4. The Y-12 National Security Complex

Y-12 National Security Complex (Y-12), a premier manufacturing facility operated by Consolidated Nuclear Security, LLC (CNS) for the National Nuclear Security Administration (NNSA), plays a vital role in the DOE Nuclear Security Enterprise. Drawing on more than 70 years of manufacturing excellence, Y-12 helps ensure a safe and reliable United States nuclear weapons deterrent.

Y-12 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 Y-12 has a new level of flexibility and versatility; therefore, while continuing its key role, Y-12 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.

Due to different permit reporting requirements and instrument capabilities, this report uses various units of measurement. The lists of units of measure and conversion factors on pages xxvii and xxviii are included to help readers convert numeric values presented herein as needed for specific calculations and comparisons.

4.1 Description of Site and Operations

4.1.1 Mission

Charged with maintaining the safety, security, and effectiveness of the United States' nuclear weapons stockpile, Y-12 is a one-of-a-kind manufacturing facility that plays an important role in United States national security. Y-12's core mission is to ensure a safe, secure, and reliable United States nuclear deterrent, which is essential to national security. Every weapon in the United States 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 weapons 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 non-explosive, peaceful uses. Y-12 provides the expertise to secure highly enriched uranium (HEU), store it with the highest security, and make material available for non-weapons 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, Tennessee, Y-12 covers more than 328 ha (810 acres) in the Bear Creek Valley, stretching 4.0 km (2.5 mi) in length down the valley and nearly 2.4 km (1.5 mi) in width across it. NNSA-related facilities located offsite from Y-12 include the Central Training Facility, Uranium Processing Facility (UPF) project offices, Y-12 Material Acquisition and Control, and the Union Valley Sample Preparation Facility.

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 Y-12.

More than 60 percent of 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, Y-12 will continue to strive toward becoming a more responsive, sustainable enterprise.

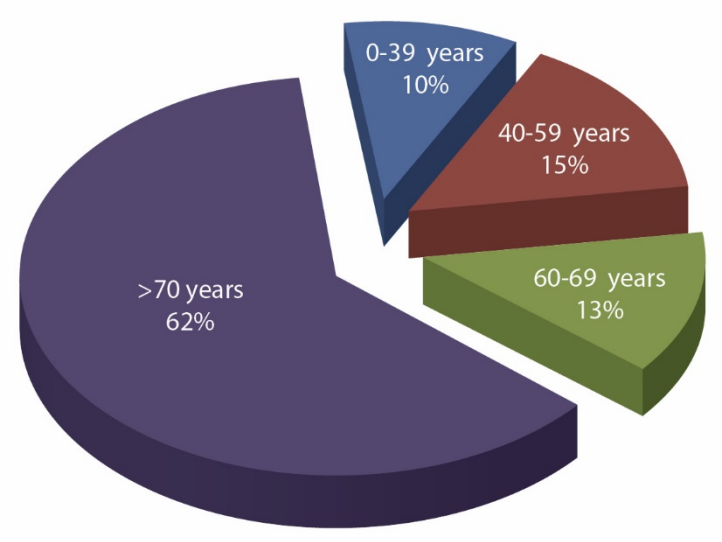


Figure 4.1. Age of mission-critical facilities at the Y-12 National Security Complex

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. Construction at UPF continues to make good progress, and replacement projects for several additional facilities are in the critical design process.

4.1.3 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 Y-12 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 Fiscal Year (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.

When the current UPF construction 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 the following:

- 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.
- Prioritizing replacement capabilities by risk-to-mission continuity, nuclear safety, and security.

4.1.4 Lithium Processing Facility

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 non-nuclear special material vital to production of canned subassemblies is performed in Building 9204-2, built in 1944. The facility (at approximately 325,000 ft^2) 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, which have caused significant deterioration to the concrete. Separation of the concrete and rebar poses a realized risk of falling concrete, which requires administrative controls, including restricted access and protective equipment in many areas. The facility, currently carrying approximately $33 million in deferred maintenance, could be replaced by a new facility less than one-third 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. Construction and replacement activities are underway for the HVAC equipment.

4.1.5 Support Facilities

Emergency response capabilities at Y-12 reside in five primary facilities—four located onsite (Buildings 9706-2, 9105, 2005, and 9710-2), and one (Building K-1650) located at ETTP. Building 9706-2 houses the Plant Shift Superintendent (PSS) and the Emergency Control Center. The Technical Support Center (TSC) was relocated to Building 9105 due to a flood event in Building 9706-02 in 2014. Building 9710-2 is the principal facility housing Fire Protection Operations, with a back-up facility (2005) located on the west end. 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 2020, includes the replacement of the PSS, TSC, and Emergency Response Center. The proposed EOC will more effectively and efficiently support 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 Fire Protection Operations facility has exceeded its useful life and needs to be replaced.

Building 2005 was constructed in 1980 and was originally occupied by 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 is planned for construction beginning in 2020. The new facility will be located on the east end of the plant and is designed to meet current codes and functional requirements.

Over the next 25-year horizon, Y-12 will continue to consolidate personnel and processes in support of the vision for long-range footprint reduction and modernization. The planned construction at Y-12 would eliminate many of the World War II-vintage buildings that currently house the nuclear operations. The following projects are under construction or are being initiated during the Future Year Nuclear Security Plan period:

- UPF
- new 13.8kV substation and plant electrical distribution
- EOC
- West End Protected Area reduction
- Fire Station
- Lithium Processing Facility
- extended life strategy for Buildings 9215, 9204-02E, and 9995
- West End Production Support Change House

The following projects are planned for construction beyond the Future Year Nuclear Security Plan period:

- Applied Technologies Laboratory
- Security Support Complex
- Consolidated Depleted Uranium Manufacturing Capability
- Maintenance Complex
- Non-Special Nuclear Material Storage and Staging Facility
- Waste Management Complex
- Enriched Uranium Manufacturing Center (9215 replacement capability)
- Assembly and Disassembly Center (9204-02E replacement capability)

4.1.6 Excess Facility Disposition

Since 2002, Y-12 has demolished more than 1.6 million gross square footage of excess facilities. Currently, more than 102 excess DOE facilities are located on the Y-12 site, with a total of 2.8 million gross square footage. The excess facilities are owned by NNSA and the DOE Office of Environmental Management (EM), Office of Science, and Office of Nuclear Energy. 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 legacy contaminated facilities.

Non-process-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 biphenyls [PCBs]). The non-process-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. In 2016, Y-12 established the Excess Facility Disposition Program to stabilize and de-inventory the three major high-risk process-contaminated facilities and to safely dispose of other excess facilities around the site.

4.2 Environmental Management System

As part of CNS's commitment to environmentally responsible operations, Y-12 has implemented an Environmental Management System (EMS) based on the requirements of the globally recognized International Organization of Standardization (ISO) 14001:2004 standard to plan, implement, control, and continually improve environmental performance at Y-12 (ISO 2004).

DOE Order (O) 436.1, *Departmental Sustainability* (DOE 2011a), provides requirements and responsibilities for managing sustainability within DOE in accordance with applicable Executive Orders (EOs). DOE O 436.1 further requires implementation of an EMS that is either registered to the requirements of ISO 14001:2004 by an accredited ISO 14001 registrar or self-declared to be in conformance to the standard in accordance with instructions issued by the 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 ISO 14001 since 2006.

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

4.2.1 Integration with Integrated Safety Management System

Y-12's 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 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, which shows the relationship between the ISMS and the integrated EMS.

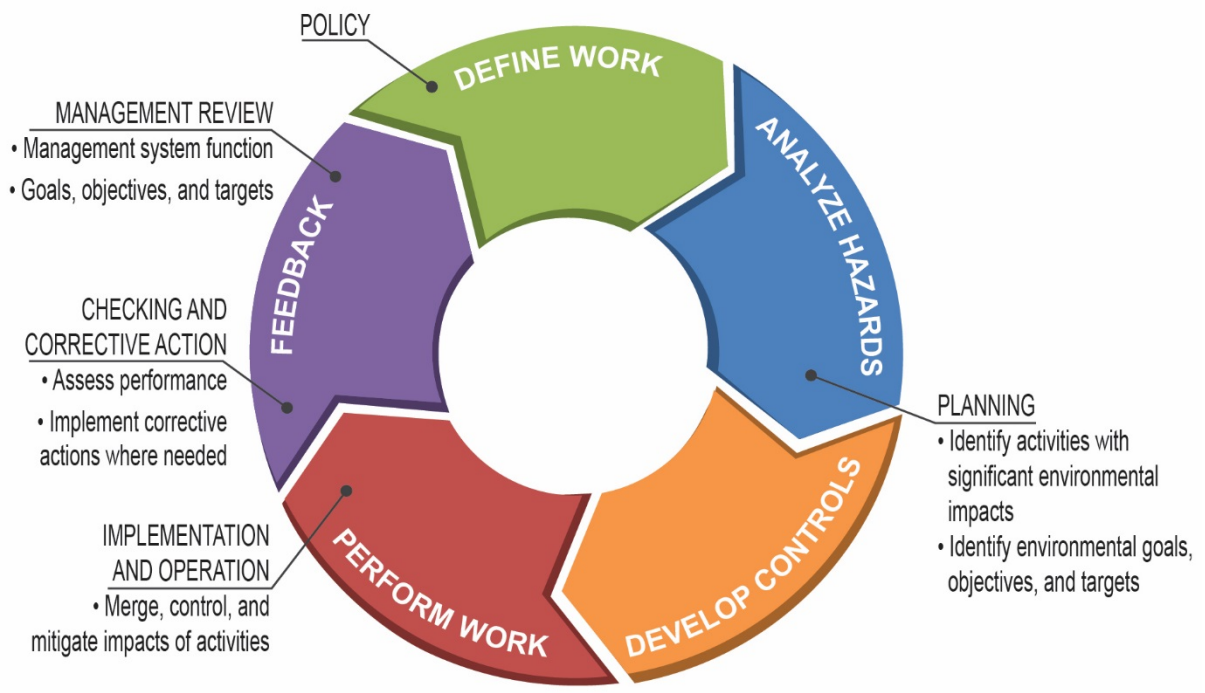


Figure 4.2. Relationship between the Y-12 National Security Complex Environmental Management System and the Integrated Safety Management System depicted in a "plan-do-check-act" cycle

4.2.2 Policy

Y-12's 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. Y-12's ES&H policy is presented in Figure 4.3.

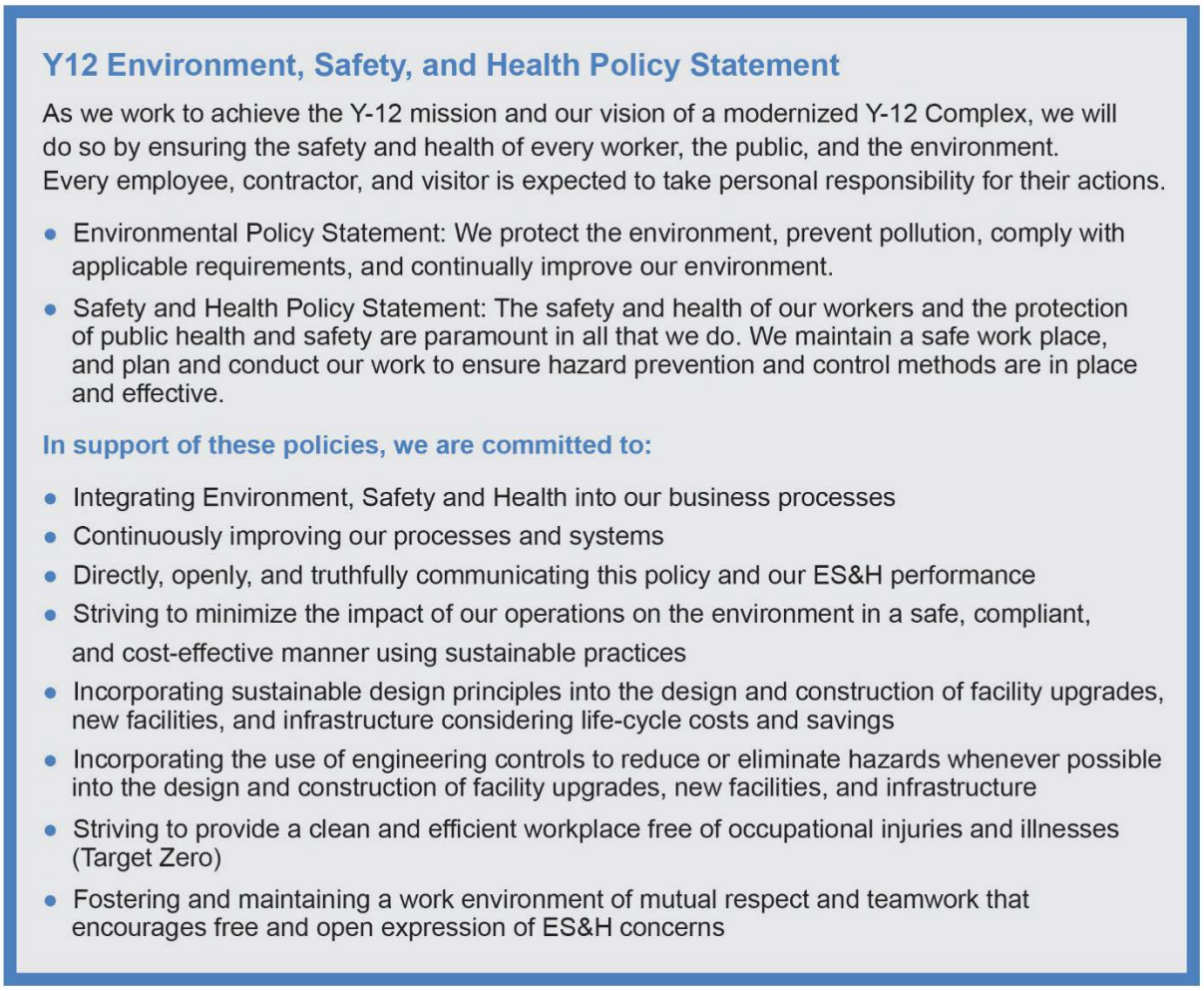


Figure 4.3. Y-12 National Security Complex's environment, safety, and health policy

In addition to Y-12's ES&H policy, CNS has issued an environmental policy that is a significant component of the CNS ISMS and contributes to sustaining the Pantex and Y-12 imperatives of safe and secure operations. The Y-12 ES&H policy and the CNS environmental policy are communicated to all employees and are incorporated into mandatory training for every employee. The policies are available for viewing on both Y-12's external and internal websites. Y-12 personnel are made aware of the commitments stated in the policies and how the commitments relate to Y-12 work activities.

4.2.3 Planning

4.2.3.1 Y-12 National Security Complex 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 analysis identified the following as significant environmental aspects in 2018:

- wastewater
- excess facilities and unneeded materials and chemicals
- surface water
- aging infrastructure and equipment
- legacy contamination and disturbance

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 considering Y-12's significant environmental aspects. They are consistent with Y-12's mission, budget guidance, ES&H work scope, and DOE sustainability 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 2018 environmental targets achieved at Y-12 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 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.

Environmental Compliance

Y-12's Environmental Compliance Department (ECD) provides environmental technical support services and oversight for Y-12 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 Os, environmental laws, and regulations; and consistent with CNS environmental policy and Y-12 site procedures. ECD serves as Y-12's 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 EPA. ECD administers compliance programs aligned with the major environmental legislation that affects Y-12 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 Y-12's EMS and spearheads initiatives to proactively address environmental concerns, to continually improve environmental performance, and to exceed compliance requirements.

Waste Management

The Y-12 Waste Management Program supports the full life cycle of all waste streams within Y-12. While ensuring compliance with federal and state regulations, DOE Os, waste acceptance criteria, and Y-12 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, characterizing, packaging, tracking, reporting, and managing waste treatment/disposal subcontracts.

Sustainability and Stewardship

The Sustainability and Stewardship Program has two major missions. The first is to establish and maintain company-wide programs and services to support sustainable material management operations. These sustainable operations include pollution prevention and recycling programs, excess materials programs, the PrYde program, generator services programs, sanitary waste/landfill coordination, and destruction and recycle facility operations. Y-12 has implemented continuous improvement activities, such as an "Items Available for Re-use" section on the Property Accountability Tracking System 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, Unneeded Materials and Chemicals (UMC), and Targeted Excess Materials. 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. Additionally, at Y-12, unneeded materials are not automatically assumed to be wastes requiring disposal. Y-12 uses a systematic disposition evaluation process. The first step in the disposition process is to determine if the items can be reused at Y-12. Items that cannot be used at Y-12 are evaluated for use at other DOE facilities or government agencies. Items are then evaluated for potential sale, recycle, or, as a last resort, disposal as waste.

Combining these programs under a single umbrella improves overall compliance with EOs, DOE Os, federal and state regulations, and NNSA expectations and eliminates duplication of efforts while providing an overall improved appearance at Y-12.

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 bio-based products), meet sustainable design requirements, and adhere to pollution prevention reporting requirements.

Energy Management

The mission of Y-12 Energy Management Program is to incorporate energy-efficient technologies sitewide 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 continues to status sustainability goals established under EO 13693, "Planning for Federal Sustainability in the next Decade" until DOE establishes new goals in concurrence with the execution of EO 13834, "Efficient Federal Operations," issued in May 2018.

4.2.4 Implementation and Operation

4.2.4.1 Roles, Responsibility, and Authority

The safe, secure, efficient, and environmentally responsible operation of Y-12 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 Y-12.

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 Y-12. 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

Y-12 is committed to keeping the community informed on operations, environmental concerns, safety, and emergency preparedness. The Community Relations Council, composed of more than 20 members from a cross-section of the community, including environmental advocates, neighborhood residents, Y-12 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 and the East Tennessee Foundation, and supported the expansion of a Girls, Inc., program that promotes science, technology, engineering, and mathematics. Additionally, an Introduce a Girl Engineering Event was held at Y-12's New Hope Center on February 22, 2018.

As part of Y-12 Earth Day and America Recycles Day activities, eight local charities received $200 donations from funds raised by Y-12 employee aluminum beverage can recycling efforts. Since the program began in 1994, more than $90,400 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 Y-12's 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 emergency response exercises.

Exercises, performance drills, and training drills were conducted at Y-12 during FY 2018. The drills and exercises focused on topics such as responding to a hazardous chemical release, natural disaster, radiological fire and release, active shooter event, and a criticality event. Building evacuation and accountability drills were also conducted.

4.2.5 Checking

4.2.5.1 Monitoring and Measurement

Y-12 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 2018 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 site-level performance. Progress is reviewed in periodic meetings with senior management and the NNSA 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 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 ISO 14001 in accordance with instructions issued by the Federal Environmental Executive and adhere to DOE O 436.1 (DOE 2011a) 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 Y-12's EMS during June 2018. The Y-12 EMS was found to fully conform, and no issues were identified. The next external verification audit is scheduled for spring 2021.

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. Y-12 used a number of DOE reporting systems, including the following, to report performance:

- The 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, greenhouse gas (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.

The DOE Office of Health, Safety, and Security annual environmental progress reports on implementation of EMS requirements and sustainability goals driven by EOs and the Office of Management and Budget's (OMB's) Environmental Stewardship Scorecard gave Y-12 an EMS scorecard rating for FY 2018 of green, indicating full implementation of EMS requirements.

4.2.6.1 Environmental Management System Objectives and Targets

At the end of FY 2017, Y-12 had achieved 5 of 10 targets that had been established; the remaining targets were carried into future years. Highlights include the following, with additional details and successes presented in other sections of this report:

- Clean Air—Y-12 finalized implementation of a new Title V air operating permit.

- Energy Efficiency—Implementation of five Energy Savings Performance Contract (ESPC) energy conservation measures began in FY 2014 for projects to improve lighting, chilled water, air compressors, and the Y-12 steam system. The five projects were completed in 2017. Significant progress was made on the effort to obtain Leadership in Energy and Environmental Design (LEED) certification on the UPF Construction Support Building. LEED awarded a Silver Certification, with the additional credit points required for obtaining a Gold Certification pending occupancy.
- Hazardous Materials—A project to disposition and ship more than 60 items of legacy mixed waste per Site Treatment Plan milestones was completed in 2018, and UMC FY 2018 priorities were completed to disposition UMCs in the Development High Head Area.
- Land/Water/Natural Resources—Projects to reduce compliance risks associated with aboveground inactive tanks, dikes, and containment areas were completed, which resulted in draining/dispositioning and/or closing more than 25 tanks in FY 2018.
- Reduce/Reuse/Recycle/Buy Green—Y-12 completed a project to improve the Destruction and Recycling Facility and a project to install a drum crusher in one facility to greatly reduce the quantity of empty drum waste.

4.2.6.2 Sustainability and Stewardship

Numerous efforts at Y-12 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 Y-12 have not only benefited the environment but have also resulted in cost efficiencies (Figure 4.4).

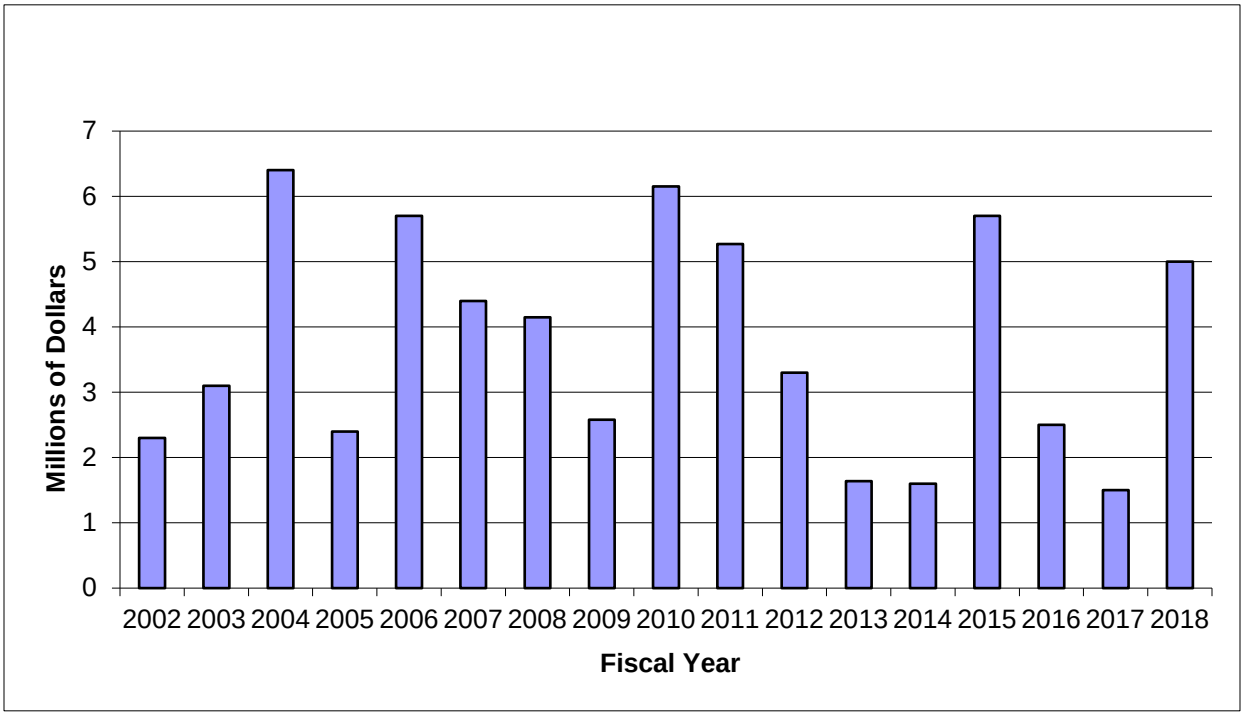


Figure 4.4. Cost efficiencies from Y-12 National Security Complex pollution prevention activities

In FY 2018, Y-12 implemented 96 pollution prevention initiatives (Figure 4.5), with a reduction of more than 62.7 million lb of waste and cost efficiencies of more than $5 million. The completed projects include the activities described below.

