4. The Y-12 National Security Complex

The Y-12 National Security Complex, a premier manufacturing facility operated by Consolidated Nuclear Security, LLC, for the National Nuclear Security Administration, plays a vital role in the US Department of Energy Nuclear Security Enterprise. Drawing on more than 60 years of manufacturing excellence, the Y 12 Complex helps ensure a safe and reliable US nuclear weapons deterrent.

The Y-12 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 that the Y-12 Complex have a new level of flexibility and versatility, so while continuing its key role, the Y-12 Complex has evolved to become the resource that 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 information found in "Units of Measure and Conversion Factors" 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

Consolidated Nuclear Security, LLC (CNS) manages and operates the Pantex Plant (Pantex) and Y-12 National Security Complex (Y-12) on behalf of the National Nuclear Security Administration (NNSA). Together, these two sites are a core element of a sustainable and robust national nuclear deterrent.

Charged with maintaining the safety, security, and effectiveness of the US nuclear weapons stockpile, the Y-12 Complex is a one-of-a-kind manufacturing facility that plays an important role in US national security. Y-12's core mission is to ensure a safe, secure, and reliable US nuclear deterrent, which is essential to national security. Every weapon in the US nuclear stockpile has components manufactured, maintained, or ultimately dismantled by Y-12. Through Life Extension Program (LEP) activities, Y-12 produces refurbished, replaced, and/or upgraded weapon components to modernize the enduring stockpile. As the nation reduces the size of its arsenal, Y-12 has a central role in decommissioning weapons systems and providing weapons material for nonexplosive, peaceful uses. Y-12 provides the expertise to secure highly enriched uranium (HEU), store it with the highest security, and make material available for nonweapons uses (e.g., in research reactors that produce cancer-fighting medical isotopes and commercial power). Y-12 also processes HEU from weapons removed from the nation's nuclear weapons stockpile for use by the Naval Reactors program to fuel nuclear-powered submarines and aircraft carriers.

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) in width across it. NNSA-related facilities located off the Y-12 Complex site but in Oak Ridge include the Central Training Facility, the Uranium Processing Facility (UPF) project offices, a records storage facility, Y-12 Shipping and Receiving, and an analytical laboratory.

4.1.2 Modernization

Government-owned facilities and operations are being challenged to become smaller, more efficient, and more responsive to changing national and global challenges. NNSA's vision for a smaller, safer, more secure and less expensive nuclear weapons complex must leverage the scientific and technical capabilities of its workforce while continuing to meet national security requirements.

Nowhere in the National Security Enterprise is this more important than at the Y-12 Complex.

Most Y-12 Complex mission-critical facilities are more than 70 years old (Fig. 4.1). To address this situation, Y-12 has been consolidating operations, modernizing facilities and infrastructure, and reducing the legacy footprint for more than a decade. These actions are consistent with and supportive of NNSA enterprise transformation planning. Through modernization projects, deferred maintenance reduction, and infrastructure reduction, the Y-12 Complex will continue to strive toward becoming a more responsive, sustainable enterprise. As evidenced by the performance achievements presented in this year's ASER, Y-12 continues to meet the challenges of declining budgets through enhanced security measures, enhanced technology, and innovative business practices.

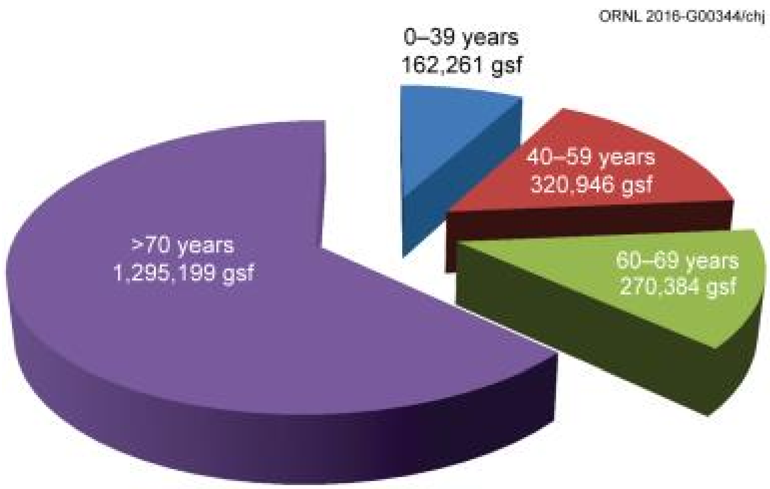

Fig. 4.1. Gross square footage by age of mission-critical facilities at the Y-12 National Security Complex.
(gsf = gross square feet.)

Replacement and revitalization are key elements of the modernization strategy at Y-12. A significant number of facilities at Y-12 are at or beyond design life. At present, several facilities are in the early construction or critical design process.

Enriched Uranium Operations

Y-12's core manufacturing and processing operations are housed in decades old buildings near or past the end of their expected life spans.

UPF is an integral part of the Y-12 Complex transformation efforts and a key component of the NNSA Uranium Center of Excellence. UPF will be a modern manufacturing facility designed and constructed for health, safety, security, and operations efficiency. In FY 2014, NNSA commissioned a Project Peer

Review Team to assess the progress and opportunities for the UPF project. This evaluation produced a number of recommendations to refocus the project to a smaller footprint and to relocate various processes to existing facilities. This effort is vital to the long-term mission for Y-12. Efforts are under way to implement the revised strategy and to incorporate bridging plans to maintain the integrity of the aged infrastructure.

When UPF is complete, it will replace a portion of HEU production functions. The remaining HEU production capability will be transitioned to Buildings 9215 and 9204 02E, which must be sustained to achieve the HEU mission strategy. The strategy includes

- accelerating transition out of Building 9212 by 2025 to reduce nuclear safety and operational risk while maintaining enriched-uranium capabilities;
- integrating evaluation of alternatives for delivery of UPF that prioritizes replacement capabilities by risk to nuclear safety, security, and mission continuity;
- substantially improving the needed Y-12 infrastructure over the next decade at a risk-based annual funding level that supports safe and secure operations; and
- prioritizing replacement capabilities by risk-to-mission continuity, nuclear safety, and security.

Lithium Production Capability

To ensure continued mission availability and to reduce annual operating costs, the lithium capability must be replaced; the equipment and facility degradation have gone beyond the option of repair. Building 9204-2, built in 1943, performs production work for lithium and related materials vital to nuclear weapons production. The facility, at approximately 325,000 ft^2, is oversized for today's mission and has both internal and external concrete deterioration. The roof, walls, and ceilings have been exposed to decades of corrosive liquids and processing fumes, requiring restricted access and protective equipment (hard hats) in many areas. The facility, currently carrying approximately $21.7M in deferred maintenance, could be replaced by a new facility less than one-fourth its size. Site production risk assessments rate two of the lithium processes as the highest equipment risk at Y-12. Critical process equipment (hydraulic press) failures caused high-priority repair efforts to minimize the negative impact on delivery schedules of directed stockpile work components. The inability to control humidity due to aged and inoperable heating, ventilation, and air-conditioning (HVAC) equipment has caused recurrent lost work days, negatively impacting directed stockpile work costs and LEP schedules. An Analysis of Alternatives is currently underway to determine the path forward for replacement of the capability.

Support Facilities

Emergency response capabilities at Y-12 reside in four primary facilities: three located on site (Buildings 9706-2, 9105 and 9710-2) with the third located off site (K-1650) near the Y-12 campus at the East Tennessee Technology Park. Building 9706-2 houses the Plant Shift Superintendent (PSS) and the Emergency Control Center (ECC). The Technical Support Center (TSC) was relocated to 9105 due to a flood event in 2014. Building 9710-2 houses the Fire Station and the Fire Department Alarm Room (FDAR). Building K-1650 houses the command center/alternate Emergency Operations Center (EOC). A proposed EOC facility line-item project is scheduled to begin in 2018. The scope of this line-item project includes the replacement of the PSS/TSC and the emergency operations center. The proposed emergency response facility will more effectively and efficiently support the Y-12 National Security Complex (NSC) missions by consolidating the aforementioned capability functions into a habitable, survivable facility that also provides space for a Technical Support Team.

The principal facility housing Fire Protection Operations (FPO) is Building 9710-2. Built in 1948, 9710-02 is located within the most highly protected area of the plant and is close to Y-12's most hazardous operations. Seismic, tornado, hazardous material release, and security events could render the fire station inaccessible. Access to the facility by off-duty personnel is critical because those personnel augment the duty staff. Although upgrades have been performed over the years, Building 9710-2 has exceeded its useful life and needs to be replaced so that long-term emergency management response to the site is ensured. Relocation of the fire station away from Y-12 hazardous material facilities is necessary to ensure that the Fire Department can respond safely and effectively to all emergencies at Y-12.

Over the next 10 years and beyond, Y 12 will continue to consolidate personnel and processes in support of the long-range footprint reduction and modernization vision. The proposed, smaller Y-12 will eliminate many of the World War II–vintage operations buildings that currently house the nuclear operations. The plan envisions a smaller future site and proposes the following new capable, responsive, and sustainable facilities:

- Projects initiated during Future Years Nuclear Security Plan (FYNSP) period:
  - EOC
  - Fire Hall
  - Lithium Capability Project
  - UPF and Bridging Strategy for 9215 and 9204-02E
- Projects planned for beyond FYNSP:
  - West End Change House
  - Applied Technologies Laboratory
  - Consolidated Manufacturing Capability
  - Maintenance Complex
  - Material Storage and Staging Facility
  - Waste Management Complex

Excess Facility Disposition

Since 2002, Y-12 has demolished more than 1.4 million ft^2 of excess facilities. The NNSA Facilities Disposition Program is under development and will continue to evaluate excess assets, prioritize their disposition, and propose the budget resources required for their disposition. Without a defined program to eliminate excess facilities, the NNSA sites will continue to use limited resources to safely maintain those facilities that no longer have a mission use.

Currently, more than 80 excess US Department of Energy (DOE) facilities are located on the Y-12 site. The facilities are owned by NNSA and DOE's Office of Environmental Management (EM), Office of Science (SC), and Office of Nuclear Energy (NE). Process-contaminated excess facilities contain radiological or chemical contamination resulting from their mission operations during the Manhattan Project and the Cold War. Process-contaminated excess facilities are expected to be managed by NNSA and its prime contractor, CNS, until facility conditions meet the criteria for transfer to EM. EM, through its contractors, will then be responsible for decommissioning and demolishing the facilities. Nonprocess contaminated excess facilities generally do not contain radiological or chemical contamination from mission operations but may contain hazardous industrial materials associated with their construction materials [e.g., asbestos insulation, lead-containing paint, or polychlorinated biphenyl (PCB)-contaminated oil]. The nonprocess contaminated excess facilities will be deactivated by NNSA and decommissioned by NNSA or EM, depending on the cost and complexity.

During FY 2015, the secretary of energy established the Laboratory Operations Board to complete the first comprehensive complex-wide assessment of DOE's infrastructure. As a subset of the Laboratory

Operations Board, the Excess Contaminated Facilities Working Group was formed with representatives from NNSA, EM, and SC. The working group is consolidating information from throughout the DOE enterprise and is developing priorities and budgetary requirements. Y-12 will work with the Excess Contaminated Facilities Working Group to ensure that there is a continued focus on both the risks presented by the excess facilities at Y-12 and the actions required to safely and effectively mitigate those risks.

4.2 Environmental Management System

As part of CNS'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*, (DOE 2011) provides requirements and responsibilities for managing sustainability within DOE in accordance with applicable Executive Orders. The order further requires implementation of an Environmental Management System (EMS) that is either certified to the requirements of ISO 14001 by an accredited ISO 14001 registrar or self-declared to be in conformance to the standard in accordance with instructions issued by the Office of the Federal Environmental Executive, a chartered task force under the White House Council on Environmental Quality.

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

The Integrated Safety Management System (ISMS) is the DOE umbrella of environment, safety, and health (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. At Y-12, the elements of the ISO 14001 EMS are incorporated in ISMS for environmental compliance, pollution prevention, waste minimization, and resource conservation.

4.2.2 Policy

The Y-12 environmental policy and 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 Y-12 ES&H policy is presented in Fig. 4.2.

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. 4.2. Y-12 National Security Complex environment, safety, and health policy.

The Y-12 ES&H 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 Y-12 external website and 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.

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

The FY 2015 analysis identified the following as significant environmental aspects:

- air emissions
- greenhouse gas (GHG) emissions (scopes 1 and 3)
- wastewater/groundwater
- excess facilities and unneeded materials and chemicals
- hazardous or mixed wastes
- radiological waste
- potable water usage
- surface water and storm water
- aging infrastructure and equipment
- legacy contamination and disturbance
- storage or use of chemicals and radioactive materials
- energy consumption (scope 2 GHGs)
- clearing, grading, or excavation (nonquarantined soil)

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

CNS responds to change and pursues sustainability initiatives by establishing and maintaining environmental objectives, targets (goals), and action plans at Y-12. Goals and commitments are established annually; are agreed to by the National Nuclear Security Administration Production Office (NPO) and CNS; and are consistent with the Y-12 Complex's mission, budget guidance, ES&H work scope, site incentive plans, and continuous improvement goals. 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, and buying green. Highlights of the 2015 environmental targets achieved at the Y-12 Complex 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.

Environmental Compliance

The 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 CNS environmental policy and Y-12 site procedures. ECD serves as the Y-12 interpretive authority for environmental compliance requirements and as the primary point of contact between Y-12 and external environmental compliance regulatory agencies such as the City of Oak Ridge, the Tennessee Department of Environment and Conservation (TDEC), and the US Environmental Protection Agency (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

Waste Management

The CNS Y-12 Waste Management Program 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 program provides services for day-to-day solid and liquid waste operations, including collection and transport, storage, on-site treatment operations, and shipment to off-site treatment/disposal. The program also provides technical support to Y-12 operations for waste planning, characterization, packaging, tracking, reporting, and managing waste treatment/disposal subcontracts.

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 programs, generator services programs, facility destruction and recycling operations, and 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 stewardship practices, the programs that manage legacy issues and assist in preventing the development of new problematic issues. Stewardship programs include Clean Sweep and Unneeded Materials and Chemicals (UMC).

Combining these programs under a single umbrella improves overall compliance with executive orders, DOE orders, state and federal regulations, and NNSA expectations and 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 (i.e., promote the purchase of products made with recycled content and biobased products, including alternative fuels such as E85), meet sustainable design requirements, and adhere to pollution prevention reporting requirements.

Energy Management

Energy management is an ongoing and comprehensive effort with 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 Services, the energy management effort 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.

The Y-12 energy management effort and the sustainability and stewardship programs support the DOE and NNSA visions for a commitment to energy efficiency and sustainability and achievement of the guiding principles. Specifically, the Y-12 vision is to support the DOE ES&H policy and the *Strategic Sustainability Performance Plan* (DOE 2015) (SSPP) while promoting overall sustainability and reduction of greenhouse gas (GHG) emissions. The mission of the Y-12 Energy Management program is to incorporate energy-efficient technologies site wide and to position Y-12 to meet NNSA energy requirement needs through 2025 and beyond. Sustainability goals, goal performance, and goal achievement are defined in the SSP issued in December 2015.

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 Y-12 and the community. The council provides feedback to Y-12 regarding its operations and ways to enhance community and public communications. Y-12 sponsored the Great Smoky Mountains National Park, the East Tennessee Foundation, and the Oak Ridge Associated Universities Science Bowl in 2015.

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 $85,600 has been donated to various local charities.

Y-12 continues to promote sustainable behaviors for environmental improvements at the site and within the community. As a part of Earth Day Activities, LiveWise personnel again collected gently used athletic shoes to support the Modular Organic Regenerative Environments Foundation Group. A United Way Coat and Toiletries Drive is conducted annually to provide coats and other needed items for the Volunteer Ministry Center for the Homeless. These activities reflect Y-12 employees' commitment to reduce landfill waste and support community outreach.

4.2.4.3 Emergency Preparedness and Response

Local, state, and federal emergency response organizations are fully involved in the Y-12 National Security Complex 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) Operations Office and the DOE Headquarters Watch Office participate in all Y-12 National Security Complex emergency response exercises.

Five exercises and seven drills were conducted at the Y-12 Complex during FY 2015. The drills and exercises focused on topics such as responding to a hazardous chemical release, natural disaster, radiological release, active shooter event, security condition change, and severe event (multiple hazards, multiple buildings). Six building evacuation and accountability drills were also conducted.

Y-12 National Security Complex expertise in emergency management continues to be recognized within DOE. Members of the Emergency Management Program Office staff participated in the DOE Emergency Management Issues Special Interest Group Conference held in Shepherdstown, West Virginia, in July 2015. The Y-12 National Security Complex staff made presentations, participated in steering committee meetings, and distributed Y-12 National Security 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 results of 2015 program activities are described throughout this chapter. Progress in achieving environmental goals is reported as a monthly metric on Performance Track, the senior management web portal that consolidates and maintains Y-12 Complex site–level performance measures. Progress is reviewed in periodic meetings with senior management and NPO.

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 internal assessment program. The assessments are designed to ensure that nonconformities with the ISO 14001:2004 standard (ISO 2004) are identified and addressed.

The environmental assessment program comprises several types of assessments, each type serving a distinct but complementary purpose. Assessments range from informal observations of specific activities to rigorous audits of site-level programs.

To self-declare conformance to the ISO 14001:2004 standard in accordance with instructions issued by the Federal Environmental Executive and adhere to DOE O 436.1 (DOE 2011) requirements, EMS must be audited by a qualified party outside of the control or scope of EMS at least every 3 years. To fulfill this requirement, a four-person audit team from The University of Tennessee Center for Industrial Services evaluated the Y-12 EMS May 11–14, 2015. The Y-12 EMS was found to fully conform, and no issues were identified. The next external verification audit is scheduled for spring 2018.

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 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 Office of Health, Safety, and Security annual environmental progress reports on implementation of EMS requirements and sustainability goals driven by executive orders, and the Office of Management and Budget's Environmental Stewardship Scorecard gave the Y-12 Complex an EMS scorecard rating for FY 2015 of green, indicating full implementation of EMS requirements.

4.2.6.1 Environmental Management System Objectives and Targets

At the end of FY 2015 Y-12 had achieved 3 of 10 targets that had been established. Seven of the targets were established with long-term time frames and were carried into future years. Overall, 33 actions were completed through September. Highlights included the following, with additional details and successes presented in other sections of this report.

- Clean Air—Y-12 completed annual boiler tune-ups and energy assessments by qualified energy assessors on the Y-12 Steam Plant, meeting new compliance requirements of the final maximum achievable control technology standards for industrial, commercial, and institutional boilers issued by the EPA (2013).

- Energy Efficiency—Implementation of five Energy Savings Performance Contract (ESPC) energy conservation measures (ECMs) began in FY 2014 for projects to improve lighting, chilled water, air compressors, and steam. Significant progress was made in many areas, and the ECM for air compressor upgrades was substantially completed by the end of FY 2015. The final completion date for this ECM was planned by the end of CY 2015.

- Hazardous Materials—Projects for legacy and excess unneeded material/equipment removal in several facilities, including 9201-1, 9215, and 9204-2, were developed and implemented. Completed actions included disposition of cooling trays, forklifts, vacuums, and several pieces of equipment in Development and Materials Management. A project to improve controls for Sealand storage containers was developed and substantially implemented in FY 2015, with controls added to the online property management system, procurement restriction for Sealands implemented, and applicable procedures changed.

- Land/Water Conservation—A project to reduce inflow and infiltration into the sanitary sewer system were substantially completed with the installation of fiberglass liner in 1000 feet of sanitary sewer, and repairing eleven manholes to eliminate inflow. Stream restoration and wetlands expansion efforts continued, and the Y-12 Environmental Sampling Services completed a multiyear effort to improve the instrument calibration program to meet requirements of the International Standard, ISO 17025 (2015).

- Reduce/Reuse/Recycle/Buy Green—Y-12 continued efforts to increase use of remanufactured toner cartridges, substantially completing revisions to applicable procedures. In addition, Y-12 added one new recycle stream to their award-winning recycling program.

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). Pollution prevention efforts at the Y-12 Complex have not only benefited the environment but have also resulted in cost efficiencies (Fig. 4.3).

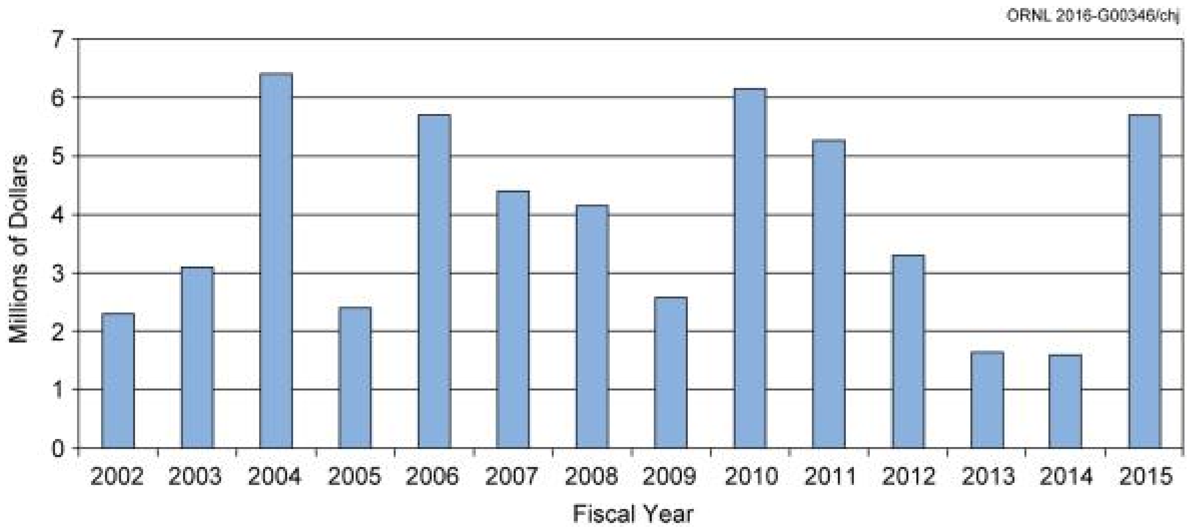

Fig. 4.3. Cost efficiencies from Y-12 National Security Complex pollution prevention activities.

In FY 2015 the Y-12 Complex implemented 94 pollution prevention initiatives (Fig. 4.4), with a reduction of more than 39.9 million kg of waste and cost efficiencies of more than $5.7 million. The completed projects include the activities described below.

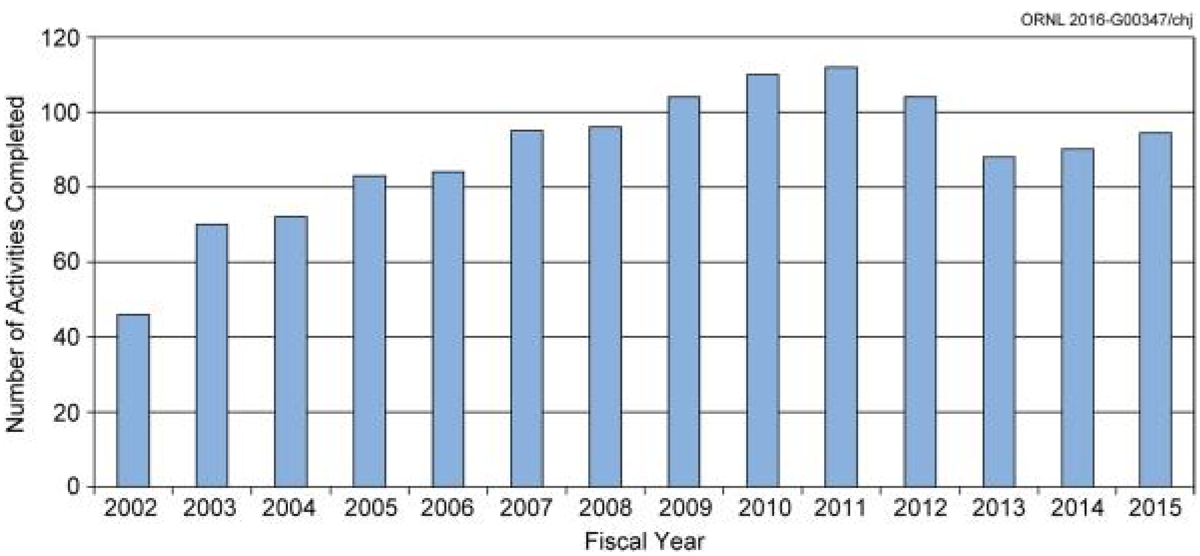

Fig. 4.4. Y-12 National Security Complex pollution prevention initiatives.

Pollution Prevention/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 sustainable initiatives have pollution prevention benefits or targets eliminating the source of pollution, including the 2015 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 2015, Y-12 procured recycled-content materials valued at more than $1.4 million for use at the site.

Solid Waste Reduction

In 2015, Y-12 diverted 60.8% of municipal and 95.9% of construction and demolition waste from landfill disposal through reuse and recycle. The Clean Sweep Program provides turnkey services to material generators, including segregation, staging and pickup of materials for excess, recycle, and disposal. Clean Sweep Specialists ensure that materials are reused or recycled to the maximum extent possible. The UPF Project recycled or reused over 74.4 million lb of materials in 2015, including brush, asphalt, and scrap metal. More 62 million lb of asphalt removed from obsolete roads and parking lots were ground into base course material that was subsequently used to maintain unpaved roads at Y-12 and on the Oak Ridge Reservation (Fig. 4.5).

Hazardous Chemical Minimization

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. In 2015, Y-12 Utilities implemented a standard automated cooling tower treatment/blowdown process to maintain tower water chemistry more efficiently. The new process prevented the use of more than 28,000 lb of water treatment chemicals and over 24 million gal of water each year. Waste Management modified the operation of the West End Treatment Facility such that pretreatment operations eliminated the need for a portion of the Effluent Polishing System while ensuring that discharge permit requirements were met. This modification prevented the use of more than 147,000 lb of treatment chemicals and the generation of over 1870 ft^3 of associated low-level waste sludge.

Recycling

Y-12 has a well-established recycling program and continues to identify new material streams and expand the types of materials that can be recycled by finding new markets and outlets for the materials. As shown in Fig. 4.6, more than 1.2 million kg of materials was diverted from landfills and into viable recycle processes during 2015. Currently recycled materials range from office-related materials to operations-related materials such as scrap metal, tires, and batteries. Y-12 adds at least one new recycle stream to the Recycle Program each year to continue to increase the waste diversion rate. Ultraviolet lamps were added in FY 2015 to broaden waste diversion efforts.

Fig. 4.5. UPF Asphalt Reuse.*[Source: Brett Pate, Y-12 photographer.]*

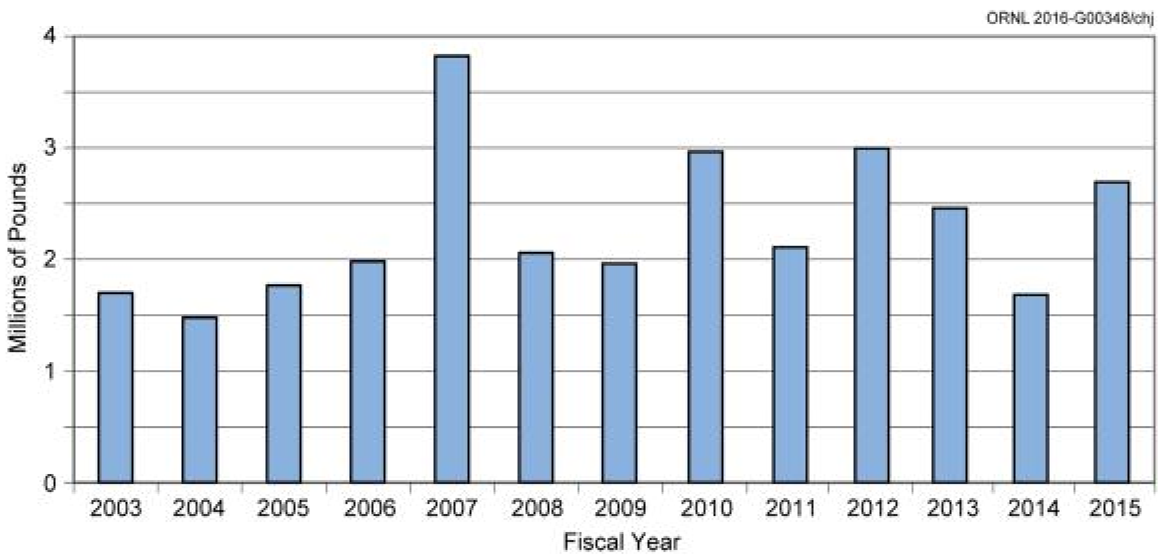

Fig. 4.6. Y-12 National Security Complex recycling results.

4.2.6.3 Energy Management

The mission of the Y-12 Energy Management program is to incorporate energy-efficient technologies site wide and to position Y-12 to meet NNSA energy requirement needs through 2025 and beyond. The program identifies improvements in energy efficiency in facilities, coordinates energy-related efforts across the site, and promotes employee awareness of energy conservation programs and opportunities. Y-12 is committed to achieving the sustainable energy and transportation goals established in Executive Order 13693.

The Energy Policy Act of 2005 established a goal of reducing building energy intensity by 30% by FY 2015 from an FY 2003 baseline. Y-12 exceeded the FY 2015 goal by achieving a 39.9% reduction in energy intensity (Fig. 4.7). A new goal has been established to achieve a 25% reduction in energy intensity by FY 2025 based on an FY 2015 baseline.

Specific initiatives that aided in the reduction of electricity consumption at Y-12 during FY 2015 included

- installing light-emitting diode and T-8 fluorescent lighting;
- improving meter readings via the Utilities Management System (UMS);
- improving employee awareness;
- achieving utility efficiencies, including reductions in steam pressure, chilled water production, and condensate return.

Additional energy reductions will be required in numerous areas to fully reduce energy use across the plant. Both facility management and utilities management are diligently focusing on improvements to achieve the goal. Efforts that are fully incorporated into planning activities for facilities include the following.

- EISA assessments are included in annual reporting.
- ECMs from both EISA and the ESPC process are included in budgeting reviews.
- Low-cost/no-cost efforts, including component replacements, are incorporated into routine activities.
- EISA assessments and condition assessment surveys (CASs) share resources, including personnel and database support.

