L
- 5/17/2011 measured mercury was 0.006098 mg/L
- 6/06/2011 measured mercury was 0.00639 mg/L

Because the limit for mercury at Outfall 55 is under appeal, these values do not represent permit violations.

There were two upset conditions reported in 2011. In January, verbal and written notifications were made to TDEC that an upset condition had occurred which allowed the leak of a brine cooling system into the storm drain system which feeds Outfall 135. The brine is a mixture of 22% methanol and water. The leak was brought under control by isolating the drain outlet with plugs and pumping the cooling system water to the sanitary sewer system or tanker trucks for on-site treatment. Y-12 Complex staff worked with city of Oak Ridge personnel to obtain approval for discharge into the sanitary system.

The second reported upset condition and notification to TDEC was a fish kill discovered on July 21 in the upper portions of EFPC inside the boundaries of Y-12 (see Sect. 4.3.9.4, "Environmental Occurrences"). Follow-up surveys over the next 5 days identified living fish throughout the creek, and the overall impact to the creek was determined to be localized and insignificant. No single factor or parameter is believed to have caused the fish to die; however, the following five factors were noticed that collectively played a part in impacting aquatic life.

1. The stream was at about one-half normal flow because flow management water was temporarily out of service.
2. Lower stream flow and elevated water temperatures likely added stress to the fish population.
3. Field readings indicated that dissolved oxygen in the water was reduced.
4. An elevated chlorine level was measured at one stream location, but additional measurements found chlorine to be less than detectible.
5. On the afternoon of July 20 (the day before the fish kill), a cloudy discharge lasting about 1.5 h was noticed in the stream.

Analysis of the July 20 discharge indicated elevated levels of metals; most notable was mercury, measured at a concentration of 0.873 mg/L. Experts at the ORNL Environmental Sciences Division Aquatic Ecology Laboratory conducted external and internal examinations on stonerollers, the primary species involved in the incident. Examinations suggested respiratory distress. Gills were found to be frayed or damaged, causing a reduction in the exchange of respiratory gases. This factor, combined with low dissolved oxygen and relatively high water temperatures, could have resulted in respiratory failure.

Dechlorination treatment in the upper reach of EFPC provided excellent control of chlorinated discharges, and toxicity testing results of three outfalls in the upper reach have shown no toxicity. Table 4.10 lists the NPDES compliance monitoring requirements with the 2011 record of compliance.

Table 4.10. National Pollutant Discharge Elimination System compliance monitoring requirements and record for the Y-12 Complex, January through December 2011

Discharge point	Effluent parameter	Daily avg (lb)	Daily max (lb)	Daily avg (mg/L)	Daily max (mg/L)	Percentage of compliance	Number of samples
Outfall 501 (Central Pollution Control)	pH, standard units			*a*	9.0	*b*	0
	Total suspended solids			31.0	40.0	*b*	0
	Total toxic organic				2.13	*b*	0
	Hexane extractables			10	15	*b*	0
	Cadmium	0.16	0.4	0.075	0.15	*b*	0
	Chromium	1.0	1.7	0.5	1.0	*b*	0
	Copper	1.2	2.0	0.5	1.0	*b*	0
	Lead	0.26	0.4	0.1	0.2	*b*	0
	Nickel	1.4	2.4	2.38	3.98	*b*	0
	Nitrate/Nitrite				100	*b*	0
	Silver	0.14	0.26	0.05	0.05	*b*	0
	Zinc	0.9	1.6	1.48	2.0	*b*	0
	Cyanide	0.4	0.72	0.65	1.20	*b*	0
	PCB				0.001	*b*	0
Outfall 502 (West End Treatment Facility)	pH, standard units			*a*	9.0	100	5
	Total suspended solids	19	36.0	31.0	40.0	100	5
	Total toxic organic				2.13	100	2
	Hexane extractables			10	15	100	5
	Cadmium	0.16	0.4	0.075	0.15	100	5
	Chromium	1.0	1.7	0.5	1.0	100	5
	Copper	1.2	2.0	0.5	1.0	100	5
	Lead	0.26	0.4	0.10	0.20	100	5
	Nickel	1.4	2.4	2.38	3.98	100	5
	Nitrate/Nitrite				100	100	5
	Silver	0.14	0.26	0.05	0.05	100	5
	Zinc	0.9	1.6	1.48	2.0	100	5
	Cyanide	0.4	0.72	0.65	1.20	100	5
	PCB				0.001	100	4
Outfall 503 (Steam Plant Wastewater Treatment Facility)	pH, standard units			*a*	9.0	*b*	0
	Total suspended solids	125	417	30.0	40.0	*b*	0
	Hexane extractables	63	83.4	10	15	*b*	0
	Iron	20.8	20.8	5.0	5.0	*b*	0
	Cadmium	0.16		0.075	0.15	*b*	0
	Chromium	0.8	0.8	0.20	0.20	*b*	0
	Copper	4.17	4.17	0.20	0.40	*b*	0
	Lead			0.10	0.20	*b*	0
	Zinc	4.17	4.17	1.0	1.0	*b*	0

Table 4.10 (continued)

Discharge point	Effluent parameter	Daily avg (lb)	Daily max (lb)	Daily avg (mg/L)	Daily max (mg/L)	Percentage of compliance	Number of samples
Outfall 512 (Groundwater Treatment Facility)	pH, standard units			*a*	9.0	100	12
	PCB				0.001	100	4
Outfall 520	pH, standard units			*a*	9.0	100	14
Outfall 200 (North/South pipes)	pH, standard units			*a*	9.0	100	53
	Hexane extractables			10	15	100	50
	Cadmium			0.001	0.025	83	13
	Lead			0.041	1.190	100	13
	PCB			0.002	0.002	100	4
Outfall 550	pH, standard units			*a*	9.0	*b*	0
	Mercury			0.002	0.004	*b*	0
Outfall 551	pH, standard units			*a*	9.0	100	52
	Mercury			0.002	0.004	100	52
Outfall 051	pH, standard units			*a*	9.0	100	11
Outfall 135	pH, standard units			*a*	9.0	100	12
	Lead			0.04	1.190	100	11
	PCB			0.002	0.002	100	5
Outfall 125	pH, standard units			*a*	9.0	100	3
	Cadmium			0.001	0.025	67	3
	Lead			0.04	1.190	100	3
	PCB			0.002	0.002	100	1
Outfall 055	pH, standard units			*a*	9.0	100	11
	Mercury				0.004	100	51
	Total Residual Chlorine				0.5	100	6
Outfall 109	pH, standard units			*a*	9.0	100	5
	Total Residual Chlorine				0.5	100	4
Outfall 021	pH, standard units			*a*	9.0	100	5
	Total Residual Chlorine				0.188	100	4
Outfall 077	pH, standard units			*a*	9.0	b	0
Outfall EFP	pH, standard units			*a*	9.0	100	192
Outfall C11	pH, standard units			*a*	9.0	100	50
	Total residual chlorine				0.019	100	24
	Temperature (^{o}C)				30.5	100	25
Outfall S06	pH, standard units			*a*	9.0	100	2
Outfall S19	pH, standard units			*a*	9.0	100	1
Outfall S24	pH, standard units			*a*	9.0	100	4
Category I outfalls	pH, standard units			*a*	9.0	100	21
Category II outfalls	pH, standard units			*a*	9.0	100	29

Table 4.10 (continued)

Discharge point	Effluent parameter	Daily avg (lb)	Daily max (lb)	Daily avg (mg/L)	Daily max (mg/L)	Percentage of compliance	Number of samples
	Total Residual Chlorine				0.5	100	40
Category III outfalls	pH, standard units			*a*	9.0	100	10
	Total residual chlorine				0.5	100	10

[a]Not applicable.
[b]No discharge.
Abbreviations
PCB = polychlorinated biphenyl

4.5.2 Radiological Monitoring Plan and Results

A radiological monitoring plan is in place at the Y-12 Complex to address compliance with DOE orders and NPDES Permit TN002968. The permit requires the Y-12 Complex to submit results from the radiological monitoring plan quarterly as an addendum to the NPDES discharge monitoring report. There were no discharge limits set by the NPDES permit for radionuclides; the requirement is to monitor and report. The radiological monitoring plan was developed based on an analysis of operational history, expected chemical and physical relationships, and historical monitoring results. Under the existing plan, effluent monitoring is conducted at three types of locations: (1) treatment facilities, (2) other point-source and area-source discharges, and (3) instream locations. Operational history and past monitoring results provide a basis for parameters routinely monitored under the plan (Table 4.11). The current radiological monitoring plan for the Y-12 Complex (B&W Y-12 2010b) was last revised and reissued in June 2010.

Table 4.11. Radiological parameters monitored at the Y-12 Complex, 2011

Parameters	Specific isotopes	Rationale for monitoring
Uranium isotopes	^{238}U, ^{235}U, ^{234}U, total U, weight % ^{235}U	These parameters reflect the major activity, uranium processing, throughout the history of the Y-12 Complex and are the dominant detectable radiological parameters in surface water
Fission and activation products	^{90}Sr, ^{3}H, ^{99}Tc, ^{137}Cs	These parameters reflect a minor activity at the Y-12 Complex, processing recycled uranium from reactor fuel elements from the early 1960s to the late 1980s, and will continue to be monitored as tracers for beta and gamma radionuclides, although their concentrations in surface water are low
Transuranium isotopes	^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu	These parameters are related to recycle uranium processing. Monitoring has continued because of their half-lives and presence in groundwater
Other isotopes of interest	^{232}Th, ^{230}Th, ^{228}Th, ^{226}Ra, ^{228}Ra	These parameters reflect historical thorium processing and natural radionuclides necessary to characterize background radioisotopes

Radiological monitoring during storm water events is accomplished as part of the storm water monitoring program. Uranium is monitored at three major EFPC storm water outfalls, four instream monitoring locations and raw water flow, and an instream outfall on Bear Creek. Results of storm event monitoring during 2011 were reported in the annual storm water report (B&W Y-12 2012a), which was last issued in January 2012. In addition, the monthly 7-day composite sample for radiological parameters taken at Station 17 on EFPC likely includes rain events.

Radiological monitoring plan locations sampled in 2011 are noted on Fig. 4.23. Table 4.12 identifies the monitored locations, the frequency of monitoring, and the sum of the percentages of the DCGs for radionuclides measured in 2011. Radiological data were well below the allowable DCGs.

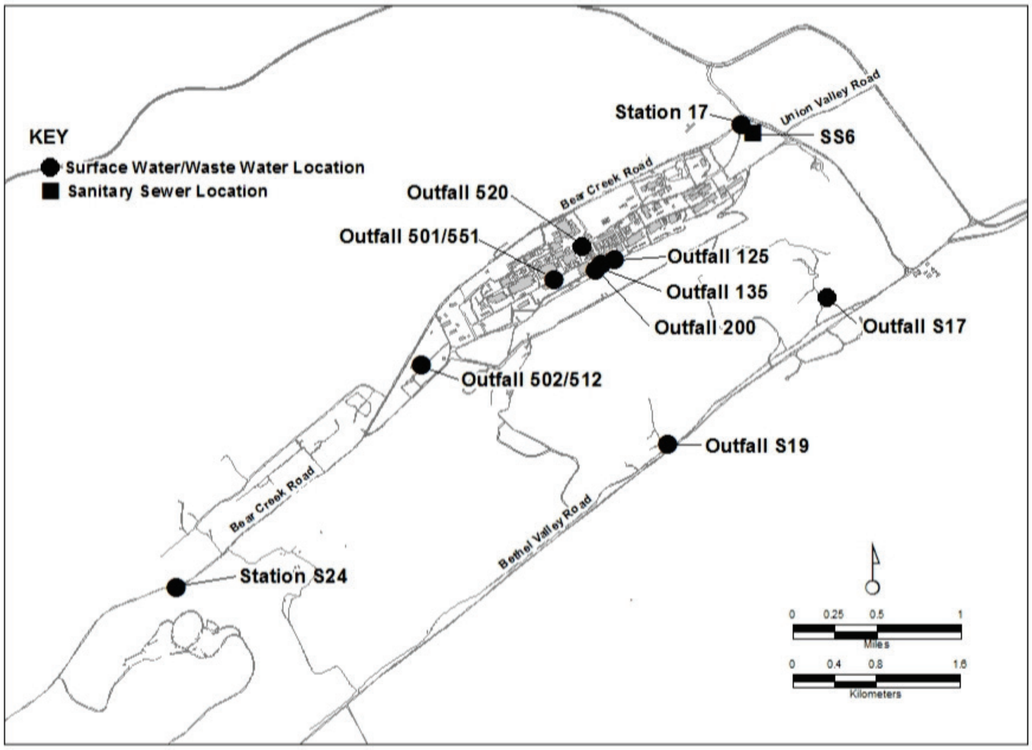

Fig. 4.23. Surface water and sanitary sewer radiological sampling locations at the Y-12 Complex.

In 2011, the total mass of uranium and associated curies released from the Y-12 Complex at the easternmost monitoring station, Station 17 on upper EFPC, was 124 kg or 0.104 Ci (Table 4.13). Figure 4.24 illustrates a 5-year trend of these releases. The total release is calculated by multiplying the average concentration (grams per liter) by the average flow (million gal per day). Converting units and multiplying by 365 days per year yields the calculated discharge. The increase in uranium quantity in 2010 may be the result of higher rainfall and subsequent movement of sediment and runoff from surfaces such as rooftops.

Table 4.12. Summary of Y-12 Complex radiological monitoring plan sample requirements and 2011 results

Outfall	Location	Sample frequency	Sample type	Sum of DCG percentage
	Y-12 Complex wastewater treatment facilities			
501	Central Pollution Control Facility	1/month	Composite during batch operation	No flow
502	West End Treatment Facility	1/batch	24 h composite	6.0
512	Groundwater Treatment Facility	4/year	24 h composite	1.7
520	Steam condensate	1/year	Grab	0.01
551	Central Mercury Treatment Facility	4/year	24 h composite	0.81
	Other Y-12 Complex point and area source discharges			
125	Outfall 125	4/year	24 h composite	6.7
135	Outfall 135	4/year	24 h composite	0.19
S17	Kerr Hollow Quarry	1/year	24 h composite	0
S19	Rogers Quarry	1/year	24 h composite	0
	Y-12 Complex instream locations			
S24	Outfall S24	4/year	7-day composite	6.3
Station 17	East Fork Poplar Creek, complex exit (east)	1/month	7-day composite	1.1
200	North/south pipes	1/month	24 h composite	1.5
	Y-12 Complex Sanitary Sewer			
SS6	East End Sanitary Sewer Monitoring Station	1/week	7-day composite	13

Abbreviations
DCG = derived concentration guide
Y-12 Complex = Y-12 National Security Complex

Table 4.13. Release of uranium from the Y-12 Complex to the off-site environment as a liquid effluent, 2007–2011

Year	Quantity released	
	Ci[a]	kg
	Station 17	
2007	0.036	70
2008	0.046	75
2009	0.067	187
2010	0.075	326
2011	0.104	124

[a]1 Ci = 3.7E+10 Bq.

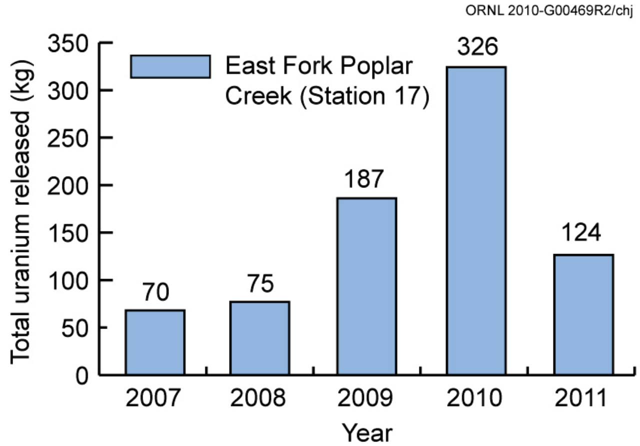

Fig. 4.24. Five-year trend of Y-12 Complex release of uranium to East Fork Poplar Creek.

The Y-12 Complex is permitted to discharge domestic wastewater to the city of Oak Ridge's publicly owned treatment works. Radiological monitoring of the sanitary sewer system discharge is conducted and reported to the city of Oak Ridge, although there are no city-established radiological limits. Potential sources of radionuclides discharging to the sanitary sewer have been identified in previous studies at the Y-12 Complex as part of an initiative to meet "as low as reasonably achievable" goals. Results of radiological monitoring were reported to the city of Oak Ridge in 2011 quarterly monitoring reports.

4.5.3 Storm Water Pollution Prevention

The storm water pollution prevention plan at the Y-12 Complex is designed to minimize the discharge of pollutants in storm water runoff. The plan identifies areas that can reasonably be expected to contribute contaminants to surface water bodies via storm water runoff and describes the development and implementation of storm water management controls to reduce or eliminate the discharge of such pollutants. This plan requires (1) characterization of storm water by sampling during storm events, (2) implementation of measures to reduce storm water pollution, (3) facility inspections, and (4) employee training.

The NPDES permit defines the primary function of the Y-12 Complex to be a fabricated metal products industry. However, it also requires that storm water monitoring be conducted for three additional sectors: scrap/waste recycling activities; landfill and land application activities; and discharges associated with treatment, storage, and disposal facilities as they are defined in the Tennessee Storm Water Multi Sector General Permit for Industrial Activities (TNR050000). Each sector has prescribed cutoff concentration values and some have defined sector mean values. The "rationale" portion of the NPDES permit for the Y-12 Complex states "cut-off [sic] concentrations were developed by the EPA and the state of Tennessee and are based on data submitted by similar industries for the development of the multi-sector general storm water permit. The cut-off [sic] concentrations are target values and should not be construed to represent permit limits." Similarly, sector mean values are defined as "a pollutant concentration calculated from all sampling results provided from facilities classified in this sector during the previous term limit."

Storm water sampling was conducted for 2011 during rain events that occurred in September, October, and November. Results were published in the annual storm water report (B&W Y-12 2012a), which was submitted to the Division of Water Pollution Control in January 2012. Consistent with permit requirements, storm water monitoring is performed each year for sector outfalls, three major outfalls that drain large areas of the Y-12 Complex, raw water flow, and four instream monitoring locations on EFPC (Fig. 4.22). The permit also calls for sampling of stream base load sediment that is being transported due to the heavy flow. Sediment sampling was performed at the four instream locations during 2011.

In general, the quality of storm water exiting the Y-12 Complex via EFPC indicated some improvement in 2011. This is attributable to construction, demolition, and remediation projects which have been completed in 2011 Emphasis will continue to be placed on site inspections and the timely implementation of improved storm water control measures.

4.5.4 Flow Management (or Raw Water)

Because of concern about maintaining water quality and stable flow in the upper reaches of EFPC, the 2006 NPDES permit required the addition of Clinch River water to the headwaters of EFPC (North/South Pipe–Outfall 200 area). The addition of Clinch River water to EFPC decreased instream water temperatures by about 5°C (from about 26°C at the headwaters).

A request to modify the NPDES permit to allow the minimum flow, measured at Station 17, to be reduced to 19 million L/day (5 million gal/day) was made, and on December 30, 2008, TDEC modified the permit. The modified permit requires 19 million L (5 million gal) rather than 26 million L (7 million gal) minimum daily flow as measured at the Station 17 location. In addition to water conservation, this action offers the potential benefit of reducing the transport of mercury from a contaminated section of the streambed.

A new NPDES permit that became effective December 1, 2011, contains a requirement to provide a schedule for the relocation of the addition of raw water to EFPC downstream of its current location to reduce the potential for mercury being suspended by the higher flow due to raw water addition at the headwaters of EFPC. A schedule for relocation of raw water addition to EFPC was submitted to TDEC in accordance with the NPDES permit indicating the raw addition will be relocated and associated water quality studies will be completed in 2015. Discussions with City of Oak Ridge water system management regarding modification of the raw water supply system for EFPC have been conducted.

4.5.5 Y-12 Complex Ambient Surface Water Quality

To monitor key indicators of water quality, a network of real-time monitors located at three instream locations along upper EFPC is used. The Surface Water Hydrological Information Support System (SWHISS) is available for real-time water quality measurements such as pH, temperature, dissolved oxygen, conductivity, and chlorine. The locations are shown in Fig. 4.25. The primary function of SWHISS is to provide an indication of potential adverse conditions that could be causing an impact on the quality of water in upper EFPC. It is operated as a best management practice.