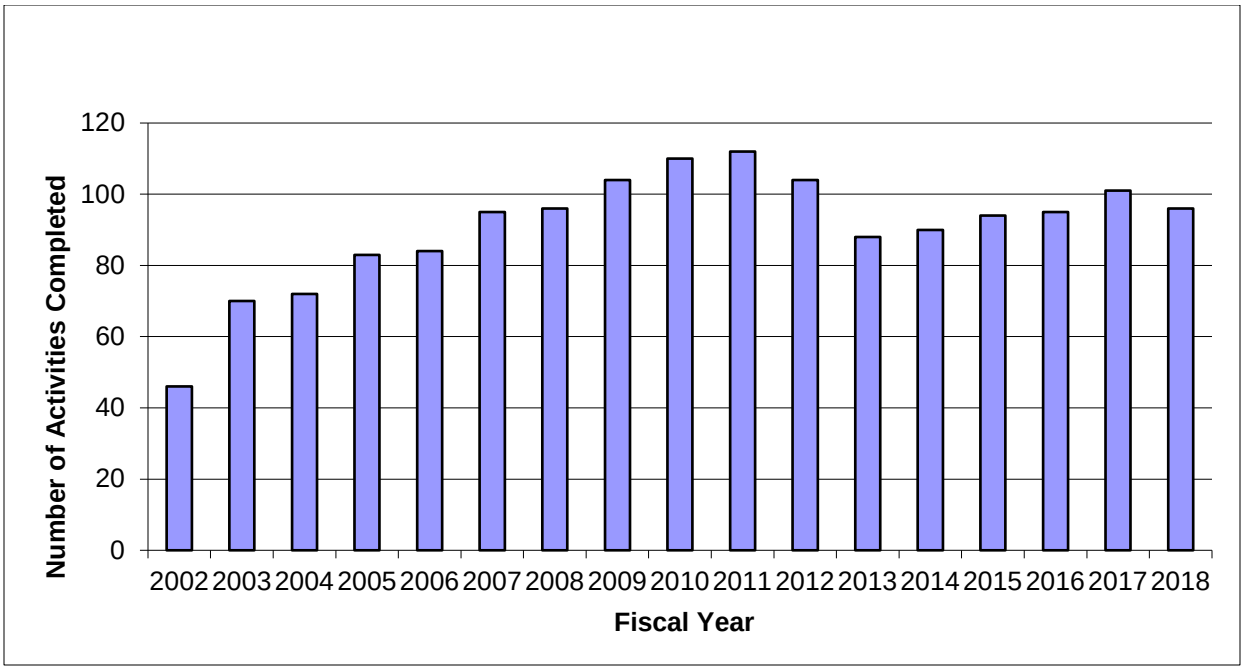


Figure 4.5. Y-12 National Security Complex pollution prevention initiatives

Pollution Prevention/Source Reduction

Sustainable initiatives have been embraced across Y-12 to reduce the impact of pollution on the environment and to increase operational efficiency. Many of Y-12's sustainable initiatives have pollution prevention benefits or targets eliminating the source of pollution, including the 2018 activities highlighted in this section.

Sustainable Acquisition—Environmentally Preferable Purchasing

Sustainable products, including recycled-content materials, are procured for use across Y-12. In 2018, Y-12 procured recycled-content materials valued at more than $14.2 million for use at the site.

Solid Waste Reduction

At Y-12, unneeded materials are not automatically assumed to be wastes requiring disposal. Y-12 uses a systematic disposition evaluation process. The first step in the disposition process is to determine if the items can be reused at Y-12. Items that cannot be reused at Y-12 are evaluated for use at other DOE facilities or government agencies. Items are then evaluated for potential sale; recycle; or, as a last resort, disposal as waste. There is not a waste-to-energy facility for non-hazardous solid municipal or construction and demolition waste in Tennessee.

In 2018, Y-12 diverted 51.6 percent of municipal and 91.5 percent of construction and demolition waste from landfill disposal through reuse and recycle. Y-12 diverted more than 2.3 million lb of municipal materials from landfill disposal through source reduction, reuse, and recycling in FY 2018. More than 60.1 million lb of construction and demolition materials were diverted from landfill disposal in FY 2018.

Hazardous Chemical Minimization

The Generator Services Group provides a material disposition management service for generators at Y-12, which includes the technical support aspect to assist generators with a determination of whether or not the materials can be recycled, excessed, or reused rather than determining that all materials received

must be declared as a waste. Generator Services Group can be used by any department or generator at Y-12. During FY 2018, Generator Services Group personnel, rather than declaring materials as waste, reused or disseminated to other Y-12 organizations for reuse, various excess materials and chemicals. In FY 2018, Generator Services Group prevented the generation of more than 3,200 lb of waste by transferring materials for on-site reuse.

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 4.6, more than 2.78 million lb of materials was diverted from landfills and into viable recycle processes during 2018. 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. The plastics recycling program was expanded in FY 2018 to broaden waste diversion efforts.

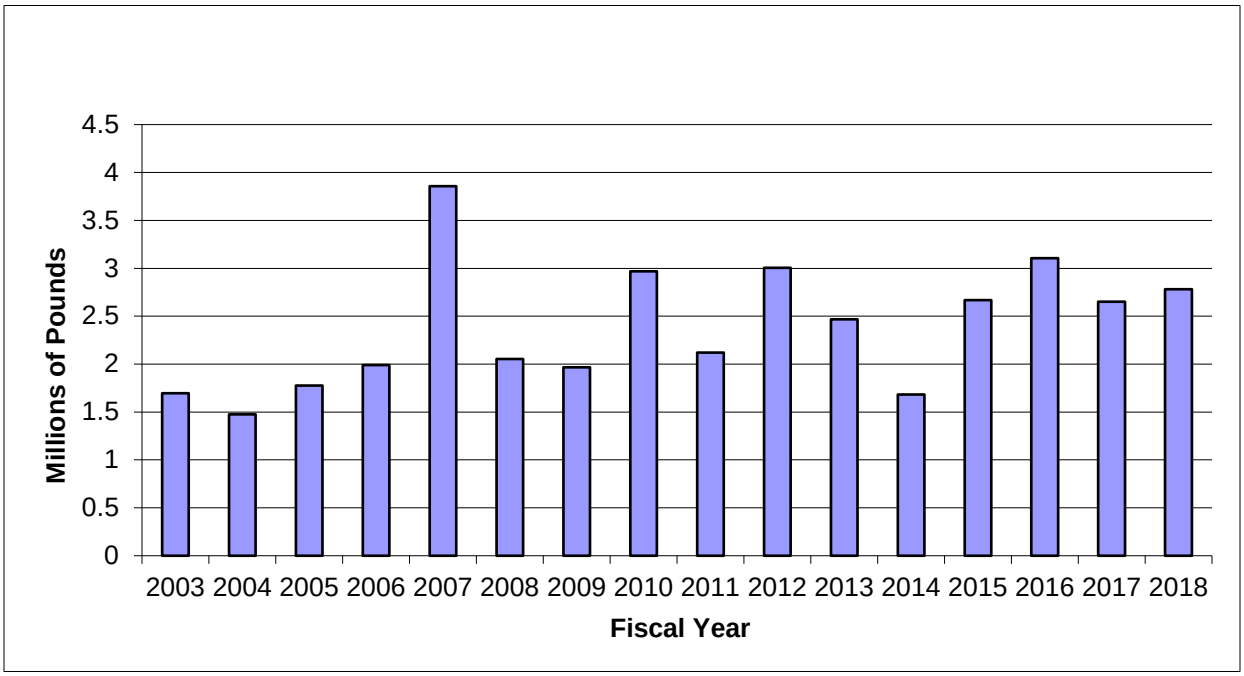


Figure 4.6. Y-12 National Security Complex recycling results

4.2.6.3 Energy Management

The mission of Y-12's Energy Management Program is to incorporate energy-efficient technologies sitewide 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.

EO 13693 established a 25-percent energy intensity reduction goal by 2025 from a FY 2015 baseline. In 2018, Y-12 achieved a 9-percent reduction in energy intensity. Significant reductions have been noted with the implementation of ESPCs at Y-12. Specific ESPC initiatives that aided in the reduction of energy consumption at Y-12 include:

- Completion of a new, more-efficient Air Compressor Plant at the end of FY 2016.

- Continuing to upgrade light fixtures.
- Replacing steam with natural gas.
- Upgrading chillers with new high-efficiency variable speed modes; retrofitting existing chillers with efficient controls; replacing constant-speed chilled water pumps with a variable-speed type; and replacing tower pumps, steam controls, and control valves.
- Replacing Cooling Towers.

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

- Energy Independence and Securities Act (EISA) assessments are included in annual reporting.
- Energy conservation measures from both EISA and the ESPC process are included in budgeting reviews.
- Low-cost/no-cost efforts, including component replacements, are incorporated into routine activities. These include 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:

- Consolidating data centers.
- Continuing installation of advanced metering as funding becomes available.
- Continuing facility upgrades for high-performance sustainable building (HPSB) compliance and implement building retro-commissioning.
- Continuing implementation of cool roof applications.
- Encouraging energy reduction through tenant awareness, including training and monthly meter reporting.

Energy Monitoring

Comprehensive water and energy audits at Y-12 are performed to meet EISA Section 432 requirements. The audits evaluate energy and water use and identify opportunities to reduce use. 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.

The actual electricity costs for Y-12 are based on total energy consumption, as defined by the Tennessee Valley Authority (TVA) revenue meters in the ELZA 1 substation. Monitoring of the ELZA 1 substation electricity usage is used to ensure accurate billing from TVA and to develop the annual utilities budget.

Efforts to read meters and monitor commodity information have been hindered during FY 2018 by communication issues with the Utilities Management System. Where meter data are available, they are entered into the Portfolio Manager for benchmarking and reporting purposes. At present, 135 facilities have been entered and are being tracked for compliance.

Energy Savings Performance Contracts

Dedicated funding for large-scale energy and water projects is provided via the ESPC mechanism. ESPC Delivery Order 2 is in the seventh period of performance at Y-12. This contract included chiller plant improvements, steam condensate return system modifications, steam trap improvements, and demineralized water production facility replacement. Efforts from Delivery Order 2 have greatly contributed toward both energy reduction and efficiency gains for the projects implemented.

In 2013, NNSA issued an ESPC to Johnson Controls and subsequently added additional scope through Modification 2 in 2014 and Modification 3 in 2015. The task order, Delivery Order 3, and modifications included the following:

- steam system decentralization
- chiller plant upgrades
- energy efficient lighting upgrades
- steam and condensate system improvements
- compressed air system upgrades

4.2.6.4 Dashboard Reporting and the Y-12 National Security Complex Site Sustainability Plan

DOE is required to meet sustainability goals mandated by statute and related EOs, including goals for GHG emissions, energy and water use, fleet optimization, green buildings, and renewable energy. Each year, DOE tracks performance and reports progress towards these goals by providing the annual GHG Inventory, Annual Energy Report, Strategic Sustainability Performance Plan, and related reports to OMB, the White House Council for Environmental Quality, and Congress (EPA 2010). In 2018, the Sustainability Performance Office utilized the web-based DOE Sustainability Dashboard to collect DOE site-level sustainability data and consolidate these data sets on behalf of the Department. CNS has completed required sustainability reporting through the DOE Sustainability Dashboard, the Department's official sustainability reporting tool.

The Sustainability Dashboard focuses on specific sustainability goals, and Site Sustainability Plans are completed within the Dashboard. These goals are based on the prior DOE EO (EO 13693) and are found in Table 4.1, along with the current Y-12 performance ratings.

Table 4.1. FY 2018 sustainability goals and performance

Prior DOE goal	Current performance status
Multiple categories	
50% Scope 1 and 2 GHG emissions reduction by FY 2025 from a FY 2008 baseline	Goal met: Site Scope 1 and 2 GHG emissions have been reduced by 55%. Contributing energy reduction efforts can be attributed to major initiatives involving infrastructure improvements completed through ESPC projects
25% Scope 3 GHG emissions reduction by FY 2025 from a FY 2008 baseline	Goal at risk: Site Scope 3 emissions have decreased by 5.6% (-1,779.5 MtCO2e/31,894.5 MtCO2e). Increasing site population and business travel negatively impact this goal
Energy management	
25% energy intensity (Btu per gross square foot) reduction in goal-subject buildings by FY 2025 from a FY 2015 baseline	Goal on track: Y-12 achieved a 9% energy intensity reduction from the 2015 baseline for FY 2018

Table 4.1. FY 2018 sustainability goals and performance (continued)

Prior DOE goal	Current performance status
EISA Section 432 continuous (4-year cycle) energy and water evaluations	Goal met: Y-12 conducts EISA evaluations on a continuous 4-year cycle
Meter all individual buildings for electricity, natural gas, steam, and water, where cost-effective and appropriate	Goal not met: Y-12 meters all utilities; however, not all appropriate buildings are currently metered
Water management	
36% potable water intensity (gal per gross square foot) reduction by FY 2025 from a FY 2007 baseline	Goal met: A 66% reduction from the 2007 baseline was achieved
30% water consumption (gal) reduction of industrial, landscaping, and agricultural water by FY 2025 from a FY 2010 baseline	Goal not applicable: Y-12 does not use industrial, landscaping, and agricultural water
Waste management	
Divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris	Goal met: 51.6% (1,066.6 metric tons/2,065.6 metric tons) of non-hazardous waste diverted from the landfill
Divert at least 50% of construction and demolition materials and debris	Goal met: 91.5% (27,301.1 metric tons/29,849.8 tons) of construction and demolition materials diverted from the landfill
Fleet management	
20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline; maintain 20% reduction thereafter	Goal not met: Alternative fuel (E85) was not available onsite in FY 2018. Y-12 currently operates under an exemption
10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter	Goal not met: Alternative fuel (E-85) was not available onsite in FY 2018. Y-12 currently operates under an exemption
Clean and renewable energy	
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 25% by FY 2025 and each year thereafter	Goal on track: Y-12 receives RECs from Pantex under the shared contract structure. This allows both sites to meet this goal
Renewable electric energy requires that renewable electric energy account for not less than 30% of a total agency electric consumption by FY 2025 and each year thereafter	Goal on track: Y-12 receives RECs from Pantex under the shared contract structure. This allows both sites to meet this goal
Green buildings	
At least 17% (by building count) of existing buildings greater than 5,000 gross ft^2 to be compliant with the revised Guiding Principles for HPSB by FY 2025, with progress to 100% thereafter	Goal at risk: Y-12 had one DOE-owned building compliant with the HPSB goals, the LEED Gold Construction Support Building for FY 2018
Acquisition and procurement	
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring bio-preferred and bio-based provisions and clauses are included in 95% of applicable contracts	Goal met: All contracts issued after October 1, 2013, contain the sustainable acquisition clauses

Table 4.1. FY 2018 sustainability goals and performance (continued)

Prior DOE goal	Current performance status
Measures, funding, and training	
Annual targets for performance contracting to be implemented in FY 2017 and annually thereafter as part of the planning of Section 14 of EO 13693	Goal met: Y-12 has supported performance contracts issued by NNSA. These contracts have been instrumental in achieving energy, water, building modernization, and infrastructure goals at Y-12
Electronic stewardship	
Purchases – 95% of eligible acquisitions each year are EPEAT-registered products	Goal met: More than 95% (6,395/6,717) of all eligible electronic acquisitions during FY 2018 were EPEAT-registered. More than 96% (6,456/6,717) were either EPEAT-registered or Energy Star-qualified products and 95.5% (4,901/5,131) of all computers (desktops and laptops), tablets, workstations, monitors, scanners, and printers were either EPEAT Gold- or Silver-registered
Power management – 100% of eligible personal computers, laptops, and monitors have power management enabled	Goal not met: Y-12 has implemented power management to feasible CPUs and laptops; power management features are enabled on all monitors not deemed mission-critical
Automatic duplexing – 100% of eligible computers and imaging equipment have automatic duplexing enabled	Goal not met: During FY 2018, more than 75.4% (4,275/5,670) of the imaging devices were set to automatically duplex. The majority of these devices that are set to non-duplex or are changed to non-duplex are used to support production and other initiatives that require simpler printed materials
End of Life – 100% of used electronics are reused or recycled using environmentally sound disposition options each year	Goal met: All FY 2018 shipments were made to a R2-certified recycler. Electronics that were not recycled were electronics that could not be radiologically cleared for release. Therefore, 100% of eligible electronics were recycled to a R2-certified recycler
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	Goal not met: Y-12 data centers are not currently metered, and the current PUE is estimated to be <2.4. During FY 2018, initial steps were made to vacate the 9117 data center allowing refurbishment of the space
Organizational resilience	
Discuss overall integration of climate resilience in emergency response, workforce, and operations procedures and protocols	Goal met: The Y-12 Severe Event Emergency Response Plan addresses severe natural phenomena events, extended loss of power events, and events that result in the loss of mutual aid. The site is monitoring the increased number of events as related to Grand Solar Minimum of Activity

Btu = British thermal unit
CPU = central processing unit
DOE = US Department of Energy
EISA = Energy Independence and Securities Act
EO = Executive Order
EPEAT = Electronic Product Environmental Assessment Tool
ESPC = Energy Savings Performance Contract
FY = fiscal year
GHG = greenhouse gas
HPSB = high-performance sustainable building
LEED = Leadership in Energy and Environmental Design
MtCO2e = metric tons of carbon dioxide equivalent
NNSA = National Nuclear Security Administration
PUE = power usage effectiveness
R2 = reused or recycled
REC = renewable energy credit
Y-12 = Y-12 National Security

4.2.6.5 Water Conservation

In FY 2018, Y-12 achieved a 66 percent water intensity reduction from the baseline, surpassing the 2025 goal of 36 percent. Y-12 is currently meeting the water intensity reduction goals and storm water initiatives. All potable water consumed at Y-12 originates from Melton Hill Lake as raw water and is pumped across the ridge to the City of Oak Ridge water treatment plant, which is located within the Y-12

boundary. Y-12 purchases potable water from the city for all domestic and industrial applications. Actions that have contributed to the overall reduction in potable water use include:

- 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
- replacing steam with natural gas in buildings

Most potable water is not metered at the point of use at Y-12, but an evaluation based on known data, facility usage, and other factors provides an estimated assessment of the usage by type. Cooling towers, production facilities, and maintenance-related activities comprise the largest consumers on the Y-12 site. Through ESPC and utility efficiency improvement initiatives, the site is seeing significant improvement in water consumption. As future projects are implemented, additional savings will be realized.Internal EISA audits are conducted on covered facilities on a 4-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. These assessments have identified a number of water conservation projects that could be implemented should funding be allocated. These projects include domestic plumbing retrofits, kitchen equipment upgrades, process system upgrades, cooling tower upgrades, and steam plant upgrades. Continued reductions in water usage will be incorporated into ongoing facility repairs and renovations as funding becomes available. These efforts will include the following:

- Upgrading toilets and urinals to low-flow, hands-free units.
- Installing flow restrictors on faucets and shower heads.
- Repairing condenser loop connections so all condenser water is returned to the cooling towers.
- Replacing existing once-through, water-cooled air conditioning systems with air-cooled equivalents.
- Installing advanced potable water meters.

Many of the domestic upgrades are identified in the Balance of Plant Facilities Plan for implementation on a building-by-building basis as funding allows. Similarly, many of the cooling tower upgrades are prioritized in the Utilities Migration Plan and will be evaluated accordingly for implementation as funding permits. Specific goals include the following:

- There are several HVAC units in Building 9201-3 that require once-through cooling water to cool the condenser. These units are old, and the controls do not work properly. These were submitted as a project to the Asset Management Program. Goal one is to replace these units.
- Replacement of very old, underground laterals that go from the water main to buildings. Because these are very old, they are suspected to leak water.
- Replacement of several vacuum pumps in Y-12 that require once-through cooling water.

4.2.6.6 Fleet Management

The Y-12 fleet is comprised of Agency and Government Services Administration (GSA)-owned sedans, light-duty trucks/vans, medium-duty trucks/vans, and heavy-duty trucks. During the last quarter of FY 2015, 240 sedans and light- and medium-duty vehicles from Y-12's agency-owned fleet were

transferred to GSA. Throughout FY 2016, GSA replaced 240 of those vehicles, with 177 of the replacements being alternative fuel (E85) vehicles. Y-12 additionally acquired 31 Flex Fuel vehicles during FY 2017 and completed an assessment of the heavy-duty vehicle inventory. As a result of the assessment, multiple heavy-duty vehicle reassignments were made to better utilize the heavy-duty fleet. This revitalization of the existing fleet has decreased the average age of Y-12's vehicles from 15 years to 2 years of age for light- and medium-duty vehicles. By replacing the older, less fuel efficient vehicles with newer, alternative fuel vehicles, Y-12 will reduce its consumption of petroleum fuels and its GHG emissions and increase its potential capacity for the use of alternative fuels. Y-12 continues to operate a taxi service as one of the strategies for fleet optimization.

Y-12 currently does not utilize alternative fuel and continues to operate under an exception from DOE. The only available on-site fuel station was placed out of service in 2015 after the rupture of an on-site fuel tank. In FY 2018, Y-12 continued to implement an interim refueling process using mobile tanker trucks to perform all vehicle and equipment refueling operations until a new fueling capability can be established. The mobile tanker trucks have only enough capacity to provide diesel and gasoline.

4.2.6.7 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. More than 95 percent of desktop computers, laptops, monitors, and thin clients purchased or leased during FY 2018 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.

4.2.6.8 Greenhouse Gases

Y-12 reduced Scope 1 and Scope 2 GHG emissions by 55 percent in FY 2018 compared to the FY 2008 baseline, meeting the 50 percent reduction goal for 2025. Emission reduction can be attributed primarily to decreased Scope 1 (on-site fuel burning) emissions from more efficient steam generation and decreased Scope 2 (purchased electricity) emissions from energy efficiency projects.

Purchased electricity is by far the biggest contributor to Y-12's GHG footprint, accounting for nearly 97 percent of Scope 1 and 2 GHG emissions. Energy reduction efforts include major initiatives involving production facilities and utility infrastructure completed through ESPC projects.

4.2.6.9 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. Y-12 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 Calendar Year (CY) 2018 include the demolition of Buildings 9111 and 9112. The area was returned to a grass area once the buildings and footings were removed. The two demolitions added about 0.5 acres of green space within Y-12.

4.2.7 Awards and Recognition

Since November 2000, the commitment to environmentally responsible operations at Y-12 has been recognized with more than 146 external environmental awards from local, state, and national agencies. The awards received in 2018 are summarized in the following sections.

4.2.7.1 Electronic Product Environmental Assessment Tool Award

Y-12 received an EPEAT Purchaser 4 Star Level Award for Excellence in Green Procurement of Electronics in a ceremony in Minneapolis, Minnesota, on May 14, 2018. Y-12 was recognized by the Green Electronics Council at the 4 Star Level for purchasing EPEAT electronics in the following categories during Fiscal Year 2017: Personal Computers and Displays, Imaging Equipment (e.g., copiers, scanners, and multi-function devices), Televisions, and Mobile Phones.

4.2.7.2 US Department of Energy and National Nuclear Security Administration Sustainability Awards

Y-12 received the following 2018 DOE Sustainability Awards:

- The Strategic Partnerships for Sustainability Award was presented to the UPF Project Office Site Infrastructure and Services Integrated Project Team for building strategic partnerships for sustainability. The award recognizes the team, and the partnership between the US Army Corps of Engineers Nashville District, UPF Project Office, and CNS, that resulted in the successful on-time and under-budget completion of the LEED Gold certification for the UPF's Construction Support Building (CSB). The innovative CSB design will support the site's sustainability efforts throughout the lifetime of the facility.
- The Sustainability Champion Award was presented to Y-12's Frank McHenry for his role in Y-12's ESPC. The activities completed under these contracts contributed to achieving or surpassing sustainability goals for GHG emissions and water and energy intensities. McHenry successfully coordinated Y-12's managing and operating contractor, CNS, and ESPC contractor personnel.

Both of these activities were also awarded a corresponding NNSA Sustainability Award.

4.3 Compliance Status

4.3.1 Environmental Permits

Table 4.2 lists environmental permits in force at Y-12 during 2018. More-detailed information can be found in the following sections.

4.3.2 National Environmental Policy Act/National Historic Preservation Act

As federal agencies, DOE and NNSA comply with National Environmental Policy Act (NEPA) requirements (procedural provisions, 40 Code of Federal Regulations [CFR] 1500 through 1508), as outlined in DOE's Implementing Procedures for NEPA (Title 10 CFR 1021). CNS fully supports NNSA's commitment to NEPA through evaluating the potential impacts of proposed federal actions 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 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.

