

## 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 the 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 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 in commercial power reactors). 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.

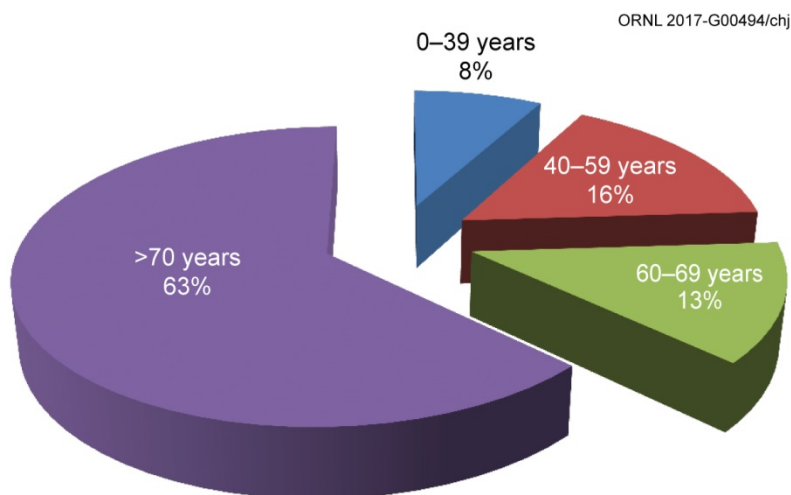
Located within the city limits of Oak Ridge, the Y-12 Complex covers more than 328 ha (810 acres) in the Bear Creek Valley, stretching 4.0 km (2.5 miles) in length down the valley and nearly 2.4 km (1.5 miles) in width across it. NNSA-related facilities located off the Y-12 Complex site but in Oak Ridge include the Central Training Facility, 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 becoming 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.

More than 60% of the Y-12 mission-critical facilities are over 70 years old (Figure 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 continued infrastructure projects, new construction, and the disposition of excess facilities, the Y-12 Complex will continue to strive toward becoming a more responsive, sustainable enterprise. As evidenced by the performance achievements presented in this chapter, Y-12 continues to meet the challenges of declining budgets through enhanced security measures, enhanced technology, and innovative business practices.



**Figure 4.1. Age of mission-critical facilities at the Y-12 National Security Complex.**

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.

#### 4.1.2.1 Enriched Uranium Operations

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

UPF will be 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. Efforts are under way to implement the revised strategy and to

incorporate bridging plans to maintain the integrity of the aged infrastructure. These efforts are vital to the long-term mission of Y-12.

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 according to 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.

#### **4.1.2.2 Lithium Production Capability**

The lithium production equipment and facilities at Y-12 have degraded to the point that repair is no longer an option. Thus, to ensure continued mission availability and to reduce annual operating costs, the lithium capability must be replaced. Production work for lithium and related nonnuclear special material vital to production of canned subassemblies is performed in Building 9204-2, built in 1944. The facility, at approximately 325,000 ft<sup>2</sup>, is oversized for today's mission and for decades concrete on the inside and outside of the building has deteriorated. The roof, walls, and ceilings have been exposed to corrosive liquids and processing fumes, requiring restricted access and protective equipment in many areas. The facility, currently carrying approximately \$22.5M 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 risks at Y-12. Critical process equipment (hydraulic press) failures caused "code blue", or immediate, repair efforts to minimize the negative impact on delivery schedules of directed stockpile work (DSW) components. The inability to control humidity due to aged and inoperable heating, ventilating, and air-conditioning (HVAC) equipment has caused recurrent lost work days, negatively affecting DSW costs and life extension program schedules. An analysis of alternatives has been completed, and CNS is evaluating options for a path forward for replacement of the HVAC equipment.

#### **4.1.2.3 Support Facilities**

Emergency response capabilities at Y-12 reside in four primary facilities: three located on site (Buildings 9706-2, 9105, and 9710-2) and one (K-1650) located at the East Tennessee Technology Park (ETTP). Building 9706-2 houses the Plant Shift Superintendent (PSS) and the Emergency Control Center. The Technical Support Center (TSC) was relocated to 9105 due to a flood event in Building 9706-02 in 2014. Building 9710-2 is the principal facility housing Fire Protection Operations (FPO). Building K-1650 houses the Command Center/alternate Emergency Operations Center (EOC). A line-item project for construction of a new EOC, scheduled to begin in 2018 includes the replacement of the PSS, the TSC, and the Emergency Response Center. The proposed EOC will more effectively and efficiently support the Y-12 missions by consolidating emergency-response capabilities into a habitable, survivable facility that also provides space for a technical support team.

Built in 1948, Building 9710-2 houses the Fire Station and the Fire Department Alarm Room. The overflow station for the fire department is located in Building 2005, at the far west end of the plant.

Building 9710-02 is located within the most highly protected area of the plant and close to Y-12's most hazardous operations. Seismic, tornado, hazardous material release, and security events could render the fire station inaccessible. Off-duty personnel augment the duty staff, and thus their access to the facility is critical. Although upgrades have been performed over the years, the FPO facility has exceeded its useful life and needs to be replaced.

Building 2005 was constructed in 1980 and was originally occupied by the Oak Ridge Reservation (ORR) roads and grounds crew. The fire department assumed occupancy of the facility in 2014 and renovated portions for crew support and vehicle staging. 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. A proposed new fire station would be located on the east end of the plant and would be designed to meet current codes and functional requirements.

Over the next 10 years and beyond, Y-12 will continue to consolidate personnel and processes in support of the vision for long-range footprint reduction and modernization. The planned renovations at Y-12 would eliminate many of the World War II–vintage buildings that currently house the nuclear operations. The plan envisions a smaller site and the following capable, responsive, and sustainable facilities on. The following projects are currently under construction or are being initiated during the Future Year Nuclear Security Plan (FYNSP) period:

- Uranium Processing Facility
- New 13.8kV Substation
- Emergency Operations Center
- Protected Area Reduction
- Fire Station
- Lithium Production Capability
- Bridging Strategy for 9215 and 9204-02E

The following projects are planned for completion beyond the FYNSP period:

- West End Change House
- Applied Technologies Laboratory
- Security Support Complex
- Consolidated Manufacturing Capability
- Maintenance Complex
- Material Storage and Staging Facility
- Waste Management Complex

#### **4.1.2.4 Excess Facility Disposition**

Since 2002, Y-12 has demolished more than 1.4 million ft<sup>2</sup> of excess facilities. Currently, more than 80 excess DOE facilities are located on the Y-12 site. The excess facilities are owned by NNSA and the US Department of Energy (DOE) 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 or the Cold War.

EM, through its contractors is 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, paint containing lead, or oil contaminated with

polychlorinated biphenyl [PCB]). The nonprocess-contaminated excess facilities will be deactivated by NNSA and decommissioned by NNSA or EM, depending on the cost and complexity.

The NNSA Facilities Disposition Program will continue to evaluate facilities, prioritize their disposition, develop cost and schedule, and communicate requirements for disposal of excess facilities. Without a defined program to eliminate excess facilities, Y-12 will continue to use limited resources to safely maintain those facilities that no longer have a mission use.

## 4.2 Environmental Management System

As part of CNS's commitment to environmentally responsible operations, the Y-12 Complex has implemented an environmental management system (EMS) based on the rigorous requirements of the globally recognized ISO 14001 (ISO 2004) standard to plan, implement, control, and continually improve environmental performance at Y-12.

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 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. Y-12 has maintained an EMS with self-declared conformance to the ISO 14001 since 2006.

The EMS requirements taken from DOE O 436.1 have been incorporated into the Environmental Protection functional area of the Y-12 Complex Contract Requirements Assurance System.

### 4.2.1 Integration with Integrated Safety Management System

The Y-12 Integrated Safety Management System (ISMS) is the basis for planning and implementing environment, safety, and health (ES&H) programs and systems that provide the necessary structure for any work activity that could affect the public, a worker, or the environment. At Y-12, the elements of the ISO 14001 EMS are incorporated in and are consistent with the ISMS to achieve environmental compliance, pollution prevention, waste minimization, resource conservation, and sustainability. Both the ISMS and the EMS are based on an internationally recognized cycle of continual improvement commonly known as the "plan-do-check-act" cycle as depicted in Figure 4.2. The figure shows the relationship between the ISMS (blue arrows) and the integrated EMS (green boxes).

ORNL 2017-G00495chj



**Figure 4.2. The relationship between the Y-12 Environmental Management System and the Integrated Safety Management System depicted in a “plan-do-check-act” cycle.**

#### 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 Figure 4-3.

**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 work 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.

**Figure 4.3. Y-12 National Security Complex environment, safety, and health policy.**

The Y-12 ES&H policy has been communicated to all employees and is incorporated into mandatory training for every employee; it is available for viewing on the Y-12 external website and on the internal Y-12 Complex website. Y-12 Complex personnel are made aware of the commitments stated in the policies and how the commitments relate to Y-12 Complex work activities.

## 4.2.3 Planning

### 4.2.3.1 Y-12 Environmental Aspects

Environmental aspects may be thought of as potential environmental hazards associated with a facility operation, maintenance job, or work activity. The environmental aspects and their impacts (potential effects on the environment) are evaluated to ensure that the significant aspects of Y-12 activities that are identified 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 2016 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 use
- surface water and storm water
- aging infrastructure and equipment
- legacy contamination and disturbance
- universal waste and other recycled streams
- 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 at Y-12 by establishing and maintaining environmental objectives, targets (goals), and action plans. Goals and commitments are established annually. They are consistent with the Y-12 Complex's mission, budget guidance, ES&H work scope, *Site Sustainability Plan* (SSP) (CNS 2016) and other 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 2016 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 requirements in DOE orders for protecting various environmental media, reducing pollution, conserving resources, and helping to promote compliance with all applicable environmental regulatory requirements and permits.

##### 4.2.3.4.1 Environmental Compliance

The 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 to exceed compliance requirements.



#### **4.2.3.4.2 Waste Management**

The 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.

#### **4.2.3.4.3 Sustainability and Stewardship**

The Sustainability and Stewardship Program has two major missions. The first is to establish and maintain companywide programs and services to support sustainable material management operations. These sustainable operations include pollution prevention and recycling programs, excess materials programs, generator services programs, and facility destruction and recycling operations. Y-12 has implemented continuous improvement activities, such as a “Stuff I Want to Get Rid of” website and a central telephone number (574-JUNK), to provide employees easy access to information and assistance related to the proper methods for disposing of excess materials.

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). The Clean Sweep Program provides turnkey services to material generators, including segregation, staging, and pickup of materials for excess, recycle, and disposal. “Sustain” areas have been established across the site to improve housekeeping through efficient material disposition. Customers place unneeded items into the transition portion of each sustain area and Clean Sweep Program personnel take care of the rest.

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.

#### **4.2.3.4.4 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. 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. Sustainability goals, goal performance, and goal achievement are defined in the CNS SSP (CNS 2016).

## **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, the 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 to 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 expansion of the Girls, Inc., program that promotes science, technology, engineering, and mathematics.

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 recycling efforts. Since the program began in 1994, more than \$86,400 raised by the collection of aluminum beverage cans 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. Personal eye glasses were also collected for donation. 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 to 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 seventeen drills were conducted at the Y-12 Complex during FY 2016. 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). Seven 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 Leesburg, Virginia, in May 2016. 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. Additionally, three members of the Emergency Management Program Office were part of a team that revised DOE O 151.1C for reissuance as DOE 151.1D *Comprehensive Emergency Management System* in August, 2016.

## **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 2016 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. Progress is reviewed in periodic meetings with senior management and National Nuclear Security Administration Production Office (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 ISO 14001 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 in accordance with instructions issued by the Federal Environmental Executive and adhere to DOE O 436.1 (DOE 2011) requirements, EMS must be audited at least every 3 years by a qualified party outside of the control or scope of EMS. 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.

- The DOE Sustainability Dashboard, which collects data on metering requirements, water use, renewable energy generation and purchases, GHG generation, and sustainable buildings. Pollution prevention waste reduction and recycling data, sustainable acquisition product purchases, electronic stewardship, and best practices data are also collected in this Dashboard system.
- SSP 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 2016 of green, indicating full implementation of EMS requirements.

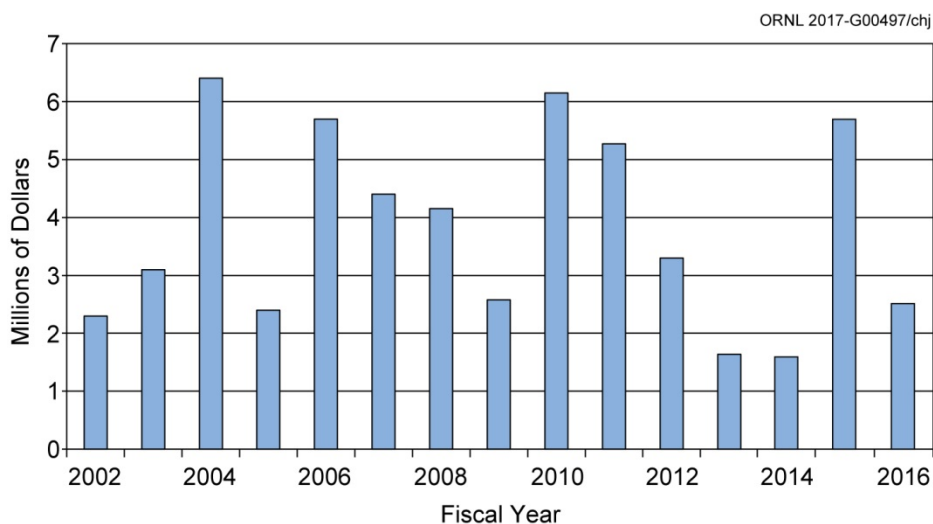
#### **4.2.6.1 Environmental Management System Objectives and Targets**

At the end of FY 2016 Y-12 had achieved 6 of 10 targets that had been established; the 4 remaining targets were carried into future years. Overall, 25 actions were completed through September. Highlights include the following, with additional details and successes presented in other sections of this report.

- Clean Air—Y-12 completed an evaluation of uranium monitored-stack infrastructure to identify refurbishment needs for continued safe and compliant operations.
- 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 2016.
- Hazardous Materials—Projects for legacy and excess unneeded material/equipment removal in several facilities were developed and implemented. A project to improve controls for Sealand storage containers was substantially implemented in FY 2016. A project to disposition 57 containers of Ash residue per Site Treatment Plan milestones was completed in July 2016, more than two years ahead of schedule.
- Land/Water—In FY 2016, a project to reduce inflow and infiltration into the sanitary sewer system was completed with the installation of fiberglass liner in 1000 feet of sanitary sewer, the repair of eleven manholes, and an expansion of stream restoration and wetlands efforts.
- Reduce/Reuse/Recycle/Buy Green—Y-12 continued efforts to increase use of remanufactured toner cartridges, completed revisions to applicable procedures, identified suitable vendors, and automated catalogs so that remanufactured toner cartridges would be preferentially procured.

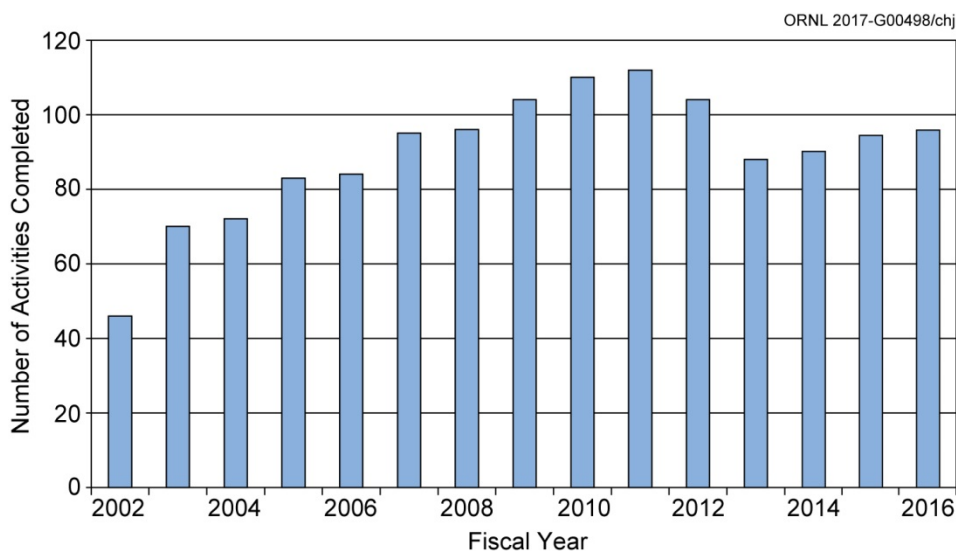
#### **4.2.6.2 Sustainability and Stewardship**

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 (Figure 4.4).



**Figure 4.4. Cost efficiencies from Y-12 National Security Complex pollution prevention activities.**

In FY 2016, the Y-12 Complex implemented 95 pollution prevention initiatives (Figure 4.5), with a reduction of more than 77 million lb. of waste and cost efficiencies of more than \$2.5 million. The completed projects include the activities described below.



**Figure 4.5. Y-12 National Security Complex pollution prevention initiatives.**

#### 4.2.6.2.1 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 2016 activities highlighted in this section.

#### **4.2.6.2.2 Sustainable Acquisition—Environmentally Preferable Purchasing**

Sustainable products, including recycled-content materials, are procured for use across the Y-12 Complex. In 2016, Y-12 procured recycled-content materials valued at more than \$1.78 million for use at the site.

#### **4.2.6.2.3 Solid Waste Reduction**

In 2016, Y-12 diverted 60.9% of municipal and 94.7% 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. In FY 2016 Clean Sweep dispositioned over 200,000 ft<sup>3</sup> of materials with approximately 76% of the materials being reused or recycled in support of landfill diversion goals.

In FY 2016, Protective Force had excess security jackets from a uniform changeover. To prevent the jackets from going to the landfill, the site obtained permission from NNSA to donate the jackets to the Volunteer Ministry Center. Radiological Control employees donated their time to survey the jackets for release, and other employees donated their time to remove the sewn-on company patches. The jackets were then cleaned and sorted by a local organization, and more than 100 obsolete security jackets were donated. The United Way Committee worked with the Volunteer Ministry Center to ensure that the jackets would go to homeless veterans (Figure 4.6). This activity reflects Y-12 employees' commitment to reduce landfill waste and to support community outreach.

#### **4.2.6.2.4 Hazardous Chemical Minimization**

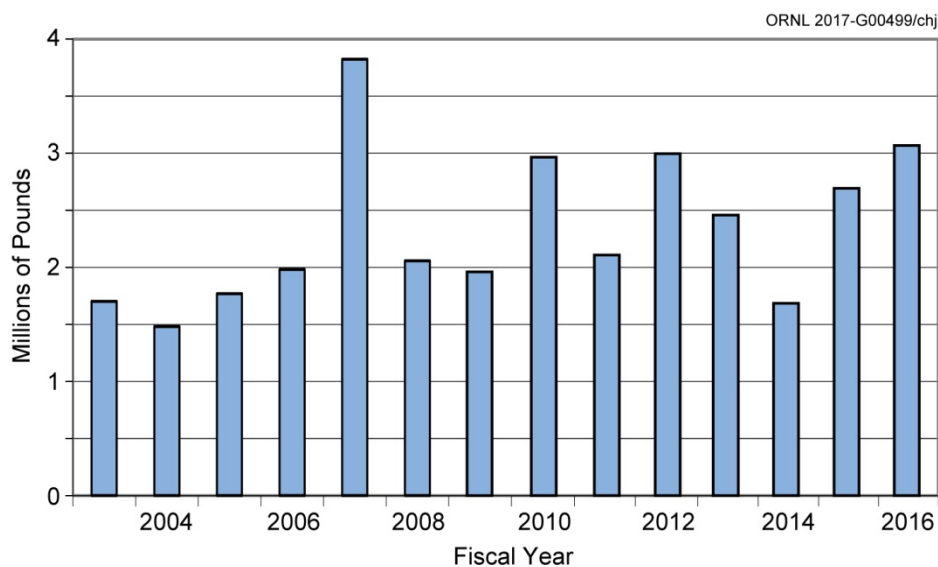
The Y-12 Complex is committed to reducing the use of toxic and hazardous chemicals and minimizing the volume of hazardous waste generated by site operations. Y-12 has established mechanisms for internal and external transfers of chemicals for reuse in order to minimize the quantity of chemicals being acquired, used, and disposed of. In FY 2016, Utilities transferred more than 3,000 gal of excess brine off site for reuse to prevent the brine from being disposed of as waste. The Generator Services group provides material disposition management service for generators at Y-12, which includes technical support to assist generators with determining whether or not the materials can be recycled, excessed, or reused. Generator Services can be used by any Y-12 department or generator. During FY 2016, Generator Services personnel reused or disseminated to other Y-12 organizations for reuse various excess materials and chemicals, preventing the generation of more than 1,200 lb of waste.

#### **4.2.6.2.5 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 Figure 4.7, more than 3.1 million lb of materials was diverted from landfills and into viable recycle processes during 2016. 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. Chain link fencing was added in FY 2016 to broaden waste diversion efforts.



**Figure 4.6. Y-12 donated obsolete security jackets to homeless veterans.** [Source: Lance King, Y-12 photographer.]

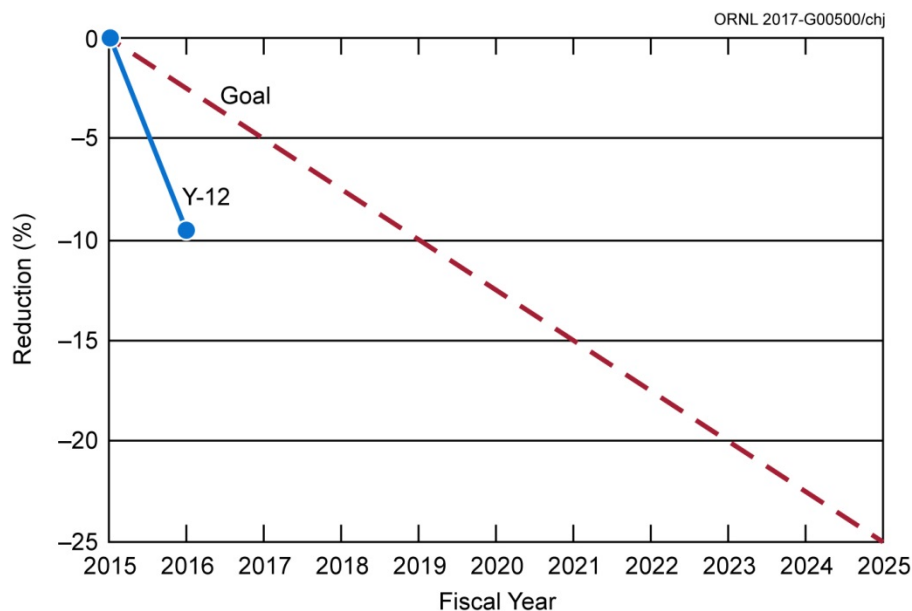


**Figure 4.7. Y-12 National Security Complex recycling results.**

### 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, *Planning for Federal Sustainability in the Next Decade*.

Executive Order 13693 established a goal of reducing building energy intensity by 25% by 2025 from a FY 2015 baseline. Y-12 exceeded the FY 2016 goal by achieving a 10% reduction in energy intensity (Figure 4.8).



**Figure 4.8. Y-12 has achieved a 10% reduction in energy intensity from the FY2015 baseline.**

The following specific initiatives aided in the reduction of electricity consumption at Y-12 during FY 2016:

- Installed light-emitting diode (LED) and T-8 fluorescent lighting,
- Replaced steam with natural gas in nine buildings,
- Replaced chillers and cooling towers,
- Retrofitted three existing chillers with energy efficient controls,
- Installed condensate return unit replacements,
- Repaired steam and condensate distribution system leaks,
- Replaced steam pressure reducing stations, and
- Installed a new compressed air facility to save electricity and maintenance by better matching the demand load for instrument air with the amount of air being produced.

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:

- Energy Independence and Securities Act (EISA) assessments are included in annual reporting;
- ECMs from both EISA and the ESPC process are included in budgeting reviews; and



- Low-cost/no-cost efforts, including component replacements, are incorporated into routine activities. These include thermostat setbacks as well as upgrades such as new control valves, leak repairs, and new faucets.

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 they may be partially offset by an accelerated demolition program.

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, and 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.

#### **4.2.6.3.1 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. Energy projects are included in out-year planning for the site and with adequate return on investment, will be funded. Specific examples include HVAC replacements and lighting upgrades in HPSB candidate facilities.

Y-12 currently has numerous standard and advanced electrical meters located on various facilities throughout the plant. Y-12 began entering facilities into the EPA Portfolio Manager in FY 2011. Y-12 enters and tracks data for both covered and noncovered 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 for annual reporting in June. Meter data are also entered into Portfolio Manager for benchmarking and reporting purposes. 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.

Minimal funding was available for dedicated metering during FY 2016. Efforts will continue on establishing communications with the Utilities Management System. Metering for HPSB candidates is still a concern for the plant. This issue prevents adequate monitoring of energy for the required 25% reduction. It is also impacting required reporting of power usage effectiveness at the plant data centers. Efforts will continue to identify funding to install meters for HPSB candidates as well as for the data centers.

#### **4.2.6.3.2 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. ESPC delivery order 2 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 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. Delivery order 3, modification 1, was in the construction phase throughout 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 chiller plant upgrades and energy-efficient lighting upgrades.

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 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, and
- steam system decentralization

#### **4.2.6.3.3 The CNS Site Sustainability Plan**

The DOE SSPs are an annual reporting requirement and are prepared in accordance with DOE Guidance for the Site Sustainability Plans (SSP) (CNS2016) and supplemental NNSA guidance from the Associate Administrator for Infrastructure and Operations, and supports the requirements of DOE O 436.1 (DOE 2011). 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, Y-12 status, and plans for these goals are summarized in Table 4.1.