Additional sampling of springs and tributaries is conducted in accordance with the Y-12 Groundwater Protection Program to monitor trends throughout the three hydrogeologic regimes (see Section 4.6).

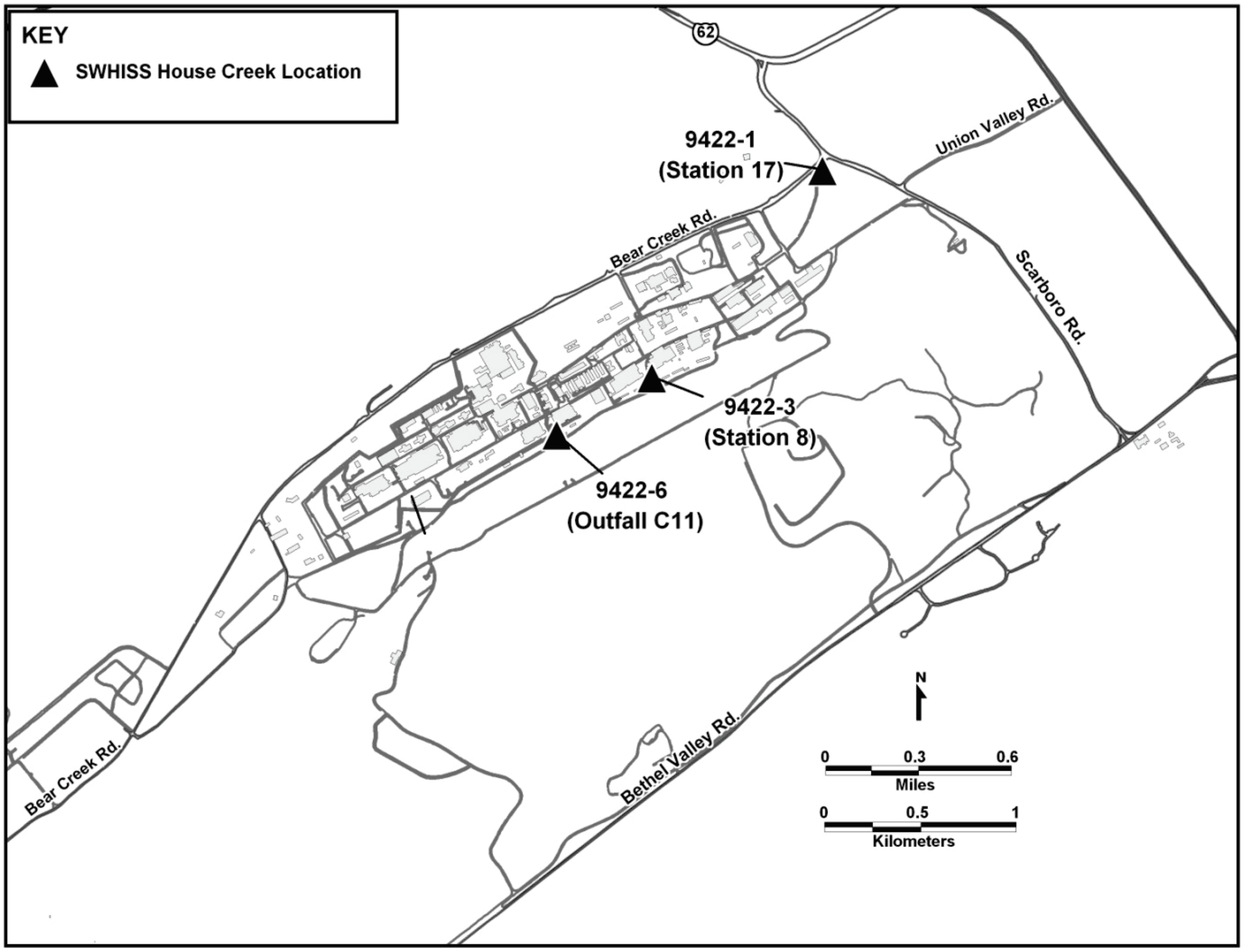

Fig. 4.25. Surface Water Hydrological Information Support System (SWHISS) monitoring locations.

4.5.6 Industrial Wastewater Discharge Permit

The Industrial and Commercial User Wastewater Discharge Permit No. 1-91 provides requirements for the discharge of wastewaters to the sanitary sewer system as well as prohibitions for certain types of wastewaters. It prescribes requirements for monitoring certain parameters at the East End Sanitary Sewer Monitoring Station. Limitations are set in the permit for most parameters. Samples for gross alpha, gross beta, and uranium are taken in a weekly 24 h composite sample. The sample is analyzed for uranium if the alpha and beta values exceed certain levels. Other parameters (including metals, oil and grease, solids, and biological oxygen demand) are monitored on a monthly basis. Organic parameters are monitored once per quarter. Results of compliance sampling are reported quarterly. Flow is measured 24 h/day at the monitoring station.

As part of the City of Oak Ridge's pretreatment program, city personnel use the monitoring station to conduct compliance monitoring as required by the pretreatment regulations. City personnel also conduct twice yearly compliance inspections. Monitoring results during 2011 (Table 4.14) indicate 6 exceedances of the permit. All were for exceeding the maximum daily allowable flow limit.

Over the last several years, Y-12 Complex personnel have conducted flow monitoring at key locations of the sanitary sewer system during wet and dry weather conditions. This effort has enabled a determination to be made of the general areas of the system most likely to contribute the greatest volume of I/I of extraneous water into the lines. Examination of the data in 2009 led to the conclusion that inflow of surface water was the major contributor, and in November 2009, a plan was developed to conduct smoke tests of the lines to locate specific inflow problems. The testing effort was initiated in 2010 and continued in 2011. During this time several inflow source corrections were made.

Table 4.14. Y-12 Complex Discharge Point SS6, Sanitary Sewer Station 6
(January through December 2011)

Effluent parameter	Number of samples	Daily average value (effluent limit)[a]	Daily maximum value (effluent limit)[b]	Percentage of compliance
Flow (mgd)	365	*c*	1.4	99
pH, standard units	14	*c*	9/6[d]	100
Silver	14	0.05	0.1	100
Arsenic	14	0.01	0.015	100
Biochemical oxygen demand	14	200	300	100
Cadmium	14	0.0033	0.005	100
Chromium	14	0.05	0.075	100
Copper	14	0.14	0.21	100
Cyanide	14	0.041	0.062	100
Iron	14	10	15	100
Mercury	14	0.023	0.035	100
Kjeldahl nitrogen	14	45	90	100
Nickel	14	0.021	0.032	100
Oil and grease	15	25	50	100
Lead	14	0.049	0.074	100
Phenols—total recoverable	27	0.3	0.5	100
Suspended solids	14	200	300	100
Zinc	14	0.35	0.75	100

[a]Units in milligrams per liter unless otherwise indicated.
[b]Industrial and commercial users wastewater permit limits.
[c]Not applicable.
[d]Maximum value/minimum value.

4.5.7 Quality Assurance/Quality Control

The Environmental Monitoring Management Information System (EMMIS) is used to manage surface water monitoring data. EMMIS uses standard sample definitions to ensure that samples are taken at the correct location at a specified frequency using the correct sampling protocol.

Field sampling QA encompasses many practices that minimize error and evaluate sampling performance. Some key quality practices include the following:

- use of standard operating procedures for sample collection and analysis;
- use of chain-of-custody and sample identification, customized chain-of-custody documents, and sample labels provided by EMMIS;
- instrument standardization, calibration, and verification;
- sample technician training;
- sample preservation, handling, and decontamination; and
- use of QC samples such as field and trip blanks, duplicates, and equipment rinses.

Surface water data are entered directly by the analytical laboratory into the Laboratory Information Management System (LIMS) on the day of approval. EMMIS routinely accesses LIMS electronically to capture pertinent data. Generally, the system will store the data in the form of concentrations.

A number of electronic data management tools enable automatic flagging of data points and allow for monitoring and trending data over time. Field information on all routine samples taken for surface water monitoring is entered in EMMIS, which also retrieves data nightly from the analytical laboratory. The system then performs numerous checks on the data, including comparisons of the individual results against any applicable screening criteria, regulatory thresholds, compliance limits, best management standards, or other water quality indicators, and produces required reports.

4.5.8 Biomonitoring Program

In accordance with the requirements of the new 2011 NPDES permit effective December 1, 2011, Part III-E, p. 31, two outfalls that discharge to the headwaters of EFPC (Outfalls 200 and 135) were evaluated for toxicity in December 2011 using fathead minnow larvae and *Ceriodaphnia dubia*. A third outfall, Outfall 125, no longer has sufficient base flows for toxicity to be evaluated. Table 4.15 summarizes the inhibition concentration (IC_{25}) results of biomonitoring tests conducted during 2011 at Outfalls 200 and 135. IC_{25} is the concentration of effluent that causes a 25% reduction in *Ceriodaphnia* survival or reproduction or fathead minnow survival or growth. Thus, the lower the value, the more toxic the effluent. IC_{25} was greater than the highest tested concentration of each effluent (100% for Outfall 200, 36% for Outfall 135) for each test conducted, indicating that no toxicity was detected during 2011.

Table 4.15. Y-12 Complex Biomonitoring Program summary information[a] for Outfalls 200 and 135 in 2011

Site	Test date	Species	IC_{25}[b] (%)
Outfall 200	12/2/11	*Ceriodaphnia*	>100
Outfall 200	12/2/11	Fathead minnow	>100
Outfall 135	12/2/11	*Ceriodaphnia*	>36
Outfall 135	12/2/11	Fathead minnow	>36

[a]Inhibition concentration (IC_{25}) is summarized for the discharge monitoring locations, Outfalls 200 and 135.

[b]IC_{25} as a percentage of full-strength effluent from Outfalls 200 and 135 diluted with laboratory control water. IC_{25} is the concentration that causes a 25% reduction in *Ceriodaphnia* survival or reproduction or fathead minnow survival or growth.

4.5.9 Biological Monitoring and Abatement Programs

The NPDES permit issued for the Y-12 Complex in 2006 mandates a BMAP with the objective of demonstrating that the effluent limitations established for the facility protect the classified uses of the receiving stream, EFPC. The 2011 BMAP sampling reported here follows the 2006 permit requirements. BMAP, which has been monitoring the ecological health of EFPC since 1985, currently consists of three major tasks that reflect complementary approaches to evaluating the effects of the Y-12 Complex discharges on the aquatic integrity of EFPC. These tasks include (1) bioaccumulation monitoring, (2) benthic macroinvertebrate community monitoring, and (3) fish community monitoring. Data collected on contaminant bioaccumulation and the composition and abundance of communities of aquatic organisms provide a direct evaluation of the effectiveness of abatement and remedial measures in improving ecological conditions in the stream.

Monitoring is currently being conducted at five primary EFPC sites although sites may be excluded or added depending on the specific objectives of the various tasks. The primary sampling sites include upper EFPC at EFPC kilometers (EFKs) 24.4 and 23.4 (upstream and downstream of Lake Reality, respectively); EFK 18.7 (also EFK 18.2), located off ORR and below an area of intensive commercial and light industrial development; EFK 13.8, located upstream from the Oak Ridge Wastewater Treatment

Facility; and EFK 6.3, located about 1.4 km downstream of the ORR boundary (Fig. 4.26). Brushy Fork at Brushy Fork kilometer 7.6 is used as a reference stream in two BMAP tasks. Additional sites off ORR are also occasionally used for reference, including Beaver Creek, Bull Run, Cox Creek, Hinds Creek, Paint Rock Creek, and Emory River in the Watts Bar Reservoir (Fig. 4.27).

Significant increases in species richness and diversity in EFPC over the last two decades demonstrate that the overall ecological health of the stream continues to improve. However, the pace of improvement in the upper reaches of EFPC near the Y-12 Complex has slowed in recent years, and fish and invertebrate communities continue to be less diverse than the corresponding communities in reference streams.

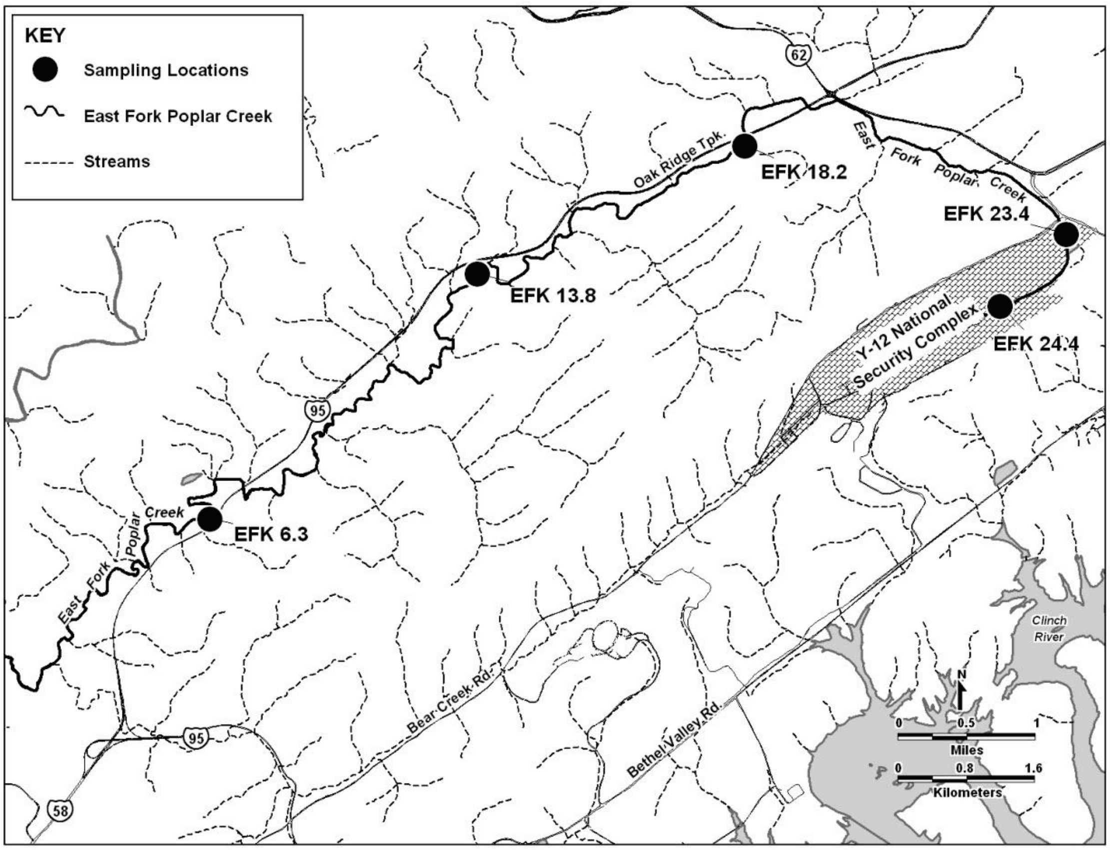

Fig. 4.26. Locations of biological monitoring sites on East Fork Poplar Creek in relation to the Y-12 Complex.

ORNL 2010-G00470/chj

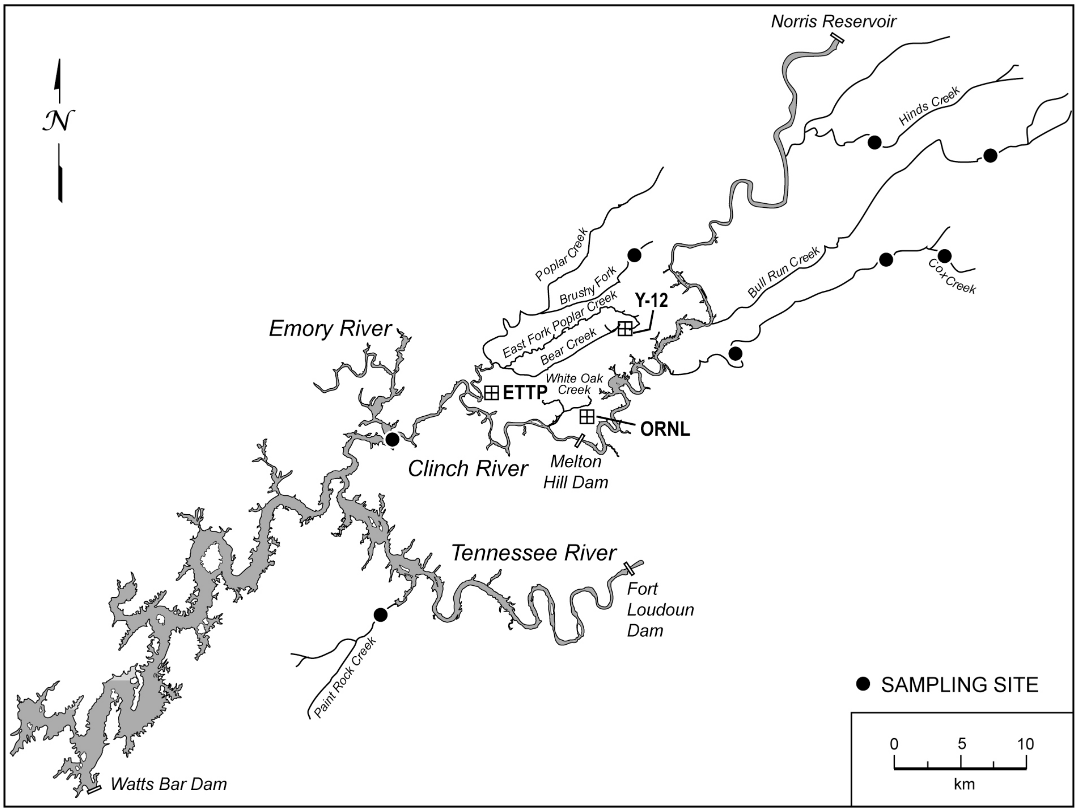

Fig. 4.27. Locations of biological monitoring reference sites in relation to the Y-12 Complex.

4.5.9.1 Bioaccumulation Studies

Mercury and PCB levels in fish from EFPC have been historically elevated relative to fish in uncontaminated reference streams. Fish in EFPC are monitored regularly for mercury and PCBs to assess spatial and temporal trends in bioaccumulation associated with ongoing remedial activities and Y-12 Complex operations.

As part of this monitoring effort, redbreast sunfish (*Lepomis auritus*) and rock bass (*Ambloplites rupestris*) are collected twice a year from five sites throughout the length of EFPC and are analyzed for tissue concentrations of mercury (twice yearly) and PCBs (annually). Mercury concentrations remained higher in fish from EFPC in 2011 than in fish from reference streams. Elevated mercury concentrations in fish from the upper reaches of EFPC indicate that the Y-12 Complex remains a continuing source of mercury to fish in the stream. Waterborne mercury concentrations in the upper reaches of EFPC have decreased substantially over the years in response to various remedial actions, first over the 1990s time period and then again in response to the Big Springs Treatment System in 2006 (Fig. 4.28). Although mercury concentrations in fish over time have not decreased commensurate with water levels in the lower sections of EFPC, mercury concentrations in fish at the uppermost sampling site (EFK 24.4) decreased steadily in the 1990s, consistent with reductions in water (Fig. 4.28). Interestingly, fish concentrations have ranged in the 0.6 µg/g range at the uppermost site during the most recent period when water concentrations have both decreased (2006) and increased (2010–2011). Mean concentrations of PCBs in fish at EFK 24.4 have not changed substantially since 2008 but continued to be much lower than peak concentrations observed in the mid-1990s (Fig. 4.29).