Table 4.2. Y-12 environmental permits, CY 2018

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	Title V Major Source Operating Permit	571832	12/01/2017	11/30/2022	DOE	DOE	CNS
CAA	Permit to Construct or Modify an Air Contaminant Source	974225	09/14/2018	09/13/2020	DOE	DOE	CNS
CWA	Industrial & Commercial User Wastewater Discharge (Sanitary Sewer) Permit	1-91	07/01/2017	03/31/2021	DOE	DOE	CNS
CWA	NPDES Permit	TN0002968	10/31/2011	11/30/2016[a]	DOE	DOE	CNS
CWA	UPF 401 Water Quality Certification/ ARAP Access/Haul Road	NRS10.083	06/10/2010	06/09/2015[c]	DOE	DOE	CNS
CWA	UPF Department of Army Section 404 Clean Water Act Permit	2010-00366	09/02/2010	09/02/2020	DOE	DOE	CNS
CWA	UPF General Storm Water Permit Y-12 (41.7 hectares/103 acres)	TNR 134022	10/27/2011	09/30/2021	DOE	CNS	CNS
CWA	No Discharge Portal 20 Pump and Haul Permit	SOP-170-14	07/08/2017	07/01/2022	DOE	DOE	CNS
CWA	No Discharge Portal 23 Pump and Haul Permit	SOP-170-15	07/08/2017	07/01/2022	DOE	DOE	CNS
CWA	No Discharge Portal 19 Pump and Haul Permit	SOP-130-31	06/26/2018	06/30/2023	DOE	DOE	CNS
CWA	No Discharge EMWMF Pump and Haul Permit	SOP-01043	09/01/2017	09/31/2022	DOE	UCOR	UCOR
RCRA	Hazardous Waste Transporter Permit	TN3890090001	12/17/2018	01/31/2020	DOE	DOE	CNS
RCRA	Hazardous Waste Corrective Action Permit	TNHW-164	09/15/2015	09/15/2025	DOE	DOE, NNSA, and all ORR co-operators of hazardous waste permits	UCOR

Table 4.2. Y-12 environmental permits, CY 2018 (continued)

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
RCRA	Hazardous Waste Container Storage Units	TNHW-122	08/31/2005	08/31/2015 [a]	DOE	DOE/CNS	CNS/ Navarro co-operator
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-127	10/06/2005	10/06/2015 [a]	DOE	DOE/CNS	CNS co-operator
RCRA	RCRA Post-closure Permit for the Chestnut Ridge Hydrogeologic Regime	TNHW-128	09/29/2006 Permit reapplication was denied and the permit closed on 02/23/2018	02/23/2018 [b]	DOE	DOE/UCOR	UCOR
RCRA	RCRA Post-closure Permit for the Bear Creek Hydrogeologic Regime	TNHW-116	12/10/2003 Permit reapplication was denied and the permit closed on 02/23/2018	02/23/2018 [b]	DOE	DOE/UCOR	UCOR
RCRA	RCRA Post-closure Permit for the Upper East Fork Poplar Creek Hydrogeologic Regime	TNHW-113	09/23/2003 Permit reapplication was denied and the permit closed on 02/23/2018	02/23/2018 [b]	DOE	DOE/UCOR	UCOR
Solid Waste	Industrial Landfill IV (operating, Class II)	IDL-01-103-0075	Permitted in 1988—most recent modification approved 12/18/2018	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Industrial Landfill V (operating, Class II)	IDL-01-103-0083	Initial permit, most recent modification approved 12/18/2018	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 01/15/1986	N/A	DOE	DOE/UCOR	UCOR

Table 4.2. Y-12 environmental permits, CY 2018 (continued)

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
Solid Waste	Construction and Demolition Landfill VI (post-closure care and maintenance)	DML-01-103-0036	Permit terminated by TDEC 03/15/2007	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Centralized Industrial Landfill II (post-closure care and maintenance)	IDL-01-103-0189	Most recent modification approved 05/08/1992	N/A	DOE	DOE/UCOR	UCOR
SDWA	Underground Injection Control Class V Injection Well Permit	Permit by Rule TDEC Rule 0400-45-06	03/12/2002	None	DOE	DOE	CNS

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

[b] A public notice to deny the renewal of the three post-closure permits and provide post-closure care under CERCLA was published on December 27, 2017, and issued final with an effective date of February 23, 2018.

[c] Monitoring and maintenance phase.

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
CY = calendar year
DOE = US Department of Energy
EMWMF = Environmental Management Waste Management Facility
N/A = not applicable
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
SDWA = Safe Drinking Water Act
TDEC = Tennessee Department of Environment and Conservation
UCOR = URS | CH2M Oak Ridge LLC
UPF = Uranium Processing Facility
Y-12 = Y-12 National Security Complex

The *Final Site-Wide Environmental Impact Statement for the Y-12 National Security Complex* (DOE 2011b) was issued in March 2011. The Site-Wide Environmental Impact Statement (SWEIS) and the Notice of Availability were published on March 4, 2011 (EIS-0387). NNSA issued a Record of Decision (ROD) in July 2011 (EIS-0387 ROD) (DOE 2011c) for the continued operation of Y-12, based on the SWEIS. Since the ROD, NNSA has updated the strategy and design approach for the 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* (ORNL 2014). The updated UPF strategy was addressed in detail in a Supplement Analysis (SA) for the Final SWEIS (DOE 2016a; EIS-0387-SA-01), and NNSA amended the ROD (DOE 2016b, 81 FR 45138) on July 22, 2017.

In accordance with 10 CFR 1021.330, DOE/NNSA shall evaluate sitewide environmental impact statements (EISs) by means of an SA at least every 5 years. The SA determines if there are substantial changes to the SWEIS, if there are significant new circumstances at the site, or if there is information that is relevant to environmental concerns as discussed in 40 CFR 1502.9(c)(1). The SA determines whether: (1) the SWEIS is sufficient, (2) a supplement EIS is required, or (3) if a new SWEIS document is required. The SA discussed above (EIS-0387-SA-01) addressed UPF's change in strategy and did not address or evaluate the remainder of operations and activities at Y-12 since the 2011 document. Therefore, in 2016, a second SA was initiated to address the continual operations and activities at Y-12. The draft of this document was issued for public comment in June 2018 with over 70 comments received. The existing ROD was not amended, and the final SA (EIS-0387-SA-03) was issued in August 2018 (DOE 2018a).

During 2018, CNS completed environmental evaluations for 50 proposed actions at Y-12, and 47 such actions were categorically excluded, as allowed by Y/TS-2312, *National Environmental Policy Act General Categorical Exclusion, Appendix B to Subpart D of Part 1021* (B&W Y-12 2012a). The majority of the proposed actions involved the sustainment of enduring facilities, bridging strategies for facilities identified with an out-year replacement, and the deactivation and demolition of facilities deemed excess to Y-12's needs. As many facilities have, or are, approaching the 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 and transformer upgrades), the Fire Suppression Upgrade Project (wet pipe sprinkler head replacements), high energy computed tomography, design of new chip melt furnaces, new chip dollies, and multiple machining tool and controller equipment upgrades. In addition, the following projects were also evaluated during 2018: (1) the West End Protection Area Reduction (WEPAR) project (including utility re-routes and disconnects); (2) the bridging and sustainment of current lithium production capabilities (equipment and facilities), including the replacement and refurbishment of the humidity control system (Kathabar), upgrades to Wet Chemistry operations, upgrades to Lithium Purification, and upgrades/changes to the Lithium Salvage Reclamation; (3) the replacement of an elevator hydraulic jack for one building; (4) the demolition and deactivation projects for multiple excess facilities (including equipment draining and removal); (5) the design and installation of three new 13-kV transmission lines inside Y-12; (6) the installation and activation of a New Brunswick Laboratory trailer for the Analytical Chemistry Organization; (7) environmental control upgrades (HVAC) to Y-12's computing data center; (8) the assessment and placement of excess stationary tanks into permanently out-of-service status; and (9) the re-surfacing and paving of Y-12 roads, with the creation of new parking lots for the UPF project. The Roof Asset Management Project, along with the planning and design of the Y-12 EOC and the Y-12 Fire Station, continued this year.

During 2018, the following categorically excluded determination forms were approved by NPO and posted on the public website:

- Property Transfer of the Y-12 West End Fuel Station, CX-ORR-18-001
- NEPA 4728, revision 1, Demolition of Building 9720-24
- NEPA 4840, Demolition of Groups #2 and #3 trailers
- NEPA 4834, revision 2, WEPAR Project

An environmental assessment determination (EAD) was sent to NNSA for review and approval for the Lithium Production Capability (LPC; NEPA #4810). NNSA concurred that an environment assessment was required to evaluate an alternative (and potential environmental impacts) for the construction of a replacement facility for the manufacturing and production capability for lithium components. In March 2018, NNSA approved the EAD and renamed the new facility as the Lithium Processing Facility (LPF). A new LPF will provide administrative and manufacturing space for the production of lithium components. The new facility will ensure Y-12 maintains the required lithium production capabilities, reduces the annual operating cost, and increases processing efficiencies—using safer, more-modern, more-agile, and more-responsive processes. The construction footprint is located within the Biology Complex, located on the east end of Y-12. DOE Office of Real Estate Management (OREM) has committed to the demolition of several of the Biology Complex buildings, removing slabs and/or footings, and the remediation of any contaminated soil. DOE OREM will need to gain regulatory concurrence that no further action will be required to address soil contamination (within the defined construction footprint) for NNSA to proceed. The LPF is anticipated to be a non-nuclear, hazardous material facility.

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 2018 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.

Fifty 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 50 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 Y-12 during World War II and the Cold War era. The interviews also provide information on day-to-day operations of Y-12, the use and operation of significant components and machinery, and how technological innovations occurred over time. Some of the information collected from past interviews is 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 brochures, books, pamphlets, postcards, and fact sheets, is available free to the public.

Y-12 partnered with the National Park Service during the annual Earth Day events on April 19, 2018. These events were held in Y-12's Jack Case Center cafeteria lobby area. The DOE Earth Day Theme was "Earth Day—There is No Planet B." 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 2018 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 2018, 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 provided visitors with windshield tours of the perimeter of Y-12 and a more in-depth tour inside Building 9731, also known as the "Pilot Plant."

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 rich and significant history of Y-12 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 Y-12. New projects are governed by construction permits and modifications to the Title V operating air permit, and eventually the requirements are incorporated into the sitewide Title V operating permit. Y-12 is currently governed by Title V Major Source Operating Permit 571832.

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 2018, and there were no permit violations or exceedances during the report period.

Ambient air monitoring, while not specifically required by any permit condition, is conducted at Y-12 to satisfy DOE O 458.1, *Radiation Protection of the Public and the Environment* (DOE 2011e), requirements as a best management practice and/or to provide evidence of sufficient programmatic control of certain emissions. Ambient air monitoring conducted specifically for Y-12 (i.e., mercury monitoring) is supplemented by additional monitoring conducted for ORR and by both on- and off-site monitoring conducted by TDEC.

Section 4.4 provides detailed information on 2018 activities conducted at Y-12 in support of the Clean Air Act (CAA).

4.3.4 Clean Water Act Compliance Status

During 2018, Y-12 continued its excellent record for compliance with the National Pollutant Discharge Elimination System (NPDES) water discharge permit. Data obtained as part of the NPDES program are provided in a monthly report to TDEC. The percentage of compliance with permit discharge limits for 2018 was 100 percent.

Approximately 2,300 data points were obtained from sampling required by the NPDES permit; no non-compliances were reported. Y-12's 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 a new permit was prepared and submitted to TDEC in May 2016. The currently expired NPDES permit continues in effect until the new permit is issued by the State of Tennessee.

4.3.5 Safe Drinking Water Act Compliance Status

The City of Oak Ridge supplies potable water to Y-12 and meets all federal, state, and local standards for drinking water. The water treatment plant, located north of Y-12, is operated by the City of Oak Ridge. Y-12 potable water distribution is operated by a State-certified distribution system operator. The distribution system is regulated by TDEC as a public water system, with public water distribution system identification number 0001068.

Tennessee Regulations for Public Water Systems and Drinking Water Quality, Chapter 0400-45-01, sets limits for biological contaminants, chemical activities, and chemical contaminants. Sampling for total coliform, chlorine residuals, lead, copper, and disinfectant byproducts is conducted by Y-12's ECD, with oversite by a State-certified operator.

In 2018, Y-12's potable water system received a sanitary survey score of 100 out of a possible 100 points and, thus, retained its approved status as a public water system in good standing with TDEC. The next sanitary survey is scheduled for 2020. All total coliform samples collected during 2018 were analyzed by the State of Tennessee laboratory, and all results were negative. Analytical results for disinfectant byproducts (total trihalomethanes and haloacetic acids) for Y-12's water distribution system were within allowable TDEC and Safe Drinking Water Act (SDWA) limits for the yearly average. Y-12's potable water system is currently sampled triennially for lead and copper. The system sampling was last completed in 2017. These results were below TDEC and SDWA limits and met the established requirements.

4.3.6 Resource Conservation and Recovery Act Compliance Status

The Resource Conservation and Recovery Act (RCRA) regulates hazardous wastes that, if mismanaged, could present risks to human health or the environment. The regulations are designed to ensure that hazardous wastes are managed from the point of generation to final disposal. In Tennessee, EPA delegates the RCRA program to TDEC, but EPA retains an oversight role. Y-12 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 offsite to licensed treatment and disposal facilities. Y-12 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 of 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 2017) 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. Y-12 has developed disposition milestones to address its remaining inventory of legacy mixed waste. Disposition milestones for the final inventory are FYs from 2016 through 2026 (see Figure 4.7). In FY 2018, Y-12 staff completed disposition of 51 percent of the inventory of legacy mixed waste listed on the ORR Site Treatment Plan.

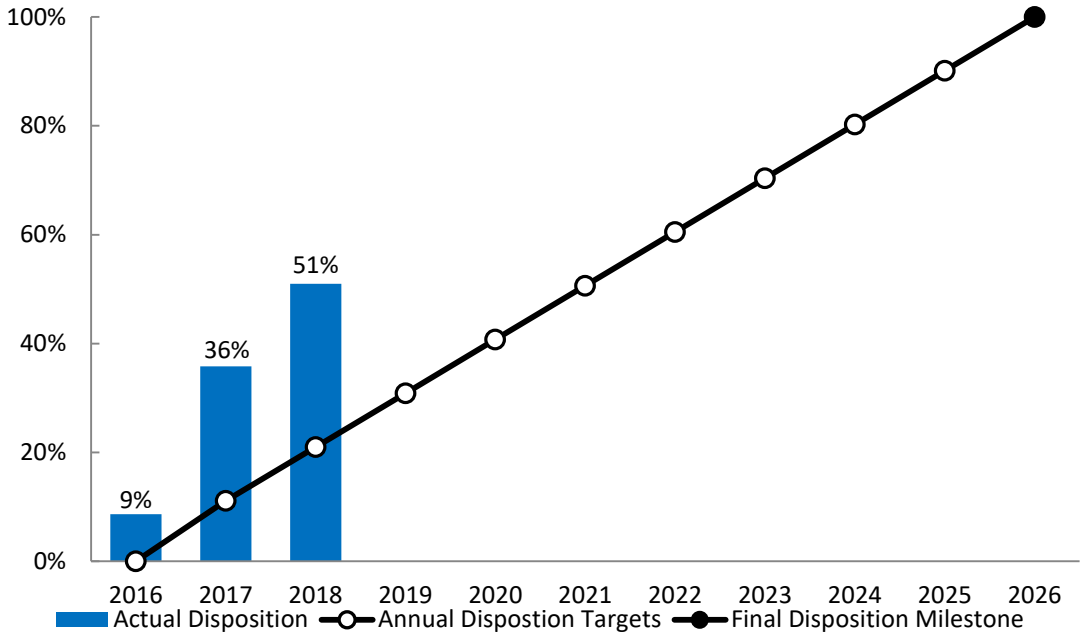


Figure 4.7. Y-12 National Security Complex's path to elimination of its inventory of legacy mixed waste as part of the Oak Ridge Reservation Site Treatment Plan by Fiscal Year

The quantity of hazardous and mixed wastes generated by Y-12 increased in 2018 (Figure 4.8). The increase was primarily due to an increase in remediation activities compared to 2017. Y-12 currently reports waste on 74 active waste streams. Y-12 is a State-permitted treatment, storage, and disposal facility. Under its permits, Y-12 received 1,539 kg of hazardous and mixed waste from the off-site Union Valley analytical chemistry laboratory and ETTP in 2018.

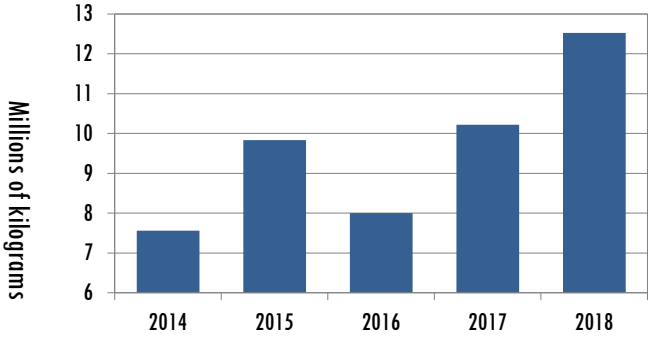


Figure 4.8. Hazardous waste generation, 2014–2018

In addition, 2,033,162 kg of hazardous and mixed waste was shipped to DOE-owned and commercial treatment, storage, and disposal facilities. More than 10 million kg of hazardous and mixed wastewater was treated at on-site wastewater treatment facilities.

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 were 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 Y-12. The facilities include two Class II operating industrial solid waste disposal landfills and one operating Class IV construction demolition landfill. The facilities are permitted by TDEC and accept solid waste from DOE operations on ORR. In addition, one Class IV facility (Spoil Area 1) is overfilled by 8,945 m^3 and has been the subject of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigation (RI)/feasibility study. A CERCLA ROD for Spoil Area 1 was signed in 1997 (DOE 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 4.2. Additional information about the operation of these landfills is addressed in Section 4.8.4, "Waste Management."

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

The ORR Federal Facility Agreement (FFA) (DOE 2017) 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 ORR Corrective Action document TNHW-164 was issued for the 10-year period from September 15, 2015, through September 15, 2025. As required in TNHW-164, the annual update of solid waste management units and areas of concern was submitted to TDEC in January 2018 as an update of the previous CY 2017 activities.

Three RCRA post-closure permits, one for each of the three hydrogeologic regimes at Y-12, had been issued to address the eight major closed waste disposal areas at Y-12. Because it falls under the jurisdiction of two post-closure permits, the S-3 Pond site was described as having two parts, eastern and former S-3 (Table 4.3). RCRA groundwater monitoring data were reported to TDEC and EPA in the Annual Groundwater Monitoring Report for Y-12 (UCOR 2018a).

Permit renewal applications had been previously submitted to TDEC, Division of Solid Waste Management for the three RCRA post-closure permits. On December 27, 2017, TDEC issued a Public Notice of their intent to deny the renewal of the three permits. The proposed denial was initiated by DOE's request to withdraw the permit renewal applications in coordination in advance with TDEC. Pursuant to the ORR FFA, this denial allows DOE to provide post-closure care for the permitted hazardous waste management units under the existing CERCLA remedial program. The public comment period for this notice ended on February 12, 2018, and was issued as a final action with an effective date of February 23, 2018. This CY 2018 ASER concludes the annual reporting actions for the three RCRA post-closure permits and all future reporting will occur through the CERCLA FFA process.

Table 4.3. 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
	Upper EFPC Hydrogeologic Regime (RCRA Post-closure Permit TNHW-113)	
New Hope Pond	Engineered cap, upper EFPC distribution channel	Cap inspection and maintenance. No current groundwater monitoring requirements in lieu of ongoing CERCLA actions in the eastern portion of Y-12
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
	Chestnut Ridge Hydrogeologic Regime (RCRA Post-closure Permit TNHW-128)	
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
	Chestnut Ridge Hydrogeologic Regime (RCRA Post-closure Permit TNHW-128)	
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

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
RCRA = Resource Conservation and Recovery Act
EFPC = East Fork Poplar Creek
Y-12 = 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 on June 7, 2017.

Given the widespread historical uses of PCBs at Y-12 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 operations involving TSCA-regulated materials were conducted in accordance with TSCA regulations and the ORR PCB FFCA.

The removal of legacy PCB waste, some of which had been stored since 1997, in accordance with the terms of the 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. Y-12 submitted reports for reporting year 2018 in accordance with requirements under EPCRA Sections 302, 303, 311, 312, and 313.

Y-12 had no unplanned release of a hazardous substance that required notification of the regulatory agencies (see Section 4.3.11 for more information). There were no new Section 311 notifications sent to TEMA and local emergency responders in 2018. 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 40 chemicals that were over Section 312 inventory thresholds in 2018.

Y-12 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 Toxics Release Inventory-Made Easy (abbreviated as TRI-ME) web-based reporting system operated by EPA. Total 2018 reportable toxic releases to air, water, and land and waste transferred off-site for treatment, disposal, and recycling were 54,977 kg (121,203 lb). Table 4.4 lists the reported chemicals for Y-12 for 2017 and 2018 and summarizes releases and off-site waste transfers for those chemicals.

Table 4.4. 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, 2017 and 2018

Chemical	Year	Quantity[a] (lb)[b]
Chromium	2017	5,853
	2018	10,513
Copper	2017	2,809
	2018	4,635
Lead compounds	2017	9,948
	2018	32,472
Manganese	2017	Form A[d]
	2018	5,245

Table 4.4. 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, 2017 and 2018 (continued)

Chemical	Year	Quantity[a] (lb)[b]
Mercury	2017	5,263
	2018	7,466
Methanol	2017	29,207
	2018	49,191
Nickel	2017	7,914
	2018	11,501
Total	2017	60,994
	2018	121,203

[a] Represents total releases to air, land, and water and includes off-site waste transfers. Also includes quantities released to the environment as a result of remedial actions, catastrophic events, or one-time events not associated with production processes.
[b] 1 lb = 0.4536 kg.
[c] Not reported in previous year.
[d] Form A is less than 500 lb released.

4.3.10 Spill Prevention, Control, and Countermeasures

The Clean Water Act, 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.

Y-12's SPCC Plan (CNS 2015) was revised in September 2015 to update general Y-12 changing site infrastructure. This plan presents the SPCC to be implemented by Y-12 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 Y-12 to facilitate spill response. All Y-12 personnel and subcontractors are required to have initial spill and emergency response training before they can work on the site.

4.3.11 Unplanned Releases

Y-12 has procedures for notifying off-site authorities for categorized events at Y-12. 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 limits must be reported to the EPA National Response Center, DOE, TEMA, and the Anderson County Local Emergency Planning Committee.

In addition, Y-12's occurrence reporting program provides timely notification to the DOE community of Y-12 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 occurrences are categorized and reported through the Occurrence Reporting and Processing System, which 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.

There were no reportable releases to the environment in 2018. During 2018, there were no unplanned radiological air emission releases for Y-12.

4.3.12 Audits and Oversight

A number of federal, state, and local agencies oversee Y-12 activities. In 2018, Y-12 was inspected by federal, state, or local regulators on four occasions. Table 4.5 summarizes the results, and additional details follow.

Table 4.5. Summary of external regulatory audits and reviews, 2018

Date	Reviewer	Subject	Issues
March 6	City of Oak Ridge	Semiannual Industrial Pretreatment Compliance Inspection	0
April 24	TDEC	Sanitary Survey of Non-Community Water System	0
August 28-29	TDEC	Annual RCRA Hazardous Waste Compliance Inspection	1
September 5	City of Oak Ridge	Semiannual Industrial Pretreatment Compliance Inspection	0

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

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 2018.

Personnel from the TDEC Division of Water Resources (DWR) performed an on-site inspection of the distribution system as part of the Sanitary Survey on April 24, 2018. The inspections covered monitoring records, data verification and compliance with requirements. The Y-12 Plant water System earned 421 points out of a possible 421 points and remains in the State's "Approved" category.

Personnel from the TDEC–Knoxville Office conducted a RCRA hazardous waste compliance inspection on August 28-29, 2018. The inspections covered 38 waste storage areas and records reviews. The report identified one finding involving two weekly inspection records that did not include the inspection time, as required.

4.3.13 Radiological Release of Property

Clearance of property from Y-12 is conducted in accordance with approved procedures that comply with DOE O 458.1, *Radiation Protection of the Public and the Environment* (DOE 2011e). Property consists of real property (i.e., land and structures), personal property, and material and equipment (M&E). At Y-12, 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 pre-approved 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.
- Evaluation using process knowledge (surface and volumetric).

These three release paths are discussed in the following sections. Table 4.6 summarizes some examples of the quantities of property released in 2018. During FY 2018, Y-12 recycled more than 2.78 million lb of materials offsite for reuse, including but not limited to computers, electronic office equipment, used oil, scrap metal, tires, batteries, lamps, and pallets.

Table 4.6. Summary of materials released in 2018

Category	Amount released
Real property (land and structures)	None
Computer equipment recycle	106,023 lb
–Computers, monitors, printers, and mainframes	
Recycling examples	
–Used oils	5,840 gal
–Used tires	8,800 lb
–Scrap metal	1,488,040 lb
–Lead acid batteries	32,557 lb
Public/negotiated sales[a]	
–Brass	8,680 lb
–Miscellaneous furniture	75,262 lb
–Vehicles and miscellaneous equipment	382,246 lb
External transfers[b]	172,250 lb

[a] Sales during Fiscal Year 2018.

[b] Vehicles; miscellaneous equipment; and materials transferred to various federal, state, and local agencies for reuse during Fiscal Year 2018.

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 the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (NRC 2000) and the *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual* (MARSAME) (NRC 2009)[1]. The surface contamination limits used at Y-12 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 240 dpm/100 cm^2 for radionuclides in Group 3 and 2,400 dpm/100 cm^2 for radionuclides in Group 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 for high toxicity alpha emitters and for beta and gamma emitters, respectively, found in 49 CFR 173, "Shippers—General Requirements for Shipments and Packagings."

[1] The *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) provides guidance on how to demonstrate that a site is in compliance with a radiation dose or risk-based regulation, otherwise known as a release criterion. The *Multi-Agency Radiation Survey and Assessment of Materials and Equipment* annual is a supplement to MARSSIM that provides technical information on approaches for determining proper disposition of materials and equipment.
Source: Vázquez 2011.