**Table 4.1. FY 2016 sustainability goals and status**

SSPP goal No.	DOE goal	Performance status through FY 2016	Planned actions and contribution
<b>Goal 1: Greenhouse Gas (GHG) Reduction</b>			
1.1	50% Scope 1 & 2 GHG reduction by FY 2025 from an FY 2008 baseline (2016 target: 22%)	<b>Goal Met for 2016</b> —Scope 1 & 2 emissions have decreased by 45% (-184,849 MTCO <sub>2</sub> e / 337,628.4 MTCO <sub>2</sub> e). Surpassed FY 2016 interim goal of 22%. <b>At Risk</b> —It is uncertain if the 2025 goal can be met due to construction of the Uranium Processing Facility (UPF).	Y-12 will continue to identify methods for reduction of GHG and further emphasize energy reductions.
1.2	25% Scope 3 GHG reduction by FY 2025 from a FY 2008 baseline (2016 target: 7%)	<b>At Risk</b> —Site Scope 3 emissions have increased by 9.4% (+3,004.1 MTCO <sub>2</sub> e /31,894.5 MTCO <sub>2</sub> e), which did not meet the FY 2016 interim goal of 7%. It is uncertain if this goal will be achievable due to increased travel between Pantex and Y-12, increased commuting due to the UPF 9/80 work schedule, and increased site population.	Y-12 will continue to promote alternative commuting methods and research other means of reducing Scope 3 emissions.
<b>Goal 2: Sustainable Buildings</b>			
2.1	25% energy intensity (Btu per gross square foot) reduction in goal-subject buildings, achieving 2.5% reductions annually, by FY 2025 from a FY 2015 baseline	<b>Goal Met</b> —Y-12 has met the 2016 goal by achieving a 10% (-2,603/251,472 Btu) reduction from the 2015 baseline. Y-12 is on the path to achieve the goal of a 25% energy intensity reduction by FY 2025.	Y-12 will continue implementation of planned energy reduction initiatives through ESPCs and further emphasize energy reductions
2.2	EISA Section 432 energy and water evaluations	<b>Goal Met</b> —Y-12 completed all required EISA-covered assessments during FY 2016	Assessments will continue to meet a 4 year cycle.
2.3	Meter all individual buildings for electricity, natural gas, steam, and water, where cost-effective and appropriate	<b>On Track</b> —Currently 93% of electricity is metered; 100% of natural gas, 100% of steam, and 100% of potable water are metered.	Y-12 will continue procurement and installation of metering at the individual building level as funding is allocated where cost-effective and appropriate.

Table 4.1 (continued)

SSPP Goal #	DOE Goal	Performance Status through FY 2016	Planned Actions and Contribution
2.4	At least 17% (by building count) of existing buildings greater than 5,000 gross square feet (GSF) to be compliant with the <i>revised</i> Guiding Principles for high-performance sustainable buildings (HPSBs) by FY 2025, with progress to 100% thereafter.	<b>At Risk</b> —Y-12 previously achieved, for GSF, an 11% (549,595/4,969,621) compliance based on gross square with HPSB Guiding Principles. Based on building count Y-12 has only met 2% compliance.	Y-12 will continue to implement initiatives to meet HPSB compliance as funding and resources allow.
2.5	Efforts to increase regional and local planning coordination and involvement	<b>Goal Met</b> —Y-12 is actively involved in local and regional efforts on transportation planning, ecosystem, watershed, and environmental management.	Y-12 will continue to participate in existing activities and look for new opportunities to leverage regional and local resources.
2.6a	Net Zero Buildings: 1% 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.	<b>At Risk</b> —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 time frames.
2.6b	Net Zero Buildings: All new buildings (> 5,000 GSF) entering the planning process designed to achieve energy net-zero beginning in FY 2020.	<b>On Track</b> —At <u>Y-12</u> , the UPF project is currently seeking a waiver for Leadership in Energy and Environmental Design (LEED) Gold certification.	If <u>Y-12</u> is granted the waiver, the UPF project will review and implement LEED scorecard credit and Guiding Principles by building, where feasible—now six buildings.
<b>Goal 3: Clean &amp; Renewable Energy</b>			
3.1	“Clean Energy” requires that the percentage of an agency’s total electric and thermal energy accounted for by renewable and alternative energy shall be not less than: 10% in FY 2016–2017, working towards 25% by FY 2025.	<b>On Track</b> —Due to sharing the Wind Renewable Energy Certificates with Pantex, Y-12 achieved 10% clean energy consumption.	Both Pantex and Y-12 plan to renew the shared credits for FY 2017 and beyond. To continue to allow both sites to achieve future “clean” and “renewable electric energy goals.
3.2	“Renewable Electric Energy” requires that renewable electric energy account for not less than 10% of a total agency electric consumption in FY 2016–2017, working towards 30% of total agency electric consumption by FY 2025.	<b>On Track</b> —Due to sharing the Wind RECs with Pantex, Y-12 achieved 10% renewable energy consumption.	Both Pantex and Y-12 plan to renew the shared credits for FY 2017 and beyond. To continue to allow both sites to achieve future “clean” and “renewable electric energy goals.

Table 4.1 (continued)

SSPP Goal #	DOE Goal	Performance Status through FY 2016	Planned Actions and Contribution
<b>Goal 4: Water Use Efficiency and Management</b>			
4.1	36% potable water intensity (gal per gross square foot) reduction by FY 2025 from a FY 2007 baseline. (2016 target: 18%)	<b>Goal Met</b> —Y-12 achieved a 65% (-137/210.8) reduction from the baseline, surpassing, not only the interim goal of 18%, but the 2025 goal of 36%.	Y-12, water conservation measures will continue to be implemented as practicable in support of the HPSB initiative.
4.2	30% water consumption (Gal) reduction of industrial, landscaping, and agricultural (ILA) water by FY 2025 from a FY 2010 baseline. (2016 target: 12%)	<b>Not Applicable</b> —Y-12 no longer consumes ILA and baseline ILA water is accounted for in Goal 4.1.	All water used at <u>Y-12</u> is potable water and included in the potable water category.
<b>Goal 5: Fleet Management</b>			
5.1	30% reduction in fleet-wide per-mile greenhouse gas emissions reduction by FY 2025 from a FY 2014 baseline. (2016 target: 3%; 2017 target: 4%)	<b>Goal Met</b> —40 of the light duty and medium duty vehicles were replaced during FY 2016. These replacements had much higher GHG ratings than the former fleet vehicles.	Future vehicle purchases and leases will include alternative fuel vehicles (AFVs), including E85, hybrid, and electric vehicles where possible
5.2	20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline; maintain 20% reduction thereafter. (2016 target: 20%)	<b>Goal Met</b> —Petroleum fuel consumption was reduced by 26% for FY 2016.	Heavy duty vehicles will be assessed in FY 2017 to better determine a replacement strategy for those vehicles.
5.3	10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter. (2016 target: 10%)	<b>Goal Was Not Met</b> —The Y-12 site does not currently have a method for dispensing E85 fuel and is operating under an exemption from the Department of Energy for using alternative fuels.	<u>Y-12</u> needs additional funding in order to install a new pumping facility on-site.
5.4	75% of light duty vehicle acquisitions must consist of AFVs. (2016 target: 75%)	<b>Goal Was Not Met</b> —At Y-12, 58.5% of the light vehicle purchases during FY 2016 were AFVs, this was due to the limited availability of AFVs through GSA.	AFVs will continue to be ordered as replacement vehicles when AFVs are listed as an option in GSA.
5.5	50% of passenger vehicle acquisitions consist of zero emission or plug-in hybrid electric vehicles by FY 2025. (2016 target: 4%)	<b>Goal Was Not Met</b> —Y-12 does not have the necessary infrastructure to support these types of vehicles. Additionally, GSA did not have zero emission or plug-in hybrid electrical vehicles available when the site was acquiring vehicles.	Future vehicle purchases and leases will include hybrid and electric vehicles where possible.

Table 4.1 (continued)

SSPP Goal #	DOE Goal	Performance Status through FY 2016	Planned Actions and Contribution
<b>Goal 6: Sustainable Acquisition</b>			
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.	<b>Goal Met</b> —Sustainable acquisition clauses have been incorporated into standard contract terms and conditions.	Y-12 will incorporate additional clauses as requested and will continue to evaluate sustainable products for use at the sites.
<b>Goal 7: Pollution Prevention &amp; Waste Reduction</b>			
7.1	Divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris.	<b>Goal Met</b> —60.9% (1,383.7 metric tons/2,273.5 metric tons) of nonhazardous waste diverted from landfill.	At least one new recycle material stream is added to the recycling program each fiscal year to further increase the diversion rate.
7.2	Divert at least 50% of construction and demolition materials and debris.	<b>Goal Met</b> —At Y-12, 94.7% (29,438.6 metric tons/31,104 metric tons) of construction and demolition (C&D) waste diverted from landfill.	A systematic disposition evaluation method will continue to be used for C&D materials to ensure maximum waste diversion is achieved.
<b>Goal 8: Energy Performance Contracts</b>			
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.	<b>Goal Met</b> —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 is in the construction phase which will continue through FY 2017.	Y-12 will continue to leverage ESPCs to help achieve sustainability goals.
<b>Goal 9: Electronic Stewardship</b>			
9.1	Purchases—95% of eligible acquisitions each year are Electronic Product Environmental Assessment Tool (EPEAT)-registered products.	<b>Goal Was Not Met</b> —Approximately 93% (2,340/2,520) of all eligible electronic acquisitions during FY 2016 were EPEAT-registered. However, more than 98% (2,473/2,520) were either EPEAT-registered or Energy Star-qualified products and more than 97% (1959/2002) of all computer desktops, laptops, tablets, workstations, monitors, and thin clients purchased were EPEAT Gold registered.	Y-12 will continue to promote the acquisition of EPEAT-registered and Energy Star-qualified products. Y-12 has a standard desktop configuration that specifies the procurement of EPEAT-registered and Energy Star-qualified products.
9.2	Power management—100% of eligible PCs, laptops, and monitors have power management enabled.	<b>At Risk</b> —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 at <u>Y-12</u> is not currently feasible with existing network security features. However <u>the site</u> will continue active implementation of power management requirements where feasible when acquiring new products.

Table 4.1 (continued)

SSPP Goal #	DOE Goal	Performance Status through FY 2016	Planned Actions and Contribution
9.3	Automatic duplexing—100% of eligible computers and imaging equipment have automatic duplexing enabled.	<b>At Risk</b> —During FY 2016, more than 21.4% of the printers, copiers, and multifunction devices were set to automatically duplex.	The recommended default for all networked printers with duplexers was “duplex” instead of “simplex.” 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.
9.4	End of Life—100% of used electronics are reused or recycled using environmentally sound disposition options each year.	<b>Goal Met</b> —Y-12’s approved electronics recycling vendor achieved R2 certification in May 2015; therefore, all FY 2016 shipments were made to an R2 certified recycler. The only electronics that were not either recycled by the R2 vendor or donated for reuse were electronics that could not be radiologically cleared for release.	With the certification of Y-12’s approved electronics recycling vendor as an R2 certified recycler, all used electronics were recycled using environmentally sound disposition options in FY 2016 and beyond.
9.5	Data Center Efficiency. Establish a power usage effectiveness target in the range of 1.2-1.4 for new data centers and less than 1.5 for existing data centers	<b>At Risk</b> —The PUE is currently estimated at lower than 1.4, since the current PUE rating for Y-12 data centers is unknown. However, this value is based solely on electricity usage and does not account for energy intensity	At Y-12 projects for chilled water and electrical metering are planned for Building 9117 when funding becomes available. This data will allow the measurement of the PUE.
<b>Goal 10: Climate Change Resilience</b>			
10.1	Update policies to incentivize planning for, and addressing the impacts of climate change.	<b>On Track</b> —Policies for planning and addressing climate change impacts are reviewed and updated as needed, particularly with regard to severe winter weather and heat stress	Y-12 will continue to track trends and information on climate change and remain engaged with organizations dedicated to future planning and impacts.
10.2	Update emergency response procedures and protocols to account for projected climate change, including extreme weather events.	<b>On Track</b> —The <i>Y-12 National Security Complex Severe Event Emergency Response Plan</i> 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.
10.3	Ensure workforce protocols and policies reflect projected human health and safety impacts of climate change.	<b>On Track</b> —Y-12 has a robust Building/Facility Emergency Program to protect personnel during severe weather emergencies, including earthquakes, tornados, and floods. Procedures contained with the Plan are designed to protect personnel during such emergencies as winter weather events and 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.

Table 4.1 (continued)

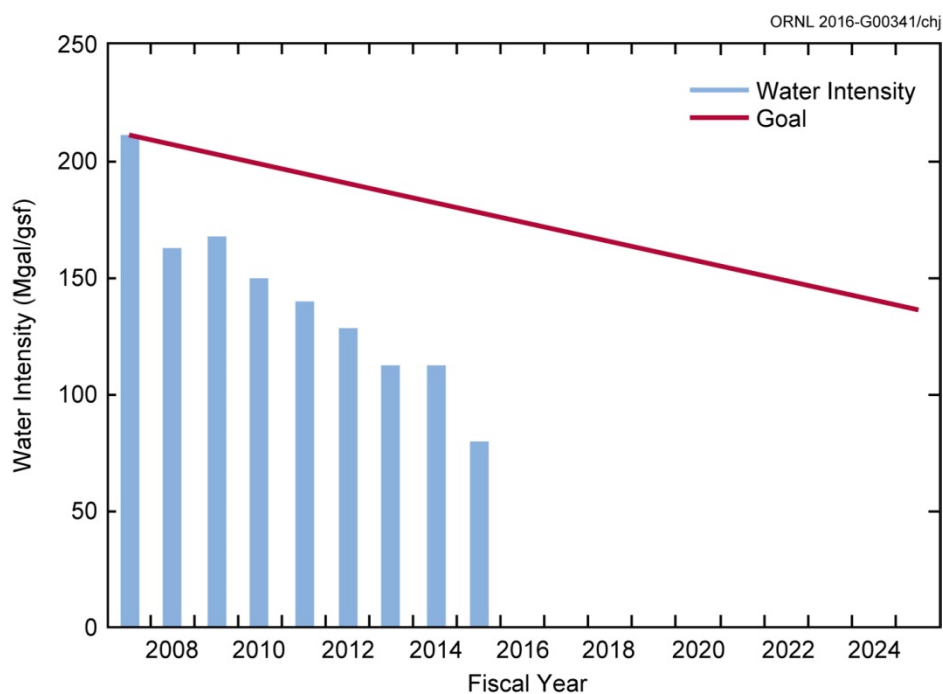
SSPP Goal #	DOE Goal	Performance Status through FY 2016	Planned Actions and Contribution
10.4	Ensure site/lab management demonstrates commitment to adaptation efforts through internal communications and policies.	<b>On Track</b> —Management communications protocols at both sites include procedures, texts/pages, 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 at both sites.
10.5	Ensure that site/lab climate adaptation and resilience policies and programs reflect best available current climate change science, updated as necessary.	<b>On track</b> —The current climate change discussion does not present any new scenarios at either Pantex or 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.	<u>Y-12</u> 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.



#### 4.2.6.4 Water Conservation

In FY 2016, Y-12 achieved a 65% (-137/210.8 MGal) water intensity reduction from the baseline, surpassing not only the interim goal of 18% but the 2025 goal of 36%. Y-12 is currently meeting the water intensity reduction goals and storm water initiatives (Figure 4.9). Actions that have contributed to the overall reduction in potable water use include the following:

- steam trap repairs and improvements;
- condensate return installations, repairs, and reroutes;
- replacement of once-through air handling units;
- low-flow fixture installation;
- chiller replacements;
- cooling tower replacements; and
- replacing steam with natural gas in buildings.



**Figure 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 2025 goal.

Although the site has met this goal, significant reductions in water consumption can still be achieved through continued improvements in facilities, metering, and replacement of inefficient HVAC units. Additionally, water use per square foot is expected to increase in the coming years. Even though it is believed existing buildings will continue to reduce consumption, UPF construction will use a large amount of water. A concrete batch plant has been constructed to supply concrete to the construction site. During the construction period water use will increase but the square footage will not, skewing the

calculation. The water is not metered separately. Therefore, there is no way to distinguish the quantity of water used for construction from the quantity of water used in buildings.

Internal EISA audits are conducted on covered facilities on a three-year rotating schedule. Additionally, in FY 2016 Pacific Northwest National Laboratory conducted a water assessment of the Y-12 Site through the Federal Energy Management Program. Both of these assessments have identified a number of water conservation projects that could be implemented if funding were allocated. These projects include domestic plumbing retrofits, kitchen equipment upgrades, process system upgrades, cooling tower upgrades, and steam plant upgrades. The site expects to participate in the NNSA Water Asset Management Program to accomplish these water-saving projects.

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

- Upgrading toilets and urinals to low-flow, hands-free units;
- Installing flow restrictors on faucets and shower heads;
- Repairing condenser loop connections so all condenser water is returned to the cooling towers;
- Replacing existing once-through water-cooled air conditioning system with air cooled equivalents;
- Installing advanced potable water meters; and
- Repairing system to allow 9212 condensate to be returned to the steam plant. The condensate return was repaired in October 2014, but several additional repairs are needed to the system. When the system is fully repaired, an estimated return of 16,848,000 gal of condensate per year back to the steam plant will be realized

#### **4.2.6.5 Fleet Management**

The Y-12 fleet is comprised of DOE-owned and Government Services Administration (GSA) sedans, light-duty trucks/vans, medium-duty trucks/vans, and heavy-duty trucks. During the last quarter of FY 2015, 240 sedans, light-duty, and medium-duty vehicles from the Y-12 DOE-owned fleet were transferred to the GSA. During FY 2016, the GSA replaced all those vehicles and 177 of the replacements were alternative fuel (E85) vehicles. This consolidation has decreased the average age of Y-12's vehicle fleet from 15 years to 1 year for light-duty and medium-duty vehicles. By replacing the older, less-fuel-efficient vehicles with newer, alternative fuel vehicles, Y-12 will greatly reduce its consumption of petroleum fuels and its GHG emissions and will increase its use of alternative fuels. 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 use and a 77.7% increase in alternative fuel use 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 the goal for FY 2016 of decreasing alternative fuel use by 10%. The site reduced petroleum use by 26%, which exceeded the 2016 goal of a 20% reduction.

Y-12 anticipates having E85 fuel available by the end of FY 2017. Y-12 is currently operating under an exception granted by DOE due to its current inability to store fuel on site. Areas where electric vehicles

could meet mission requirements will be evaluated in FY 2017 along with the infrastructure that will be required to meet the new telematics requirements. Y-12 will continue to monitor vehicle use and will redistribute or remove vehicles from the fleet as needed (see Figure 4.10).

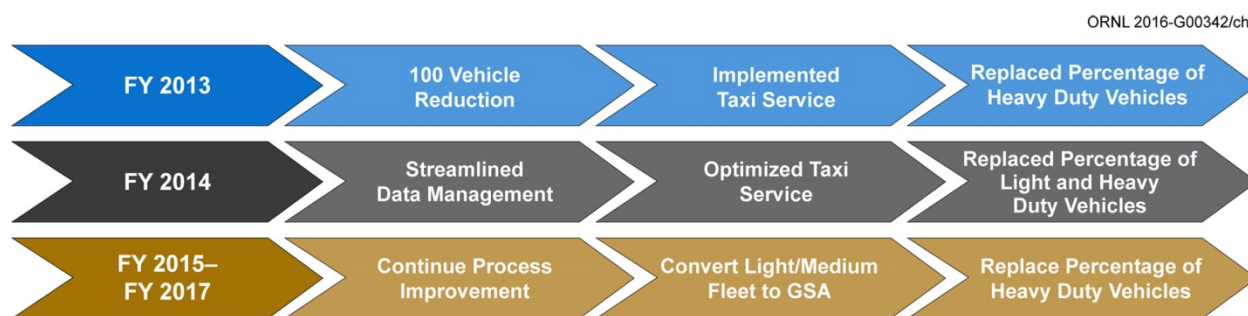


Figure 4.10. Fleet management roadmap.

#### 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. Approximately 93% of desktop computers, laptops, monitors, and thin clients purchased or leased during FY 2016 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 13693) and FY 2016. The Y-12 Complex has reduced Scopes 1 and 2 GHG emissions by 45.3% since the 2008 baseline year, primarily due to decreased Scope 1 emissions from steam generation and decreased Scope 2 emissions from energy efficiency projects. Scope 3 GHG emissions have increased by 9.4% since the 2008 baseline year. This increase is due primarily to rising employee commuting emissions due to site population growth. (Any increase in on-site personnel directly affects employee commuting.)

**Table 4.2. Y-12 National Security Complex greenhouse gas emissions summary**

GHG emission source	FY 2008 baseline (metric ton CO <sub>2</sub> e/year)	FY 2016 (metric ton CO <sub>2</sub> e/year)
<i>Scope 1<sup>a</sup></i>		
Steam (coal, natural gas, fuel oil)	129,021	51,064
Industrial fugitive emissions	22,542	8,089
On-site wastewater treatment	6.9	9.5
Fleet fuels (Gas, E85, Diesel)	1,063	-
<i>Scope 2<sup>a</sup></i>		
Renewable energy certificates		(16,290) <sup>b</sup>
Purchased electricity	184,995	141,977
<b>Total Scopes 1 and 2</b>	<b>337,627.9</b>	<b>184,849</b>
<i>Scope 3<sup>a</sup></i>		
T&D losses	12,185.8	9,352.2
Off-site municipal wastewater treatment	25.3	13.4
Employee commuting	17,447	24,587.3
Business ground and air travel	2,251	2,018.4
Renewable energy certificates	N/A	(1,072.7)
<b>Total Scope 3</b>	<b>31,909.1</b>	<b>34,898.6</b>
<b>TOTAL GHG emissions</b>	<b>369,537</b>	<b>219,747.6</b>

<sup>a</sup> 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 production process, such as electricity consumed in DOE buildings.

<sup>b</sup> 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<sub>2</sub>e = CO<sub>2</sub> 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 2016 include the following.

- UPF continued transferring portions of soil; there has not been a significant change (up or down) in green space during FY 2016 due to UPF site readiness activities. The new paved areas for UPF should be offset by the constructed sediment ponds with the Faircloth skimmers that mitigate the rate of the storm water leaving the area.
- UPF establishes vegetative cover (grass) as final grade is achieved at excess soil placement areas such as West Borrow Area and Wet Spoils Area consistent with the storm water control plan.

- Y-12 evaluates and incorporates, as feasible, the principles of low-impact development in the design of new construction projects such as the EOC project, which will replace the existing PSS facility. The use of low-impact development techniques such as landscape rock gardens and permeable pavers to reduce storm water runoff are being incorporated in the design of the project.

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 commitment to environmentally responsible operations at the Y-12 Complex has been recognized with more than 136 external environmental awards from local, state, and national agencies. The awards received in 2016 are summarized in the following sections.

### **4.2.7.1 Tennessee Chamber of Commerce and Industry Award**

Y-12 was recognized at the 34th Annual Tennessee Chamber of Commerce and Industry Environment and Energy Conference in an awards ceremony on October 26, 2016, at Montgomery Bell State Park. Y-12 received the Energy Excellence Award for “Y-12 ESPCs Building a Sustainable Future in Energy Conservation.” (See Figure 4.11.)

### **4.2.7.2 Electronic Product Environmental Assessment Tool Award**

Y-12 received an EPEAT Purchaser 2 Star Level Award for Excellence in Green Procurement of Electronics in a ceremony in Washington, DC, on May 23, 2016. Y-12 was recognized by the Green Electronics Council at the 2 Star Level for purchasing EPEAT electronics in the following categories: PCs and Displays; Imaging Equipment (e.g., copiers, scanners, multifunction devices); and Televisions. (See Figure 4.12.)

### **4.2.7.3 DOE Sustainability Awards**

Y-12 received two DOE Sustainability Awards in 2016. “Terry Cothron Builds Bridges to a Brighter Future at Y-12” was recognized in the Change Agent category and “Y-12 Reduced Water Usage and Improved Water Quality” was recognized in the Water category.

### **4.2.7.4 NNSA Sustainability Awards**

Y-12 received four NNSA Sustainability Best In Class Awards in 2016: “Terry Cothron Builds Bridges to a Bright Future at Y-12” in the Change Agent category, “Y-12 Reduced Water Usage and Improved Water Quality” in the Water category, “Y-12 Perseveres to Prevent Pollution in Wastewater Treatment Operations” in the Waste Reduction and Pollution Prevention category, and “Y-12 Energy Savings Performance Contracts Investing in a Sustainable Future” in the Performance Based Contracts category. Y-12 also received two NNSA Environmental Stewardship Award Certificates: “Y-12 Steams Ahead—Wise Utilities Management” in the Greenhouse Gas Scope 1 and 2 category and “Y-12 Uranium Processing Facility Sustainable Practices” in the Waste Reduction and Pollution Prevention category.



**Figure 4.11. Tennessee Chamber of Commerce and Industry awards ceremony for Y-12, Montgomery Bell State Park, October 26, 2016.**



**Figure 4.12. In a ceremony in Washington, DC, on May 23, 2016, Y-12 received the Electronic Product Environmental Assessment Tool Award Purchaser 2 Star Level Award for Excellence in Green Procurement of Electronics.**

## 4.3 Compliance Status

### 4.3.1 Environmental Permits

Table 4.3 lists environmental permits in force at the Y-12 Complex during 2016. More detailed information can be found in the following sections.

**Table 4.3. Y-12 National Security Complex environmental permits, CY 2016**

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 <sup>a</sup>	DOE	DOE	CNS
CWA	NPDES Permit	TN0002968	10/31/2011	11/30/2016 <sup>b</sup>	DOE	DOE	CNS
CWA	UPF 401 Water Quality Certification/ ARAP Access/Haul Road	NRS10.083	6/10/2010	6/09/2015 <sup>c</sup>	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	9/30/2021	DOE	CNS	CNS
RCRA	Hazardous Waste Transporter Permit	TN3890090001	12/22/2016	1/31/2018	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 <sup>b</sup>	DOE	DOE/CNS	CNS/ Navarro co-operator
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-127	10/06/2005	10/06/2015 <sup>b</sup>	DOE	DOE/CNS	CNS co-operator

**Table 4.3 (continued)**

<b>Regulatory driver</b>	<b>Title/description</b>	<b>Permit number</b>	<b>Issue date</b>	<b>Expiration date</b>	<b>Owner</b>	<b>Operator</b>	<b>Responsible contractor</b>
RCRA	RCRA Post closure Permit for the Chestnut Ridge Hydrogeologic Regime	TNHW-128	9/29/2006	9/29/2016 <sup>b</sup>	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 <sup>b</sup>	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 <sup>b</sup>	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)

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
SDWA	Underground Injection Control Class V Injection Well Permit	Permit by Rule TDEC Rule 0400-45-06	3/12/2002	None	DOE	DOE	CNS

<sup>a</sup> Continue to operate in compliance pending City of Oak Ridge action on renewal and reissuance.

<sup>b</sup> Continue to operate in compliance pending TDEC action on renewal and reissuance

<sup>c</sup> 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 decision-making process and that such decisions are documented in accordance with the DOE/NNSA and the Council on Environmental Quality regulations. Such a prescribed evaluation process ensures that the proper level of environmental review is performed before an irreversible commitment of resources is made.