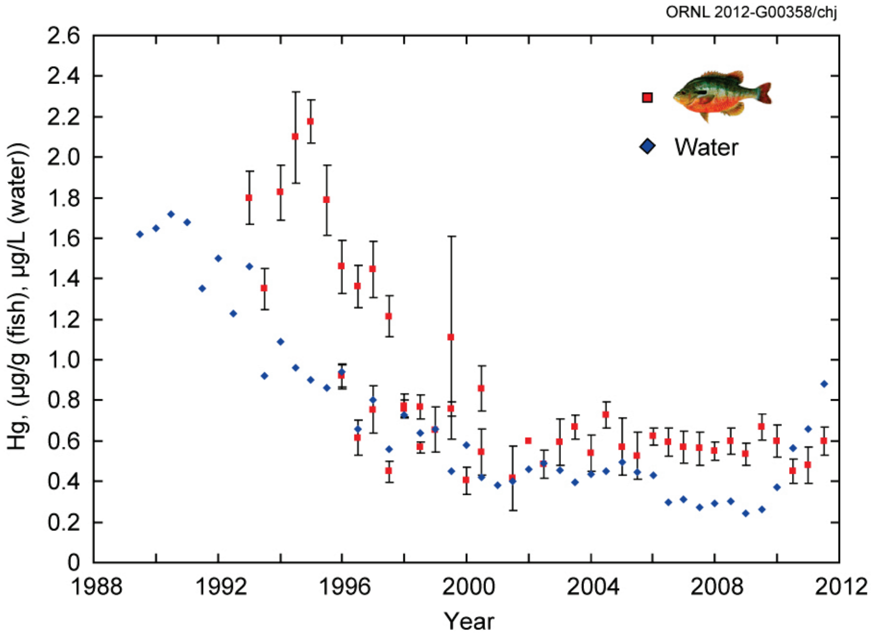

Fig. 4.28. Semiannual average mercury concentration in water and muscle fillets of redbreast sunfish in East Fork Poplar Creek at EFK 24.4 through spring 2011.

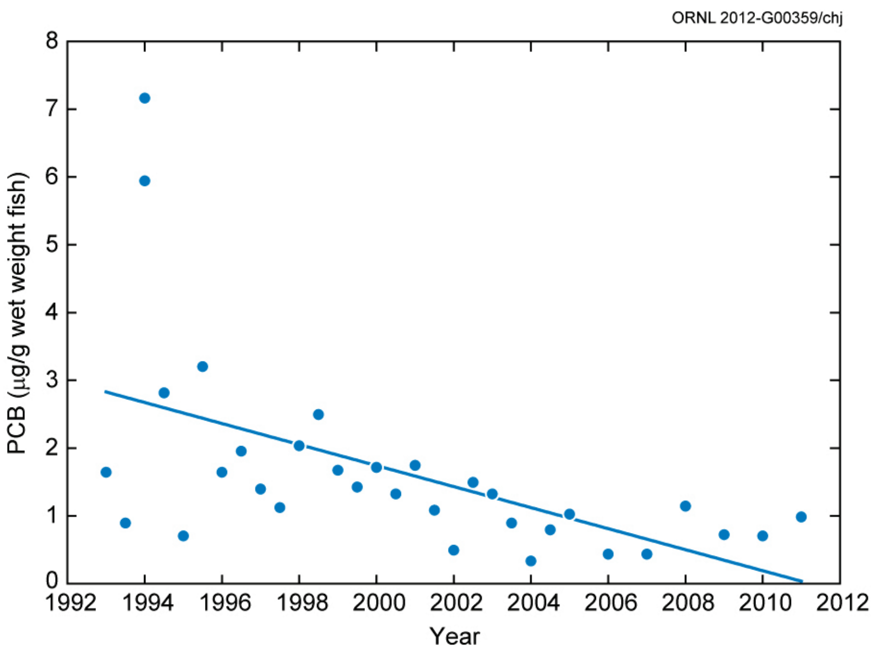

Fig. 4.29. Mean concentrations of PCBs in redbreast sunfish muscle fillets in East Fork Poplar Creek at EFK 24.4 through spring 2011.

4.5.9.2 Benthic Invertebrate Surveys

Monitoring of benthic macroinvertebrate communities continued at three sites in EFPC and at two reference streams in the spring of 2011. The macroinvertebrate community at EFK 23.4 and EFK 24.4 remained degraded as compared with reference communities, although recent trends at EFK 23.4 suggest improvement has occurred at that site since 2004. Trends at EFK 24.4, on the other hand, suggest that no substantial change has occurred at that site since 1999 (Fig. 4.30). Results from 2011 for EFK 13.8 continue to suggest that no substantial change has occurred at that site since the late 1980s and that mildly degraded conditions remain.

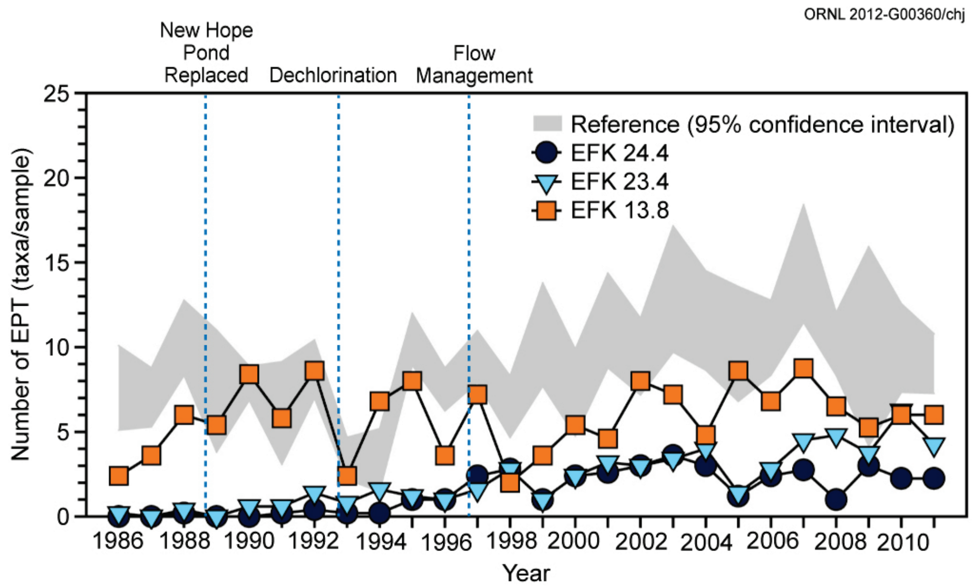

Fig. 4.30. Total taxonomic richness of the *Ephemeroptera*, *Plecoptera*, and *Trichoptera* (EPT) (mean number of EPT taxa/sample) of the benthic macroinvertebrate communities sampled in spring from East Fork Poplar Creek and two nearby reference streams (Brushy Fork and Hinds Creek).

4.5.9.3 Fish Community Monitoring

Fish communities were monitored in the spring and fall of 2011 at five sites along EFPC and at a reference stream. Over the past two decades, overall species richness, density, biomass, and number of pollution-sensitive fish species have increased at all sampling locations below Lake Reality. The number of sensitive species over time is shown in Fig. 4.31 and dramatically highlights the major improvements in the fish community in the middle to lower sections of EFPC. However, the EFPC fish community continues to lag behind the reference stream community in most important metrics of fish diversity and community structure. This is especially true at the monitoring sites closest to the Y-12 Complex where the sensitive species richness ranges from 0 to 25% of the reference value.

ORNL 2012-G00361/chj

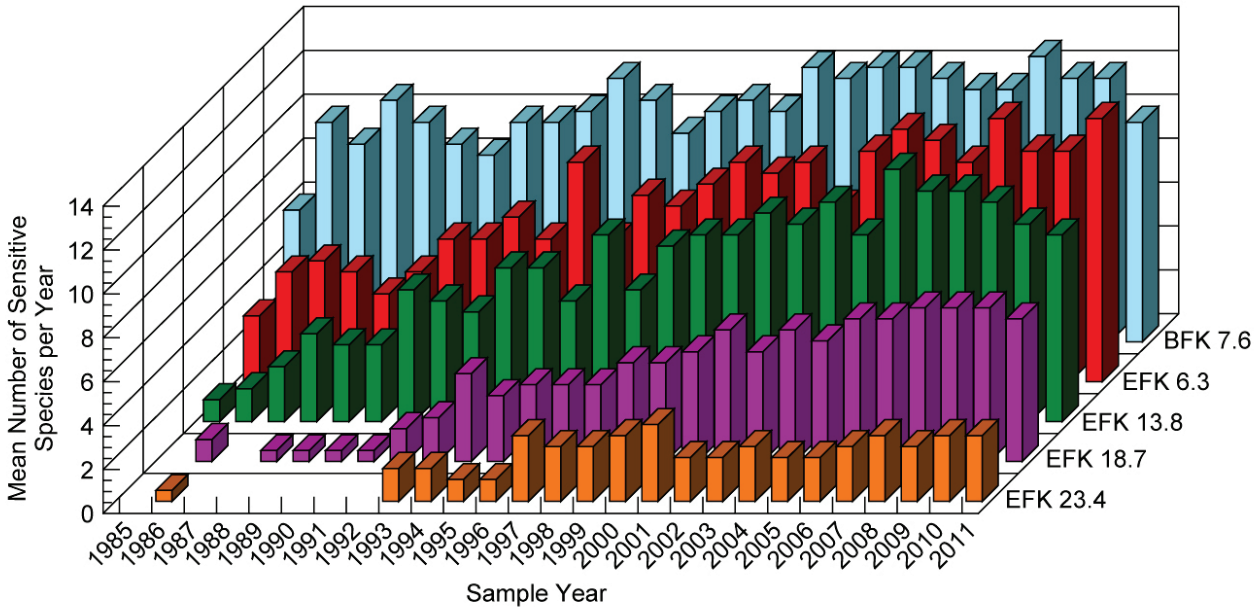

Fig. 4.31. Comparison of mean sensitive species richness (number of species) collected each year from 1985 through 2011 from four sites in East Fork Poplar Creek and a reference site (Brushy Fork).

4.6 Groundwater at the Y-12 Complex

Groundwater monitoring at the Y-12 Complex is performed to comply with federal and state requirements and to determine what impacts to the environment from legacy and current operations are occurring. More than 200 sites have been identified at the Y-12 Complex that represent known or potential sources of contamination to the environment as a result of past operational and waste management practices. Monitoring provides information on the nature and extent of contamination of groundwater, which is then used to determine what actions must be taken to protect the worker, public, and environment in compliance with regulations and DOE orders. Figure 4.32 depicts the major facilities or areas for which groundwater monitoring was performed during CY 2011.

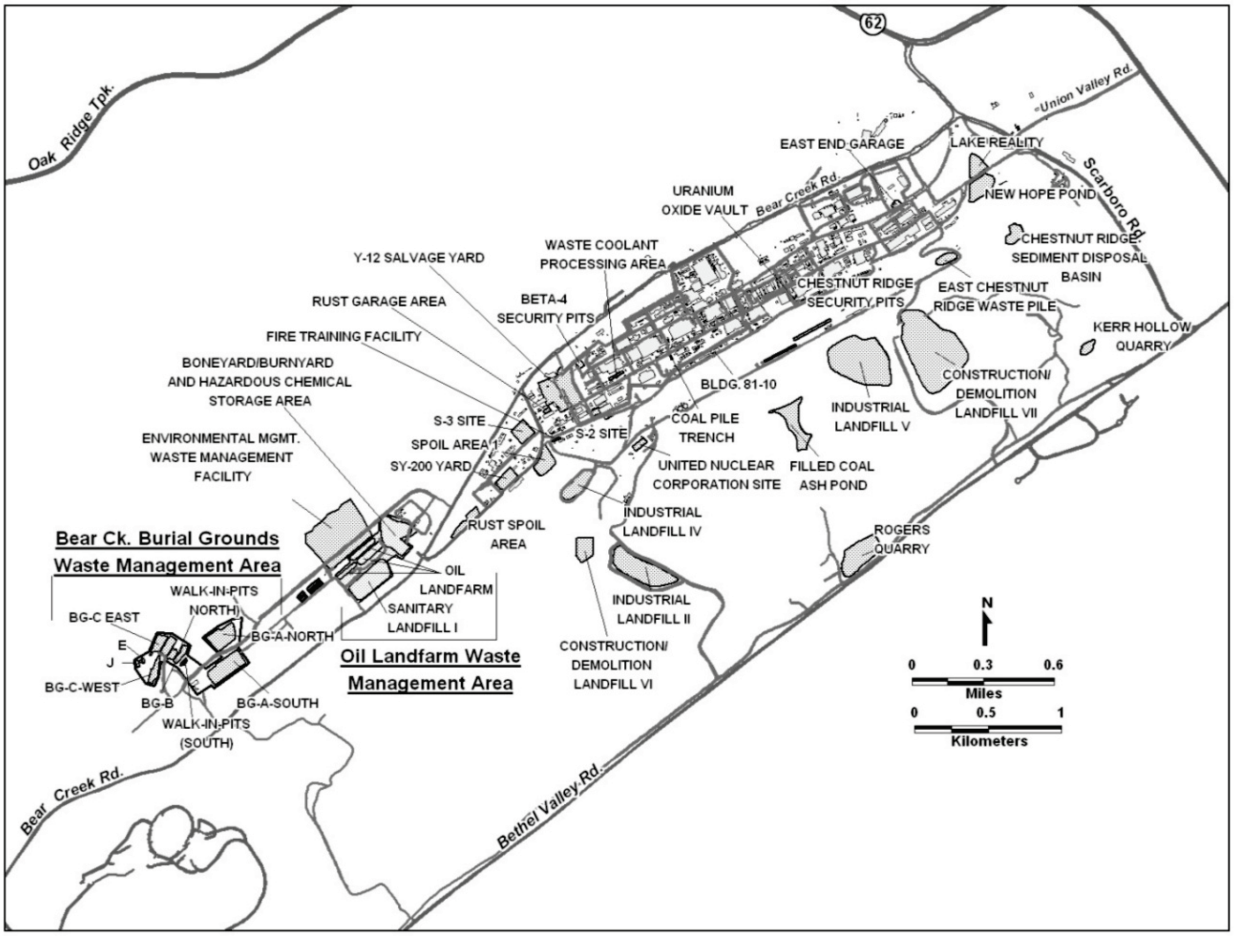

Fig. 4.32. Known or potential contaminant sources for which groundwater monitoring was performed at the Y-12 Complex during CY 2011.

4.6.1 Hydrogeologic Setting

The Y-12 Complex is divided into three hydrogeologic regimes (Bear Creek, upper EFPC, and Chestnut Ridge), which are delineated by surface water drainage patterns, topography, and groundwater flow characteristics (Fig. 4.33). Most of the Bear Creek and upper EFPC regimes are underlain by the shales, siltstones, and sandstones with a subordinate and locally variable amount of carbonate bedrock mentioned in Section 1.3.5 and hydrostratigraphically referred to as aquitards. Aquitards are rock units that contain water but do not readily yield significant water to pumping wells. Geologic units that are considered aquitards can often yield water in quantities sufficient for domestic or small farm use (Domenico and Schwartz 1990). The southern portion of the two regimes is underlain by the Maynardville Limestone, which is part of the Knox Aquifer. The entire Chestnut Ridge regime is underlain by the Knox Aquifer. In general, groundwater flow in the water table interval follows the topography. Shallow groundwater flow in the Bear Creek and upper EFPC regimes is divergent from the topographic and groundwater divide located near the western end of the Y-12 Complex that defines the boundary between the two. In addition, flow converges on the primary surface streams (Bear Creek and upper EFPC) from Pine Ridge and Chestnut Ridge. In the Chestnut Ridge regime, a groundwater divide exists that nearly coincides with the crest of the ridge. Shallow groundwater flow tends to be toward either flank of the ridge, with discharge primarily to surface streams and springs located in Bethel Valley to the south and Bear Creek Valley to the north.

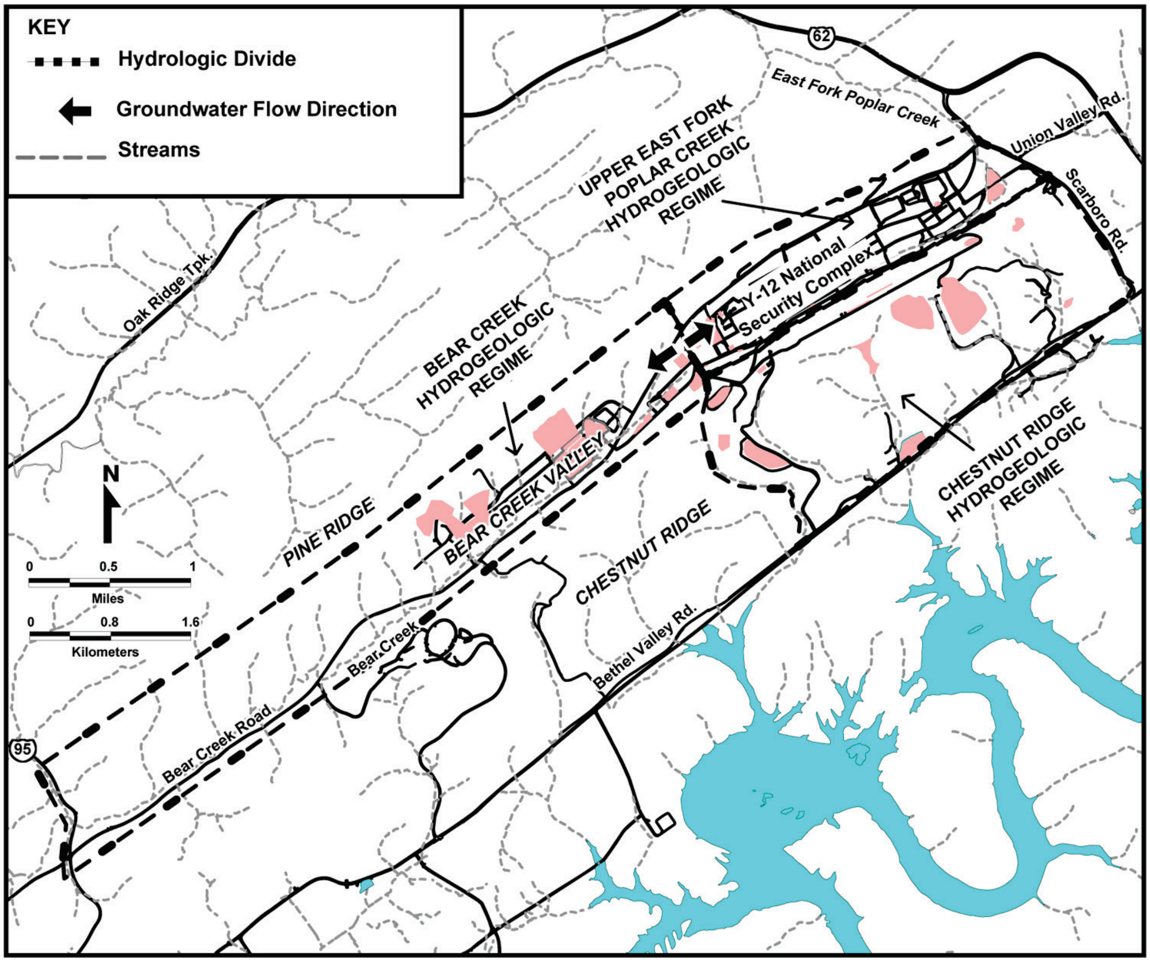

Fig. 4.33. Hydrogeologic regimes at the Y-12 Complex.

In Bear Creek Valley, groundwater in the intermediate and deep intervals moves predominantly through fractures in the aquitard, converging on and then moving through fractures and solution conduits in the Maynardville Limestone. Karst development in the Maynardville Limestone has a significant impact on groundwater flow paths in the water table and intermediate intervals. In general, groundwater flow parallels the valley and geologic strike. Groundwater flow rates in Bear Creek Valley vary widely; they are very slow within the deep interval of the fractured noncarbonate rock (<1 ft/year) but can be quite rapid within solution conduits in the Maynardville Limestone (tens to thousands of feet per day). The rate of groundwater flow perpendicular to geologic strike from the aquitard units of the lower Conasauga Group to the Maynardville Limestone is also very slow below the water table interval.

Contaminant migration is primarily advective (contaminants are transported along with flowing groundwater through the pore spaces, fractures, or conduits of the hydrogeologic system). Strike-parallel transport of some contaminants can occur within the aquitard units for significant distances, where they discharge to surface water tributaries or underground utility and storm water distribution systems in industrial areas. Continuous elevated levels of nitrate (a groundwater contaminant from legacy waste disposals) within the fractured bedrock of the aquitards are known to extend east and west from the S-3 site for thousands of feet. VOCs (e.g., petroleum products, coolants, and solvents) at source units over or in the fractured clastic dominated bedrock, however, can remain close to source areas because they tend to adsorb to the bedrock matrix, diffuse into pore spaces within the matrix, and degrade before migrating to exit pathways where more rapid transport occurs for longer distances. Regardless, extensive VOC contamination occurs throughout the groundwater system in both the Bear Creek and upper EFPC regimes.