Table 4.7. US Department of Energy Order 458.1 pre-approved authorized limits[a,b]

Radionuclide[c]	Average[d,e]	Maximum[d,e]	Removable[f]
Group 1—Transuranics, ^{125}I, ^{129}I, ^{227}Ac, ^{226}Ra, ^{228}Ra, ^{228}Th, ^{230}Th, ^{231}Pa	100	300	20
Group 2—Th-natural, ^{90}Sr, ^{126}I, ^{131}I, ^{133}I, ^{223}Ra, ^{224}Ra, ^{232}U, ^{232}Th	1,000	3,000	200
Group 3—U-Natural, ^{235}U, ^{238}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 ^{90}Sr and others noted above[g]	5,000	15,000	1,000
Tritium (applicable to surface and subsurface)[h]	N/A	N/A	10,000

[a] The values in this table (except for tritium) apply to radioactive material deposited on but not incorporated into the interior or matrix of the property. No generic concentration guidelines have been approved for release of material that has been contaminated in depth, such as activated material or smelted contaminated metals (e.g., radioactivity per unit volume or per unit mass). Authorized limits for residual radioactive material in volume must be approved separately.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[d] Measurements of average contamination should not be averaged over an area of more than 1 m^2. Where scanning surveys are not sufficient to detect levels in the table, static counting must be used to measure surface activity. Representative sampling (static counts on the areas) may be used to demonstrate by analyses of the static counting data. The maximum contamination level applies to an area of not more than 100 cm^2.

[e] The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 millirad per hour (mrad/h) and 1.0 mrad/h, respectively, at 1 cm.

[f] The amount of removable material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. When removable contamination of objects on surfaces of less than 100 cm^2 is determined, the activity per unit area should be based on the actual area, and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate the total residual surface contamination levels are within the limits for removable contamination.

[g] This category of radionuclides includes mixed fission products, including the ^{90}Sr that is present in them. It does not apply to ^{90}Sr that has been separated from the other fission products or mixtures where the ^{90}Sr has been enriched.

[h] Measurement should be conducted by a standard smear measurement but using a damp swipe or material that will readily absorb tritium, such as polystyrene foam. Property recently exposed or decontaminated should have measurements (smears) at regular time intervals to prevent a buildup of contamination over time. Because tritium typically penetrates material it contacts, the surface guidelines in Group 4 do not apply to tritium. Measurements demonstrating compliance of the removable fraction of tritium on surfaces with this guideline are acceptable to ensure non-removable fractions and residual tritium in mass will not cause exposures that exceed US Department of Energy dose limits and constraints.

N/A = not applicable

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 Y-12. 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 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 Y-12 without monitoring or analytical data and to implement a graded approach (less than 100 percent monitoring) for monitoring of some M&E (MARSAME Classes II and III) (NRC 2009). A conservative approach (nearly 100 percent 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 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 non-radiological 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 non-radiological areas.
- Subcontractor/vendor/privately owned vehicles, tools, and equipment used in non-radiological 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 locations.
- New computer equipment distributed from Building 9103.
- Subcontractor/vendor/privately owned vehicles, tools, and equipment that have not been used in contaminated areas or for excavation activities. Subcontractor/vendor/privately owned vehicles, tools, and equipment that have not been used in contaminated areas or for excavation activities.
- New cardboard.
- Consumer glass containers.

4.4 Air Quality Program

Sections of Y-12's Title V Permit 571832 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 Y-12. 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, non-radiological 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

The following Title V permitting actions were submitted and approved in 2018: an administrative permit amendment to remove a redundant recordkeeping requirement from the emergency generators conditions, a significant modification to update UPF changes, declaration of insignificant activity for a new gasoline dispensing facility, a minor permit modification request to remove Stack 44 process equipment, a minor permit modification to add a calciner process, and an operational flexibility request for lithium chloride operations (wet chemistry).A construction air permit application for an electrorefining process operation was also submitted and approved.

Demonstrating compliance with the conditions of air permits is a significant effort at Y-12. 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 Y-12. 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 tasks consist of 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 Y-12.

The Y-12 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 radiological emissions; another is an Annual Title V Compliance Certification Report, which indicates compliance status with all conditions of the permit. A third is a Title V Semiannual Report, which covers a 6-month period for some specific emission sources and consists of monitoring and record-keeping requirements for the sources. Another annual report is the Boiler Maximum Available Control Technology Report for the Y-12 Steam Plant, which requires the boilers to be tuned-up on an annual basis. Table 4.8 gives the actual emissions versus allowable emissions for the Y-12 steam plant.

Table 4.8. Actual versus allowable air emissions from the Y-12 National Security Complex steam plant, 2018

	Emissions (tons/year)[a]		
Pollutant	**Actual**	**Allowable**	**Percentage of allowable**
Particulate	3.43	41	8.4
Sulfur dioxide	0.27	39	0.7
Nitrogen oxides[b]	14.27	81	17.6
VOCs[b]	2.39	9.4	25.4
Carbon monoxide[b]	36.57	139	26.3

NOTE: The emissions are based on fuel usage data for January through December 2018. The volatile organic compound (VOC) emissions include VOC hazard air pollutant emissions.

[a] 1 ton = 907.2 kg.

[b] When there is no applicable standard or enforceable permit condition for a pollutant, the allowable emissions are based on the maximum actual emissions calculation, as defined in Tennessee Department of Environment and Conservation Rule 1200-3-26-.02(2)(d)3 (maximum design capacity for 8,760 hr/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

Y-12, 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.

Control of Asbestos

Y-12 has numerous buildings and equipment that contain asbestos-containing materials (ACMs). The compliance program for management of removal and disposal of ACMs 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 2018. There were four notifications of asbestos demolition or renovation, one revision of notification of asbestos demolition or renovation, and one annual estimate for CY 2018. There was one notification revised three times (May 9, April 17, and March 15). The 2018 annual estimates of friable asbestos were also submitted to TDEC on November 8, 2018, for their records. A revised annual estimate of friable asbestos submitted to TDEC on December 11, 2018.

Stratospheric Ozone Protection

As required by the CAA Title VI Amendments of 1990 and in accordance with 40 CFR Part 82, actions have been implemented to comply with the prohibition against intentionally releasing ODSs during maintenance activities performed on refrigeration equipment. During 2017, EPA enacted major revisions to the Stratospheric Ozone rules to include the regulation of non-ODS substitutes as part of 40 CFR 82 Subpart F. These revisions were effective January 1, 2018, for disposal of small appliances and January 1, 2019, for the leak rate provisions for large appliances. An assessment was conducted in 2018 to identify necessary changes to the Stratospheric Ozone Protection compliance program to comply with the requirements of the new rule.

Fugitive Particulate Emissions

As modernization reduction efforts increase at Y-12, the need also increases for good work practices and controls to minimize fugitive dust emissions from construction and demolition activities. Y-12 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 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 Y-12 occurs almost exclusively as a result of plant production, maintenance, and waste management activities. The major radionuclide emissions contributing to the dose from Y-12 are ^{234}U, ^{235}U, ^{236}U, and ^{238}U, which are emitted as particulates (Figure 4.9). 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.
- Emissions from room ventilation exhausts (calculated using radiological control monitoring data from the work area).

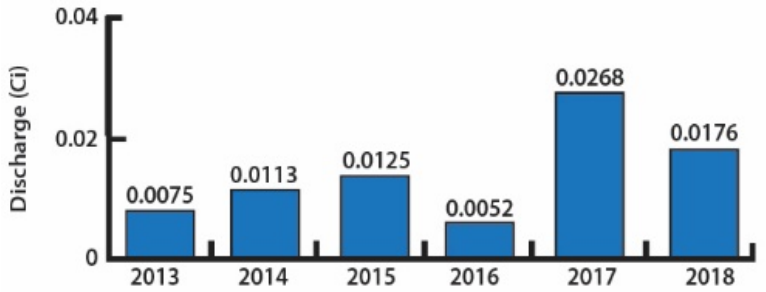


Figure 4.9. Total curies of uranium discharged from the Y-12 National Security Complex to the atmosphere, 2014–2018

Continuous sampling systems are used to monitor emissions from a number of process exhaust stacks at Y-12. 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 2018, 33 process exhaust stacks were continuously monitored, 25 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 2018, unmonitored uranium emissions at Y-12 occurred from 37 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 source term includes an estimate of these emissions.

Y-12's Analytical Chemistry Organization (ACO) operates out of two main laboratories. One is located onsite in Building 9995. The other is located in a leased facility on Union Valley Road, about 0.3 miles east of Y-12, and is not within the ORR boundary. In 2018, 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 percent of the derived air concentration, 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. Four emission points from room ventilation exhausts were identified in 2018 where emissions exceeded 10 percent of the derived air concentration. These emission points feed to monitored stacks, and any radionuclide emissions are accounted for as noted for monitored emission points.

Y-12 Title V (Major Source) Operating Permits contain a sitewide, streamlined alternate emission limit for enriched and depleted uranium process emission units. A limit of 907 kg/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 0.0176 Ci (3.4 kg) of uranium was released into the atmosphere in 2018 as a result of Y-12 process and operational activities.

The calculated radiation dose to the maximally exposed off-site individual from airborne radiological release points at Y-12 during 2018 was 0.15 mrem. This dose is well below the National Emission Standards for Hazardous Air Pollutant (NESHAP) standard of 10 mrem and is less than 0.05 percent 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.

Lastly, a UPF is presently being designed and constructed. It is intended that this facility house some of the processes that are currently in existing production buildings. The UPF project was issued a Construction Air Permit (No. 967550P) in March 2014. With concurrence from TDEC Air Division, the UPF was included in the 2018 update of Y-12's Site Title V Operating Permit. The facility will be maintained on the Permit as inactive until operations commence in approximately 2025.

4.4.1.3 Quality Assurance

Quality assurance (QA) activities for the Rad-NESHAPs program are documented in the *Y-12 National Security Complex Quality Assurance Project Plan for National Emission Standards for Hazardous Air Pollutants 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 Y-12 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 Y-12 radionuclide emission measurements data from the continuous samplers, breakthrough monitors, and minor radionuclide release points. It specifies the procedures for managing 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 Y-12 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 Y-12. 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 Y-12 and use of acetonitrile at a single source are primary sources of volatile organic compound (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 2018 are 67.993 lb (0.034 tons) and 49,005 lb (24.50 tons), respectively. The highest calculated amount of acetonitrile and isopropyl alcohol (VOCs) emitted to the atmosphere during any period of 12 consecutive months in CY 2018 was 2.685 tons, which was less than the permitted value of 9 tons/year.

4.4.1.5 Mandatory Reporting of Greenhouse Gas Emissions under 40 Code of Federal Regulations 98

Title 40 of CFR Part 98, *Mandatory Greenhouse Gas Reporting* (EPA 2010), 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, methane, nitrous oxide, sulfur hexafluoride, 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_2e).

Y-12 is subject only to the Subpart A general provisions and reporting from stationary fuel combustion sources covered in 40 CFR 98, Subpart C, *General Stationary Fuel Combustion*. Currently, the rule does not require control of GHGs; rather, it requires only that sources emitting above the 25,000-CO_2e threshold level monitor and report emissions.

The Y-12 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/hr. Natural gas is the primary fuel source for the boilers; Number 2 fuel oil is 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/hr. In Building 9215, 10 natural gas torches, each at 300 standard ft^3/hr, 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/hr.

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 Y-12. 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 emissions 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 Y-12 is shown in Table 4.9. The decrease in emissions from 2010 to 2017 is associated with the fact that coal is no longer burned since the natural-gas-fired steam plant came on line. The slight increase in CO_2e emissions was due to the fact that fuel oil was burned for a few days in December 2018.

Table 4.9. Greenhouse gas emissions from Y-12 National Security Complex stationary fuel combustion sources

Year	GHG emissions (metric tons CO_2e)
2010	97,610
2011	70,187
2012	63,177
2013	61,650
2014	58,509
2015	51,706.9
2016	50,671.6
2017	50,292.7
2018	51,010.7

CO_2e = CO_2 equivalent GHG = greenhouse gas

4.4.1.6 Hazardous Air Pollutants (Non-radiological)

Beryllium emissions from machine shops are regulated under a State-issued permit and are subject to a limit of 10 g/24 hr. 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 2018 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 Y-12, 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.

In 2007, EPA vacated a proposed Maximum Achievable Control Technology (MACT) standard that was intended to minimize HAP emissions. At that time, a case-by-case MACT review was conducted as part of the construction-permitting process for the Y-12 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 on 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. The new rule requires that tune-ups for the boilers must be completed 13 months from the previous tune-ups. 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. The tune-ups for boilers were completed on January 8 and 9, 2019.

Unplanned releases of HAPs are regulated through the Risk Management Planning regulations. Y-12 personnel have determined no processes or facilities contain inventories of chemicals in quantities exceeding thresholds specified in rules pursuant to CAA, Title III, Section 112(r), *Prevention of Accidental*

Releases. Therefore, Y-12 is not subject to that rule. Procedures are in place to continually review new processes and/or process changes against the rule thresholds.

EPA has created multiple national air pollution regulations to reduce air emissions from Reciprocating Internal Combustion Engines (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 (EPA 2013; Title 40 CFR Part 63, Subpart DDDDD). 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 Y-12's 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, Y-12 prepared a significant permit modification to Y-12's Title V (Major Source) Operating Air Permit to add numerous stationary, emergency-use engines/generators located throughout Y-12. 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 Y-12's Title V (Major Source) Operating Air Permit dated March 9, 2011, Y-12 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 Y-12. 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 non-resettable hour meter on each engine/generator. Documentation must be maintained of how many hours are spent for emergency operation, maintenance checks and readiness testing, and non-emergency operation. Each engine/generator must use only diesel fuel with low sulfur content (15 parts per million) and acetane index of 40.

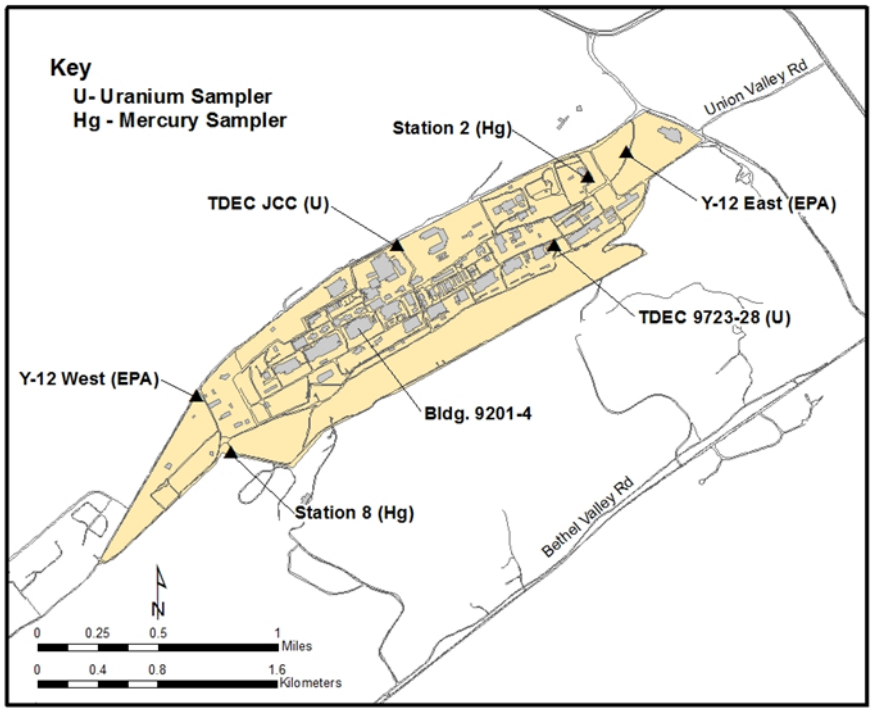
4.4.2 Ambient Air

To understand the complete picture of ambient air monitoring in and around Y-12, data from on- and off-site monitoring conducted specifically for Y-12, DOE reservation-wide 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 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

Y-12's 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 Y-12. The two atmospheric mercury monitoring stations currently operating at Y-12, ambient air (monitoring) station (AAS)2 and AAS8, are located near the east and west boundaries of Y-12, respectively

(Figure 4.10). 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 Y-12, two additional monitoring sites were operated: a reference site (rain gauge 2) was operated on Chestnut Ridge in the Walker Branch Watershed for a 20-month period in 1988 and 1989 to establish a reference concentration, and a site was operated at New Hope Pond for a 25-month period from August 1987 to September 1989.



EPA = US Environmental Protection Agency [sampler] TDEC = Tennessee Department of Environment and Conservation
JCC = Jack Case Center

Figure 4.10. Locations of ambient air monitoring stations at the Y-12 National Security Complex

To determine mercury concentrations in ambient air, airborne mercury vapor is collected by pulling ambient air through a sampling train consisting of a Teflon filter and an iodinated-charcoal sampling trap. A flow-limiting orifice upstream of the sampling trap restricts airflow through the sampling train to approximately 1 L/min. Actual flows are measured bi-weekly with a calibrated Gilmont flowmeter in conjunction with the bi-weekly change-out of the sampling trap. The charcoal in each trap is analyzed for total mercury using cold vapor atomic fluorescence spectrometry after acid digestion. The average concentration of mercury vapor in ambient air for each 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 2018 is 0.0038 $\mu g/m^3$ (N = 25), 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 2018 was 0.0049 $\mu g/m^3$ (N = 24), similar to levels reported for 2008 and the early 2000s.

Table 4.10. Summary of data for the Y-12 National Security Complex ambient air monitoring program for mercury, Calendar Year 2018

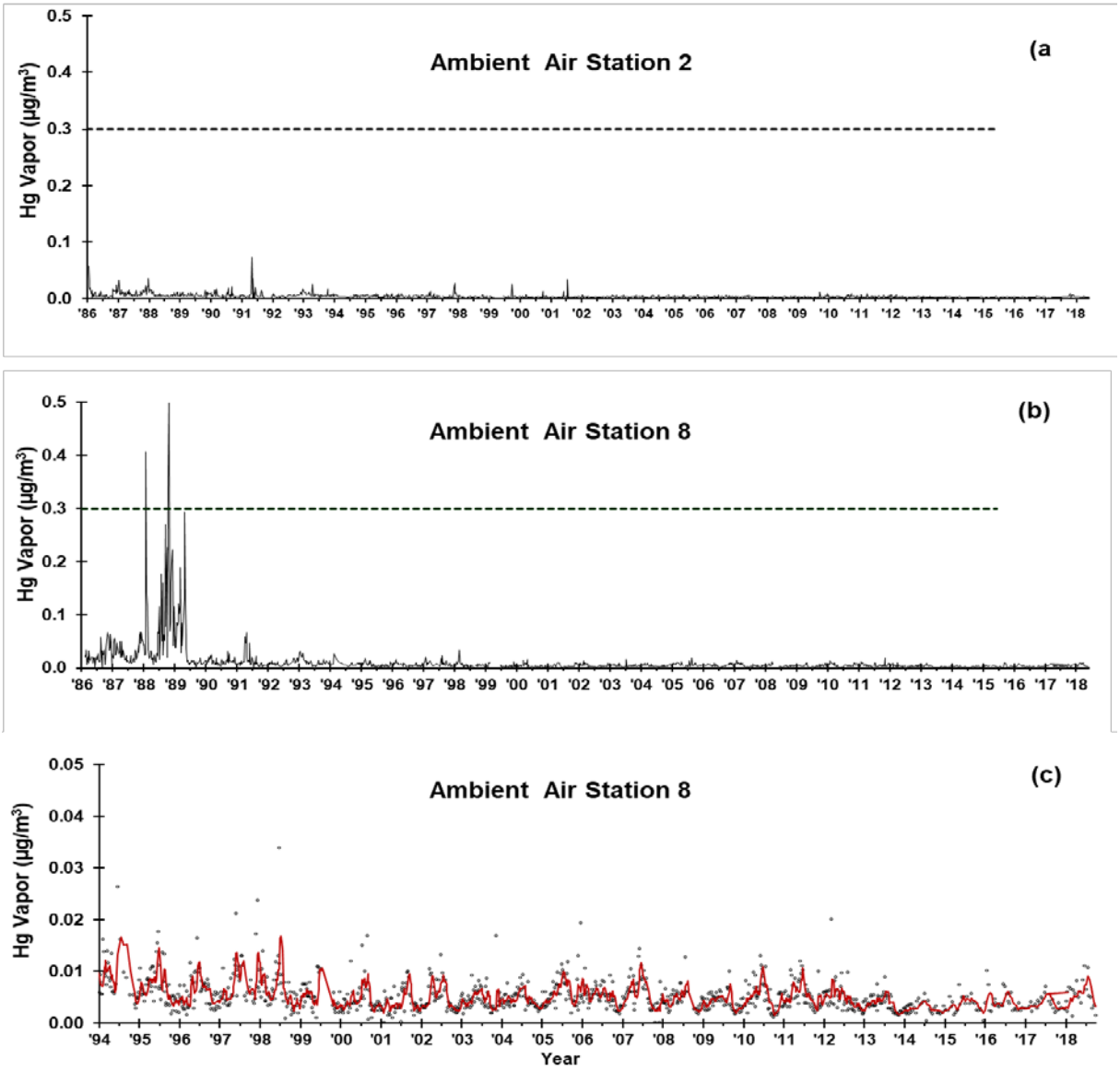
Ambient air monitoring stations	Mercury vapor concentration (µg/m^3)			
	2018 Minimum	2018 Maximum	2018 Average	1986–1988[a] Average
AAS2 (east end of Y-12)	0.0019	0.0090	0.0038	0.010
AAS8 (west end of Y-12)	0.0013	0.0110	0.0049	0.033
Reference site, rain gauge 2 (1988[b])	N/A	N/A	N/A	0.006
Reference site, rain gauge 2 (1989[c])	N/A	N/A	N/A	0.005

[a] Period in late 1980s with elevated ambient air mercury levels; shown for comparison.
[b] Data for period from February 9 through December 31, 1988.
[c] Data for period from January 1 through October 31, 1989.

AAS = ambient air (monitoring) station
Y-12 = Y-12 National Security Complex

Table 4.10 summarizes the 2018 mercury results, with results from the 1986 through 1988 period included for comparison. Figure 4.11 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 2018 [parts (a) and (b)] and seasonal trends at AAS8 from 1994 through 2018 [part (c)]. The dashed line superimposed on the plots in Figures 4.11(a) and (b) is the EPA reference concentration of 0.3 µg/m^3 for chronic inhalation exposure. The large increase in mercury concentration at AAS8 observed in the late 1980s [part (b)] was thought to be related to disturbances of mercury-contaminated soils and sediments during the Perimeter Intrusion Detection Assessment System installation and storm drain restoration projects under way at that time. In Figure 4.11(c), a monthly moving average has been superimposed over the AAS8 data to highlight seasonal trends in mercury at AAS8 from January 1994 through 2018.

In conclusion, 2018 average mercury concentrations at the two mercury monitoring sites were comparable to reference levels measured for the Chestnut Ridge reference site in 1988 and 1989. More importantly, measured concentrations continue to be well below current environmental and occupational health standards for inhalation exposure to mercury vapor (i.e., the National Institute for Occupational Safety and Health-recommended exposure limit of 50 µg/m^3 time-weighted average [TWA] for up to a 10-hr workday, 40-hr workweek; the American Conference of Governmental Industrial Hygienists workplace threshold limit value of 25 µg/m^3 as a TWA for a normal 8-hr workday and 40-hr workweek; and the current EPA reference concentration of 0.3 µg/m^3 for elemental mercury for a continuous inhalation exposure to the human population without appreciable risk of harmful effects during a lifetime).



The dashed lines superimposed on (a) and (b) represent the US Environmental Protection Agency reference concentration of 0.3 µg/m^3 for chronic inhalation exposure. In (c) [note the 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 December 2018, with higher concentrations generally measured during the warm weather months.

Figure 4.11. Temporal trends in mercury vapor concentration for the boundary monitoring stations at the Y-12 National Security Complex, July 1986–December 2018 [(a) and (b)] and January 1994–December 2018 for ambient air station 8 [(c)]

4.4.2.2 Quality Control

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

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

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

A minimum of 5 percent 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 percent 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 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 on November 29, 2018.