Environmental evaluations were completed for 72 proposed actions during CY 2016, and 67 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). The majority of proposed actions involved the sustainment of enduring facilities and bridging strategies for facilities identified with an out-year replacement. Since many facilities are approaching end of design life, substantial investment is required to ensure that they remain viable for the near future. The following projects were evaluated for the Extended Life Program (for existing enriched uranium facilities): the Nuclear Facility Electrical Maintenance Project (electrical improvements to 9215 and 9204-2E), Fire Suppression upgrades (wet pipe sprinkler head replacements), Building 9995 Air Handling Unit Project, other humidity control improvements, and multiple machining tool and controller equipment upgrades or replacements. The following projects continue in 2016: the Energy Conservation Measure project—with the Chiller Plant upgrade as the last project, the Roof Asset Management Project, the Emergency Operations Center, the Y-12 Fire Station Construction project, and the bridging and sustainment of lithium production capabilities (equipment and facilities). NNSA has performed an analysis of alternative for constructing a new Lithium Production Capability facility.

During CY 2016, the following CXs were signed by NNSA Production Office and posted on the Y-12 public website:

- NEPA #4201.16, Easement to Tennessee Valley Authority (TVA) for the new Pine Ridge Substation and Associated Transmission Line Feeds for the Uranium Processing Facility (UPF) at the Y-12 National Security Complex;
- NEPA #4752, Depleted Uranium Technology Testing for the Uranium Processing Facility (UPF);
- NEPA #4201.17, UPF, Multi-Purpose Fabrication Facility; and
- NEPA #4779, Building 9204-2 Annex Demolition Project at the Y-12 National Security Complex.

The *Final Site-Wide Environmental Impact Statement for the Y-12 National Security Complex* (DOE 2011a) was issued in March, 2011. The Site-Wide Environmental Impact Statement – (SWEIS) and the notice of availability were published March 4, 2011, and are available on the Internet at <http://nnsa.energy.gov/content/y12sweis2011>. NNSA issued a ROD in July 2011 for the Continued Operation of the Y-12 National Security Complex, based on the SWEIS. Since the ROD, NNSA has updated the strategy and design approach for UPF. NNSA would use a hybrid approach of upgrading existing Y-12 facilities and building multiple UPF facilities, which was 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 updated UPF strategy was addressed in detail in a Supplement Analysis Final Site-Wide Environmental Impact Statement (EIS-0387-SA-01) and the ROD was amended July 22, 2016. Please see <http://energy.gov/nepa/downloads/eis-0387-sa-01-supplement-analysis>. As required by DOE's NEPA implementing procedures, 10 CFR 1021, a 5-year evaluation of the 2011 SWEIS is currently in process for the continued operations of Y-12.

In accordance with the National Historic Preservation Act of 1966, 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 2016 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 schools.

Seventy-two 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 72 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 identify leads to conduct oral interviews and 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 also 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.

Y-12 partnered with The National Park Service during the annual Earth Day events on April 19, 2016. These events were held in the Y-12's Jack Case Center cafeteria lobby area. The DOE Earth Day Theme was "Earth Day—Everyday." Information was made available to help individuals take action on behalf of the environment.

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. A foundational document has been completed. This document will establish a baseline for park planning and interpretive activities and provide basic guidance for planning and management decisions. 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 2016 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 continues to partner 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 to local and visiting schools, agencies, and organizations included tours and presentations on the history of the Y-12 Complex and Oak Ridge.

### **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 site-wide 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 2,000 data points are obtained and reported each year. All reporting requirements were met during CY 2016, and there were no permit violations or exceedances during the report period.

The TDEC–Knoxville Office, Clean Air Compliance, did not complete the Y-12 annual Clean Air Compliance inspection for CY 2016. They plan to perform an inspection in CY 2017.

Ambient air monitoring, while not specifically required by any permit condition, is conducted at the Y-12 Complex to satisfy DOE Order 458.1, *Radiation Protection of the Public and the Environment* (DOE 2011c) 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 ORR and by both on-site and off-site monitoring conducted by TDEC.

Section 4.4 provides detailed information on 2016 activities conducted at Y-12 in support of CAA.

### **4.3.4 Clean Water Act Compliance Status**

During 2016, the Y-12 Complex continued its excellent record for compliance with the 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 2016 was almost 100%.

About 2,300 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 expired on November 30, 2016.

An application for new permit was prepared and submitted to TDEC in May 2016.

### **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 Department.

In 2016, the Y-12 Complex potable water system received a sanitary survey score of 98 out of a possible 100 points and thus retained its approved status for potable water with TDEC. All total coliform samples collected during 2016 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. Lead and copper samples will be taken in June 2017.

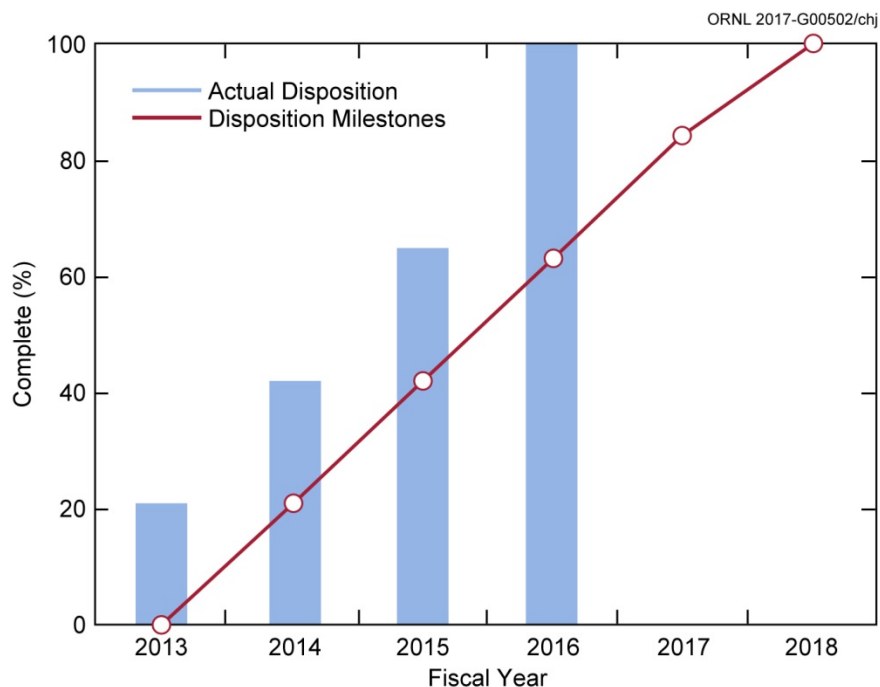
In 2016, the potable water compliance moved from Y-12 Infrastructure to Environmental Compliance. Y-12 Infrastructure remains responsible for maintenance to the distribution system; Environmental Compliance is now responsible for potable water monitoring and oversight of the cross-connection control program.

#### **4.3.6 Resource Conservation and Recovery Act Compliance Status**

RCRA regulates hazardous wastes that, if mismanaged, could present risks to human health or the environment. The regulations are designed to ensure that hazardous wastes are managed from the point of generation to final disposal. In Tennessee, EPA delegates the RCRA program to TDEC, but EPA retains an oversight role. The Y-12 Complex is considered a large-quantity generator because it may generate more than 1,000 kg 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 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 can 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 2016) 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 the final inventory are in fiscal years from 2013 through 2018 (see Figure 4.13). In 2016, the Y-12 Complex staff completed disposition of 100% of the inventory of legacy mixed waste listed on the ORR site treatment plan 2 years ahead of the 2018 completion milestone. Additional future milestones have been developed for newly identified legacy mixed waste identified in 2016.



**Figure 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 decreased in 2016 (Figure 4.14). The decrease was primarily due to a decrease in contaminated leachate from legacy operations, which made up 97% of the total hazardous and mixed waste generated in 2016. 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 1,770 kg of hazardous and mixed waste from the off-site Union Valley analytical chemistry laboratory and the Central Training Facility in 2016. In addition, 116,879 kg of hazardous and mixed waste was shipped to DOE-owned and commercial treatment, storage, and disposal facilities. More than 7 million kg of hazardous and mixed wastewater was treated at on-site wastewater treatment facilities.

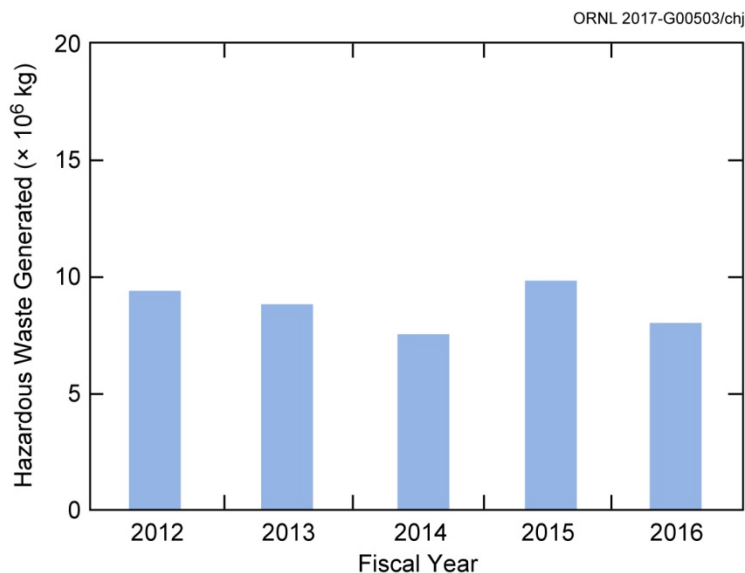


Figure 4.14. Hazardous waste generation, 2012–2016.

#### 4.3.6.1 Resource Conservation and Recovery Act Underground Storage Tanks

TDEC regulates active petroleum underground storage tanks (USTs). Existing UST systems that remain in service must comply with performance requirements described in TDEC UST regulations (TN 0400-18-01).

Closure and removal of the last 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 8,945 m<sup>3</sup> and has been the subject of a CERCLA remedial investigation/feasibility study. A CERCLA ROD for Spoil Area 1 was signed in 1997. One Class II facility (Landfill II) has been closed and is subject to post-closure 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 4.8.2, “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 document (formerly known as the Hazardous and Solid Waste Amendments permit) with CERCLA response actions.

During CY 2015, the renewal of the Oak Ridge Reservation Corrective Action document TNHW-164 was issued for the 10-year period from September 15, 2015, through September 15, 2025. During CY 2016, the annual update of Solid Waste Management Units and Areas of Concern was submitted to TDEC in January 2016.

Three RCRA post-closure 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 post-closure permits, the S-3 pond site is described as having two parts, eastern and former S-3 (Table 4.4). In March 2016, an application was submitted to TDEC to renew the post-closure permit for the Chestnut Ridge Hydrogeologic Regime. Groundwater corrective actions required under the post-closure 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 2016).

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 from 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 affect future CERCLA environmental remediation actions.

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

Unit	Major components of closure	Major post-closure requirements
<i>Upper East Fork Poplar Creek Hydrogeologic Regime (RCRA Post-closure Permit TNHW-113)</i>		
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	Post-closure corrective action monitoring. Inspection and maintenance of monitoring network
<i>Chestnut Ridge Hydrogeologic Regime (RCRA Post-closure Permit TNHW-128)</i>		
Chestnut Ridge security pits	Engineered cap	Cap inspection and maintenance. Post-closure corrective action monitoring. Inspection and maintenance of monitoring network and survey benchmarks
Kerr Hollow Quarry	Waste removal, access controls	Access controls inspection and maintenance. Post-closure detection monitoring. Inspection and maintenance of monitoring network and survey benchmarks
Chestnut Ridge sediment disposal basin	Engineered cap	Cap inspection and maintenance. Post-closure detection monitoring. Inspection and maintenance of monitoring network and survey benchmarks
East Chestnut Ridge Waste Pile	Engineered cap	Cap inspection and maintenance. Post-closure detection monitoring. Inspection and maintenance of monitoring network, leachate collection sump, and survey benchmarks. Management of leachate



Table 4.4 (continued)

Unit	Major components of closure	Major post-closure requirements
<i>Bear Creek Hydrogeologic Regime (RCRA Post-closure Permit TNHW-116)</i>		
Former S-3 ponds (S-3 pond site)	Neutralization and stabilization of wastes, engineered cap, asphalt cover	Cap inspection and maintenance. Post-closure corrective action monitoring. Inspection and maintenance of monitoring network and survey benchmarks
Oil landfarm	Engineered cap	Cap inspection and maintenance. Post-closure 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. Post-closure corrective action monitoring. Inspection and maintenance of monitoring network and survey benchmarks

**Acronyms**

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act

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 contain 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 9, 2016.

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 2016 in accordance with requirements under EPCRA Sections 302, 303, 311, 312, and 313.

The Y-12 Complex had no unplanned release of a hazardous substance which required notification of the regulatory agencies. See Section 4.3.11 for more information. Section 311 notifications were sent to TEMA and local emergency responders in 2016 because chemicals newly exceeded the reporting

thresholds or new information was identified about previously reported chemicals. Those chemicals included HFC-134a (CAS No. 811-97-2) used in upgraded chiller systems; asphalt (CAS No. 8052-42-4) from roofing projects; fly ash (mixture), Portland cement (CAS No. 65597-15-1) and slag (mixture) used in a new concrete batch plant; and propane (CAS No. 74-98-6) used in various facility and construction activities. 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 48 chemicals that were over Section 312 inventory thresholds in 2016.

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 2016 reportable toxic releases to air, water, and land and waste transferred off-site for treatment, disposal, and recycling were 32,967 kg (72,679 lb). Table 4.5 lists the reported chemicals for the Y-12 Complex for 2015 and 2016 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, 2015 and 2016**

Chemical	Year	Quantity <sup>a</sup> (lb) <sup>b</sup>
Chromium	2015	3,474
	2016	7,006
Copper	2015	3,605
	2016	2,747
Diisocyanate compounds	2015	--- <sup>c</sup>
	2016	568
Lead compounds	2015	14,914
	2016	10,013
Manganese	2015	3,763
	2016	6,038
Mercury	2015	179
	2016	25
Methanol	2015	16,350
	2016	37,554
Nickel	2015	3,622
	2016	8,728
Silver	2015	Form A <sup>d</sup>
	2016	Form A <sup>d</sup>
<b>Total</b>	2015	45,907
	2016	72,679

<sup>a</sup>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.

<sup>b</sup>1 lb = 0.4536 kg.

<sup>c</sup>Not reported in previous year.

<sup>d</sup>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.

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 2015) 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 the Tennessee Oversight Agreement. As an example, any observable oil sheen on East Fork Poplar Creek (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 2016 there was one reportable release. On December 28, 2016, there was a slight oil sheen observed at Outfall 200 of East Fork Poplar Creek. The oil sheen was no longer present on December 29, 2016, and there were no observed impacts to aquatic life. The source of the oily substance could not be determined. The appropriate authorities were notified of the oil sheen.

During 2016, there were no unplanned radiological air emission releases for the Y-12 Complex.

#### **4.3.12 Audits and Oversight**

A number of federal, state, and local agencies oversee Y-12 Complex activities. In 2016, the Y-12 Complex was inspected by federal, state, or local regulators on three 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 compliance inspections twice yearly. No issues were identified in 2016.

Personnel from EPA Region 4 and the TDEC Knoxville Field Office conducted a RCRA hazardous waste compliance inspection August 15–17, 2016. The inspections covered 48 waste storage areas and records

reviews. The report identified two findings involving a single container of used lamps (light bulbs). The lamps were not dated and labeled as required. These issues were immediately corrected.

**Table 4.6. Summary of external regulatory audits and reviews, 2016**

Date	Reviewer	Subject	Issues
February 23	TDEC	Biennial Survey of Potable Water Distribution System	1
March 29	COR	Semiannual Industrial Pretreatment Compliance Inspection	0
August 15–17	EPA/TDEC	Annual RCRA Hazardous Waste Compliance Inspection	2
August 30	COR	Semiannual Industrial Pretreatment Compliance Inspection	0

**Acronyms**

COR = City of Oak Ridge  
 EPA = U.S. Environmental Protection Agency  
 RCRA = Resource Conservation and Recovery Act  
 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 that 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 2016. During FY 2016, Y-12 recycled more than 3.10 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 2016**

Category	Amount released
Real property (land and structures)	None
Computer equipment recycle	134,471 lb
– Computers, monitors, printers, and mainframes	
Recycling examples	
– Used oils	4,730 gal
– Used tires	15,760 lb

– Scrap metal	1,767,446 lb
– Lead acid batteries	77,303 lb
Public/negotiated sales <sup>a</sup>	
– Copper	11,836 lb
– Miscellaneous furniture	240,044 lb
– Vehicles and miscellaneous equipment	177,754 lb
External transfers <sup>b</sup>	191,826 lb

<sup>a</sup> Sales during FY 2015.

<sup>b</sup> Vehicles; miscellaneous equipment; and materials transferred to various federal, state, and local agencies for reuse during FY 2016.

#### 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 technical justification (process knowledge 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)).<sup>1</sup> 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 4.7.

Y-12 uses an administrative limit for total activity of 2,400 dpm/100 cm<sup>2</sup> for radionuclides in groups 3 and 4 (see Table 4.7). 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.”

**Table 4.8. DOE O 458.1 preapproved authorized limits<sup>a,b</sup>**

Radionuclide <sup>c</sup>	Average <sup>d,e</sup>	Maximum <sup>d,e</sup>	Removable <sup>f</sup>
Group 1—Transuranics, <sup>125</sup> I, <sup>129</sup> I, <sup>227</sup> Ac, <sup>226</sup> Ra, <sup>228</sup> Ra, <sup>228</sup> Th, <sup>230</sup> Th, <sup>231</sup> Pa	100	300	20
Group 2—Th-natural, <sup>90</sup> Sr, <sup>126</sup> I, <sup>131</sup> I, <sup>133</sup> I, <sup>223</sup> Ra, <sup>224</sup> Ra, <sup>232</sup> U, <sup>232</sup> Th	1,000	3,000	200
Group 3—U-Natural, <sup>235</sup> U, <sup>238</sup> U, associated decay products, alpha emitters	5,000	15,000	1,000
Group 4—Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except <sup>90</sup> Sr and others noted above <sup>g</sup>	5,000	15,000	1,000
Tritium (applicable to surface and subsurface) <sup>h</sup>	Not applicable	Not applicable	10,000

<sup>1</sup> 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* manual is a supplement to MARSSIM that provides technical information on approaches for determining proper disposition of materials and equipment.

Source: Vázquez 2011.

<sup>a</sup>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.

<sup>b</sup>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.

<sup>c</sup>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.

<sup>d</sup>Measurements of average contamination should not be averaged over an area of more than 1 m<sup>2</sup>. 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<sup>2</sup>.

<sup>e</sup>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.

<sup>f</sup>The amount of removable material per 100 cm<sup>2</sup> 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<sup>2</sup> 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.

<sup>g</sup>This category of radionuclides includes mixed fission products, including the <sup>90</sup>Sr that is present in them. It does not apply to <sup>90</sup>Sr that has been separated from the other fission products or mixtures where the <sup>90</sup>Sr has been enriched.

<sup>h</sup>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 US Department of Energy dose limits and constraints.

#### 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, aluminum beverage cans, 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 that were delivered to Stores in error and that have 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-NESHAPs) (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 2016, the Y-12 Complex received an extension to the construction air permit for UPF, amended by TDEC on February 9, 2016. The Y-12's Title V (Major Source) Operating Air Permit was revised/updated in CY 2016. The air permit is due to expire on January 8, 2017. The terms of the air permit require that a complete and timely permit renewal application be submitted no later than 180 days prior to expiration. The permit renewal application was delivered to TDEC, Division of Air Pollution Control (DAPC), on July 11, 2016, for review and approval in accordance with Condition A-12 of the Y-12 Major Source (Title V) Operating Air Permit 562767. The complete permit renewal application consists of Volumes 1, 2, 3, and 4. The edited, unclassified nonsensitive versions being provided to the TDEC to enable application processing are Volumes 1, 2, 3.1, and 4.1. Also provided are the unclassified sensitive Volumes 3.2 and 4.2, which are edited for classification reasons. Due to its classified nature, Volume 4.3 is held on site at the Y-12 Complex for appropriately Q-cleared TDEC personnel to review as needed. An operational flexibility request to add a new machine to the Graphite Carbon Machine Shop, located in Building 9201-1, was submitted to TDEC DAPC on April 25, 2016, for review and approval. TDEC approved the request on April 26, 2016. Another operational flexibility request change to the ventilation system for the Purification Facility located in Building 9225-3 was submitted to TDEC DAPC on June 23, 2016, for review and approval. TDEC approved the request on June 30, 2016.

Permit administration fees are paid to TDEC annually in support of the Title V program.

CNS Y-12 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 2016, emissions categorized as actual emissions totaled 32,160 kg, and emissions calculated by the allowable method totaled 590,342 kg. The total emissions fee paid was \$22,697.23.

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 site-wide permit requires annual and semiannual reports. One report is the overall annual ORR Rad-NESHAPs report) 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, 2016**

Pollutant	Emissions (tons/year) <sup>a</sup>		Percentage of allowable
	Actual	Allowable	
Particulate	3.34	41	8.1
Sulfur dioxide	0.26	39	0.7
Nitrogen oxides <sup>b</sup>	14.07	81	17.4
Volatile organic compounds <sup>b</sup>	3.25	9.4	34.6
Carbon monoxide <sup>b</sup>	36.94	139	26.6

**NOTE:** The emissions are based on fuel usage data for January through December 2016. The volatile organic compound emissions include volatile organic compound hazard air pollutant emissions.

<sup>a</sup>1 ton = 907.2 kg.

<sup>b</sup>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 (ODSs) and fugitive particulate emissions are notable examples.

##### 4.4.1.1.1 Control of Asbestos

The Y-12 Complex has numerous buildings and equipment that contain asbestos-containing materials. The compliance program for management of removal and disposal of asbestos-containing materials includes demolition and renovation notifications to TDEC and inspections, monitoring, and prescribed work practices for abatement and disposal of asbestos materials. There was no reportable release of asbestos in 2016. There were three notifications of asbestos demolition or renovation, one revision of notification of asbestos demolition or renovation, one annual estimate for CY 2017, one revised annual estimate for CY 2016.

An internal surveillance of the asbestos NESHAP reporting process was conducted on November 28, 2016. The scope of the 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 in cleaning operations involving solvents. 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-based 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 use 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 of.

#### **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, 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 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  $^{234}\text{U}$ ,  $^{235}\text{U}$ ,  $^{236}\text{U}$ , and  $^{238}\text{U}$ , which are emitted as particulates (Figure 4.15). 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 61 Appendix D calculations; and

- emissions from room ventilation exhausts (calculated using radiological control monitoring data from the work area).

Continuous sampling systems are used to monitor emissions from a number of process exhaust stacks at the Y-12 Complex. In addition, a probe-cleaning program is in place, and the results from the probe cleaning at each source are incorporated into the respective emission point source terms. In 2016, 32 process exhaust stacks were continuously monitored, 24 of which were major sources; the remaining 8 were minor sources. The sampling systems on the stacks have been approved by EPA Region 4.

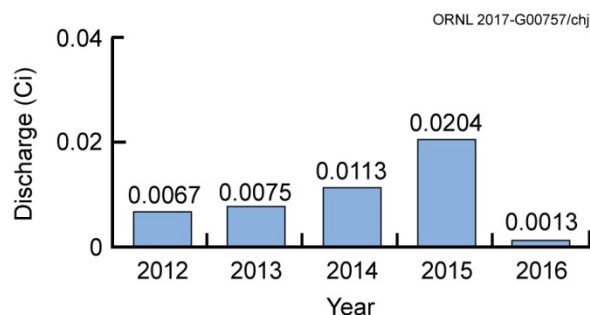
During 2016, unmonitored uranium emissions at the Y-12 Complex occurred from 31 emission points associated with on-site, unmonitored processes and laboratories operated by CNS. Emission estimates for the processes and laboratory stacks were made using inventory data with emission factors provided in 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 2016, 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. Five emission points from room ventilation exhausts were identified in 2016 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 site-wide, 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 0.0052 Ci (1.5 kg) of uranium was released into the atmosphere in 2016 as a result of Y-12 Complex process and operational activities.

A UPF, presently being designed, is intended to 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.



**Figure 4.15. Total curies of uranium discharged from the Y-12 National Security Complex to the atmosphere, 2012–2016.**

The calculated radiation dose to the maximally exposed off-site individual from airborne radiological release points at the Y-12 Complex during 2016 was 0.04 mrem. This dose is well below the NESHAP standard of 10 mrem and is less than 0.02% 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

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 versus allowable emissions from the steam plant is provided in Table 4.8.

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

Use of Solvent 140/142 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 2016 are 102.06 lb (0.05 tons) and 39,204 lb (19.60 tons), respectively. The highest calculated

amount of acetonitrile emitted to the atmosphere for CY 2016 was 5.5 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<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), sulfur hexafluoride (SF<sub>6</sub>), hydrofluorocarbons, perfluorochemicals, and other fluorinated gases (e.g., nitrogen trifluoride and hydrofluorinated ethers). These gases are often expressed in metric tons of carbon dioxide equivalent (CO<sub>2</sub>e).

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<sub>2</sub>e 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<sup>3</sup>/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 use 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 to 2016 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 <sub>2</sub> e)
2010	97,610
2011	70,187
2012	63,177
2013	61,650
2014	58,509
2015	51,706.9
2016	50,671.6

**Acronyms**CO<sub>2e</sub> = CO<sub>2</sub> 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 2016 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 (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 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 standard 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 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. The new rule requires that a one-time energy assessment for the steam plant must be completed on or after January 1, 2008. To comply with that requirement, an energy assessment for the Y-12 Steam Plant, performed by a qualified energy assessor, was completed in July 2013. Tune-ups for boilers were completed on January 13 and 14, 2016.