Groundwater flow in the Chestnut Ridge regime is through fractures and solution conduits in the Knox Group. Discharge points for intermediate and deep flow are not well known. Groundwater is currently presumed to flow toward Bear Creek Valley to the north and Bethel Valley to the south. Groundwater from intermediate and deep zones may discharge at certain spring locations along the flanks of Chestnut Ridge. Following the crest of the ridge, water table elevations decrease from west to east, demonstrating an overall easterly trend in groundwater flow.

4.6.2 Well Installation and Plugging and Abandonment Activities

A number of monitoring devices are routinely used for groundwater data collection at the Y-12 Complex. Monitoring wells are permanent devices used for the collection of groundwater samples; they are installed according to established regulatory and industry standards. Figure 4.34 shows a cross section of a typical groundwater monitoring well. Other devices or techniques are sometimes used to gather groundwater data, including drive points.

In CY 2011, seven monitoring wells were installed at the Y-12 Complex. Two new compliance monitoring wells were installed at EMWMF. Five wells were installed in support of research activities by the Oak Ridge Field Research Center. The purpose of the Field Research Center is to investigate the interactions and processes within a contaminated groundwater system to assist in the development of remediation strategies and tools for groundwater cleanup.

No monitoring wells were plugged and abandoned during the year.

4.6.3 CY 2011 Groundwater Monitoring

Groundwater monitoring in CY 2011 was performed to comply with DOE orders and regulations by the Y-12 Groundwater Protection Program, the DOE EM WRRP, and other projects. Compliance requirements were met by monitoring 216 wells and 47 surface water locations and springs (Table 4.16). Figure 4.35 shows the locations of Y-12 Complex perimeter/exit pathway groundwater monitoring stations.

ORNL 2011-G00531/chj

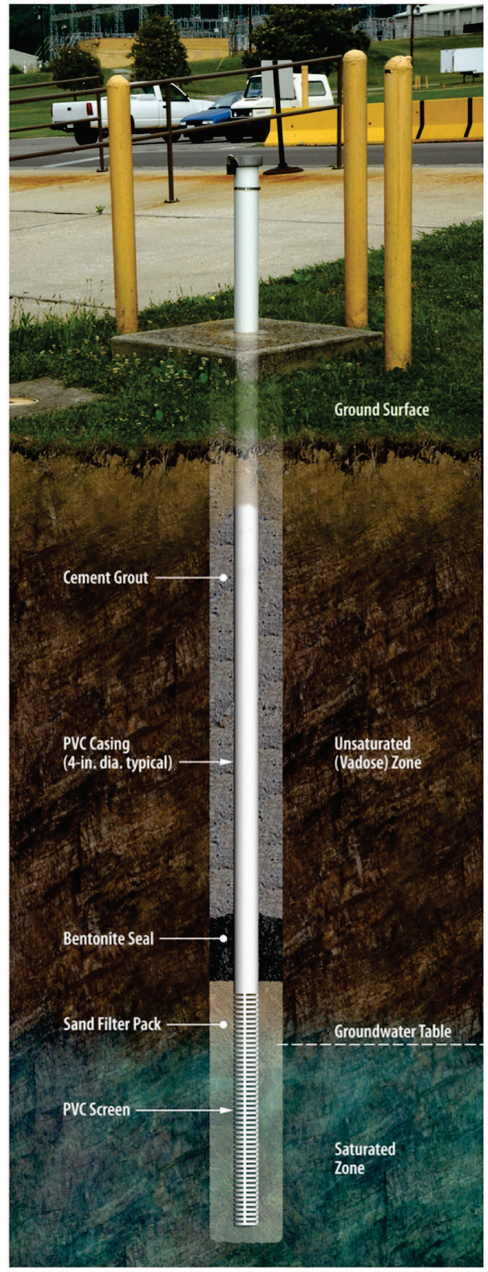

Fig. 4.34. Cross section of a typical groundwater monitoring well.

In an attempt to gain efficiencies in sampling activities, the Y-12 Groundwater Protection Program continued to use passive diffusion bag samplers in 2011 (Fig. 4.36). The passive diffusion bag sampling method is suitable only for monitoring for the presence and concentration of selected VOCs in groundwater. This method involves suspending a polyethylene bag

Table 4.16. Summary groundwater monitoring at the Y-12 Complex, 2011

	Purpose for which monitoring was performed				
	Restoration[a]	**Waste management**[b]	**Surveillance**[c]	**Other**[d]	**Total**
Number of active wells	60	34	122	104	320
Number of other monitoring stations (e.g., springs, seeps, surface water)	23	6	18	45	92
Number of samples taken[e]	156	40*	166	4360	4722
Number of analyses performed	7,066	3,557*	12,375	17,502	40500
Percentage of analyses that are nondetects	73.7	87.9	80.1	24	58
Ranges of results for positive detections, VOCs (µg/L)[f]					
Chloroethenes	0.42-4,300	6.72-7.22	2-130,000	NA[g]	
Chloroethanes	0.38-210	11-37.8	2-2,100	NA	
Chloromethanes	0.79-1,200	ND[h]	2-900	NA	
Petroleum hydrocarbons	1-100	ND	2-1,600	NA	
Uranium (mg/L)	0.0042-0.41	ND	0.00051-1.05	0.00-61.15	
Nitrates (mg/L)	0.021-7,700	0.15-2.4	0.054-11,599	.449 -32294	
Ranges of results for positive detections, radiological parameters (pCi/L)[i]					
Gross alpha activity	1.94-267	1.22-4.59	1.6-440	NA	
Gross beta activity	2.92-13,100	2.65-19.1	5.5-14,000	NA	

[a]Monitoring to comply with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements and with Resource Conservation and Recovery Act postclosure detection and corrective action monitoring.

[b]Solid waste landfill detection monitoring and CERCLA landfill detection monitoring; * = excludes EMWMF.

[c]DOE O 450.1, O 436.1, and O 458.1 surveillance monitoring.

[d]Research-related groundwater monitoring associated with activities of the DOE Office of Science Oak Ridge Field Research Center (ORFRC).

[e]The number of unfiltered samples, excluding duplicates, determined for unique location/date combinations. Samples from the "Other" category are all filtered.

[f]These ranges reflect concentrations of individual contaminants [not summed volatile organic compound (VOC) concentrations].

Chloroethenes—includes tetrachloroethene, trichloroethene, 1,2-dichloroethene (*cis* and *trans*) 1,1-dichloroethene, and vinyl chloride.

Chloroethanes—includes 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane.

Chloromethanes—includes carbon tetrachloride, chloroform, and methylene chloride.

Petroleum hydrocarbon—includes benzene, toluene, ethylbenzene, and xylene.

[g]NA—not analyzed.

[h]ND—not detected.

[i]1 pCi = 3.7×10^2 Bq.

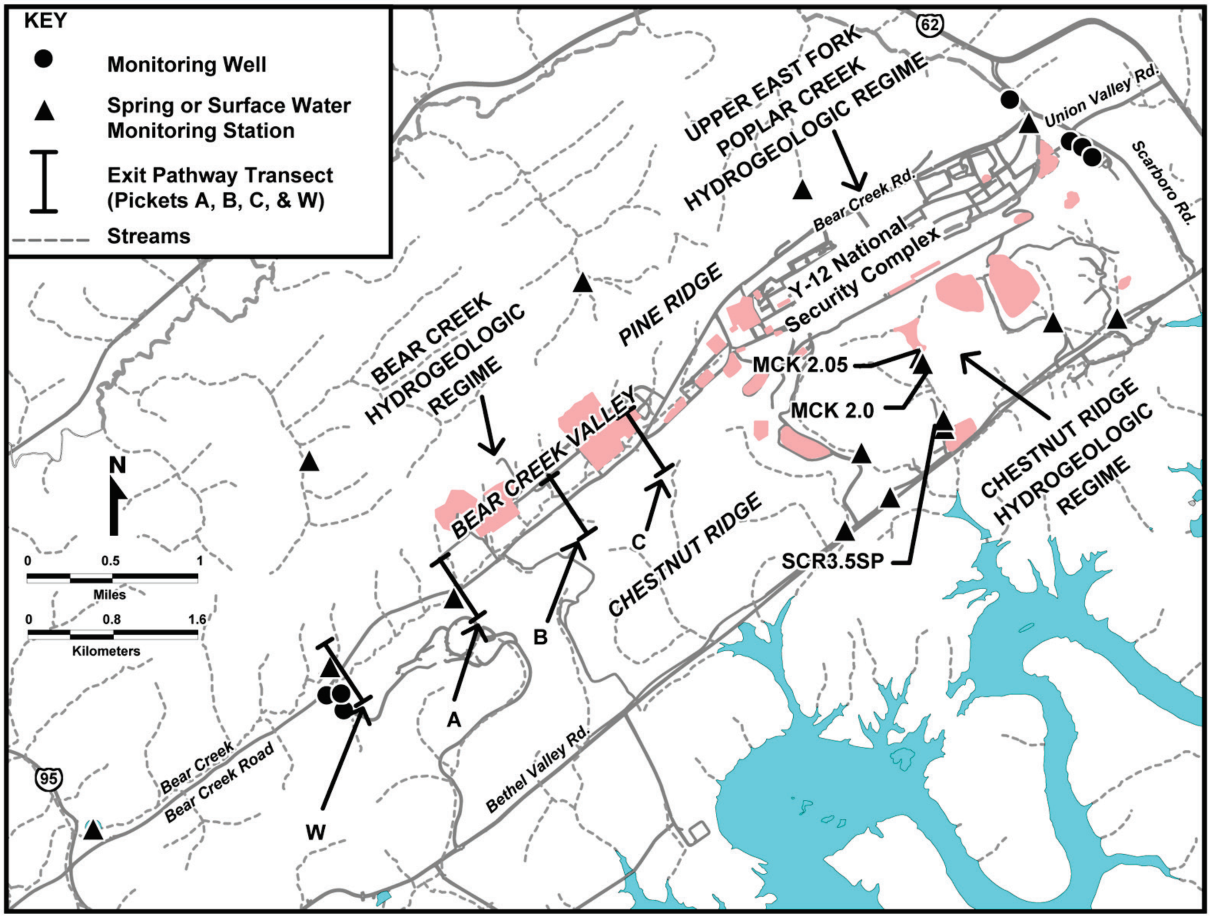

Fig. 4.35. Location of Y-12 Complex perimeter/exit pathway well, spring, and surface water monitoring stations.

(semipermeable membrane) filled with deionized water at a selected depth within the monitored interval of the well and leaving the passive diffusion bag in place for a prescribed period (at least 2 weeks). The chemical concentration gradient between the uncontaminated deionized water in the passive diffusion bag and the surrounding contaminated groundwater induces VOCs in the groundwater to diffuse through the bag into the deionized water until equilibrium conditions are achieved. When retrieved, the water in the passive diffusion bag is decanted into VOC sample bottles and analyzed using standard procedures.

Comprehensive water quality results of groundwater monitoring activities at the Y-12 Complex in CY 2011 are presented in *Calendar Year 2011 Groundwater Monitoring Report* (B&W Y-12 2012b).

Details of monitoring efforts performed specifically for CERCLA baseline and remediation evaluation are published in the FY 2011 and FY 2012 WRRP sampling and analysis plans (BJC 2010, UCOR 2011) and the annual remediation effectiveness reports [DOE 2012, DOE 2013 (scheduled)].

Groundwater monitoring compliance reporting to meet RCRA postclosure permit requirements can be found in the annual RCRA groundwater monitoring report (UCOR 2012).

ORNL 2012-G00387/chj

Fig. 4.36. Groundwater sampling at the Y-12 Complex. Technicians use a passive diffusion bag to sample for volatile organic compounds in groundwater.

4.6.4 Y-12 Complex Groundwater Quality

Historical monitoring efforts have shown that there are four primary contaminants that have impacted groundwater quality at the Y-12 Complex: nitrate, VOCs, metals, and radionuclides. Of those, VOCs are the most widespread as a result of their common use and disposal at the site. Uranium and ^{99}Tc are the radionuclides of greatest concern. Trace metals, the least extensive groundwater contaminants, generally occur close to source areas. Historical data have shown that plumes from multiple-source units have mixed with one another and that contaminants (other than nitrate and ^{99}Tc) are no longer easily associated with a single source.

4.6.4.1 Upper East Fork Poplar Creek Hydrogeologic Regime

Among the three hydrogeologic regimes on the Y-12 Complex, the upper EFPC regime encompasses most of the known and potential sources of surface water and groundwater contamination. A brief description of waste management sites is given in Table 4.17. Chemical constituents from the S-3 site (primarily nitrate and ^{99}Tc) and VOCs from multiple source areas are observed in the groundwater in the western portion of the upper EFPC regime; groundwater in the eastern portion, including Union Valley, is predominantly contaminated with VOCs.

Table 4.17. History of waste management units and underground storage tanks included in groundwater monitoring activities, Upper East Fork Poplar Creek Hydrogeologic Regime, 2011

Site	Historical data
New Hope Pond	Built in 1963. Regulated flow of water in upper East Fork Poplar Creek before exiting the Y-12 Complex grounds. Sediments include PCBs, mercury, and uranium but not hazardous according to toxicity characteristic leaching procedure. An oil skimmer basin was built as part of the pond when constructed. This basin collected oil and floating debris from upper East Fork Poplar Creek before discharge into the pond. Closed under RCRA in 1990.
Salvage Yard Scrap Metal Storage Area	Used from 1950 to present for scrap metal storage. Some metals contaminated with low levels of depleted or enriched uranium. Runoff and infiltration are the principal release mechanisms to groundwater. In 2011 a CERCLA action to characterize and remove the scrap was completed. Characterization and analysis performed in 2010 and 2011 determined that this facility is not a significant risk to groundwater.
Salvage Yard Oil/Solvent Drum Storage Area	Primary wastes included waste oils, solvents, uranium, and beryllium. Closed under RCRA. Leaks and spills represent the primary contamination mechanisms for groundwater. Characterization and analysis performed in 2010 and 2011 determined that this facility is not a significant risk to groundwater.
Salvage Yard Oil Storage Tanks	Used from 1978 to 1986. Two tanks used to store PCB-contaminated oils, both within a diked area. Characterization and analysis performed in 2010 and 2011 determined that this facility is not a significant risk to groundwater.
Salvage Yard Drum Deheader	Used from 1959 to 1989. Sump tanks 2063-U, 2328-U, and 2329-U received residual drum contents. Sump leakage is a likely release mechanism to groundwater. In 2011, the soils beneath this facility were excavated and replaced with clean fill and gravel to remediate the site.
Building 81-10 Area	Mercury recovery facility operated from 1957 to 1962. Potential historical releases to groundwater and surface water from leaks and spills of liquid wastes or mercury. The building structure was demolished in 1995.
Rust Garage Area	Former vehicle and equipment maintenance area, including four former petroleum USTs. Petroleum product releases to groundwater are documented.
9418-3 Uranium Oxide Vault	Originally contained an oil storage tank. Used from 1960 to 1964 to dispose of nonenriched uranium oxide. Leakage from the vault to groundwater is the likely release mechanism.
Fire Training Facility	Used for hands-on firefighting training. Sources of contamination to soil include flammable liquids and chlorinated solvents. Infiltration is the primary release mechanism to groundwater.
Beta-4 Security Pits	Used from 1968 to 1972 for disposal of classified materials, scrap metals, and liquid wastes. Site is closed and capped. Primary release mechanism to groundwater is infiltration.
S-2 Site	Used from 1945 to 1951. An unlined reservoir received liquid wastes. Infiltration is the primary release mechanism to groundwater.
Waste Coolant Processing Area	Used from 1977 to 1985. Former biodegradation facility used to treat waste coolants from various machining processes. Closed under RCRA in 1988.
East End Garage	Used from 1945 to 1989 as a vehicle fueling station. Five USTs used for petroleum fuel storage were excavated, 1989 to 1993. Petroleum releases to the groundwater are documented.
Coal Pile Trench	Located beneath the current steam plant coal pile. Disposals included solid materials (primarily alloys). Trench leachate is a potential release mechanism to groundwater. In 2011, the Coal Pile overlying the Coal Pile Trench was removed and the area resurfaced with gravel.

Abbreviations
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
PCB = polychlorinated biphenyl
RCRA = Resource Conservation and Recovery Act
UST = underground storage tank

4.6.4.1.1 Plume Delineation

Sources of groundwater contaminants monitored during CY 2011 include the S-2 site, the Fire Training Facility, the S-3 site, the Waste Coolant Processing Facility, petroleum USTs, New Hope Pond, the Beta-4 Security Pits, the Salvage Yard, and process/production buildings throughout the Y-12 Complex. Although the S-3 site, now closed under RCRA, is located west of the current hydrologic divide that separates the upper EFPC regime from the Bear Creek regime, it has contributed to groundwater contamination in the western part of the upper EFPC regime. As previously mentioned, contaminant plumes in the EFPC regime are elongated in shape as a result of preferential transport of the contaminants parallel to strike (parallel to the valley axis) in both the Knox Aquifer and the fractured bedrock of the aquitard units.

4.6.4.1.2 Nitrate

Unlike many groundwater contaminants, nitrate is highly soluble and moves easily with groundwater. Nitrate concentrations in groundwater at the Y-12 Complex exceed the 10 mg/L drinking water standard in part of the western portion of the upper EFPC regime in the aquitard units (a complete list of national drinking water standards is presented in Appendix C) and in the Maynardville Limestone unit of the Knox Aquifer. The two primary sources of nitrate contamination are the S-2 and S-3 sites. The extent of the nitrate plume is essentially defined in the unconsolidated and shallow bedrock zones. In CY 2011, groundwater containing nitrate concentrations as high as 8,940 mg/L (well GW-275) occurred in the shallow bedrock just east of the S-3 site (Fig. 4.37). These results are consistent with results from previous years.

4.6.4.1.3 Trace Metals

Concentrations of barium, beryllium, cadmium, chromium, copper, lead, nickel, thallium, and uranium exceeded drinking water standards during CY 2011 in samples collected from various monitoring wells and surface water locations downgradient of the S-2 site, the S-3 site, and the Salvage Yard and throughout the complex. Trace metal concentrations above standards tend to occur only adjacent to the source areas due to their low solubility in natural water systems.

Concentrations of uranium exceed the standard (0.03 mg/L) in a number of source areas (e.g., S-3 site, production areas, and the former Oil Skimmer Basin) and contribute to the uranium concentration in upper EFPC.

One trace metal absent from the list of those that exceed drinking water standards in CY 2011 is mercury. Due to very low solubility in water and a very high affinity for clay-rich soils such as those on ORR, mercury exhibits little tendency for extensive transport in diffuse groundwater plumes. Additionally, the hydrogeologic complexities of the fracture/conduit flow system underlying the Y-12 Complex make it challenging to delineate the vertical and horizontal extents of any groundwater contamination. Elevated mercury concentrations (above analytical detection limits) in groundwater have been consistently observed only near known source areas (Fig. 4.38). In the past, mercury concentrations above the drinking water standard (0.002 mg/L) have been observed in groundwater monitoring wells at the identified source areas presented in Fig. 4.38.

Because of past processes and disposal practices, mercury is a legacy contaminant at the Y-12 Complex. It is commonly found in the soils near specific areas where it was used in processes in the 1950s and 1960s. This metal is a COC in surface waters discharging from these areas. However, the transport mechanisms and connections between process buildings, soil contamination, storm drains, shallow groundwater, buried tributaries, and stream channels are not well understood. When mercury is discharged from the storm drain system into the open creek channel, it is rapidly sequestered by particulate materials, and sediment/particle transport becomes the primary mechanism of mobility. In an attempt to understand the fate and transport of mercury at the Y-12 Complex, researchers have developed a conceptual model integrating known hydrologic, geochemical, and physical data (Peterson et al. 2011).