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 [1 per 10 samples; any laboratory duplicates differing by more than 10 percent at 5 or more times the detection limit are to be rerun (third duplicate) to resolve the discrepancy]
- archiving all primary laboratory records for at least 1 year

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

Ambient air monitoring is conducted at multiple locations near ORR to measure radiological and other selected parameters directly in the ambient air. These monitors are operated in accordance with DOE Orders. Their locations were selected so that areas of potentially high exposure to the public are monitored continuously for parameters of concern. This monitoring provides direct measurement of airborne concentrations of radionuclides and other HAPs, allows facility personnel to determine the relative level of contaminants at the monitoring locations during an emergency, verifies that the contributions of fugitive and diffuse sources are insignificant, and serves as a check on dose-modeling calculations. As part of the ORR network, an AAS located in the Scarboro Community of Oak Ridge (Station 46) measures off-site impacts of Y-12 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 Y-12 (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 operations, there are three uranium ambient air monitors within the Y-12 boundary that, since 1999, have been used by TDEC personnel in their environmental monitoring program. Each of the monitors uses 47-mm, borosilicate glass-fiber filters to collect particulates as air is

pulled through the units. The monitors control airflow with a pump and rotometer set to average about 2 standard ft^3/min. During 2012, these uranium monitors at Stations 4, 5, and 8 were phased out of service, and two additional high-volume samplers (Figure 4.10) 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 DOE Oversight Division air quality monitoring includes several other types of monitoring on ORR, for example:

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

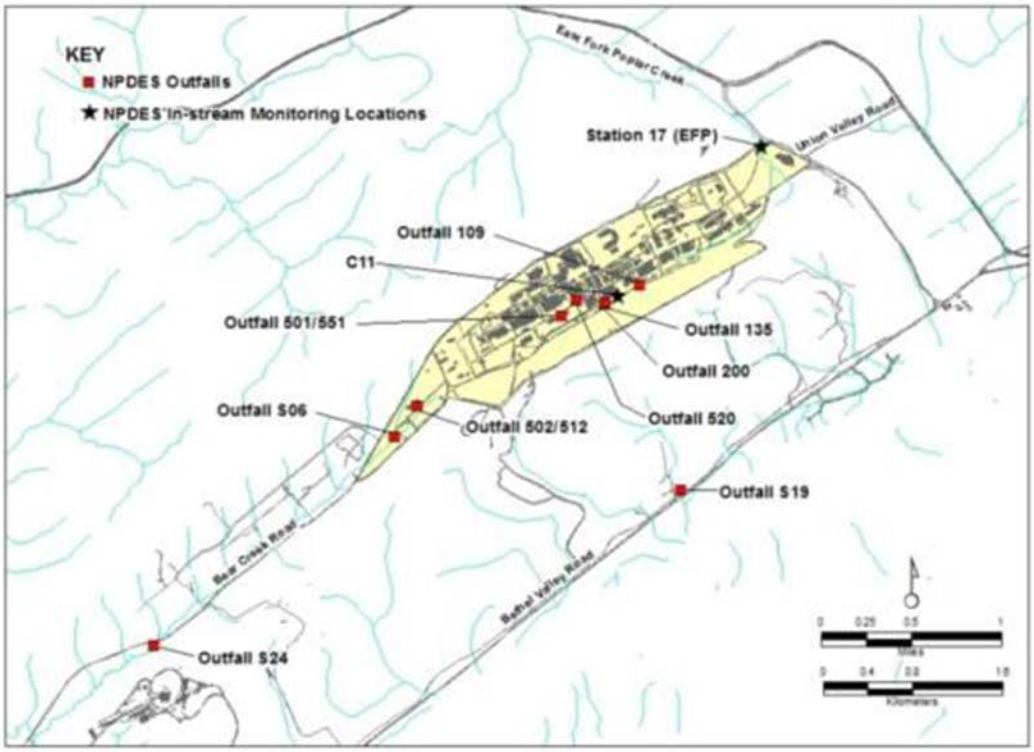
Results of these activities are summarized in annual status reports, which are issued by the TDEC DOE Oversight Division.

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 NPDES Permit (TN0002968) requires sampling, analysis, and reporting for about 56 outfalls. Major outfalls are depicted in Figure 4.12. The number is subject to change as outfalls are eliminated or consolidated or if permitted discharges are added. Currently, Y-12 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.



EFP = East Fork Poplar

Figure 4.12. Major Y-12 National Security Complex National Pollutant Discharge Elimination System (NPDES) outfalls and monitoring locations

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

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

Requirements of the NPDES Permit for 2018 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 2018 was 99.9 percent (see Table 4.11).

Table 4.11. National Pollutant Discharge Elimination System compliance monitoring requirements and record for the Y-12 National Security Complex, January–December 2018

Discharge point	Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Outfall 501 (Central Pollution Control)	pH, standard units			*a*	9.0	*b*	0
	Total suspended solids			31.0	40.0	*b*	0
	Total toxic organic				2.13	*b*	0
	Hexane extractables			10	15	*b*	0
	Cadmium	0.16	0.4	0.07	0.15	*b*	0
	Chromium	1.0	1.7	0.5	1.0	*b*	0
	Copper	1.2	2.0	0.5	1.0	*b*	0
	Lead	0.26	0.4	0.1	0.2	*b*	0
	Nickel	1.4	2.4	2.38	3.98	*b*	0
	Nitrate/Nitrite				100	*b*	0
	Silver	0.14	0.26	0.05	0.05	*b*	0
	Zinc	0.9	1.6	1.48	2.0	*b*	0
	Cyanide	0.4	0.72	0.65	1.2	*b*	0
	PCB				0.001	*b*	0
Outfall 502 (West End Treatment Facility)	pH, standard units			*a*	9.0	*b*	0
	Total suspended solids		31		40	*b*	0
	Total toxic organic				2.13	*b*	0
	Hexane extractables			10	15	*b*	0
	Cadmium		0.4		0.15	*b*	0
	Chromium		1.7		1.0	*b*	0
	Copper		2.0		1.0	*b*	0
	Lead		0.4		0.2	*b*	0
	Nickel		2.4		3.98	*b*	0
	Nitrate/Nitrite				100	*b*	0
	Silver		0.26		0.05	*b*	0
	Zinc		0.9		1.48	*b*	0
	Cyanide		0.72		1.20	*b*	0
	PCB				0.001	*b*	0
Outfall 512 (Groundwater Treatment Facility)	pH, standard units			*a*	9.0	100	13
	PCB				0.001	100	2
Outfall 520	pH, standard units			*a*	9.0	*b*	0
Outfall 200 (North/South pipes)	pH, standard units			*a*	9.0	100	53
	Hexane extractables			10	15	100	15
	Cadmium			0.001	0.023	100	13
	IC_{25} *Ceriodaphnia*			37% Minimum		0	2
	IC_{25} *Pimephales*			37% Minimum		100	2
	Total residual chlorine			0.024	0.042	100	12
Outfall 551	pH, standard units			*a*	9.0	100	52
	Mercury			0.002	0.004	100	52

Table 4.11. National Pollutant Discharge Elimination System compliance monitoring requirements and record for the Y-12 National Security Complex, January–December 2018 (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 C11	pH, standard units			*a*	9.0	100	14
Outfall 135	pH, standard units			*a*	9.0	100	12
	IC_{25} *Ceriodaphnia*			9% Minimum		100	1
	IC_{25} *Pimephales*			9% Minimum		100	1
Outfall 109	pH, standard units			*a*	9.0	100	5
	Total residual chlorine			0.010	0.017	100	4
Outfall S19	pH, standard units			*a*	9.0	100	1
Outfall S06	pH, standard units			*a*	9.0	100	2
Outfall S24	pH, standard units			*a*	9.0	100	1
Outfall EFP	pH, standard units			*a*	9.0	100	12
Category I outfalls	pH, standard units			*a*	9.0	100	34
Category II outfalls	pH, standard units			*a*	9.0	100	17
	Total residual chlorine				0.5	100	16
Category III outfalls	pH, standard units			*a*	9.0	100	7
	Total residual chlorine			*a*	0.5	100	6

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

IC_{25} = 25% inhibition concentration
PCB = polychlorinated biphenyl

4.5.2 Radiological Monitoring Plan and Results

A radiological monitoring plan is in place at Y-12 to address compliance with DOE Orders and NPDES Permit TN0002968. The permit requires Y-12 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 4.12). The current Radiological Monitoring Plan for Y-12 (B&W Y-12 2012b) was last revised and reissued in January 2012.

Table 4.12. Radiological parameters monitored at the Y-12 National Security Complex, 2018

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

Y-12 = 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 2018 are noted on Figure 4.13. Table 4.13 identifies the monitored locations, the frequency of monitoring, and the sum of the percentages of the derived concentration standards (DCS) for radionuclides measured in 2018. Radiological data were well below the allowable DCS.

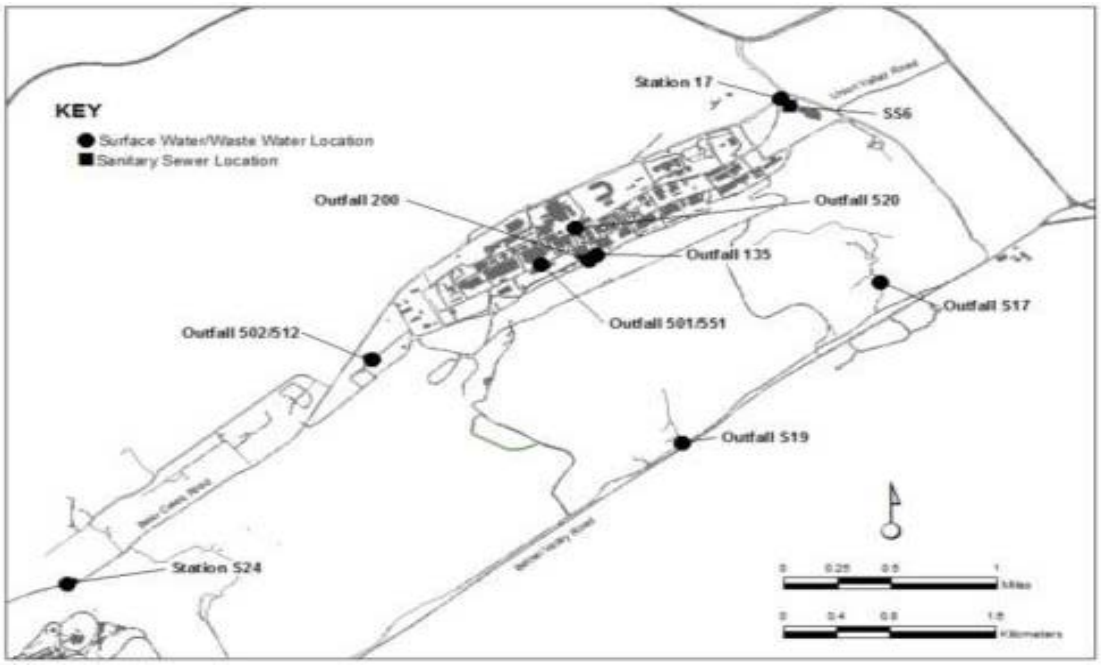


Figure 4.13. Surface water and sanitary sewer radiological sampling locations at the Y-12 National Security Complex

Table 4.13. Summary of Y-12 National Security Complex radiological monitoring plan sample requirements and 2018 results

Location	Sample frequency	Sample type	Sum of DCS percentages
Y-12 wastewater treatment facilities			
Central Pollution Control Facility	1/batch	Composite during batch operation	No flow
West End Treatment Facility	1/batch	24-hr composite	No flow
Groundwater Treatment Facility	4/year	24-hr composite	1.8
Steam condensate	1/year	Grab	No flow
Central Mercury Treatment Facility	4/year	24-hr composite	0.7
Other Y-12 point- and area-source discharges			
Outfall 135	4/year	24-hr composite	0.77
Kerr Hollow Quarry	1/year	24-hr composite	4.5
Rogers Quarry	1/year	24-hr composite	0.54
Y-12 instream locations			
Outfall S24	1/year	7-day composite	7.4
East Fork Poplar Creek, complex exit (east)	1/month	7-day composite	1.7
North/south pipes	1/month	24-hr composite	4.1
Y-12 Sanitary Sewer			
East End Sanitary Sewer Monitoring Station	1/year	7-day composite	35

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

In 2018, the total mass of uranium and associated curies released from Y-12 at the easternmost monitoring station, Station 17 on upper EFPC, was 205 kg or 0.084 Ci (Table 4.14).

Table 4.14. Release of uranium from the Y-12 National Security Complex to the off-site environment as a liquid effluent, 2011–2018

	Quantity released	
Year	Ci[a]	kg
Station 17		
2013	0.055	140
2014	0.061	90
2015	0.068	116
2016	0.045	88
2017	0.080	154
2018	0.084	205

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

Figure 4.14 illustrates a 5-year trend of these releases. The total release is calculated by multiplying the average concentration (g/L) by the average flow (million gallons per day [mgd]). Converting units and multiplying by 365 days per year yields the calculated discharge.

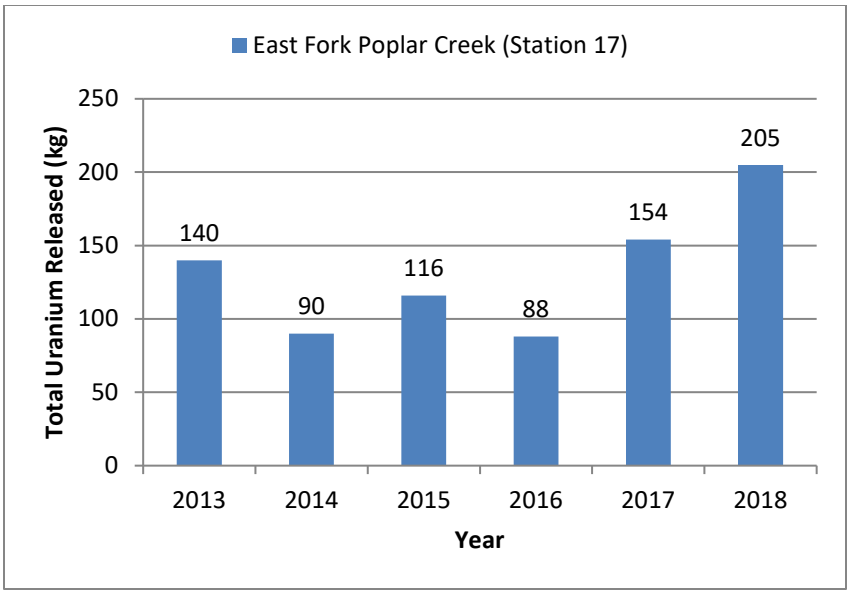


Figure 4.14. Six-year trend of Y-12 National Security Complex releases of uranium to East Fork Poplar Creek

Y-12 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 Y-12 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 2018 quarterly monitoring reports.

4.5.3 Storm Water Pollution Prevention

The Storm Water Pollution Prevention Plan (SWPPP) at Y-12 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 characterization of storm water by sampling during storm events, implementation of measures to reduce storm water pollution, facility inspections, and employee training.

Y-12's 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 Y-12 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 Y-12 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 2018 during rain events that occurred on March 29, August 1, and September 10. Results were published in the *Annual Storm Water Report* (CNS 2018), which was submitted to TDEC, Division of Water Pollution Control in January 2019. Consistent with permit requirements, storm water monitoring is performed each year for sector outfalls, three major outfalls that drain large areas of Y-12, and two instream monitoring locations on EFPC (Figure 4.15).

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 mgd, or about 60 percent).

An area of concern continues to be 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; however, it was not monitored in 2018 due to the degraded condition of the outfall piping and the inability to gather reliable flow rate data. Data collected to date are presented in Table 4.15.

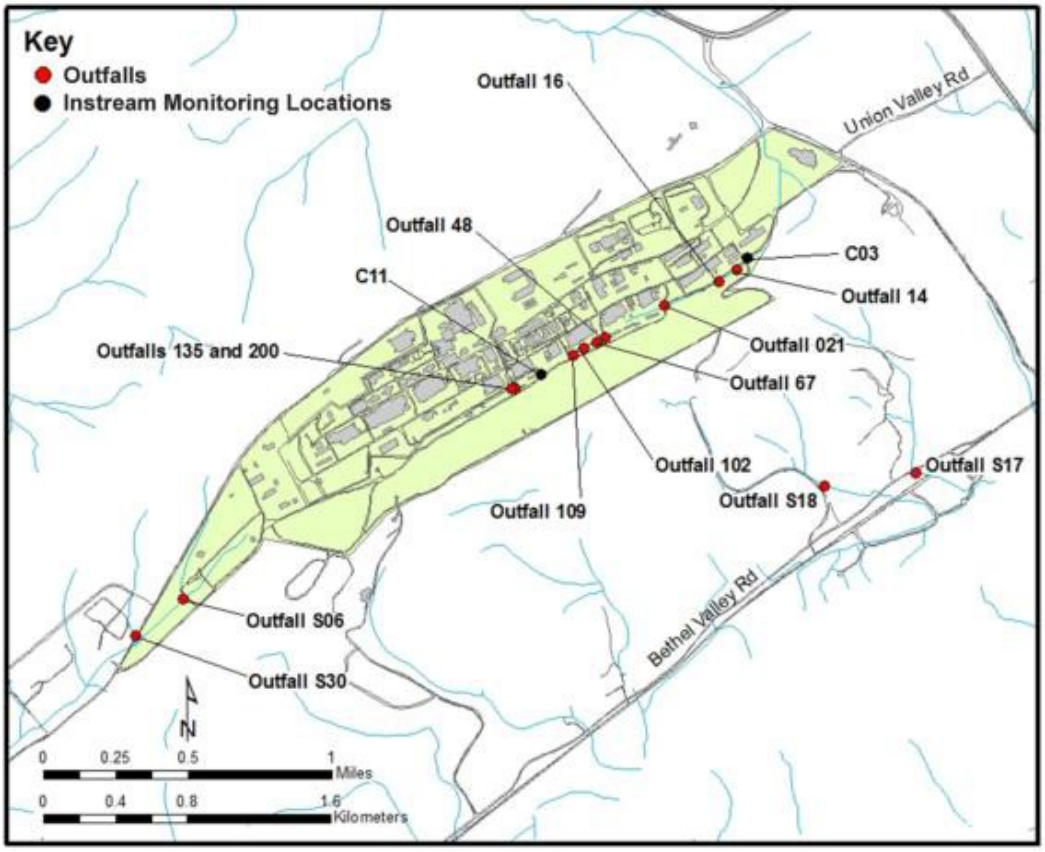


Figure 4.15. Y-12 National Security Complex storm water monitoring locations, East Fork Poplar Creek

Table 4.15. Mercury concentrations at Outfall 014

Calendar year	2013	2014	2015	2016	2017	2018
Mercury concentration (µg/L)	7.12	0.892	9.11	0.49	0.237	N/A

N/A = not available

Sampling conducted in 2018 revealed unusually high concentrations of *Escherichia coli* in the two instream locations and two of the major outfalls. The reason for the elevated concentrations is unknown at this time. Additional sampling and analysis for this contaminant will occur in 2019.

4.5.4 Y-12 National Security 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 4.16. The primary function of SWHISS is to indicate 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.

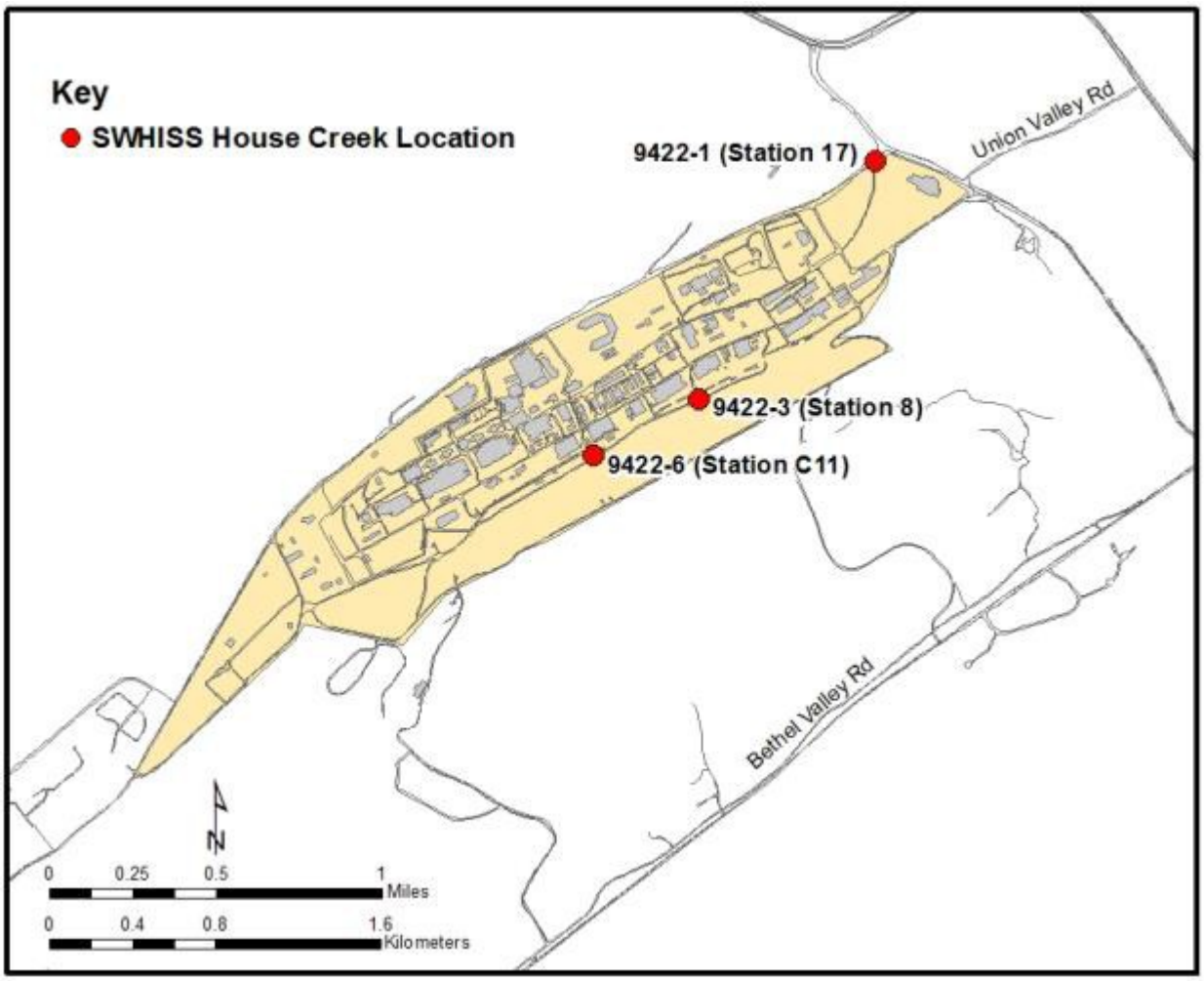


Figure 4.16. Surface Water Hydrological Information Support System monitoring locations

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

4.5.5 Industrial Wastewater Discharge Permit

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-hr 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 4.16) to conduct compliance monitoring as required by the pretreatment regulations. City personnel also conduct twice-yearly compliance inspections.

Monitoring results from 2018 are contained in Table 4.16. There were a total of four exceedances of permit limits in 2018; three exceedances of the 2,100-gpm instantaneous limit and one exceedance of the average daily flow limit.

Table 4.16. Y-12 National Security Complex Plant discharge point SS6 (all units are mg/L unless noted otherwise)

Effluent parameter	Number of samples	Average value	Daily maximum (gpm)[a]	Monthly average (effluent limit)[a]	Number of limit exceedances
Max flow rate (gpm)	365	N/A	2,100	N/A	4
Flow (average kgpd) January through March	90	510.6	N/A	500	1
Flow (average kgpd) April through June	91	299.9	N/A	500	0
Flow (average kgpd) July through September	92	298.3	N/A	500	0
Flow (average kgpd) October through December	92	393.6	N/A	500	0
pH (standard units)	15	N/A	N/A	9/6[b]	0
Biochemical oxygen demand	13	59.2	N/A	200	0
Kjeldhal nitrogen	15	22.0	N/A	45	0
Phenols—total recoverable	15	<0.027	N/A	0.15	0
Oil and grease	24	<15	N/A	25	0
Suspended solids	17	85.6	N/A	200	0
Cyanide	15	<0.0027	N/A	0.005	0
Arsenic	14	<0.005	N/A	0.010	0
Cadmium	14	<0.0006	N/A	0.0033	0
Chromium, hexavalent	12	0.006U	N/A	0.053	0
Copper	14	0.0275	N/A	0.14	0
Iron	14	0.592	N/A	10	0
Lead	14	<0.006	N/A	0.049	0
Mercury	14	0.00137[d]	N/A	0.035[d]	0
Nickel	14	<0.005	N/A	0.021	0
Silver	14	<0.002	N/A	0.05	0

Table 4.16. Y-12 National Security Complex Plant discharge point SS6 (all units are mg/L unless noted otherwise) (continued)

Effluent parameter	Number of samples	Average value	Daily maximum (gpm)[a]	Monthly average (effluent limit)[a]	Number of limit exceedances
Zinc	14	0.19	N/A	0.35	0
Molybdenum	14	0.0479	N/A	0.05[c]	N/A
Selenium	14	<0.001	N/A	0.01[c]	N/A
Toluene	3	0.005U	N/A	0.005[c]	N/A
Ammonia	4	20.2	N/A	0.10[c]	N/A
Methanol	3	0.98U	N/A	1.0[c]	N/A
Benzene	3	0.005U	N/A	0.005[c]	N/A
1,1,1-Trichloroethane	3	0.005U	N/A	0.005[c]	N/A
Ethylbenzene	3	0.005U	N/A	0.005[c]	N/A
Carbon tetrachloride	3	0.005U	N/A	0.005[c]	N/A
Chloroform	3	0.004UJ	N/A	0.005[c]	N/A
Tetrachloroethene	3	0.003J	N/A	0.005[c]	N/A
Trichloroethene	3	0.005U	N/A	0.005[c]	N/A
trans-1,2-Dichloroethylene	3	0.005U	N/A	0.005[c]	N/A
Methylene chloride	3	0.005U	N/A	0.005[c]	N/A

Units are pounds per day.
[a] Industrial and commercial users wastewater permit limits.
[b] Maximum value/minimum value.
[c] There is not a permit limit for this parameter. This value is the required detection limit.
gpm = gallons per minute kgpm = thousand gallons per minute N/A = not applicable

Additionally, there was one failure to perform required monitoring during CY 2018. Eleven of the organic compounds listed in Table 4.16 are listed as having three samples taken instead of the required four (one per calendar quarter). This occurred due to an administrative oversight during the July through September timeframe. The regulatory authority (City of Oak Ridge) issued a Notice of Violation to Y-12, and a corrective action plan to prevent recurrence has been approved and is being implemented.