Unplanned releases of HAPs are regulated through the Risk Management Planning regulations. Y-12 Complex personnel have determined no processes or facilities contain 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 Engines: 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 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 requirements 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**

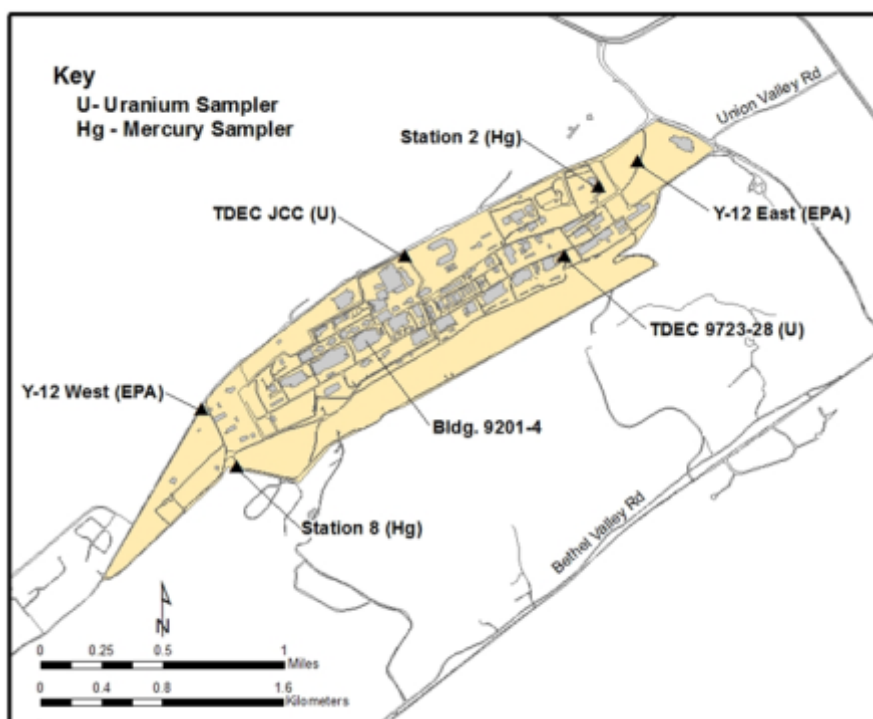
To understand the complete picture of ambient air monitoring in and around the Y-12 Complex, data from on- and off-site monitoring conducted specifically for the Y-12 Complex, reservation wide surveillance monitoring, and on- and off-site monitoring conducted by EPA and TDEC personnel must be considered.



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). The two atmospheric mercury monitoring stations, ambient air monitoring station (AAS) 2 and AAS8, located near the east and west boundaries of the Y-12 Complex, respectively, are currently operating (Figure 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: (1) 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 (2) a site was operated at New Hope Pond for a 25 month period from August 1987 to September 1989.



**Figure 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.

As reported previously, average mercury concentration at the ambient air monitoring sites has declined significantly since the late 1980s. Recent average annual concentrations at the two boundary stations are comparable to concentrations measured in 1988 and 1989 at the Chestnut Ridge reference site (Table 4.10). Average mercury concentration at the AAS2 site for 2016 is 0.0028  $\mu\text{g}/\text{m}^3$  (N = 24), comparable to averages measured since 2003. After an increase in average concentration at AAS8 for the period 2005 through 2007, thought to be possibly due to increased decontamination and decommissioning work on the west end, the average concentration at AAS8 for 2016 was 0.0037  $\mu\text{g}/\text{m}^3$  (N = 23), similar to levels reported for 2008 and for the early 2000s.

Table 4.11 summarizes the 2016 mercury results; results from the 1986 through 1988 period are included for comparison. Figure 4.18 illustrates temporal trends in mercury concentration for the two active mercury monitoring sites for the period since the inception of the program in 1986 through 2016 [parts (a) and (b)] and seasonal trends at AAS8 from 1994 through 2016 [part (c)]. The dashed line superimposed on the plots in Figures 4.18(a) and (b) is the EPA reference concentration of 0.3  $\mu\text{g}/\text{m}^3$  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 Figure 4.18(c), a monthly moving average has been superimposed over the AAS8 data to highlight seasonal trends in mercury at AAS8 from January 1994 through 2016.

**Table 4.11. Summary of data for the Y-12 National Security Complex ambient air monitoring program for mercury for CY 2016**

Ambient air monitoring stations	Mercury vapor concentration ( $\mu\text{g}/\text{m}^3$ )			
	2016 minimum	2016 maximum	2016 average	1986–1988 <sup>a</sup> average
AAS2 (east end of the Y-12 Complex)	0.0016	0.0044	0.0028	0.010
AAS8 (west end of the Y-12 Complex)	0.0004	0.0075	0.0037	0.033
Reference site, rain gauge 2 (1988 <sup>b</sup> )	N/A	N/A	N/A	0.006
Reference site, rain gauge 2 (1989 <sup>c</sup> )	N/A	N/A	N/A	0.005

<sup>a</sup>Period in late '80s with elevated ambient air mercury levels; shown for comparison.

<sup>b</sup>Data for period from February 9 through December 31, 1988.

<sup>c</sup>Data for period from January 1 through October 31, 1989.

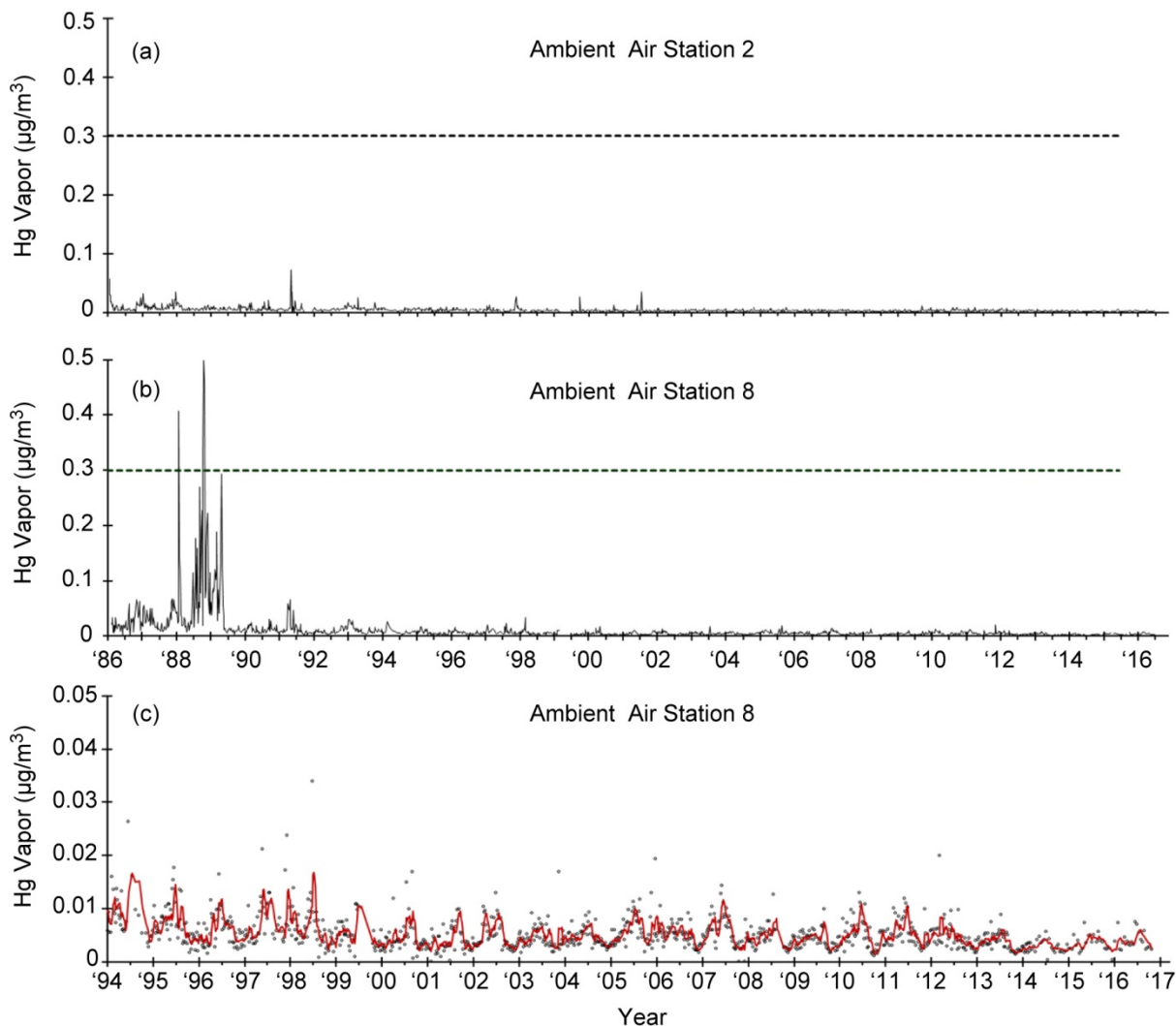
#### Acronyms

AAS = ambient air (monitoring) station

CY = calendar year

Y-12 Complex = Y-12 National Security Complex

N/A = not applicable



**Figure 4.17. Temporal trends in mercury vapor concentration for the boundary monitoring stations at the Y-12 Complex, July 1986 to January 2017 [(a) and (b)] and January 1994 to January 2017 for ambient air station 8 [(c)]. Note the different concentration scale in (c).**

The dashed lines superimposed on (a) and (b) represent the EPA reference concentration of  $0.3 \mu\text{g}/\text{m}^3$  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 2017, with higher concentrations generally measured during the warm weather months.

In conclusion, 2016 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  $50 \mu\text{g}/\text{m}^3$ , time-weighted average for up to a 10 h workday, 40 h workweek; the American Conference of Governmental Industrial Hygienists workplace threshold limit value of  $25 \mu\text{g}/\text{m}^3$  as a time-weighted average for a normal 8 h workday and 40 h workweek; and the

current EPA reference concentration of  $0.3 \mu\text{g}/\text{m}^3$  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 that 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 either purchased annually or, if not new, is shipped back to the manufacturer annually for calibration in accordance with standards set by the National Institute of Standards and Technology.

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

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

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

A field performance evaluation is conducted annually by the project manager to ensure that proper procedures are followed by the sampling technicians. No issues were identified in the last evaluation conducted, August 4, 2016.

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; if any laboratory duplicates differ by more than 10% at five or more times the detection limit a third aliquot (identical to the duplicates) is analyzed 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. The 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 (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, there are three uranium ambient air monitors within the Y-12 Complex boundary that, since 1999, have been used by TDEC personnel in their environmental monitoring program. Each of the monitors uses 47 mm borosilicate glass-fiber filters to collect particulates as air is pulled through the units. The monitors control airflow with a pump and rotometer set to average about 2 standard ft<sup>3</sup>/min. During 2012, the uranium monitors at stations 4, 5, and 8 were phased out of service, and two additional high-volume samplers (Figure 4.17) are now being used by TDEC 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.

In addition, TDEC Division of Remediation Oak Ridge Office conducts several other air quality monitoring programs on the ORR including:

- sample collection in support of EPA's nationwide RadNet air monitoring system,
- 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.

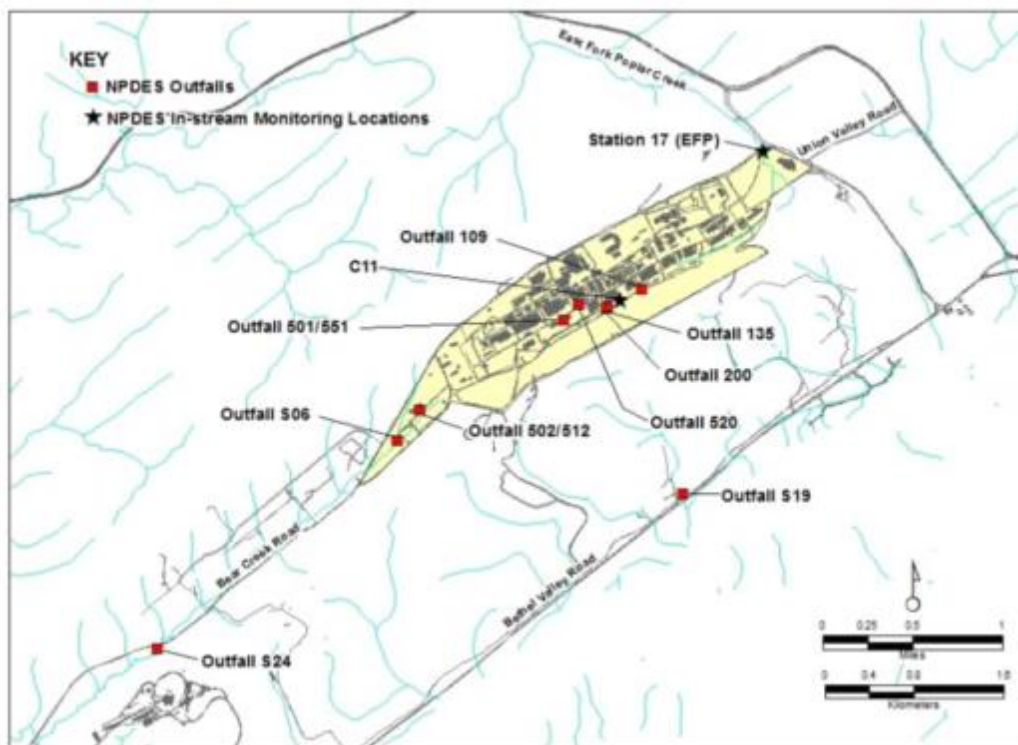
The State of Tennessee also operates a number of regional monitors to assess ambient concentrations of criteria pollutants such as sulfur dioxide, particulate (various forms), and ozone for comparison against ambient standards. The results are summarized and available through EPA and state reporting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



**Figure 4.18. Major Y-12 National Security Complex National Pollutant Discharge Elimination System (NPDES) outfalls and monitoring locations . EFP = East Fork Poplar**

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 EFP before the water exits the Y-12 Complex. EFP eventually flows through the City of Oak Ridge to Poplar Creek and into the Clinch River. Bear Creek water quality is affected by area source runoff and groundwater discharges. The NPDES permit requires regular monitoring and storm water characterization in Bear Creek and several of its tributaries.

Requirements of the NPDES permit for 2016 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 2016 was almost 100% (Table 4.12).

**Table 4.12. National Pollutant Discharge Elimination System compliance monitoring requirements and record for the Y-12 National Security Complex, January through December 2016**

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			<i>a</i>	9.0	<i>b</i>	0
	Total suspended solids			31.0	40.0	<i>b</i>	0
	Total toxic organic				2.13	<i>b</i>	0
	Hexane extractables			10	15	<i>b</i>	0
	Cadmium	0.16	0.4	0.07	0.15	<i>b</i>	0
	Chromium	1.0	1.7	0.5	1.0	<i>b</i>	0
	Copper	1.2	2.0	0.5	1.0	<i>b</i>	0
	Lead	0.26	0.4	0.1	0.2	<i>b</i>	0
	Nickel	1.4	2.4	2.38	3.98	<i>b</i>	0
	Nitrate/Nitrite				100	<i>b</i>	0
	Silver	0.14	0.26	0.05	0.05	<i>b</i>	0
	Zinc	0.9	1.6	1.48	2.0	<i>b</i>	0
	Cyanide	0.4	0.72	0.65	1.2	<i>b</i>	0
	Polychlorinated biphenyl (PCB)				0.001	<i>b</i>	0
Outfall 502 (West End Treatment Facility)	pH, standard units			<i>a</i>	9.0	100	3
	Total suspended solids		31		40	100	3
	Total toxic organic				2.13	100	3
	Hexane extractables			10	15	100	3
	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
	Silver		0.26		0.05	100	3
	Zinc		0.9		1.48	100	3
	Cyanide		0.72		1.20	100	3
	PCB				0.001	100	3
Outfall 512 (Groundwater Treatment Facility)	pH, standard units			<i>a</i>	9.0	100	12
	PCB				0.001	100	1
Outfall 520	pH, standard units			<i>a</i>	9.0	<i>b</i>	0
Outfall 200 (North/South pipes)	pH, standard units			<i>a</i>	9.0	100	53
	Hexane extractables			10	15	100	13
	Cadmium			0.001	0.023	100	16
	IC <sub>25</sub> <i>Ceriodaphnia</i>			37% Minimum		100	1
	IC <sub>25</sub> <i>Pimephales</i>			37% Minimum		100	1
	Total residual chlorine			0.024	0.042	100	13

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
Outfall 551	pH, standard units			<i>a</i>	9.0	100	53
	Mercury			0.002	0.004	100	52
Outfall C11	pH, standard units			<i>a</i>	9.0	100	14
Outfall 135	pH, standard units			<i>a</i>	9.0	100	12
	IC <sub>25</sub> <i>Ceriodaphnia</i>			9% Minimum		100	1
	IC <sub>25</sub> <i>Pimephales</i>			9% Minimum		100	1
Outfall 109	pH, standard units			<i>a</i>	9.0	60	5
	Total residual chlorine			0.010	0.017	100	5
Outfall S19	pH, standard units			<i>a</i>	9.0	100	2
Outfall S06	pH, standard units			<i>a</i>	9.0	100	2
Outfall S24	pH, standard units			<i>a</i>	9.0	100	2
Outfall EFP	pH, standard units			<i>a</i>	9.0	100	12
Category I outfalls	pH, standard units			<i>a</i>	9.0	100	52
Category II outfalls	pH, standard units			<i>a</i>	9.0	100	21
	Total residual chlorine				0.5	100	25
Category III outfalls	pH, standard units			<i>a</i>	9.0	100	8
	Total residual chlorine			<i>a</i>	0.5	100	10

<sup>a</sup>Not applicable.

<sup>b</sup>No discharge.

#### 4.5.2 Radiological Monitoring Plan and Results

A radiological monitoring plan is in place at the Y-12 Complex to address compliance with DOE orders and NPDES permit 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, 2016**

Parameters	Specific isotopes	Rationale for monitoring
Uranium isotopes	$^{238}\text{U}$ , $^{235}\text{U}$ , $^{234}\text{U}$ , total U, weight % $^{235}\text{U}$	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	$^{90}\text{Sr}$ , $^3\text{H}$ , $^{99}\text{Tc}$ , $^{137}\text{Cs}$	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	$^{241}\text{Am}$ , $^{237}\text{Np}$ , $^{238}\text{Pu}$ , $^{239/240}\text{Pu}$	These parameters are related to recycle uranium processing. Monitoring has continued because of their half-lives and presence in groundwater
Other isotopes of interest	$^{232}\text{Th}$ , $^{230}\text{Th}$ , $^{228}\text{Th}$ , $^{226}\text{Ra}$ , $^{228}\text{Ra}$	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. 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 2016 are noted on Figure 4.19. Table 4.14 identifies the monitored locations, the frequency of monitoring, and the sum of the percentages of the derived concentration standards (DCSs) for radionuclides measured in 2016. Radiological data were well below the allowable DCSs.

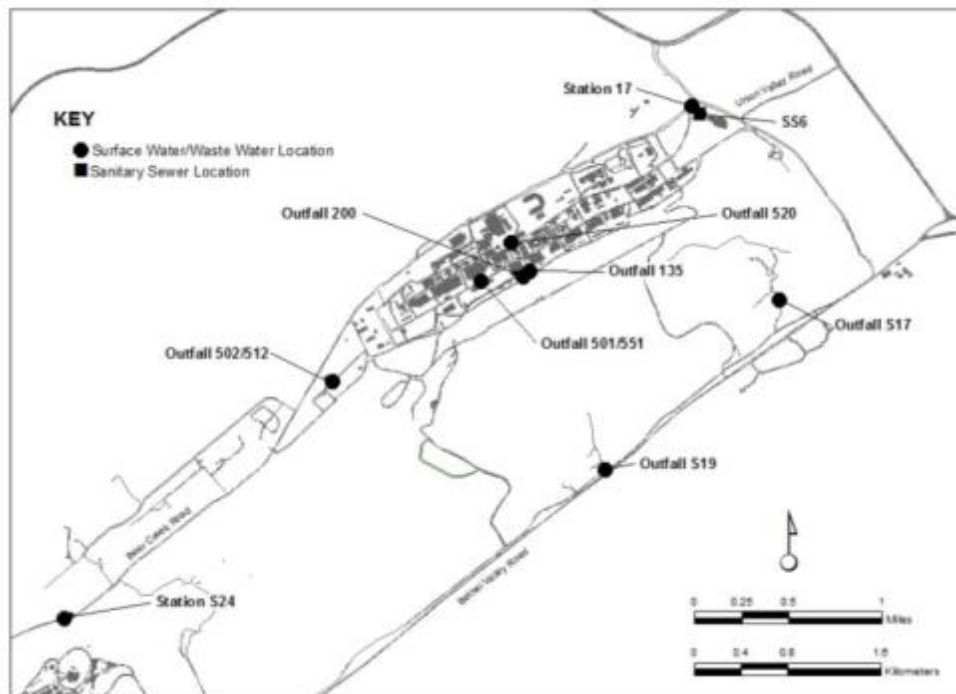


Figure 4.19. Surface water and sanitary sewer radiological sampling locations at the Y-12 National Security Complex.

Table 4.14. Summary of Y-12 National Security Complex radiological monitoring plan sample requirements and 2016 results

Location	Sample frequency	Sample type	Sum of DCS percentages
<i>Y-12 Complex wastewater treatment facilities</i>			
Central Pollution Control Facility	1/batch	Composite during batch operation	No flow
West End Treatment Facility	1/batch	24 h composite	13
Groundwater Treatment Facility	4/year	24 h composite	8.8
Steam condensate	1/year	Grab	No flow
Central Mercury Treatment Facility	4/year	24 h composite	0
<i>Other Y-12 Complex point and area source discharges</i>			
Outfall 135	4/year	24 h composite	3.1
Kerr Hollow Quarry	1/year	24 h composite	4.1
Rogers Quarry	1/year	24 h composite	0
<i>Y-12 Complex instream locations</i>			
Outfall S24	1/year	7-day composite	9.5
East Fork Poplar Creek, complex exit (east)	1/month	7-day composite	0
North/south pipes	1/month	24 h composite	2.4
<i>Y-12 Complex Sanitary Sewer</i>			
East End Sanitary Sewer Monitoring Station	1/year	7-day composite	0

#### Acronyms

DCS = derived concentration standard

Y-12 Complex = Y-12 National Security Complex

In 2016, 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 88 kg or 0.045 Ci (Table 4.15).

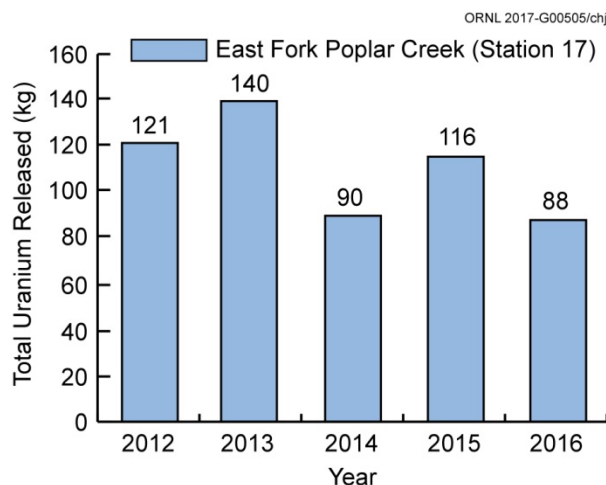
Figure 4.20 illustrates a 5-year trend of these releases. The total release is calculated by multiplying the average concentration (grams per liter) by the average flow (million gallons per day). Converting units and multiplying by 365 days per year yields the calculated discharge.

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 goals to keep levels as low as reasonably achievable. Results of radiological monitoring were reported to the City of Oak Ridge in 2016 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, 2011–2016**

Year	Quantity released	
	Ci <sup>a</sup>	Kg
	<i>Station 17</i>	
2011	0.104	124
2012	0.039	121
2013	0.055	140
2014	0.061	90
2015	0.068	116
2016	0.045	88

<sup>a</sup>1 Ci = 3.7E+10 Bq.



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

### 4.5.3 Storm Water Pollution Prevention

The Storm Water Pollution Prevention Plan (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 in response 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 2016 during rain events that occurred on February 1, November 19, and November 29. Results were published in the annual storm water report (CNS 2016b), which was submitted to the TDEC Division of Water Pollution Control in January 2017. 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 (Figure 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. The discontinuation of flow augmentation has reduced the flow in EFPC by a significant amount (about 3.3 million gal per day, or about 60%).

In general, the quality of storm water exiting the Y-12 Complex via EFPC remained relatively stable from 2015 to 2016. 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. In 2016, the concentration was measured to be 0.49 µg/L. These elevated and sporadic changes in mercury concentrations at this location have garnered the attention of TDEC Division of Water Resources personnel and 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.

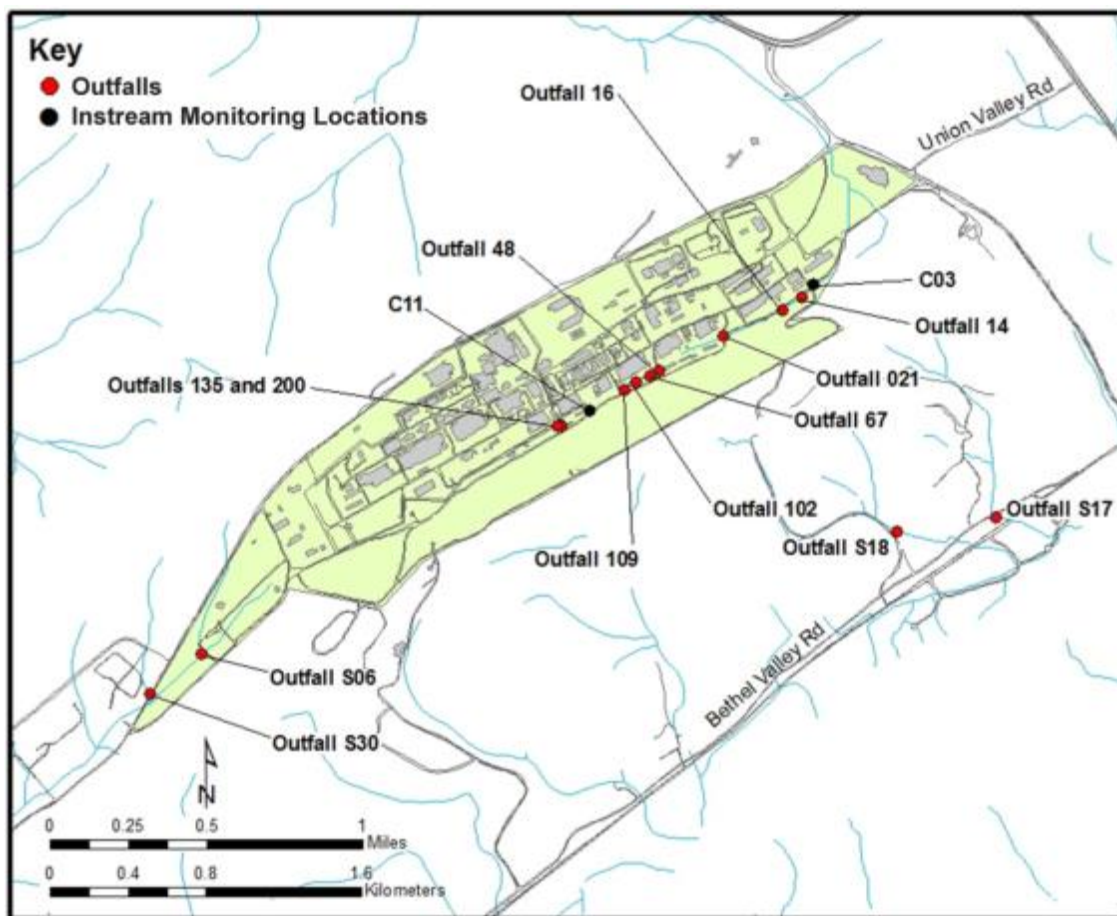


Figure 4.21. Y-12 National Security Complex storm water monitoring locations. East Fork Poplar Creek.