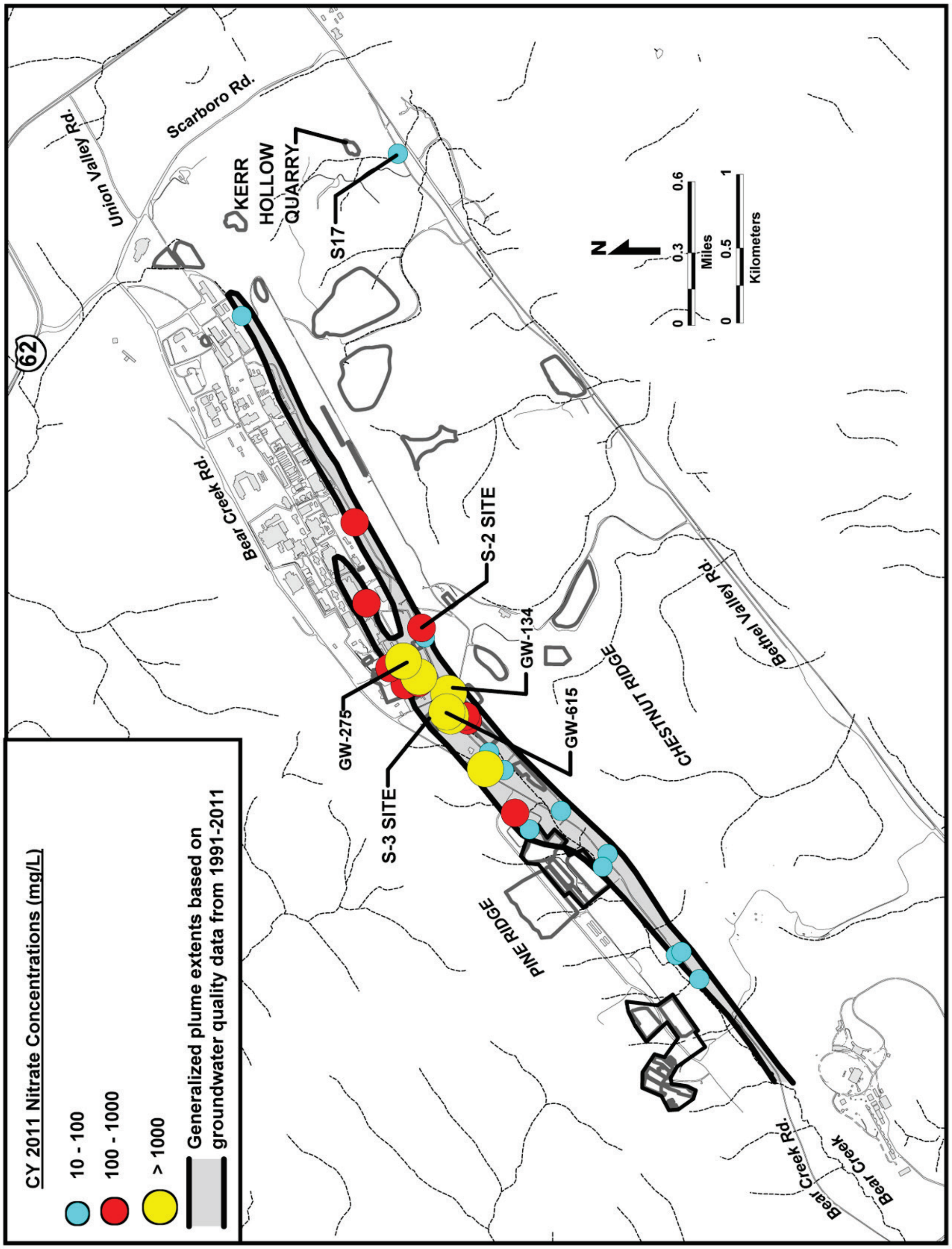

Fig. 4.37. Nitrate observed in groundwater at the Y-12 Complex, 2011.

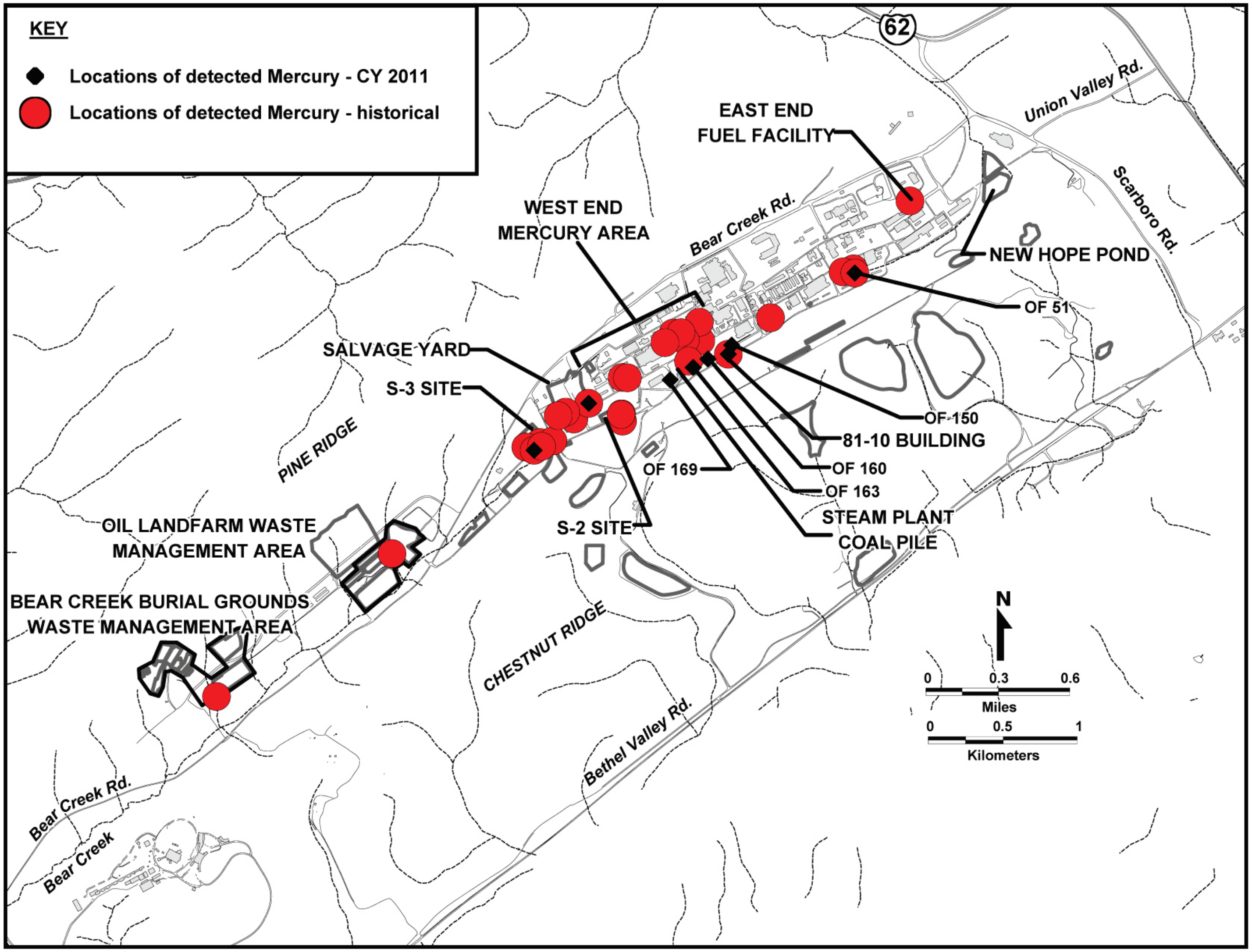

Fig. 4.38. Y-12 Complex groundwater monitoring stations where mercury has been detected.

In tightly fractured shale with a high clay content and other noncarbonate bedrock, the natural flow paths are such that significant advective transport of mercury through the groundwater is not likely. This is supported by extensive groundwater surveillance monitoring data. In industrialized areas of the Y-12 Complex where the shallow subsurface has been reworked extensively, some preferential transport along building foundations and underground utilities is apparent as evident from elevated surface water concentrations of mercury. The actual mechanism of transport (e.g., advective, chemically diffusive, colloidal) is uncertain.

Interconnections between the surface water and groundwater systems have been demonstrated by tracer investigations (DOE 2001) and the discharge of elevated concentrations of mercury from a buried spring (i.e., Outfall 51) adjacent to EFPC. This discharge is presently captured and treated to remove the mercury at the Big Springs Water Treatment System. Additionally, the regular observation of elemental mercury in storm drains in the western part of the EFPC regime has resulted in an increase in monitoring in recent years in several catch basins in the storm drain system (e.g., Outfall 169, Outfall 163, Outfall 160, and Outfall 150).

4.6.4.1.4 Volatile Organic Compounds

Because of the many legacy source areas, VOCs are the most widespread groundwater contaminants in the EFPC regime. Dissolved VOCs in the regime primarily consist of chlorinated solvents and petroleum hydrocarbons. In CY 2011, the highest summed concentration of dissolved chlorinated solvents (152,607 µg/L) was again found in groundwater at well 55-3B in the western portion of the Y-12 Complex adjacent to manufacturing facilities. The highest dissolved concentration of petroleum hydrocarbons (16,660 µg/L) was obtained from well GW-658 at the closed East End Garage.

The CY 2011 monitoring results generally confirm findings from the previous years of monitoring. A continuous dissolved plume of VOCs in groundwater in the bedrock zone extends eastward from the S-3 site over the entire length of the regime (Fig. 4.39). The primary sources are the Waste Coolant Processing Facility, fuel facilities (Rust Garage and East End), Salvage Yard, and other waste-disposal and production areas throughout the Y-12 Complex. Chloroethene compounds (PCE, TCE, DCE, and vinyl chloride) tend to dominate the volatile organic plume composition in the western and central portions of the Y-12 Complex. However, PCE and isomers of DCE are almost ubiquitous throughout the extent of the plume, indicating many source areas. Chloromethane compounds (carbon tetrachloride, chloroform, and methylene chloride) are the predominant VOCs in the eastern portion of the Y-12 Complex.

Variability in concentration trends of chlorinated VOCs near source areas is seen within the upper EFPC regime. As seen in previous years, data from most of the monitoring wells have remained relatively constant (i.e., stable) or have decreased since 1988. Increasing trends are observed in monitoring wells associated with the Rust Garage, Old Salvage Yard, and S-3 site in the western part of the Y-12 Complex; some production/process facilities in central areas; and the East End VOC plume, indicating that some portions of the plume are still showing activity.

Within the exit pathway (the Maynardville Limestone, underlying EFPC) the general trends are also stable or decreasing, with one exception. One shallow well (GW-605) exhibits an increasing trend in chloroethenes, indicating active transport in this region of the groundwater plume. This well is west and upgradient of the pumping well (GW-845) operated to capture the East End VOC plume before it migrates off ORR into Union Valley. The pumping well may be influencing plume stability causing mobilization in the region of well GW-605. Other than well GW-605, the trends west of New Hope Pond are indicators that the contaminants from source areas are attenuating due to factors such as (1) dilution by surrounding uncontaminated groundwater, (2) dispersion through a complex network of fractures and conduits, (3) degradation by chemical or biological means, or (4) adsorption by surrounding bedrock and soil media. Wells to the southwest to southeast of New Hope Pond are displaying the effects of pumping well GW-845. Wells east of New Hope Pond and north of well GW-845 exhibit increasing trends in VOC concentrations, indicating that little impact or attenuation from the plume capture system is apparent across lithologic units (perpendicular to strike). However, no subsequent downgradient detection of these compounds is apparent, so either migration is limited or some downgradient across-strike influence by the plume capture system is occurring.

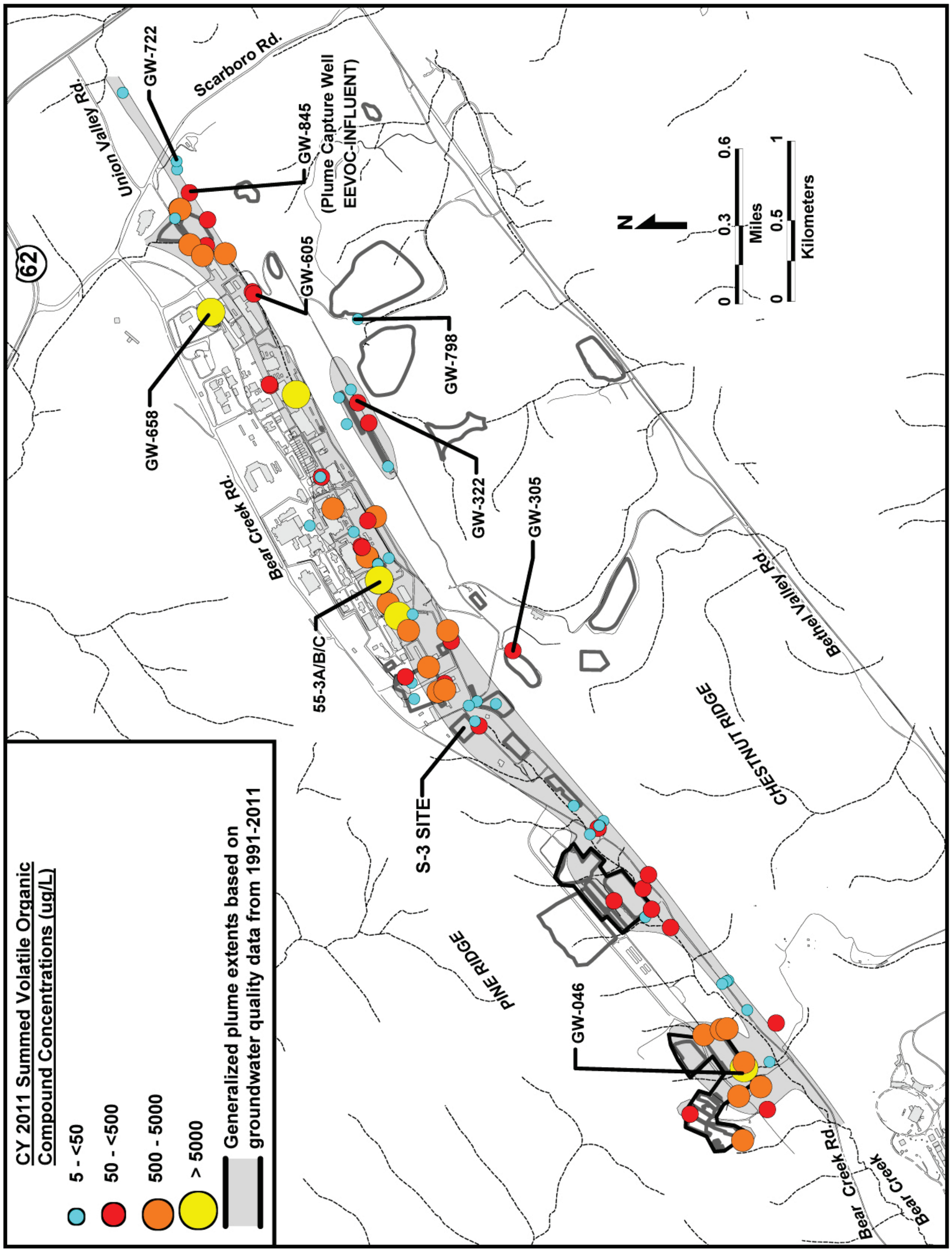

Fig. 4.39. Summed volatile organic compounds observed in groundwater at the Y-12 Complex, 2011.

4.6.4.1.5 Radionuclides

The primary alpha-emitting radionuclides found in the EFPC regime during CY 2011 are isotopes of uranium. Historical data show that gross alpha activity consistently exceeds the drinking water standard (15 pCi/L) and that it is most extensive in groundwater in the unconsolidated zone in the western portion of the Y-12 Complex near source areas such as the S-3 site and the Salvage Yard. However, the highest gross alpha activity (267 pCi/L) in groundwater continues to be observed on the east end of the Y-12 Complex in well GW-154, east of the former Oil Skimmer Basin (Fig. 4.40).

The primary beta-emitting radionuclides observed in the upper EFPC regime during CY 2011 were ^{99}Tc and isotopes of uranium. Elevated gross beta activity in groundwater in the upper EFPC regime shows a pattern similar to that observed for gross alpha activity, where ^{99}Tc is the primary contaminant exceeding the screening level of 50 pCi/L in groundwater in the western portion of the regime with the source being the S-3 site (Fig. 4.41). The highest gross beta activity in groundwater was observed during CY 2011 from well GW-108 (13,100 pCi/L), east of the S-3 site.

4.6.4.1.6 Exit Pathway and Perimeter Monitoring

Data collected to date indicate that VOCs are the primary class of contaminants that are migrating through the exit pathways in the upper EFPC regime. Historically, the compounds have been observed at depths of almost 500 ft in the Maynardville Limestone, the primary exit pathway on the east end of the Y-12 Complex. The deep fractures and solution channels that constitute flow paths within the Maynardville Limestone appear to be well connected, resulting in contaminant migration for substantial distances off ORR into Union Valley to the east of the complex.

In addition to the intermediate-to-deep pathways within the Maynardville Limestone, shallow groundwater within the water table interval of that geologic unit near New Hope Pond, Lake Reality, and upper EFPC are also monitored. Historically, VOCs have been observed near Lake Reality from monitoring wells, a dewatering sump, and the New Hope Pond distribution channel underdrain. In that area, shallow groundwater flows north-northeast through the water table interval east of New Hope Pond and Lake Reality, following the path of the distribution channel for upper EFPC.

During CY 2011, the observed concentrations of VOCs at the New Hope Pond distribution channel underdrain continued to remain low (26.5 µg/L). This may be because the continued operation of the groundwater plume–capture system in well GW-845 southeast of New Hope Pond is effectively reducing the levels of VOCs in the area. The installation of the plume capture system was completed in June 2000. This system pumps groundwater from the intermediate bedrock depth to mitigate off-site migration of VOCs. Groundwater is continuously pumped from the Maynardville Limestone at about 95 L/min (25 gal/min), passes through a treatment system to remove the VOCs, and then discharges to upper EFPC.

Monitoring wells near well GW-845 continue to show an encouraging response to the pumping activities. The multiport system installed in well GW-722, about 153 m (500 ft) east and downgradient of well GW-845, permits sampling of vertically discrete zones within the Maynardville Limestone between 27 and 130 m (87 and 425 ft) below ground surface (Fig. 4.39). This well has been instrumental in characterizing the vertical extent of the east-end plume of VOCs and is critical in the evaluation of the effectiveness of the plume capture system. Monitoring results from the sampled zones in well GW-722 indicate reductions in VOCs due to groundwater pumping upgradient at well GW-845 (Fig. 4.42). Other wells also show decreases that may be attributable to the plume capture system operation. These indicators show that operation of the plume capture system is decreasing VOCs upgradient and downgradient of well GW-845.

Upper EFPC flows north from the Y-12 Complex through a large gap in Pine Ridge. Shallow groundwater moves through the exit pathway, and very strong upward vertical flow gradients exist. Continued monitoring of the wells since about 1990 has shown no indication of any contaminants moving via that exit pathway (Fig. 4.35). Only one shallow well was monitored in CY 2011, and no groundwater contaminants were observed.

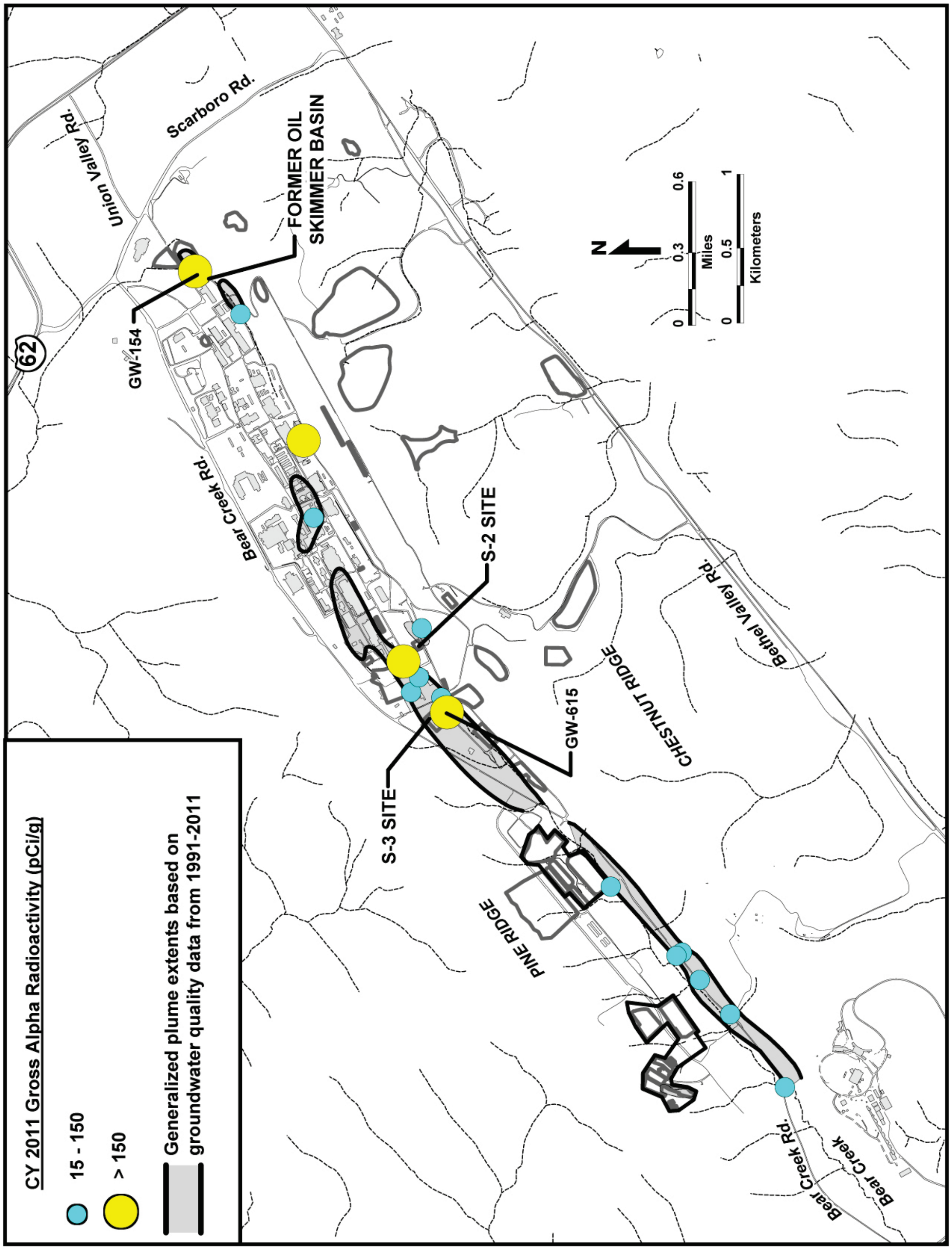

Fig. 4.40. Gross alpha radioactivity observed in groundwater at the Y-12 Complex, 2011.