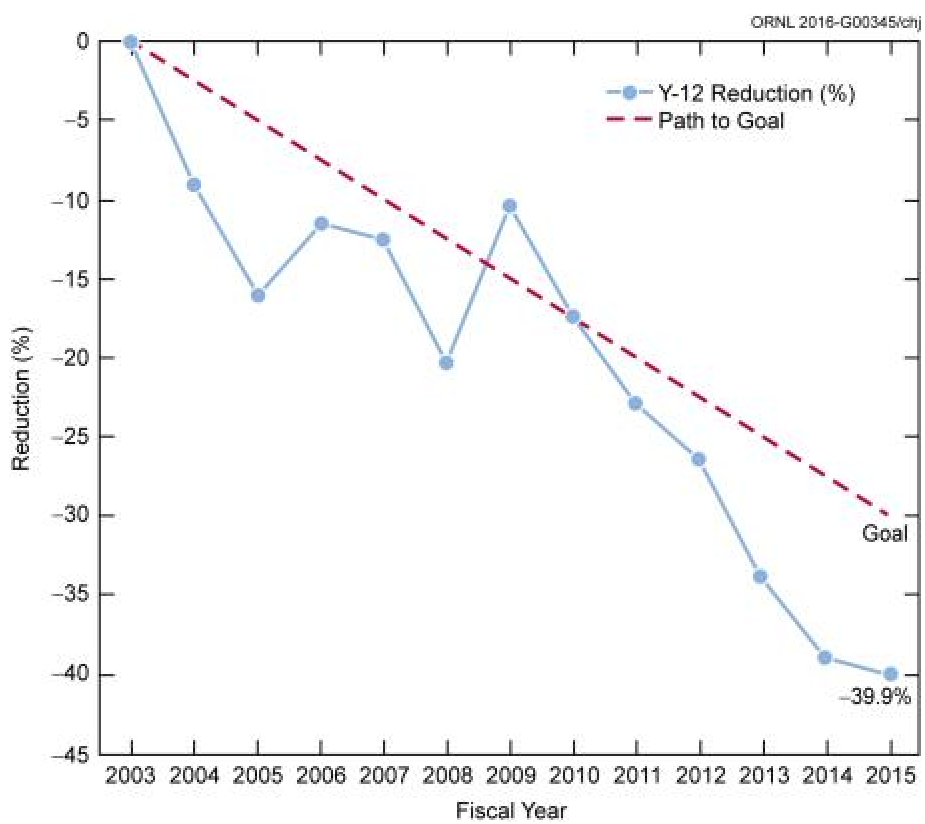

Fig. 4.7. Y-12 has achieved a 39.9% reduction in energy intensity compared to the baseline year, 2003.

As shown in Fig. 4.8, future reductions may be challenging due to a projected increase in the site's energy intensity. Current projections indicate increases once UPF goes on line, but those may be partially offset by an accelerated demolition program.

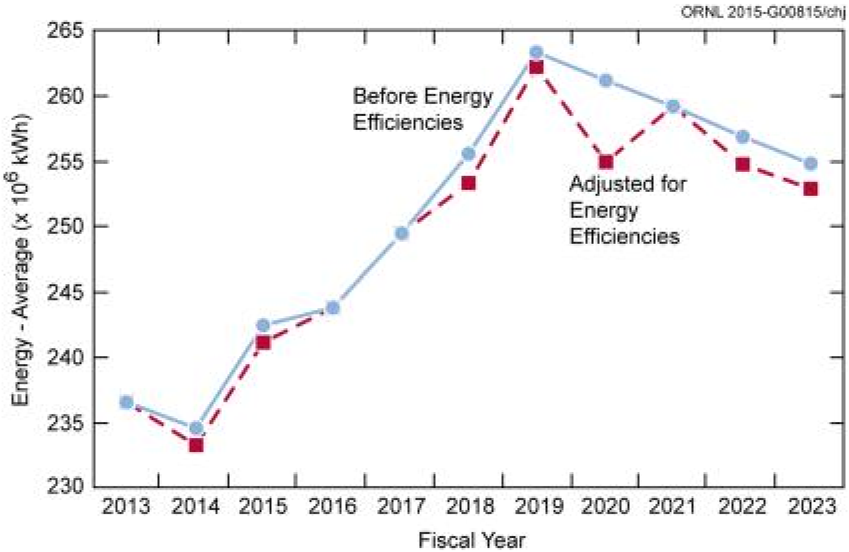

Fig. 4.8. Y-12 National Security Complex electricity load forecast.

The following efforts are planned to ensure continued site success for energy reduction.

- Complete implementation of ESPC Delivery Order 3 and additional modifications (lighting, chilled water, steam, natural gas, compressed air).
- Consolidate data centers, per Office of Management and Budget definition, and install electric meters.
- Continue installation of advanced metering.
- Continue facility upgrades for high-performance sustainable building (HPSB) compliance and implement building retro-commissioning.
- Continue implementation of cool roof applications.
- Encourage energy reduction through tenant awareness, including training and monthly meter reporting.

Energy Monitoring

Comprehensive water and energy audits at Y-12 are performed to meet EISA Section 432. The audits evaluate energy and water use and identify opportunities to reduce use. The audits are performed by a certified energy auditor. The implementation costs for the ECMs are developed using the Condition Assessment Information System database. Based on the requirement to assess 100% of the covered facilities at the site, Y-12 successfully completed the first 4-year assessment cycle in FY 2012 and began the second assessment or reassessment cycle in FY 2013, and continued through FY 2015. Additional assessments were completed during FY 2014 and FY 2015 as part of the ESPC Investment Grade Audit for Delivery Order 3. Energy projects are included in out-year planning for the site and where possible and with adequate return on investment, will be funded. Specific examples include heating, ventilating, and air-conditioning (HVAC) replacements, lighting upgrades, and occupancy sensors in HPSB candidate facilities.

Y-12 currently has numerous standard and advanced electrical meters located on various facilities throughout the plant. Efforts to read meters and monitor commodity information have improved significantly due to the connection of several additional meters to the Utilities Management System (UMS). The actual electricity costs for the plant are based on total energy consumption as defined by the Tennessee Valley Authority (TVA) revenue meters in the ELZA 1 substation. Y-12 does not use a space chargeback system, and individual building metering is not currently used for such purposes. The ELZA 1 substation electricity use is monitored to ensure accurate billing from TVA and to develop the annual utilities budget.

Btu meters were installed on components of the chilled water system as part of the ESPC project, and these meters, along with newly installed cooling tower meters, have been added to the automatic output from UMS. Natural gas meters are located at the steam plant on each of the boilers.

Recent focus has been on installation of new meters and connectivity to UMS. As these connections have progressed, data have been migrated to the energy management module for eventual use in site metrics, data reporting, and ECMs. Meter data are also entered into the EPA Portfolio Manager for benchmarking and reporting purposes.

Minimal funding was available for dedicated metering during FY 2015. Efforts will continue on establishing communications with the UMS. Metering for HPSB candidates is still a concern for the plant. This issue prevents adequate monitoring of energy for the required 20% reduction. It is also impacting required reporting of power usage effectiveness (PUE) at the plant data centers. Efforts will continue to identify funding to install electric meters for HPSB candidates as well as electric, chilled water, and steam metering for the data centers.

Y-12 began entering facilities into the EPA Portfolio Manager in FY 2011. Y-12 enters and tracks data for both covered and non-covered facilities. Data from the Portfolio Manager is shared with NNSA sustainability contacts and is automatically migrated to DOE's web-based EISA Section 432 Compliance Tracking System (CTS) for annual reporting in June. Meter data are also entered into Portfolio Manager for benchmarking and reporting purposes.

Energy Savings Performance Contracts

Dedicated funding for energy and water projects is provided via the ESPC mechanism. Y-12 has taken advantage of the energy saving opportunities provided by the ESPCs. ESPC delivery order 2 is in the fourth period of performance at Y-12. This contract included chiller plant improvements, steam condensate return system modifications, steam trap improvements, and demineralized water production facility replacement. Efforts from delivery order 2 have greatly contributed toward both energy reduction and efficiency gains for the projects implemented.

Y-12 entered into its third ESPC contract in September 2013. Delivery order 3 is in the construction phase, which will continue through FY 2017. Delivery order 3 will result in an estimated annual energy and water cost savings of $2.9 million and estimated energy-related operations and maintenance (O&M) annual energy and water cost savings of $2.4 million. The site will continue to work with NNSA for successful accomplishment of these efforts. Delivery order 3 includes the following ECMs.

- Steam System Decentralization
- Chiller Plant Upgrades

- Energy Efficient Lighting Upgrades
- Steam and Condensate System Improvements
- Compressed Air System Upgrades

Y-12 entered into its first modification to Delivery Order 3 in September 2014 which is in the construction phase, will continue through FY 2016, and will result in an estimated annual energy and water cost savings of $240K and an estimated energy-related O&M annual energy and water cost savings of $100K. Delivery Order 3, Modification 1 includes the following ECMs.

- Chiller Plant Upgrades

- Energy Efficient Lighting Upgrades (because lighting sensors were omitted in ESPC Delivery Order 3, the energy and cost savings were adjusted in this modification.)

Y-12 entered into its second modification to Delivery Order 3 in September 2015. Modification 2 adds 160 buildings to the lighting scope, 9 buildings to the steam decentralization scope, and replaces 1 more cooling tower. Modification 2 is in the construction phase, will continue through FY 2017 and will result in an estimated annual energy and water cost savings of $240K with no other energy-related O&M annual energy and water cost savings. Delivery Order 3, Modification 2, includes the following ECMs.

- Chiller Plant Upgrades
- Energy Efficient Lighting Upgrades
- Steam System Decentralization

Site Sustainability Plan

The DOE SSPs are an annual reporting requirement and are prepared in accordance with the Department of Energy's (DOE's) Guidance for the Site Sustainability Plans (SSP) (CNS.2015) and supplemental NNSA guidance from the Associate Administrator for Infrastructure and Operations, and supports the requirements of DOE O 436.1 Departmental Sustainability. The Y-12 and Pantex SSPs were combined into a single CNS SSP to fulfill the planning and reporting requirements for FY 2016. The DOE sustainability goals and Y-12 status and plans for these goals are summarized in Table 4.1.

Table 4.1. FY 2015 sustainability goals and status

SSPP Goal	DOE Goal	Performance Status	Planned Actions and Contribution	Risk of Non-attainment
		Goal 1: GHG Reduction		
1.1	50% Scope 1 & 2 GHG reduction by FY 2025 from an FY 2008 baseline (2015 target: 19%)	Goal Met for FY 2015 – Scope 1 & 2 emissions have decreased by 41% for FY 2015. Surpassed FY 2015 interim goal of 19%. At Risk - It is uncertain if the 2025 goal can be met due to UPF construction.	Continue to identify methods for reduction of GHG; further emphasize energy reductions.	Medium
1.2	25% Scope 3 GHG reduction by FY 2025 from a FY 2008 baseline (2015 target: 6%)	At Risk – Site Scope 3 emissions have decreased by 4.9% which did not meet the FY 2015 interim goal of 6%. It is uncertain if this goal will be achievable due to increased travel between Pantex and Y-12 and increased commuting due to the UPF 9/80 work schedule.	Y-12 will continue to promote alternative commuting methods.	High
		GOAL 2: Sustainable Buildings and Regional & Local Planning		
2.1	25% energy intensity reduction in goal-subject buildings, achieving 2.5% reductions annually, by FY 2025 from a FY 2015 baseline	Goal Met – The site met the 2015 goal by achieving a 39.9% reduction from the 2003 baseline. The new goal will be compared to the FY 2015 baseline. It is unlikely this goal can be met during UPF construction.	Continue implementation of planned energy reduction initiatives, including ESPC Delivery Order 3, as well as Mod. 1 and Mod. 2.	High
2.2	EISA Section 432 energy and water evaluations	Goal Met – Y-12 completed all required EISA-covered assessments during FY 2015.	Assessments will continue to meet a 3-year cycle.	Low
2.3	Meter all individual buildings for electricity, natural gas, steam and water, where cost-effective and appropriate	On Track – Currently 88% of electricity is metered; 100% of natural gas; 5% of steam; 100% of chilled water are metered.	Continue procurement and installation of meters as funding is allocated.	Electricity: Low Steam: Medium Natural Gas: Low Chilled Water: Low

Table 4.1. (continued)

SSPP Goal	DOE Goal	Performance Status	Planned Actions and Contribution	Risk of Non-attainment
2.4	At least 15% (by building count or gross square feet) of existing buildings greater than 5,000 gross square feet (GSF) to be compliant with the revised Guiding Principles for HPSB by FY 2025, with progress to 100% thereafter	On Track – Y-12 has achieved, for GSF, an 11% compliance with HPSB Guiding Principles.	Y-12 will continue to implement initiatives to meet HPSB compliance as funding and resources allow.	Medium
2.5	Efforts to increase regional and local planning coordination and involvement	Goal Met – Y-12 is actively involved in local and regional efforts on transportation planning, ecosystem, watershed, and environmental management.	Continue to participate in existing activities and look for new opportunities to leverage regional and local resources.	N/A
2.6a	Net Zero Buildings: Percentage of the site's existing buildings above 5,000 gross square feet intended to be energy, waste, or water net-zero buildings by FY 2025.	At Risk – An assessment for the installation of renewable energy projects for both solar and wind technologies found neither to be feasible for Y-12.	Y-12 will continue to evaluate opportunities as market advances bring payback within reasonable timeframes.	High
2.6b	Net Zero Buildings: Percentage of new buildings (> 5,000 GSF) entering the planning process designed to achieve energy net-zero beginning in FY 2020.	On Track – The UPF project is currently seeking a waiver for Leader- ship in Energy and Environmental Design (LEED) Gold certification.	If waiver is granted, Project will review and implement LEED scorecard credit and Guiding Principles by building, where feasible-now six buildings.	Medium
2.7	Data Center Efficiency. Establish a power usage effectiveness (PUE) target in the range of 1.2-1.4 for new data centers and less than 1.5 for existing data centers.	At Risk – The PUE is currently estimated at lower than 1.4, since the current PUE rating for Y-12 data centers in unknown. However, this value is based solely on electricity usage and does not account for energy intensity.	Chilled water and electrical metering are planned for Building 9117 in FY 2016. This data will allow the measurement of the PUE.	Medium
		Goal 3: Clean & Renewable Energy		
3.1	"Clean Energy" requires that the percentage of an agency's total electric and thermal energy ac- counted for by renewable and alternative energy shall be not less than: 10% in FY 2016-2017, working towards 25% by FY 2025.	On Track – See 3.2 below.	See 3.2 below.	Low

Table 4.1. (continued)

SSPP Goal	DOE Goal	Performance Status	Planned Actions and Contribution	Risk of Non-attainment
3.2	"Renewable Electric Energy" requires that renewable electric energy account for not less than 10% of a total agency electric consumption in FY16-17, working towards 30% of total agency electric consumption by FY 2025.	On Track – Due to sharing the Wind RECs with Pantex, Y-12 achieved 9.5% renewable energy consumption, exceeding the 7.5% interim goal for FY 2015 and is on track to meet the 10% goal in FY 2016.	Y-12 plans to renew the shared credits for FY 2016 and beyond.	Low
		Goal 4: Water Use Efficiency and Management		Low
4.1	36% potable water intensity reduction by FY 2025 from a FY 2007 baseline. (2015 target: 16%)	Goal Met – Y-12 achieved a 61.6% reduction from the baseline, surpassing, not only the interim goal of 16%, but the 2025 goal of 36%.	Water conservation measures will continue to be implemented as practicable in support of the HPSB initiative.	
4.2	30% water consumption reduction of industrial, landscaping, and agricultural (ILA) water by FY 2025 from a FY 2010 baseline. (2015 target: 10%)	Y-12 no longer consumes ILA and baseline ILA water is accounted for in Goal 4.1.	All water used at Y-12 is potable water and included in the potable water category.	N/A
		Goal 5: Fleet Management		
5.1	20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline; maintain 20% reduction thereafter. (2015 target: 20%)	Goal Not Met – Petroleum fuel consumption increased from FY 2014 as E85 was unavailable due to a fuel tank rupture. For FY 2015 Y-12 had a 1.5% decrease in petroleum usage as compared to the FY 2005 baseline whereas there was a 40% reduction in FY 2014.	New tanks will be installed during FY 2016, including an E85 tank. Older vehicles are being replaced by newer, alternative fuel vehicles (AFV) when available by GSA.	High for FY 2016 Low for FY 2017 and beyond
5.2	10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter. (2015 target: 10%)	Goal Not Met – Since E85 fuel was unavailable due to a fuel tank rupture, alternative fuel consumption was minimal for FY 2015 with a 93% reduction in consumption as compared to the FY 2005 baseline. In FY 2014, there was a 77.7% increase in alternative fuel consumption as compared to the FY 2005 baseline.	New tanks will be installed during FY 2016, including an E85 tank. Older vehicles are being replaced by newer, alternative fuel (when available) vehicles by GSA.	High for FY 2016 Low for FY 2017 and beyond

Table 4.1. (continued)

SSPP Goal	DOE Goal	Performance Status	Planned Actions and Contribution	Risk of Non-attainment
5.3	30% reduction in fleet-wide per-mile greenhouse gas emissions reduction by FY 2025 from a FY 2014 baseline. (2015 target: N/A; 2017 target: 4%)	N/A	Future vehicle purchases and leases will include AFVs, including E85, hybrid, and electric vehicles where possible.	Low
5.4	75% of light duty vehicle acquisitions must consist of alternative fuel vehicles (AFV). (2015 target: 75%)	Goal Met – There were no passenger vehicle purchases made during FY 2015. All passenger vehicles are being leased from GSA.	Passenger vehicles will continue to be leased through GSA with more availability of AFVs.	Low
5.5	50% of passenger vehicle acquisitions consist of zero emission or plug-in hybrid electric vehicles by FY 2025. (2015 target: N/A)	N/A	Future vehicle purchases and leases will include hybrid and electric vehicles where possible.	Low
		Goal 6: Sustainable Acquisition		
6.1	Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring Bio-Preferred and bio-based provisions and clauses are included in 95% of applicable contracts.	Goal Met – The sustainable acquisition clause 952.223-78 was incorporated into Y-12 procurement clauses in FY 2011. The terms and conditions were revised in 2012 to include Federal Acquisition Regulation clause 52.223-15. In April 2013 and July 2014 Y-12's terms and conditions were modeled after sustainable acquisition DEAR Clause 952.223-78, which includes the requirements for considering recycled content, bio-based content, energy efficient, water efficient, and other environmentally preferable products. Therefore, all contracts issued after October 1, 2013 contain the sustainable acquisition clauses.	Y-12 will incorporate additional clauses as requested and will continue to evaluate sustainable products for use at the site.	
		Goal 7: Pollution Prevention & Waste Reduction		
7.1	Divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris.	Goal Met – Over 60.8% of non-hazardous 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 Goal	DOE Goal	Performance Status	Planned Actions and Contribution	Risk of Non-attainment
7.2	Divert at least 50% of construction and demolition materials and debris.	Goal Met – Over 95.0% (38,588.5 metric tons/ 40,222.5 metric tons) of construction and demolition (C&D) waste diverted from landfill.	Systematic disposition evaluation method will continue to be used for C&D materials to ensure maximum waste diversion is achieved.	Low
		Goal 8: Energy Performance Contracts		
8.1	Annual targets for performance contracting to be implemented in FY 2017 and annually thereafter as part of the planning of section 14 of E.O. 13693.	Goal Met – Y-12 has taken advantage of the energy saving opportunities provided by the ESPCs. ESPC Delivery Order #2 is in the fourth period of performance at Y-12. Delivery Order #3, Mod #1, is in the construction phase which will continue through FY 2016. Delivery Order #3, Mod #2, is in the construction phase which will continue through FY 2017.	Y-12 will continue to leverage ESPCs to help achieve sustainability goals.	Low
		Goal 9: Electronic Stewardship		
9.1	Purchases – 95% of eligible acquisitions each year are EPEAT-registered products.	Goal Met – 100% of all computer desktops, laptops, monitors, tablets and thin clients purchased or leased during FY 2015 were EPEAT-registered or Energy Star-qualified products and more than 96% were EPEAT Gold registered.	Y-12 has a standard desktop configuration that specifies the procurement of EPEAT-registered and Energy Star-qualified products.	Low
9.2	Power management – 100% of eligible PCs, laptops, and monitors have power management enabled.	At Risk – Y-12 has implemented power management to feasible CPUs and laptops; power management features are enabled on all monitors not deemed mission critical.	100% implementation of PCs and laptops is not currently feasible with existing network security features. The site will continue active implementation of power management by replacing PCs with thin clients where feasible.	High

Table 4.1. (continued)

SSPP Goal	DOE Goal	Performance Status	Planned Actions and Contribution	Risk of Non-attainment
9.3	Automatic duplexing – 100% of eligible computers and imaging equipment have automatic duplexing enabled.	At Risk – During FY 2015, 20% of the printers, copiers, and multi- function devices were set to automatically duplex.	Recommended default for all networked printers with duplexers was “duplex” instead of “simplex.” Included sustainable acquisition for communication services equipment evaluation and repair. The number of non-networked printers that either don’t have duplex capability or can be changed by the user to a simplex default will make this goal difficult to achieve.	Medium
9.4	End of Life – 100% of used electronics are reused or recycled using environmentally sound disposition options each year.	On Track – Y-12’s approved electronics recycling vendor achieved Responsible Recycling© (R2) certification in May 2015. Therefore, the last two shipments of electronics were made to an R2 certified recycler.	With the certification of Y-12’s approved electronics recycling vendor as an R2 certified recycler, all used electronics will be recycled using environmentally sound disposition options in FY 2016 and beyond.	Low
		Goal 10: Climate Change Resilience		
10.1	Update policies to incentivize planning for, and addressing the impacts of climate change.	On Track – Policies for planning and addressing climate change impacts are reviewed and updated as needed, particularly with regard to severe winter weather and heat stress.	Continue to track trends and information on climate change and is engaged in numerous organizations dedicated to future planning and impacts.	N/A
10.2	Update emergency response procedures and protocols to account for projected climate change, including extreme weather events.	On Track – The Y-12 National Security Complex Severe Event Emergency Response Plan addresses severe natural phenomena events such as tornadoes, earthquakes, snow and ice, extended loss of power events and events that result in the loss of mutual aid.	Continue to review and update Emergency Response procedures as needed.	N/A

Table 4.1. (continued)

SSPP Goal	DOE Goal	Performance Status	Planned Actions and Contribution	Risk of Non-attainment
10.3	Ensure workforce protocols and policies reflect projected human health and safety impacts of climate change.	On Track – Y-12 has a robust Building/Facility Emergency Program to protect personnel during severe weather emergencies, including earthquakes, tornados, and floods. The Inclement Winter Weather procedure is designed to protect personnel during winter weather events. The Temperature Extreme procedure is designed to protect personnel during both extreme cold and hot events.	Protocols, processes and procedures will continue to be reviewed and revised as needed based on improved understanding/lessons learned regarding climate change impact.	N/A
10.4	Ensure site/lab management demonstrates commitment to adaptation efforts through internal communications and policies.	On Track – Management communications include procedures, texts/pages, emergency call-in number, and safety messages as applicable.	Communications will continue to be evaluated to ensure a good understanding by plant personnel of climate adaptation policies.	N/A
10.5	Ensure that site/lab climate adaptation and resilience policies and programs reflect best available current climate change science, updated as necessary.	On track – The current climate change discussion does not present any new scenarios at Y-12 that have not been planned for already therefore no changes to policies or programs were needed based on advancements in climate change science or on-site analysis.	Y-12 will continue to partner with Oak Ridge National Laboratory (ORNL), TVA, and others to remain current on climate change science and will update on-site policies and programs as needed.	N/A

Acronyms

AFV = alternative fuel vehicle
E85 = Ethanol fuel blend up to 85% Ethanol and 15% gasoline or other hydrocarbon
EISA = Energy Independence and Security Act
EPEAT = Electronic Product Environmental Assessment Tool
ESPC = Energy Savings Performance Contract
GHG = greenhouse gas
GSF = gross square feet
REC = renewable energy certificate
SSPP = *Strategic Sustainability Performance Plan* (DOE)
UPF = Uranium Processing Facility

4.2.6.4 Water Conservation

In FY 2015 Y-12 achieved a 61.6% water intensity reduction from the FY 2007 baseline, surpassing not only the FY 2015 interim goal of 16%, but the 2025 goal of 36% (Fig. 4.9). Actions that have contributed to the overall reduction in potable water use include the following:

- steam trap repairs and improvements,
- condensate return repairs and reroutes,
- replacement of once-through air handling units, and
- low-flow fixture installation.

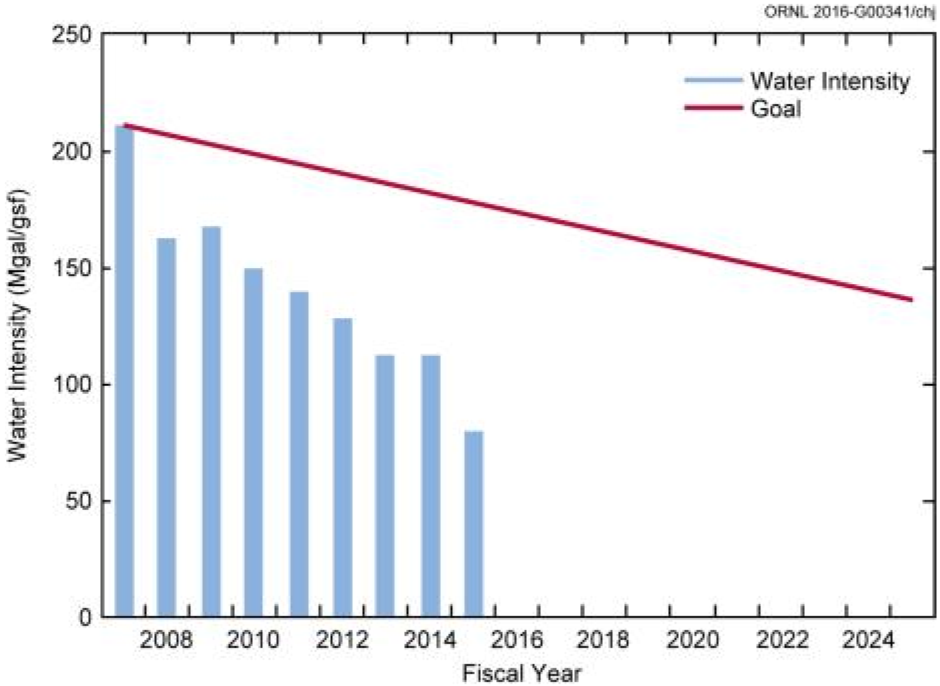

Fig. 4.9. Y-12 National Security Complex water intensity goals.*(Mgal = millions of gallons, gsf = gross square foot)*

Meters are installed on the potable water tanks and on various facilities within the plant. Future metering will include advanced meter installations for all enduring facilities, as applicable, to comply with the 2016 goal. Additionally, new advanced meters will be installed on the potable water tanks as the existing meters are flow meters rather than totalizing meters.

Although Y-12 is currently exceeding the FEMP water use reduction goal, significant reductions in water consumption can still be achieved. This can be accomplished through continuing water saving improvement projects within the facilities as funding becomes available. These improvements include: replacing or modifying HVAC units that use once through cooling water so they no longer discharge the cooling water into the storm drain; upgrading plumbing fixtures to new water saving fixtures; and replacing steam heating with natural gas heating which will save the steam condensate that is usually not returned to the steam plant.

Y-12 was selected to participate in the FY 2016 pilot for the new HVAC Asset Management Program (HVAC AMP). The HVAC AMP will replace a 30 Ton and a 15 Ton HVAC unit which will, in turn, eliminate the need for a 60 Ton water cooled chiller. These two HVAC units will be replaced with energy efficient heat pumps that don't use water. This project has been postponed until 2017 by the HVAC AMP.

Y-12 is also in the process of having a second plant wide water assessment completed by the Federal Energy Management Program with engineers from Pacific Northwest National Laboratory (PNNL). This is being done not only to identify water saving projects but also to qualify Y-12 for the new Water Asset Management Program (Water AMP). This program may help Y-12 in the future with implementing water saving projects.

These efforts, which were recommended by the Federal Energy Management Program/Pacific Northwest National Laboratory water assessment, will include

- upgrading toilets and urinals to low-flow, hands-free units;
- installing flow restrictors on faucets and shower heads;
- repairing condenser loop connections to the cooling towers;
- replacing once-through water-cooled air conditioning systems with air-cooled equivalents;
- installing advanced potable water meters; and
- repairing system to allow Building 9212 condensate to be returned to the steam plant.

4.2.6.5 Fleet Management

The Y-12 fleet is composed of agency-owned and General Services Administration (GSA) sedans, light-duty trucks/vans, medium-duty trucks/vans, and heavy-duty trucks. During the last quarter of FY 2015, 242 sedans and light-duty and medium-duty vehicles from theY-12 agency-owned fleet were transferred to the GSA. The GSA replaced 64 of those vehicles with newer, alternative-fuel vehicles (AFVs) where available, during CY 2015. The remaining 178 are to be replaced in CY 2016. This consolidation will decrease the average age of Y-12's vehicle fleet from 15 years to between 3 to 5 years of age. By replacing the older, less-fuel-efficient vehicles with the AFVs, Y-12 will greatly reduce its consumption of petroleum fuels and emissions of GHGs and will increase its use of alternative fuels. Fleet Management is working closely with vehicle custodians during the replacement process to ensure that replacement vehicles are appropriately assigned to meet mission requirements. Areas where electric vehicles could meet mission requirements will also be evaluated. Y-12 continues to operate a taxi service as one of the strategies for fleet optimization.

Y-12 had surpassed both FY 2015 goals regarding alternative fuel use and petroleum use at the end of FY 2014 with a 40% reduction in petroleum usage and a 77.7% increase in alternative fuel usage compared to the FY 2005 baseline. The rupture of an on-site fuel tank at the subcontractor-operated fuel station, and subsequent concerns that surfaced during the investigation resulted in the fuel station being placed out of service, effectively eliminating availability of E85 fuel for Y-12 vehicles. Therefore, Y-12 was not able to meet its goals for FY 2015 of decreasing alternative fuel usage by 93% and reducing petroleum use by 1.5%.

A project is under way to install new above-ground fuel storage tanks, including one for E85 fuel, on site. When completed, the new fueling station will enable Y-12 to meet both the petroleum reduction and the alternative fuel consumption goals. The new station is not expected to be operational until the end of FY 2016, which will placeY-12's ability to meet the alternative fuel consumption goal at risk in FY 2016. It is uncertain at this time if the reduction in petroleum usage from the replacement of the older vehicles with new, more-fuel-efficient vehicles will be sufficient to meet the petroleum reduction goal in FY 2016. Y-12 will continue to monitor vehicle usage and will redistribute or remove vehicles from the fleet as needed. Y-12 currently owns and operates four low-speed electric vehicles and a 25-

passenger diesel-electric hybrid bus. Actions taken since FY 2013 to improve the fleet and planned actions through FY 2017 are shown in Fig. 4.10.

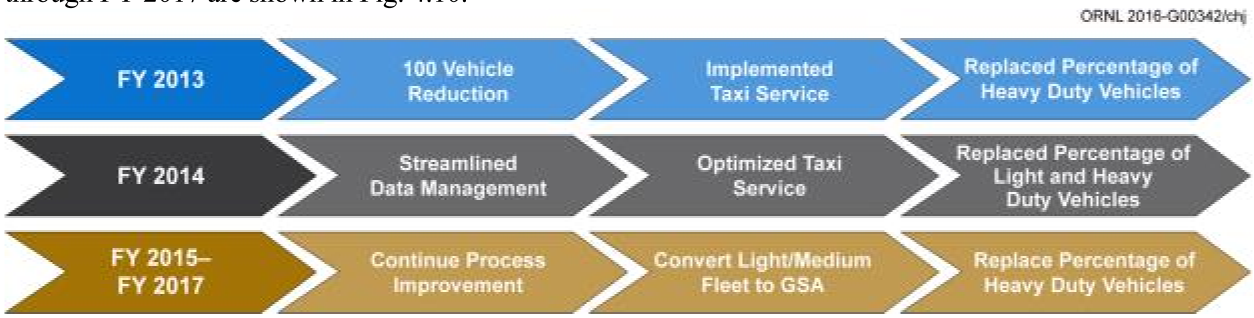

Fig. 4.10. Fleet management roadmap.