#### 4.5.4 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 Figure 4.23. 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).

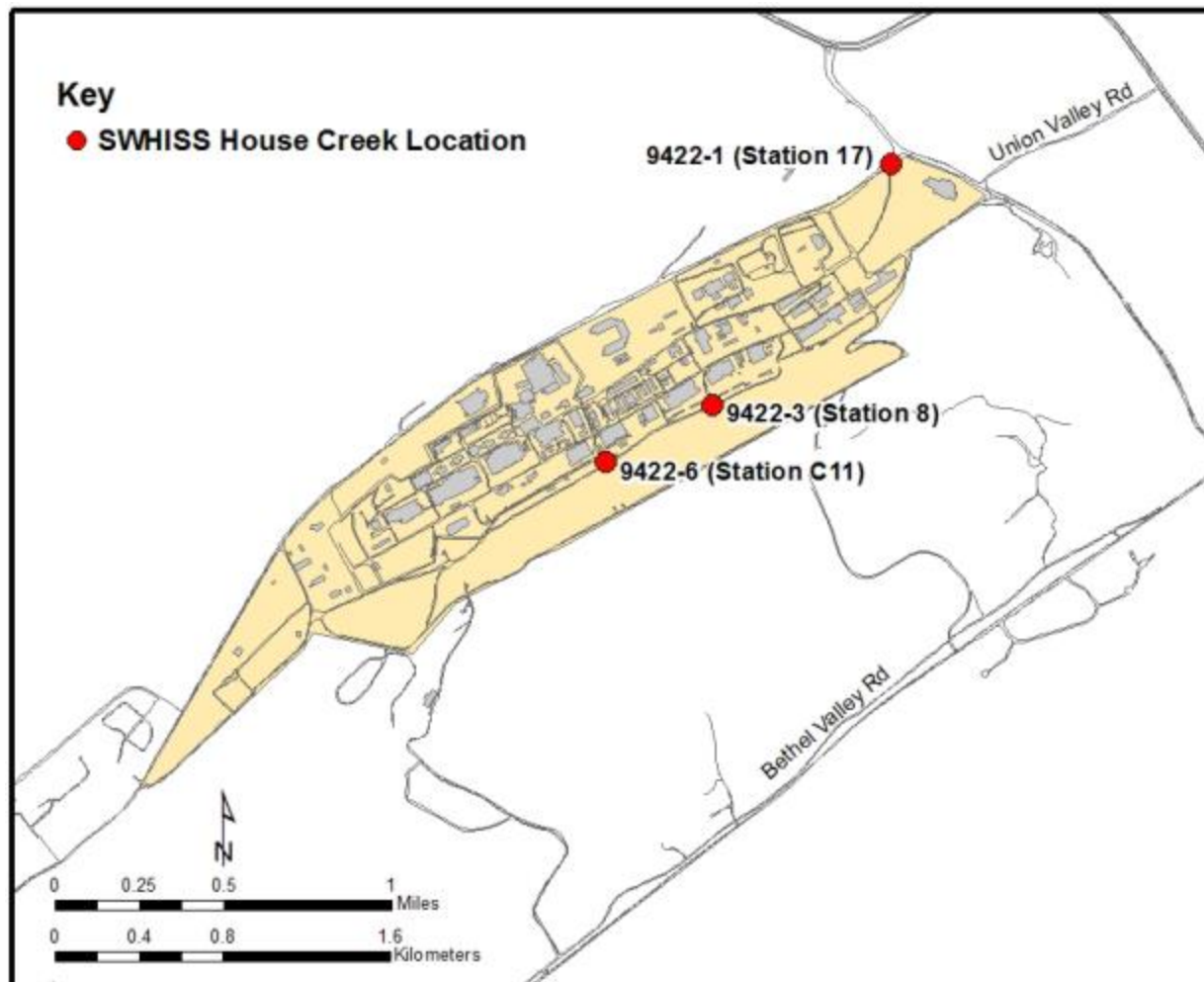


Figure 4.22. Surface Water Hydrological Information Support System (SWHISS) monitoring locations.

#### 4.5.5 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 Figure 4.22) to conduct compliance monitoring as required by the pretreatment regulations. City personnel also conduct twice-yearly compliance inspections. Monitoring results during 2016 (Table 4.16) indicate three exceedances of permit limits. Two were for exceedances of the daily flow limit and the third was for an exceedance of the oil and grease limit.

In January 2016, the City of Oak Ridge issued a new Industrial and Commercial Users Wastewater Discharge Permit 1-91 to the Y-12 Complex. Due to numerous changes in parameter limits and allowable flow rates, an appeal was filed with the City of Oak Ridge within thirty days of the issuance of the new permit. Negotiations between the two parties then ensued, and a resolution is still pending. The monitoring requirements and limits of the previous permit remained in effect during the period of appeal.

**Table 4.16. Y-12 National Security Complex discharge point SS6, Sanitary Sewer Station 6, January through December 2016 (all units are mg/L unless noted otherwise)**

Effluent parameter	Number of samples	Average value	Daily maximum (effluent limit) <sup>a</sup>	Monthly average (effluent limit) <sup>a</sup>	Number of limit exceedances
Flow (kgal/day)	365	355	1,400	N/A	2
pH (standard units)	14	N/A	9/6 <sup>b</sup>	9/6 <sup>b</sup>	0
Biochemical oxygen demand	14	84.7	300	200	0
Kjeldahl nitrogen	14	20.0	90	45	0
Phenols—total recoverable	14	<0.002	0.3	0.15	0
Oil and grease	14	<9.5	50	25	1
Suspended solids	23	99.7	300	200	0
Cyanide	14	<0.006	0.062	0.041	0
Arsenic	14	<0.004	0.025	0.010	0
Cadmium	14	<0.0003	0.005	0.0033	0
Chromium	14	<0.0032	0.075	0.05	0
Copper	14	0.0211	0.21	0.14	0
Iron	14	0.423	30	10	0
Lead	14	<0.002	0.074	0.049	0
Mercury	23	0.001	0.035	0.023	0
Nickel	14	<0.004	0.032	0.021	0
Silver	14	0.003	0.10	0.05	0
Zinc	14	0.0961	0.75	0.35	0
Molybdenum	14	0.0545	0.05 <sup>c</sup>	0.05 <sup>c</sup>	Not applicable
Selenium	14	<0.01	0.01 <sup>c</sup>	0.01 <sup>c</sup>	Not applicable
Toluene	4	0.005U	0.005 <sup>c</sup>	0.005 <sup>c</sup>	Not applicable
Benzene	4	0.005U	0.005 <sup>c</sup>	0.005 <sup>c</sup>	Not applicable
1,1,1-trichloroethane	4	0.005U	0.005 <sup>c</sup>	0.005 <sup>c</sup>	Not applicable
Ethylbenzene	4	0.005U	0.005 <sup>c</sup>	0.005 <sup>c</sup>	Not applicable
Carbon tetrachloride	4	0.005U	0.005 <sup>c</sup>	0.005 <sup>c</sup>	Not applicable
Chloroform	4	0.006J	0.005 <sup>c</sup>	0.005 <sup>c</sup>	Not applicable
Tetrachloroethylene	4	0.003J	0.005 <sup>c</sup>	0.005 <sup>c</sup>	Not applicable
Trichloroethene	4	0.005U	0.005 <sup>c</sup>	0.005 <sup>c</sup>	Not applicable
Trans-1,2-dichloroethylene	4	0.005	0.005 <sup>c</sup>	0.005 <sup>c</sup>	Not applicable
Methylene chloride	4	0.005JU	0.005 <sup>c</sup>	0.005 <sup>c</sup>	Not applicable

<sup>a</sup>Industrial and commercial users wastewater permit limits.

<sup>b</sup>Maximum value/minimum value.

<sup>c</sup>There is not a permit limit for this parameter. This value is the required detection limit.

#### 4.5.6 Quality Assurance/Quality Control

The Environmental Monitoring Management Information System (EMMIS) is used to manage surface water monitoring data at Y-12. 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 on the day of approval. EMMIS routinely accesses the Laboratory Information Management System 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.

#### 4.5.7 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 2016 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 2016 outfall biomonitoring tests in terms of the 25% inhibition concentration (IC<sub>25</sub>), the concentration (i.e., a percentage of full-strength effluent diluted with laboratory control water) 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<sub>25</sub>, the more toxic the effluent.



**Table 4.17. Y-12 National Security Complex Biomonitoring Program summary information for outfalls 200 and 135 in 2016<sup>a</sup>**

Site	Test start date	Species	IC <sub>25</sub> <sup>b</sup> (%)
Outfall 200	7/06/16	<i>Ceriodaphnia dubia</i>	>100
Outfall 200	7/06/16	<i>Pimephales promelas</i>	>100
Outfall 135	7/06/16	<i>Ceriodaphnia dubia</i>	>36
Outfall 135	7/06/16	<i>Pimephales promelas</i>	>36

<sup>a</sup>Inhibition concentration (IC<sub>25</sub>) is summarized for the discharge monitoring locations, Outfalls 200 and 135.

<sup>b</sup>IC<sub>25</sub> as a percentage of full-strength effluent from Outfalls 200 and 135 diluted with laboratory control water. IC<sub>25</sub> 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.

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<sub>25</sub> for survival, growth, or reproduction was therefore >36% (the highest concentration of this effluent that was tested). Toxicity is demonstrated according to the NPDES permit if the IC<sub>25</sub> is less than or equal to the permit limit (9% whole effluent for outfall 135).

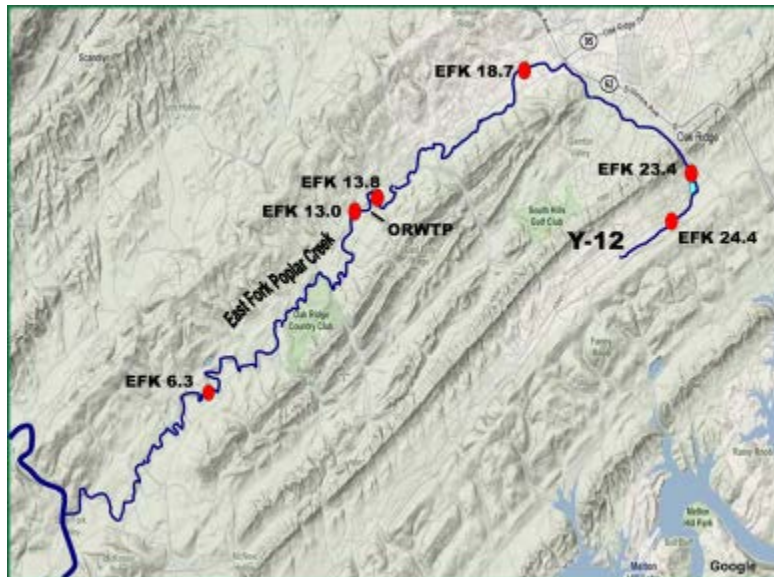
Effluent from outfall 200 also did not reduce fathead minnow survival or growth or *C. dubia* survival or reproduction by 25% or more at any of the tested concentrations. Therefore, the fathead minnow IC<sub>25</sub> for survival, growth, or reproduction was >100% (the highest concentration of this effluent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

#### 4.5.8 Biological Monitoring and Abatement Programs

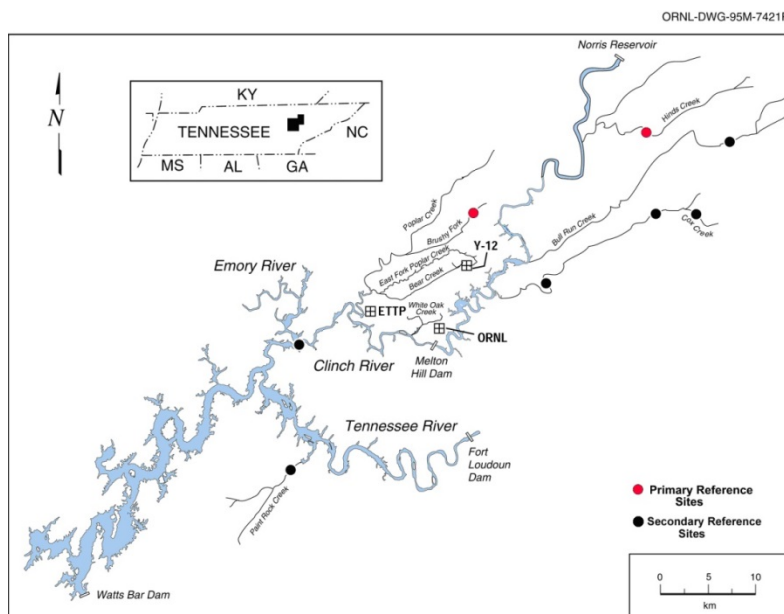
The NPDES permit issued for the Y-12 National Security Complex mandates a biological monitoring and abatement program (BMAP) with the objective of demonstrating that the effluent limitations established for the facility protect the classified uses of the receiving stream, EFPC. The 2016 BMAP sampling efforts reported in this chapter follow the NPDES-required Y-12 National Security Complex BMAP plan (Peterson et al. 2013). The Y-12 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 and EFK 18.2, located off the 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 (Figure 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 (Figure 4.24).



**Figure 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.)**



**Figure 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 National Security Complex has slowed in recent years, and

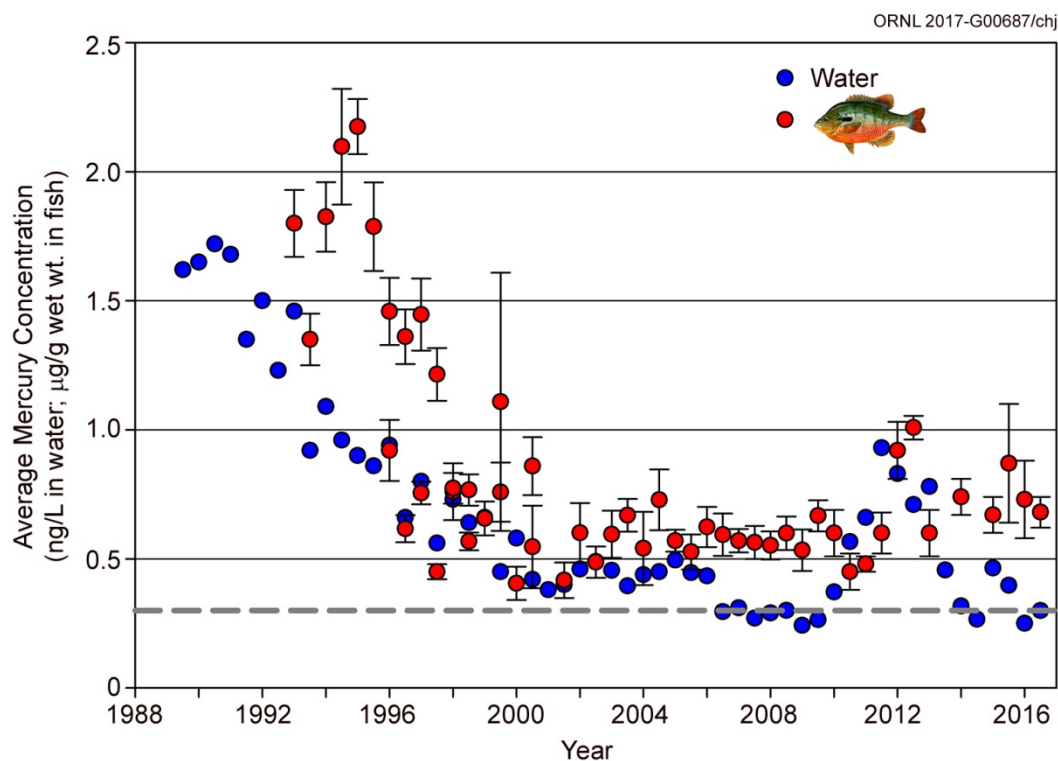
fish and invertebrate communities continue to have fewer species than the corresponding communities in reference streams. The impacts on stream ecology of recent remedial and abatement actions to address mercury releases at Y-12, including a major storm drain cleanout in WEMA (2011) and flow augmentation 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 continue to be a focus of future monitoring and investigation.

#### 4.5.8.1 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.

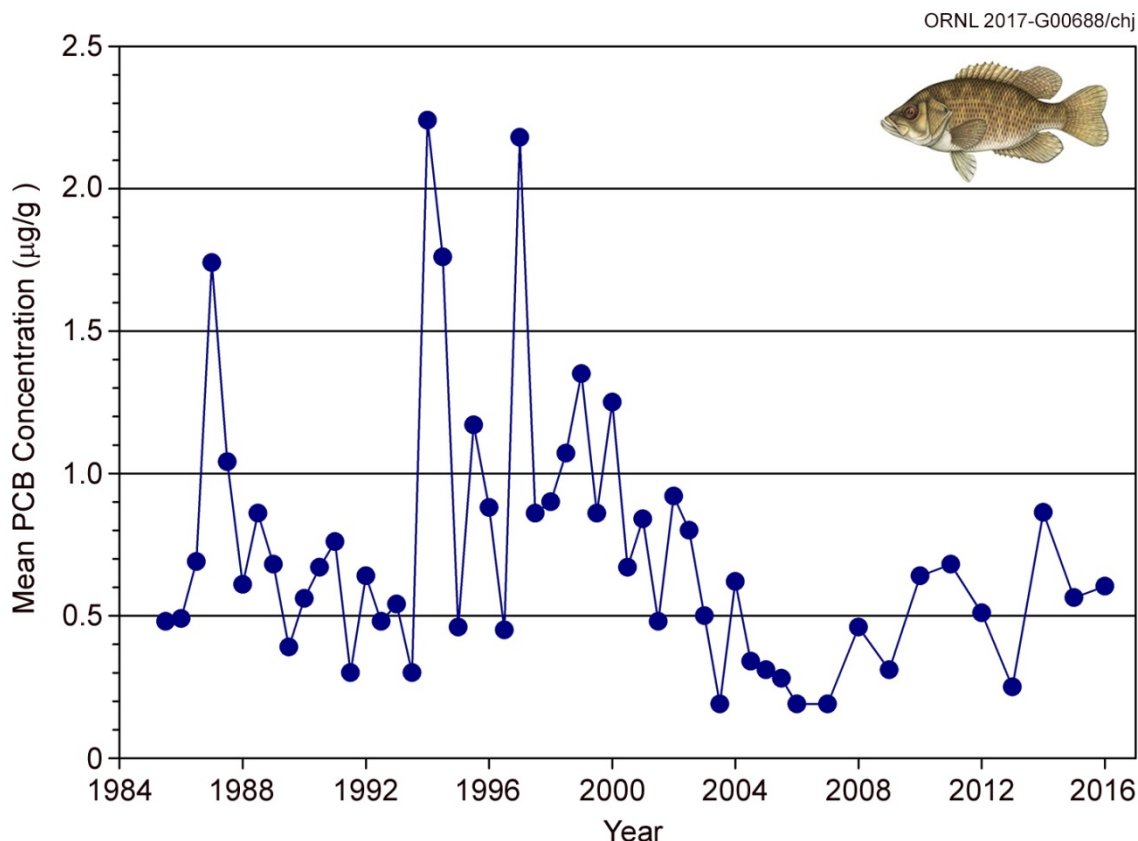
As part of this monitoring effort, redbreast sunfish (*Lepomis auritus*) and rock bass (*Ambloplites rupestris*) are collected twice a year from five sites throughout the length of EFPC and are analyzed for tissue concentrations of mercury (twice yearly) and PCBs (annually) (Figure 4.25). Mercury concentrations remained higher in fish from EFPC in 2016 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 remedial actions, 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 (Figure 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 sunfish collected from the EFK 24.4 sampling site, about 1 km upstream of Station 17, appear 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 2013–2016 (~0.7 µg/g). These concentrations are above the EPA ambient water quality criterion 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 EFPC and to better predict how remedial changes may impact mercury concentrations in fish in the future.



**Figure 4.25. Semiannual average mercury concentration in muscle fillets of redbreast sunfish and water from East Fork Poplar Creek (EFPC) at EFPC kilometers 23.4 (water) and 24.4 (fish), FY 2016. Dashed grey line represents the ambient water quality criterion for methylmercury in fish fillets (0.3 mg/kg).**

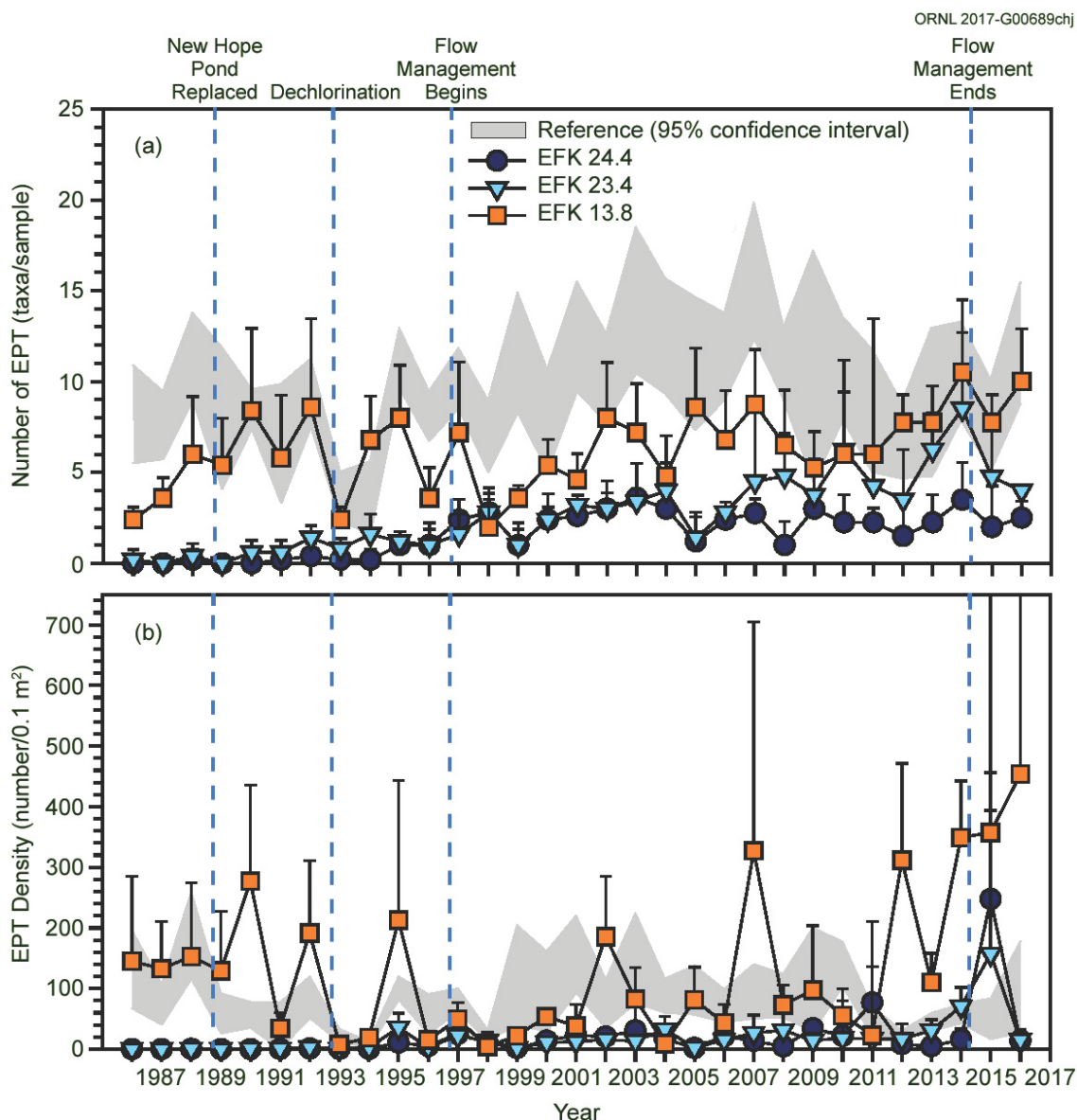
The mean total PCB concentration in sunfish fillets at EFK 23.4 was 0.60 µg/g in FY 2016, which was comparable to the concentration in FY 2015 (0.56 µg/g) (Figure 4.26). Regulatory guidance and human health risk levels have varied widely for PCBs, depending on the regulatory program and the assumptions 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 Loudoun; 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, 0.60 µg/g in fish fillets, is well above this concentration.



**Figure 4.26. Annual mean concentrations of polychlorinated biphenyls (PCBs) in rock bass muscle fillets at East Fork Poplar Creek kilometer 23.4., FY 2016.**

#### 4.5.8.2 Benthic Invertebrate Surveys

Monitoring of the benthic macroinvertebrate community continued in the spring of 2016 at three sites in EFPC and at two reference streams. The numbers of pollution-intolerant taxa (Ephemeroptera, Plecoptera, and Trichoptera, or EPT taxa) increased in 2016 at all monitored sites with the exception of EFK 23.4 (Figure 4.27a). The densities of these pollution-intolerant taxa increased in 2016 at the reference sites and at EFK 13.8, but decreased at the two sites nearest the Y-12 Complex (EFK 23.4 and EFK 24.4) (Figure 4.28b). Of particular significance, the mean densities of the pollution-intolerant taxa at EFK 13.8 have continued to exceed the upper bound of the reference site confidence limits since 2012. However, at EFK 23.4 and EFK 24.4, where mean densities for pollution-intolerant taxa exceeded that of reference sites in 2015 for the first time since monitoring began in 1985, densities returned in 2016 to typical low levels indicative of mildly degraded conditions. Considered together, these results suggest that the actual long-term effects on the invertebrate community of ending flow management in EFPC will only become evident as conditions stabilize and additional data become available.