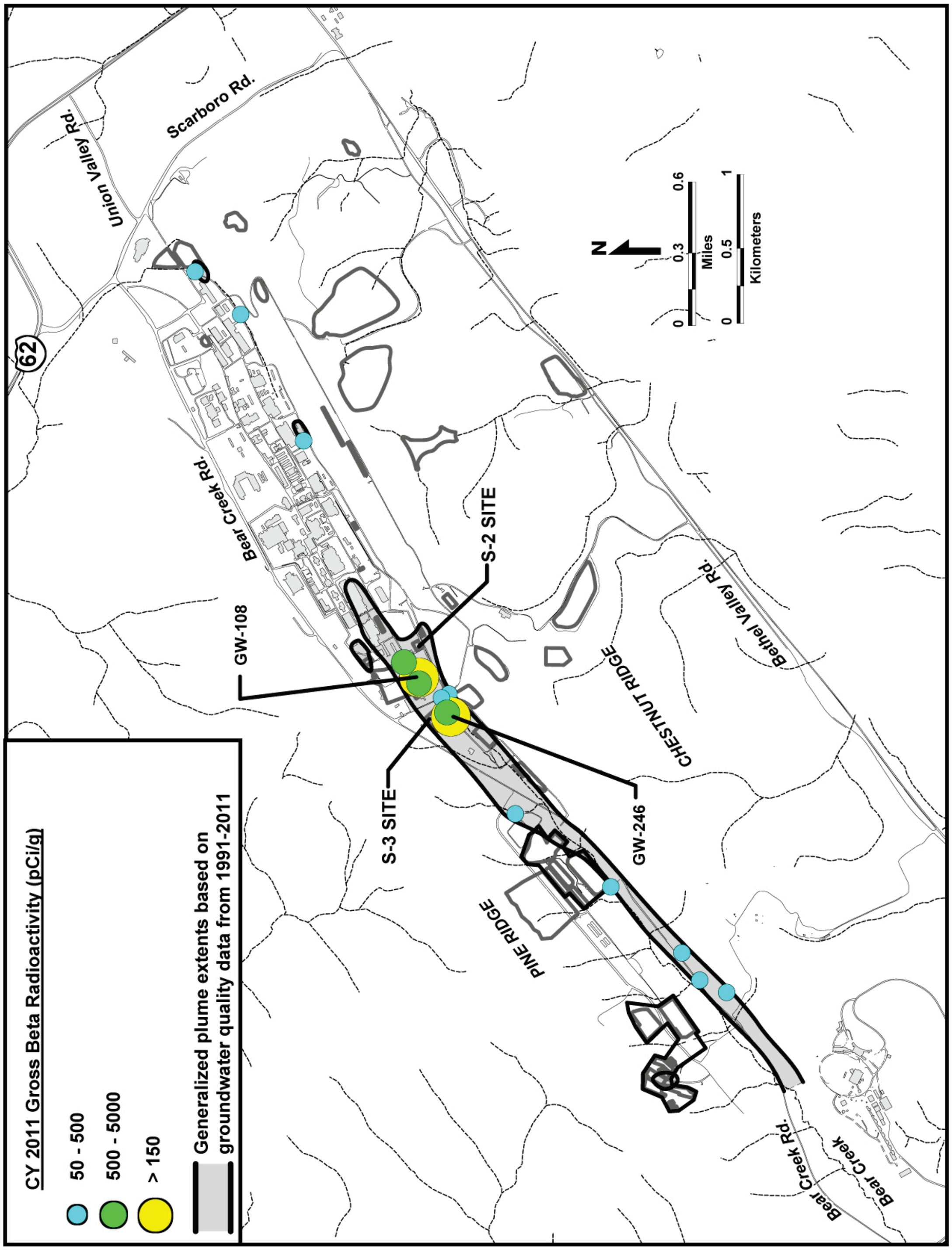

Fig. 4.41. Gross beta radioactivity observed in groundwater at the Y-12 Complex, 2011.

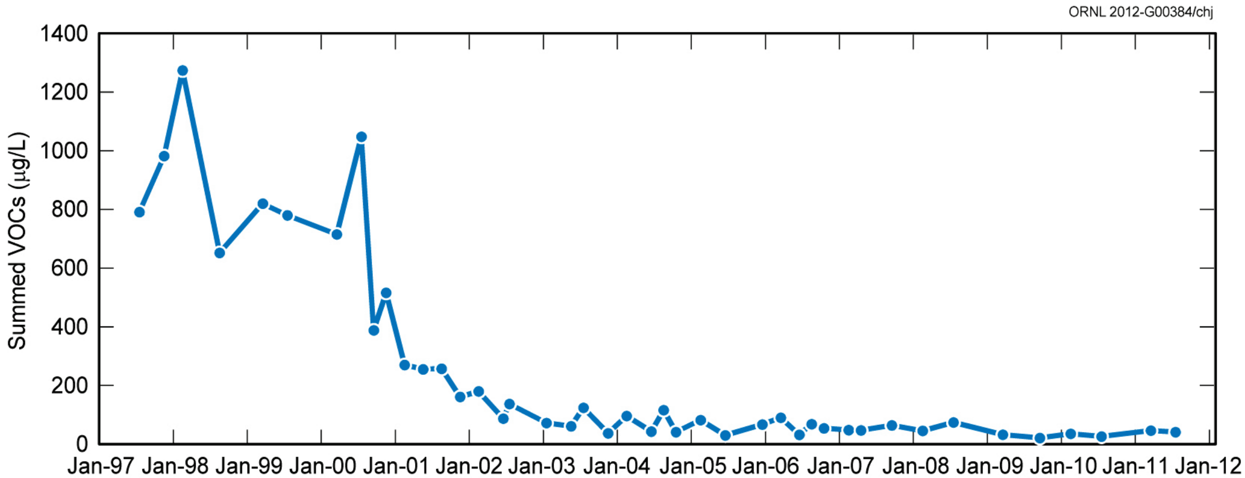

Fig. 4.42. Decreasing summed volatile organic compounds observed in exit pathway well GW-722-17 near New Hope Pond, 2011.

Three sampling locations continue to be monitored north and northwest of the Y-12 Complex to evaluate possible contaminant transport from ORR. Those locations are considered unlikely groundwater or surface water contaminant exit pathways; however, monitoring continues to be performed due to previous public concerns regarding potential health impacts from Y-12 Complex operations to nearby residences. One of the stations monitored a tributary that drains the north slope of Pine Ridge on ORR and discharges into the adjacent Scarboro Community. One location monitors an upper reach of Mill Branch, which discharges into the residential areas along Wiltshire Drive. The remaining location monitors Gum Hollow Branch as it discharges from ORR and flows adjacent to the Country Club Estates community. Samples were obtained and analyzed for metals, inorganic parameters, VOCs, and gross alpha and gross beta activities. No results exceeded a drinking water standard nor were there any indications that contaminants were being discharged from ORR into those communities.

4.6.4.1.7 Union Valley Monitoring

Groundwater monitoring data obtained during the early 1990s provided the first strong indication that VOCs were being transported off ORR through the deep Maynardville Limestone exit pathway. The upper EFPC remedial investigation (DOE 1998) provided a discussion of the nature and extent of the VOCs.

In CY 2011, monitoring of locations in Union Valley continued, showing overall decreasing or very low concentration stable trends (less than drinking water standards) in the individual concentrations of contaminants forming the groundwater contaminant plume in Union Valley.

Under the terms of an interim ROD, administrative controls such as restrictions on potential future groundwater use have been established and maintained. Additionally, the previously discussed plume capture system (well GW-845) was installed, and operations were initiated to mitigate the migration of groundwater contaminated with VOCs into Union Valley (DOE 2012, DOE 2013).

In July 2006, the Agency for Toxic Substances and Diseases Registry, the principal federal public health agency charged with evaluating the human health effects of exposure to hazardous substances in the environment, published a report in which groundwater contamination across ORR was evaluated (ATSDR 2006). In the report, it was acknowledged that extensive groundwater contamination exists throughout ORR, but the authors concluded that there is no public health hazard from exposure to contaminated groundwater originating at ORR. The Y-12 Complex east end VOC groundwater contaminant plume was acknowledged as the only confirmed off-site contaminant plume migrating across the ORR boundary. The report recognized that the institutional and administrative controls established in the ROD do not provide for reduction in toxicity, mobility, or volume of COCs, but it concluded that the controls are protective of public health to the extent that they limit or prevent community exposure to contaminated groundwater in Union Valley.

4.6.4.2 Bear Creek Hydrogeologic Regime

Located west of the Y-12 Complex in Bear Creek Valley, the Bear Creek regime is bounded to the north by Pine Ridge and to the south by Chestnut Ridge. The regime encompasses the portion of Bear Creek Valley extending from the west end of the Y-12 Complex to State Highway 95. Table 4.18 describes each of the waste management sites within the Bear Creek regime.

Table 4.18. History of waste management units included in CY 2011 groundwater monitoring activities, Bear Creek hydrogeologic regime

Site	Historical data
S-3 Site	Four unlined surface impoundments constructed in 1951. Received liquid nitric acid/uranium–bearing wastes via the Nitric Acid Pipeline until 1983. Other disposals included ^{99}Tc. Closed and capped under RCRA in 1988. Infiltration was the primary release mechanism to groundwater.
Oil Landfarm	Operated from 1973 to 1982. Received waste oils and coolants tainted with metals and PCBs. Closed and capped under RCRA in 1989. Infiltration was the primary release mechanism to groundwater.
Boneyard	Used from 1943 to 1970. Unlined shallow trenches used to dispose of construction debris and to burn magnesium chips and wood. Excavated and restored in 2002–2003 as part of Boneyard/Burnyard remedial activities.
Burnyard	Used from 1943 to 1968. Wastes, metal shavings, solvents, oils, and laboratory chemicals were burned in two unlined trenches. Excavated and restored in 2002–2003.
Hazardous Chemical Disposal Area	Used from 1975 to 1981. Built over the Burnyard. Handled compressed gas cylinders and reactive chemicals. Residues placed in a small, unlined pit. The northwest portion was excavated and restored in 2002–2003 as part of Boneyard/Burnyard remedial activities.
Sanitary Landfill I	Used from 1968 to 1982. Nonhazardous industrial landfill. May be a source of certain contaminants to groundwater. Closed and capped under TDEC requirements in 1985. Evaluation under CERCLA determined that no further action was need.
Bear Creek Burial Grounds: A, C, and Walk-in Pits	A and C received waste oils, coolants, beryllium and uranium, various metallic wastes, and asbestos into unlined trenches and standpipes. Walk-in Pits received chemical wastes, shock-sensitive reagents, and uranium saw fines. Activities ceased in 1981. Final closure certified for A (1989), C (1993), and the Walk-in Pits (1995). Infiltration is the primary release mechanism to groundwater.
Bear Creek Burial Grounds: B, D, E, J, and Oil Retention Ponds 1 and 2	Burial Grounds B, D, E, and J, unlined trenches, received depleted uranium metal and oxides and minor amounts of debris and inorganic salts. Ponds 1 and 2, built in 1971 and 1972, respectively, captured waste oils seeping into two Bear Creek tributaries. The ponds were closed and capped under RCRA in 1989. Certification of closure and capping of Burial Grounds B and part of C was granted February 1995.
Rust Spoil Area	Used from 1975 to 1983 for disposal of construction debris but may have included materials bearing solvents, asbestos, mercury, and uranium. Closed under RCRA in 1984. Site is a source of VOCs to shallow groundwater according to CERCLA remedial investigation and current surveillance monitoring.

Table 4.18. (continued)

Site	Historical data
Spoil Area I	Used from 1980 to 1988 for disposal of construction debris and other stable, nonradioactive wastes. Permitted under TDEC solid waste management regulations in 1986; closure began shortly thereafter. Soil contamination is of primary concern. CERCLA ROD issued in 1997.
SY-200 Yard	Used from 1950 to 1986 for equipment and materials storage. No documented waste disposal at the site occurred. Leaks, spills, and soil contamination are concerns. CERCLA ROD issued in 1996.
Above-Grade LLW Storage Facility	Constructed in 1993. Consists of six above-grade storage pads used to store inert, low level radioactive debris and solid wastes packaged in steel containers.
Environmental Management Waste Management Facility	Constructed in 2002. CERCLA landfill receiving legacy wastes from ETTP, ORNL, the Y-12Complex, and nearby off-site CERCLA action sites within the state of Tennessee.

Abbreviations

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
ETTP = East Tennessee Technology Park (formerly the K-25 Gaseous Diffusion Plant)
LLW = low level (radioactive) waste
ORNL = Oak Ridge National Laboratory
PCB = polychlorinated biphenyl
RCRA = Resource Conservation and Recovery Act
ROD = record of decision
TDEC = Tennessee Department of Environment and Conservation
VOC = volatile organic compound
Y-12 Complex = Y-12 National Security Complex

4.6.4.2.1 Plume Delineation

The primary groundwater contaminants in the Bear Creek regime are nitrate, trace metals, VOCs, and radionuclides. The S-3 Site is a source of all four contaminants. The Bear Creek Burial Grounds and the Oil Landfarm waste management areas are significant sources of uranium and other trace metals and VOCs. High concentrations of chlorinated hydrocarbons and PCBs have been observed as deep as 82 m (270 ft) below the Bear Creek Burial Grounds (MMES 1990).

Contaminant plume boundaries are essentially defined in the bedrock formations that directly underlie many waste disposal areas in the Bear Creek regime, particularly the Nolichucky Shale. This fractured aquitard unit is positioned north of and adjacent to the exit pathway unit, the Maynardville Limestone. The elongated shape of the contaminant plumes in the Bear Creek regime is the result of preferential transport of the contaminants parallel to strike (parallel to the valley axis) in the Maynardville Limestone and the aquitard units.

4.6.4.2.2 Nitrate

The limits of the nitrate plume probably define the maximum extent of groundwater contamination in the Bear Creek regime. The horizontal extent of the nitrate plume is essentially defined in groundwater in the upper to intermediate bedrock intervals of the aquitard units and Knox Aquifer [less than 92 m (300 ft) below the ground surface].

Data obtained during CY 2011 indicate that nitrate concentrations in groundwater continue to exceed the drinking water standard in an area that extends west from the source area at the S-3 site. The highest nitrate concentration (11,599 mg/L) was observed at well GW-615 adjacent to the S-3 site at a depth of 68 m (223 ft) below ground surface (Fig. 4.37), indicating that high concentrations persist deeper in the subsurface groundwater system. A multiport monitoring well, GW-134, was sampled in CY 2011 and continues to show elevated concentrations of nitrate (1,420 mg/L) as deep as 226 m (740 ft) below ground surface.

4.6.4.2.3 Trace Metals

During CY 2011, arsenic, barium, beryllium, boron, cadmium, lead, manganese, nickel, and uranium were identified from groundwater monitoring as the trace metal contaminants in the Bear Creek regime that exceeded drinking water standards. Historically, elevated concentrations of many of the trace metals were observed at shallow depths near the S-3 site. In the Bear Creek regime, where natural geochemical conditions prevail, the trace metals may occur sporadically and in close association with source areas because conditions are typically not favorable for dissolution and migration. Disposal of acidic liquid wastes at the S-3 site reduced the pH of the groundwater, which allows the metals to remain in solution longer and migrate further from the source area.

The most prevalent trace metal contaminant observed within the Bear Creek regime is uranium, indicating that geochemical conditions are favorable for its migration. Early characterization indicated that the Boneyard/Burnyard site was the primary source of uranium contamination of surface water and groundwater. Historically, uranium has been observed at concentrations exceeding the drinking water standard of 0.03 mg/L in shallow monitoring wells, springs, and surface water locations downgradient from all of the waste areas. In 2003, the final remedial actions at the Boneyard/Burnyard were performed with the objective of removing materials contributing to surface water and groundwater contamination to meet existing ROD goals. About 65,752 m^3 (86,000 yd^3) of waste materials was excavated and placed in the EMWMF (DOE 2007). There were significant decreases in uranium concentration and flux in the surface water tributary immediately downstream of the Boneyard/Burnyard (NT-3), which indicate that the remedial actions performed from 2002 to 2003 were successful in removing much of a primary source of uranium in Bear Creek Valley. However, beginning in 2007, flow proportionate composite samples from NT-3 show an increase in the uranium flux that continues to be observed. These increases indicate that even with overall decreasing uranium concentrations (Table 4.19), certain areas still present a significant impact to the overall health of Bear Creek.

Table 4.19. Nitrate and uranium concentrations in Bear Creek[a]

Bear Creek Monitoring Station (distance from S-3 site)	Contaminant	Average Concentration (mg/L)					
		1990–1993	1994–1997	1998–2001	2002–2005	2006–2009	2010–2011
BCK[b]-11.84 to 11.97	Nitrate	119	80	80	79.5	33.4	53.8
(~0.5 miles downstream)	Uranium	0.196	0.134	0.139	0.133	0.122	0.173
BCK-09.20 to 09.47	Nitrate	16.4	9.6	10.6	11.3	9.1	5.1
(~2 miles downstream)	Uranium	0.091	0.094	0.171	0.092	0.067	0.048
BCK-04.55	Nitrate	4.6	3.6	2.6	2.9	1.1	0.9
(~5 miles downstream)	Uranium	0.034	0.031	0.036	0.026	0.022	0.016

[a]Excludes results that do not meet data quality objectives.
[b]BCK = Bear Creek kilometer

Additional monitoring has been initiated to attempt to determine uranium inputs to the stream from source areas and the karst groundwater system underlying Bear Creek. Other trace metal contaminants that have been observed in previous years in the Bear Creek regime are mercury, selenium, strontium, thallium, and zinc. Concentrations have commonly exceeded background values in groundwater near contaminant source areas.

4.6.4.2.4 Volatile Organic Compounds

VOCs are widespread in groundwater in the Bear Creek regime. The primary compounds are PCE, TCE, 1,2-DCE, vinyl chloride, and 1,1-DCA. In most areas, they are dissolved in the groundwater and can occur in bedrock at depths up to 92 m (300 ft) below ground surface. Groundwater in the fractured bedrock of the aquitard units that contain detectable levels of VOCs occurs within about 305 m (1,000 ft) of the source areas. The highest concentrations observed in CY 2011 in the Bear Creek regime occurred in the shallow unconsolidated zone at the Bear Creek Burial Ground waste management area, with a maximum summed VOC concentration of 6,690 µg/L in well GW-046 (Fig. 4.39).