4.2.6.6 Electronic Stewardship

Y-12 has implemented a variety of electronic stewardship activities, including server virtualization, virtual desktop infrastructure, procurement of energy-efficient computing equipment, reuse and recycle of computing equipment, replacement of aging computing equipment with more energy-efficient equipment, and reconfiguration of data centers to achieve more energy-efficient operations. All desktop computers, laptops, monitors, and thin clients purchased or leased during FY 2015 were registered Electronic Product Environmental Assessment Tool (EPEAT) products. Y-12's standard desktop configuration specifies the procurement of EPEAT-registered and Energy Star–qualified products.

4.2.6.7 Greenhouse Gases

Table 4.2 provides a summary of Y-12 Complex GHG emissions for FY 2008 (the baseline year as required by EO 13514) and FY 2015. The Y-12 Complex has reduced Scopes 1 and 2 GHG emissions by 41% since the 2008 baseline year, primarily due to decreased Scope 1 emissions from steam generation and industrial fugitive emissions and decreased Scope 2 emissions from energy efficiency projects, renewable energy certificate credits from the Pantex Renewable Energy Project, and HPSB improvements. Scope 3 GHG emissions have been reduced by 4.9% since the 2008 baseline year. This reduction is due primarily to renewable energy certificates and reductions in business travel and transmission and distribution losses.

Employee commuting GHG emissions account for 65% of the Scope 3 emissions. Y-12's four day per week (10 hours per day) work schedule is critical to Y-12's Scope 3 emissions reduction efforts. 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 4.2. Y-12 National Security Complex greenhouse gas emissions summary

GHG emission source	FY 2008 baseline (metric ton CO_2e/year)	FY 2015 (metric ton CO_2e/year)
	***Scope 1*[a]**	
Steam (coal, natural gas, fuel oil)	129,021	57,010
Industrial fugitive emissions	22,542	9,399
On-site wastewater treatment	6.9	8.0
	1,063	-

Table 4.2. (continued)

GHG emission source	FY 2008 baseline (metric ton CO_2e/year)	FY 2015 (metric ton CO_2e/year)
	Scope 2 [a]	
Renewable energy certificates		(14,376)[b]
	184,995	147,129
Total Scopes 1 and 2	**337,627.9**	**199,170**
	Scope 3 [a]	
T&D losses	12,185.8	9,691.6
Off-site municipal wastewater treatment	25.3	26.4
Employee commute	17,447	19,707.3
Business ground and air travel	2,251	1,865.9
Renewable energy certificates	N/A	(946.9)
Total Scope 3	**31,909.1**	**30,344.3**
TOTAL GHG emissions	**369,537**	**229,514**

[a] Greenhouse gas (GHG) emissions are classified as Scope 1, 2, or 3. Scope 1 includes GHG emissions occurring directly on site, such as heating or air conditioning in DOE buildings or the combustion of fuel in vehicles owned or operated by DOE. Scope 2 includes indirect emissions that are produced by an outside source as part of the productions process, such as electricity consumed in DOE buildings.

[b] With the agreement of the NPO for the Y-12 and Pantex sites, the Y-12 Complex GHG inventory was credited with renewable energy produced by the Pantex Renewable Energy Project as part of the Pantex–Y-12 integration effort. This renewable energy strategy was supported by the fact that CNS Pantex meets the DOE renewable energy goal requirement through purchase of renewable energy credits.

Acronyms

CNS = Consolidated Nuclear Security, LLC
CO_2e = CO_2 equivalent
FY = fiscal year
GHG = greenhouse gas
NPO = National Nuclear Security Administration Production Office
T&D = transmission and distribution

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

EISA Section 438 requires federal agencies 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. During the last few years several green infrastructure initiatives have been implemented to reduce the size and number of impervious surfaces through the use of sustainable vegetative practices and porous pavements. Actions that have contributed to the overall prevention of storm water runoff during FY 2015 include the following.

- There has not been a significant change (up or down) in green space during FY 2015 due to UPF site readiness activities. The planned paved areas for UPF should be offset by the constructed sediment ponds with the Faircloth skimmers (Fig. 4.11) that mitigate the rate of the storm water leaving the area.

- UPF site readiness construction used a mulcher/chipper (Fig. 4.12) to produce mulch that was used as erosion control along the haul road.

- UPF established vegetative cover (grass) on the previously disturbed area along the new Bear Creek Road and new haul road extension corridors, improving storm water quality.

Fig. 4.11. Faircloth skimmer previously installed at Sediment Basin 1.

Fig. 4.12. Uranium Processing Facility site readiness construction used a mulcher/chipper to produce mulch that was used as erosion control along the haul road.

In all, about 3.5 acres have been added to the green bank to offset future projects within the Y-12 Complex.

4.2.7 Awards and Recognition

Since November 2000, the Y-12 Complex commitment to environmentally responsible operations has been recognized with more than 125 external environmental awards from local, state, and national agencies. The awards received in 2015 are summarized in the following sections.

Tennessee Chamber of Commerce and Industry Awards

Y-12 was recognized in two areas at the 33rd Annual Tennessee Chamber of Commerce and Industry Environment and Energy Conference in an awards ceremony on October 14, 2015, at Montgomery Bell State Park. Y-12 received the Solid and Hazardous Waste Award for "UPF Sustainable Practices." Additionally, Y-12 received a Water Quality Award for "Y-12 Reduced Water Usage and Improved Water Quality."

Electronic Product Environmental Assessment Tool Award

Y-12 received an EPEAT Purchaser 3 Star Level Award for Excellence in Green Procurement of Electronics in a ceremony in Washington, DC, on April 22, 2015. Y-12 was recognized by the Green Electronics Council at the 3 Star Level for purchasing EPEAT electronics in the following categories: PCs and Displays; Imaging Equipment (e.g., copiers, scanners, multifunction devices); and Televisions.

Federal Energy Management Program Award

Y-12 received a FEMP Federal Energy and Water Management Award for "Y-12 Steams Ahead with Wise Utilities Management" on October 14, 2015, in a ceremony in Washington, D. C.

4.3 Compliance Status

4.3.1 Environmental Permits

Table 4.3 lists environmental permits in force at the Y-12 Complex during 2015. More detailed information can be found in the following sections.

Table 4.3. Y-12 National Security Complex environmental permits, 2015

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	Title V Major Source Operating Permit	562767	1/8/2012	1/8/2017	DOE	DOE	CNS
CAA	UPF Construction Permit	967550P	3/01/2014	3/01/2017	DOE	DOE	CNS
CWA	Industrial & Commercial User Wastewater Discharge (Sanitary Sewer) Permit	1-91	4/1/2010	3/30/2015[a]	DOE	DOE	CNS
CWA	NPDES Permit	TN0002968	10/31/2011	11/30/2016	DOE	DOE	CNS
CWA	UPF 401 Water Quality Certification/ ARAP Access/Haul Road	NRS10.083	6/10/2010	6/09/2015[b]	DOE	DOE	CNS
CWA	UPF Department of Army Section 404 Clean Water Act Permit	2010-00366	9/02/2010	9/02/2020	DOE	DOE	CNS
CWA	UPF General Storm Water Permit Y-12 Complex (41.7 hectares/103 acres)	TNR 134022	10/27/2011	5/23/2016	DOE	CNS	CNS
RCRA	Hazardous Waste Transporter Permit	TN3890090001	1/7/2016	1/31/2017	DOE	DOE	CNS
RCRA	Hazardous Waste Corrective Action Permit	TNHW-164	9/15/2015	9/15/2025	DOE	DOE, NNSA, and all ORR co-operators of hazardous waste permits	UCOR
RCRA	Hazardous Waste Container Storage Units	TNHW-122	8/31/2005	8/31/2015[a]	DOE	DOE/CNS	CNS/ Navarro co-operator
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-127	10/06/2005	10/06/2015[a]	DOE	DOE/CNS	CNS co-operator

Table 4.3. (continued)

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
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 Postclosure Permit for the Bear Creek Hydrogeologic Regime	TNHW-116	12/10/2003 Permit reapplication submitted to TDEC on 1/31/13	12/10/2013[a]	DOE	DOE/UCOR	UCOR
RCRA	RCRA Postclosure Permit for the Upper East Fork Poplar Creek Hydrogeologic Regime	TNHW-113	9/23/2003 Permit reapplication submitted to TDEC on 1/31/13	9/23/2013[a]	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
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

Table 4.3. (continued)

[a] Continue to operate in compliance pending TDEC action on renewal and reissuance.

[b] Monitoring and maintenance phase.

Acronyms

ARAP = Aquatic Resource Alteration Permit
CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CNS = Consolidated Nuclear Security LLC
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 National Environmental Policy Act/National Historic Preservation Act

As federal agencies, DOE and NNSA comply with the National Environmental Policy Act (NEPA) requirements (procedural provisions, 40 CFR 1500 thru 1508), as outlined in the DOE's Implementing Procedures for NEPA (Title 10 CFR 1021). CNS fully supports NNSA's commitment to NEPA by evaluating proposed federal actions for potential impacts that affect the quality of the environment at Y-12. CNS ensures that reasonable alternatives for implementing such actions have been considered in the decisionmaking process and that such decisions are documented in accordance with the DOE/NNSA and the Council on Environmental Quality (CEQ) regulations. Such a prescribed evaluation process ensures that the proper level of environmental review is performed before an irreversible commitment of resources is made.

During CY 2015, environmental evaluations were completed for 39 proposed actions, and 38 proposed actions were determined to be covered by a categorical exclusion (CX), as listed in Appendix B for facility operations to Subpart D of Part 1021 in *National Environmental Policy Act General Categorical Exclusion* (Y/TS-2312). This included the evaluation of a new Y-12 Fire Station, the continuation of the Energy Conservation Measure project, and several projects to replace/upgrade existing equipment and facility infrastructure at Y-12. An Environmental Assessment was conducted for NNSA's proposed action to design and build a new on-site Emergency Operations Center (EOC) at Y-12 to support the future Y-12 mission. The proposed action consolidates the Plant Shift Superintendent's office, the Emergency Control Center, the Technical Support Center, and the Fire Department Alarm Room from their present locations to a single facility. This facility will meet current DOE orders, is survivable and sustainable for 72 hours, and would achieve the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Gold Certification.*Environmental Assessment of the Emergency Operations Center Project* (DOE/EA-2014a) was issued September, 2015. *Finding of No Significant Impact (FONSI) for the Emergency Operation Center Project* (DOE/EA-2014b) was issued October, 2015.

The *Final Site-Wide Environmental Impact Statement (SWEIS) for the Y-12 National Security Complex* (DOE 2011a) was issued in March, 2011. This final SWEIS is available on the Internet at http://nnsa.energy.gov/content/y12sweis2011. The SWEIS evaluated the modernization proposals for Y-12, including the UPF, and updated the analyses presented in the original Y-12 Complex SWEIS, issued in November 2001. The final SWEIS and the notice of availability were published March 4, 2011. NNSA issued a record of decision (ROD) in July 2011 for the *Continued Operation of the Y-12 National Security Complex*, based on the SWEIS. The DOE's NEPA implementing procedures, 10 CFR 1021, requires a 5-year evaluation of the final SWEIS, beginning in 2016.

Since the publication of the ROD, NNSA updated the strategy and design approach for UPF. Under the updated strategy, NNSA would use a hybrid approach of upgrading existing Y-12 facilities and building new UPF facilities. The updated strategy is consistent with recommendations from a project peer review of the UPF, *Final Report of the Committee to Recommend Alternatives to the Uranium Processing Facility Plan in Meeting the Nation's Enriched Uranium Strategy* (the Red Team Report, issued April, 2014). The single-structure UPF concept would be separated into multiple buildings, with each constructed to safety and security requirements appropriate to the building's function. The UPF strategy is addressed in detail in a *Supplement Analysis Final Site-Wide Environmental Impact Statement* (EIS-0387-SA-01). See http://energy.gov/nepa/downloads/eis-0387-sa-01-supplement-analysis.

In accordance with the National Historic Preservation Act of 1966 (NHPA), NNSA is committed to identifying, preserving, enhancing, and protecting its cultural resources. The prescribed evaluation process ensures that the proper level of environmental review is performed before an irreversible commitment of resources is made. Compliance activities in 2015 included completing Section 106 reviews of ongoing and new projects, collecting and storing historic artifacts, conducting tours, maintaining the Y-12 History Center, and participating in various outreach projects with local organizations and school

Thirty-nine proposed projects were evaluated to determine whether any historic properties eligible for inclusion in the *National Register of Historic Places* would be adversely impacted. It was determined that none of the 39 projects would have an adverse effect on historic properties eligible for listing in the *National Register* and that no further Section 106 documentation was required. The Y-12 Oral History Program continues efforts to conduct oral interviews 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 provide 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. The Y-12 History Center features many historical photographs and artifacts, a history library, and a video viewing area. More interactive and video-based exhibits are planned for the future. The Y-12 History Center is open to the public Monday through Thursday from 8:00 a.m. to 5:00 p.m. and on Fridays by special request. A selection of materials, including documentary DVDs, books, pamphlets, postcards, and fact sheets are available free to the public.

Congress passed the National Defense Authorization Act of 2015, which included provisions authorizing a park to be located at three sites: Oak Ridge, Tennessee; Hanford, Washington; and Los Alamos, New Mexico. President Obama signed the National Defense Authorization Act into law on December 19, 2014.

On November 10, 2015, the secretary of the interior and the secretary of energy signed a memorandum of agreement between the two agencies defining the respective roles in creating and managing the park. The agreement included provisions for enhanced public access, management, interpretation, and historic preservation. With the signing, the Manhattan Project National Historical Park officially was established.

Outreach activities in 2015 consisted of partnering with the City of Oak Ridge, the Oak Ridge Convention and Visitor's Bureau, and the Arts Council of Oak Ridge, which sponsor the annual Secret City Festival. In June, The Secret City Festival promoted the history of the Manhattan Project by providing information to visitors regarding the History of Y-12 and directions for them to visit the Y-12 History Center.

Y-12 also partnered with the American Museum of Science and Energy by providing guided public tours of the Y-12 History Center from March through November. Other outreach activities included providing tours and conducting presentations on the history of the Y-12 Complex and Oak Ridge to local and visiting schools, agencies, and organizations.

4.3.3 Clean Air Act Compliance Status

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 modifications to the Title V operating air permit, and eventually the requirements are incorporated into the sitewide Title V operating permit. The Y-12 Complex is currently governed by Title V Major Source Operating Permit 562767.

The permit requires annual and semiannual reports. More than 3000 data points are obtained and reported each year. All reporting requirements were met during CY 2015, and there were no permit violations or exceedances during the report period.

The TDEC–Knoxville Office, Clean Air Compliance, completed the Y-12 annual Clean Air Compliance inspection on March 9 and 10, 2015, and on November 17 and 19, 2015. No noncompliance findings were identified.

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 the Oak Ridge Reservation (ORR) and by both on-site and off-site monitoring conducted by TDEC.

Section 4.4 provides detailed information on 2015 activities conducted at Y-12 in support of CAA.

4.3.4 Clean Water Act Compliance Status

During 2015 the Y-12 Complex continued its excellent record for compliance with the National Pollutant Discharge Elimination System (NPDES) water discharge permit. Data obtained as part of the NPDES program are provided in a monthly report to TDEC. The percentage of compliance with permit discharge limits for 2015 was almost 100%.

About 2500 data points were obtained from sampling required by the NPDES permit; no noncompliances were reported. The Y-12 NPDES permit in effect during 2015 (TN0002968) was issued on October 31, 2011, and became effective on December 1, 2011. A modification was effective in May 2014. It will expire on November 30, 2016.

The effluent limitations contained in the permit are based on the protection of water quality in the receiving streams. The permit emphasizes biological, toxicological, and radiological monitoring of storm water runoff.

Some of the key requirements and changes incorporated in the modified permit are summarized below.

- The requirement to manage the flow of East Fork Poplar Creek (EFPC) such that a minimum of 5 million gal/day is guaranteed by adding raw water from the Clinch River to the headwaters of EFPC was removed.
- Flow and mercury monitoring and reporting requirements were removed for outfall 200.
- Monitoring and reporting requirements for Kjeldahl nitrogen and phosphorus at outfall 200 were added.
- Flow and mercury monitoring and reporting requirements were removed for outfall C11.
- Flow and mercury monitoring and reporting requirements were removed for station EFP.
- Requirements for monitoring and reporting of ammonia, phosphorus, and Kjeldahl nitrogen were added for station EFP.

4.3.5 Safe Drinking Water Act Compliance Status

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

Tennessee Regulations for Public Water Systems and Drinking Water Quality, Chap. 0400-45-01, set limits for biological contaminants, chemical activities, and chemical contaminants. Sampling for total coliform, chlorine residuals, lead, copper, and disinfectant by-product is conducted by the Y-12 Environmental Compliance Division.

In 2015 the Y-12 Complex potable water system retained its approved status for potable water with TDEC. All total coliform samples collected during 2015 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 2014. These results were below TDEC and SDWA limits and met the established requirements.

Although a notice of violation was issued by TDEC on August 5, 2015 for a drinking water monitoring deficiency, the Y-12 Plant Water System retains the State’s “Approved” category.

Two required water samples were not taken in accordance with the schedule stated in the Stage 2 Disinfection Byproduct monitoring plan. The samples were taken 19 days late due to a shipping error by a subcontracted analytical laboratory. The analytical results for these samples were well within regulatory limits. Process modifications were implemented to ensure that future compliance samples are taken in accordance with the monitoring plan. A public notification was issued to inform all Y-12 NSC employees about the delayed monitoring.

4.3.6 Resource Conservation and Recovery Act Compliance Status

The 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 1000 kg 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 is updated annually and submitted to TDEC for review. The current plan (TDEC 2015) 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 has developed new disposition milestones to address its remaining inventory of legacy mixed waste. Disposition milestones for this final inventory are in fiscal years from 2013 through 2018 (see Fig.4.13).

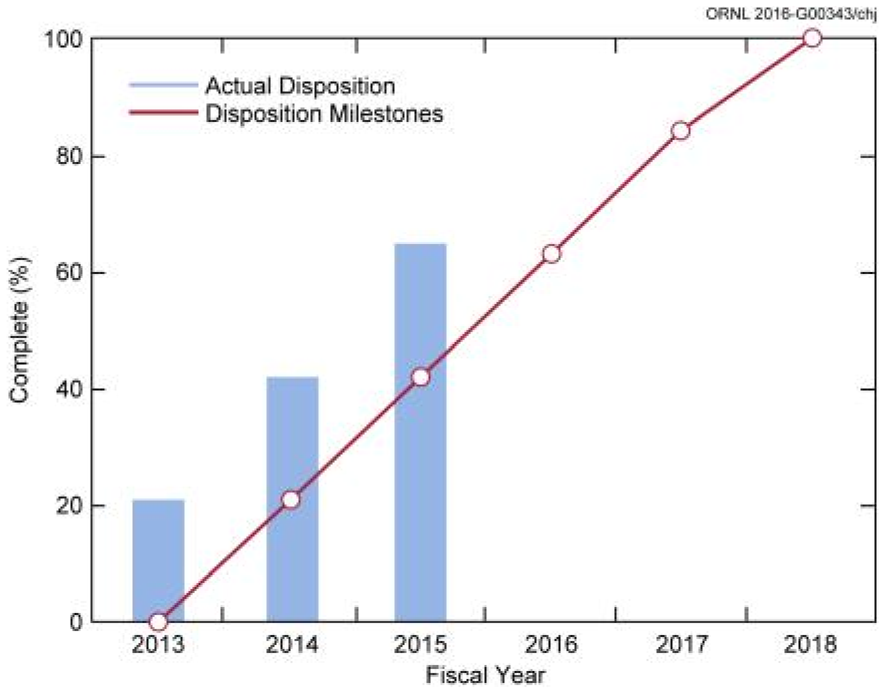

Fig. 4.13. Y-12 National Security Complex path to elimination of its inventory of legacy mixed waste as part of the Oak Ridge Reservation site treatment plan.

The quantity of hazardous and mixed wastes generated by the Y-12 Complex increased in 2015 (Fig. 4.14). This increase was primarily due to an increase in contaminated leachate from legacy operations, which made up 97% of the total hazardous and mixed waste generated in 2015. The Y-12 Complex currently reports waste on 77 active waste streams. The Y-12 Complex is a state-permitted treatment, storage, and disposal facility. Under its permits, the Y-12 Complex received 1473 kg of hazardous and mixed waste from the off-site Union Valley analytical chemistry laboratory in 2015. In addition, 126,761 kg of hazardous and mixed waste was shipped to DOE-owned and commercial treatment, storage, and disposal facilities. More than 9 million kg of hazardous and mixed wastewater was treated at on-site wastewater treatment facilities.

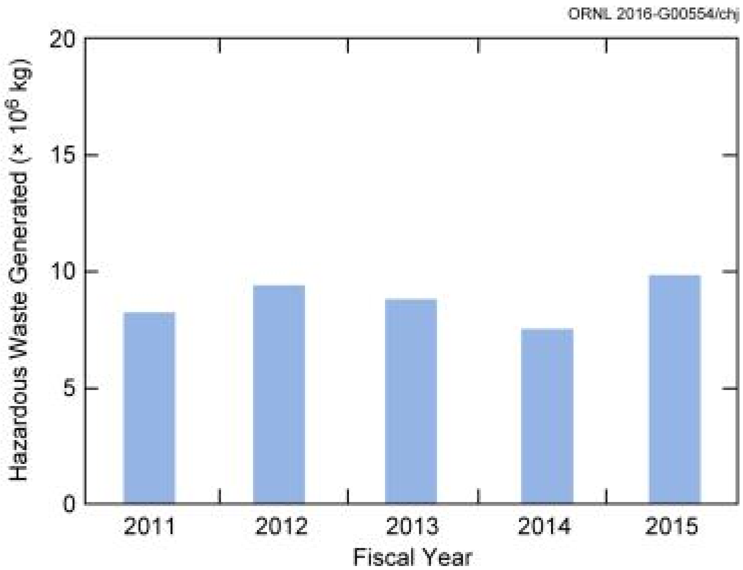

Fig. 4.14. Hazardous waste generation, 2010–2015.

4.3.6.1 Resource Conservation and Recovery Act Underground Storage Tanks

TDEC regulates the active petroleum underground storage tanks (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 0400-18-01).

Closure and removal of two petroleum USTs at the East End Fuel Station was completed in August 2012. There are no petroleum USTs remaining at Y-12.

4.3.6.2 Resource Conservation and Recovery Act Subtitle D Solid Waste

The ORR landfills operated by the DOE EM 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 the ORR. In addition, one Class IV facility (Spoil Area 1) is overfilled by 8945 m^3 and has been the subject of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigation/feasibility study (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 4.3. 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 Federal Facility Agreement (DOE 2014b) 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.

During CY 2015 several actions were taken to facilitate TDEC's renewal of TNHW-121 ORR Hazardous Waste Corrective Action document. The TNHW-121 document was dated for a period from 2004 through September 28, 2014. The annual solid waste management unit/area of concern Table A-1 and A-2 update lists were submitted to TDEC on January 22, 2015. A public notice on the renewal of the TNHW-121 document was issued on July 15, 2015, in coordination with a public notice with renewal information for the ETTP Site RCRA Part B TNHW-117 Permit. Based on the timely renewal submittals that met TDEC expectations for the TNWH-121 document, ORR operations continue to operate in compliance with the TNHW-121 document through the middle of September 2015. On September 15, 2015, the renewal of the Oak Ridge Reservation Corrective Action document TNHW-164 was issued with a ten year period from September 15, 2015, through September 15, 2025.

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 4.4). 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 2015).

Periodic updates of proposed construction and demolition (C&D) 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 C&D projects that warrant CERCLA oversight. The goal is to ensure that modernization efforts do not diminish the effectiveness of previously completed CERCLA environmental remediation actions and that they do not adversely impact future CERCLA environmental remediation actions.

Table 4.4. Y-12 National Security Complex Resource Conservation and Recovery Act postclosure status for former treatment, storage, and disposal units on the Oak Ridge Reservation

Unit	Major components of closure	Major postclosure requirements
	Upper East Fork Poplar Creek Hydrogeologic Regime (RCRA Postclosure Permit 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
	Chestnut Ridge Hydrogeologic Regime (RCRA Postclosure Permit 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 TNHW-116)	
Former S-3 ponds (S-3 pond 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, seep collection system specific to the burial grounds	Cap inspection and maintenance. Postclosure corrective action monitoring. Inspection and maintenance of monitoring network and survey benchmarks

Acronyms

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

4.3.8 Toxic Substances Control Act Compliance Status

The storage, handling, and use of PCBs are regulated under the Toxic Substances Control Act (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 and was last submitted June 12, 2015

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, the ORR PCB Federal Facility Compliance Agreement (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 ORR PCB FFCA.

The removal of legacy PCB waste, some of which had been stored since 1997, in accordance with the terms of ORR PCB FFCA, was completed in 2011.

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

The Emergency Planning and Community Right-to-Know Act (EPCRA) requires that facilities report inventories (i.e., Tier II report sent to state and local emergency responders) and releases (i.e., toxic release inventory report submitted to state and federal environmental agencies) of certain chemicals that exceed specified thresholds. The Y-12 Complex submitted reports in 2015 in accordance with requirements under EPCRA Sections 302, 303, 311, 312, and 313.

The Y-12 Complex had one unplanned release of a hazardous substance which required notification of the regulatory agencies. On June 9, 2015 during the demolition of Building 9808, 2,117 pounds of mercury and mercury-containing sludge were spilled which exceeded a hazardous substance reportable quantity. This event was reported to the appropriate agencies in accordance with regulatory requirements. See section 4.3.11 for more information.

Section 311 notifications were sent to TEMA and local emergency responders in 2015 because chemicals newly exceeded the reporting thresholds or new information was identified about previously reported chemicals. Those chemicals included coal tar pitch (CAS No. 65996-93-2) and asphalt oxidized (CAS No. 64742-93-4) from roofing projects, ferric sulfate (CAS No. 10028-22-5) used in wastewater treatment, and ammonia (CAS No. 7664-41-7) used in various facility and laboratory operations. Inventories, locations, and associated hazards of over-threshold hazardous and extremely hazardous chemicals were submitted to TEMA and local emergency responders in the annual Tier II report required by Section 312. Data submittal was through the E-Plan web-based reporting system, as requested by TEMA. Some local emergency responders also accepted data through the E-Plan system, but others require that electronic copies of the Tier II reports be submitted via email. Y-12 reported 52 chemicals that were over Section 312 inventory thresholds in 2015.

Y-12 Complex operations are evaluated annually to determine the applicability for submittal of a toxic release inventory report to TEMA and EPA in accordance with EPCRA Section 313 requirements. The amounts of certain chemicals manufactured, processed, or otherwise used are calculated to identify those that exceed reporting thresholds. After threshold determinations are made, releases and off-site transfers are calculated for each chemical that exceeds a threshold. Submittal of the data to TEMA and EPA is made through the TRI-ME (Toxics Release Inventory-Made Easy) web-based reporting system operated by EPA.

Total 2015 reportable toxic releases to air, water, and land and waste transferred off-site for treatment, disposal, and recycling were 20,823 kg (45,907 lb). Table 4.6 lists the reported chemicals for the Y-12 Complex for 2014 and 2015 and summarizes releases and off-site waste transfers for those chemicals.

Table 4.5. Emergency Planning and Community Right-to-Know Act Section 313 toxic chemical release and off-site transfer summary for the Y-12 National Security Complex, 2014 and 2015

Chemical	Year	Quantity[a] (lb)[b]
Chromium	2014	3,312
	2015	3,474
Copper	2014	4,494
	2015	3,605
Lead compounds	2014	19,324
	2015	14,914
Manganese	2014	--[c]
	2015	3,763
Mercury	2014	436
	2015	179
Methanol	2014	20,274
	2015	16,350
Nickel	2014	5,356
	2015	3,622
Silver	2014	--[c]
	2015	Form A[d]
Total	2014	53,196
	2015	45,907

[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 = 0.4536 kg.
[c]Not reported in previous year.
[d]Form A – less than 500 lbs. released.

4.3.10 Spill Prevention, Control, and Countermeasures

The Clean Water Act (CWA), Section 311, regulates the discharge of oils or petroleum products to waters of the United States and requires the development and implementation of spill prevention, control, and countermeasures (SPCC) plans to minimize the potential for oil discharges. The major requirements for SPCC plans are contained in Title 40 CFR Part 112. These regulations require that SPCC plans be reviewed, evaluated, and amended at least once every 5 years or earlier if significant changes occur. The SPCC rule includes requirements for oil spill prevention, preparedness, and response to prevent oil discharges to navigable waters and adjoining shorelines. The rule requires specific facilities to prepare, amend, and implement SPCC plans.

The Y-12 Complex SPCC plan (B&W Y-12 2010) was revised in September 2015 to update general Y-12 Complex changing site infrastructure. This plan presents the SPCC to be implemented by the Y-12 Complex to prevent spills of oil and hazardous constituents and the countermeasures to be invoked should a spill occur. In general, the first response of an individual discovering a spill is to call the PSS. 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.

SPCC-related improvements have been made at Y-12 by reducing the amount of oil stored on site, particularly electrical transformer oil. The revised Y-12 SPCC Plan (CNS Y-12 2015a) was completed in September 2015, meeting the regulatory requirement to review and update the SPCC Plan every 5 years.

4.3.11 Unplanned 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 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 reportable quantity (RQ) limits must be reported to the EPA National Response Center, DOE, TEMA, and the Anderson County Local Emergency Planning Committee.

In addition, 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 safeguards and security interests, functioning of DOE facilities, or the reputation of DOE.

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.

During CY 2015 there was one release of a hazardous substance exceeding an RQ.

There was a release of a hazardous substance exceeding an RQ on June 9, 2015, when a mercury spill occurred at Building 9808. This building was being prepared for demolition. The appropriate authorities were notified of the release, and the mercury was cleaned up.

Additionally, there was one reportable occurrence related to the Water Program.

The Central Mercury Treatment Facility experienced a bypass on March 7, 2015. The event was reported to the TDEC (NA--NPO-CNS-Y12NSC-2015-0013). A high level alarm automatically shut down the treatment system, but failed to notify the appropriate personnel. It is estimated that between 0.052 and 0.070 grams of mercury were discharged during the approximately 3 hour event.

4.3.12 Audits and Oversight

A number of federal, state, and local agencies oversee Y-12 Complex activities. In 2015, the Y-12 Complex was inspected by federal, state, or local regulators on four occasions. Table 4.6 summarizes the results, and additional details follow.

As part of the City of Oak Ridge's pretreatment program, city personnel collect samples from the Y-12 monitoring station to conduct compliance monitoring as required by the pretreatment regulations. City personnel also conduct twice yearly compliance inspections. No issues were identified in 2015.

Personnel from the TDEC Knoxville Field Office completed two clean air compliance inspections on March 10 and November 19, 2015. The inspections covered 33 air emission sources, several emergency generators, and included facility walkthroughs and records reviews. There were no findings or deficiencies identified.