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.
- 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 practices, or other water quality indicators, and produces required reports.

4.5.7 Biomonitoring Program

The NPDES Permit for Y-12 (TN0002968, Part III, Section E) contains chronic toxicity testing requirements. These requirements specify that chronic toxicity testing (a 3-Brood *Ceriodaphnia dubia* survival and reproduction test and a 7-day fathead minnow larval survival and growth test) is required annually at Outfalls 135 and 200 to determine whether the effluent is contributing chronic toxicity to the receiving water. According to permit requirements, chronic toxicity testing is to be performed using 100 percent effluent and the dilution series shown below in Table 4.17.

Table 4.17. Serial dilutions for whole effluent toxicity testing, as a percent of effluent

Outfall 200	**Control**	**0.25 x PL**	**0.50 x PL**	**PL**	**(100+ PL)/2**	**100% Effluent**
	0	9.3	18	37	74	100
Outfall 135	**Control**	**0.25 x PL**	**0.50 x PL**	**PL**	**2 x PL**	**4 x PL**
	0	2.3	4.5	9	18	36

NOTE: The effluent water is diluted with control laboratory water. PL = permit limit

Table 4.18 summarizes the results of the 2018 outfall biomonitoring tests in terms of the 25 percent inhibition concentration (IC_{25}), which is the concentration (i.e., a percentage of full-strength effluent diluted with laboratory control water) of each outfall effluent that causes a 25-percent reduction in the survival or reproduction of water fleas (*Ceriodaphnia dubia*) or the survival or growth of fathead minnow (*Pimephales promelas*) larvae (with respect to these same endpoints for these animals measured in control laboratory water). The lower the value of the IC_{25}, the more toxic the effluent. According to the NPDES permit, toxicity is demonstrated if the IC_{25} is less than or equal to the permit limit (9 percent whole effluent for Outfall 135 and 37 percent whole effluent for Outfall 200).

Effluent from Outfall 135 did not reduce fathead minnow (*Pimephales promelas*) survival or growth of water fleas (*Ceriodaphnia dubia*) survival or reproduction by 25 percent or more at any of the tested concentrations. For both species, the IC_{25} for survival, growth, or reproduction was >36 percent (the highest concentration of this effluent that was tested) (Table 4.18). However, toxicity was observed in Outfall 200 effluent in July 2018 in water fleas (*Ceriodaphnia dubia*), with the IC_{25} for reproduction being 26.3 percent effluent, which is lower than the permit limit of 37 percent (Table 4.18). According to the NPDES permit, if toxicity is found, a follow-up test must be initiated using the same serial dilutions within 2 weeks. Toxicity was again observed in the follow-up test in August 2018, with IC_{25} values of 33.8 and 25.2 percent effluent for water fleas (*Ceriodaphnia dubia*) survival and reproduction, respectively. With toxicity observed in two consecutive tests, a toxicity identification/evaluation reduction plan was initiated. This investigation included follow-on toxicity tests and characterization of the water chemistry in the storm drain network leading to Outfall 200. After the August 2018 test, no further toxicity was observed in the remainder of CY 2018 at this outfall.

Table 4.18. Y-12 National Security Complex biomonitoring program summary information for Outfalls 200 and 135, 2018[a]

Water collection dates	Outfall	Test type	Test organism	End point	Metric	IC_{25}[b] (%)
07/18–23/18	200	Chronic	Fathead minnow (*Pimephales promelas*)	Survival	IC_{25}	>100%
				Growth	IC_{25}	86.3%
			Water fleas (*Ceriodaphnia dubia*)	Survival	IC_{25}	55.5%
				Reproduction	IC_{25}	26.3%
07/18–23/18	135	Chronic	Fathead minnow (*Pimephales promelas*)	Survival	IC_{25}	>36%
				Growth	IC_{25}	>36%
			Water fleas (*Ceriodaphnia dubia*)	Survival	IC_{25}	>36%
				Reproduction	IC_{25}	>36%
08/07/18–08/13/18	200	Chronic	Water fleas (*Ceriodaphnia dubia*)	Survival	IC_{25}	33.80%
				Reproduction	IC_{25}	25.20%
			Fathead minnow (*Pimephales promelas*)	Survival	IC_{25}	>100%
				Growth	IC_{25}	89.40%

NOTE: Red font highlights IC_{25} values that were below permit limits, indicating toxicity as defined by the National Pollutant Discharge Elimination System Permit.

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

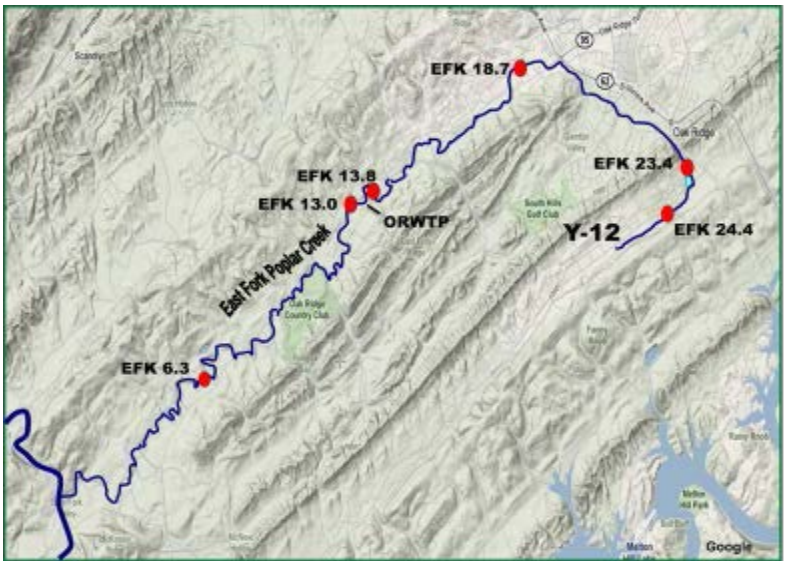
[b] IC_{25} as a percentage of full-strength effluent from Outfalls 200 and 135 diluted with laboratory control water. IC_{25} is the concentration that causes a 25% reduction in water fleas (*Ceriodaphnia dubia*) survival or reproduction or fathead minnow (*Pimephales promelas*) survival or growth; 36% is the highest concentration of Outfall 135 tested.

IC_{25} = 25% inhibition concentration

4.5.8 Biological Monitoring and Abatement Program

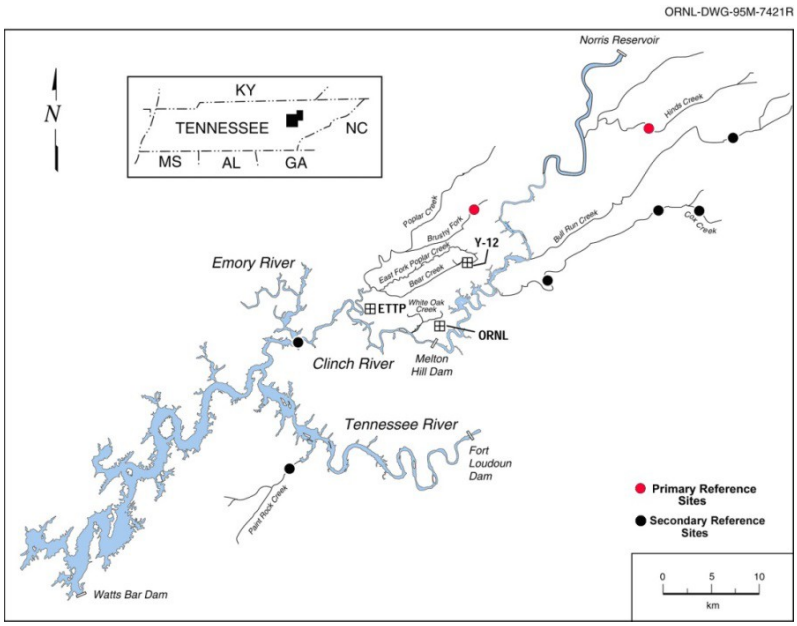
The NPDES permit issued for Y-12 mandates a Biological Monitoring and Abatement Program (BMAP) with the objective of demonstrating that the effluent limitations established for the facility protect the classified uses of the receiving stream, EFPC. The 2018 BMAP sampling efforts reported in this chapter follow the NPDES-required Y-12 BMAP Plan (Peterson et al. 2013). Y-12's 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 Y-12 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-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, respectively; and EFK 6.3, located about 1.4 km downstream of the ORR boundary (Figure 4.17). Brushy Fork at Brushy Fork kilometer (BFK) 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 4.18).



EFK = East Fork Poplar Creek kilometer ORWTP = Oak Ridge Water Treatment Plant

Figure 4.17. Locations of biological monitoring sites on East Fork Poplar Creek in relation to the Y-12 National Security Complex



ETTP = East Tennessee Technology Park ORNL = Oak Ridge National Laboratory Y-12 = Y-12 National Security

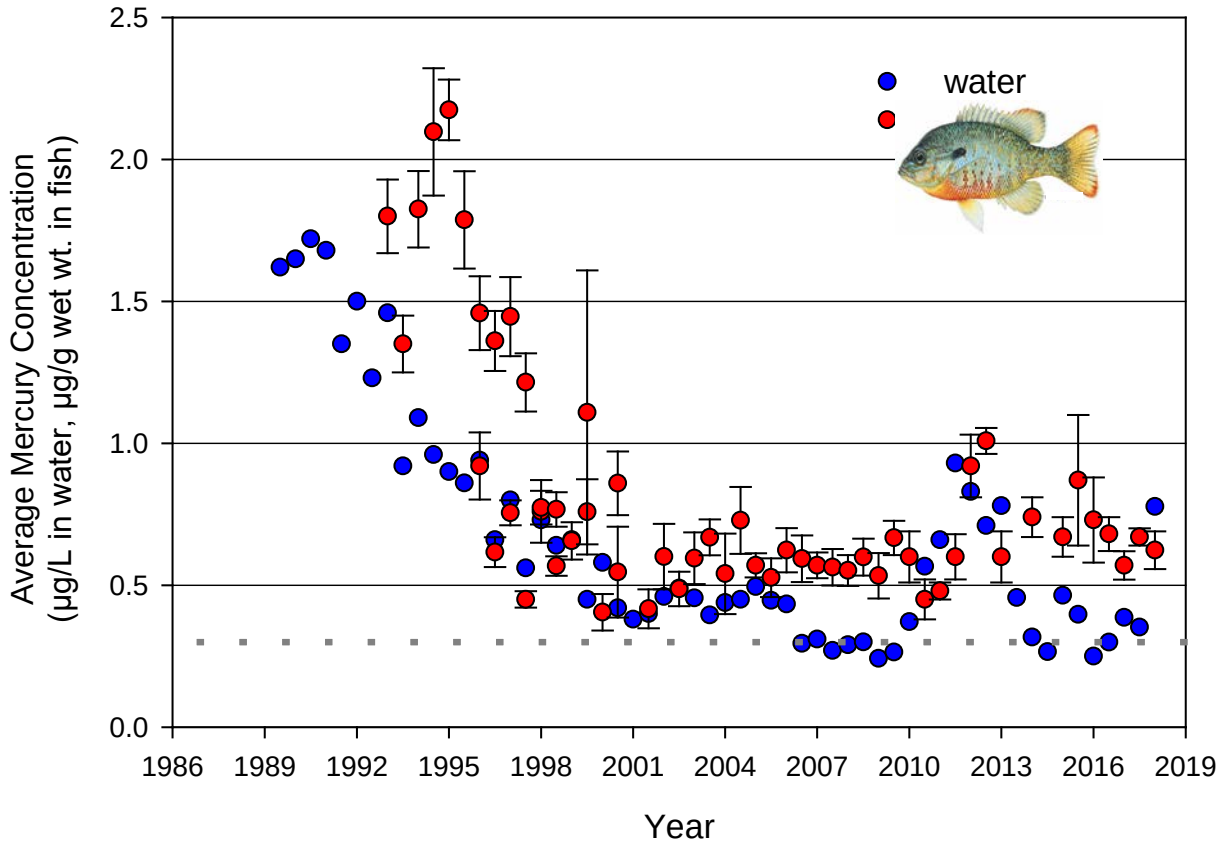
Figure 4.18. Locations of biological monitoring reference sites in relation to the Y-12 National Security Complex

Significant increases in the number of invertebrate and fish species in EFPC over the last three decades demonstrate that the overall ecological health of the stream continues to improve. However, the pace of improvement in upper EFPC near Y-12 has slowed in recent years, and fish and invertebrate communities continue to have fewer species than the corresponding communities in reference streams.

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 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 4.19). Mercury concentrations remained higher in fish from EFPC in 2018 than in fish from reference streams. Elevated mercury concentrations in fish from the upper reach of EFPC indicate that Y-12 remains a continuing source of mercury to fish in the stream.



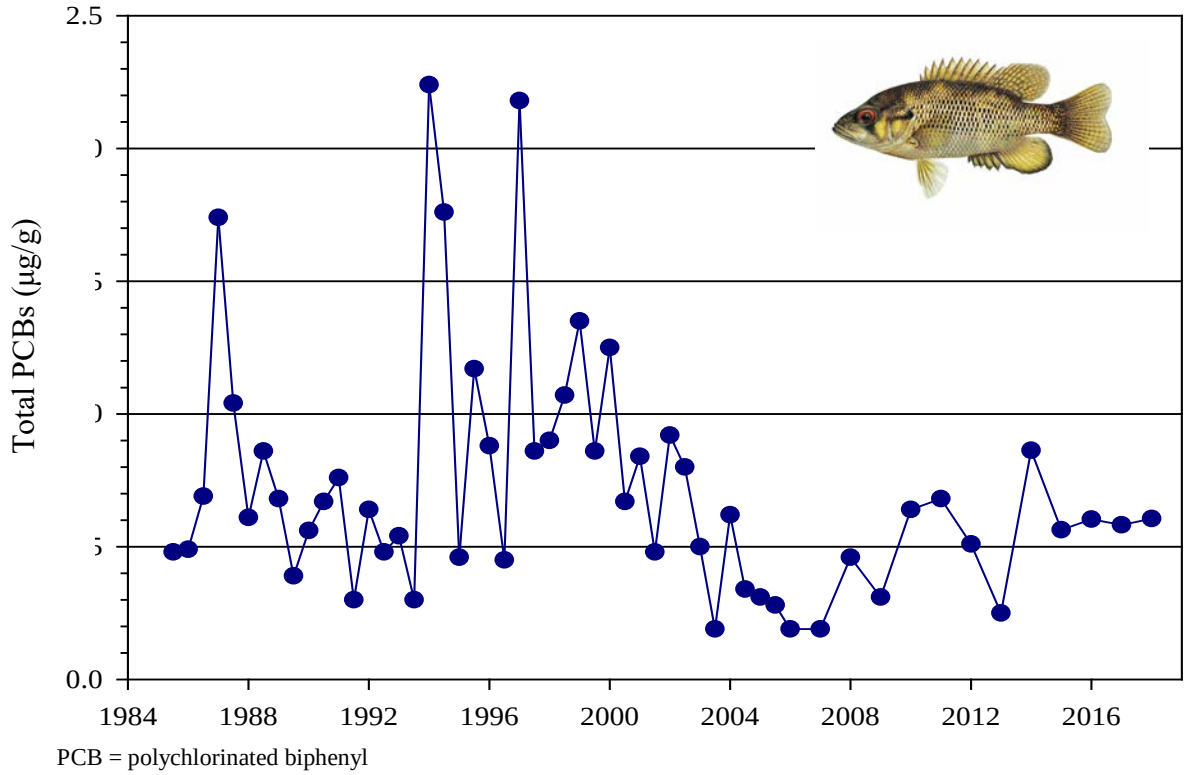
Dashed grey line represents the ambient water quality criterion for methylmercury in fish fillets [0.3 µg/g]

Figure 4.19. Semiannual average mercury concentration in muscle fillets of redbreast sunfish and water from East Fork Poplar Creek at East Fork Poplar Creek kilometer 23.4 (water) and East Fork Poplar Creek kilometer 24.4 (fish), Fiscal Year 2018

Figure 4.19 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. Water-borne 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 4.19). 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 approximately 0.6 µg/g in 2011 to above 1 µg/g in 2012 and dropped back down in 2013 through 2018 (approximately 0.6 µg/g). These concentrations are above the EPA-recommended 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.

The mean total PCB concentration in sunfish fillets at EFK 23.4 was 0.61 µg/g in FY 2018, which was comparable to the concentration in FY 2017 (0.58 µg/g) (Figure 4.20). 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, including for local reservoirs (Melton Hill, Watts Bar, and Fort Loudoun; TDEC 2010a, 2010b, 2010c).



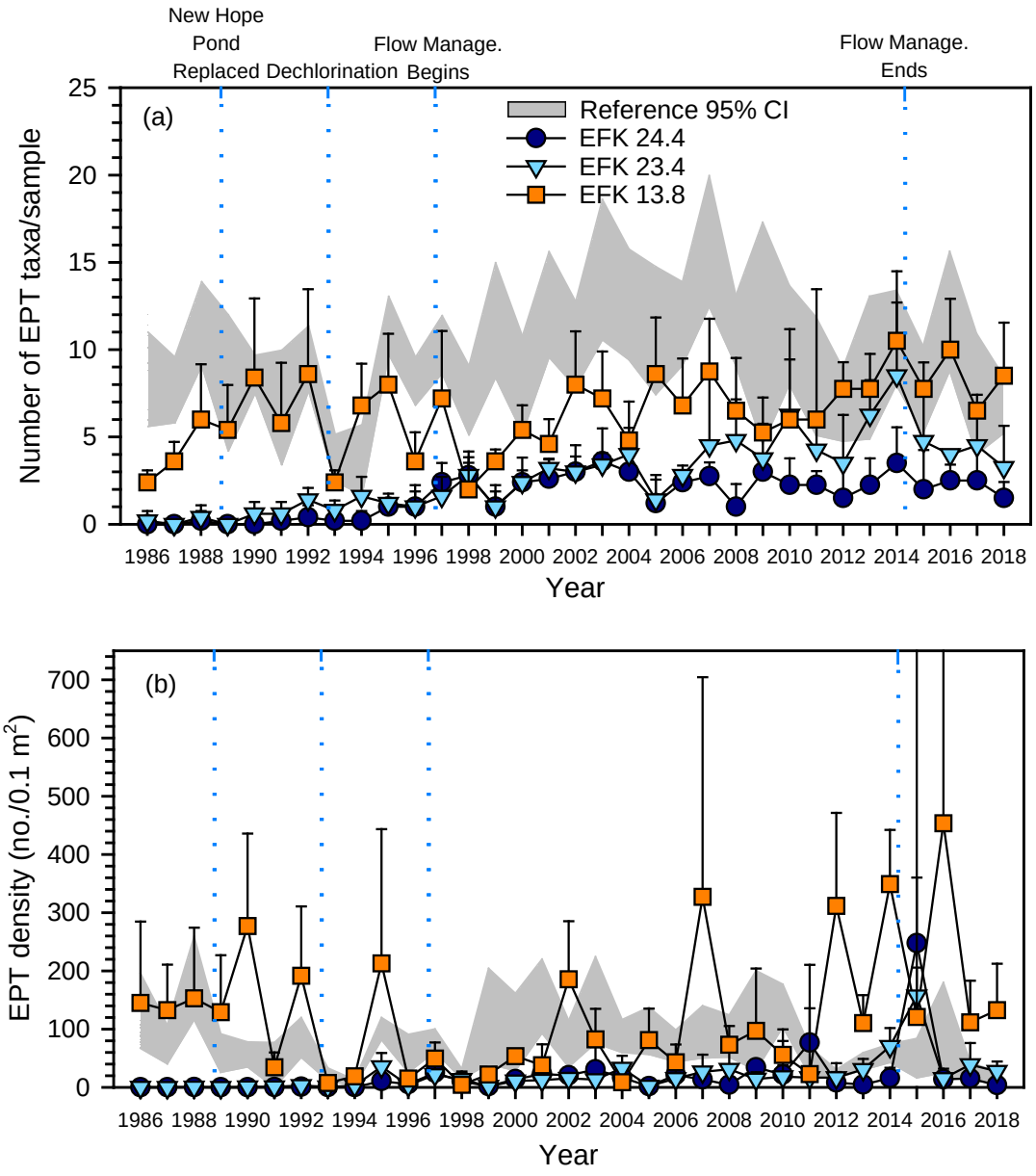
PCB = polychlorinated biphenyl

Figure 4.20. Annual mean concentrations of polychlorinated biphenyls in rock bass muscle fillets at East Fork Poplar Creek kilometer 23.4, Fiscal Year 2018

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 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 total maximum daily load (TDEC 2007). This concentration is 0.02 µg/g PCBs in fish fillets (TDEC 2010a, 2010b, 2010c). The mean fish PCB concentration in upper EFPC, 0.60 µg/g in fish fillets, is well above this concentration.

4.5.8.2 Benthic Invertebrate Surveys

Monitoring of the benthic macroinvertebrate community continued in the spring of 2018 at three sites in EFPC and at two reference streams. The numbers of pollution-intolerant taxa (Ephemeroptera, Plecoptera, and Tricoptera [EPT taxa]) increased at EFK 13.8 and decreased at EFKs 23.4 and 24.4 (Figure 4.21a). The densities of these pollution-intolerant taxa increased at EFK 13.8 but decreased at the two sites nearest Y-12 (EFK 23.4 and EFK 24.4) and at the reference sites (Figure 4.21b). 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, mean densities for pollution-intolerant taxa remain at typical low levels, indicative of degraded conditions after exceeding densities at reference sites in 2015 for the first time since monitoring began in 1985. The implications of ending flow management in 2014 on invertebrate communities in EFPC are still uncertain; however, EPT taxa richness at EFK 23.4 suggests that changes in hydrology may have influenced the community. EPT taxa richness at EFK 23.4 displayed consistent increases in EPT taxa richness from the mid-2000s to 2014, but after flow augmentation ceased, values have consistently declined. The effects of ending flow augmentation on lower EFPC (EFK 13.8) do not seem as evident, which makes intuitive sense as flow augmentation contributed a smaller percentage of total discharge at downstream sites. The long-term effects on the invertebrate community of ending flow management in EFPC will become more evident as conditions stabilize and additional data become available.