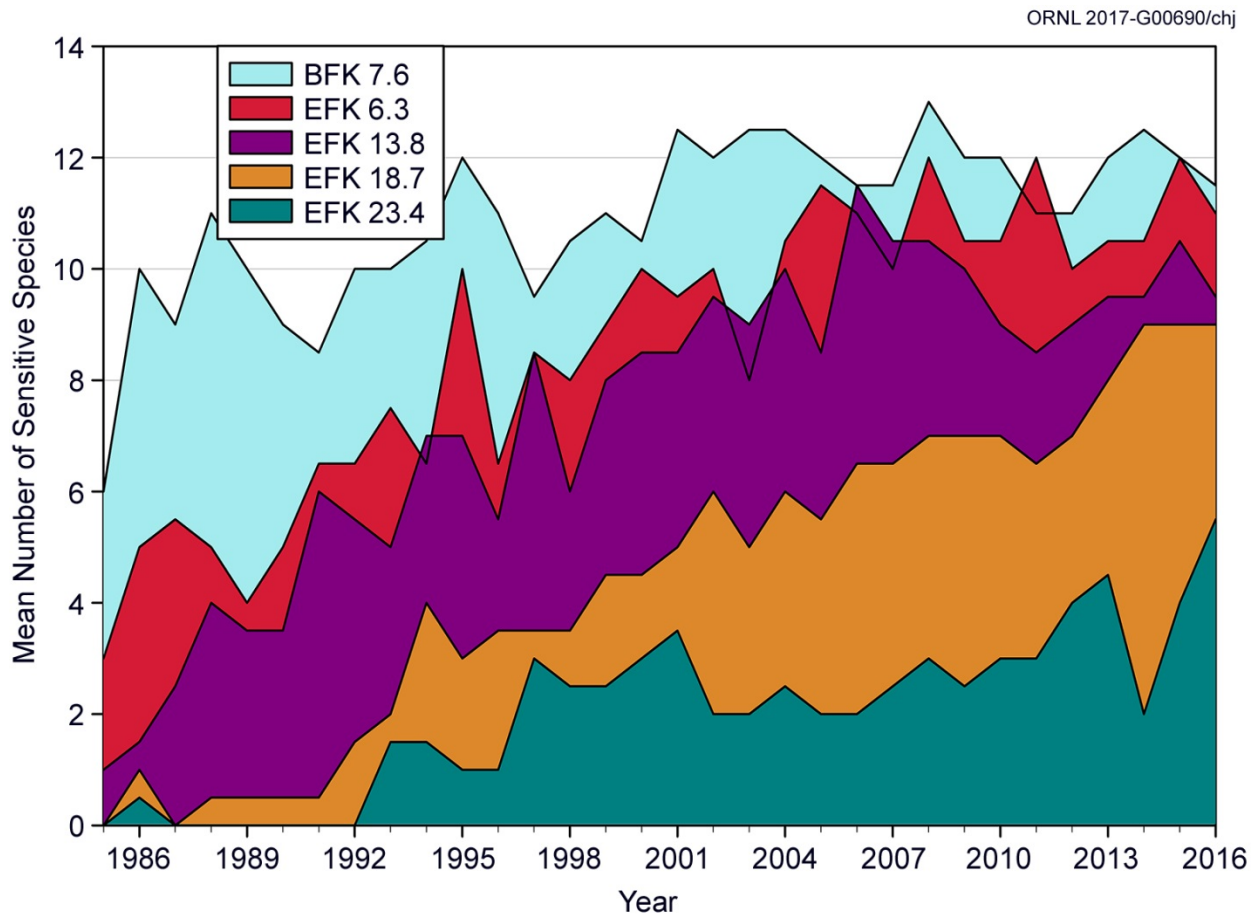
**Figure 4.27. (a) Taxonomic richness (mean number of taxa per sample) and (b) density (mean number of taxa per square meter) of the Ephemeroptera, Plecoptera, and Trichoptera (EPT) in the benthic macroinvertebrate communities sampled in the spring from East Fork Poplar Creek and two nearby reference streams (Brushy Fork and Hinds Creek), 1986–2016. (EFK = East Fork Poplar Creek kilometer.)**

#### 4.5.8.3 Fish Community Monitoring

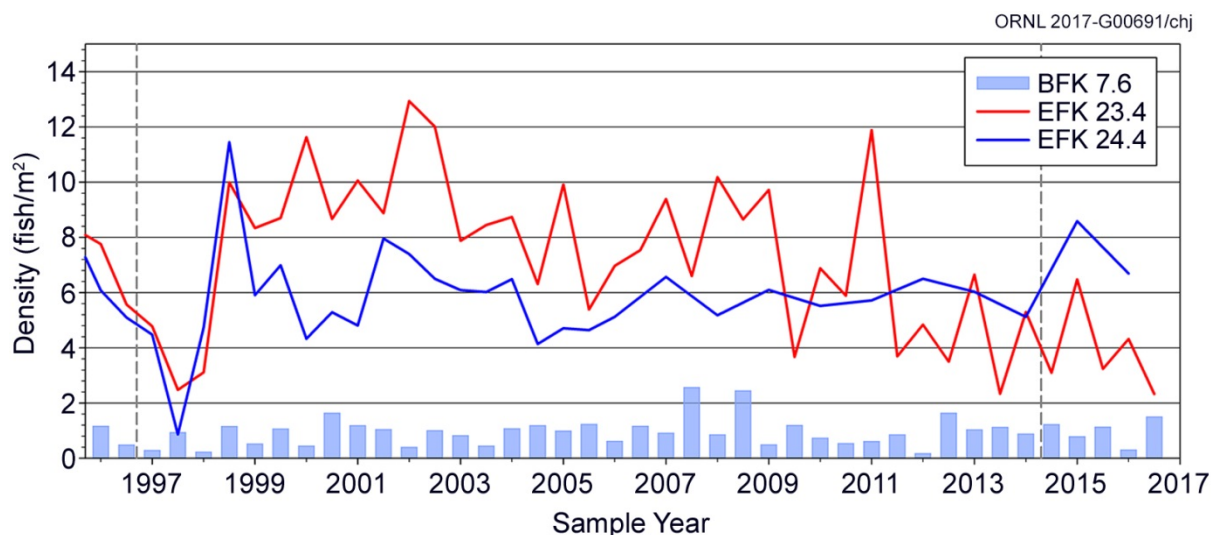
Fish communities were monitored in the spring and fall of 2016 at five sites along EFPC and at a comparable local reference stream (Brushy Fork). In the past two decades, overall species richness, density, biomass, and number of pollution-sensitive fish species improved at all sampling locations below 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 at four sites in EFPC and the reference stream is shown in Figure 4.28, dramatically highlighting 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, especially at the monitoring sites closest to the Y-12 Complex.

Fish communities appeared to be stable in upper EFPC in 2016, even under the reduced stream flows associated with the termination of flow augmentation from Melton Hill in April 2014. No fish kills were observed in 2016 in upper EFPC, and in contrast fish densities were considerably higher at the uppermost sampling location (Figure 4.29). Very high densities are not always a positive indicator of fish health however, and the most abundant species within these sites are considered tolerant species. Continued monitoring will provide additional insight into these variabilities.



**Figure 4.28. Comparison of mean sensitive species richness (number of species) collected each year from 1985 to 2016 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.)**



**Figure 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 1996 to 2016.** (BFK = Brushy Fork kilometer and EFK = East Fork Poplar Creek kilometer). The interval of time between the dashed lines represents the period of flow management in East Fork Poplar Creek.

#### 4.5.8.4 Upper Bear Creek Remediation

As part of the construction of the UPF inside Y-12, Haul Road was expanded in 2013–2014, and several wetlands were negatively affected. This resulted in the need for mitigation, 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 ft 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 to reestablish the stream's riparian zone following the construction.

Annual monitoring of the remediated wetland sites through 2016 revealed that, in general, the wetlands are responding as intended and have shown remarkable wetland plant coverage over the past couple of years. 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 to understand responses to annual precipitation patterns. Keeping invasive plants in check is also important because invasive 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 several leaks 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 actions 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 2017). 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 of the Y-12 Complex and known and potential groundwater contaminant sources for which groundwater monitoring is performed.

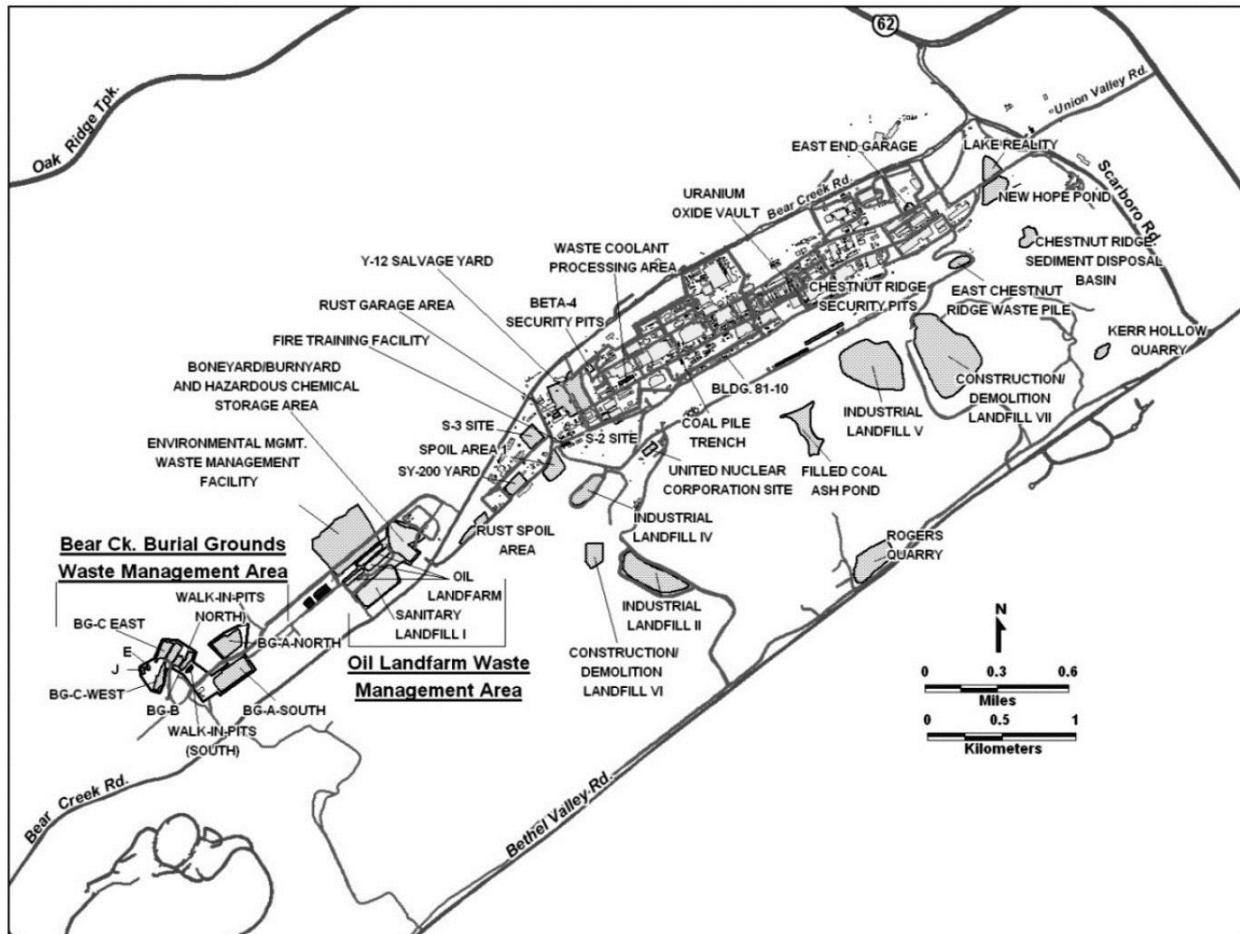


Figure 4.30. Known or potential contaminant sources for which groundwater monitoring is performed at the Y-12 National Security Complex.

#### 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 (Figure 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 (Figure 4.32). 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.

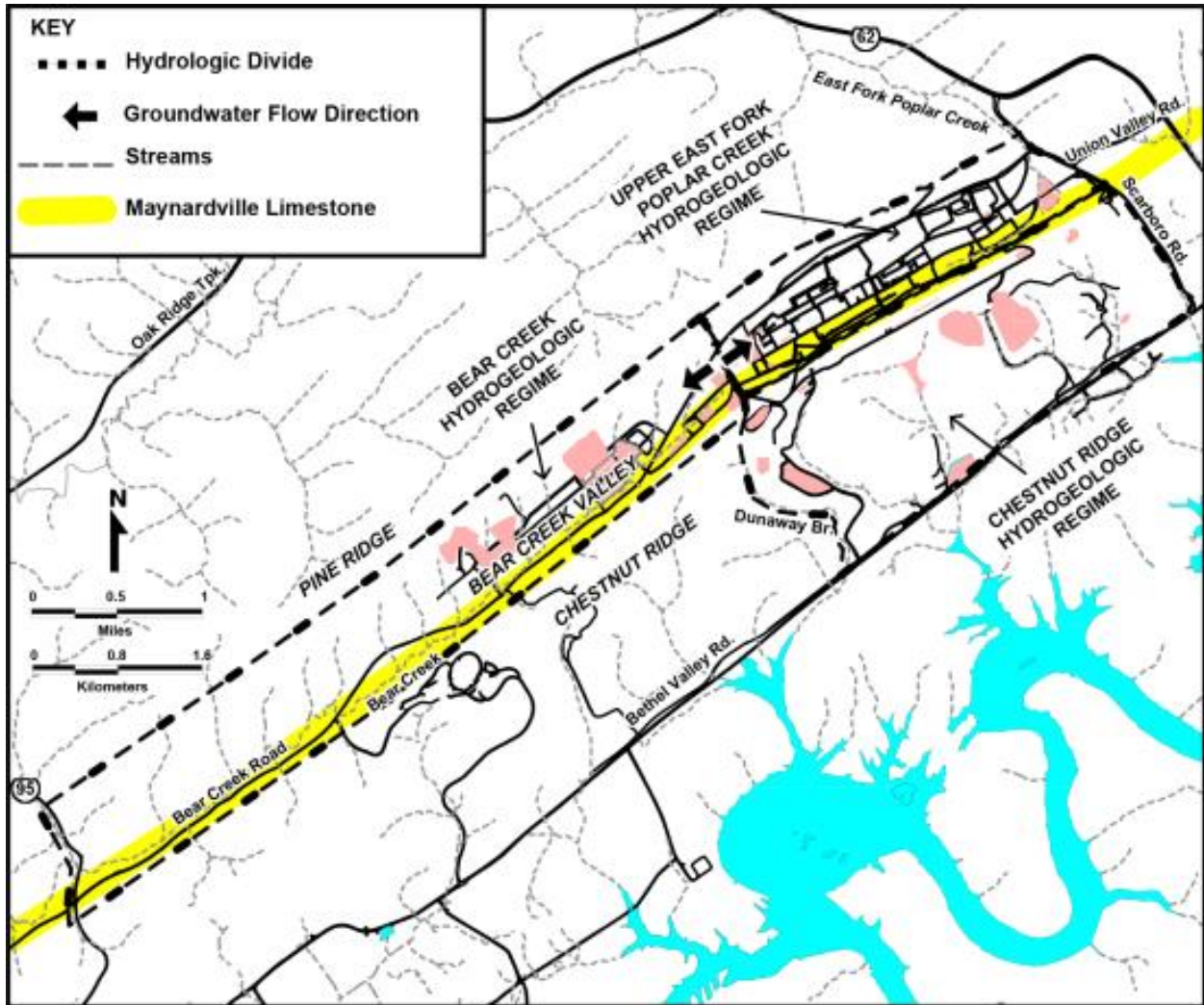
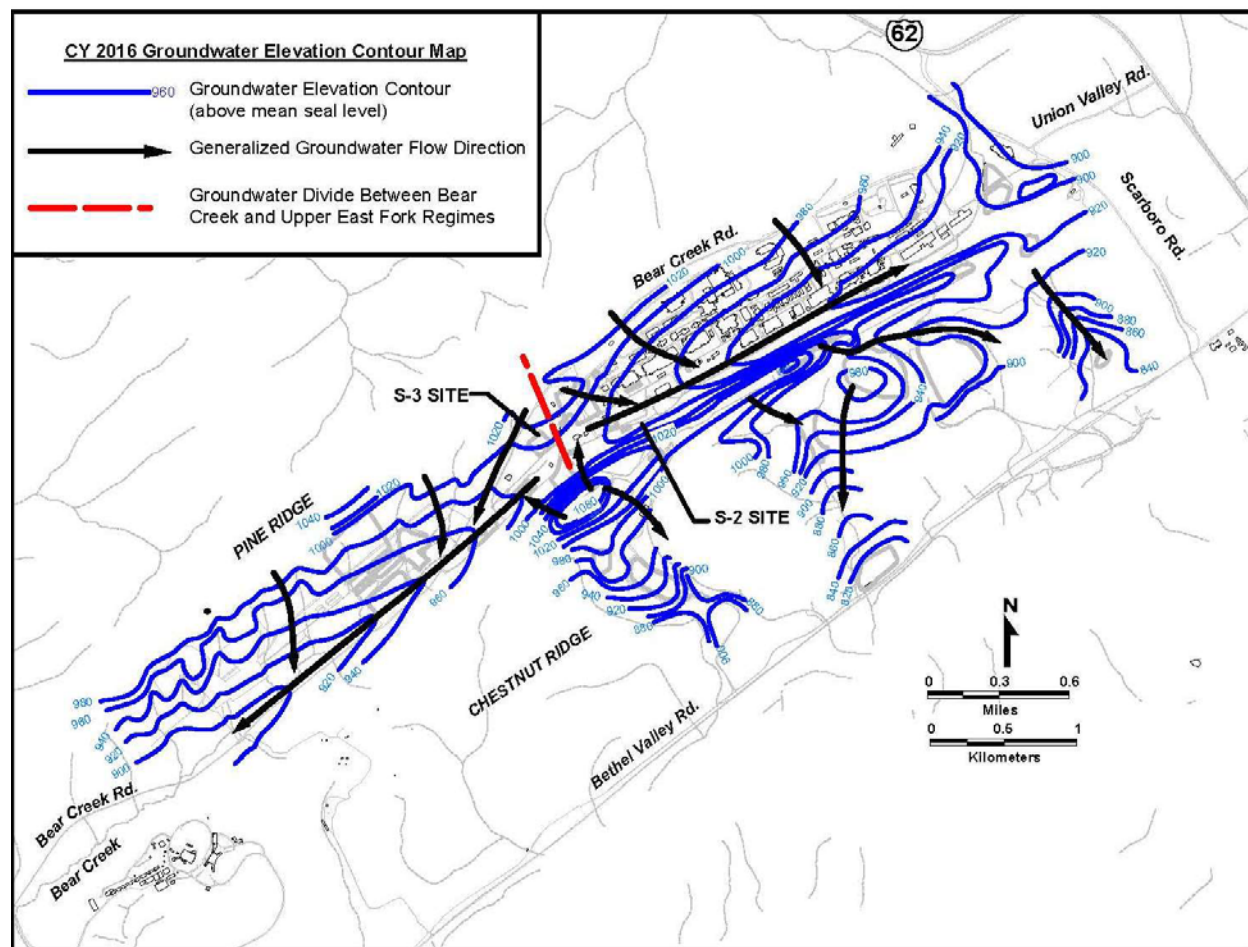


Figure 4.31. Hydrogeologic regimes at the Y-12 National Security Complex and the position of the Maynardville Limestone in Bear Creek Valley.



**Figure 4.32. Groundwater elevation contours and flow directions at the Y-12 National Security Complex.**

In Bear Creek Valley, groundwater in the intermediate and deep intervals moves predominantly through fractures in the aquitard, converging on and then moving through fractures and solution conduits in the Maynardville Limestone (Figure 4.31). 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 (10–500 ft/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 and to a lesser extent in the Chestnut Ridge regime.

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 (Figure 4.32). 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 4.33 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.

No wells were installed or plugged and abandoned in CY 2016.

#### 4.6.3 CY 2016 Groundwater Monitoring

Groundwater monitoring in CY 2016 was performed to comply with DOE orders and regulations as part of the Y-12 (GWPP, DOE EM programs such as the Water Resources Restoration Program (WRRP), and other projects. Compliance requirements were met by monitoring 201 wells and 50 surface water locations and springs (Table 4.18). Figure 4.34 shows the locations of Y-12 Complex perimeter/exit pathway groundwater monitoring stations.

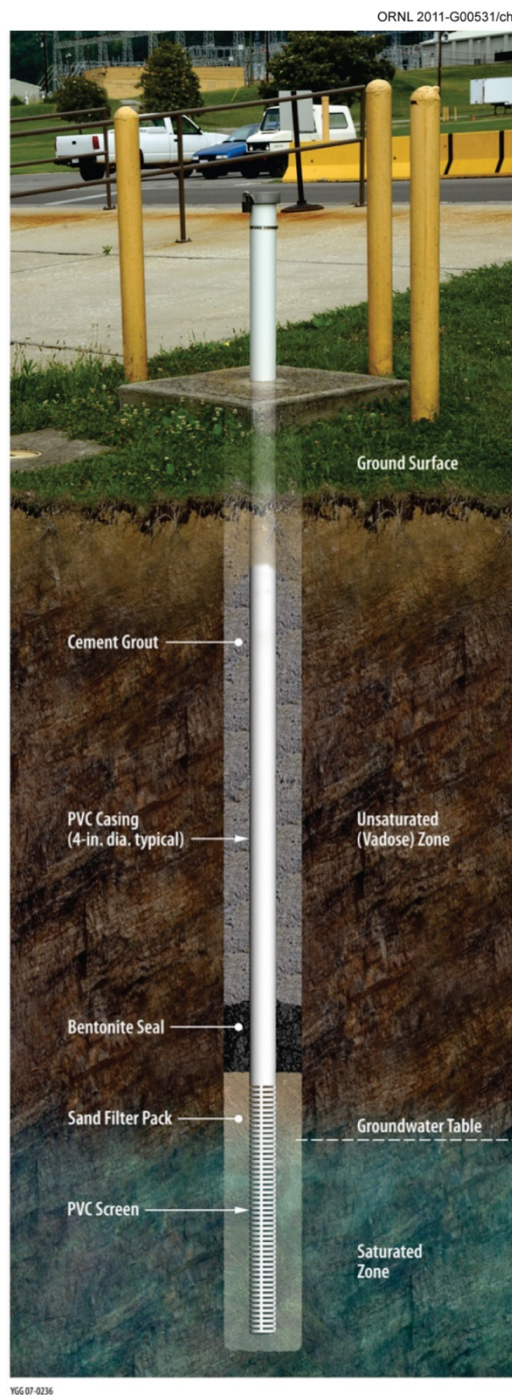


Figure 4.33. Cross section of a typical groundwater monitoring well.

Table 4.18. Summary of groundwater monitoring at the Y-12 Complex, 2016

	Purpose for which monitoring was performed				Total
	Restoration <sup>a</sup>	Waste management <sup>b</sup>	Surveillance <sup>c</sup>	Other <sup>d</sup>	
Number of active wells	63	33	105	27	228
Number of other monitoring stations (e.g., springs, seeps, surface water)	30	6	14	0	50
Number of samples taken <sup>e</sup>	182	69	121	663	1,035
Number of analyses performed	9,466	9,203	10,739	5,869	35,277
Percentage of analyses that are non-detects	68.5	91.4	81.0	10.5	68.6
<b>Ranges of results for positive detections, VOCs (µg/L)<sup>f</sup></b>					
Chloroethenes	0.25–2,600	5.74–8.37	1–48,000	NA <sup>g</sup>	
Chloroethanes	0.35–550	7.72–75	2–1,300	NA	
Chloromethanes	0.33–950	ND <sup>h</sup>	2–1,500	NA	
Petroleum hydrocarbons	0.31–1,200	ND	1–2,500	NA	
Uranium (mg/L)	0.0042–0.55	ND	0.00051–0.283	NA	
Nitrates (mg/L)	0.0033–5,700	0.594–2.26	0.0429–9,600	0.2–22.8	
<b>Ranges of results for positive detections, radiological parameters (pCi/L)<sup>i</sup></b>					
Gross alpha activity	2.55–249	1.4–7.71	4.6–340	NA	
Gross beta activity	2.94–11,200	3.45–12.3	7.8–15,000	NA	

<sup>a</sup> Monitoring to comply with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements and with Resource Conservation and Recovery Act post closure detection and corrective action monitoring.

<sup>b</sup> Solid waste landfill detection monitoring and CERCLA landfill detection monitoring

<sup>c</sup> DOE Order surveillance monitoring

<sup>d</sup> Research-related groundwater monitoring associated with activities of the DOE Oak Ridge Field Research Center and Enigma.

<sup>e</sup> The number of unfiltered samples, excluding duplicates, determined for unique location/date combinations.

<sup>f</sup> These ranges reflect concentrations of individual contaminants (not summed volatile organic compound concentrations):

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

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

Chloromethanes—includes carbon tetrachloride, chloroform, and methylene chloride

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

<sup>g</sup> NA—not analyzed.

<sup>h</sup> ND—not detected.

<sup>i</sup> pCi =  $3.7 \times 10^2$  Bq.

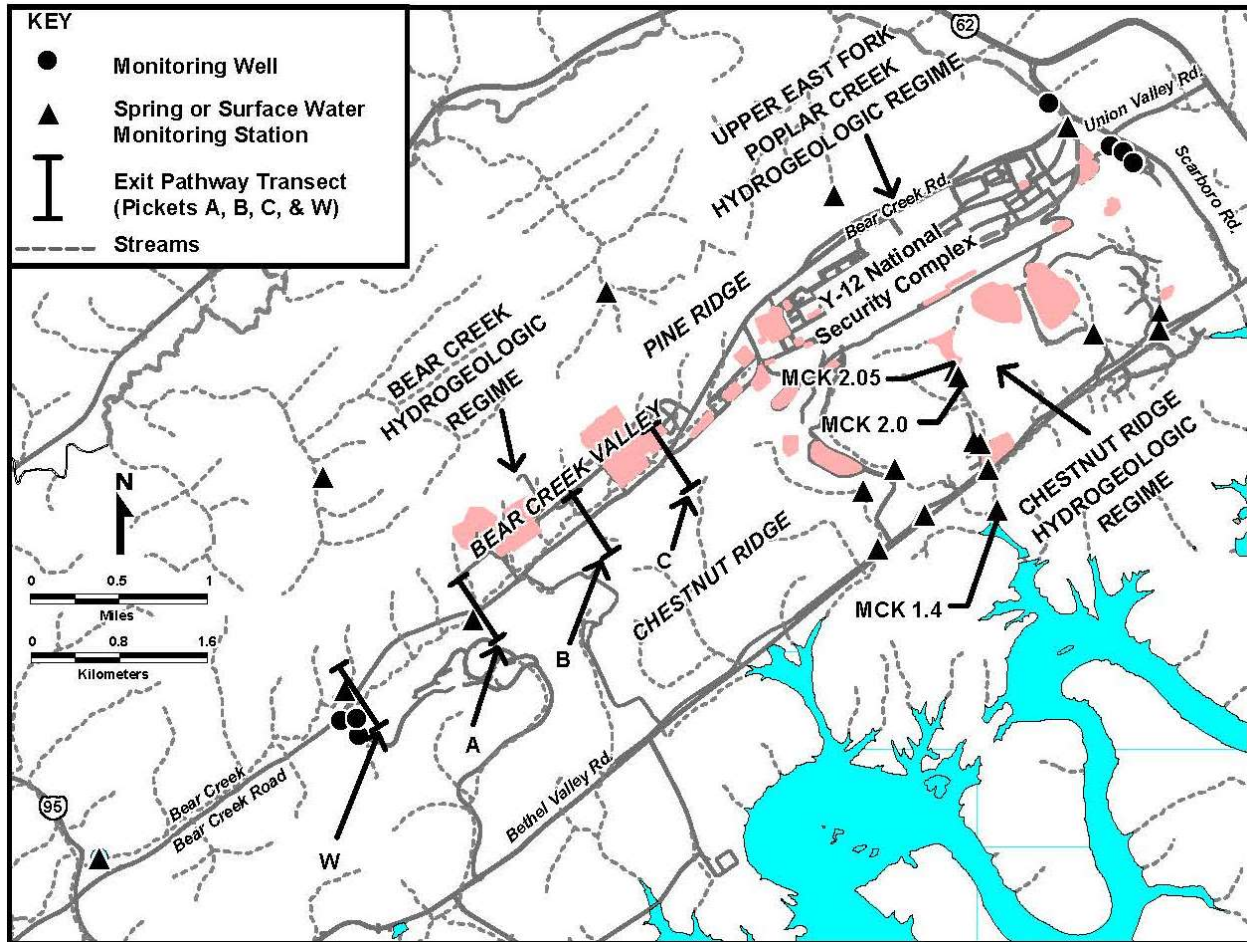


Figure 4.34. Location of Y-12 National Security Complex perimeter/exit pathway well, spring, and surface water monitoring stations. (MCK = McCoy Branch kilometer.)