Table 4.6. Summary of external regulatory audits and reviews, 2015

Date	Reviewer	Subject	Issues
February 12	COR	Semiannual Industrial Pretreatment Compliance Inspection	0
March 9-10	TDEC	Annual CAA Inspection	0
September 16	COR	Semiannual Industrial Pretreatment Compliance Inspection	0
November 17–19	TDEC	Annual CAA Inspection	0

Acronyms
CAA = Clean Air Act
COR = City of Oak Ridge
TDEC = Tennessee Department of Environment and Conservation

4.3.13 Radiological Release of Property

Clearance of property from the Y-12 National Security Complex is conducted in accordance with approved procedures that comply with DOE O 458.1, *Radiation Protection of the Public and the Environment* (DOE 2011c). Property consists of real property (i.e., land and structures), personal property, and material and equipment (M&E). At the Y-12 National Security Complex there are three paths for releasing property to the public based on the potential for radiological contamination:

- survey and release of property potentially contaminated on the surface (using preapproved authorized limits for releasing property),
- evaluation of materials with a potential to be contaminated in volume (volumetric contamination) to ensure no radioactivity has been added, and
- evaluation using process knowledge (surface and volumetric).

These three release paths are discussed in the following sections. Table 4.7 summarizes some examples of the quantities of property released in 2015. During FY 2015, Y-12 recycled more than 2.67 million lb of materials off the site for reuse, including but not limited to computers, electronic office equipment, used oil, scrap metal, tires, batteries, lamps, and pallets.

Table 4.7. Summary of materials released in 2015

Category	Amount released
Real property (land and structures) computer equipment recycle	None
– Computers, monitors, printers, & mainframes	81,973 lb
Electronic office equipment recycle[a]	
– used office & telecommunications equipment	2,027 lb
Recycling examples	
– Used oils	2,295 gal
– Used tires	21,120 lb
– Scrap metal	1,315,122 lb
– Lead acid batteries	85,443 lb
Public sales[b]	
– Copper	10,268 lb
– miscellaneous furniture	138,372 lb
– vehicles and miscellaneous equipment	100,484 lb
External transfers[c]	109,065 lb

[a] Items such as typewriters, telephones, shredders, calculators, laminators, and overhead projectors.
[b] Sales during FY 2015.
[c] Vehicles; miscellaneous equipment; and materials transferred to various federal, state, and local agencies for reuse during FY 2015.

4.3.13.1 Property Potentially Contaminated on the Surface

Property that is potentially contaminated on the surface is subject to a complete survey unless it can be released based on process knowledge or via a survey plan that provides survey instructions along with ~~the~~ technical (process knowledge) justification for the survey plan based on *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (NRC 2000) and *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual* (MARSAME) (NRC 2009) [1]. The surface contamination limits used at the Y-12 National Security Complex to determine whether M&E are suitable for release to the public are provided in Table 4.8.

Y-12 uses an administrative limit for total activity of 2400 dpm/100 cm² for radionuclides in groups 3 and 4 (see Table 4.8). The use of the more restrictive administrative limits ensures that M&E do not enter into commerce exceeding the definition of contamination found in 49 CFR 173, "Shippers—General Requirements for Shipments and Packagings."

[1] The *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) provides guidance on how to demonstrate that a site is in compliance with a radiation dose or risk-based regulation, otherwise known as a release criterion. The *Multi-Agency Radiation Survey and Assessment of Materials and Equipment* anual is a supplement to MARSSIM that provides technical information on approaches for determining proper disposition of materials and equipment.

Table 4.8. DOE O 458.1 preapproved authorized limits[a,b]

Radionuclide[c]	Average[d,e]	Maximum[d,e]	Removable[f]
Group 1—Transuranics, ^{125}I, ^{129}I, ^{227}Ac, ^{226}Ra, ^{228}Ra, ^{228}Th, ^{230}Th, ^{231}Pa	100	300	20
Group 2—Th-natural, ^{90}Sr, ^{126}I, ^{131}I, ^{133}I, ^{223}Ra, ^{224}Ra, ^{232}U, ^{232}Th	1000	3,000	200
Group 3—U-Natural, ^{235}U, ^{238}U, associated decay products, alpha emitters	5000	15,000	1000
Group 4—Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above[g]	5000	15,000	1000
Tritium (applicable to surface and subsurface)[h]	Not applicable	Not applicable	10,000

[a]The values in this table (except for tritium) apply to radioactive material deposited on but not incorporated into the interior or matrix of the property. No generic concentration guidelines have been approved for release of material that has been contaminated in depth, such as activated material or smelted contaminated metals (e.g., radioactivity per unit volume or per unit mass). Authorized limits for residual radioactive material in volume must be approved separately.
[b]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
[c]Where surface contamination by both alpha-emitting and beta-gamma-emitting radionuclides exists, the limits established for alpha-emitting and beta-gamma-emitting radionuclides should apply independently.
[d]Measurements of average contamination should not be averaged over an area of more than 1 m^2. Where scanning surveys are not sufficient to detect levels in the table, static counting must be used to measure surface activity. Representative sampling (static counts on the areas) may be used to demonstrate by analyses of the static counting data. The maximum contamination level applies to an area of not more than 100 cm^2.
[e]The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 millirad per hour (mrad/h) and 1.0 mrad/h, respectively, at 1 cm.
[f]The amount of removable material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. When removable contamination of objects on surfaces of less than 100 cm^2 is determined, the activity per unit area should be based on the actual area, and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate the total residual surface contamination levels are within the limits for removable contamination.
[g]This category of radionuclides includes mixed fission products, including the ^{90}Sr that is present in them. It does not apply to ^{90}Sr that has been separated from the other fission products or mixtures where the ^{90}Sr has been enriched.
[h]Measurement should be conducted by a standard smear measurement but using a damp swipe or material that will readily absorb tritium, such as polystyrene foam. Property recently exposed or decontaminated should have measurements (smears) at regular time intervals to prevent a buildup of contamination over time. Because tritium typically penetrates material it contacts, the surface guidelines in group 4 do not apply to tritium. Measurements demonstrating compliance of the removable fraction of tritium on surfaces with this guideline are acceptable to ensure nonremovable fractions and residual tritium in mass will not cause exposures that exceed DOE dose limits and constraints.

Acronyms
N/A = not applicable
DOE = US Department of Energy

Source: Vázquez 2011.

4.3.13.2 Property Potentially Contaminated in Volume (Volumetric Contamination)

Materials such as activated materials smelted contaminated metals, liquids, and powders are subject to volumetric contamination (e.g., radioactivity per unit volume or per unit mass) and are treated separately from surface-contaminated objects. No authorized volumetric contamination limits have been approved for material released from the Y-12 National Security Complex. Materials that are subject to volumetric contamination are evaluated for release by the following three methods.

1. Unopened, Sealed Containers—Material is still in an original commercial manufacturer's sealed, unopened container. A seal can be a visible manufacturer's seal (i.e., lock tabs, heat shrink) or a manufacturer's seal that cannot be seen (e.g., unbroken fluorescent bulbs, sealed capacitors) as long as the container remains unopened once received from the manufacturer.

2. Process Knowledge—If it can be determined that there is no likelihood of contamination being able to enter a system then this is documented and used to justify release; then the basis for release is documented. Often this is accompanied by confirmatory surveys.

3. Analytical—The material is sampled, and the analytical results are evaluated against measurement-method critical levels or background levels from materials that have not been impacted by Y-12 National Security Complex activities. If the results meet defined criteria, then they are documented and the material is released.

4.3.13.3 Process Knowledge

Process knowledge is used to release property from the Y-12 National Security Complex without monitoring or analytical data and to implement a graded approach (less than 100% monitoring) for monitoring of some M&E (MARSAME Classes II and III) (NRC 2009). A conservative approach (nearly 100% monitoring) is used to release older M&E for which a complete and accurate history is difficult to compile and verify (MARSAME Class I). The process knowledge evaluation processes are described in Y-12 Complex procedures.

The following M&E are released without monitoring based on process knowledge; this does not preclude conducting verification monitoring, for example, before sale.

- All M&E from buildings evaluated and designated as "RAD-Free Zones."
- Pallets generated from administrative buildings.
- Pallets that are returned to shipping during the same delivery trip.
- Lamps from administrative buildings.
- Drinking water filters.
- M&E approved for release by Radiological Engineering Technical Review.
- Portable restrooms used in nonradiological areas.
- Documents, mail, diskettes, compact disks, and other office media; personal M&E; paper, plastic products, water bottles, ABCs, and toner cartridges; office trash, house-keeping materials, and associated waste; breakroom, cafeteria, and medical wastes; and medical and bioassay samples generated in nonradiological areas.
- Subcontractor/vendor/privately owned vehicles, tools, and equipment used in nonradiological areas.
- M&E that are administratively released.

- M&E misdelivered to Stores that has not been distributed to other Y-12 National Security Complex locations.
- New computer equipment distributed from Building 9103 subcontractor/vendor/privately owned vehicles, tools, and equipment that has not been used in contaminated areas or for excavation activities.

4.4 Air Quality Program

Sections of the Y-12 Complex Title V permit 562767 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 Radiological National Emission Standards for Hazardous Air Pollutants (Rad-NESHAP) (40 CFR 61) requirements and the numerous requirements associated with emissions of criteria pollutants and other, nonradiological hazardous air pollutants (HAPs). 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 of Tennessee.

4.4.1 Construction and Operating Permits

In 2015 the Y-12 Complex received an extension to the construction air permit for UPF, amended by TDEC on January 26, 2015. There were no modifications to the Y-12's Title V Operating Air Permit in 2015.

Permit administration fees are paid to TDEC annually in support of the Title V program. CNS has chosen to pay the fees based on a combination of actual emissions [steam plant, methanol, solvent 140/142 volatile organic compounds (VOCs)] and allowable emissions (balance of plant). In 2015, emissions categorized as actual emissions totaled 37,703 kg, and emissions calculated by the allowable method totaled 590,342 kg. The total emissions fee paid was $27,713.23.

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 annual ORR Rad-NESHAPs report (DOE 2015a), which includes specific information regarding Y-12 Complex radiological emissions; the second is an annual Title V compliance certification report indicating compliance status with all conditions of the permit. The third is a Title V semiannual report, which covers a 6-month period for some specific emission sources. It consists of monitoring and record-keeping requirements for the sources. Table 4.9 gives the actual emissions versus allowable emissions for the Y-12 Complex Steam Plant.

Table 4.9. Actual versus allowable air emissions from the Y-12 National Security Complex Steam Plant, 2015

Pollutant	Emissions (tons/year)[a]		Percentage of allowable
	Actual	Allowable	
Particulate	3.55	41	8.7
Sulfur dioxide	0.28	39	0.7
Nitrogen oxides[b]	14.73	81	18.2
Volatile organic compounds[b]	2.43	9.4	25.9
Carbon monoxide[b]	37.42	139	26.9

NOTE: The emissions are based on fuel usage data for January through December 2015. 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 a pollutant, 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). Both actual and allowable emissions were calculated based on the latest US Environmental Protection Agency compilation of air pollutant emission factors (EPA 1995 and 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, ozone-depleting substances (ODS) 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 2015. There were five notifications of asbestos demolition or renovation, five revisions of notification of asbestos demolition or renovation, two records of oral regulatory communication, one revised annual estimate for CY 2015, one annual estimate for CY 2016, and one notification of change in the management and operating contractor for the Y-12 Complex submitted to TDEC in 2015 for its review and records.

An internal surveillance of the asbestos NESHAP reporting process was conducted on November 24, 2015. The scope of this surveillance was focused on compliance with applicable state and federal environmental regulations, specifically reporting and record-keeping requirements for on-site demolition and renovation activities for buildings. There were no findings or deficiencies identified as a result of this surveillance.

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 2014) provides a complete discussion of requirements and compliance activities at the Y-12 Complex. Past ODS-reduction initiatives that began in the early 1980s focused on elimination of Class I ODS use in refrigerants and solvent- cleaning operations. In 2012, the last remaining chiller system at the Y-12

Complex with Class I ODSs was taken out of service. The refrigerant from that system was sent to the Defense Logistics Agency.

Y-12 Complex initiatives have also involved elimination of ODS solvents in cleaning processes. Operations personnel developed and implemented changes in one process that eliminated ODS solvents 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 that 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 on site, and Class II ODS usage is limited wherever possible.

Site procedures are in place for disposition of excess refrigerant or refrigerant-containing equipment. Recovered refrigerant is recycled/reused in equipment in the Y-12 Complex whenever feasible. Refrigerant is recovered from refrigerant-containing equipment before disposal of the equipment. Class I ODSs that cannot be used on-site are first made available to the Defense Logistics Agency. Remaining refrigerants, including Class I and Class II ODSs, are sold to refrigerant reclamation facilities or properly disposed.

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 C&D 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. Precautions used to prevent particulate matter from becoming airborne include but are not be limited to (1) use, where possible, of water or chemicals for control of dust in demolition of existing buildings or structures, construction operations, grading of roads, or the clearing of land; (2) application of asphalt, oil, water, or suitable chemicals on dirt roads, material stockpiles, and other surfaces that can create airborne dusts; and (3) installation and use of hoods, fans, and fabric filters to enclose and vent the handling of dusty materials.

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;

- processes or operations exhausting through laboratory hoods, also involving 40 CFR 61Appendix 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 terms. In 2015, 34 process exhaust stacks were continuously monitored, 25 of which were major sources; the remaining 9 were minor sources. The Nuclear Facilities Risk Reduction (NFRR) Project was completed in early 2015 and resulted in two major stacks being removed from the sampling program (Stacks UB-027 and UB-043). Additionally, an increase in mission-related activities resulted in three stacks being brought on line, and sampling was reinstated for Stacks US-009, -010, and -011. Because of activities associated with the startup of these processes, the total amount of increased uranium emissions increased at the Y-12 NSC, which is provided below. The sampling systems on the stacks have been approved by EPA Region 4.

During 2015, unmonitored uranium emissions at the Y-12 Complex occurred from 31emission points associated with on-site, unmonitored processes and laboratories operated by CNS. Emission estimates for these processes and laboratory stacks were made using inventory data with emission factors provided in 40 CFR Part 61, Appendix D. The Y-12 Complex source term includes an estimate of these emissions.

The Y-12 Analytical Chemistry Organization operates out of two main laboratories. One is located on the site in Building 9995. 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 2015, there were no radionuclide 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 2013) 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 2015 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 per year of particulate was set for the sources for the purposes of paying fees. The compliance method requires the annual actual mass emission particulate emissions to be generated using the same monitoring methods required for Rad-NESHAPs compliance. An estimated 0.0204 Ci (13.5 kg) of uranium was released into the atmosphere in 2015 as a result of Y-12 Complex process and operational activities (Figs. 4.15 and 4.16).

A UPF is presently being designed. It is intended that this facility house some of the processes that are currently in existing production buildings. The UPF project was issued a Construction Air Permit, 967550P. The current strategy, with concurrence from the TDEC Air Division, is to include the UPF in the 2017 update of the Y-12 Site Title V Operating Permit and to maintain the facility on the permit as inactive until operations commence in about 2025.

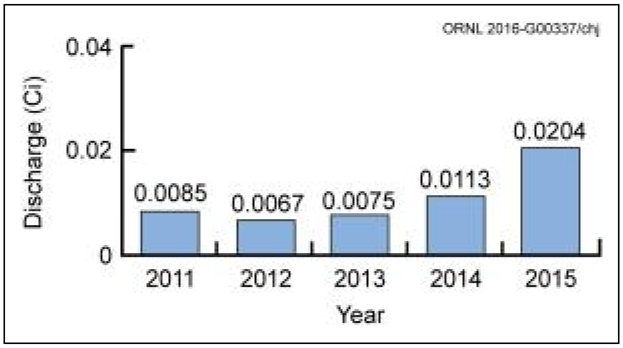

Fig. 4.15 Total curies of uranium discharged from the Y-12 National Security Complex to the atmosphere, 2011–2015

The calculated radiation dose to the maximally exposed off-site individual from airborne radiological release points at the Y-12 Complex during 2015 was 0.114 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 Chapter 7 for an explanation of how the airborne radionuclide dose was determined.)

4.4.1.3 Quality Assurance

QA activities for the Rad-NESHAPs 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 2010). The plan satisfies the QA requirements in 40 CFR Part 61, Method 114, 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 only natural gas and Number 2 fuel oil are permitted to be burned. Information regarding actual vs. allowable emissions from the steam plant is provided in Table 4.9.

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 140/142 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 calculated amounts of Solvent 140/142 and methanol emitted for CY 2015 are 2,313 lb (1.16 tons) and 25,641 lb (12.82 tons), respectively. The highest calculated amount of acetonitrile emitted to the atmosphere for CY 2015 was 5 tons, which was less than the permitted value of 9 tons/year.

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_2e.

The Y-12 Complex is subject only to the Subpart A general provisions and reporting from stationary fuel combustion sources covered in 40 CFR 98, 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 the boilers; 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 is shown in Table 4.10. The decrease in emissions from 2010 to2015 is associated with the fact that coal is no longer burned since the natural-gas-fired steam plant came on line.

Table 4.10. Greenhouse gas emissions from Y-12 National Security Complex stationary fuel combustion sources

Year	GHG emissions (metric tons CO_2e)
2010	97,610
2011	70,187
2012	63,177
2013	61,650
2014	58,509
2015	51,706.9

Acronyms
CO_{2e} = CO_2 equivalent
GHG = greenhouse gas

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 2015 and were 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 Maximum Achievable Control Technology Standards (MACT) standard that 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 on line on April 20, 2010, and coal is no longer combusted. Specific conditions aimed at minimizing hazardous air pollutant (HAP) emissions from the new steam plant were incorporated into the operating permit issued January 9, 2012 (see Section 4.4.1). In addition, the boiler MACT was revised and reissued on January 31, 2013. TDEC issued a minor modification to the Title V air permit on October 29, 2014, which included the new boiler MACT requirements. The steam plant must comply with the new requirements no later than January 31, 2016. The new requirements (work practice standards) include conducting annual tune-ups and a one-time energy assessment of the boilers to meet these requirements. There are no numeric emission limit requirements for the steam plant.

Unplanned releases of HAPs 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.

4.4.1.7 Reciprocating Internal Combustion Engine Standards for New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants

Reciprocating internal-combustion engines (RICEs) use reciprocating motion to convert heat energy into mechanical work. A number of stationary emergency-use RICEs (which power generators) are located throughout the Y-12 Complex. The emergency engines/generators are used to provide power for critical systems in the event of electrical power failures/outages at the Y-12 Complex. Emergency RICEs are defined as stationary RICEs whose operations are limited to emergency situations and require testing and maintenance activities to ensure operation during emergencies. A stationary RICE used for peak shaving is not considered an emergency stationary RICE, although such a RICE may be used for periods of emergency demand response, subject to restriction.

EPA has created multiple national air pollution regulations to reduce air emissions from RICEs. Two types of federal air standards are applicable to RICEs: (1) New Source Performance Standards (Title 40 CFR Part 60, Subpart IIII) and (2) NESHAPs (Title 40 CFR Part 63, Subpart ZZZZ). The compression ignition engines/generators located at Y-12 are subject to these rules. EPA is concerned about how RICEs are used and also the emissions generated from these engines in the form of both HAPs and criteria pollutants.

All previous stationary emergency engines/generators were listed in the Y-12 Title V air permit application as “insignificant activities.” However, on January 16, 2013, EPA finalized revisions to standards to reduce air pollution from stationary engines that generate electricity and power equipment at sites of major sources of HAPs. Regardless of engine size, the rules apply to any existing, new, or reconstructed stationary RICE located at a major source of HAP emissions.

To comply with the rules, the Y-12 Complex prepared a significant permit modification to the Y-12 Major Source (Title V) Operating Air Permit to add numerous stationary, emergency-use engines/generators located throughout the Y-12 Complex. The permit application was submitted to TDEC on May 6, 2013, for review and approval. TDEC downgraded the significant modification to a minor modification per EPA’s review and request. In a prior, updated permit application for renewal of the Y-12 Major Source (Title V) Operating Air Permit dated March 9, 2011, Y-12 Complex staff identified Title 40 CFR, Part 60, Subpart IIII, and “Standards of Performance for Stationary Compression Ignition Internal Combustion Engines,” as a requirement applicable to the stationary emergency use engines located at the Y-12 Complex. TDEC issued Y-12 a minor permit modification to the Title V air permit on March 3, 2014, for the emergency engines/generators. Compliance for the engines/generators is determined through monthly records of the operation of the engines/generators that are recorded through a nonresettable hour meter on each engine/generator. Documentation must be maintained of how many hours are spent for (1) emergency operation, (2) maintenance checks and readiness testing, and (3) nonemergency operation. Each engine/generator must use only diesel fuel with low sulfur content (15 ppm) and a cetane index of 40.

4.4.2 Ambient Air

To understand the complete picture of ambient air monitoring in and around the Y-12 Complex, data from on- and off-site monitoring conducted specifically for the Y-12 Complex, DOE reservationwide monitoring, and on- and off-site monitoring conducted by EPA and 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 concentrations 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 the West End Mercury –Use Area 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 (AAS) 2 and AAS8, are located near the east and west boundaries of the Y-12 Complex, respectively (Fig. 4.16). 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 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, and a site was operated at New Hope Pond for the 25-month period from August 1987 to September 1989.

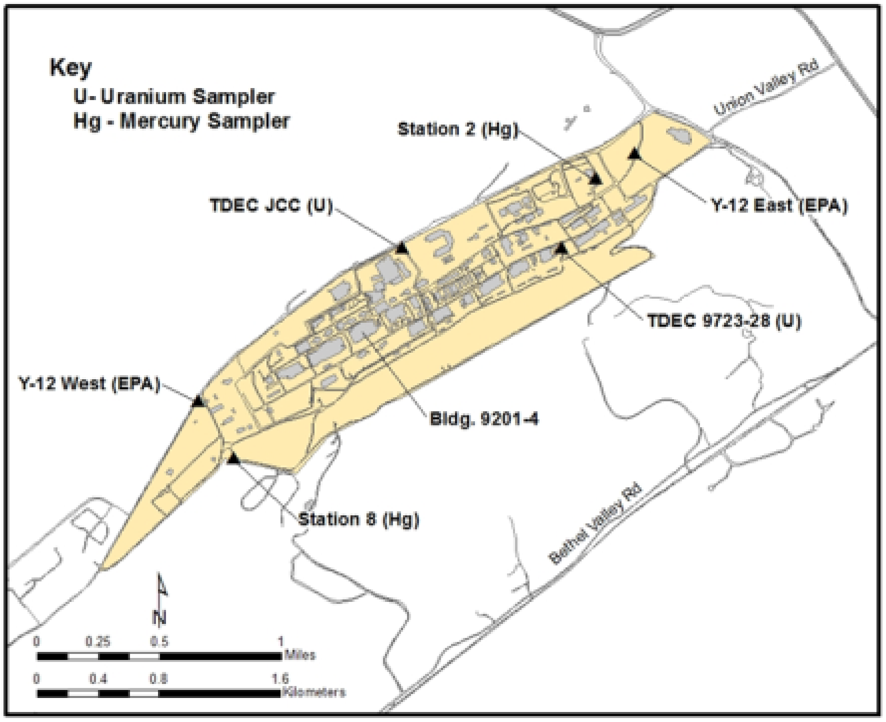

Fig. 4.16. Locations of ambient air monitoring stations at the Y-12 Complex. *[EPA = US Environmental Protection Agency (sampler) TDEC = Tennessee Department of Environment and Conservation, and JCC = Jack Case Center.]*

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 biweekly with a calibrated Gilmont flowmeter in conjunction with the biweekly 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 14-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 14-day sampling period.

The 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 4.11). Average mercury concentration at the AAS2 site for 2015 is 0.0026 $\mu g/m^3$ (N = 24), comparable to averages measured since 2003. After an increase in the average concentration at AAS8 for the period of 2005 through 2007, thought to be possibly due to increased decontamination and decommissioning D&D work on the west end, the average concentration at AAS8 for 2015 was 0.0035 $\mu g/m^3$ (N = 23), similar to levels reported for 2008 and the early 2000s. Based on the decreased mercury concentrations, the sampling schedule was changed from a weekly to biweekly duration last year. The sampling schedule will revert back to a weekly basis if the data suggest an increase in ambient air mercury concentrations or if breakthrough of the charcoal traps is observed.

Table 4.11 summarizes the 2015 mercury results with results from the 1986 through 1988 period included for comparison. Figure 4.17, Parts a, b, and c, illustrate temporal trends in mercury concentration for the two active mercury-monitoring sites for the period since the inception of the program in 1986 through 2015 [parts (a) and (b)] and seasonal trends at AAS8 from 1994 through 2015 [part (c)]. The dashed line superimposed on the plots in Figs. 4.18(a) and (b) is the EPA reference concentration of 0.3 μg/m^3 for chronic inhalation exposure. The large increase in mercury concentration at AAS8 observed in the late 1980s [part (b)] 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 4.21(c), a monthly moving average has been superimposed over the AAS8 data to highlight seasonal trends in mercury at AAS8 from January 1994 through 2015.

Table 4.11. Summary of data for the Y-12 National Security Complex ambient air monitoring program for mercury for CY 2015

Ambient air monitoring stations	Mercury vapor concentration (μg/m^3)			
	2015 Minimum	2015 Maximum	2015 Average	1986–1988[a] Average
AAS2 (east end of the Y-12 Complex)	0.0013	0.0055	0.0026	0.010
AAS8 (west end of the Y-12 Complex)	0.0015	0.0074	0.0035	0.033
Reference site, rain gauge 2 (1988[b])	N/A	N/A	N/A	0.006
Reference site, rain gauge 2 (1989[c])	N/A	N/A	N/A	0.005

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

Acronyms
AAS = ambient air (monitoring) station
CY = calendar year
Y-12 Complex = Y-12 National Security Complex

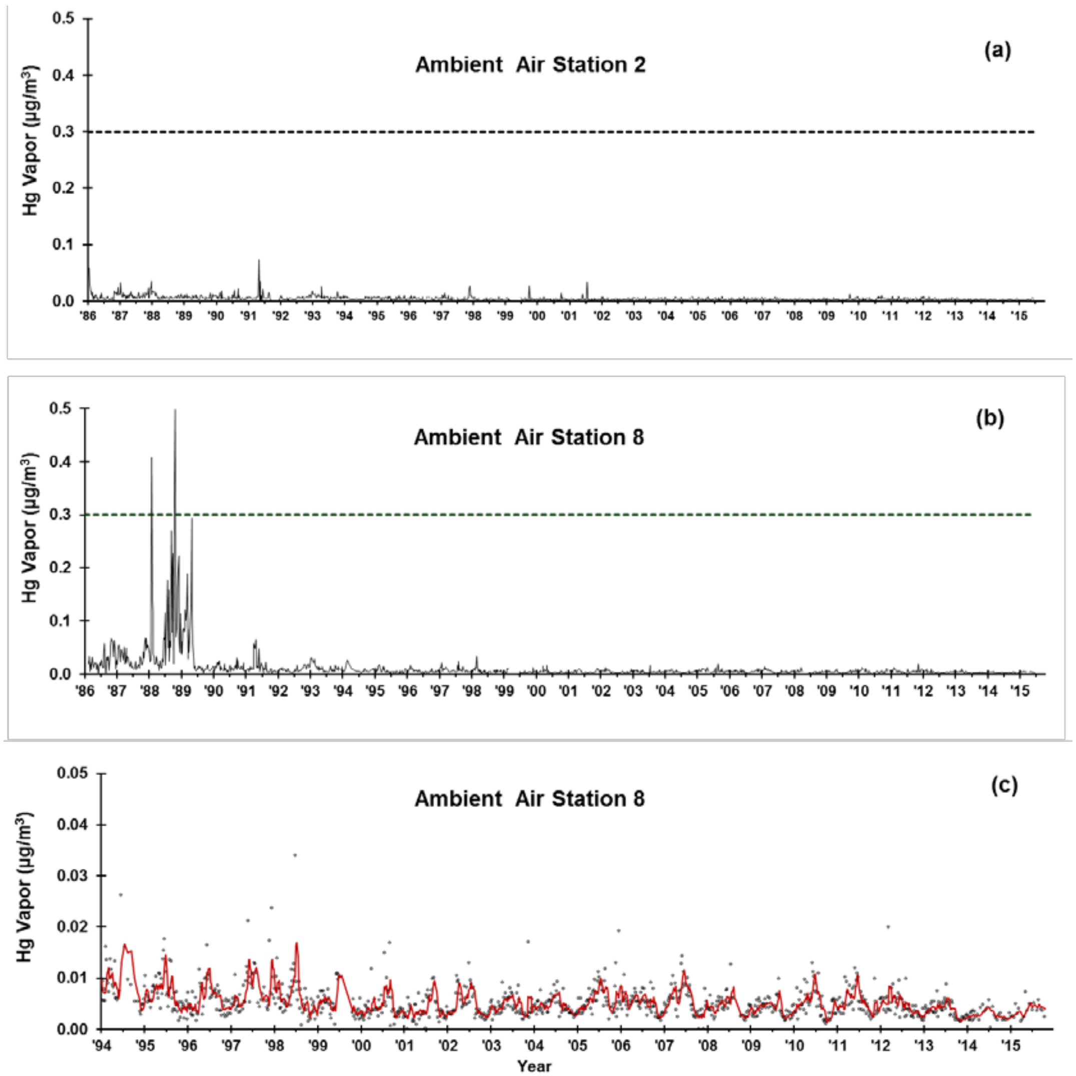

Fig. 4.17. Temporal trends in mercury vapor concentration for the boundary monitoring stations at the Y-12 Complex, July 1986 to January 2016 [(a) and (b)] and January 1994 to January 2016 for ambient air station 8 [(c)].

The dashed lines superimposed on (a) and (b) represent the US Environmental Protection Agency reference concentration of 0.3 µg/m^3 for chronic inhalation exposure. In (c) (note different concentration scale), a monthly moving average has been superimposed over the data to highlight seasonal trends in mercury at ambient air station 8 from January 1993 to January 2016, with higher concentrations generally measured during the warm weather months.

In conclusion, 2015 average mercury concentrations at the two mercury-monitoring sites were 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/m^3, 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/m^3 as a TWA for a normal 8 h workday and 40 h workweek; and the current EPA reference concentration of 0.3 µg/m^3 for elemental mercury for a continuous inhalation exposure to the human population without appreciable risk of harmful effects during a lifetime].

4.4.2.2 Quality Control

A number of QA/quality control (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.

The 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).

Each batch of samples submitted to the analytical laboratory contains a minimum of 5% 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.

The project manager conducts a field performance evaluation annually to ensure that proper procedures are followed by the sampling technicians. No issues were identified in the last evaluation conducted, May 14, 2015.

Analytical QA/QC requirements include the following:

- 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 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 HAPs, 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 AAS 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).

In addition to the monitoring described above, the State of Tennessee (i.e., TDEC) and EPA perform ambient air monitoring to characterize the region in general and to characterize and monitor DOE operations locally. Specific to Y-12 Complex operations, three uranium ambient air monitors within the Y-12 Complex boundary, used by TDEC since 1999, were phased out of service in 2012. TDEC is now using two additional high-volume samplers (Fig. 4.17) to provide isotopic uranium monitoring capability. These are located on the east side of the Jack Case Center and on the south side of the Building 9723-28 change house. EPA performs ambient air monitoring on the east end of the plant near the intersection of Scarboro Road and Bear Creek Road and on the west end of the plant near the intersection of Bear Creek Road and Old Bear Creek Road.

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

- RADNet[2] 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 56 outfalls. Major outfalls are depicted in Fig. 4.18. 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.

[2] The US Environmental Protection Agency's nationwide radiological monitoring program for air, precipation, and drinking water.

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.