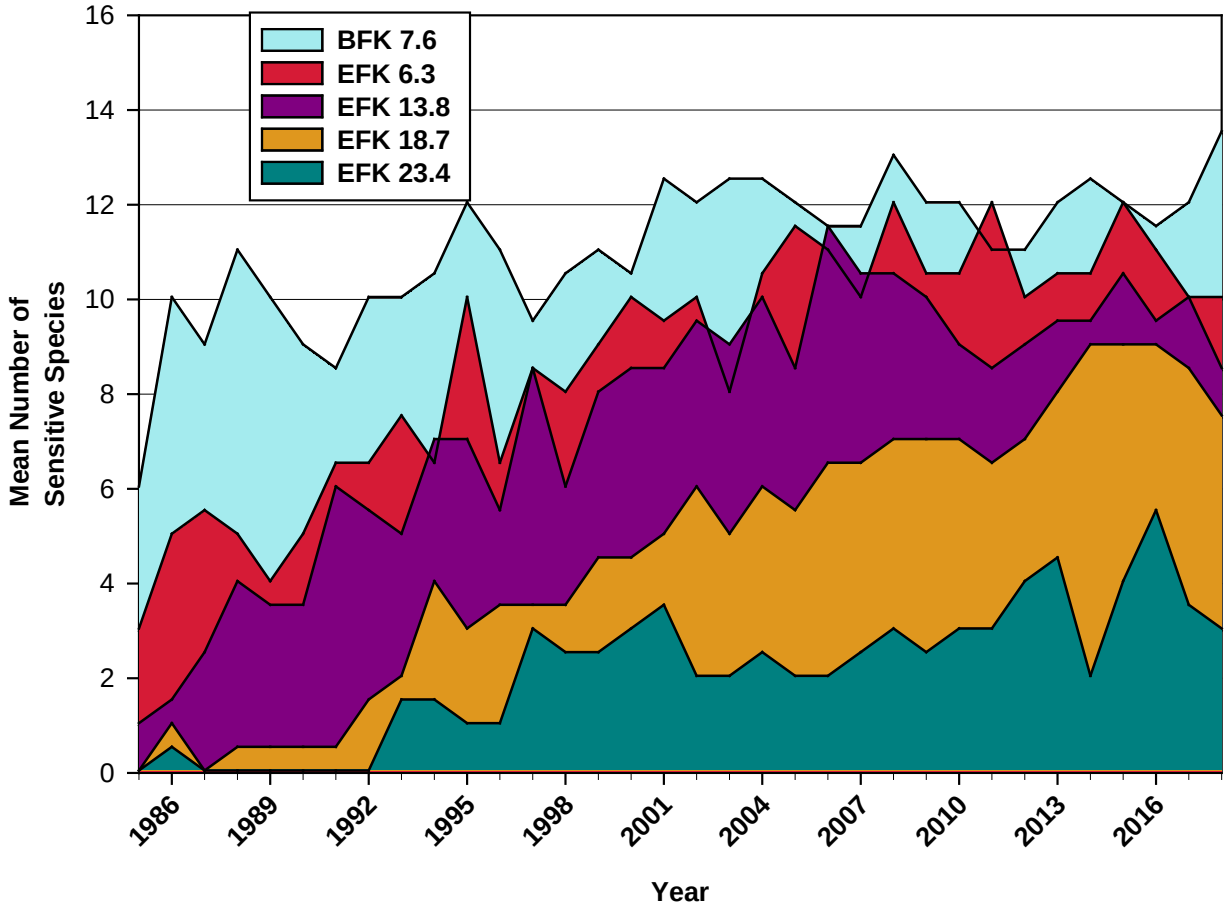


EFK = East Fork Poplar Creek kilometer
EPT taxa = Ephemeroptera, Plecoptera, and Tricoptera

Figure 4.21. (a) Taxonomic richness (mean number of taxa per sample), and (b) density (mean number of taxa per square meter) of Ephemeroptera, Plecoptera, and Tricoptera in the benthic macroinvertebrate communities sampled in the spring from East Fork Poplar Creek and two nearby reference streams (Brushy Fork and Hinds Creek), 1986–2018

4.5.8.3 Fish Community Monitoring

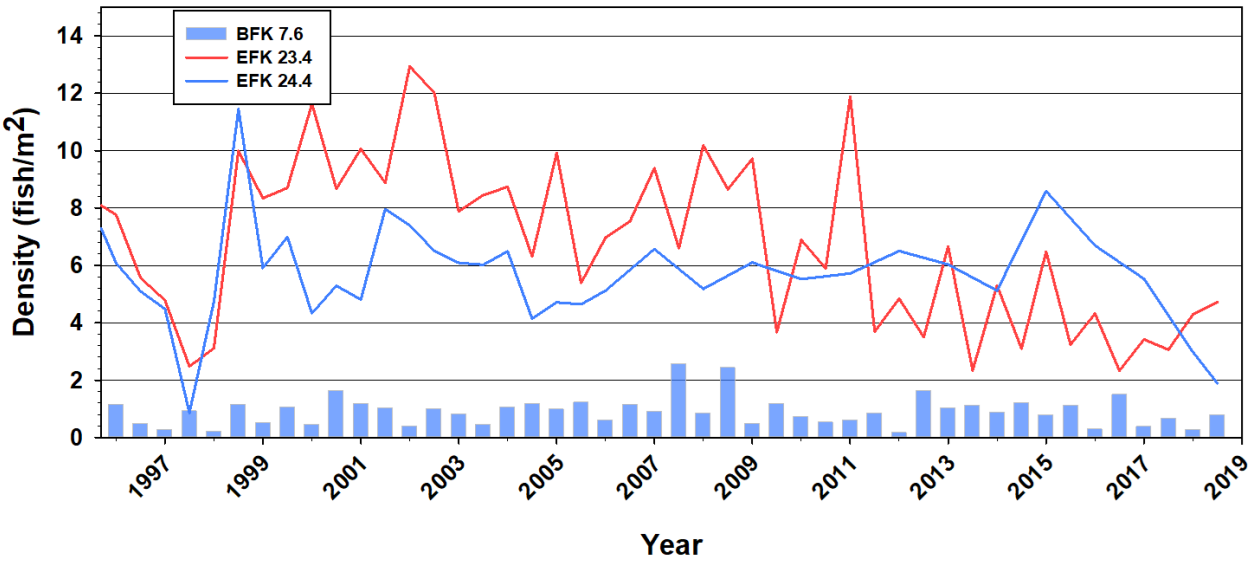
Fish communities were monitored in the spring and fall of 2018 at five sites along EFPC and at a comparable local reference stream (Brushy Fork). In the past three decades, overall species richness, density, biomass, and number of pollution-sensitive fish species improved at all sampling locations below 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 4.22, dramatically highlighting major improvements in the fish community in the middle to lower sections (EFK 6.3 and EFK 13.8) of the stream. However, the EFPC fish community continues to lag behind the reference stream community (BFK 7.6) in the most important metrics of fish diversity and community structure, especially at the monitoring sites closest to Y-12 (EFK 23.4 and EFK 24.4).



BFK = Brushy Fork kilometer EFK = East Fork Poplar Creek kilometer

Figure 4.22. Comparison of mean sensitive species richness (number of species) collected each year (1985–2018) from four sites in East Fork Poplar Creek and a reference site (Brushy Fork)

Fish communities in upper EFPC in 2018 continued to experience some fluctuation in density. Reduced stream flows associated with the termination of flow augmentation from Melton Hill in April 2014 and the extreme drought in 2016 are likely factors driving the decrease in fish densities in these upper sites (Figure 4.23). Despite this, the fish diversity remained relatively consistent. Very high densities are not always a positive indicator of fish health, and the most abundant species within these sites continue to be those that are considered tolerant. Continued monitoring will provide additional insight into these variabilities.



BFK = Brushy Fork kilometer 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

Figure 4.23. Fish density (number of fish per square meter) for two sites in upper East Fork Poplar Creek and a reference site (Brushy Fork), 1996–2018

The fish communities in upper EFPC were impacted in 2018 by two incidents that resulted in fish kills. On January 29, 2018, a high-water event associated with a water line break resulted in 58 fish mortalities in the upper end of EFPC above Station 8. A second incident occurred in July 2018 when most of the dead fish were encountered, but low-level fish mortality was observed through October 2018. In total, 416 fish and 309 crayfish were collected during 30 surveys from July 11 through October 29, 2018. Fish community surveys were conducted in fall (August) 2018 to assess the potential impact of the fish kill and current status of the communities. These surveys indicated that the fish community in upper EFPC (EFK 25.1 and EFK 24.4) was considerably lower than in spring 2018. Future monitoring of these sites will provide additional insight into the condition of these fish communities.

4.5.8.4 Upper Bear Creek Remediation

As part of the construction of the UPF inside Y-12, a haul road was constructed in 2013 and 2014, and several wetlands were lost or 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, were 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 wetland 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 re-establish the stream's riparian zone following the construction.

Annual monitoring of the remediated wetland sites through 2018 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 at these sites, additional deeper-water species of plants were added in 2018. Some additional actions to lower the water level are being considered in 2019.

The stream remediation site in upper Bear Creek appears to be a remediation success story. After some initial issues with drainage in the new channel, the old channel was backfilled to prevent this issue, and now flows appear to be much more stable. Native flora is abundant in the area adjacent to the stream. The fish and aquatic invertebrate communities in the remediated section of Bear Creek were slightly impacted by the drought in summer 2016, but the fish community appears to be recovering in 2017 and 2018 samples.

4.6 Groundwater at the Y-12 National Security Complex

Groundwater monitoring is performed to comply with federal, state, and local requirements and to determine the environmental impact from legacy and current operations. More than 140 known or potential sources of contamination are identified in the FFA (DOE 2018b). Groundwater monitoring provides information on the nature and extent of contamination, which is used to identify actions needed to protect the worker, the public, and the environment. Figure 4.24 depicts the major areas for which groundwater monitoring is performed.

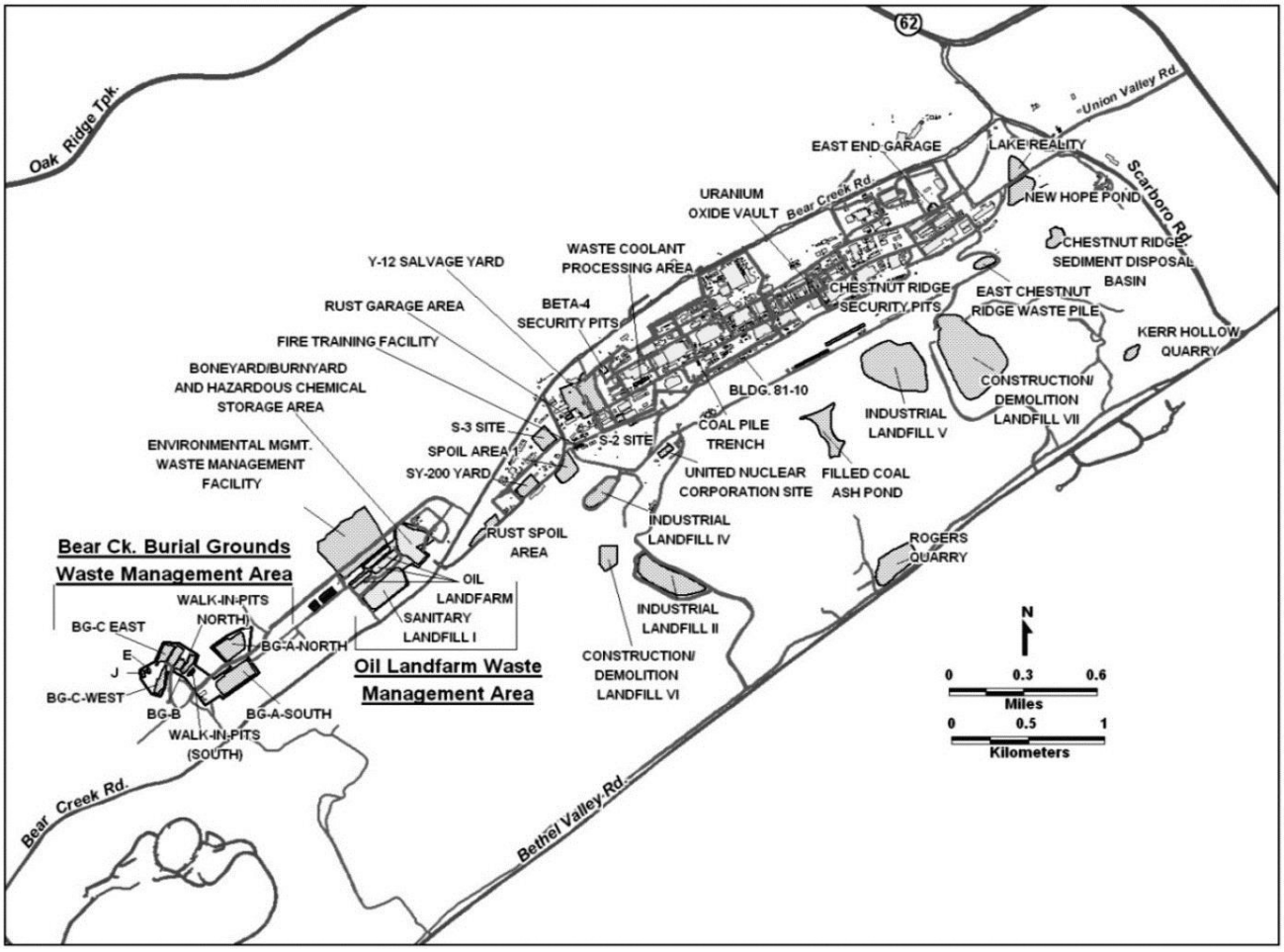
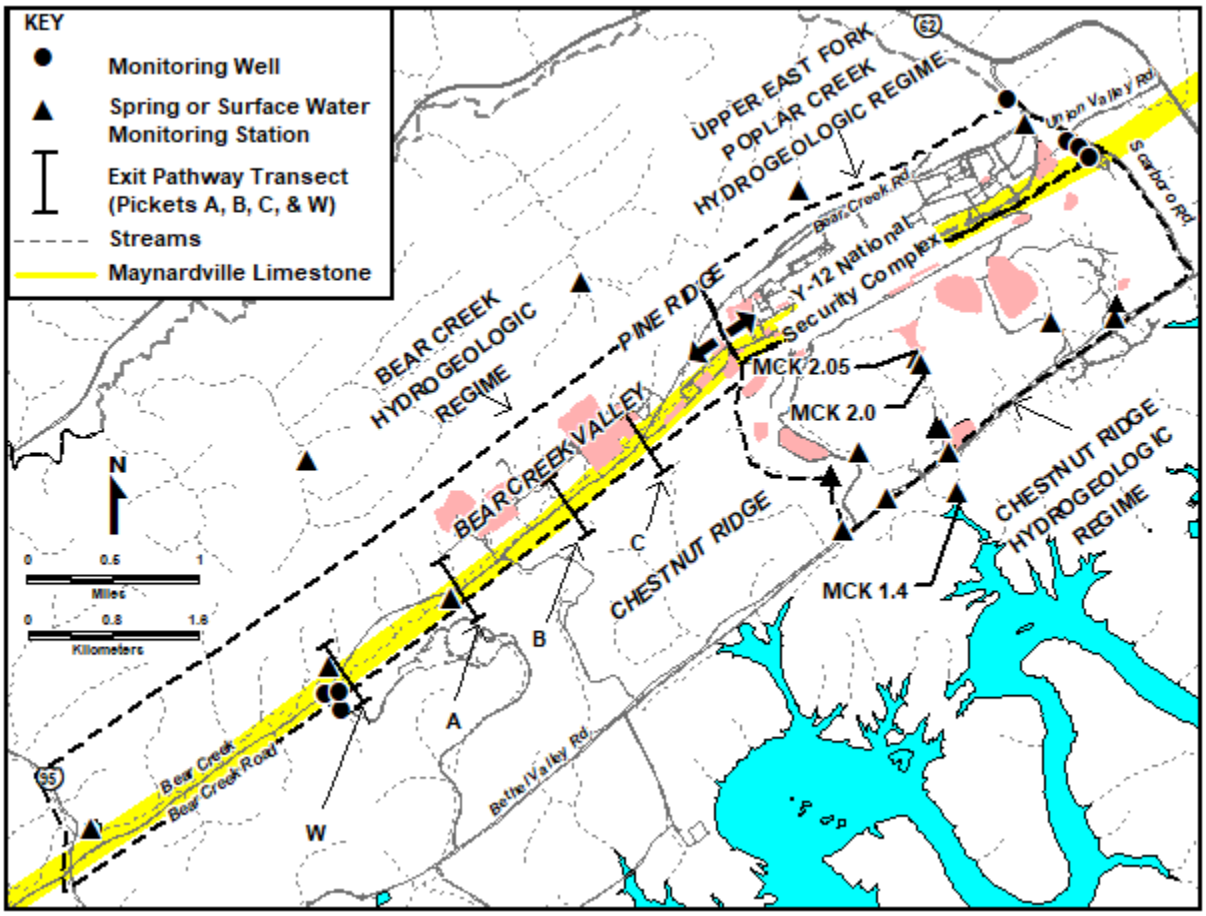


Figure 4.24. Known or potential contaminant sources for which groundwater monitoring is performed at the Y-12 National Security Complex

4.6.1 Hydrogeologic Setting

Y-12 is divided into three hydrogeologic regimes (Bear Creek, upper EFPC, and Chestnut Ridge) (Figure 4.25). Most of the Bear Creek and upper EFPC regimes are underlain by shale, siltstone, and sandstone bedrock, which act as an aquitard. An aquitard can contain water but does not readily yield that water to pumping wells. However, the southern portion of the Bear Creek and upper EFPC regimes is underlain by the Maynardville Limestone, which is part of the Knox aquifer. (An aquifer more readily yields water to pumping wells.) The Chestnut Ridge regime is almost entirely underlain by the Knox aquifer.



MCK = McCoy Branch kilometer

Figure 4.25. Hydrogeologic regimes; flow directions; and perimeter/exit pathway well, spring, and surface water monitoring stations, and the position of the Maynardville Limestone in Bear Creek Valley at the Y-12 National Security

In general, groundwater flow in the water table interval follows the topography; therefore, it flows off areas of higher elevation into the valleys and then flows parallel to the valley, along geologic strike (Figure 4.25). Shallow flow in the Bear Creek and upper EFPC regimes is divergent from a topographic and groundwater divide located near the western end of Y-12. In the Chestnut Ridge regime, a groundwater divide nearly coincides with the crest of the ridge. On Chestnut Ridge, shallow groundwater flow tends to be toward either flank of the ridge, with discharge primarily to surface streams and springs in Bethel Valley to the south and Bear Creek Valley to the north.

In Bear Creek Valley, groundwater in the intermediate and deep intervals moves through fractures in the aquitard, converging on and then moving through fractures and solution conduits in the Maynardville Limestone (Figure 4.25). Karst development in the Maynardville Limestone has a significant impact on groundwater flow paths in the water table and intermediate intervals. Groundwater flow rates in Bear Creek Valley vary; they are slow within the deep interval of the fractured non-carbonate rock (less than 10 ft/year) but can be quite rapid within solution conduits in the Maynardville Limestone (10 to 5,000 ft/day).

Contaminants are transported along with flowing groundwater through the pore spaces, fractures, or solution conduits of the hydrogeologic system. Strike-parallel transport of some contaminants can even 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. For example, elevated levels of nitrate (a contaminant from legacy waste disposals) within the fractured bedrock of the aquitard are known to extend east and west from the S-2 and S-3 sites for thousands of feet. VOC contamination from multiple sources is observed in both the Bear Creek and upper EFPC regimes, and to a lesser extent in the Chestnut Ridge regime. However, VOCs (e.g., petroleum products, coolants, and solvents) at source units over or in the fractured 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.

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. Following the crest of the Chestnut 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

Monitoring wells are devices used for the collection of groundwater samples. Figure 4.26 shows a cross-section of a typical groundwater monitoring well.

In CY 2018, 30 piezometers (small-diameter boreholes for measuring water levels and collecting water samples) were installed for the hydrologic investigation of the proposed EM Disposal Facility.

One well (GW-923) at the Environmental Management Waste Management Facility was plugged and abandoned in CY 2018.

4.6.3 Calendar Year 2018 Groundwater Monitoring

Groundwater monitoring in CY 2018 was performed as part of Y-12's GWPP, DOE EM programs such as the Water Resources Restoration Program, and other projects. Compliance requirements were met by monitoring 182 wells and 51 surface water locations and springs (Table 4.19). Specific wells of interest based on the CY 2018 data are called out later in this section. However, Figure 4.25 shows the locations of perimeter/exit pathway stations that are monitored closely because they are the locations closest to the reservation boundaries.

Most of the conventional monitoring wells at Y-12 were sampled using industry standard methods approved by TDEC and EPA (Figure 4.27).

Water quality results of groundwater monitoring activities in CY 2018 are presented in the *Calendar Year 2018 Groundwater Monitoring Report* (CNS 2019).

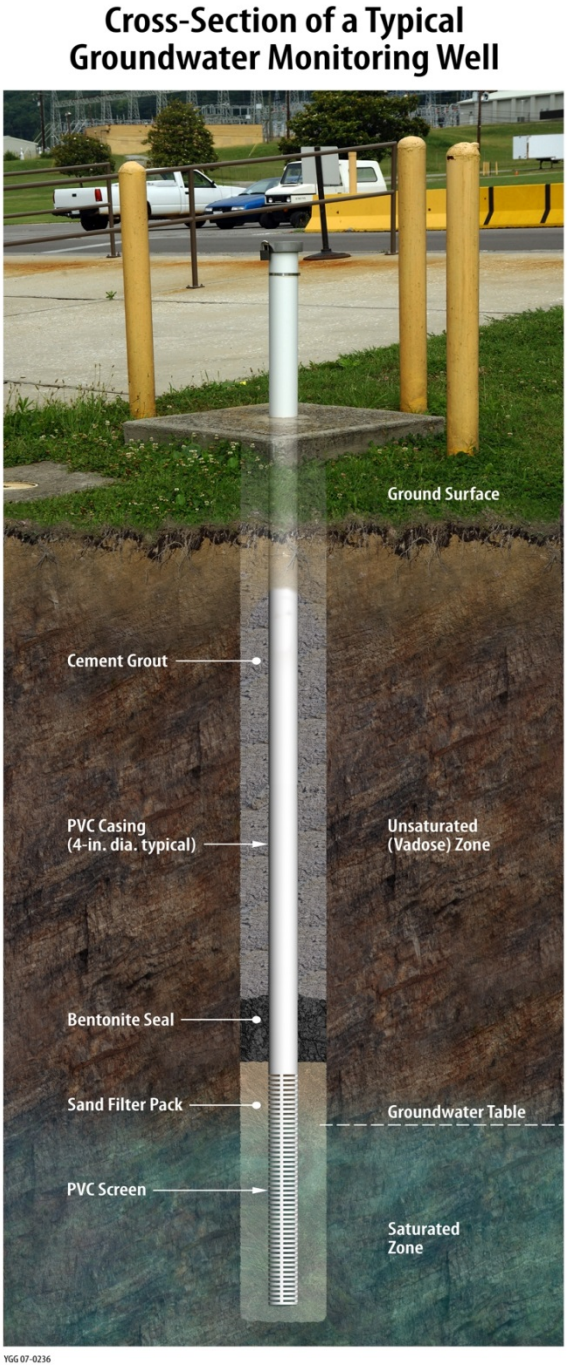


Figure 4.26. Cross-section of a typical groundwater monitoring well

Monitoring efforts performed specifically for CERCLA baseline and remediation evaluation are published in the FY 2018 and FY 2019 Water Resources Restoration Program Sampling and Analysis Plans (UCOR 2017, 2018b, respectively) and the Annual CERCLA Remediation Effectiveness Reports (DOE 2018c, 2019).

Table 4.19. Summary of groundwater monitoring at the Y-12 National Security Complex, 2018

	Purpose for which monitoring was performed				
	Restoration[a]	Waste management[b]	Surveillance[c]	Other[d]	Total
Number of active wells	65	33	84	24	206
Number of other monitoring stations (e.g., springs, seeps, and surface water)	31	6	14	3	54
Number of samples taken[e]	160	134	99	134	527
Number of analyses performed	7,823	6,279	7,622	2,615	24,336
Percentage of analyses that are non- detects	64.8	86.9	83.5	25.0	72.0
Ranges of results for positive detections, VOCs (µg/L)[f]					
Chloroethenes	0.32–2,500	2.73–6.64	1–37,000	NA	
Chloroethanes	0.32–240	4.58–75.5	1–1,900	NA	
Chloromethanes	0.33–1,100	ND	1–4,200	NA	
Petroleum hydrocarbons	0.41–6,500	ND	1–510	NA	
Uranium (mg/L)	0.0005–0.26	0.00141–0.0371	0.000546–0.0266	0.000148–23.5	
Nitrates (mg/L)	0.0032–6,600	0.513–1.96	0.0477–9,250	0.15–25.13	
Ranges of results for positive detections, radiological parameters (pCi/L)[g]					
Gross-alpha activity	4.23–351	0.872–4.98	5–110	NA	
Gross-beta activity	2.94–9,060	2.08–11.5	10–8,600	NA	

[a] Monitoring to comply with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements and with Resource Conservation and Recovery Act (RCRA) post-closure detection and corrective action monitoring.
[b] Solid waste landfill detection monitoring and CERCLA landfill detection monitoring.
[c] US Department of Energy (DOE) Order surveillance monitoring.
[d] Research-related groundwater monitoring associated with activities of the DOE Oak Ridge Field Research Center and Ecosystems and Networks Integrated with Genes and Molecular Assemblies.
[e] The number of unfiltered samples, excluding duplicates, determined for unique location/date combinations.
[f] These ranges reflect concentrations of individual contaminants (not summed VOC concentrations):
Chloroethenes—includes tetrachloroethene; trichloroethene; 1,2-dichloroethene (cis- and trans-); 1,1-dichloroethene; and vinyl chloride.
Chloroethanes—includes 1,1,1-trichloroethane; 1,2-dichloroethane; and 1,1-dichloroethane.
Chloromethanes—includes carbon tetrachloride, chloroform, and methylene chloride.
Petroleum hydrocarbon—includes benzene, toluene, ethylbenzene, and xylene.
[g] $pCi = 3.7 \times 10^{-2}$ Bq

Bq = becquerel
NA = not analyzed
ND = not detected

Source: Kathryn Fahey, Y-12 National Security Complex photographer

Figure 4.27. Groundwater monitoring well sampling at the Y-12 National Security Complex

4.6.4 Y-12 National Security Complex Groundwater Quality

Historical monitoring shows that four primary contaminants adversely affect groundwater quality at Y-12: nitrate, VOCs, metals, and radionuclides. Of those, VOCs are the most widespread. Uranium and technetium-99 (^{99}Tc) are the radionuclides of greatest concern. Trace metals (e.g., arsenic, barium, cadmium, chromium, and mercury), the least extensive groundwater contaminants, generally occur close to source areas because of their high adsorption characteristics. 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, the upper EFPC regime contains most of the known and potential sources of contamination. (Summary descriptions of waste management sites shown on Figure 4.24 have been provided in previous year ASERs and are not repeated this year.) Contaminants

from the S-3 site (nitrate and ^{99}Tc) and VOCs from multiple source areas are observed in the groundwater in the western portion of the upper EFPC regime; whereas, groundwater in the eastern portion of the regime is predominantly contaminated with VOCs.