High concentrations of VOCs like this and in other near source wells, coupled with increasing trends observed downgradient of the Bear Creek Burial Ground waste management area in the clastic (noncarbonated) dominated fractured bedrock of the aquitard units (Fig. 4.43), indicate that a considerable mass of dense nonaqueous phase organic compounds is still present at a depth below the Bear Creek Burial Grounds, providing a source for dissolved phase migration of VOCs. This migration parallel to the valley axis and toward the exit pathway (Maynardville Limestone) is occurring in both the unconsolidated and bedrock intervals.

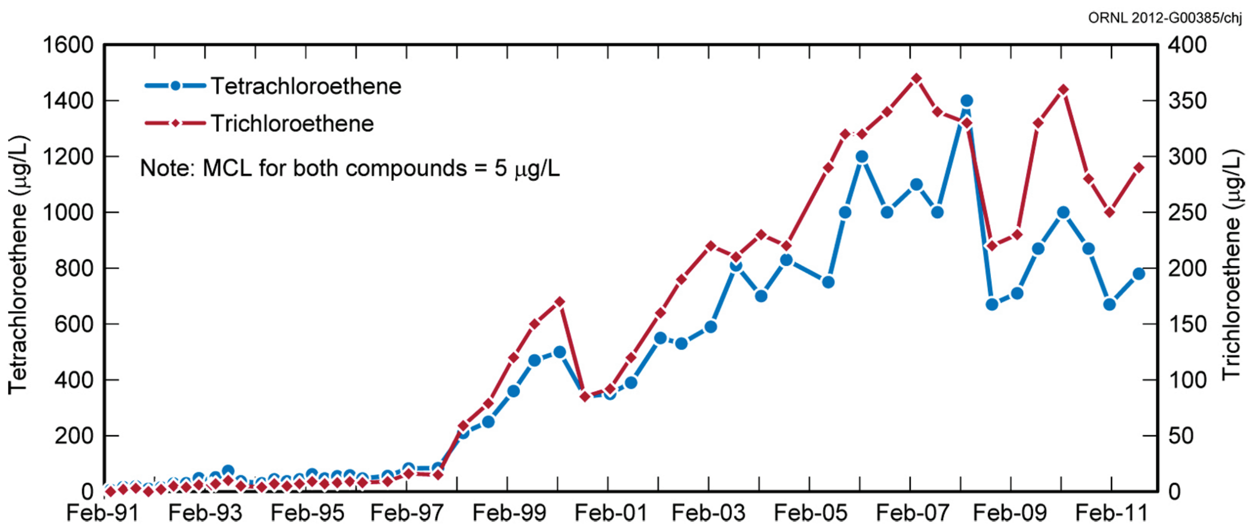

Fig. 4.43. Increasing levels of volatile organic compounds observed in groundwater at well GW-627 west and downgradient of the Bear Creek Burial Grounds, 2011.

Significant transport of VOCs has occurred in the Maynardville Limestone. Data obtained from exit pathway monitoring locations show that in the shallow groundwater interval, an apparently continuous dissolved plume extends at least 2,440 m (8,000 ft) westward from the S-3 site to just south of the Bear Creek Burial Ground waste management area.

4.6.4.2.5 Radionuclides

The primary radionuclides identified in the Bear Creek regime are isotopes of uranium and ^{99}Tc. Neptunium, americium, radium, strontium, thorium, plutonium, and tritium are secondary and less widespread radionuclides which historically have been observed in groundwater near the S-3 site. Evaluations of the extents of radionuclides in groundwater in the Bear Creek regime during CY 2011 were based primarily on measurements of gross alpha activity and gross beta activity. If the annual average gross alpha activity in groundwater samples from a well exceeded 15 pCi/L (the drinking water standard for gross alpha activity), then one (or more) of the alpha-emitting radionuclides (e.g., uranium) was assumed to be present at elevated levels in the groundwater monitored by the well. A similar rationale was used for annual average gross beta activity that exceeded 50 pCi/L. Technetium-99, a more volatile radionuclide, is qualitatively screened by gross beta activity analysis and, at certain monitoring locations, is evaluated isotopically.

Groundwater with elevated levels of gross alpha activity occurs near the S-3 site and the Oil Landfarm and Bear Creek Burial Grounds waste management areas. In the bedrock interval, gross alpha activity exceeds 15 pCi/L in groundwater in the fractured bedrock of the aquitard units only near source areas (Fig. 4.40). Data obtained from exit pathway monitoring stations during CY 2011 show that gross alpha activity in groundwater in the Maynardville Limestone and in the surface waters of Bear Creek exceeds the drinking water standard for over 3,353 m (11,000 ft) west of the S-3 site. The highest gross alpha activity observed in CY 2010 was 440 pCi/L in well GW-615 located adjacent to the S-3 site.

The distribution of gross beta radioactivity in groundwater is similar to that of gross alpha radioactivity. During CY 2011, the lateral extent of gross beta activity within the exit pathway groundwater interval and surface water above the drinking water standard has again extended back to just south of the Bear Creek Burial Grounds. Gross beta activity exceeded 50 pCi/L within the Maynardville Limestone exit pathway for 2,440 m (8,000 ft) from the S-3 site (Fig. 4.41). This apparent oscillation in the plume length is dependent on rainfall and other seasonal factors. The highest gross beta activity in groundwater in the Bear Creek regime in 2011 was 15,000 pCi/L at well GW-246 located adjacent to the S-3 site.

4.6.4.2.6 Exit Pathway and Perimeter Monitoring

Exit pathway monitoring began in 1990 to provide data on the quality of groundwater and surface water exiting the Bear Creek regime. The Maynardville Limestone is the primary exit pathway for groundwater. Bear Creek, which flows across the Maynardville Limestone in much of the Bear Creek regime, is the principal exit pathway for surface water. Various studies have shown that the surface water in Bear Creek, the springs along the valley floor, and the groundwater in the Maynardville Limestone are hydraulically connected. Surveys have been performed that identify gaining (groundwater discharging into surface waters) and losing (surface water discharging into a groundwater system) reaches of Bear Creek. The western exit pathway well transect (Picket W) serves as the perimeter well location for the Bear Creek regime (Fig. 4.35).

Exit pathway monitoring consists of continued monitoring at four well transects (pickets) and selected springs and surface water stations. Groundwater quality data obtained during CY 2011 from the exit pathway monitoring wells indicate that groundwater is contaminated above drinking water standards in the Maynardville Limestone as far west as Picket B and trends are generally decreasing (Fig. 4.44).

Surface water samples collected during CY 2011 indicate that water in Bear Creek contains many of the compounds found in the groundwater. Additionally, nitrate and uranium concentrations exceeding their respective drinking water standards have been observed in surface water west of the burial grounds as far as Picket A. The concentrations in the creek decrease with distance downstream of the waste disposal sites (Table 4.19). Even though increases in uranium flux have been observed in surface water, which will require additional evaluation to pinpoint ungauged sources, individual monitoring locations along Bear Creek also show a general decrease in concentration with respect to time.

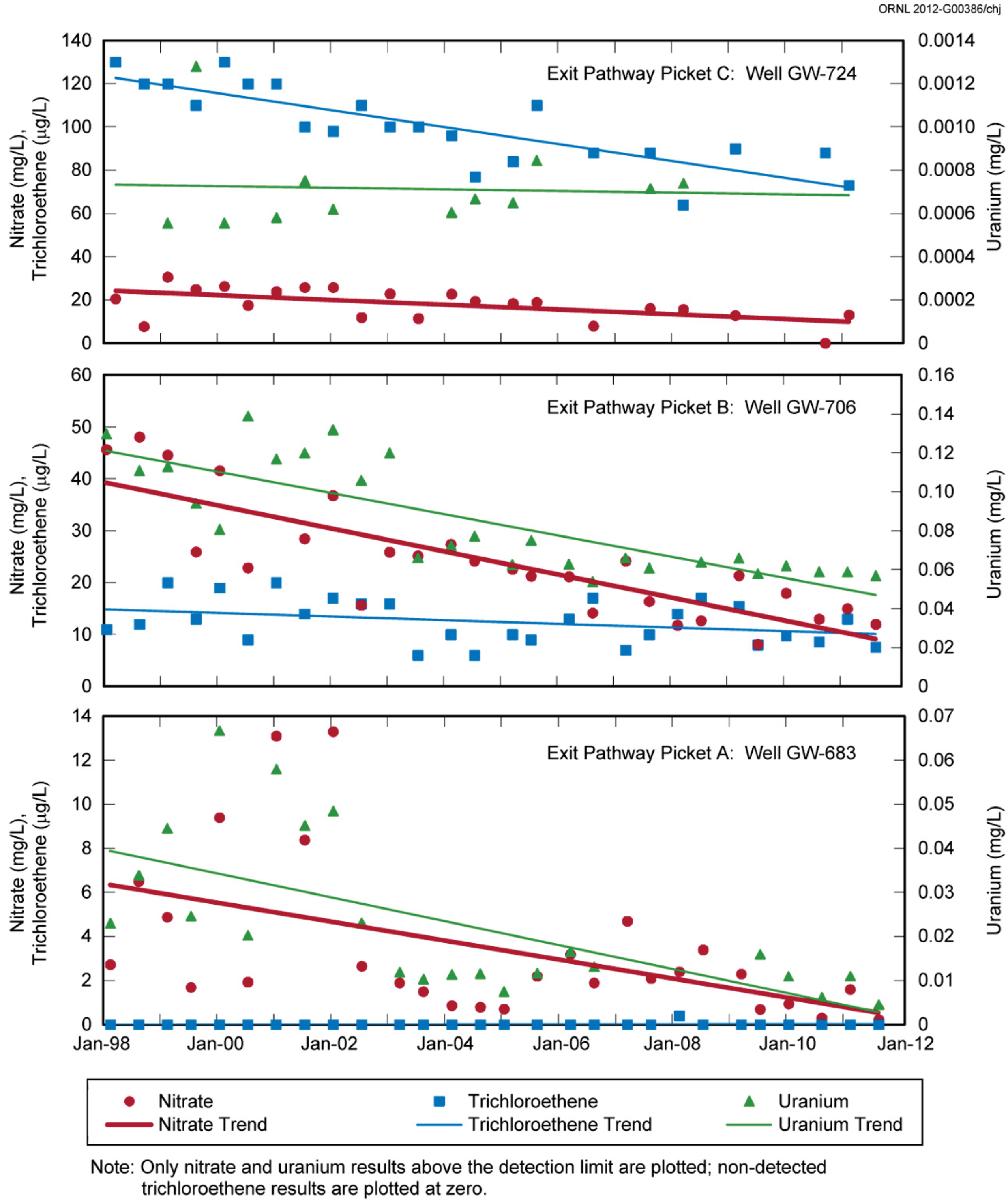

Fig. 4.44. CY 2011 concentrations of selected contaminants in exit pathway monitoring wells GW-724, GW-706, and GW-683 in the Bear Creek hydrogeologic regime.

4.6.4.3 Chestnut Ridge Hydrogeologic Regime

The Chestnut Ridge hydrogeologic regime is flanked to the north by Bear Creek Valley and to the south by Bethel Valley Road (Fig. 4.33). The regime encompasses the portion of Chestnut Ridge extending from Scarboro Road, east of the complex, to Dunaway Branch, located just west of Industrial Landfill II.

The Chestnut Ridge Security Pits area is the only documented source of groundwater contamination in the regime. Contamination from the security pits is distinct and does not mingle with plumes from other sources. Table 4.20 summarizes the operational history of waste management units in the regime.

Table 4.20. History of waste management units included in groundwater monitoring activities, Chestnut Ridge hydrogeologic regime, 2011

Site	Historical data
Chestnut Ridge Sediment Disposal Basin	Operated from 1973 to 1989. Received soil and sediment from New Hope Pond and mercury-contaminated soils from the Y-12 Complex. Site was closed under RCRA in 1989. Not a documented source of groundwater contamination.
Kerr Hollow Quarry	Operated from 1940s to 1988. Used for the disposal of reactive materials, compressed gas cylinders, and various debris. RCRA closure (waste removal) was conducted between 1990 and 1993. Certification of closure with some wastes remaining in place was approved by TDEC February 1995.
Chestnut Ridge Security Pits	Operated from 1973 to 1988. Series of trenches for disposal of classified materials, liquid wastes, thorium, uranium, heavy metals, and various debris. Closed under RCRA in 1989. Infiltration is the primary release mechanism to groundwater.
United Nuclear Corporation Site	Received about 29,000 drums of cement-fixed sludges and soils demolition materials and low level radioactive contaminated soils. Closed in 1992; CERCLA ROD has been issued.
Industrial Landfill II	Operated from 1983–1995. Central sanitary landfill for ORR. Detection monitoring under postclosure plan has been ongoing since 1996.
Industrial Landfill IV	Opened for operations in 1989. Permitted to receive only nonhazardous industrial solid wastes. Detection monitoring under TDEC solid-waste-management regulations has been ongoing since 1988. Assessment monitoring began in 2008 because of consistent exceedence of a TDEC groundwater protection standard.
Industrial Landfill V	Initiated operations April 1994. Currently under TDEC solid-waste-management detection monitoring.
Construction/Demolition Landfill VI	Facility operated from December 1993 to November 2003. The postclosure period ended and the permit was terminated March 2007
Construction/Demolition Landfill VII	Facility construction completed in December 1994. TDEC granted approval to operate January 1995. Permit-required detection monitoring per TDEC was temporarily suspended October 1997 pending closure of construction/demolition Landfill VI. Reopened and began waste disposal operations in April 2001.
Filled Coal Ash Pond	Site received Y-12 Steam Plant coal ash slurries from 1955–1968. A CERCLA ROD has been issued. Remedial action complete.
East Chestnut Ridge Waste Pile	Operated from 1987 to 1989 to store contaminated soil and spoil material generated from environmental restoration activities at the Y-12 Complex. Closed under RCRA in 2005 and incorporated into RCRA postclosure permit issued by TDEC in 2006.

Abbreviations

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
ORR = Oak Ridge Reservation
RCRA = Resource Conservation and Recovery Act
ROD = record of decision
TDEC = Tennessee Department of Environment and Conservation
Y-12 Complex = Y-12 National Security Complex

4.6.4.3.1 Plume Delineation

Through extensive monitoring of the wells on Chestnut Ridge, the horizontal extent of the VOC plume at the Chestnut Ridge Security Pits seems to be reasonably well defined in the water table and shallow bedrock zones. With two possible exceptions, historical monitoring indicates that the VOC plume from the Chestnut Ridge Security Pits has not migrated very far in any direction [305 m (<1,000 ft)]. Groundwater quality data obtained during CY 2011 indicate that the western lateral extent of the plume of VOCs at the site has not changed significantly from previous years. The continued observation of VOC contaminants over the past several years at a well about 458 m (1,500 ft) southeast of the Chestnut Ridge Security Pits (well GW-798, Fig. 4.39) shows that some migration of the eastern plume has occurred. Additionally, dye tracer test results and the intermittent detection of very low concentrations of VOCs (similar to those found in wells adjacent to the Chestnut Ridge Security Pits) at a natural spring about 2,745 m (9,000 ft) to the east and along geologic strike may suggest that Chestnut Ridge Security Pits groundwater contaminants have migrated much further than the monitoring well network indicates.

4.6.4.3.2 Nitrate

Nitrate concentrations were below the drinking water standard at all monitoring stations in the Chestnut Ridge hydrogeologic regime except one. Exit pathway/perimeter surveillance monitoring location S17 (Figure 4.37) presented an increasing trend in nitrate as nitrogen that just exceeded the drinking water standard in August 2011 (10.1 mg/L). This surface water monitoring station is located on the tributary that drains Chestnut Ridge adjacent to Kerr Hollow Quarry and is monitored due to the known interrelationship between the groundwater and surface waters on Chestnut Ridge. Following this detection, a detailed survey of the tributary was performed in an attempt to pinpoint the possible source of this contaminant. This survey, completed in December 2011, determined that no further elevated concentrations of nitrate as nitrogen above the drinking water standard have been observed and that one natural spring appears to be the source of the elevated nitrate concentrations. This tributary and the surrounding areas continue to be evaluated for a possible source of nitrate.

4.6.4.3.3 Trace Metals

Elevated concentrations of arsenic were observed in two surface water monitoring locations and a natural spring downstream from the Filled Coal Ash Pond, which is monitored under a CERCLA ROD (DOE 2012). Under the ROD a constructed wetland area is being used to reduce surface water contamination by effluent from the Filled Coal Ash Pond. During CY 2011, elevated arsenic levels were detected both upgradient [McCoy Branch kilometer (MCK) 2.05] and downgradient (MCK 2.0) of this wetland area and in one of two groundwater samples obtained from a natural spring, SCR3.5SP, about 610 m (2,000 ft) downstream of the wetlands. An exit pathway/perimeter surface water monitoring location adjacent to and downstream from Spring SCR3.5SP was also sampled during CY 2011 with no detectable arsenic. These locations will continue to be monitored in CY 2012.

4.6.4.3.4 Volatile Organic Compounds

In 2011, the highest summed VOC concentration observed in the Chestnut Ridge hydrogeologic regime was at Chestnut Ridge Security Pits well GW-322 (124 μg/L) (Fig. 4.39). Monitoring VOCs in groundwater attributable to the Chestnut Ridge Security Pits has been in progress since 1987. A review of historical data indicates that concentrations of VOCs in groundwater at the site have generally decreased since 1988. However, a stable to very shallow increasing trend in VOCs in groundwater samples from monitoring well GW-798 (Fig. 4.39) to the southeast and downgradient of the Chestnut Ridge Security Pits has been developing since CY 2000. The maximum summed VOC concentration observed at well GW-798 during CY 2011 was 34 μg/L. The VOCs detected in well GW-798 continue to be characteristic of the Chestnut Ridge Security Pits plume.

At Industrial Landfill IV, a number of VOCs have been observed since 1992. Monitoring well GW-305, located immediately to the southeast of the facility, has historically displayed concentrations of compounds below applicable drinking water standards, but the concentrations have exhibited a shallow increasing trend. In CY 2011, samples continue to exceed the drinking water standard for 1,1-DCE (7 µg/L). This has resulted in an increased level of monitoring to further evaluate the trend.

4.6.4.3.5 Radionuclides

In CY 2011, no gross alpha or gross beta activity above the drinking water standard of 15 pCi/L and 50 pCi/L, respectively, was observed in any groundwater samples collected in the Chestnut Ridge hydrogeologic regime.

4.6.4.3.6 Exit Pathway and Perimeter Monitoring

Contaminant and groundwater flow paths in the karst bedrock underlying the Chestnut Ridge regime have not been well characterized by conventional monitoring techniques. A number of tracer studies have been conducted that show groundwater from Chestnut Ridge discharging into Scarboro Creek and other tributaries that feed into Melton Hill Lake. However, no springs or surface streams that represent discharge points for groundwater have been conclusively correlated to a waste management unit or operation at the Y-12 Complex that is a known or potential groundwater contaminant source. Water quality from a spring along Scarboro Creek is monitored quarterly by the TDEC DOE Oversight Office, and trace concentrations of VOCs are intermittently detected. The detected VOCs are suspected to originate from the Chestnut Ridge Security Pits; however, this has not been confirmed.

Monitoring natural groundwater exit pathways is a basic monitoring strategy in a karst regime such as that of Chestnut Ridge. Perimeter springs and surface water tributaries were monitored to determine whether contaminants are exiting the downgradient (southern) side of the regime. Five springs and three surface water monitoring locations were sampled during CY 2011. Only in surface water monitoring location S17 (see the discussion in Section 4.6.4.3.2) were any contaminants detected at levels above drinking water standards.

4.6.5 Quality Assurance

All groundwater monitoring is performed under quality controls to ensure that representative samples and analytical results are obtained. Because there are a number of organizations responsible for performing groundwater sampling and analysis activities to meet separate requirements, there may be some minor differences in sampling and analysis procedures and methods, but the final results are comparable and therefore useful for all projects and programs. This permits the integrated use of all groundwater quality data obtained at the Y-12 Complex.

A number of QA measures are performed to ensure accurate, consistent, and comparable groundwater results. These measures are described in sampling and analysis plans and include the following.