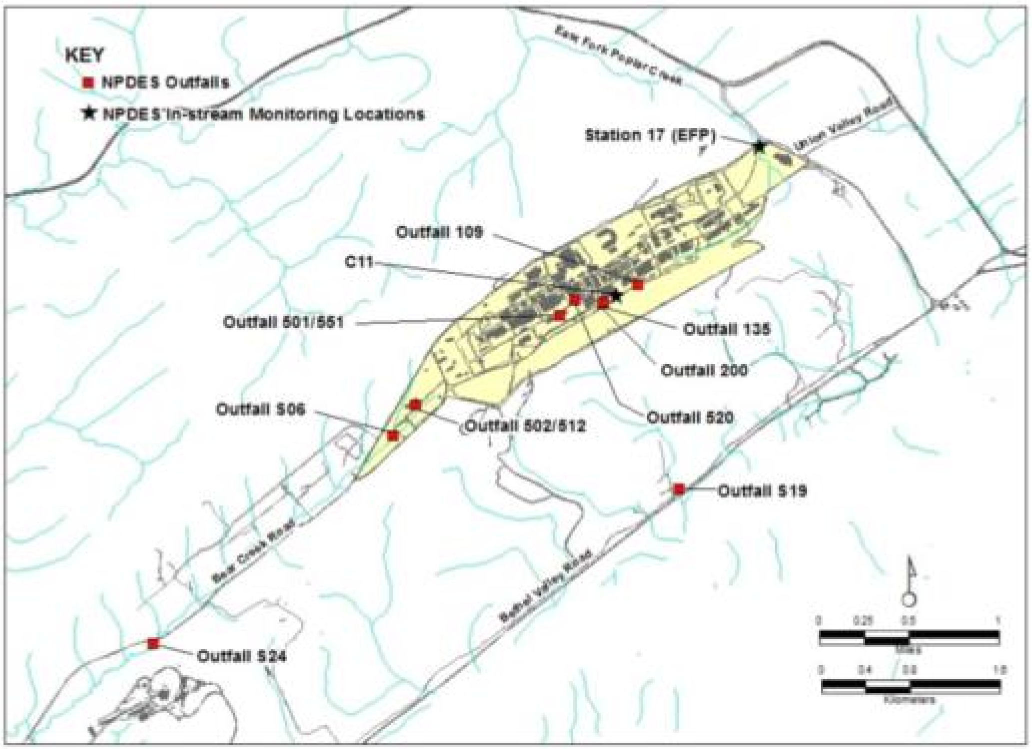

Fig. 4.18. Major Y-12 National Security Complex National Pollutant Discharge Elimination System (NPDES) outfalls and monitoring locations.

Requirements of the NPDES permit for 2015 were satisfied and monitoring of outfalls and instream locations indicated excellent compliance. Data obtained as part of the NPDES program along with other events and observations are provided in a monthly discharge monitoring report to TDEC. The percentage of compliance with permit discharge limits for 2015 was almost 100%.

Table 4.12. National Pollutant Discharge Elimination System compliance monitoring requirements and record for the Y-12 National Security Complex, January through December 2015

Discharge point	Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (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	0.07	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	1.2	*b*	0
	Polychlorinated biphenyl (PCB)				0.001	*b*	0
Outfall 502 (West End Treatment Facility)	pH, standard units			*A*	9.0	100	2
	Total suspended solids		31		40	100	3
	Total toxic organic				2.13	100	2
	Hexane extractables			10	15	100	2
	Cadmium		0.4		0.15	100	3
	Chromium		1.7		1.0	100	3
	Copper		2.0		1.0	100	3
	Lead		0.4		0.2	100	3
	Nickel		2.4		3.98	100	3
	Nitrate/Nitrite				100	100	3

Table 4.12. (continued)

Discharge point	Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
	Silver		0.26		0.05	100	3
	Zinc		0.9		1.48	100	3
	Cyanide		0.72		1.20	100	2
	PCB				0.001	100	2
Outfall 512 (Groundwater Treatment Facility)	pH, standard units			*A*	9.0	100	13
	PCB				0.001	100	1
Outfall 520	pH, standard units			*A*	9.0	100	0
Outfall 200 (North/South pipes)	pH, standard units			*A*	9.0	100	54
	Hexane extractables			10	15	100	14
	Cadmium			0.001	0.023	95	19
	IC_{25} *Ceriodaphnia*			37% Minimum		100	1
	IC_{25} *Pimephales*			37% Minimum		100	1
	Total residual chlorine			0.024	0.042	100	13
Outfall 551	pH, standard units			*A*	9.0	100	52
	Mercury			0.002	0.004	96	51
Outfall C11	pH, standard units			*A*	9.0	100	14
Outfall 135	pH, standard units			*A*	9.0	100	14
	IC_{25} *Ceriodaphnia*			9% Minimum		100	1
	IC_{25} *Pimephales*			9% Minimum		100	1
Outfall 109	pH, standard units			*A*	9.0	100	6
	Total residual chlorine			0.010	0.017	100	49
Outfall S19	pH, standard units			*A*	9.0	100	1
Outfall S06	pH, standard units			*A*	9.0	100	3
Outfall S24	pH, standard units			*A*	9.0	100	2
Outfall EFP	pH, standard units			*A*	9.0	100	14
Category I outfalls	pH, standard units			*A*	9.0	100	58
Category II outfalls	pH, standard units			*A*	9.0	100	23
	Total residual chlorine				0.5	100	24
Category III outfalls	pH, standard units			*A*	9.0	100	9
	Total residual chlorine			*A*	0.5	100	7

[a]Not applicable.
[b]No discharge.

4.5.2 Mercury Removal from Storm Drain Catch Basins

Mercury tends to collect in low spots in the storm drain system following heavy rains. During 2015, spill response and waste services personnel continued to inspect the Y-12 storm drain system for visible mercury.

During CY 2015, 0.25 lb of mercury was collected from the storm system. See Section 4.8.2 for additional discussion of the DOE EM mercury remediation strategy (DOE 2014d).

4.5.3 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 TN0002968. 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 4.13). The current radiological monitoring plan for the Y-12 Complex (B&W Y-12 2012) was last revised and reissued in January 2012.

Table 4.13. Radiological parameters monitored at the Y-12 National Security Complex, 2015

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

Acronyms
Y-12 Complex = Y-12 National Security Complex

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, two instream monitoring locations, and an outfall on Bear Creek. Results of storm event monitoring during 2015 were reported in the annual storm water report (T/TS-2035/R9), issued in November 2015. 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 2015 are noted on Fig. 4.19. Table 4.14 identifies the monitored locations, the frequency of monitoring, and the sum of the percentages of the DCSs for radionuclides measured in 2015. Radiological data were well below the allowable DCSs.

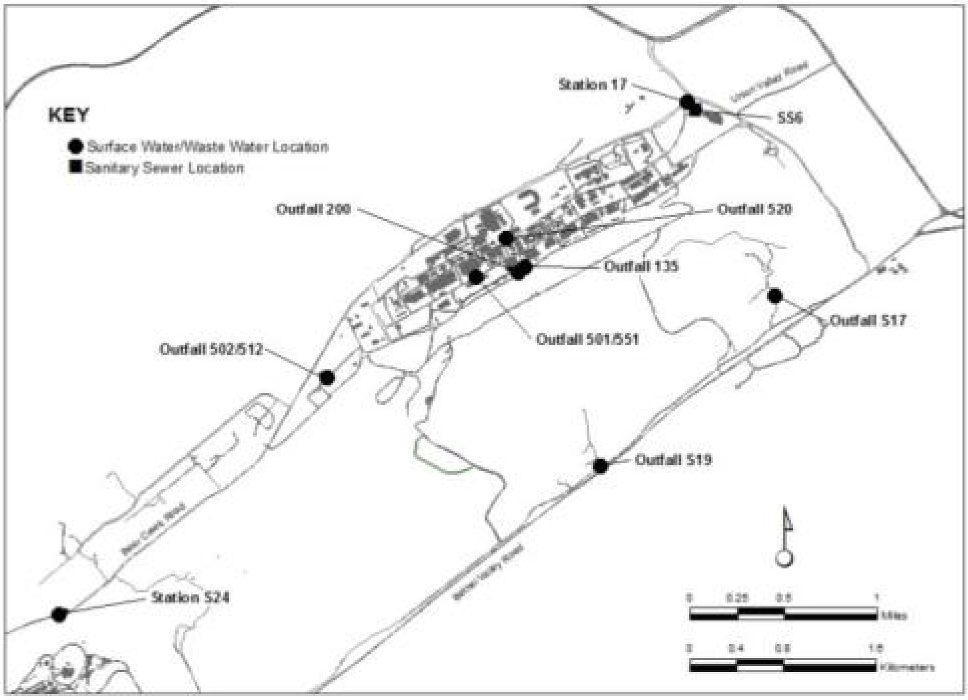

Fig. 4.19. Surface water and sanitary sewer radiological sampling locations at the Y-12 National Security Complex.

Table 4.14. Summary of Y-12 National Security Complex radiological monitoring plan sample requirements and 2015 results

Location	Sample frequency	Sample type	Sum of DCS percentages
Y-12 Complex wastewater treatment facilities			
Central Pollution Control Facility	1/batch	Composite during batch operation	No flow
West End Treatment Facility	1/batch	24 h composite	64
Groundwater Treatment Facility	4/year	24 h composite	5.8
Steam condensate	1/year	Grab	No Flow
Central Mercury Treatment Facility	4/year	24 h composite	2.0
Other Y-12 Complex point and area source discharges			
Outfall 135	4/year	24 h composite	3.1
Kerr Hollow Quarry	1/year	24 h composite	8.3
Rogers Quarry	1/year	24 h composite	0.19
Y-12 Complex instream locations			
Outfall S24	1/year	7-day composite	8.2
East Fork Poplar Creek, complex exit (east)	1/month	7-day composite	2.5
North/south pipes	1/month	24 h composite	6.7
Y-12 Complex Sanitary Sewer			
East End Sanitary Sewer Monitoring Station	1/year	7-day composite	44

Acronyms
DCS = derived concentration standard
Y-12 Complex = Y-12 National Security Complex

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In 2015, 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 116 kg or 0.068 Ci (Table 4.15). Figure 4.20 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 gallons per day). Converting units and multiplying by 365 days per year yields the calculated discharge.

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. Alpha and beta levels are measured weekly, and subsequent uranium analyses are performed if the alpha or beta levels are above prescribed levels. 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 ALARA goals. Results of radiological monitoring were reported to the City of Oak Ridge in 2015 quarterly monitoring reports.

Table 4.15. Release of uranium from the Y-12 National Security Complex to the off-site environment as a liquid effluent, 2011–2015

Year	Quantity released	
	Ci[a]	Kg
	Station 17	
2011	0.104	124
2012	0.039	121
2013	0.055	140
2014	0.061	90
2015	0.068	116

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

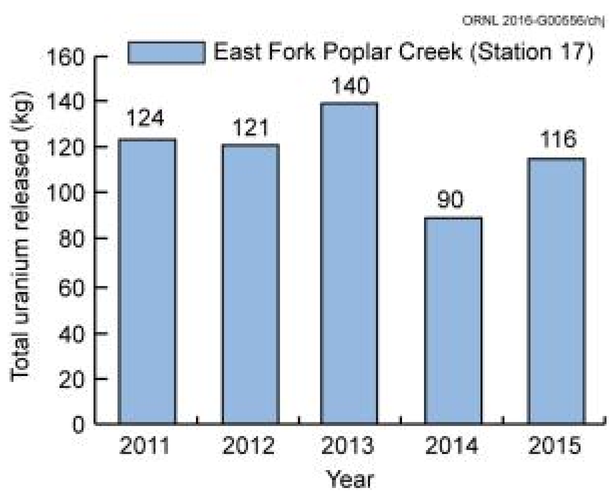

Fig. 4.20. Five-year trend of Y-12 National Security Complex releases of uranium to East Fork Poplar Creek.

4.5.4 Storm Water Pollution Prevention

The SWPPP 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 Y-12 SWPPP underwent a significant rewrite in September 2012. This was due to issuance of a modified NPDES permit in November 2011. Significant changes included the elimination of two instream monitoring locations (C05 and C08) and the removal of the requirement to perform instream base-load sediment sampling. Other requirements remained essentially the same, with the exception of the lowering of a few benchmark values for certain sector outfalls. 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 benchmark values and some have defined sector mean values. The “rationale” portion of the NPDES permit for the Y-12 Complex states “These benchmark values 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 benchmark concentrations are target values and should not be construed to represent permit limits.”

Storm water sampling was conducted in 2015 during rain events that occurred on March 19 and June 8. Results were published in the annual storm water report (CNS 2015b), which was submitted to the TDEC Division of Water Pollution Control in December 2015. 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, and two instream monitoring locations on EFPC (Fig. 4.21). The permit no longer calls for sampling of stream base load sediment that is being transported as a result of the heavy flow.

A significant change from 2013 to 2014 was the elimination of flow augmentation in EFPC. This discharge of raw water into EFPC was discontinued on April 30, 2014; thus, raw water is no longer required to be sampled. This has reduced the flow in EFPC by about 3.3 million gal per day, a significant amount (about 60%).

In general, the quality of storm water exiting the Y-12 Complex via EFPC remained relatively stable from 2014 to 2015. The one area of concern is the concentration of mercury being measured in the discharge from outfall 014. Since the first unexpected elevated result in 2013 (7.12 µg/L) this sector outfall has been on an annual monitoring schedule. The result in 2014 (0.892 µg/L) showed some improvement. However, in 2015, the result was 9.11 µg/L which is the highest measurement to date. This has garnered the attention of TDEC Division of Water Resources personnel. This has resulted in some discussion of including discharges from this outfall to be routed to the planned mercury treatment system which is to be located nearby. A final decision on this issue is still pending.

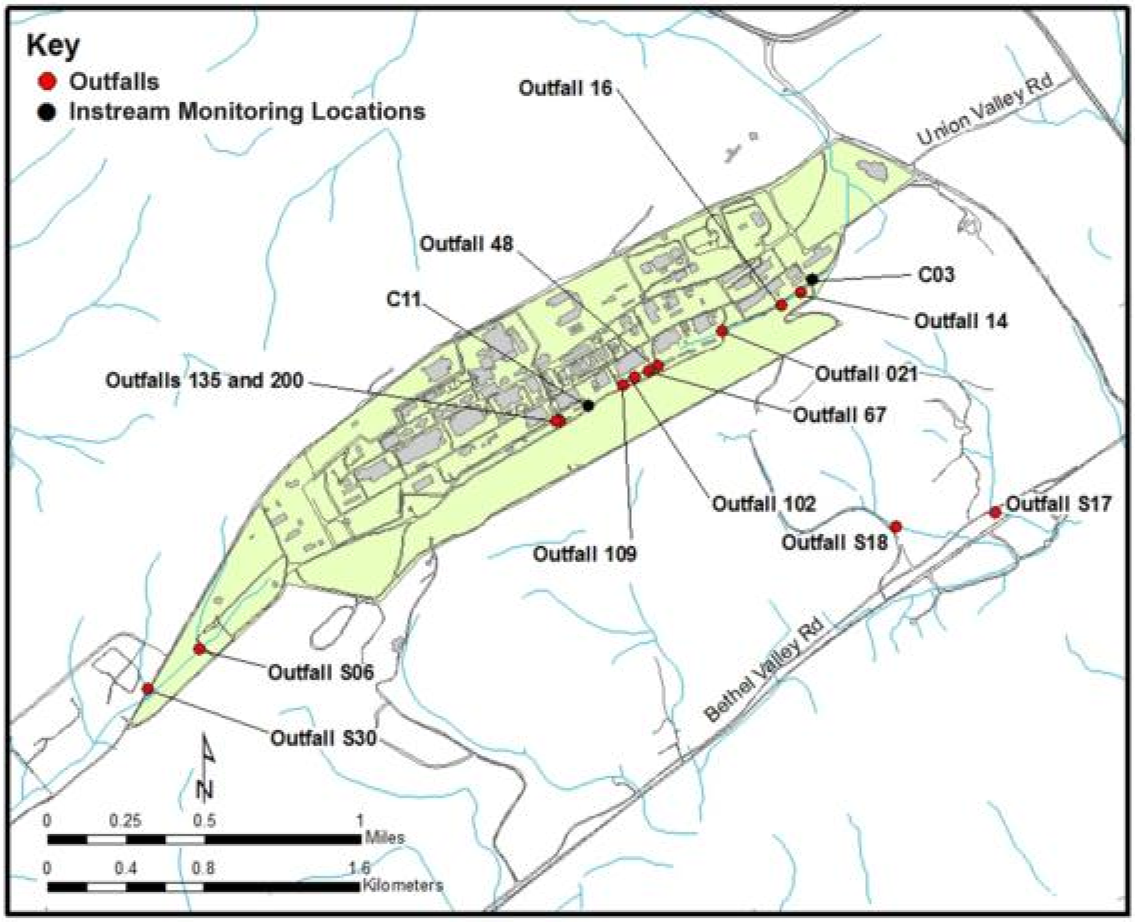

Fig. 4.21. Y-12 National Security Complex storm water monitoring locations.

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. 4.22. 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 (GWPP) to monitor trends throughout the three hydrogeologic regimes (see Section 4.6).

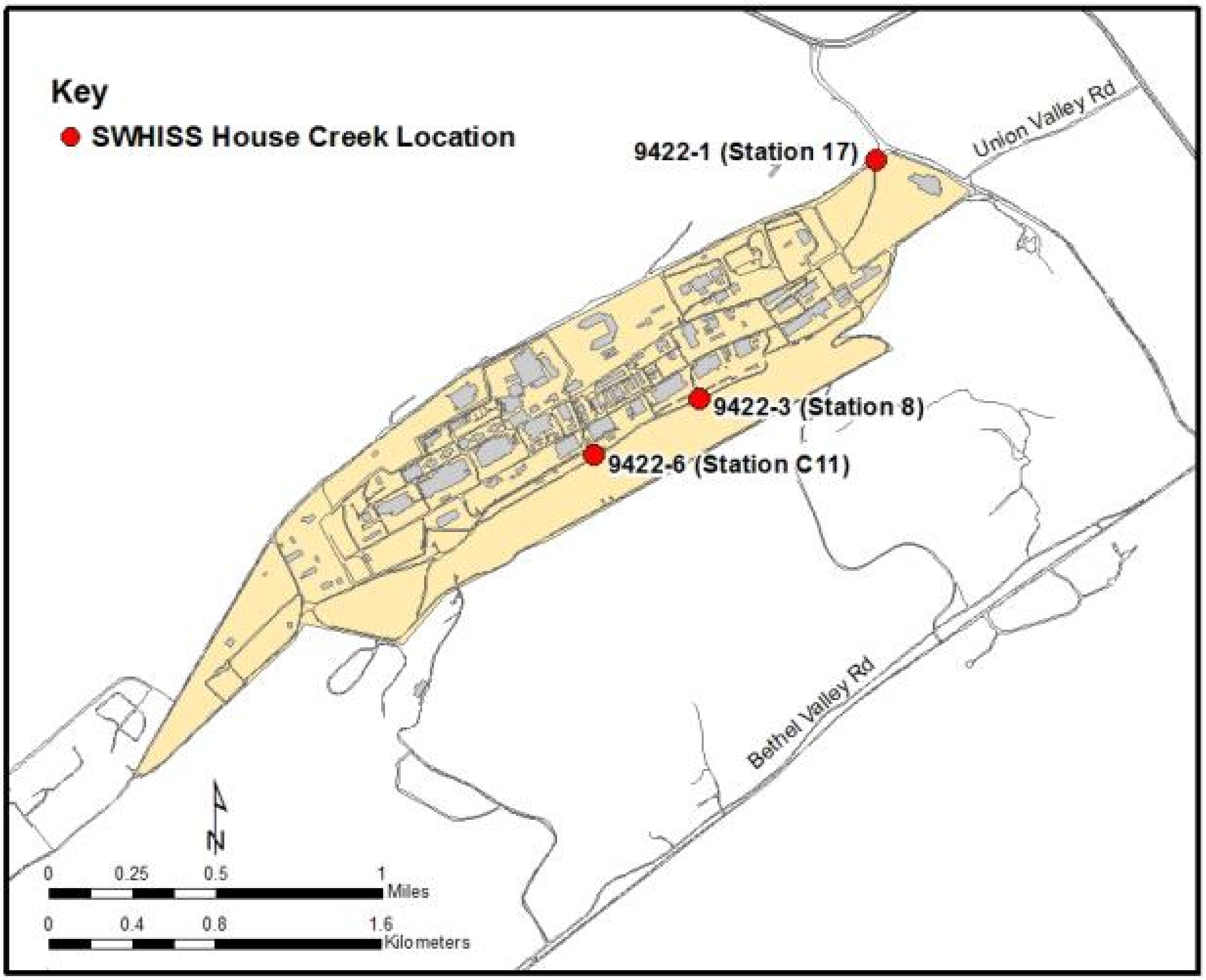

Fig. 4.22. Surface Water Hydrological Information Support System (SWHISS) monitoring locations.

4.5.6 Industrial Wastewater Discharge Permit

The Industrial and Commercial User Wastewater Discharge Permit 1-91 defines 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. The permit sets limits for most parameters. Samples for gross alpha, gross beta and uranium are taken in a weekly 24 hour 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 continuously at the monitoring station.

As part of the City of Oak Ridge's pretreatment program, city personnel also use the east end monitoring station (also known as SS6, see Fig. 4.20) to conduct compliance monitoring as required by the pretreatment regulations. City personnel also conduct twice yearly compliance inspections. Monitoring results during 2015 (Table 4.16) indicate two exceedances of the permit. These were for two exceedances of the daily flow limit which occurred on November 30 and December 1, 2015.

Table 4.16. Y-12 National Security Complex discharge point SS6, Sanitary Sewer Station 6, January through December 2015
(all units are mg/L unless noted otherwise)

Effluent parameter	Number of samples	Average value	Daily maximum (effluent limit)[a]	Monthly average (effluent limit)[a]	Number of limit exceedances
Flow (gal/day)	365	383,000	1,400,000	1,400,000	2
pH (standard units)	13	7.5	9/6[b]	9/6[b]	0
Biochemical oxygen demand	13	<74	300	200	0
Kjeldahl nitrogen	13	18.8	90	45	0
Phenols—total recoverable	13	<0.025	0.3	0.15	0
Oil and grease	13	<8.1	50	25	0
Suspended solids	34	77	300	200	0
Cyanide	13	<0.006	0.062	0.041	0
Arsenic	18	<0.01	0.025	0.010	0
Cadmium	18	<0.0009	0.005	0.0033	0
Chromium	18	<0.004	0.075	0.05	0
Copper	18	0.0365	0.21	0.14	0
Iron	18	0.682	30	10	0
Lead	18	<0.007	0.074	0.049	0
Mercury	33	0.0022	0.035	0.023	0
Nickel	18	<0.007	0.032	0.021	0
Silver	18	<0.01	0.10	0.05	0
Zinc	18	0.155	0.75	0.35	0
Molybdenum	18	0.067	0.05[c]	0.05[c]	Not Applicable
Selenium	18	<0.02	0.01[c]	0.01[c]	Not Applicable
Toluene	4	0.005U	0.005[c]	0.005[c]	Not Applicable
Benzene	4	0.005U	0.005[c]	0.005[c]	Not Applicable
1,1,1-trichloroethane	4	0.005U	0.005[c]	0.005[c]	Not Applicable
Ethylbenzene	4	0.005U	0.005[c]	0.005[c]	Not Applicable
Carbon tetrachloride	4	0.005U	0.005[c]	0.005[c]	Not Applicable
Chloroform	4	0.004JU	0.005[c]	0.005[c]	Not Applicable
Tetrachloroethylene	4	0.003JU	0.005[c]	0.005[c]	Not Applicable
Trichloroethene	4	0.005U	0.005[c]	0.005[c]	Not Applicable
Trans-1,2-dichloroethylene	4	0.005U	0.005[c]	0.005[c]	Not Applicable
Methylene chloride	4	0.005U	0.005[c]	0.005[c]	Not Applicable

[a]Industrial and commercial users wastewater permit limits.
[b]Maximum value/minimum value.
[c]There is not a permit limit for this parameter. This value is the required detection limit.

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 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 during 2015 using fathead minnow (*Pimephales promelas*) larvae and water fleas (*Ceriodaphnia dubia)*. A third discharge, outfall 125, no longer has sufficient base flows for toxicity to be evaluated. Table 4.17 summarizes the results of the 2015 outfall biomonitoring tests in terms of the IC_{25}, the concentration of each outfall effluent that causes a 25% reduction in *C. dubia* survival or reproduction or fathead minnow survival or growth. The lower the value of the IC_{25}, the more toxic the effluent.

Table 4.17. Y-12 National Security Complex Biomonitoring Program summary information for outfalls 200 and 135 in 2015[a]

Site	Test start date	Species	IC_{25}[b] (%)
Outfall 200	7/08/15	*Ceriodaphnia dubia*	>100
Outfall 200	7/08/15	*Pimephales promelas*	>100
Outfall 135	7/09/15	*Ceriodaphnia dubia*	>36
Outfall 135	7/09/15	*Pimephales promelas*	>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 *C. dubia* survival or reproduction or fathead minnow survival or growth; 36% is the highest concentration of outfall 135 tested.

Acronyms
Y-12 Complex = Y-12 National Security Complex

Effluent from outfall 135 did not reduce fathead minnow survival or growth or *C. dubia* survival or reproduction by 25% or more at any of the tested concentrations. For both species, the IC_{25} for survival, growth, or reproduction was therefore >36% (the highest concentration of effluent tested). Toxicity is demonstrated according to the NPDES permit if the IC_{25} is less than or equal to the permit limit (9% whole effluent for outfall 135).

Effluent from outfall 200 also did not reduce fathead minnow survival or growth or *C. dubia* survival or reproduction by 25% or more at any of the tested concentrations. Therefore, the fathead minnow IC_{25} for survival, growth, or reproduction was >100% (the highest concentration of this effluent that was tested). Toxicity is demonstrated according to the NPDES permit if the IC_{25} is less than or equal to the permit limit (37% whole effluent for outfall 200).

4.5.9 Biological Monitoring and Abatement Programs

The NPDES permit issued for the Y-12 Complex 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 2015 BMAP sampling reported here follows the NPDES-required Y-12 BMAP plan (Peterson et al. 2013). 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 and EFK 13.0, located upstream and downstream of the Oak Ridge Wastewater Treatment Facility; and EFK 6.3, located about 1.4 km downstream of the ORR boundary (Fig. 4.23). 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. 4.24).

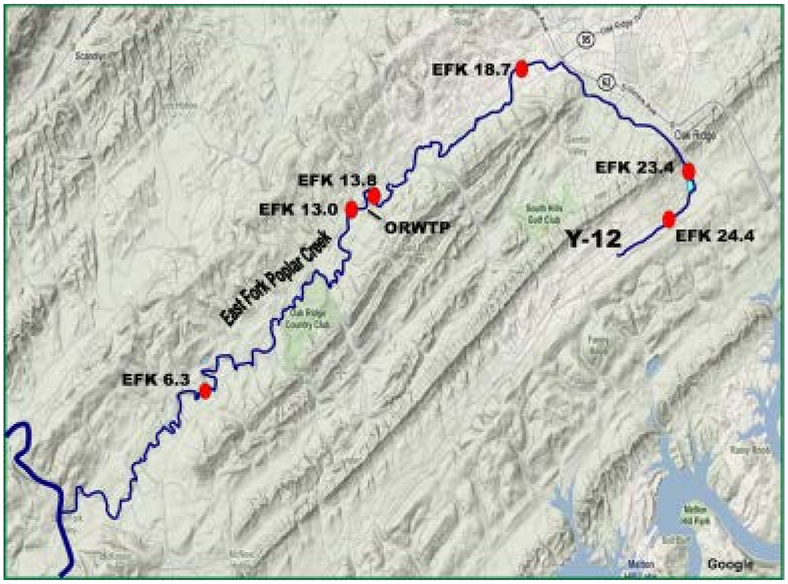

Fig. 4.23. Locations of biological monitoring sites on East Fork Poplar Creek in relation to the Y-12 National Security Complex. *(EFK = East Fork Poplar Creek kilometer and ORWTP = Oak Ridge Water Treatment Plant.)*

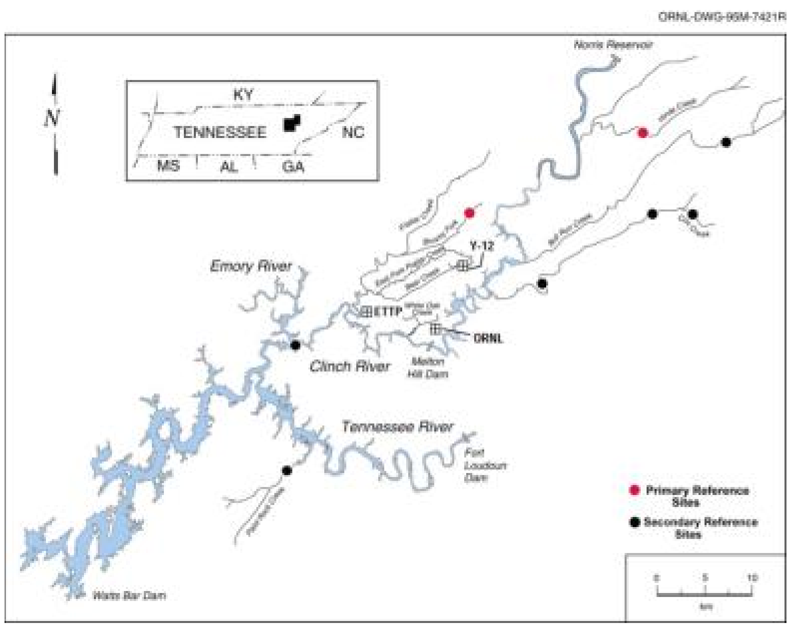

Fig. 4.24. Locations of biological monitoring reference sites in relation to the Y-12 National Security Complex. *(ETTP = East Tennessee Technology Park, ORNL = Oak Ridge National Laboratory, and Y-12 = Y-12 National Security Complex.)*

Significant increases in the number of invertebrate and fish species 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 upper EFPC near the Y-12 Complex has slowed in recent years, and fish and invertebrate communities continue to have fewer species than the corresponding communities in reference streams. The impacts on stream ecology of recent remedial and abatement actions to address mercury releases at Y-12, including a major storm drain cleanout in WEMA (2011) and flow augmentation cessation (April 30, 2014), are still uncertain and, along with additional anticipated changes in stream conditions in upper EFPC with a planned mercury treatment facility in the EFPC headwaters, will be continue to be a focus of future monitoring and investigation.

4.5.9.1 Bioaccumulation Studies

Historically mercury and PCB levels in fish from EFPC have been 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) (Fig. 4.25). A new sampling site was added in 2013 at EFK 13.0, just downstream of the Oak Ridge STP. Mercury concentrations remained higher in fish from EFPC in 2015 than in fish from reference streams. Elevated mercury concentrations in fish from the upper reach of EFPC indicate that the Y-12 Complex remains a continuing source of mercury to fish in the stream.