Most of the conventional monitoring wells at the Y-12 Complex were sampled using industry standard methods approved by TDEC and EPA (Figure 4.35).



**Figure 4.35. 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 2016 are presented in the *Calendar Year 2016 Groundwater Monitoring Report* (CNS 2017).

Details of monitoring efforts performed specifically for CERCLA baseline and remediation evaluation are published in the FY 2016 and FY 2017 WRRP sampling and analysis plans (UCOR 2015 2016a) and the annual CERCLA remediation effectiveness report (DOE 2017a).

Groundwater monitoring compliance reporting to meet RCRA postclosure permit requirements can be found in the annual RCRA groundwater monitoring report (UCOR 2017).

#### **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 <sup>99</sup>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 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 <sup>99</sup>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, 2016**

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.

Table 4.19 (continued)

Site	Description
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 2016 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. 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 (Figures 4.37–4.40) represent CY 2016 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, including the primary contaminants (B&W Y-12 2013). Plume maps in previous ASERs were developed from those presented in CERCLA remedial investigations (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 4.7.4.1.4).

#### 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 2016, groundwater concentrations of nitrate as high as 9,600 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 (Figure 4.36). These results are consistent with results from previous years.

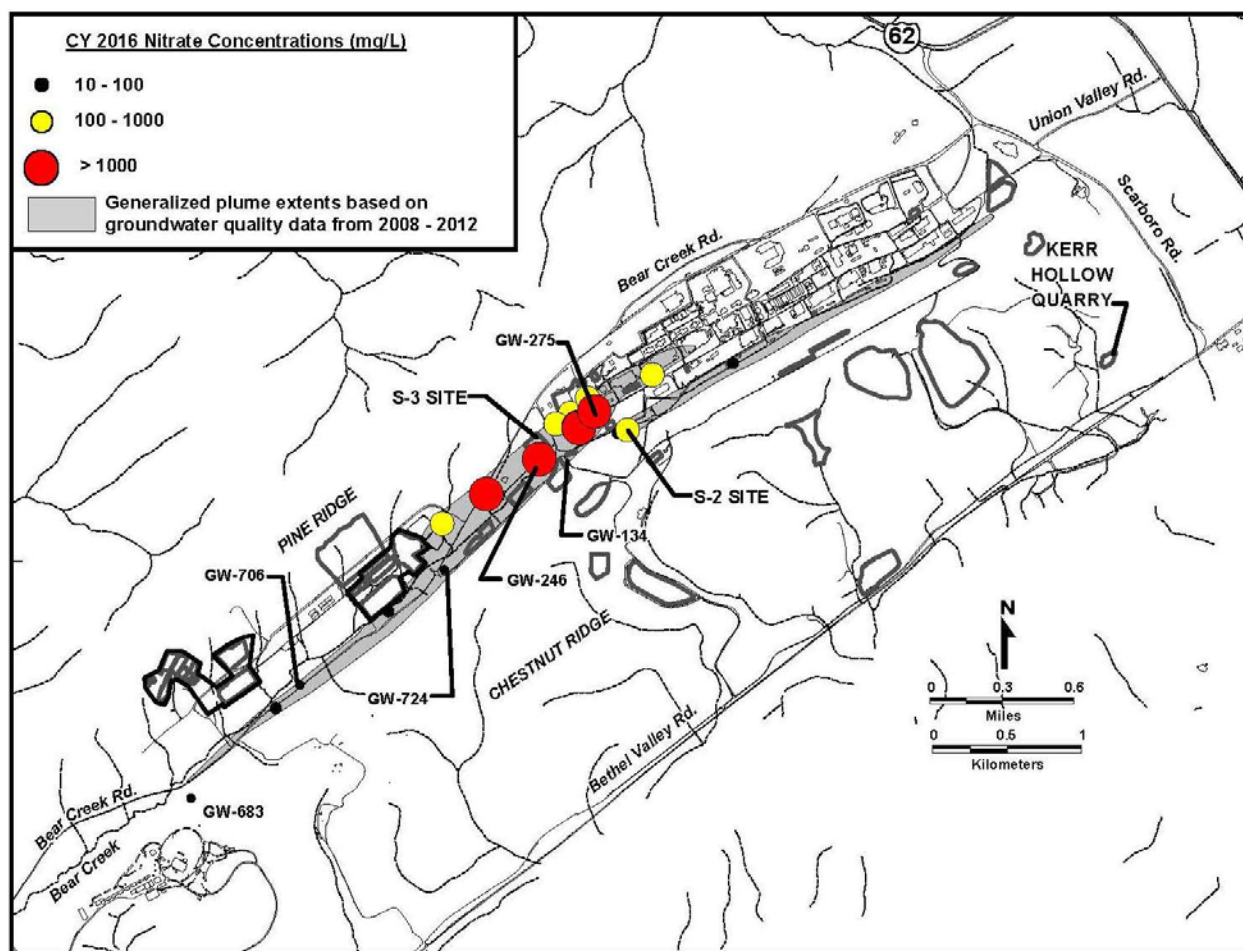


Figure 4.36. Nitrate observed in groundwater at the Y-12 National Security Complex, 2016.

#### 4.6.4.1.3 Trace Metals

Concentrations of barium, beryllium, cadmium, chromium, copper, lead, nickel, thallium, and uranium exceeded drinking water standards during CY 2016 in samples collected from various groundwater monitoring locations throughout the complex, specifically at and downgradient of the S-2 and S-3 sites. Trace metal concentrations above standards tend to occur only adjacent to 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.

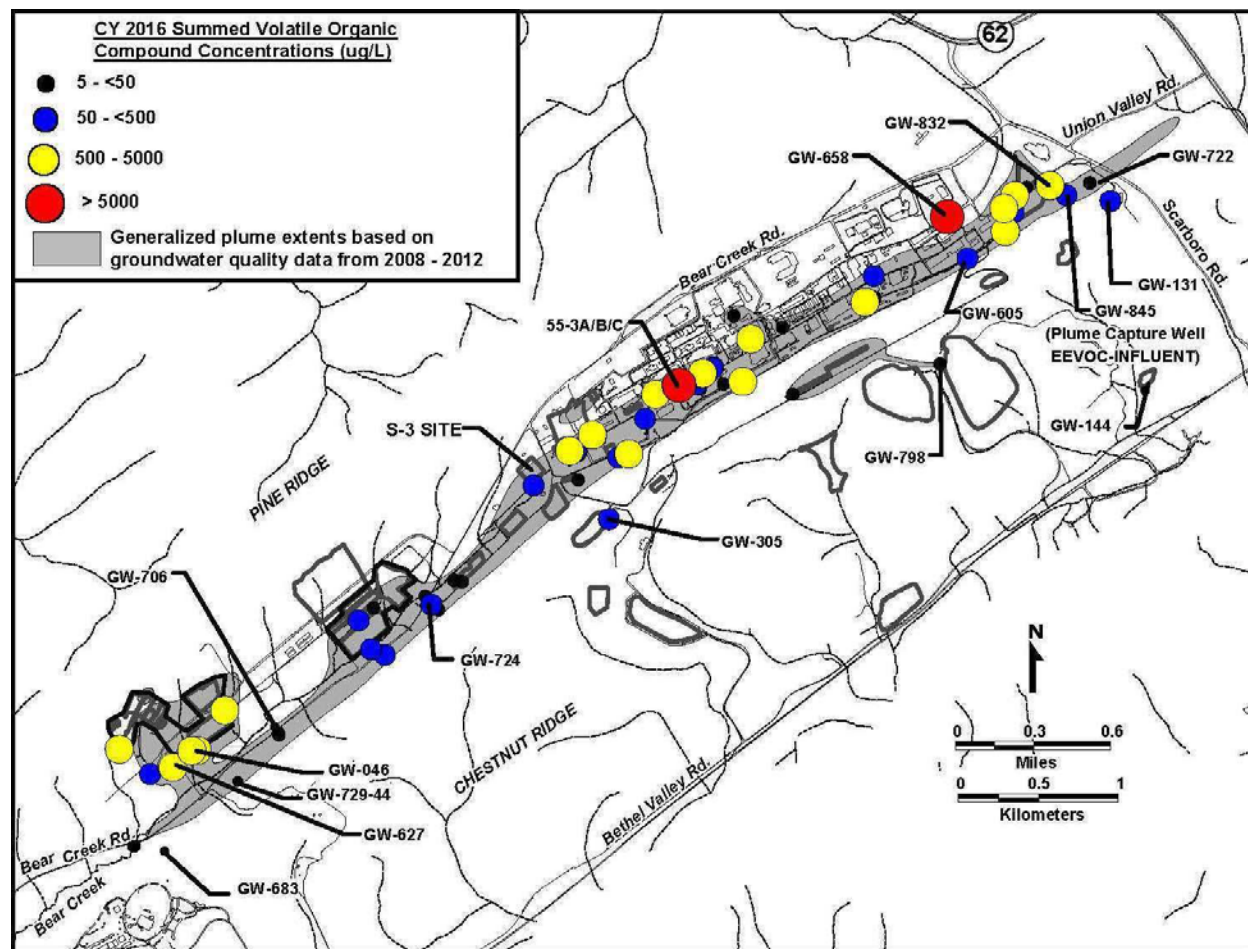
Concentrations of uranium exceed the standard (0.03 mg/L) in a number of source areas (e.g., the S-3 site, the Uranium Oxide Vault, New Hope Pond, and the former oil skimmer basin) and contribute to the uranium concentration in upper EFPC.

#### **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. VOC contaminants in the regime primarily consist of chlorinated and petroleum hydrocarbons. In CY 2016, the highest summed concentration of dissolved chlorinated hydrocarbons (55,843 µg/L) was again found in groundwater at well 55-3B in the western portion of the Y-12 Complex, adjacent to currently inactive manufacturing facilities. The highest dissolved concentration of petroleum hydrocarbons (10,452 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 (Figure 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 (Tetrachloroethene, Trichloroethene, Dichloroethene, 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. However, 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.



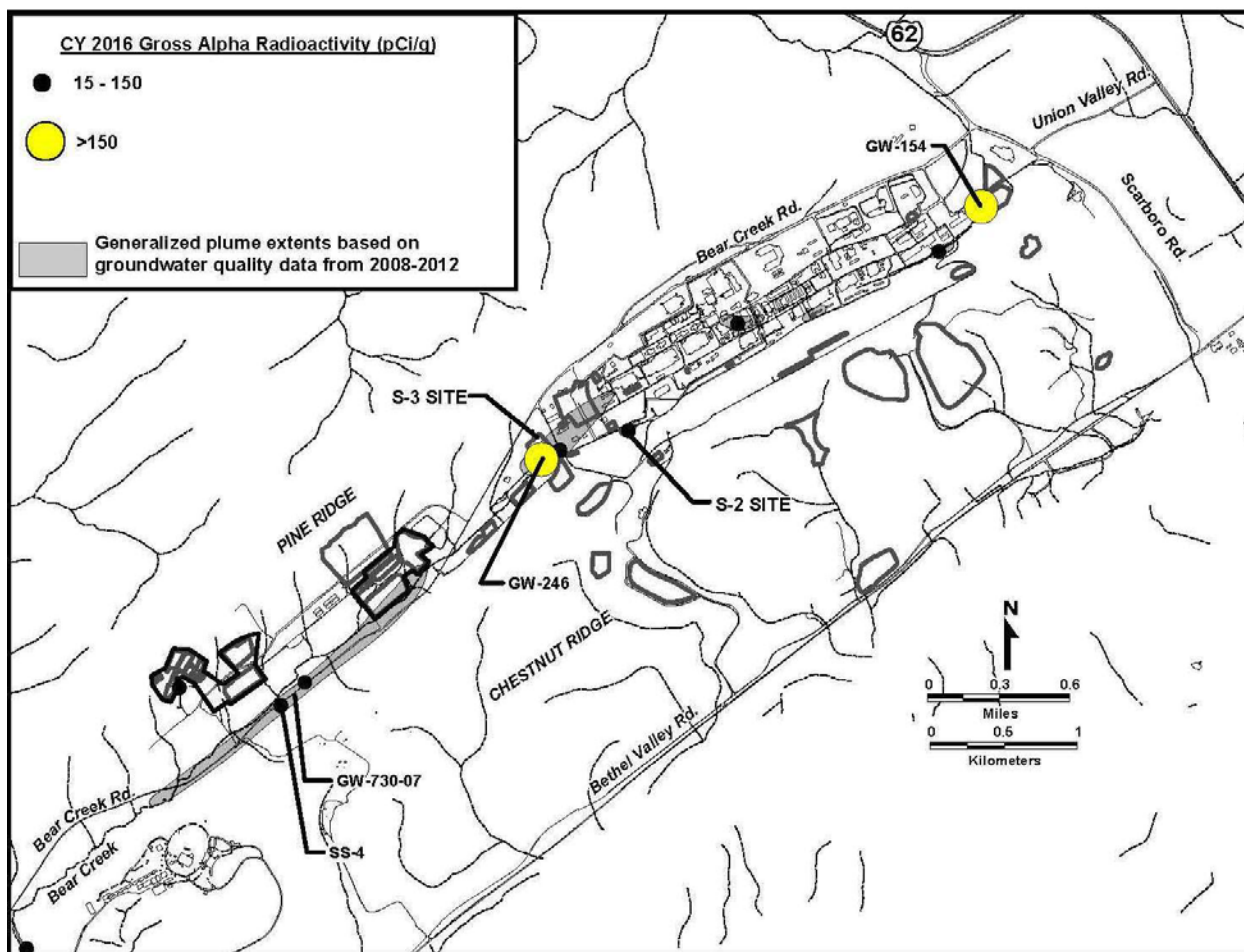
**Figure 4.37. Summed volatile organic compounds observed in groundwater at the Y-12 National Security Complex, 2016.** (EEVOC = east end volatile organic compound.)

Within the exit pathway (the Maynardville Limestone underlying EFPC) the general trends are also stable or decreasing. However, one shallow well (GW-605) exhibits an increasing trend in chloroethenes, indicating active transport in that region of the groundwater plume. The well is west and upgradient of the pumping well (GW-845) operated to capture the east end VOC plume before it migrates off the 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 decreasing and stable 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 and 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 2016 are isotopes of uranium. These radionuclides are not as widely occurring in groundwater as VOCs. Exceedances of the drinking water standard for gross alpha (15 pCi/L) have been observed in the western portion of the Y-12 Complex near the S-3 Site and Salvage Yard source areas and also in the east end near the former oil skimmer basin at the former inlet to the New Hope Pond, which is now capped. In CY 2016, the maximum occurrence of gross alpha activity in groundwater in the upper EFPC regime was 249 pCi/L at well GW-154 on the east end (Figure 4.38).



**Figure 4.38. Gross alpha activity observed in groundwater at the Y-12 National Security Complex, 2016.**

The primary beta-emitting radionuclides observed in the upper EFPC regime are technetium-99 ( $^{99}\text{Tc}$ ) 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 on the west end of the Y-12 Complex. Technetium-99 is the primary contaminant exceeding the screening level of 50 pCi/L; the source is the S-3 site (Figure 4.39). The highest gross beta activity in groundwater was observed during CY 2016 from well GW-108 (11,200 pCi/L), east of the S-3 site.

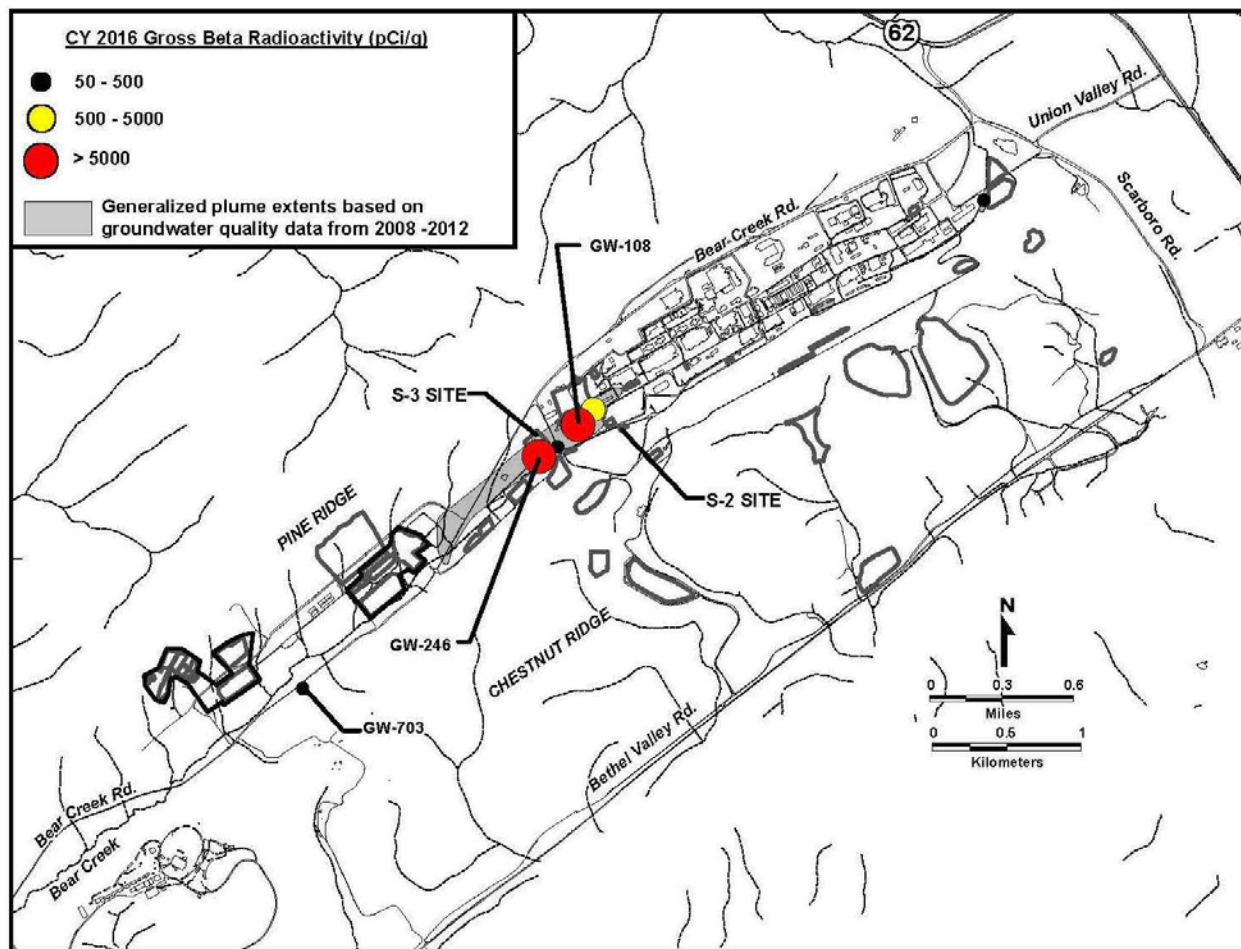


Figure 4.39 Gross beta activity observed in groundwater at the Y-12 National Security Complex, 2016.

#### 4.6.4.1.6 Exit Pathway and Perimeter Monitoring

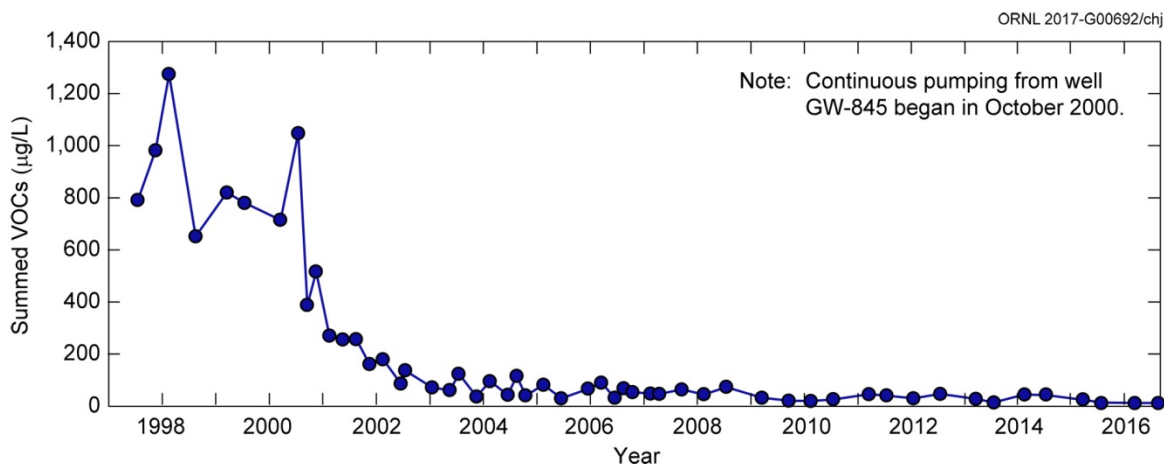
Data collected to date indicate that VOCs are the primary class of contaminants migrating through the exit pathways in the upper EFPC regime. Historically, the compounds have been observed at depths of up to 500 ft below ground surface in the Maynardville Limestone, the primary exit pathway for groundwater 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 (GW-832). 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 2016, the observed concentrations of VOCs at the New Hope Pond distribution channel underdrain remained low (23.3  $\mu\text{g/L}$ ). 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 (Figure 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 Figure 4.41. 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.



**Figure 4.40. Decreasing summed volatile organic compounds (VOCs) observed in exit pathway well GW-722-17 near the New Hope Pond, 2016.**

Ten zones of the Westbay™ multiport monitoring well GW-131, located on the east end of the upper EFPC regime (Figure 4.40), were sampling in CY 2016 with 6 of the 10 zones showing summed VOCs greater than 5 µg/L. However, the VOCs observed in these zones did not include the typical components of the East End VOC Plume (i.e., carbon tetrachloride, PCE, TCE) and none of them exceeded drinking water standards.

Traces of petroleum hydrocarbons (benzene, ethylbenzene, toluene, and xylene) were detected in 5 of the 10 zones. Traces of petroleum hydrocarbons naturally present at depth in the low-permeability bedrock may explain the detection of those compounds. Natural hydrocarbons have been observed in groundwater samples from other deep wells installed in carbonate units (limestone and dolomite) on the ORR.

Other non-EEVOC plume characteristic compounds (acrylonitrile, styrene) were detected in seven of Well GW-131's 10 zones. According to the manufacturer, the Westbay™ sampling system contains several components made with acrylonitrile and styrene, and detection of those compounds is often an



artifact from sampling ports in low-permeability zones. Two zone samples yielded chloroform results at very low levels (2 µg/L).

Upper EFPC flows north from the Y-12 Complex through a large gap in Pine Ridge. Shallow groundwater moves through that 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 (Figure 4.34.) One shallow well was monitored in CY 2016, and no groundwater contaminants were observed.

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, and there were no indications that contaminants were being discharged from the ORR into those communities.

#### **4.6.4.1.7 Union Valley Monitoring**

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

In CY 2016, 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 2015b).

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 contaminants of concern, 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 2016 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 <sup>99</sup> Tc. Closed and capped under RCRA in 1988. Infiltration was the primary release mechanism to groundwater.
Oil Landfarm	Operated from 1973 to 1982. Received waste oils and coolants tainted with metals and PCBs. Closed and capped under RCRA in 1989. Infiltration was the primary release mechanism to groundwater.
Boneyard	Used from 1943 to 1970. Unlined shallow trenches used to dispose of construction debris and to burn magnesium chips and wood. Excavated and restored in 2002–2003 as part of Boneyard-Burnyard remedial activities.
Burnyard	Used from 1943 to 1968. Wastes, metal shavings, solvents, oils, and laboratory chemicals were burned in two unlined trenches. Excavated and restored in 2002–2003 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 needed.
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.

Table 4.20 (continued)

Site	Description
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  
 ETPP = 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 (Figures 4.37–4.40) represent CY 2016 monitoring results. (See Section 4.7.4.1.1 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 2016 indicate that nitrate concentrations in groundwater continue to exceed the drinking water standard (10 mg/L) in an area that extends west from the source area at the S-3 site. The highest nitrate concentration (2,329 mg/L) was observed at well GW-246 adjacent to the S-3 site at a depth of 23 m (76 ft) below ground surface (Figure 4.37). Samples drawn from multiport monitoring well

GW-134 in CY 2011 showed elevated concentrations of nitrate (1,420 mg/L) as deep as 226 m (740 ft) below ground surface near the S-3 source area. Concentrations exceeding the drinking water standard in CY 2016 were observed in groundwater as far as 2,438 m (8,000 ft) west of the S-3 site.

#### 4.6.4.2.3 Trace Metals

During CY 2016, 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 4.7.4.2.3). 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 remedial actions at the Boneyard-Burnyard were performed with the objective of removing materials contributing to surface water and groundwater contamination to meet existing ROD goals. About 65,752 m<sup>3</sup> (86,000 yd<sup>3</sup>) of waste materials was excavated and was placed in the Environmental Management Waste Management Facility (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 remedial actions 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 in Bear Creek since 1990 (Table 4.21); however, concentrations of uranium in the upper reaches of Bear Creek have been fairly stable, indicating that this contaminant still presents a significant impact in surface water and groundwater.