- Groundwater sampling is performed across the Y-12 Complex using a number of sampling methods and procedures. The predominant method of sampling monitoring wells is by using a low-flow minimum drawdown method. Using this method, a sample is obtained from a discrete depth interval of the monitoring interval (screened or open borehole) without introducing stagnant water from the well casing. Groundwater is pumped from the well at a flow rate low enough to minimize drawdown of the water level in the well; field readings are also taken to ensure that the sample is representative of the groundwater system and not the well casing itself. All sampling methods follow industry/regulator–recognized protocols to ensure that consistent and repeatable samples are obtained.
- QCs such as field blank, trip blank, duplicate, and equipment rinsate samples are collected.
- All groundwater samples are controlled under chain of custody from their collection in the field to the analytical laboratory that performs the analyses.
- Laboratory analyses are performed using standard methods and protocols within established holding times.

During 2011 all groundwater monitoring and related analytical activities were performed in accordance with the established protocols.

4.7 Quality Assurance Program

It is the intent of B&W Y-12 that the Y-12 Complex Quality Assurance Program be fully consistent with and supportive of the ISMS program's functions and guiding principles. Management requirement Y60-101PD, *Quality Program Description*, details the methods used to carry out work processes safely and securely and in accordance with established procedures. It also describes mechanisms in place to seek continuous improvements by identifying and correcting findings and preventing recurrences.

Many factors can potentially affect the results of environmental data collection activities, including sampling personnel, methods, and procedures; field conditions; sample handling, preservation, and transport; personnel training; analytical methods; data reporting; and record keeping. QA programs are designed to minimize these sources of variability and to control all phases of the monitoring process.

Field sampling QA encompasses many practices that minimize error and evaluate sampling performance. Some key quality practices include the following:

- use of work control processes and standard operating procedures for sample collection and analysis;
- use of chain-of-custody and sample-identification procedures;
- instrument standardization, calibration, and verification;
- sample technician and laboratory analyst training;
- sample preservation, handling, and decontamination; and
- use of QC samples, such as field and trip blanks, duplicates, and equipment rinses.

Analytical results may be affected by a large number of factors inherent to the measurement process. Laboratories that support the Y-12 Complex environmental monitoring programs use internal QA/QC programs to ensure the early detection of problems that may arise from contamination, inadequate calibrations, calculation errors, or improper procedure performance. Internal laboratory QA/QC programs include routine calibrations of counting instruments, yield determinations, frequent use of check sources and background counts, replicate and spiked sample analyses, matrix and reagent blanks, and maintenance of control charts to indicate analytical deficiencies. These activities are supported by the use of standard materials or reference materials (e.g., materials of known composition that are used in the calibration of instruments, methods standardization, spike additions for recovery tests, and other practices). Certified standards traceable to NIST, DOE sources, or EPA are used (when available) for such work.

The Y-12 Analytical Chemistry Organization (ACO) Quality Assurance Plan describes QA program elements that are based on the B&W Y-12 Quality Assurance Program; customer-specific requirements; certification program requirements, International Standard ISO/IEC 17025, General Requirements for Competence of Testing and Calibration Laboratories; federal, state, and local regulations; and waste acceptance criteria. As a government-owned client-operated laboratory that performs work for DOE, the ACO laboratory operates in accordance with DOE O 414.1D, *Quality Assurance.* To meet these requirements, the ACO laboratory adheres to the latest edition of the *DOE Quality Systems for Analytical Services* (DOE 2010) where it applies.

Other internal practices used to ensure that laboratory results are representative of actual conditions include training and managing staff; maintaining adequacy of the laboratory environment; safety; controlling the storage, integrity, and identity of samples; record keeping; maintaining and calibrating instruments; and the using technically validated and properly documented methods.

Verification and validation of environmental data are performed as components of the data collection process, which includes planning, sampling, analysis, and data review. Some level of verification and validation of field and analytical data collected for environmental monitoring and restoration programs is necessary to ensure that data conform to applicable regulatory and contractual requirements. Validation of field and analytical data is a technical review performed to compare data with established quality criteria to ensure that data are adequate for the intended use. The extent of project data verification and validation activities is based on project-specific requirements.

For routine environmental effluent monitoring and surveillance monitoring, data verification activities may include processes of checking whether (1) data have been accurately transcribed and recorded, (2) appropriate procedures have been followed, (3) electronic and hard-copy data show one-to-one correspondence, and (4) data are consistent with expected trends. Typically, routine data verification actions alone are sufficient to document the validity and accuracy of environmental reports. For restoration projects, routine verification activities are more contractually oriented and include checks for data completeness, consistency, and compliance with a predetermined standard or contract.

Certain projects may require a more thorough technical validation of the data as mandated by the project's data quality objectives. Sampling and analyses conducted as part of a remedial investigation to support the CERCLA process may generate data that are needed to evaluate risk to human health and the environment, to document that no further remediation is necessary, or to support a multimillion-dollar construction activity and treatment alternative. In these cases, the data quality objectives of the project may mandate a thorough technical evaluation of the data against rigorous predetermined criteria. The validation process may result in the identification of data that do not meet predetermined QC criteria or in the ultimate rejection of data for their intended use. Typical criteria evaluated in the validation of Contract Laboratory Program data include the percentage of surrogate recoveries, spike recoveries, method blanks, instrument tuning, instrument calibration, continuing calibration verifications, internal standard response, comparison of duplicate samples, and sample holding times.

4.8 Environmental Management and Waste Management Activities

4.8.1 Upper East Fork Poplar Creek Remediation

Remediation of the upper EFPC watershed is being conducted in two stages under RODs using a phased approach. Phase 1 addresses remediation of mercury-contaminated soil, sediment, and groundwater discharges that contribute contamination to surface water.

The initial project of the Phase 1 ROD, construction of the Big Springs Water Treatment System, was completed in 2006. The system has been fully operational since September 2006, removing mercury from local spring and sump waters that discharge to upper EFPC.

WEMA (historic mercury use area) was completed in FY 2011 (see Section 4.8.2).

Additionally, a water treatment evaluation and ultimate implementation of recommended actions is being conducted with ARRA funding with a focus on significant reduction in mercury discharge to the upper EFPC (Section 4.8.2).

4.8.2 American Recovery and Reinvestment Act-Funded Projects at the Y-12 Complex

Funding from ARRA has allowed more cleanup work to be performed at the Y-12 Complex. Seven "shovel-ready" projects, which as a group were completed before the end of FY 2011, were regulated under CERCLA and were authorized by a time-critical removal action memorandum. These Y-12 Complex recovery act projects meet or exceed existing regulatory milestones, and as a result of efficient and effective management and supplemental ARRA funding, additional projects were added. Results and progress on each of these projects are detailed in this section.

Building 9735 Deactivation and Demolition

Demolition of Building 9735, the last building to be removed from Engineering Row, was completed in June 2010.

Biology Complex Deactivation and Demolition

The Biology Complex deactivation and demolition project eliminated 135,812 ft^2 of unused building space and the risk associated with the deteriorated facilities. Four buildings, including 9211 (Fig. 4.45), were demolished as part of this project.

ORNL 2012-G00354/chj

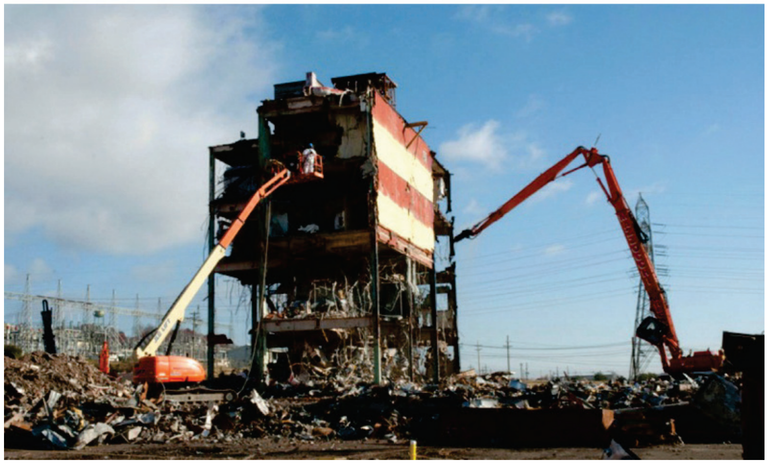

Fig. 4.45. Building 9211 demolition.

9204-4 Legacy Materials Removal Project

This project comprises removal and disposal of legacy materials from Building 9204-4, also known as Beta 4, to prepare for deactivation and demolition of the facility as part of the site transformation plan. 5,071 cubic meters of materials were characterized, packaged, and disposed of as sanitary and/or low level radioactive waste.

9201-5 Legacy Materials Removal Project

Building 9201-5, also known as Alpha-5, is the largest building at the Y-12 Complex, measuring 613,642 ft^2. The project removed and disposed 23,457 m^3 of legacy materials from the building and characterized the building structure to prepare for eventual deactivation and demolition as part of the EM Program. The project was completed before September 30, 2011.

Building 9206 Filter House Removal

The Building 9206 Filter House Removal Project removed a contaminated process system and was completed in 2011 (Fig. 4.46).

ORNL 2012-G00355/chj

Fig. 4.46. Building 9206 Filter House Removal Operations.

West End Mercury Area Storm Sewer Remediation Project

Remediation of the WEMA storm sewer (Fig. 4.47) was completed in September 2011. This involved cleaning 8,790 linear feet and lining 2,213 linear feet of storm sewers. Processing and disposal of the resulting mercury waste continues with completion expected in early 2012.

ORNL 2012-G00356/chj

Fig. 4.47. Contaminated storm sewers were the primary source of mercury contamination in Poplar Creek.

Old Salvage Yard Scrap Removal Project

Cleanup of the 7-acre site, established in the early 1970s, used for storing scrap metal and hazardous wastes until 1999 was completed. The project characterized 21,894 m^3 of waste materials and disposed of them at EMWMF. In addition to scrap removal, this project performed characterization of the soil for a follow-on project that would perform any required remediation activities.

Old Salvage Yard Soil Remediation Project

A single 50 ft by 50 ft area of the Old Salvage Yard was determined to be contaminated to a level that required remediation of the soil and disposal as low level waste. The area was remediated to a depth of 2 ft and backfilled and stabilized in late 2011. The resulting waste has been characterized and is stored on-site pending the completion of the waste profile that will permit disposal at EMWMF.

Water Treatment Evaluation

A water treatment analysis of Outfall 163 in upper EFPC has been undertaken to gather and analyze data which will permit a scope of work to be defined that will focus on a significant reduction in mercury discharge to the environment. Preliminary evaluation results suggest a phased approach to be the most cost effective strategy.

Exposure Unit 9 Characterization (Federal Facilities Agreement Milestone for 2012)

This project will define the extent of contamination at EU9, model the connection of EU9 to the upper EFPC, and complete a remedial design report. This project is significant because the mercury recovery furnace used during the cold war was located in this exposure unit. Field work will begin on this project in early 2012, and its completion will meet an FFA milestone before September 30, 2012.

4.8.3 Waste Management

Much of the waste generated during FY 2011 cleanup activities was disposed at ORR facilities (DOE 2011a). EMWMF, located in Bear Creek Valley west of the Y-12 Complex, is an engineered landfill that accepts waste generated from CERCLA response actions and cleanup activities on ORR.

This engineered landfill consists of six disposal cells and accepts low level radioactive and hazardous waste that meet specific waste acceptance criteria. Waste types that qualify for disposal include soil, dried sludge and sediment, solidified wastes, stabilized waste, building debris, scrap equipment, and personal protective equipment.

Construction of Cell 6 at EMWMF, which kicked off in May 2010, was completed in the spring of 2011. The completion of Cell 6 marked the final expansion effort for EMWMF, which now has a total disposal capacity of 2,180,000 yd^3. Cell 6 construction also added two 30,000 gal leachate storage tanks, four 250,000 gal contact water tanks, and a new leachate loading station to improve the facility's water management capability.

During FY 2011 EMWMF received 19,507 truckloads (about 197,000 tons) of waste. EMWMF operations collected, analyzed, and dispositioned about 4.8 million gal of leachate and 1.3 million gal of contact water at the ORNL Liquid/Gaseous Waste Operations Facility in FY 2011. An additional 10 million gal of contact water was collected, analyzed, and released to the storm water retention basin after it was determined that it met the release criteria. Operating practices also effectively controlled site erosion and sediment.

Projects that disposed of waste at EMWMF during FY 2011 include

- K-25 Building Demolition Project;
- K-33 Building Demolition Project;
- ETTP D&D Project, including K-770 Scrap Yard, K-1070-B Burial Ground, and K-1093 Scrap Yard;
- Y-12 Complex Old Salvage Yard;
- Y-12 Complex Alpha 5 and Biology Projects;
- and several ORNL demolition projects.

DOE also operates solid waste disposal facilities called the Oak Ridge Reservation Landfills (ORRLs), which are located within the boundary of the Y-12 Complex. ORRLs are engineered facilities used for the disposal of sanitary, industrial, construction, and demolition waste.

Construction of the ARRA-funded expansion at ORRLs, which started in April 2010, was completed in January 2011. The ILF-V Area 4 construction encompassed about 4.6 acres to provide about 294,354 m^3 (385,000 yd^3) of new disposal capacity. In addition, a new truck receiving station was constructed to provide a safe and efficient area for landfill acceptance technicians to receive paperwork, inspect waste shipments, and direct trucks through the newly placed vehicle portal monitors to the appropriate landfill. Lastly, the ILF-IV leachate conveyance pipeline was designed and constructed for the controlled release of leachate into the Y-12 Complex sanitary sewer system.

In FY 2011, about 83,000 yd^3 of industrial wastes and construction/demolition debris were disposed in the landfill. Operation of ORRLs generated about 1.3 million gal of leachate that was collected, monitored, and discharged to the Y-12 Complex sanitary sewer system, which discharges to the Oak Ridge sewer system under an industrial sewer user permit.

4.8.4 Wastewater Treatment

NNSA at the Y-12 Complex treated 127 million gal of contaminated ground/sump water at the Groundwater Treatment Facility, the Central Mercury Treatment System, Big Springs Water Treatment System, and the East End Volatile Organic Compounds Treatment System.

The Big Springs Water Treatment System treated 112 million gal of mercury-contaminated groundwater. The East End Volatile Organic Compound Treatment System treated 11 million gal of VOC-contaminated groundwater.

The West End Treatment Facility and the Central Pollution Control Facility at the Y-12 Complex processed 1.2 million gal of wastewater primarily in support of NNSA operational activities.

The Central Pollution Control Facility also downblended more than 37,175 gal of enriched wastewaters using legacy and newly generated uranium oxides from on-site storage.

4.9 References

ATSDR. 2006. *Public Health Assessment: Evaluation of Potential Exposures to Contaminated Off-Site Groundwater from the Oak Ridge Reservation.* Agency for Toxic Substances and Diseases Registry. Atlanta, Ga.

B&W Y-12. 2009a. *Y-12 Complex Ozone Depleting Substances (ODS) Phase-Out and Management Plan.* Y/TS-1880/R2, March 2009.

B&W Y-12. 2010a. *Y-12 National Security Complex Quality Assurance Project Plan for National Emission Standards for Hazardous Air Pollutants (NESHAP) for Radionuclide Emission Measurements.* Y/TS874, December 2010.

B&W Y-12. 2010b. *Radiological Monitoring Plan for the Oak Ridge Y-12 National Security Complex: Surface Water*. Y/TS-1704/R2, June 2010.

B&W Y-12. 2011. FY 2012 Y-12 Site 2012 Sustainability Plan, Y/IA-451, December 2011.

B&W Y-12. 2012a. *Annual Storm Water Report for the Y-12 National Security Complex, Oak Ridge, Tennessee*. Y/TS-2035/R4, January 2012.

B&W Y-12. 2012b. *Calendar Year 2011 Groundwater Monitoring Report.* Y/SUB/12-73231/1. US Department of Energy Y-12 National Security Complex, Oak Ridge, Tennessee.

BJC. 2010. *Bechtel Jacobs Company Sampling and Analysis Plan for the Water Resources Restoration Program for Fiscal Year 2011 Oak Ridge Reservation, Oak Ridge, Tennessee*. WRRP/SAP-2011, Bechtel Jacobs Company.

CFR. 2007. Test Methods for Measuring Radionuclide Emission from Stationary Sources, Method 114. August.

CFR. 2009a. Department of Energy Air Emissions Annual Report. 40 CFR 61.94, Subpart H.

CFR. 2009b. Methods for Estimating Radionuclide Emissions, Appendix D, in National Emission Standards for Hazardous Air Pollutants.

CFR. 2010. Title 40, Protection of Environment; Chapter 1, Environmental Protection Agency; Subchapter C, Air Programs, Part 75—Continuous Emission Monitoring. June 16.

DOE. 1998. *Report on the Remedial Investigation of the Upper East Fork Poplar Creek Characterization Area at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee.* US Department of Energy, Office of Environmental Management, Oak Ridge, Tennessee, DOE/OR/01-1641/V1-V4&D2.

DOE. 2001. *Treatability Study Report for Evaluating the Upper East Fork Poplar Creek Hydraulic Connection at the Y-12 National Security Complex, Oak Ridge, Tennessee.* DOE/OR/01-1963&D1, US Department of Energy, Washington, DC.

DOE. 2005. *Compliance Plan, National Emission Standards for Hazardous Air Pollutants for Radionuclides on the Oak Ridge Reservation, Oak Ridge, Tennessee.* DOE/ORO/2196, US Department of Energy, Washington, DC.

DOE. 2007. *2007 Remediation Effectiveness Report for the U. S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee, Volume 1: Compendium.* DOE/OR/01-2337&D2/V1, US Department of Energy, Washington, DC.

DOE. 2010. *Quality Systems for Analytical Services*, Revision 2.6, November.

DOE. 2011. *National Environmental Policy Act Implementing Procedures; Final Rule*. 10 CFR 1021. November 14.

DOE. 2011a. 2011 Clean-up Progress Annual Report to the Oak Ridge Community, DOE/ORO/2399. October 2011.

DOE. 2011b. *Strategic Sustainability Performance Plan*, Report to The White House Council on Environmental Quality and Office of Management and Budget. October 2011.

DOE. 2012. *2012 Remediation Effectiveness Report for the U. S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee, Data and Evaluation.* DOE/OR/01-2544&D2, US Department of Energy, Washington, DC.

DOE. 2013. *2013 Remediation Effectiveness Report for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee, Data and Evaluation.* US Department of Energy, Washington, DC (scheduled for publication in 2013).

Domenico, P. A., and F. W. Schwartz. 1990. *Physical and Chemical Hydrogeology*. John Wiley & Sons, p. 824.

EPA. 1995 and 1998. Compilation of Air Pollutant Emission Factors AP-42, Fifth Edition, Volume 1: Stationary Point and Area Sources. US Environmental Protection Agency, Research Triangle Park, N.C. January 1995 and September 1998.

EPA. 2009. *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act,* EPA 841-B-09-001, December 2009.

ISO. 2004. "Environmental Management Systems—Requirements with Guidance for Use." International Organization for Standardization, http://www.iso.org.

MMES. 1990. *Report and Preliminary Assessment of the Occurrence of Dense, Nonaqueous Phase Liquids in the Bear Creek Burial Grounds Hazardous Waste Disposal Unit at the Oak Ridge Y-12 Plant.* (Y/TS-960). Martin Marietta Energy Systems, Inc.

NNSA. 2009. *Draft Site-Wide Environmental Impact Statement for the Y-12 National Security Complex.* DOE National Nuclear Security Administration, Y-12 Site Office. October.

Peterson, M., B. Looney, G. Southworth, C. Eddy-Dilek, D. B. Watson, R. H. Ketelle, and M. A. Bogle. 2011. *Conceptual Model of Primary Mercury Sources, Transport Pathways, and Flux at the Y-12 Complex and Upper East Fork Poplar Creek, Oak Ridge, Tennessee*. Oak Ridge National Laboratory, ORNL/TM-2011/75.

TDEC. 2011. *Site Treatment Plan for Mixed Wastes on the U.S. Department of Energy Oak Ridge Reservation*. TDEC-REV. 16.0. October.

UCOR. 2011. *URS | CH2M Oak Ridge LLC Sampling and Analysis Plan for the Water Resources Restoration Program for Fiscal Year 2012 Oak Ridge Reservation, Oak Ridge, Tennessee*. UCOR-4025, URS | CH2M Oak Ridge LLC.

UCOR. 2012. *URS | CH2M Oak Ridge LLC Calendar Year 2011, Resource Conservation and Recovery Act Annual Monitoring Report for the U. S. Department of Energy Y-12 National Security Complex, Oak Ridge, Tennessee.* (UCOR-4116). URS | CH2M Oak Ridge LLC.