Figure 4.25 shows temporal trends for mercury concentrations in water collected from EFK 23.4 (Station 17) and in fish collected just upstream of this monitoring station at EFK 24.4. Waterborne mercury concentrations in the upper reach of EFPC have decreased substantially over the years in response to various RAs, first over the 1990s time period and then again in response to the Big Springs Treatment System in 2006. Although mercury concentrations in fish over time have not decreased commensurate with mercury levels in water 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 decreased concentrations in water (Fig. 4.26). Significant fluctuations in aqueous mercury concentrations (thought to be the result of storm drain relining and cleanout) have been seen at EFK 23.4 since 2009. Redbreast collected from the EFK 24.4 sampling site, about 1 km upstream of Station 17, appears to have responded to the recent peak and decline in aqueous mercury concentrations. Mean concentrations at EFK 24.4 increased from ~0.6 μg/g in 2011 to above 1 μg/g in 2012 and dropped back down in 2013–2015 (~0.6 μg/g). These concentrations are above the EPA AWQC for mercury (0.3 μg/g mercury as methylmercury in fish fillet). That this species appears to have responded to changes in water mercury concentrations in the upper reaches of the creek is interesting, given it has not responded to decreases in aqueous total mercury concentrations at downstream sites throughout EFPC in the past 20 years. The relationship between aqueous total mercury concentrations and fish tissue concentrations is complex. Aqueous mercury concentrations vary by orders of magnitude throughout the various watersheds across ORR, but fish tissue concentrations tend not to vary greatly (twofold to threefold). Multiple ongoing investigations are being conducted to better understand mercury bioaccumulation dynamics in this creek and to better predict how remedial changes may impact mercury concentrations in fish in the future.

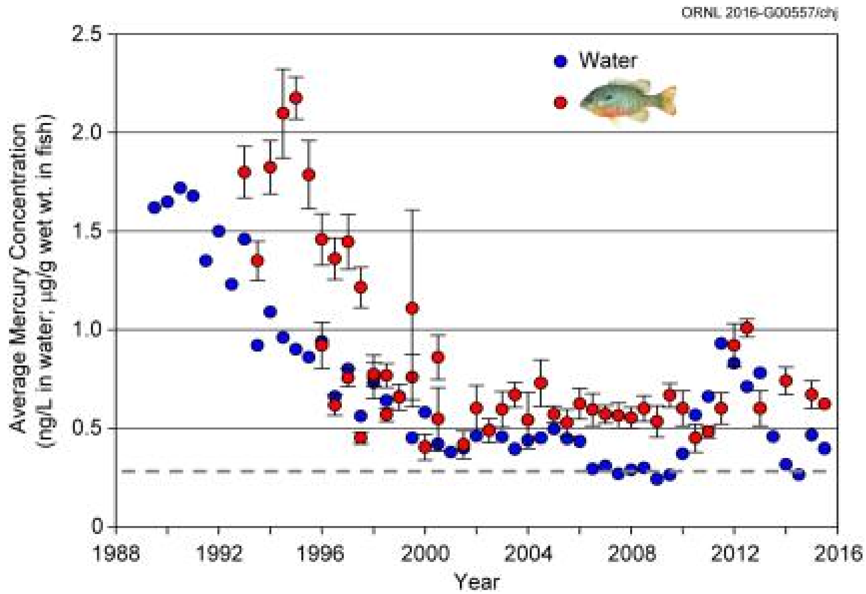

Fig. 4.25. Semiannual average mercury concentration in water from and muscle fillets of redbreast sunfish in East Fork Poplar Creek (EFPC) at EFPC kilometers 23.4 (water) and 24.4 (fish), FY 2015. *Dashed grey line represents the ambient water quality criterion for methylmercury in fish fillets (0.3 mg/kg).*

The mean total PCB concentration in sunfish fillets at EFK 23.4 was 0.56 µg/g in FY 2015, which was significantly lower than the concentration in FY 2014 (0.87 µg/g) (Fig. 4.26). Regulatory guidance and human health risk levels have varied widely for PCBs, depending on the regulatory program and the assumptions used in the risk analysis. The Tennessee water quality criteria for individual Aroclors and total PCBs are both 0.00064 µg/L under the recreation designated-use classification and are the targets for PCB-focused Total Maximum Daily Loads (TMDLs), including for local reservoirs (Melton Hill, Watts Bar, and Fort Loudon; TDEC 2010a, b, c). In the state of Tennessee, assessments of impairment for water body segments as well as public fishing advisories are based on fish tissue concentrations. Historically, the US Food and Drug Administration threshold limit of 2 µg/g PCBs in fish fillets was used for advisories, and then for many years an approximate range of 0.8 to 1 µg/g was used, depending on the data available and factors such as the fish species and size. The remediation goal for fish fillets at the ETTP K-1007-P1 pond on ORR is 1 µg/g PCBs. Most recently, the water quality criterion has been used to calculate the fish tissue concentration triggering impairment and a TMDL (TDEC 2007); this concentration is 0.02 mg/kg PCBs in fish fillets (TDEC 2010a, b, and c). The mean fish PCB concentration in upper EFPC, 0.56 µg/g in fish fillets, is well above this concentration.

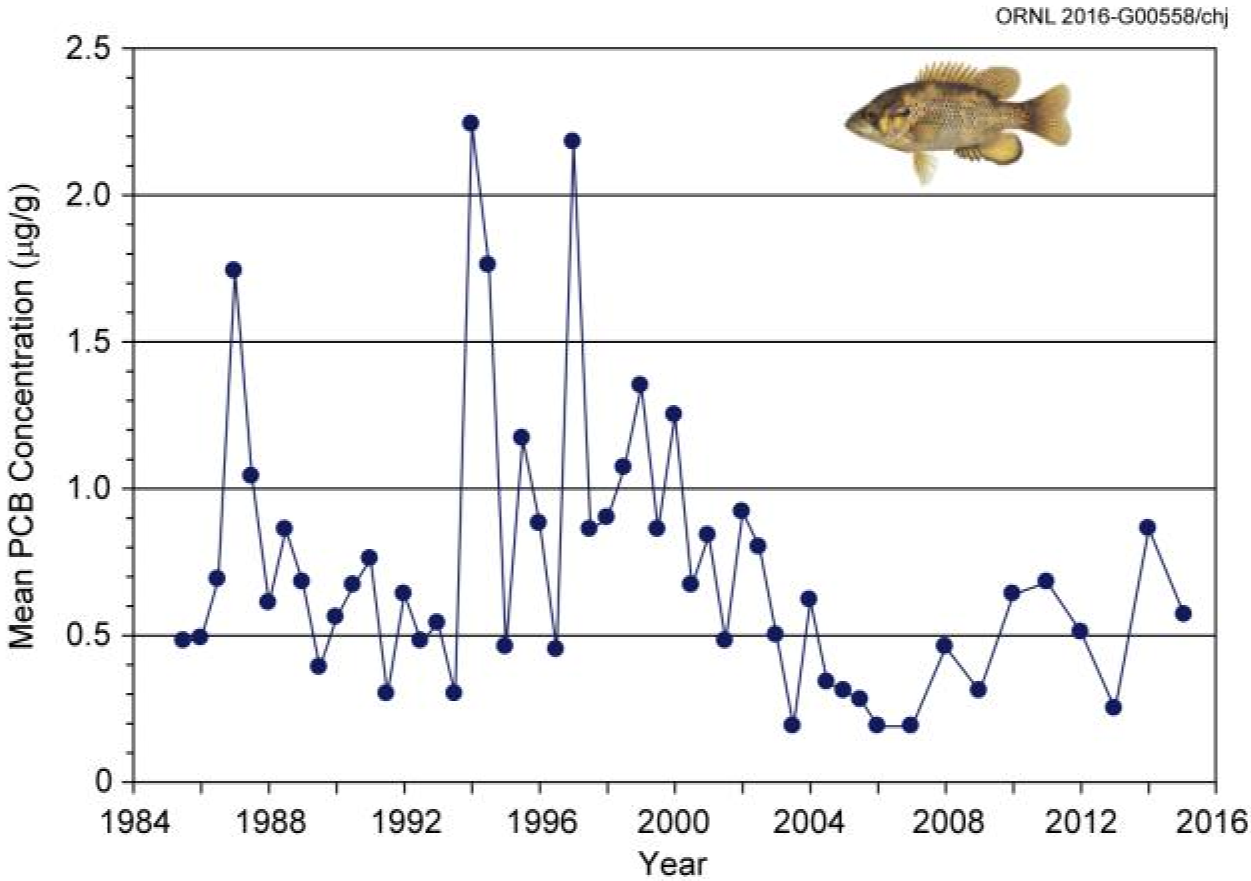

Fig. 4.26. Annual mean concentrations of polychlorinated biphenyls (PCBs) in rock bass muscle fillets at East Fork Poplar Creek kilometer 23.4., FY 2015.

4.5.9.2 Benthic Invertebrate Surveys

Monitoring of the benthic macroinvertebrate community continued at three sites in EFPC and two reference streams in the spring of 2015. The number of pollution-intolerant taxa at all three sites in EFPC and both reference sites was higher in 2014 than in 2015 (Fig. 4.27a), although densities of the pollution-intolerant taxa were higher at all sites in 2015, most notably at EFK 24.4 (Fig. 4.28b). This combination of results suggests that lower taxa richness but higher densities were widespread phenomena. Also of significance was that the mean densities of the pollution-intolerant taxa in 2015 exceeded the upper bound of the reference site confidence limits for the first time at EFK 23.4 and EFK 24.4 since monitoring began in 1985, which may indicate that cessation of flow management, may not be negatively affecting stream conditions for benthic macroinvertebrates in upper EFPC. Even with the notable increases in the densities of the pollution-intolerant taxa at EFK 23.4 and EFK 24.4, the number of pollution-intolerant taxa remain low relative to the reference sites, thus, indicating mild degraded conditions remain. The true effect of ending flow management on the invertebrate community will become more evident as more data become available.

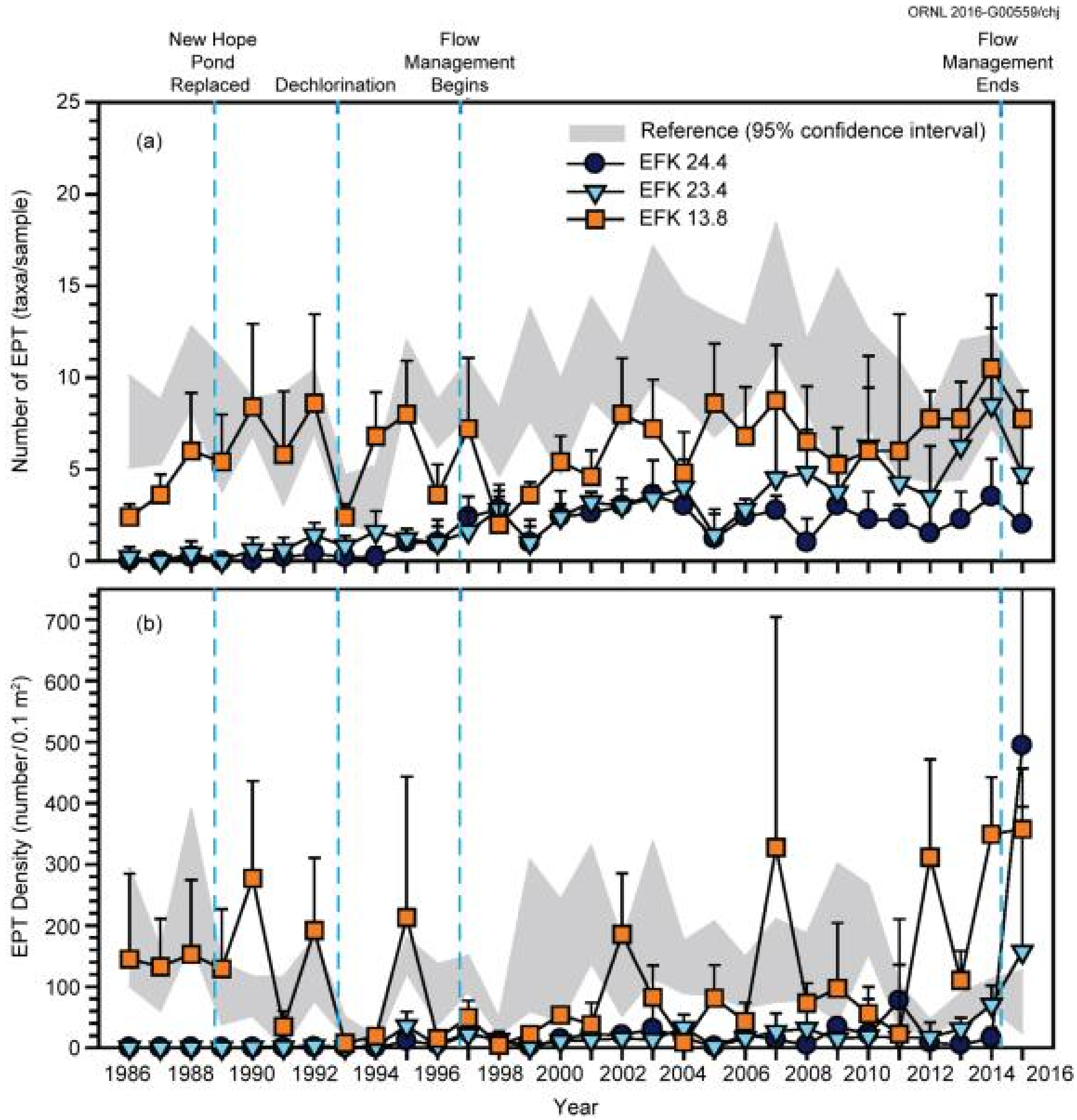

Fig. 4.27. (a) Taxonomic richness (mean number of taxa per sample) and (b) density (mean number of taxa per square meter) of the Ephemeroptera, Plecoptera, and Trichoptera (EPT) in the benthic macroinvertebrate communities sampled in the spring from East Fork Poplar Creek and two nearby reference streams (Brushy Fork and Hinds Creek), 1986–2015. *(EFK = East Fork Poplar Creek kilometer.)*

4.5.9.3 Fish Community Monitoring

Fish communities were monitored in the spring and fall of 2015 at five sites along EFPC and at a comparable reference stream (Brushy Fork). Over the past two decades, overall species richness, density, biomass, and number of pollution-sensitive fish species have improved at all sampling locations below Lake Reality. Some species of fish are considered sensitive and require very specific habitat conditions to survive and can only tolerate a narrow range of environmental disturbance. The mean number of sensitive species occurring at four sites in EFPC and a reference stream is shown in Fig. 4.28 and dramatically highlights the major improvements in the fish community in the middle to lower sections of the stream.

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 33% of the reference value.

Fish communities appear to be stable in upper EFPC in 2015, even under reduced flows associated with the termination of flow augmentation from Melton Hill in April 2014. No fish kills were observed in 2015 in upper EFPC and in contrast fish densities were considerably higher at the uppermost sampling location (Fig. 4.29). Very high densities are not usually a positive indicator of fish health however, and continued monitoring will provide additional insight into these variabilities.

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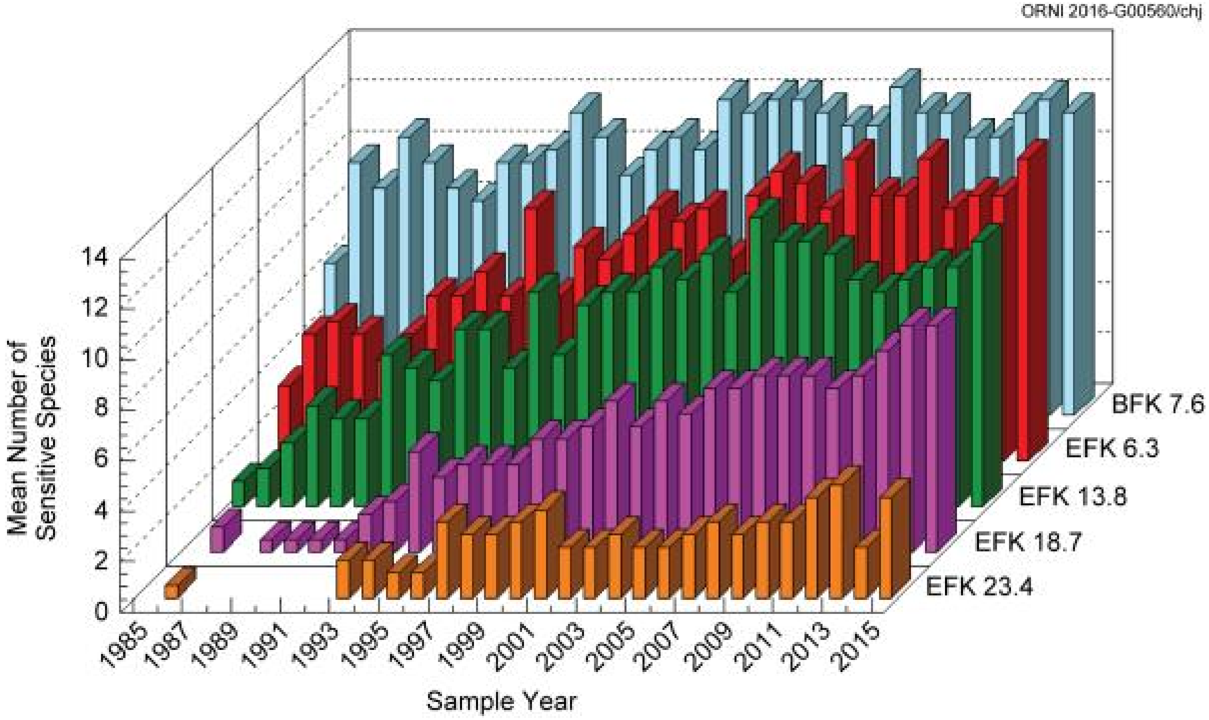

Fig. 4.28. Comparison of mean sensitive species richness (number of species) collected each year from 1985–2015 from four sites in East Fork Poplar Creek and a reference site (Brushy Fork). *(BFK = Brushy Fork kilometer and EFK = East Fork Poplar Creek kilometer.)*

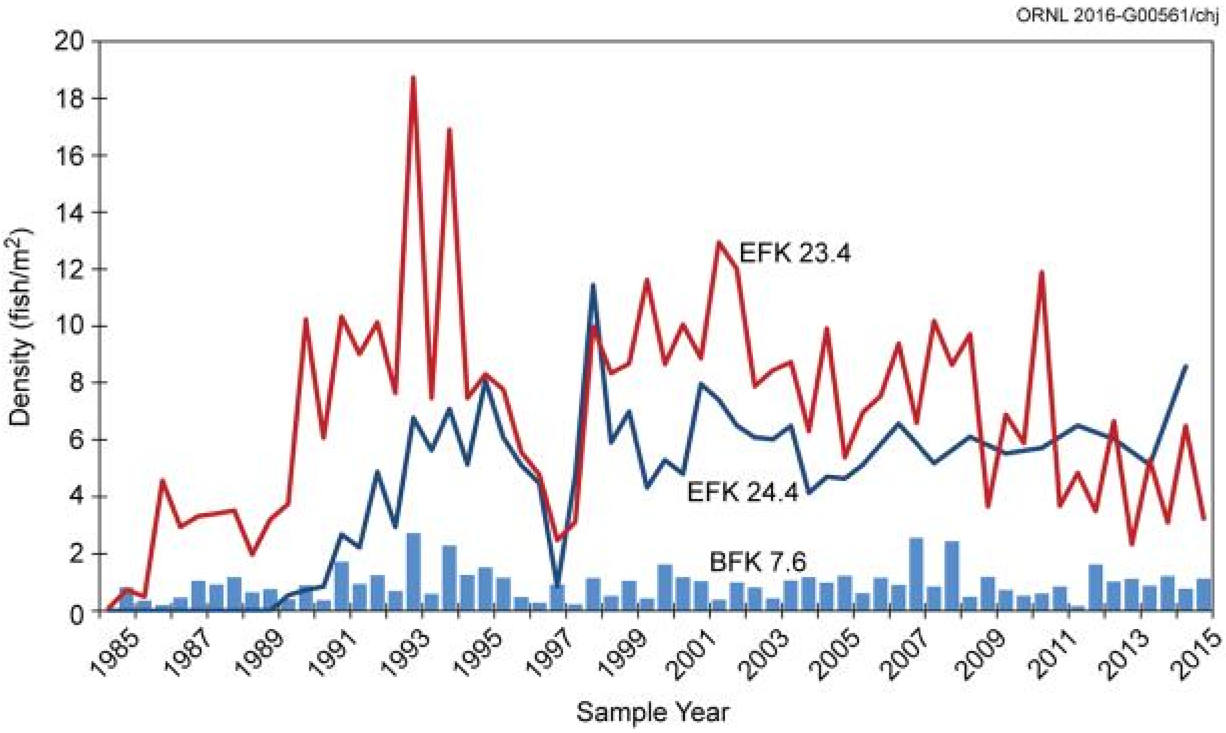

Fig. 4.29. Fish density (number of fish per square meter) for two sites in upper East Fork Poplar Creek and a reference site (Brushy Fork) from 1985–2015. *(BFK = Brushy Fork kilometer and EFK = East Fork Poplar Creek kilometer.)*

4.5.9.4 Upper Bear Creek Remediation

As part of the construction of the Uranium Processing Facility inside Y-12, Haul Road was expanded in 2013-2014 and several wetlands were negatively impacted. This resulted in the need for mitigations including the creation and expansion of wetlands in the Bear Creek watershed. All wetland mitigation sites were constructed during the Haul Road expansion except one which will be completed in the future. Wetland soils available after road construction, with their associated wetland plant seed banks, was used to support the establishment of hydric soils and wetland plant species in the mitigation areas. In all, 3.51 acres of wetlands will be constructed to compensate for the removal of 1 acre. The compensation ratios are intended to ensure that there is no net loss of resource value.

As part of haul road construction it was also necessary to culvert two sections of north tributary streams to Bear Creek. To mitigate the loss of natural streams a previously impacted section of Bear Creek was identified for restoration to more natural conditions. Approximately 300 feet of upper Bear Creek was remediated in 2014 by diverting the stream out of a channelized section and back into its original channel. This remediated section was lined extensively with erosion matting along both banks and various size river rocks were added to the channel to create pool/riffle complexes throughout the site. The natural meander of the channel was kept and only slight modifications were made. All disturbed soils were seeded and native plants were added to the site to stabilize sediments and reestablish the streams riparian zone post-construction.

Annual monitoring of these remediated wetland sites in 2015 revealed that, in general, the wetlands are responding as intended and have shown remarkable wetland plant coverage in the first year. The wetland soil bank was undoubtedly key to the restoration effort. There are some wetlands with extensive open water areas, and there are some areas with somewhat less wet conditions. However, this is not unusual at this stage of wetland restoration projects. It will be important to carefully monitor hydrologic conditions and wetland plant growth with time, and understand responses to annual precipitation patterns. Keeping invasive plants in check is also important, as these species can be aggressive shortly after soil disturbance.

Similarly, there have been positive developments associated with the stream mitigation site, in that the stream channel has a more natural meander and habitat appears to be much improved. Follow-up engineering actions have been applied to address some earlier challenges associated with a leak in the weir separating the two channels. Additional plantings were also needed to supplement the riparian plantings which experienced some plant mortality. Future monitoring will help determine whether the restoration and follow up action have been successful.

4.6 Groundwater at the Y-12 Complex

Groundwater monitoring at the Y-12 Complex is performed to comply with federal, state, and local requirements and DOE Orders to determine the degree of environmental impact from legacy and current operations. More than 150 known or potential sources of environmental contamination have been identified at the Y-12 Complex, some from plant operations and some from former waste management practices (DOE 2014b). 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. Figure 4.30 depicts the major facilities or areas for which groundwater monitoring was performed during CY 2015.

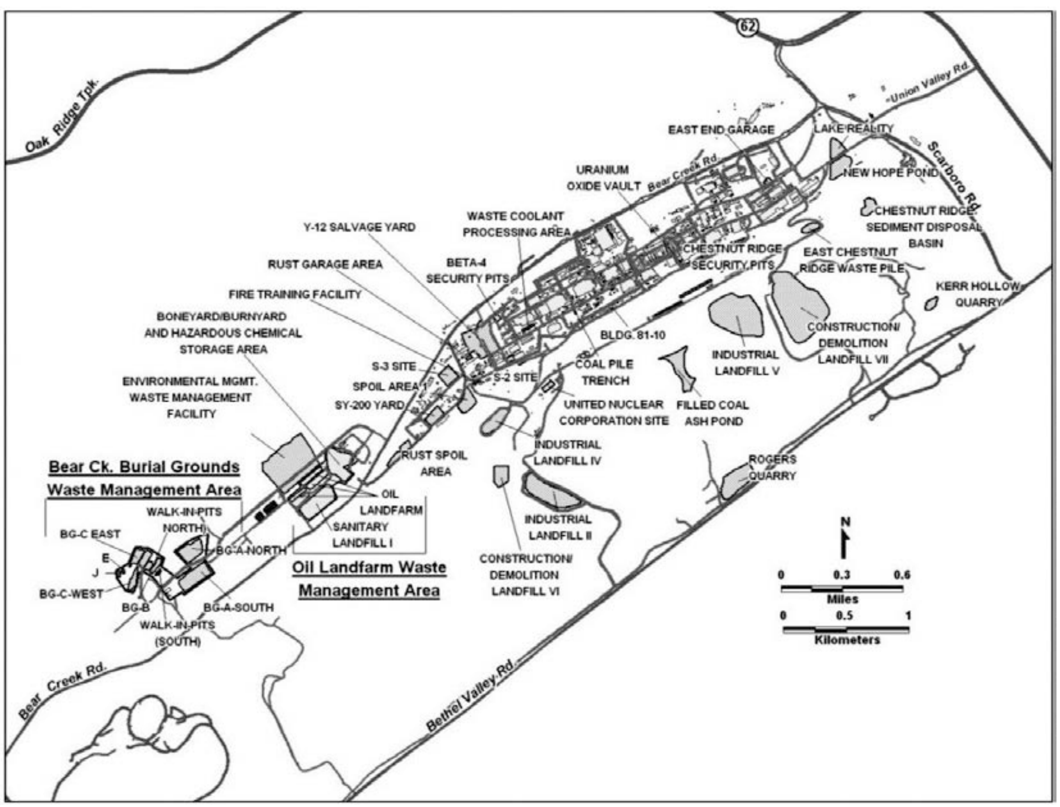

Fig. 4.30. Known or potential contaminant sources for which groundwater monitoring was performed at the Y-12 National Security Complex during CY 2015.

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. 4.31). 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. However, 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 Chestnut Ridge regime is almost entirely underlain by the Knox aquifer. The southernmost portion near Bethel Valley Road consists of the lowest members of the Chickamauga Group. 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.

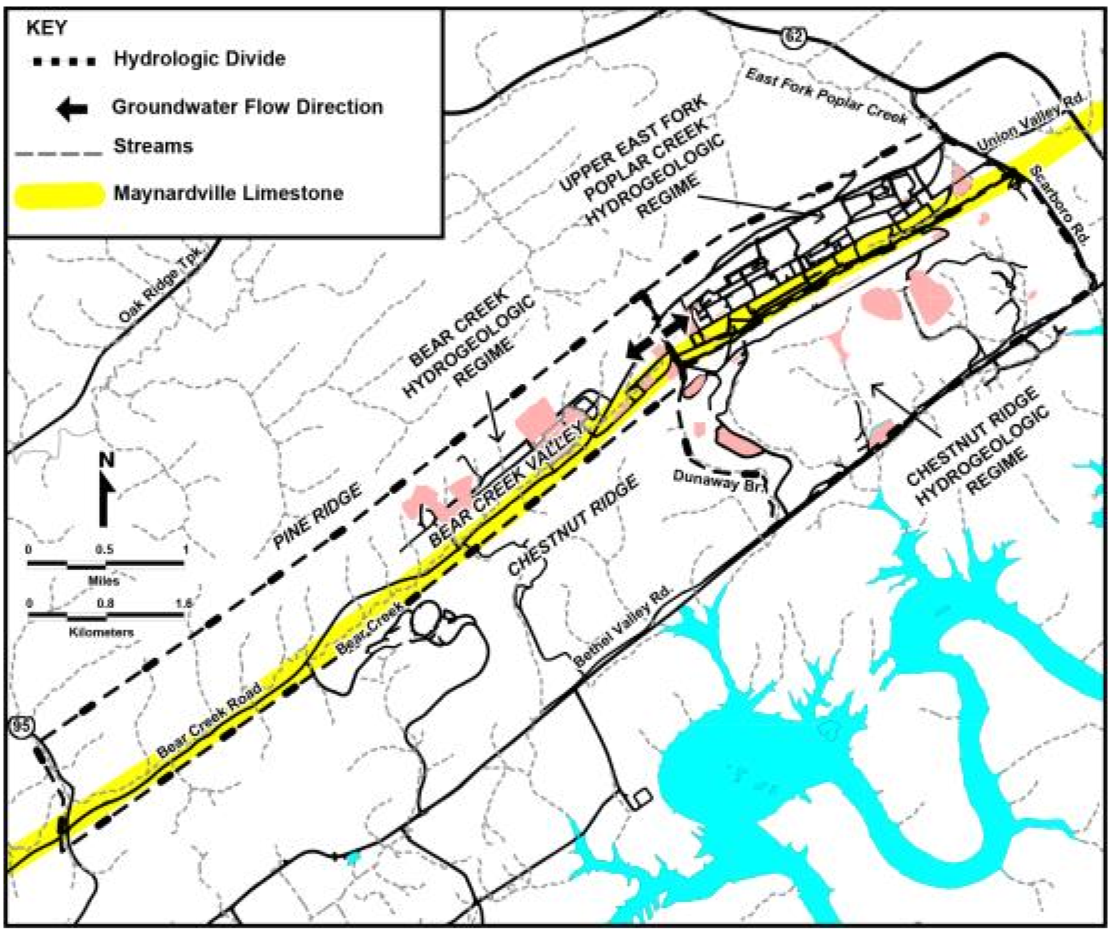

Fig. 4.31. Hydrogeologic regimes at the Y-12 National Security Complex and the position of the Maynardville Limestone in Bear Creek Valley.

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 (Fig. 4.32). 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 (less than 10 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-2 and S-3 sites for thousands of feet. VOCs (e.g., petroleum products, coolants, and solvents) at source units over or in the fractured clastic dominated bedrock 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. However, extensive VOC contamination from multiple sources is observable throughout the groundwater system in both the Bear Creek and upper EFPC regimes.

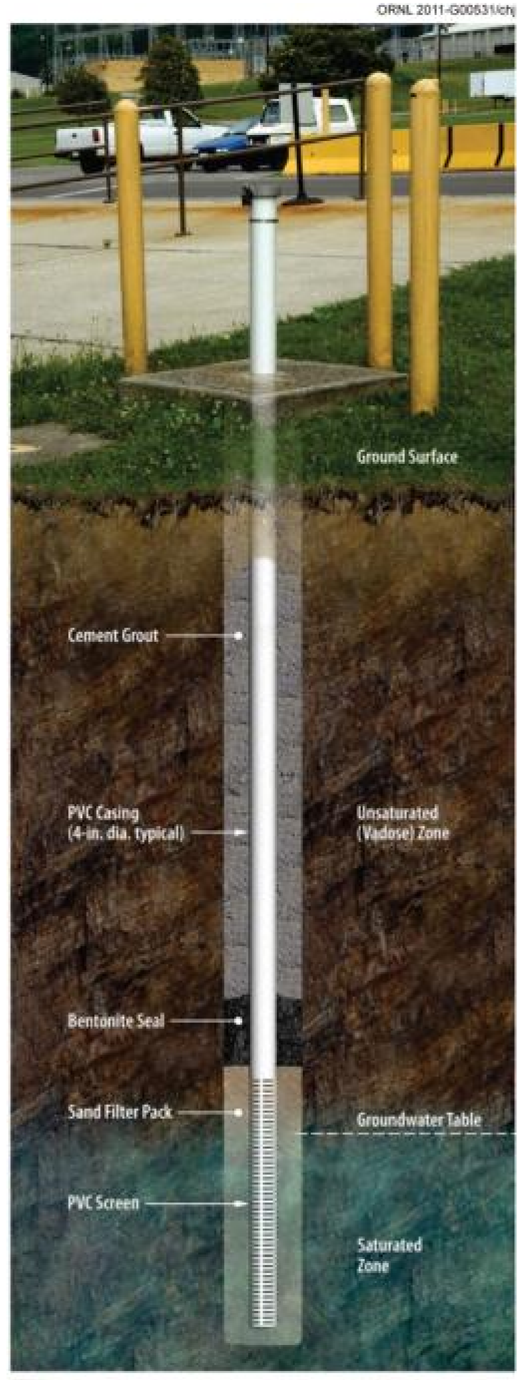

Fig. 4.32. Cross section of a typical groundwater monitoring well.