**Table 4.21. Nitrate and uranium concentrations in Bear Creek**

Bear Creek Monitoring Station (distance from S-3 site)	Contaminant	Average concentration <sup>a</sup> (mg/L)					
		1990– 1994	1995– 1999	2000– 2004	2005– 2009	2010– 2014	2015– 2016
BCK <sup>b</sup> -11.84 to 11.97 (~0.5 miles downstream)	Nitrate	116	65.7	89.5	43.3	53.3	27
	Uranium	0.203	0.112	0.129	0.112	0.172	0.199
BCK-09.20 to 09.47 (~2 miles downstream)	Nitrate	16.1	7.8	12.1	8.4	4.4	4.2
	Uranium	0.098	0.093	0.135	0.060	0.051	0.059
BCK-04.55 (~5 miles downstream)	Nitrate	4.7	2.3	3.5	1.1	0.8	0.9
	Uranium	0.034	0.030	0.033	0.020	0.016	0.021

<sup>a</sup>Excludes results that do not meet data quality objectives.

<sup>b</sup>BCK = Bear Creek kilometer

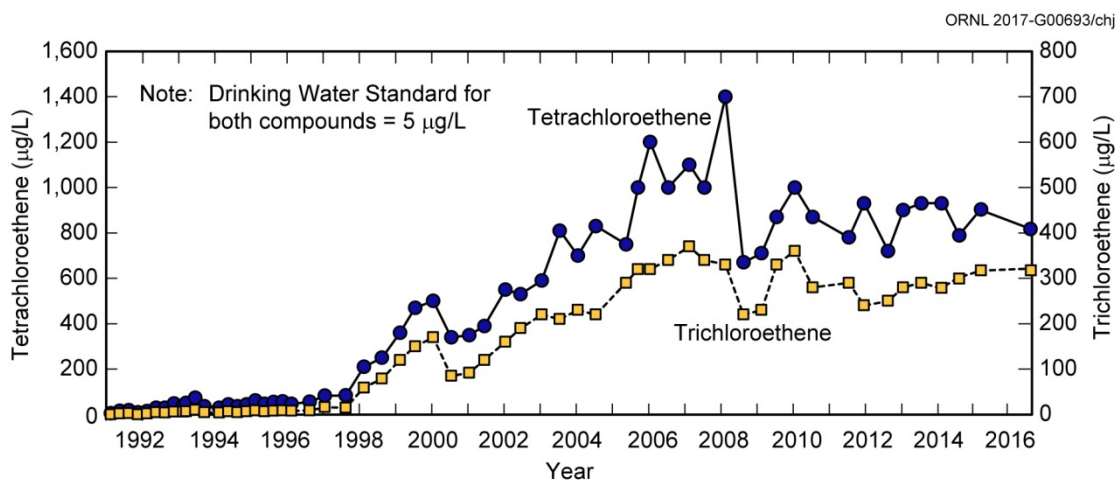
Additional monitoring is ongoing in an attempt to determine uranium inputs to the stream from source areas and the karst groundwater system underlying Bear Creek. Other trace metals observed in the groundwater of Bear Creek regime are arsenic, boron, chromium, copper, mercury, selenium, strontium, thallium, 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 (1,026 ft below ground surface) 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. This was confirmed with follow-up monitoring (GW-790-02) in CY 2016, which did not reveal mercury above detection limits.

#### 4.6.4.2.4 Volatile Organic Compounds

VOCs are widespread in groundwater in the Bear Creek regime. The primary compounds are PCE, TCE, 1,2-1,2-dichloroethene vinyl chloride, and 1,1-dichloroethane. 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 2016 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 4,293  $\mu\text{g/L}$  in well GW-046 (Figure 4.38).

High concentrations of VOCs like this and in other near source wells, coupled with increasing and elevated stable trends (the latter are increasing trends that have plateaued, having become stable at the high concentrations) observed downgradient of the Bear Creek Burial Ground waste management area in the clastic (noncarbonated) dominated fractured bedrock of the aquitard units (Well GW-627, Figure 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.



**Figure 4.41. Increasing volatile organic compounds observed in groundwater at well GW-627 west and downgradient of the Bear Creek Burial Grounds, 2016.**

Significant transport of VOCs has occurred in the Maynardville Limestone. Historical data obtained from monitoring well GW-729-44 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  $^{99}\text{Tc}$ . Neptunium, americium, radium, strontium, thorium, plutonium, and tritium are secondary and less-widespread radionuclides that 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 2016 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) is assumed to be present at elevated levels in the groundwater monitored by the well and, at certain monitoring locations, is evaluated isotopically. A similar rationale is used for annual average gross beta activity that exceeds 50 pCi/L. Technetium-99, a more volatile radionuclide, is qualitatively screened by gross beta activity analysis.

Groundwater in the Bear Creek Regime 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 (Figure 4.39). 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) the zone (GW-730-07) is more than 1,200 ft deep and is unlikely to be hydrologically active; and (3) the sample had an extremely high concentration of total dissolved solids, which can have a significant deleterious effect on the analytical determination of both gross alpha and gross beta activity. The zone was resampled in CY 2016 with no detectable gross alpha activity, confirming that the CY 2015 gross alpha result was anomalous.

Data obtained from exit pathway monitoring stations during CY 2016 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 (SS-4, 30 pCi/L). The highest gross alpha activity observed in the Bear Creek Regime in groundwater was located adjacent to the S-3 Site in CY 2016 (pCi/L in well GW-340).

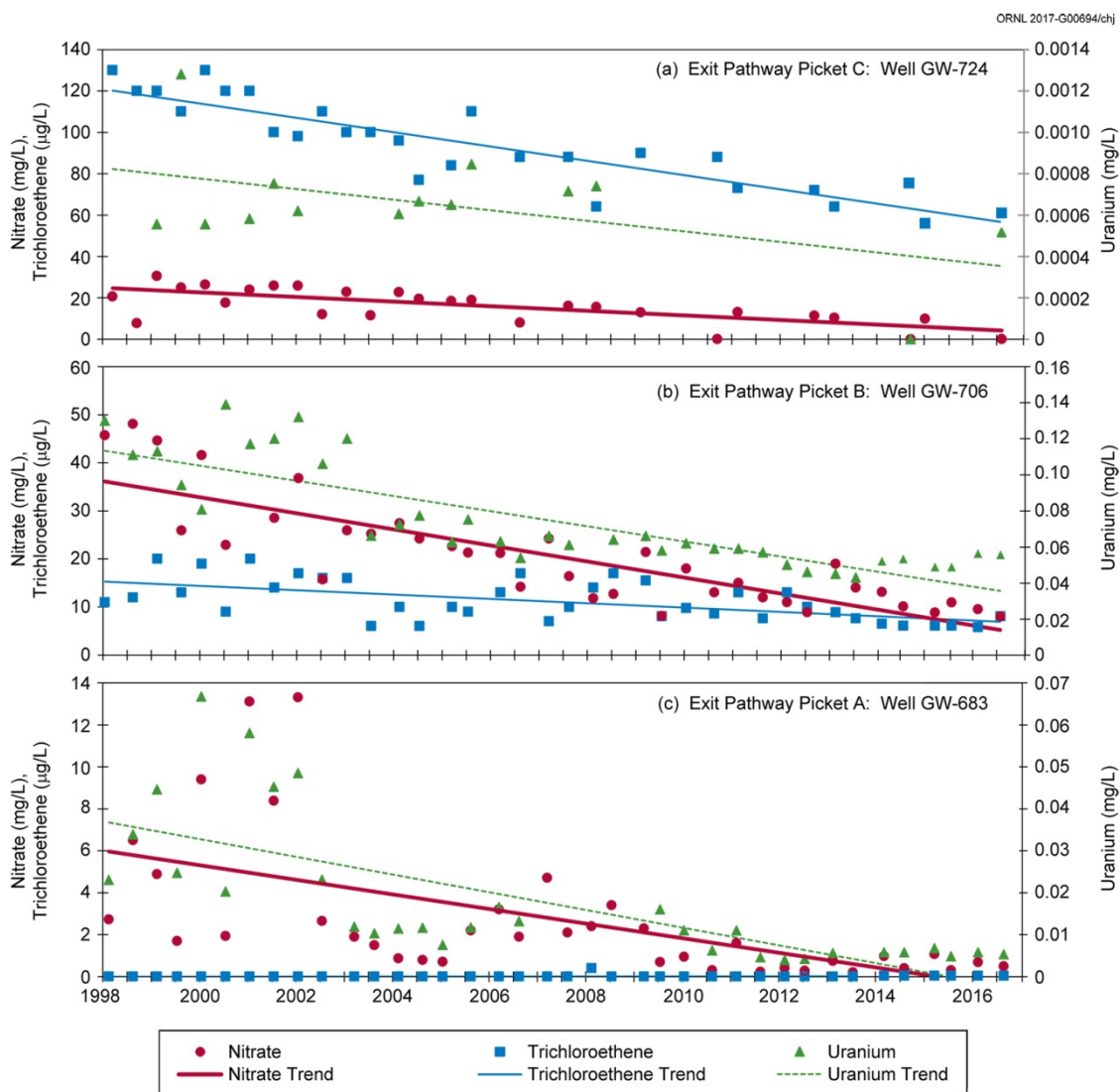
In CY 2016, the highest gross beta activity in groundwater in the Bear Creek regime was also observed at well GW-246 (15,000 pCi/L) indicating that this site continues to be a significant source of radionuclide contamination. One well located at transect B (Figure 4.35) about 2,195 m (7,200 ft) west of the S-3 Site, Well GW-703, presented a gross beta activity (82 pCi/L) in CY 2016 above the drinking water standard. Well GW-703 has historically had elevated activities, but this is the first exceedance since CY 2005.

#### 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 (Figure 4.35).

Exit pathway monitoring consists of continued monitoring at four well transects (pickets) and selected springs and surface water stations. Groundwater quality data obtained during CY 2016 from the exit pathway monitoring wells indicate that groundwater is contaminated above drinking water standards in the Maynardville Limestone between Pickets A and C. Trends continue to be generally stable to decreasing (Figure 4.42).

Surface water samples collected during CY 2016 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 (Table 4.20; see Section 4.7.4.2.3).



Note: Only nitrate and uranium results above the detection limit are plotted; undetected trichloroethene results are plotted at zero.

Figure 4.42. CY 2016 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 (Figure 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, 2016**

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 2016 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; Figure 4.38) 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 (Figures 4.37–4.40) represent CY 2016 monitoring results. (See Section 4.7.4.1.1 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 2016, elevated arsenic levels were detected both upgradient (McCoy Branch kilometer [MCK] 2.05) and downgradient (MCK 2.0) of this wetland area (Figure 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 passive wetland treatment area reduces total arsenic concentrations by about 46% with associated reductions of dissolved arsenic of about 75% (based on sampling results obtained between 2011 and 2016)(DOE 2017). 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 2016; no arsenic was detected.

#### **4.6.4.3.4 Volatile Organic Compounds**

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 (Figure 4.38) have been developing since CY 2000. The maximum summed VOC concentration observed at well GW-798 during CY 2016 was 23.77  $\mu\text{g/L}$ . 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; and in CY 2016 this well had the highest summed VOC concentration (90.3 µg/L) observed in the Chestnut Ridge Hydrogeologic Regime. In CY 2015, samples from this well continued to exceed the drinking water standard for 1,1-DCE (7 µg/L). That finding led to quarterly monitoring to further evaluate the trend. The CY 2015 samples had concentrations of 5.8 to 9.8 µg/L, but in CY 2016 only one quarterly sample exceed the drinking water standard for 1,1-DCE at a concentration of 7.43 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 (Figure 4.38). This well is sampled as part of a RCRA postclosure permit with TDEC managed by UCOR, a DOE EM contractor. Three consecutive samples (all below 4 µg/L) confirmed the presence of carbon tetrachloride. 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 samples yielded only one detection of carbon tetrachloride at GW-144 (1.1 µg/L). In CY 2016, carbon tetrachloride was not detected at either location.

#### **4.6.4.3.5 Radionuclides**

In CY 2016, 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 springs along Scarboro Creek are monitored, 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. Six springs and four surface water monitoring locations were sampled during CY 2016. No contaminants at any of these monitoring stations were detected at levels above primary drinking water standards. However, A gross beta activity above the drinking water standard of 50 pCi/L was observed at surface water location MCK 2.05 (113 pCi/L) in February. This result is unusual; historical activities are typically at background levels. The sample taken the following August was back within the historical range of gross beta activity and was below the drinking water standard.

#### **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 are 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 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 2016 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 2016 for water, soil, and air filter matrices for metals, organics, and radionuclides. The overall acceptability rating from both studies was greater than 96%.

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 surrounding soil, groundwater, and biota. Subsequent transport from the facility resulted in off-site contamination of the lower EFPC. Starting in late 2014, mercury research and technology development activities have been conducted in an effort to develop potential remedial alternatives for lower EFPC.

In FY 2016, a major focus has been on understanding mercury transport and fate in the EFPC system. Monitoring sites from upstream to downstream EFPC were established to measure flow, water chemistry, groundwater, and biota. Once researchers have a better understanding of key mercury sources areas and processes, targeted technologies can be developed. Field studies have pointed to the importance of bank soil erosion as a source of mercury to the creek, especially in the upstream section. Instream factors such as water chemistry and flow characteristics also influence mercury concentration, including the production of methylmercury. Research studies have also highlighted the importance of methylmercury and its bioaccumulation in the food chain.

Technology development activities have focused on developing strategies that may influence the major factors controlling mercury bioaccumulation in fish: the amount of mercury to the system, the conversion of inorganic mercury to methylmercury, and the uptake of mercury in the food chain. Field and laboratory studies have focused on the development of sorbents that might be effective in sequestering mercury, the use of alternative treatment chemicals at Y-12 that might help reduce mercury flux, and the addition of filtering organisms such as mussels that might help change instream chemistry to limit mercury transport on particles or algae.

The multiyear research and technology development effort in lower EFPC is providing detailed and valuable information that will inform remedial alternatives evaluation currently scheduled for the mid-2020s.

### **4.8.2 Designing the Mercury Treatment Facility**

The Oak Ridge Office of Environmental Management (OREM) is working to plan, design, and construct the Outfall 200 Mercury Treatment Facility to reduce mercury concentrations in water exiting the Y-12

Complex. The facility opens the door for large-scale demolition to begin at Y-12 by providing a mechanism to limit and control potential mercury releases caused from disturbing the western portion of the site. It will also help the cleanup program make progress toward achieving compliance with regulatory criteria.

Outfall 200 is the point where the west end Y-12 storm drain system discharges to upper EFPC. Mercury from historical operations is present in the Outfall 200 storm water entering upper EFPC.

In FY 2016, OREM prepared the Preliminary Design Report UCOR-4784, *Preliminary Design Report for the Outfall 200 Mercury Treatment Facility, Y-12 National Security Complex, Oak Ridge, Tennessee* (UCOR 2016) and completed independent design, cost, and constructability reviews. OREM also completed a site geotechnical investigation to support the final design of the facility.

Final design efforts began in early 2016, with completion scheduled for FY 2017. OREM is designing the mercury treatment facility with the capability to treat 3,000 gpm, and the designs also include a 2-million-gal storage tank to collect storm water during peak flow conditions. The facility will treat mercury using chemical precipitation, clarification, and media filtration. The treated water will then be discharged back into upper EFPC.

Employees working on the design are incorporating a modular design that enables future modifications as needed, such as adding additional storm water storage or unit operations to achieve greater mercury reductions based on performance monitoring data.

### **4.8.3 Waste Management**

#### **4.8.3.1 CERCLA Waste Disposal**

During FY 2016, EMWMF received 10,668 waste shipments, accounting for 100,208 tons, from K-27's demolition and several smaller cleanup projects at ETPP, ORNL, and Y-12. The EMWMF, an engineered landfill, consists of six disposal cells that only accept low-level radioactive and hazardous CERCLA waste that meets specific waste acceptance criteria. Waste types that qualify for disposal include soil, dried sludge and sediment, solidified waste, stabilized waste, building debris, scrap equipment, personal protective equipment, and classified waste.

In FY 2016, EMWMF operations collected, analyzed, and dispositioned approximately 3.6 million gal of leachate at the ORNL Liquid and Gaseous Waste Operations (LGWO) facility. No contact water (water that comes in contact with waste but does not enter the leachate collection system) required treatment at ORNL. However, 7.6 million gal of contact water was collected, analyzed, and released to the storm water retention basin after laboratory analyses verified the water met all discharge standards.

#### **4.8.3.2 Solid Waste Disposal**

DOE operates and maintains solid waste disposal facilities called the Oak Ridge Reservation Landfills, three of which are active. In FY 2016, approximately 33,632 cubic yards of waste were disposed in the landfills, which marks a 13% decrease from FY 2015 volumes. However, the clean spoils receipts increased 81% over FY 2015. Clean spoils have the potential for being reused and are segregated to avoid taking up valuable landfill space. Construction of phase two of three phases of the classified landfill was also initiated.

Operation of the ORR landfills generated approximately 2.1 million gal of leachate that was collected, monitored, and discharged into the Y-12 Complex sanitary sewer system.

### 4.8.3.3 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 112 million gal of wastewater was provided at various facilities during the year.

- The West End Treatment Facility and the Central Pollution Control Facility at the Y-12 Complex processed more than 1.1 million gal of wastewater, primarily in support of NNSA operational activities.
- Big Springs Water Treatment System treated more than 94 million gal of mercury-contaminated groundwater. The East End Volatile Organic Compounds Treatment System treated 12.8 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 2.1 million gal of mercury-contaminated sump waters from the Alpha 4 building.

## 4.9 References

- ATSDR. 2006. Public Health Assessment: Evaluation of Potential Exposures to Contaminated Off-Site Groundwater from the Oak Ridge Reservation. Agency for Toxic Substances and Diseases Registry. Atlanta, Georgia.
- B&W Y-12. 2010. Y-12 National Security Complex Quality Assurance Project Plan for National Emission Standards for Hazardous Air Pollutants (NESHAP) for Radionuclide Emission Measurements, Y/TS-874. Babcock & Wilcox Technical Services Y-12, LLC, Oak Ridge, Tennessee.
- B&W Y-12. 2012. Radiological Monitoring Plan for the Oak Ridge Y-12 National Security Complex: Surface Water, Y/TS-1704/R3. Babcock & Wilcox Technical Services Y-12, LLC, Oak Ridge, Tennessee.
- B&W Y-12. 2013. Y-12 Groundwater Protection Program Extent of the Primary Groundwater Contaminants at the Y-12 National Security Complex. Prepared by Elvado Environmental LLC. Y/SUB/13-08769/3.
- B&W Y-12. 2014. Y-12 Complex Ozone Depleting Substances (ODS) Phase-Out and Management Plan, Y/TS-1880/R3. Babcock & Wilcox Technical Services Y-12, LLC, Oak Ridge, Tennessee.
- CNS. 2015. Annual Storm Water Report for the Y-12 National Security Complex, Oak Ridge, Tennessee. Y/TS-2035/R9.
- CNS. 2016. CNS (Pantex/Y-12) FY 2017 Site Sustainability Plan, PLN CNS-F-0003 000 01. Consolidated Nuclear Security, LLC, Oak Ridge, Tennessee.
- CNS. 2017. Calendar Year 2016 Groundwater Monitoring Report. Y/SUB/17-104048/1. US Department of Energy Y-12 National Security Complex, Oak Ridge, Tennessee.
- DOE. 1997. Report on the Remedial Investigation of Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee, DOE/ORR/01-1455/V1/V6&D2. US Department of Energy, Washington, D.C.
- DOE. 1998. Report on the Remedial Investigation of the Upper East Fork Poplar Creek Characterization Area at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee, DOE/OR/01-1641/V1-V4&D2. US Department of Energy, Office of Environmental Management, Oak Ridge, Tennessee.
- DOE. 2007. 2007 Remediation Effectiveness Report for the US Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee, Volume 1: Compendium, DOE/OR/01-2337&D2/V1. US Department of Energy, Washington, DC.
- DOE. 2011. Departmental Sustainability, DOE O 436.1. Approved 5-2-11. US Department of Energy, Washington, DC.
- DOE. 2011a. Final Site-Wide Environmental Impact Statement for the Y-12 National Security Complex, DOE/EIS-0387. US Department of Energy, National Nuclear Security Administration, Y-12 Site Office, Oak Ridge, Tennessee.
- DOE. 2011b. Quality Assurance, DOE O 414.1D. Approved April 25, 2011. US Department of Energy, Washington, DC.
- DOE. 2011c. Radiation Protection of the Public and the Environment, DOE O 458.1. Approved February 11, 2011; Change 2 approved June 6, 2011. US Department of Energy, Washington, DC.
- DOE. 2013. Compliance Plan, National Emission Standards for Hazardous Air Pollutants for Airborne Radionuclides on the Oak Ridge Reservation, Oak Ridge, Tennessee, DOE/ORO/2196 Rev.1. US Department of Energy, Washington, DC.



- DOE. 2015. 2015 Remediation Effectiveness Report for the US Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee, Data and Evaluations, DOE/OR/01-2675&D2. US Department of Energy, Oak Ridge, Tennessee.
- DOE 2016. Amended Record of Decision for the Continued Operations of the Y-12 National Security Complex, National Nuclear Security Administration, Federal Register, Vol. 81, No. 133, approved July 7, 2016.
- DOE. 2016a. Resource Conservation and Recovery Act Post Closure Permit Renewal Application for the Chestnut Ridge Hydrogeologic Regime at the U.S. Department of Energy Y-12 National Security Complex, Oak Ridge, Tennessee, UCOR-4738. U S Department of Energy, Oak Ridge, Tennessee.
- DOE. 2017. Federal Facility Agreement for the Oak Ridge Reservation, Appendix C, Latest Revision—FFA-PM/17-001, DOE/OR-1014. US Department of Energy, Office of Environmental Management, Oak Ridge, Tennessee, available online at [http://www.ucor.com/ettp\\_ffa.html](http://www.ucor.com/ettp_ffa.html).
- DOE. 2017. 2017 Remediation Effectiveness Report for the US Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee, Data and Evaluations, DOE/OR/01-2731&D1. US Department of Energy, Oak Ridge, Tennessee.
- Domenico, P. A., and F. W. Schwartz. 1990. Physical and Chemical Hydrogeology. John Wiley & Sons, p. 824.
- EO 13693, Planning for Federal Sustainability in the Next Decade, March 25, 2015, Fed. Reg. Vol. 80 (27).
- EPA. 1995 and 1998. Compilation of Air Pollutant Emission Factors AP-42, Fifth Edition, Volume 1: Stationary Point and Area Sources. US Environmental Protection Agency, Research Triangle Park, North Carolina January 1995 and September 1998.
- ISO. 2004. Environmental management systems—Requirements with guidance for use. ISO 14001:2004. International Organization for Standardization; available online at <http://www.iso.org>.
- ISO. 2005. General Requirements for the Competence of Testing and Calibration Laboratories. ISO/IEC 17025:2005. International Organization for Standardization/International Electrotechnical Commission; available online at <http://www.iso.org>.
- MMES. 1990. Report and Preliminary Assessment of the Occurrence of Dense, Nonaqueous Phase Liquids in the Bear Creek Burial Grounds Hazardous Waste Disposal Unit at the Oak Ridge Y-12 Plant, Y/TS-960. Martin Marietta Energy Systems, Inc., Oak Ridge, Tennessee.
- NRC. 2000. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, Rev. 1/EPA 402-R-97-016, Rev. 1/DOE/EH-0624, Rev. 1. US Nuclear Regulatory Commission, Environmental Protection Agency, Department of Defense, and Department of Energy, Washington, DC.
- NRC. 2009. Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME), NUREG-1575, Supplement 1/EPA 402-R-09-001/DOE/HS-0004. US Nuclear Regulatory Commission, Environmental Protection Agency, Department of Defense, and Department of Energy, Washington, DC.
- TDEC. 2007. State of Tennessee Water Quality Standards, Chapter 1200-4-3, “General Water Quality Criteria,” October 2007. Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Approved March 2008. Tennessee Department of Environment and Conservation.
- TDEC. 2010a. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Melton Hill Reservoir: Lower Clinch River Watershed (HUC 06010207),

Anderson, Knox, Loudon, and Roane Counties, Tennessee. Tennessee Department of Environment and Conservation, Nashville, Tennessee.

TDEC. 2010b. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Watts Bar Reservoir: Watts Bar Lake Watershed (HUC 06010201), Lower Clinch River Watershed (HUC 06010207), and Emory River Watershed (HUC 06010208), Loudon, Meigs, Morgan, Rhea, and Roane Counties, Tennessee. Tennessee Department of Environment and Conservation, Nashville, Tennessee.

TDEC. 2010c. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Fort Loudon Reservoir: Fort Loudon Lake Watershed (HUC 06010201), Blount, Knox, and Loudon Counties, Tennessee. Tennessee Department of Environment and Conservation, Nashville, Tennessee.

TDEC. 2016. Site Treatment Plan for Mixed Wastes on the US Department of Energy Oak Ridge Reservation, TDEC-REV. 21.0. Tennessee Department of Environment and Conservation, Nashville, Tennessee.

UCOR. 2014. Sampling and Analysis Plan for the Water Resources Restoration Program for Fiscal Year 2015 Oak Ridge Reservation, Oak Ridge, Tennessee, UCOR-4587. URS | CH2M Oak Ridge LLC, Oak Ridge, Tennessee.

UCOR. 2015. Sampling and Analysis Plan for the Water Resources Restoration Program for Fiscal Year 2016 Oak Ridge Reservation, Oak Ridge, Tennessee, UCOR-4587-R1. URS | CH2M Oak Ridge LLC, Oak Ridge, Tennessee.

UCOR. 2016. Sampling and Analysis Plan for the Water Resources Restoration Program for Fiscal Year 2017 Oak Ridge Reservation, Oak Ridge, Tennessee, UCOR-4587-R2. URS | CH2M Oak Ridge LLC, Oak Ridge, Tennessee.

UCOR. 2016. Preliminary Design Report for the Outfall 200 Mercury Treatment Facility, Y-12 National Security Complex, Oak Ridge, Tennessee (UCOR-4784).

UCOR. 2017. Calendar Year 2016, Resource Conservation and Recovery Act Annual Monitoring Report for the US Department of Energy Y-12 National Security Complex, Oak Ridge, Tennessee, UCOR-4946. URS | CH2M Oak Ridge LLC, Oak Ridge, Tennessee.

Vázquez, G. 2011. Clearance of Real and Personal Property Under New DOE Radiation Protection Directive DOE Order 458.1, Radiation Protection of the Public and the Environment. Presented at the 56th Annual Meeting of the Health Physics Society, June 26–30, 2011, West Palm Beach, Florida.