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 have been 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 4.32 shows a cross section of a typical groundwater monitoring well. Other devices or techniques (e.g., drive points and direct push installations) are sometimes used to gather groundwater data.

In CY 2015, one well (FW-306) was installed as a background well at the DOE Oak Ridge Field Center and Enigma Site. This flush-mount well was installed to a depth of 19.9 ft. bgs. Ecosystems and Networks Integrated with Genes and Molecular Assemblies (ENIGMA), a Scientific Focus Area Program at Lawrence Berkeley National Laboratory, is supported by the Office of Science, Office of Biological and Environmental Research, of the U. S. Department of Energy.

Two surveillance monitoring wells were plugged and abandoned during the year. These wells, GW-777 and GW-778, were removed in support of UPF construction activities.

4.6.3 CY 2015 Groundwater Monitoring

Groundwater monitoring in CY 2015 was performed to comply with DOE orders and regulations as part of the Y-12 Groundwater Protection Program (GWPP), DOE EM programs such as the Water Resources Restoration Program (WRRP), and other projects. Compliance requirements were met by monitoring 210 wells and 52 surface water locations and springs (Table 4.18). Figure 4.33 shows the locations of Y-12 Complex perimeter/exit pathway groundwater monitoring stations.

Table 4.18. Summary groundwater monitoring at the Y-12 National Security Complex, 2015

	Purpose for which monitoring was performed				
	Restoration[a]	Waste management[b]	Surveillance[c]	Other[d]	Total
Number of active wells	63	33	114	71	281
Number of other monitoring stations (e.g., springs, seeps, surface water)	29	6	17	0	52
Number of samples taken[e]	195	78	135	216	624
Number of analyses performed	10,695	10,715	11,481	10,804	43,695
Percentage of analyses that are nondetects	69.2	91.5	81.6	50	73.2
Ranges of results for positive detections, VOCs (µg/L)[f]					
Chloroethenes	0.3-3,600	5.46-9.77	2–42,000	NA	
Chloroethanes	0.31-410	7.85-73.7	1-1,100	NA	
Chloromethanes	0.3-950	ND	2–3,600	NA	
Petroleum hydrocarbons	0.32-6,600	ND	1–690	NA	
Uranium (mg/L)	0.0042–0.48	ND	0.00053–0.716	0.01-1.1	
Nitrates (mg/L)	0.005–6,200	0.512–2.53	0.065–11,300	0.1-25.0	
Ranges of results for positive detections, radiological parameters (pCi/L)[g]					
Gross alpha activity	2.81-325	0.65–6.32	3.4–1,600	NA	
Gross beta activity	2.61–15,100	2.85–18.4	7.8–10,000	NA	

Table 4.18. (continued)

[a]Monitoring to comply with CERCLA requirements and with RCRA postclosure detection and corrective action monitoring.
[b]Solid waste landfill detection monitoring and CERCLA landfill detection monitoring.
[c]DOE order surveillance monitoring.
[d]Research-related groundwater monitoring associated with activities of the DOE Oak Ridge Field Research Center and Enigma Project.
[e]The number of unfiltered samples, excluding duplicates, determined for unique location/date combinations.
[f]These ranges reflect concentrations of individual contaminants (not summed VOC concentrations):

- chloroethenes—include tetrachloroethene, trichloroethene, 1,2-dichloroethene (*cis* and *trans*) 1,1-dichloroethene, and vinyl chloride
- chloroethanes—include 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane
- chloromethanes—include carbon tetrachloride, chloroform, and methylene chloride
- petroleum hydrocarbons—include benzene, toluene, ethylbenzene, and xylene

[g]1 pCi = 3.7×10^{2} Bq.

Acronyms

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
NA = not analyzed
ND = not detected
RCRA = Resource Conservation and Recovery Act
VOC = volatile organic compound

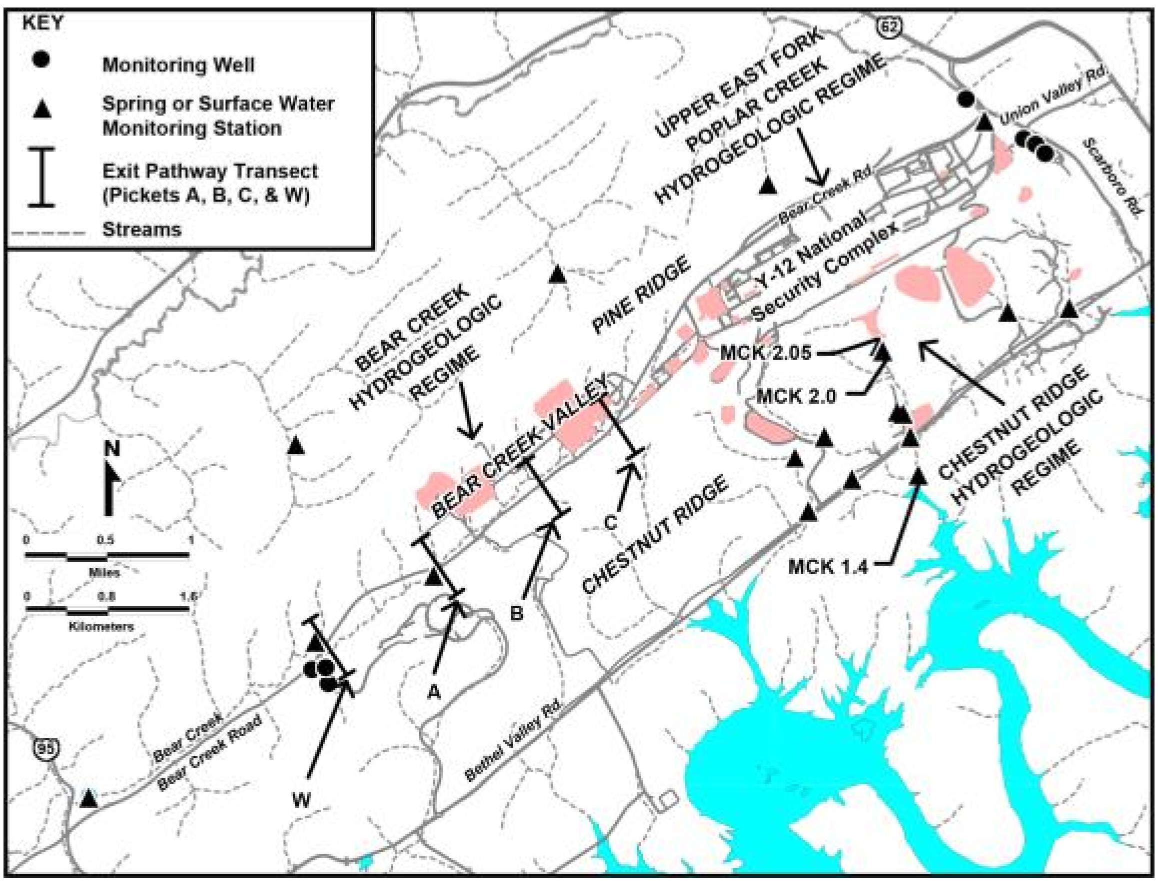

Fig. 4.33. Location of Y-12 National Security Complex perimeter/exit pathway well, spring, and surface water monitoring stations. *(MCK = McCoy Branch kilometer.)*

Most of the conventional monitoring wells at the Y-12 Complex were sampled using industry standard methods approved by TDEC and EPA (Fig. 4.34).

Fig. 4.34. Groundwater monitoring well sampling at the Y-12 National Security Complex. *[Source: Kathryn Fahey, Y-12 photographer.]*

Comprehensive water quality results of groundwater monitoring activities at the Y-12 Complex in CY 2015 are presented in the *Calendar Year 2015 Groundwater Monitoring Report* (CNS 2016).

Details of monitoring efforts performed specifically for CERCLA baseline and remediation evaluation are published in the FY 2015 and FY 2016 WRRP sampling and analysis plans (UCOR, 2014c, 2015) and the annual CERCLA remediation effectiveness reports (DOE 2016).

Groundwater monitoring compliance reporting to meet RCRA postclosure permit requirements can be found in the annual RCRA groundwater monitoring report (UCOR 2016).

4.6.4 Y-12 Complex Groundwater Quality

Historical monitoring efforts show that four primary contaminants impact 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 (e.g., arsenic, barium, cadmium, chromium, mercury), the least extensive groundwater contaminants, generally occur close to source areas because of their generally high adsorption characteristics. Historical data show that plumes from multiple-source units have mixed with one another and that contaminants (other than nitrate and ^{99}Tc) are not always easily associated with a single source.

4.6.4.1 Upper East Fork Poplar Creek Hydrogeologic Regime

Among the three hydrogeologic regimes underlying 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 4.19. 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 is predominantly contaminated with VOCs.

Table 4.19. Description of waste management units and underground storage tanks included in groundwater monitoring activities, upper East Fork Poplar Creek hydrogeologic regime, 2015

Site	Description
New Hope Pond	Built in 1963 and closed in 1988. Regulated flow of water in upper East Fork Poplar Creek before exiting the Y-12 Complex. Sediments include PCBs, mercury, and uranium. 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. A minor source of uranium in groundwater, the basin was closed under RCRA in 1990.
Salvage Yard Scrap Metal Storage Area	Used from 1950 to 1999 for scrap metal storage. Some metals contaminated with low levels of uranium. In 2011 a CERCLA action to characterize and remove the scrap was completed. Soil 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	Operated from 1976 to 1989. Primary wastes included waste oils, solvents, uranium, and beryllium. Closed under RCRA with all drums removed. Soil 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 oil, both within a diked area. Tanks were removed after 1993. Soil 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. Tanks removed in 1989. Sump leakage was a likely release mechanism to groundwater. The facility was demolished and removed and the soils beneath this facility were excavated and replaced with clean fill and gravel to remediate the site in 2011.
Building 81-10 Area	Mercury recovery facility operated from 1957 to 1962. Historical releases to soil, 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. All tanks were removed by 1990. Petroleum product releases to groundwater are documented.
Building 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. The Bldg 9754 Fuel Station transfer lines and dispenser tanks were removed in October 1993.
Coal Pile Trench	Located beneath the former 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.

Acronyms

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
PCB = polychlorinated biphenyl
RCRA = Resource Conservation and Recovery Act
UST = underground storage tank
Y-12 Complex = Y-12 National Security Complex

4.6.4.1.1 Plume Delineation

Sources of groundwater contaminants monitored during CY 2015 include the S-2 site, the Fire Training Facility, the S-3 site, the Waste Coolant Processing Facility, former petroleum UST sites, 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 upper 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.

The plumes depicted in this section reflect the average concentrations and radioactivity in groundwater between CYs 2008 and 2012. The circular icons presented on the plume maps (Figs. 4.35, 4.37-4.39) represent CY 2015 monitoring results.

In CY 2013, the Y-12 GWPP evaluated the extent of current groundwater contamination and updated the plume maps for a number of contaminants of concern (COCs), including the primary contaminants (B&W Y-12 2013). Plume maps in previous ASERs were developed from those presented in CERCLA RIs that took place in the late 1990s (DOE 1997, 1998). The RI plume maps were determined to be representative of groundwater contamination at Y-12 during the years subsequent to publication and were considered relevant for presentation in the ASERs. The updated maps are based on the more extensive and more recent sampling and analysis results, which include data not available for the RIs (e.g., existing or new wells being sampled subsequent to the RIs). These results were used to capture current groundwater conditions and in some areas reflect substantially different (higher or lower) contaminant concentrations than the data used during the RIs. These changes are due to improved data availability and/or changes within the hydrogeologic system (i.e., plume migration and/or degradation processes) either related to time and natural processes or as a result of actions taken to mitigate groundwater contamination (i.e., the east end VOC plume capture system, Section 4.6.4.1.4).

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 (a complete list of national drinking water standards is presented in Appendix C) in part of the western portion of the upper EFPC regime in the aquitard units 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 2015, groundwater concentrations of nitrate as high as 9,300 mg/L (well GW-275) were observed in the shallow–intermediate bedrock intervals about 20 m (65 ft) below ground surface and about 396 m (1,300 ft) east of the S-3 site (Fig. 4.36). These results are consistent with results from previous years.

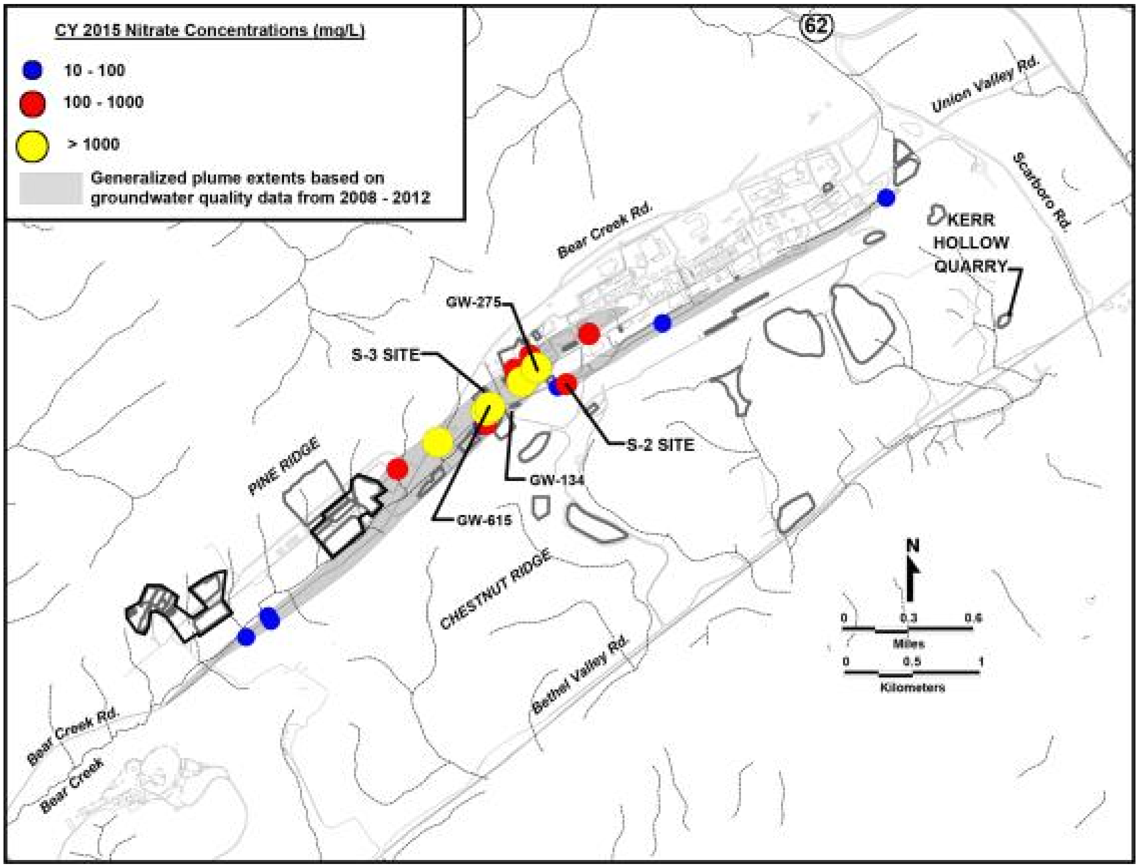

Fig. 4.35. Nitrate observed in groundwater at the Y-12 National Security Complex, 2015.

4.6.4.1.3 Trace Metals

Concentrations of arsenic, barium, beryllium, cadmium, chromium, copper, ~~lead~~, nickel, thallium, and uranium exceeded drinking water standards during CY 2015 in samples collected from various groundwater monitoring locations at or downgradient of the S-2 site, the S-3 site, 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 and high adsorption to the clay-rich soils and bedrock underlying the Y-12 Complex.

Concentrations of uranium exceed the standard (0.03 mg/L) in a number of source areas (e.g., the S-3 site, the Uranium Oxide Vault, New Hope Pond 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 groundwater in CY 2015 is mercury. Because mercury has similar characteristics as other trace metals (i.e., low solubility and high adsorption to clay-rich soils and bedrock), it 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 the surveillance monitoring analytical detection limits) in groundwater have been consistently observed only near known source areas (Fig. 4.36).

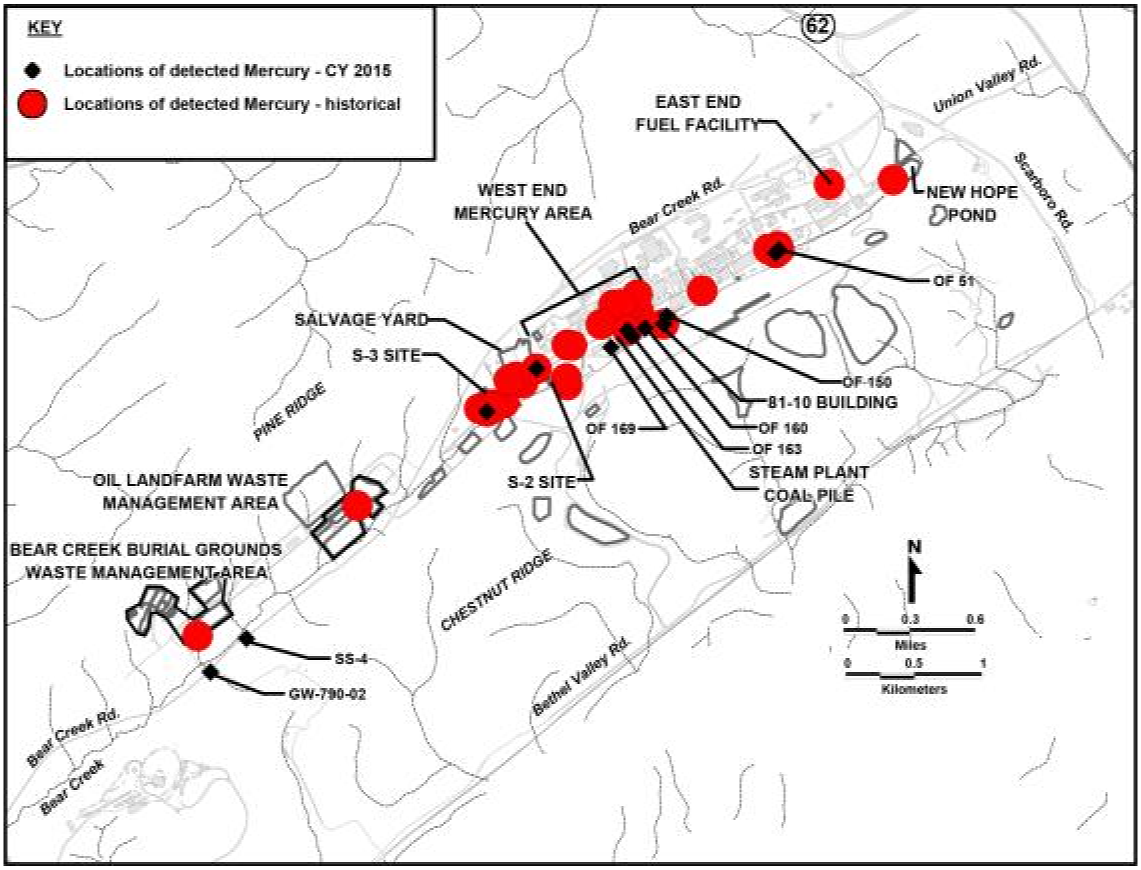

Fig. 4.36. Y-12 National Security Complex groundwater and surface water monitoring stations where mercury has been detected.

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 captured 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 developed a conceptual model integrating known hydrologic, geochemical, and physical data (Peterson et al. 2011). More recently, UCOR and ORNL have teamed to develop a number of mercury remediation technology activities (see Section 4.8.1).

In tightly fractured shale with 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 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 upper 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 area of the Y-12 Complex has resulted in an increase in monitoring in recent years in several storm drain catch basins [e.g., outfall 169, outfall 163, outfall 160, and outfall 150 (Fig. 4.38)] by WRRP. In recent years, storm drain lines in this area have undergone extensive cleaning and lining.

4.6.4.1.4 Volatile Organic Compounds

Because of the many legacy source areas, VOCs are the most widespread groundwater contaminants in the upper EFPC regime. Dissolved VOCs in the regime primarily consist of chlorinated and petroleum hydrocarbons. In CY 2015, the highest summed concentration of dissolved chlorinated hydrocarbons (49,297 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 (13,911 µg/L) was obtained from well GW-658 at the closed East End Garage.

These monitoring results are consistent with data 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. 4.37). The primary sources are the Waste Coolant Processing Facility, fuel facilities (Rust Garage and East End Garage), 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 is 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 and petroleum 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 have been 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 legacy sources at production/process facilities in central areas; and the east end VOC plume, indicating that some portions of the plume are still showing activity.

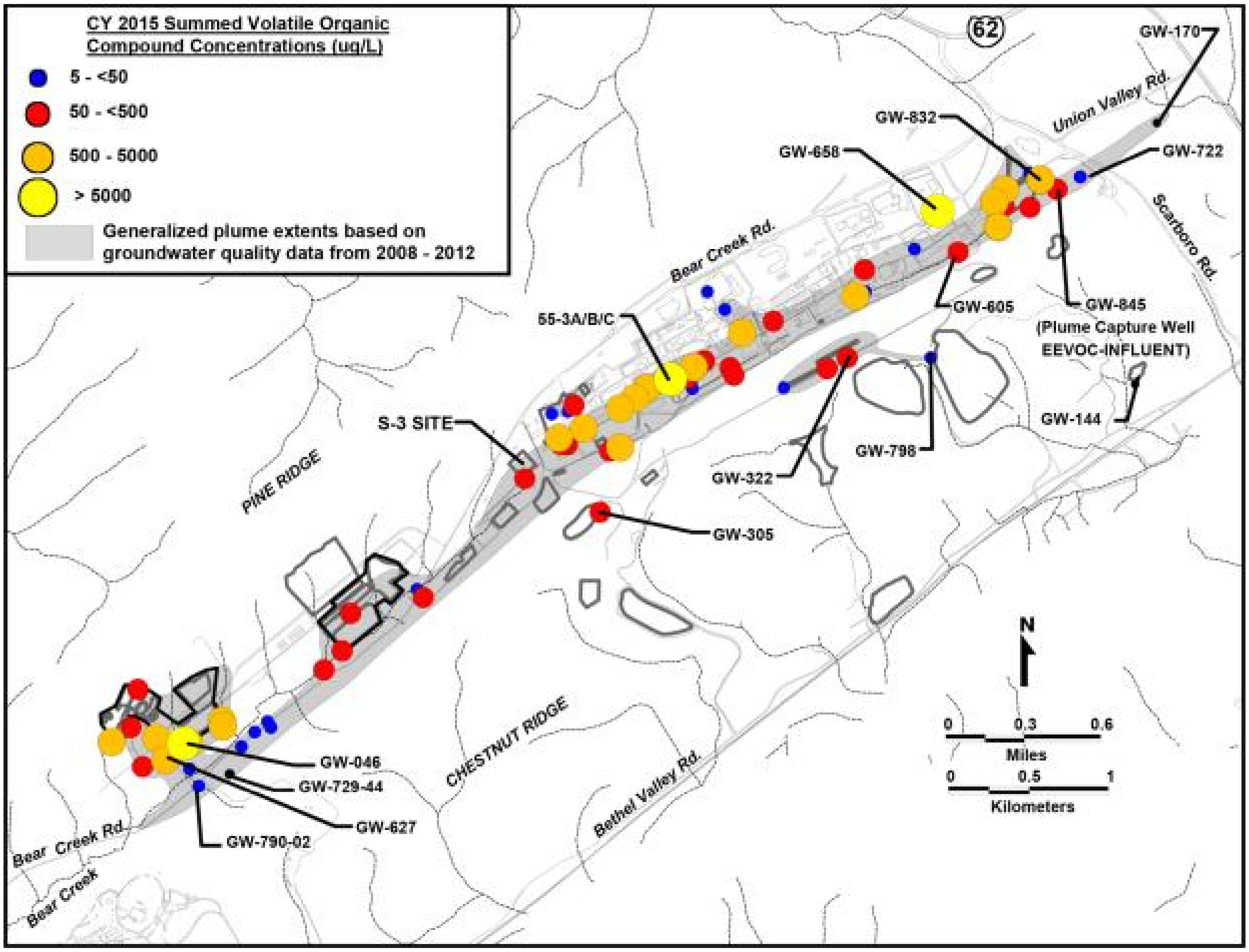

Fig. 4.37. Summed volatile organic compounds observed in groundwater at the Y-12 National Security Complex, 2015. *(EEVOC = east end volatile organic compound.)*

Within the exit pathway (the Maynardville Limestone underlying EFPC) the general trends are also stable or decreasing. 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, and/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 stable to 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.

4.6.4.1.5 Radionuclides

The primary alpha-emitting radionuclides found in the upper EFPC regime during CY 2015 are isotopes of uranium. Prior to 2014 most of the exceedances of the drinking water standard for gross alpha

(15 pCi/L) occurred in the western portion of the Y-12 Complex near the S-3 Site and Salvage Yard source areas. However, in CY 2014 and again in CY 2015 the highest gross alpha activity in groundwater (325 pCi/L) was observed on the east end of the Y-12 Complex in well GW-154, located at the former oil skimmer basin at the former inlet to the New Hope Pond which is now capped (Fig. 4.38).

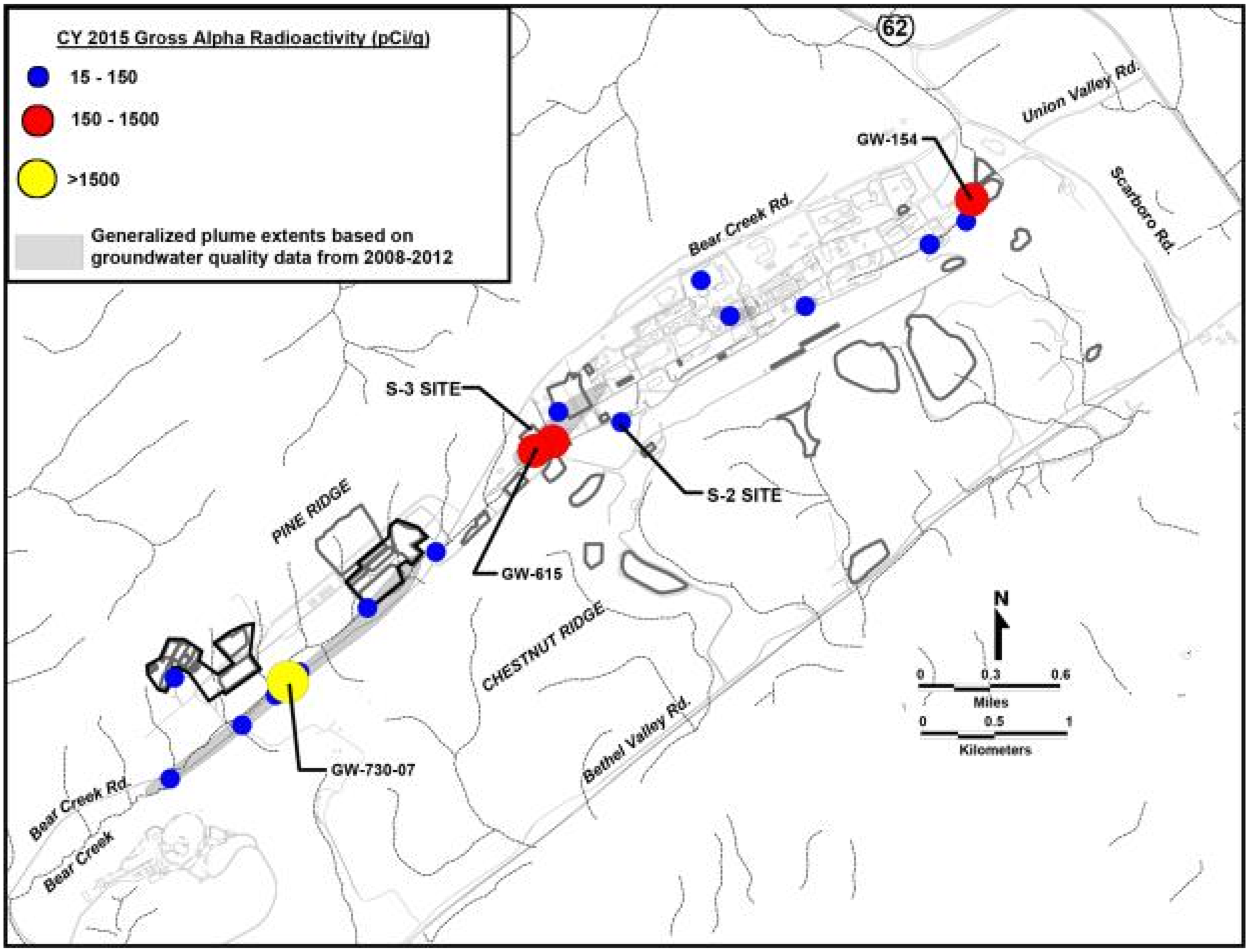

Fig. 4.38. Gross alpha activity observed in groundwater at the Y-12 National Security Complex, 2015.

The primary beta-emitting radionuclides observed in the upper EFPC regime are Technetium-99 (^{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 historical gross alpha activity. Technetium-99 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. 4.39). The highest gross beta activity in groundwater was observed during CY 2015 from well GW-108 (15,100 pCi/L), east of the S-3 site.

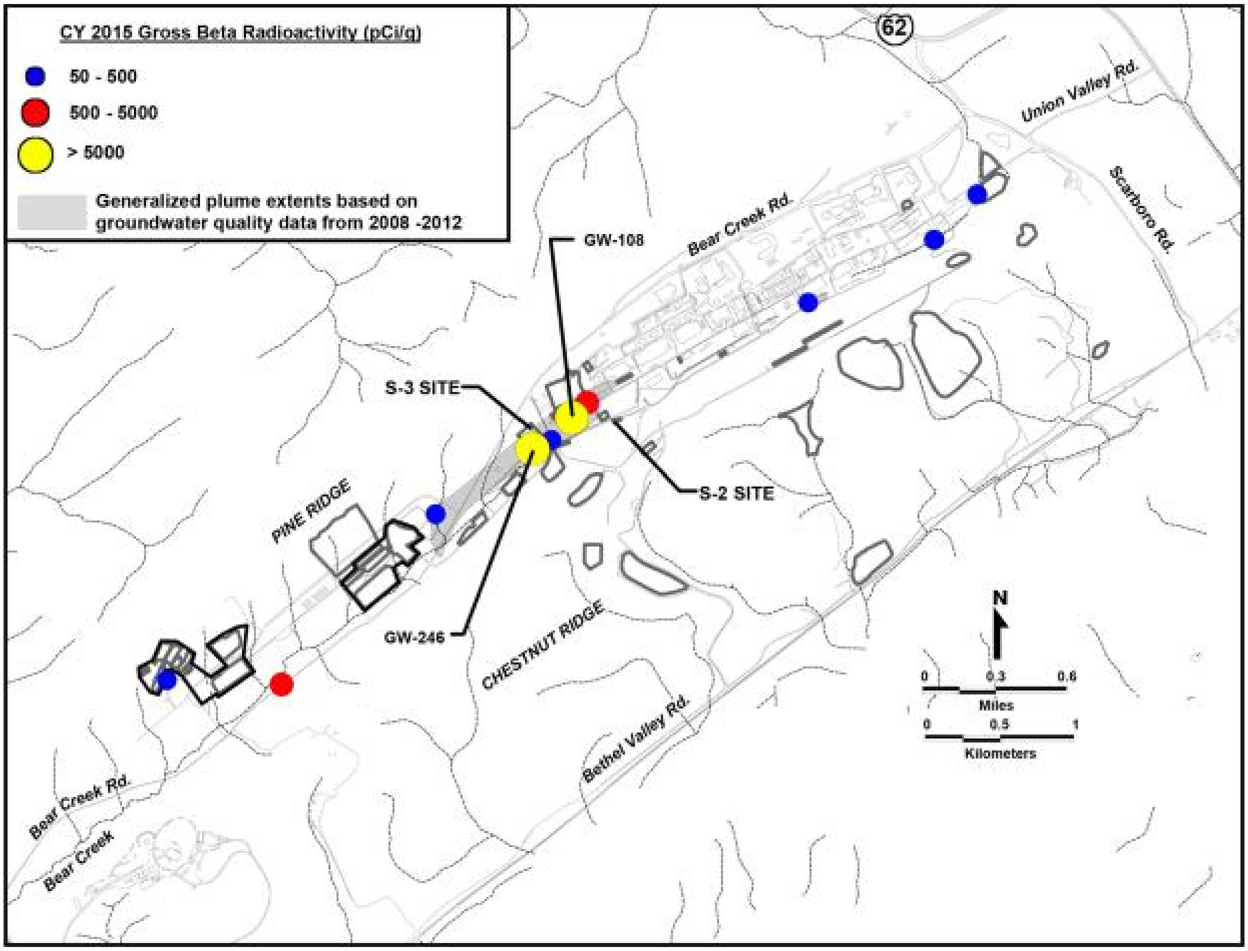

Fig. 4.39. Gross beta activity observed in groundwater at the Y-12 National Security Complex, 2015.

4.6.4.1.6 Exit Pathway and Perimeter Monitoring

Data collected to date indicate that VOCs are the primary class of contaminants migrating through the exit pathways in the upper EFPC regime. Historically, the compounds have been observed at depths of up to 500 ft below ground surface 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 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 2015, the observed concentrations of VOCs at the New Hope Pond distribution channel underdrain (GW-832) remained low (26.8 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 (The East End Volatile

Organic Compound Treatment System [EEVOCTS]) was completed in June 2000. This system pumps groundwater from the intermediate bedrock 48 to 134 m (157 to 438 ft) below ground surface 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 EEVOCTS operations. 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. 4.38). 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 [as shown in sample zone GW-722-17 (385 ft below ground surface), in Fig. 4.40]. Other wells also show decreases that may be attributable to the EEVOCTS operation. These indicators demonstrate that operation of the plume capture system is decreasing VOCs upgradient and downgradient of well GW-845, minimizing exposure to the public and the environment.

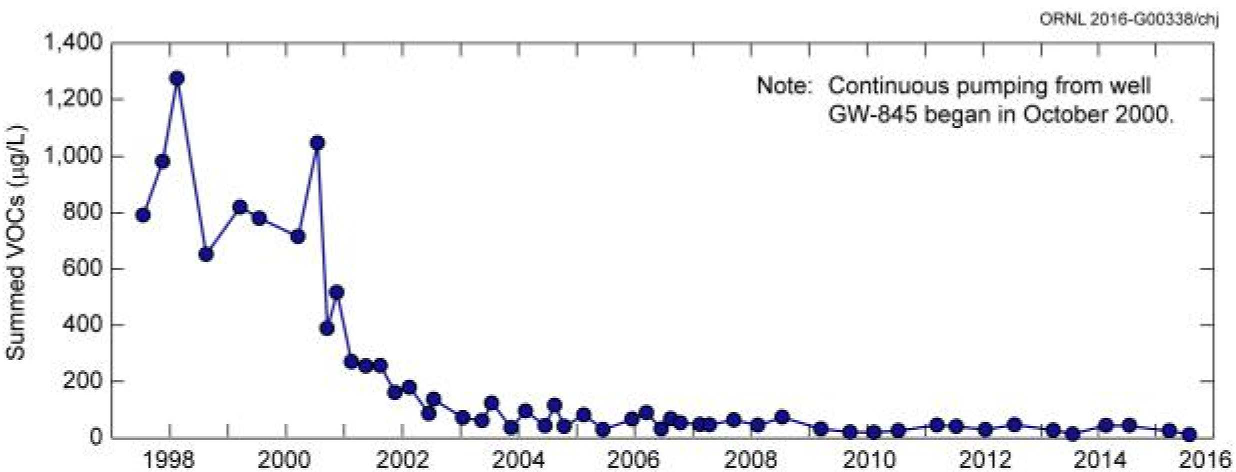

Fig. 4.40. Decreasing summed volatile organic compounds (VOCs) observed in exit pathway well GW-722-17 near the New Hope Pond, 2015. *Note: Continuous pumping from well GW-845 began in October 2000.*

Upper EFPC flows north from the Y-12 Complex through a large gap in Pine Ridge. Shallow groundwater moves through this exit pathway, and very strong upward vertical flow gradients exist. Continued monitoring of the wells in this pathway gap since about 1990 has shown no indication of any contaminants moving via that exit pathway (Fig. 4.33. One shallow well was monitored in CY 2015, and no groundwater contaminants were observed.

Three sampling locations continue to be monitored north and northwest of the Y-12 Complex to evaluate possible contaminant transport from the ORR. Those locations are considered unlikely groundwater or surface water contaminant exit pathways; however, monitoring continues to be performed to assess potential health impacts from Y-12 Complex operations to nearby residences. One of the stations monitored is a tributary that drains the north slope of Pine Ridge on the perimeter of the 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 the perimeter of the 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 primary drinking water standard nor were there any indications that contaminants were being discharged from the ORR into those communities. 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 RI (DOE 1998) provided a discussion of the nature and extent of the VOCs.

In CY 2015, monitoring of locations in Union Valley continued, showing overall decreasing or very low concentration stable trends (less than primary 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 EEVOCTS (well GW-845) was installed, and operations were initiated to mitigate the migration of groundwater contaminated with VOCs into Union Valley (DOE 2015).

In July 2006, the Agency for Toxic Substances and Diseases Registry (ATSDR), 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 the ORR was evaluated (ATSDR 2006). In the report, it was acknowledged that extensive groundwater contamination exists throughout the ORR, but the authors concluded that there is no public health hazard from exposure to contaminated groundwater originating on the 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 4.20 describes each of the waste management sites within the Bear Creek regime.

Table 4.20. Description of waste management units included in calendar year 2015 groundwater monitoring activities, Bear Creek hydrogeologic regime

Site	Description
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.

Table 4.20. (continued)

Site	Description
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 as part of the Boneyard-Burnyard remedial activities.
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 and C and Walk-In Pits	Burial grounds A and C received waste oils, coolants, beryllium, uranium, various metallic wastes, and asbestos into unlined trenches and standpipes. The walk-in pits received chemical wastes, shock-sensitive reagents, and uranium saw fines. Activities ceased in 1981. Final closure was 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, and J and Oil Retention Ponds 1 and 2	Burial grounds B, D, E, and J consisted of unlined trenches. These burial grounds received uranium chip, metal, and oxide wastes and uranium contaminated debris. 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 ground B and part of C was granted in 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.
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.
Environmental Management Waste Management Facility	A CERCLA ROD defines the construction, operation, and closure of this on-site facility for disposal of radioactive, hazardous, and mixed wastes generated from CERCLA cleanup projects conducted on the ORR and associated sites. The facility began accepting wastes in 2002 with full capacity estimated to be reached in FY 2020.

Acronyms

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
ETTP = East Tennessee Technology Park
ORNL = Oak Ridge National Laboratory
ORR – Department of Energy Oak Ridge Reservation
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.

The plumes depicted in this section reflect the average concentrations and radioactivity in groundwater between CYs 2008 and 2012. The circular icons presented on the plume maps (Fig. 4.35, 4.37-4.39) represent CY 2015 monitoring results. (See Section 4.6.4.1.1 for more details.)

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 2015 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 (11,300 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. 4.35), 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 2015, barium, beryllium, 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 (see Section 4.6.4.1.3). 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 RAs 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 RAs performed from 2002 to 2003 were successful in removing much of a primary source of uranium in Bear Creek Valley. There has been an overall decrease in uranium concentrations since 1990 (Table 4.21); however, in CY 2014 and again in CY 2015 slight increases were observed in the upper reaches of Bear Creek, indicating that this contaminant still presents a significant impact.

Table 4.21. Nitrate and uranium concentrations in Bear Creek

Bear Creek Monitoring Station (distance from S-3 site)	Contaminant	Average concentration[a] (mg/L)					
		1990–1994	1995–1999	2000–2004	2005–2009	2010–2014	2015
BCK[b]-11.84 to 11.97	Nitrate	116	65.7	89.5	43.3	53.3	31.8
(~0.5 miles downstream)	Uranium	0.203	0.112	0.129	0.112	0.172	0.247
BCK-09.20 to 09.47	Nitrate	16.1	7.8	12.1	8.4	4.4	4.38
(~2 miles downstream)	Uranium	0.098	0.093	0.135	0.060	0.051	0.055
BCK-04.55	Nitrate	4.7	2.3	3.5	1.1	0.8	0.79
(~5 miles downstream)	Uranium	0.034	0.030	0.033	0.020	0.016	0.021

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

Additional monitoring is ongoing in an attempt to determine uranium inputs to the stream from source areas and the karst groundwater system underlying Bear Creek. Other trace metals observed in the Bear Creek regime are arsenic, boron, chromium, copper, lead, mercury, nickel, selenium, strontium, thallium, and zinc. Concentrations have commonly exceeded background values in groundwater near contaminant source areas. One exception to this is the detection of mercury in the bottom zone (1026 ft bgs) of Westbay™ well GW-790 in CY 2015. Due to the depth of the location and the hydrologic and geochemical characteristics of the groundwater from this zone (total dissolved solids analysis from this sample was 179,000 mg/L) it is unlikely that the detected result indicates a Y-12 source. Follow-up monitoring in 2016 will be performed to further evaluate this mercury result.

In recent years some investigators have been applying very sensitive analytical methods for the extremely low level detection of mercury in water samples. These detection limits are below surveillance monitoring detection limits. As a result, mercury was again observed at slightly above the background concentration in natural spring SS-4 along Bear Creek this year (Fig. 4.37). This location is not near known source areas of mercury contamination. The source of the mercury is uncertain; however, it could be from upstream/upgradient locations where mercury is a known Y-12 legacy contaminant, or other off-site anthropogenic sources (i.e., coal-fired power generation plants) unrelated to DOE operations.

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) laterally of the source areas. The highest concentrations observed in CY 2015 in the Bear Creek regime occurred in the Nolichucky shale bedrock unit (an aquitard) at the Bear Creek Burial Ground waste management area, with a maximum summed VOC concentration of 5,683 µg/L in well GW-046 (Fig. 4.38).

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. 4.41), 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.

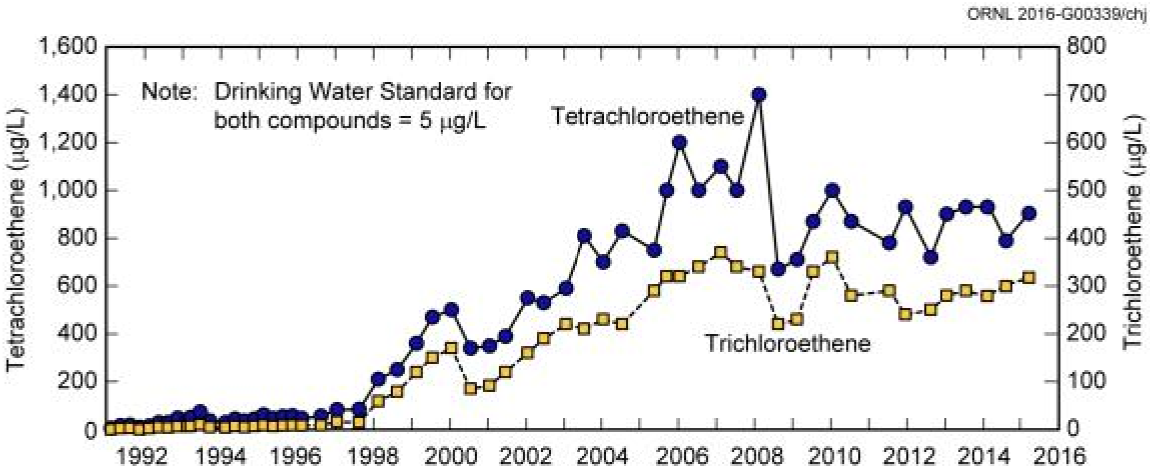

Fig. 4.41. Increasing volatile organic compounds observed in groundwater at well GW-627 west and downgradient of the Bear Creek Burial Grounds, 2015.
Drinking water standard for both compounds = 5 mg/L

Significant transport of VOCs has occurred in the Maynardville Limestone. Data obtained from monitoring well GW-729-44 in 2014 shows that in the intermediate–deep groundwater interval [98 m (320 ft) below the ground surface], an apparently continuous dissolved plume extends at least 2,591 m (8,500 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 2015 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 waste management area. In the bedrock interval, gross alpha activity has historically exceeded 15 pCi/L in groundwater in the fractured bedrock of the aquitard units only near source areas (Fig. 4.38. However, in CY 2015 in a deep zone of GW-730, an anomalous gross alpha activity of 1,600 pCi/L was observed. Monitoring well GW-730 is a multiport Westbay™ well located downgradient of the Oil Landfarm waste management area. This sample is considered anomalous because: 1) uranium, the primary alpha-emitting radionuclide in the Bear Creek regime, was not detected in this sample, 2) this zone (GW-730-07) is over 1,200 ft deep and is unlikely to be hydrologically active, and 3) this sample had an extremely high Total Dissolved Solids (TDS) concentration which can have a significant impact on the analytical determination of both gross alpha and gross beta activity. Additional sampling will be performed in CY 2016 for further evaluation.

Data obtained from exit pathway monitoring stations during CY 2015 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 2,438 m (8,000 ft) west of the S-3 site. The highest gross alpha activity observed in groundwater located adjacent to the S-3 Site in CY 2015 was 200 pCi/L in well GW-246.

In CY 2015, the highest gross beta activity in groundwater in the Bear Creek regime was 10,000 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. 4.34).

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 2015 from the exit pathway monitoring wells indicate that groundwater is contaminated above drinking water standards in the Maynardville Limestone between Pickets A and C, and trends continue to be generally stable to decreasing (Fig. 4.42).

Surface water samples collected during CY 2015 indicate that water in Bear Creek contains many of the compounds found in the groundwater. Uranium concentrations exceeding the drinking water standard have been observed in surface water west of the burial grounds as far as Picket W. The concentrations in the creek generally decrease with distance downstream of the waste disposal sites; however, an increase in these chemicals has been observed in upper reaches (Table 4.21; see Section 4.6.4.2.3).

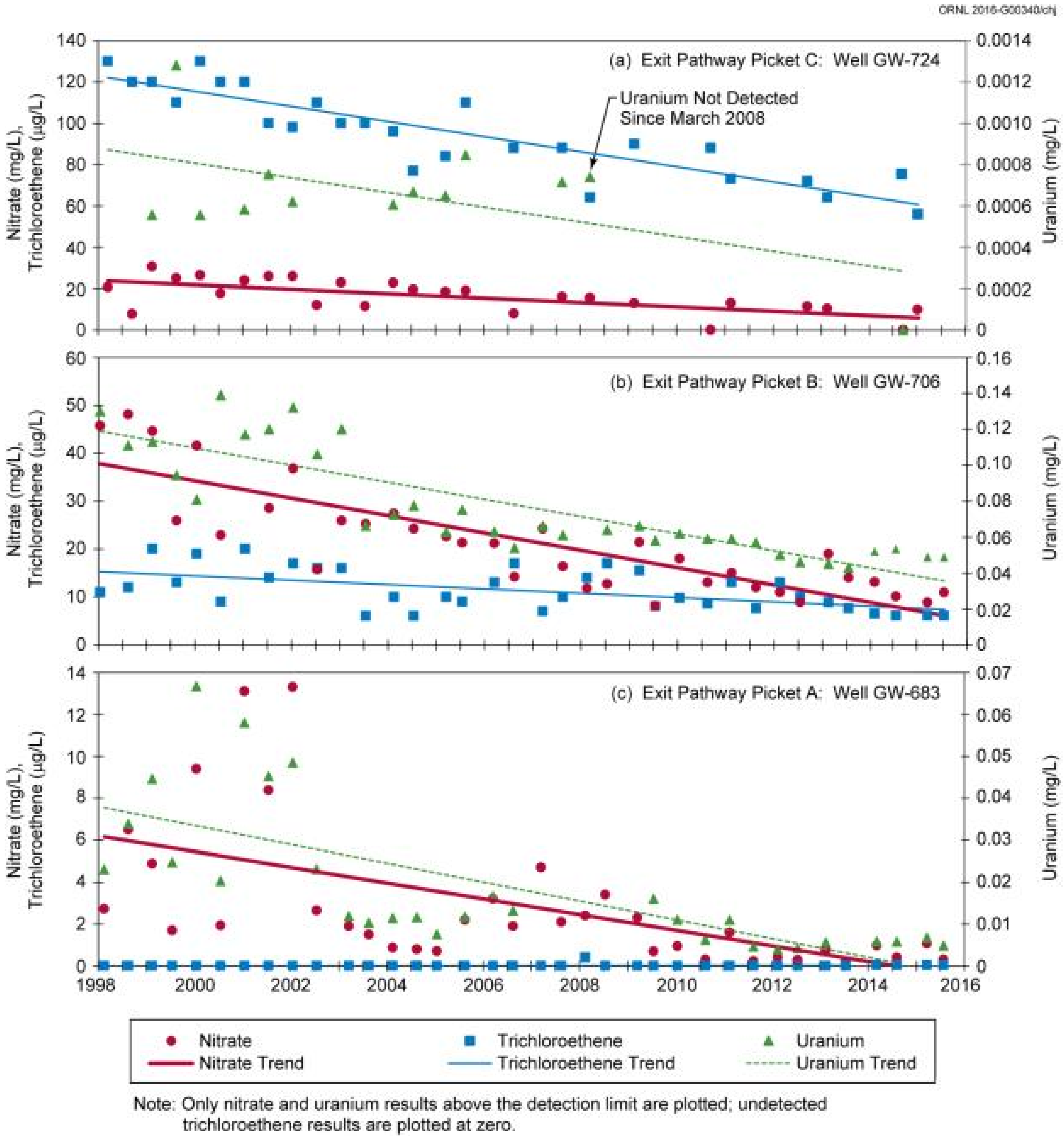

Fig. 4.42. CY 2015 concentrations of selected contaminants in exit pathway monitoring wells in the Bear Creek hydrogeologic regime.

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. 4.35). 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 primary source of groundwater contamination in the regime. Contamination from the security pits is distinct and does not mingle with plumes from other sources. Table 4.22 summarizes the operational history of waste management units in the regime.

Table 4.22. Description of waste management units included in groundwater monitoring activities, Chestnut Ridge hydrogeologic regime, 2015

Site	Description
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. CERCLA ROD issued in 1991.
Industrial Landfill II	Operated from 1983–1995. During operations this was the 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 exceedance of the TDEC groundwater protection standard for 1,1-dichloroethene.
Industrial Landfill V	Initiated operations April 1994, replacing Industrial Landfill II. Currently under TDEC solid-waste-management detection monitoring.
Construction/Demolition Landfill VI	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 to 1968. A CERCLA ROD was issued in 1996. Remedial action complete. Monitoring under the ROD is ongoing.
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.

Acronyms

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
ORR = Department of Energy 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 2015 indicate that the western lateral extent of the plume of VOCs at the site has not changed significantly from previous years. However, the continued observation of VOC contaminants over the past several years at a well about 458 m (1,500 ft) southeast and downgradient 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 trace 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.

The plumes depicted in this section reflect the average concentrations and radioactivity in groundwater between CYs 2008 and 2012. The circular icons presented on the plume maps (Figs. 4.37, 4.39-4.41) represent CY 2015 monitoring results. (See Section 4.6.4.1.1 for more details.)

4.6.4.3.2 Nitrate

Nitrate concentrations were below the drinking water standard at all monitoring stations in the Chestnut Ridge hydrogeologic regime.

4.6.4.3.3 Trace Metals

Elevated concentrations of arsenic were observed in two surface water monitoring locations downstream from the Filled Coal Ash Pond, which is monitored under a CERCLA ROD (DOE 2016). Under the ROD, migration of contaminated effluent from the Filled Coal Ash Pond is being reduced by a constructed wetland area. During CY 2015, elevated arsenic levels were detected both upgradient [McCoy Branch kilometer (MCK) 2.05] and downgradient (MCK 2.0) of this wetland area (Fig. 4.35). Even though both MCK 2.05 and MCK 2.0 monitoring station concentrations were higher than the drinking water standard for arsenic (0.01 mg/L), the results were 91% and 95% less than the preremediation average concentrations, respectively (DOE 2016). A surface water monitoring location (MCK 1.4) about 1,021 m (3,900 ft) downstream from the Filled Coal Ash Pond was also sampled during CY 2015 with one observed detection of arsenic below the drinking water standard (Fig. 4.35).

4.6.4.3.4 Volatile Organic Compounds

In 2015, the highest summed VOC concentration observed in the Chestnut Ridge hydrogeologic regime was at Chestnut Ridge Security Pits well GW-322 (126 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, stable to very shallow increasing trends in VOCs in groundwater samples from monitoring well GW-798 (Fig. 4.39) have been developing since CY 2000. The maximum summed VOC concentration observed at well GW-798 during CY 2015 was 12.3 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 shallow increasing trends. In CY 2015, samples continue to exceed the drinking water standard for 1,1-DCE (7 µg/L). This has led to quarterly monitoring to further evaluate the trend. The CY 2015 samples had concentrations of 5.8 – 9.8 µg/L.

In CY 2014 a VOC, carbon tetrachloride, was consistently detected at low concentrations in groundwater samples from well GW-144 at Kerr Hollow Quarry (Fig. 4.39). This well is sampled as part of a RCRA postclosure permit with TDEC managed by the DOE EM contractor, UCOR. Three consecutive samples (all below 4 µg/L) confirmed the presence of this compound. Additional sampling at this well and at a downgradient surface water location was implemented in CY 2015 to more closely monitor this VOC. The CY 2015 carbon tetrachloride concentration at GW-144 was 1.1 µg/L and the contaminant was undetected at the associated downgradient surface water location.

4.6.4.3.5 Radionuclides

In CY 2015, 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 five surface water monitoring locations were sampled during CY 2015. No contaminants at any of these monitoring stations were detected at levels above primary drinking water standards.

4.6.5 Quality Assurance

All groundwater monitoring is performed under QCs 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 within 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 water column inside the well casing itself. All sampling methods follow industry/regulator–recognized protocols to ensure that consistent and repeatable samples are obtained.

- QC samples 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 2015 all groundwater monitoring and related analytical activities were performed in accordance with the established protocols.

4.7 Quality Assurance Program

The Y-12 Complex Quality Assurance Program establishes a quality policy and requirements for the overall QA program for the Y-12 site. Management requirement Y60-101PD, *Quality Assurance 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.

Y-12 Environmental Sampling Services performs field sampling, sample preservation and handling, and chain-of-custody and takes field control (QC) samples in accordance with Y-12 Environmental Compliance’s internal procedures. Environmental Sampling Services developed a standards and calibration program (SCP) that conforms to ISO/IEC 17025, *General Requirements for Competence of Testing and Calibration Laboratories* (ISO 2005), and provides a process for uniform standardization, calibration, and verification of measurement and test equipment (M&TE). SCP ensures measurements are made using appropriate, documented methods; traceable standards; appropriate M&TE of known accuracy; trained personnel; and technical best practices.

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 manual describes QA program elements that are based on the Y-12 Complex Quality Assurance Program; customer-specific requirements; certification program requirements; 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, contractor-operated laboratory that performs work for DOE, the ACO laboratory operates in accordance with DOE O 414.1D, *Quality Assurance* (DOE 2011b).

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.

The Y-12 ACO participated in both Mixed Analyte Performance Evaluation Program studies conducted in 2015 for water, soil, and air filter matrices for metals, organics, and radionuclides. The overall acceptability rating from both studies was greater than 97%.

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 an RI 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 Mercury Technology Development Activities for Y-12, East Fork Poplar Creek

Mercury remediation in the Oak Ridge area is a high priority for DOE. Releases of mercury during Y-12 operations during the 1950s and early 1960s resulted in contamination of soil and groundwater. Subsequent transport from these sources resulted in off-site contamination of the lower EFPC.

As EM continues its mercury studies, results are revealing that source reduction alone at Y-12 may not achieve mercury regulatory goals in downstream waters (UCOR 2014). Mercury concentration, methylation, and bioaccumulation processes in the creek are complex and are driven by the mass of mercury in the system in addition to physical, chemical, and ecological factors in the receiving stream.

In FY 2014, DOE contracted with UCOR and ORNL to develop a number of mercury remediation technology activities (DOE. 2014a). The UCOR-ORNL technology development studies in the next few years will be timely because they will support evaluations of alternatives by regulators, which are scheduled in the early 2020s. In the years leading to that time, EM will conduct studies in a phased, adaptive approach to reduce uncertainties; to better define and target potential actions or new technology use; and to increase efficiencies in characterization, targeted removal and treatment, and waste disposition.

In FY 2015, research and technology development activities focused on the major factors influencing the accumulation of mercury in fish (fish are the major route of both human and wildlife exposure) were under way. Three lines of investigation for East Fork Poplar Creek were developed to: (1) examine potential downstream sources, such as bank soil and sediment control, (2) investigate the water chemistry and flow characteristics of the creek and its influence on mercury, and (3) study the ecology and how differences in food chain processes may influence the uptake of mercury in fish.

Understanding movement of mercury in the East Fork Poplar Creek system was deemed essential to the development of new technologies and ultimately to the development of remedial options and strategies for the creek. Early studies have pointed to the importance of bank soils and sediments as a source of mercury to the creek, especially during high flow events. Research is under way to examine potential technologies that may limit mercury erosion. Stream management changes, such as controlling nutrients or algae growth or managing fish populations, are also under investigation.

In March 2015, Oak Ridge National Laboratory scientists issued a report that offers science-based approaches and ideas to research and technology development activities that may lead to new options for mercury remediation (ORNL 2015).

DOE is conducting preliminary evaluations to determine the feasibility of placing a field research station along lower EFPC. The station will serve as a near-stream research facility for mercury research.

UCOR is investigating waste management practices to gain a better understanding of mercury-contaminated debris disposal techniques, strategies to reduce the quantity of debris that requires treatment, and the extent of contamination in mercury-contaminated areas at the Y-12 site. The results of these studies will be used in planning future D&D and RA projects within Y-12 mercury contamination zones using the latest cleanup and treatment techniques.

4.8.2 Mercury Remediation Strategy Developed

In 2015, DOE Headquarters approved the Outfall 200 Mercury Treatment Facility (MTF) Conceptual Design Report as well as plans to proceed with MTF design. The goal of the MTF is to reduce the mercury concentration in water exiting the Y-12 Complex and in levels of fish in East Fork Poplar Creek.

Outfall 200 is the point at which the west end Y-12 storm drain system discharges to Upper East Fork Poplar Creek. Mercury from historical operations is present in the Outfall 200 storm water entering Poplar Creek.

Also in 2015, eight pre-design studies were completed to provide information to support design. The studies evaluated storm water chemistry, optimal treatment parameters, potential water diversion strategies, storm impacts on mercury levels, and MTF siting.

As a CERCLA project, a Focused Feasibility Study and Proposed Plan that describes the MTF and goal has been prepared and approved. A public comment period, including a public meeting, was initiated to obtain comments and questions. An amendment to the Phase I UEFPC Record of Decision is being prepared to document the final remedy.

The MTF is being designed to treat storm water up to 3,000 gallons per minute and includes a 2-million-gallon storage tank to collect storm water during peak flow conditions up to 40,000 gallons per minute and treat it after storm flow subsides. Captured storm water will be piped to a treatment facility located on an available site east of Outfall 200.

Mercury treatment will be accomplished using chemical precipitation, clarification, and media filtration. Treated water will be discharged back into UEFPC. The Outfall 200 MTF design incorporates flexibility and expandability of treatment processes, if required in the future.

4.8.3 Waste Management

CERCLA Waste Disposal

The Environmental Management Waste Management Facility (EMWMF), located in east Bear Creek Valley near the Y-12 Complex, received 10,554 truckloads of waste, accounting for 99,787 tons during FY 2015. This engineered landfill consists of six disposal cells that only accept low-level radioactive and hazardous waste meeting 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.

EMWMF operations collected, analyzed, and dispositioned approximately 5.2 million gallons of leachate at the ORNL Liquid/Gaseous Waste Operations Facility in FY 2015. No contact water (water that comes in contact with waste but does not enter the leachate collection system) required treatment at ORNL in FY 2015. However, 10.9 million gallons of contact water were collected, analyzed, and released to the storm water retention basin after laboratory analyses verified it met all discharge standards. Operating practices at the landfill also effectively controlled site erosion and sediment.

Solid Waste Disposal

In FY 2015, approximately 38,410 cubic yards of industrial wastes and construction/demolition debris were disposed in the landfill, which was a 22.7 percent increase over FY 2014 volumes.

Operation of the Oak Ridge Reservation Landfills generated approximately 2 million gallons of leachate that was collected, monitored, and discharged into the Y-12 Complex sanitary sewer system.

Wastewater Treatment

NNSA at the Y-12 Complex treats wastewater generated from both production activities and environmental cleanup activities. Safe and compliant treatment of more than 116 million gal of wastewater was provided at various facilities during the year.

West End Treatment Facility (WETF) and the Central Pollution Control Facility at the Y-12 Complex processed more than 717,000 gal of wastewater, primarily in support of NNSA operational activities.

Big Springs Water Treatment System treated more than 99 million gal of mercury-contaminated groundwater. The East End Volatile Organic Compounds Treatment System treated 11 million gal of VOC-contaminated groundwater.

The Liquid Storage Facility and Groundwater Treatment Facility treated more than 2.3 million gal of leachate from burial grounds and well purge waters from remediation areas.

The Central Mercury Treatment System treated approximately 2.0 million gal of mercury-contaminated sump waters from the Alpha 4 building.

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