Plume Delineation

Sources of contaminants monitored during CY 2018 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 Y-12. The S-3 site is located near the hydrologic divide that separates the upper EFPC regime from the Bear Creek regime, and the site has contributed to groundwater contamination to both regimes. Contaminant plumes in both regimes (shown in gray shading on Figures 4.28 through 4.31) are elongated 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.

The plumes depicted (gray shading) reflect the average concentrations and radioactivity in groundwater between CYs 2013 and 2017. The circular icons presented on the plume maps (Figures 4.28 through 4.31) represent CY 2018 monitoring results for both the upper EFPC regime (discussed in this section) and the Bear Creek regime (discussed in Section 4.6.4.2).

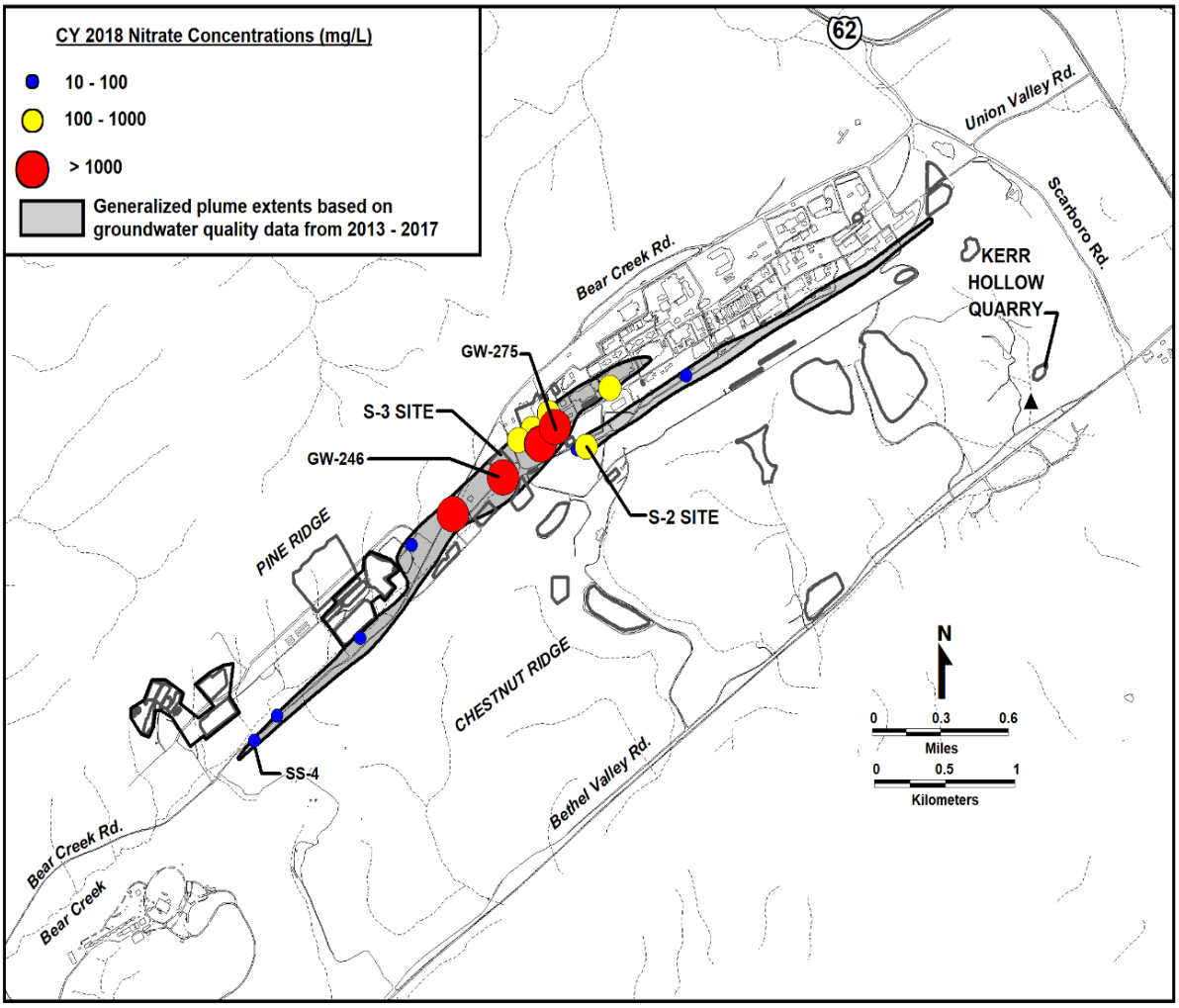


Figure 4.28. Nitrate in groundwater at the Y-12 National Security Complex, 2018

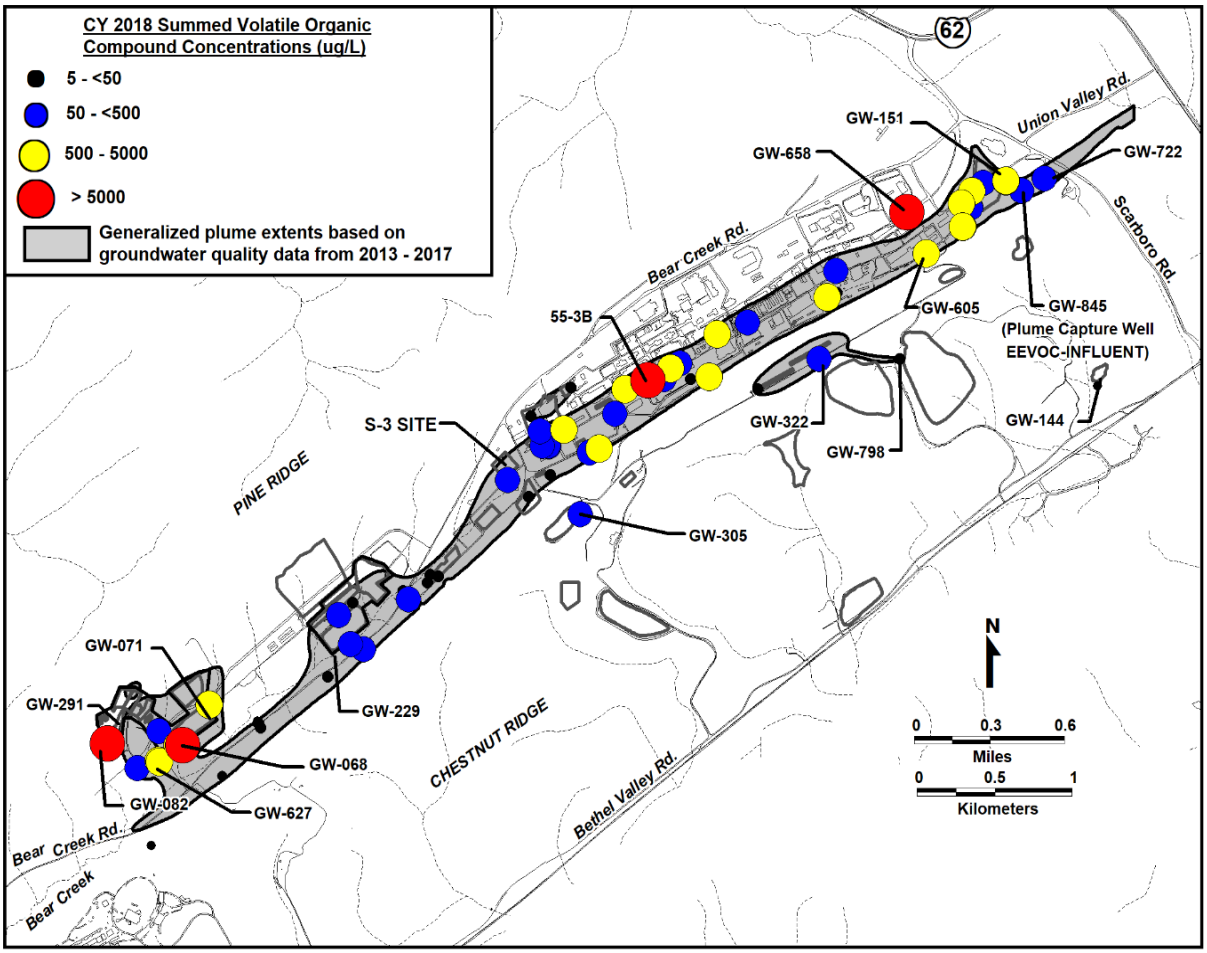


Figure 4.29. Summed volatile organic compounds in groundwater at the Y-12 National Security Complex, 2018

(EEVOC = east end volatile organic compound)

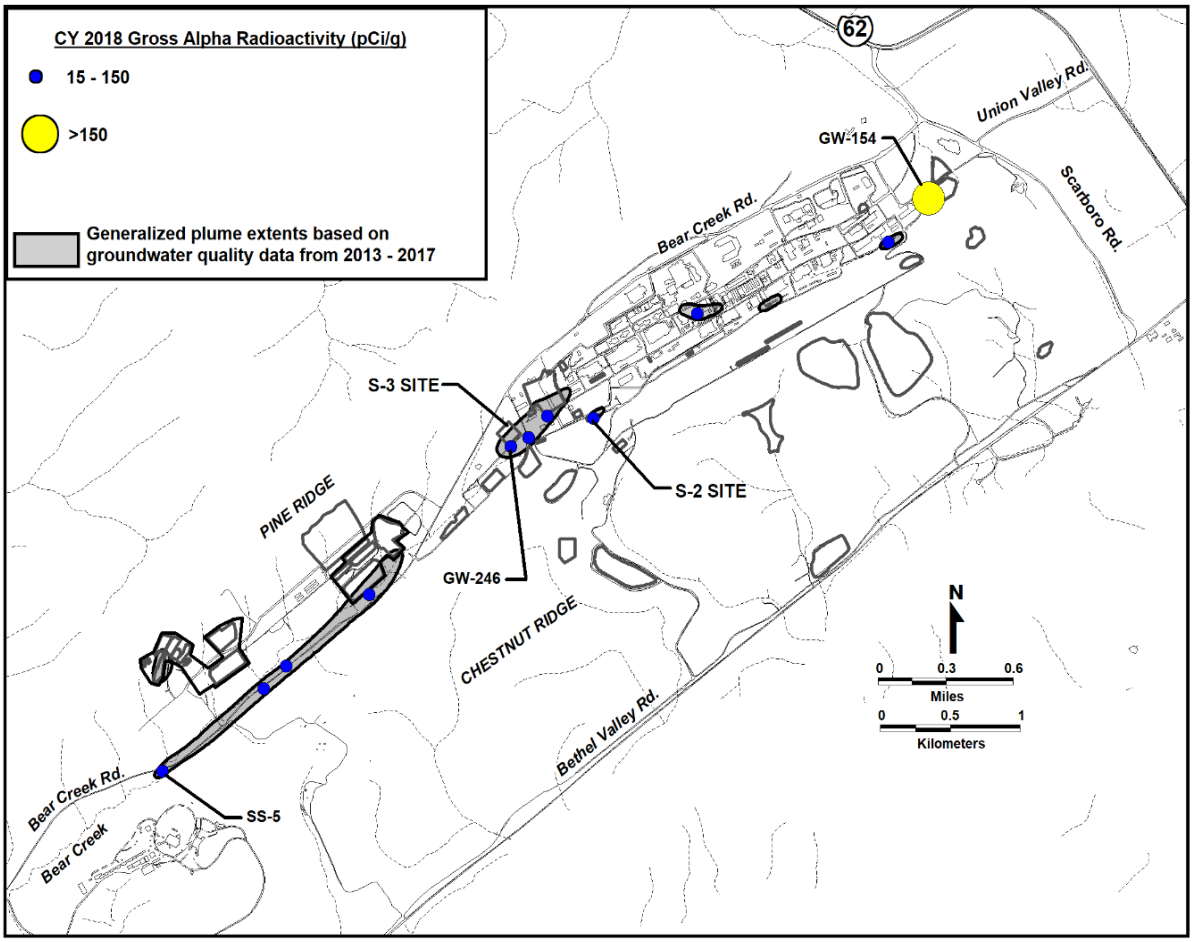


Figure 4.30. Gross-alpha activity in groundwater at the Y-12 National Security Complex, 2018

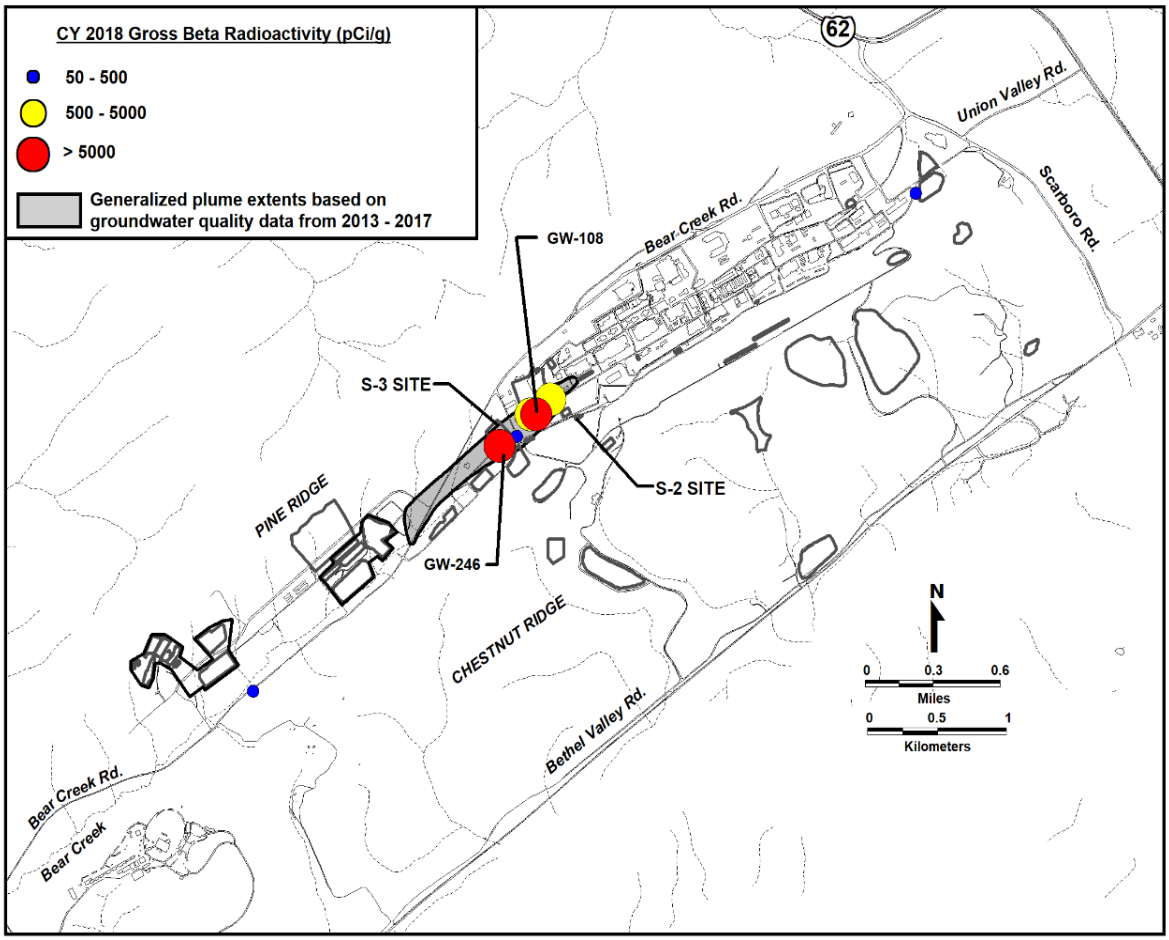


Figure 4.31. Gross-beta activity in groundwater at the Y-12 National Security Complex, 2018

Nitrate

Nitrate is highly soluble and moves easily with groundwater. In the central and western portions of upper EFPC, nitrate concentrations exceed the 10-mg/L drinking water standard. (A list of the national drinking water standards is presented in Appendix C.) The two primary sources of nitrate contamination are the S-2 and S-3 sites. In CY 2018, there was a maximum nitrate concentration of 9,250 mg/L in well GW-275. This well is located about 396 m (1,300 ft) east of the S-3 site and is screened in the shallow-intermediate bedrock interval about 20 m (65 ft) below ground surface (Figure 4.28).

Trace Metals

In CY 2018, barium, beryllium, cadmium, chromium, copper, nickel, thallium, and uranium exceeded primary drinking water standards in groundwater samples across the upper EFPC, but predominately at and downgradient of the S-2 and S-3 sites. Trace metal concentrations above standards tend to occur adjacent to source areas because of their low solubility and high adsorption to the clay-rich soils and bedrock.

Volatile Organic Compounds

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 2018, the highest

summed concentration of dissolved chlorinated hydrocarbons (43,837 µg/L) was again found at well 55-3B in the western portion of Y-12, adjacent to currently inactive manufacturing facilities. The highest dissolved concentration of petroleum hydrocarbons (16,698 µg/L) was from well GW-658 at the closed East End Garage.

These monitoring results are consistent with data from the previous years. A dissolved plume of VOCs in the bedrock zone extends eastward from the S-3 site over the entire length of the regime (Figure 4.29). Additional sources are the Waste Coolant Processing Facility, fuel facilities (Rust Garage and East End Garage), and other waste disposal and production areas. Chloroethene compounds (tetrachloroethene [PCE], trichloroethene [TCE], dichloroethene [DCE], and vinyl chloride) tend to dominate the VOC plume composition in the western and central portions of Y-12. However, PCE is almost ubiquitous throughout, indicating many source areas. Chloromethane compounds (carbon tetrachloride, chloroform, and methylene chloride) are the predominant VOCs in the eastern portion of Y-12.

Variability in concentration trends of chlorinated and petroleum VOCs is seen within the upper EFPC regime. Data from most of the monitoring wells have remained relatively constant or have decreased since 1988. However, increasing trends have been observed in wells associated with the Rust Garage, Old Salvage Yard, and S-3 site; some legacy sources at production/process facilities in central areas; and the east end VOC plume.

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 (see additional information in the Exit Pathway and Perimeter Monitoring section below). The pumping well may be 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 are attenuating due to factors such as: (1) dilution by uncontaminated groundwater, (2) dispersion through a network of fractures and conduits, (3) degradation by chemical or biological means, and/or (4) adsorption by surrounding bedrock and soil media.

Wells east of New Hope Pond and north of well GW-845 exhibit stable to increasing trends in VOCs, indicating that little impact from the plume capture system is apparent across lithologic units (perpendicular to strike). However, no downgradient detection of these compounds is apparent; therefore, either migration is limited, or some downgradient across-strike influence by the plume capture system is occurring.

Radionuclides

The primary alpha-emitting radionuclides found in the upper EFPC regime during CY 2018 are isotopes of uranium. Exceedances of the drinking water standard for gross alpha (15 pCi/L) have been observed near the S-3 site, the Salvage Yard, and other western source areas; in the central areas near production facilities and the Uranium Oxide Vault; and also in the east end near the former oil skimmer basin at the former inlet to the New Hope Pond, which was capped in 1988. In CY 2018, the maximum occurrence of gross-alpha activity in groundwater in the upper EFPC regime was 351 pCi/L at well GW-154.

The primary beta-emitting radionuclides observed in the upper EFPC regime are ^{99}Tc and isotopes of uranium. Elevated gross-beta activity in groundwater shows a pattern similar to that observed for gross-alpha activity.

Technetium-99 is the primary contaminant exceeding the gross-beta screening level of 50 pCi/L; the source is the S-3 site. The highest gross-beta activity in groundwater was observed during CY 2018 from well GW-108 (9,060 pCi/L).

Exit Pathway and Perimeter Monitoring

In the upper EFPC regime, VOCs have been observed at depths of up to 500 ft below ground surface. The deep fractures and solution channels within the Maynardville Limestone (the primary exit pathway) appear to be well connected and facilitate contaminant migration into Union Valley offsite to the east of Y-12.

Because of the off-site migration of contaminants, a plume capture system (the East End VOC Treatment System [EEVOCTS]) was constructed in and around existing well GW-845 in June 2000 and began continuous operation in October 2000. This system pumps groundwater from the intermediate bedrock 48 to 134 m (157 to 438 ft) below ground surface to mitigate the 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 the plume capture system have shown an encouraging response. For example, the Westbay multiport system installed in well GW-722, about 153 m (500 ft) east and downgradient of the system, permits sampling of vertically discrete zones within the Maynardville Limestone between 27 and 130 m (87 and 425 ft) below ground surface (Figure 4.29). 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 well GW-722 indicate reductions in VOCs due to the plume capture system, as shown in sample zone GW-722-17 (385 ft below ground surface) in Figure 4.32. These indicators demonstrate that operation of the plume capture system is decreasing VOC contamination.

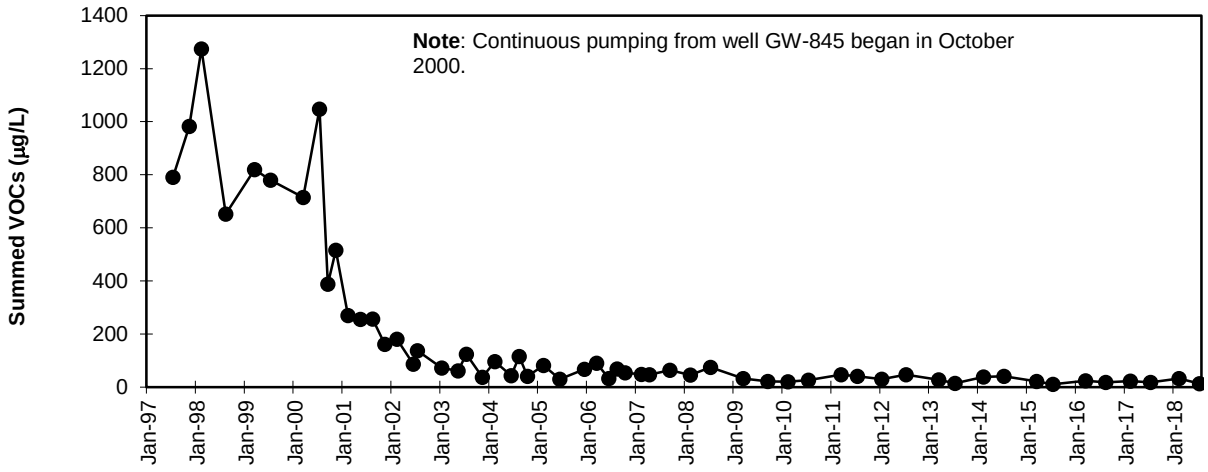


Figure 4.32. Decreasing summed volatile organic compounds observed in exit pathway well GW-722-17 near New Hope Pond, 2018

Five zones in well GW-722 were sampled in CY 2018, with four of the five zones showing summed VOCs greater than 5 µg/L. Only four zones exceeded individual drinking standards (from carbon tetrachloride and PCE, the highest of which was 41 µg/L of carbon tetrachloride).

In addition to the deep system in the eastern portion of upper EFPC, VOCs have also been observed in the shallow groundwater where it flows north-northeast (mimicking the flow of the creek) east of the New Hope Pond site and Lake Reality. In this area, GW-832 has been installed in a distribution channel underdrain associated with the former New Hope Pond. During CY 2018, the observed concentrations of VOCs at the New Hope Pond distribution channel underdrain remained low (30.4 µg/L).

Upper EFPC flows north exiting Y-12 through a gap in Pine Ridge. As mentioned previously, shallow groundwater mimics the creek and also moves through Pine Ridge due to strong upward vertical flow gradients. Monitoring of the wells in this gap has shown no indication of contaminants moving via that exit pathway. One shallow well was monitored in CY 2018, and no groundwater contaminants were detected.

Perimeter sampling locations continue to be monitored north and northwest of Y-12 to evaluate possible contaminant transport, even though those locations are considered unlikely contaminant exit pathways. One of the stations monitored is a tributary that drains the north slope of Pine Ridge 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 flows adjacent to the Country Club Estates community. There were no indications that contaminants were being discharged from the ORR into those communities.

Union Valley Monitoring

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

In CY 2018, monitoring of locations in Union Valley continued, showing overall decreasing or low concentration stable trends. Vinyl chloride at 2.1 µg/L (just above the maximum contaminant level of 2 mg/L) was detected at GW-230.

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 to mitigate the migration of groundwater contaminated with VOCs into Union Valley (DOE 2018b).

In July 2006, the Agency for Toxic Substances and Diseases Registry, the principal federal public health agency charged with evaluating the human health effects of exposure to hazardous substances in the environment, published a report in which groundwater contamination across the ORR was evaluated (ATSDR 2006). In the report, it was acknowledged that 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 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 Y-12 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 Y-12 to State Highway 95. Descriptions of waste management sites in the Bear

Creek regime and shown on Figure 4.24 have been provided in previous year ASERs and are not repeated this year.

Plume Delineation

The primary 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 sources of uranium, other trace metals, and VOCs. 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 constrained by the bedrock formations (particularly the Nolichucky Shale) that underlie the waste disposal areas in the Bear Creek regime. This fractured aquitard unit is north of and adjacent to the exit pathway unit, the Maynardville Limestone (an aquifer). The elongated shape of the 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, as well as the aquitard.

The plumes in the Bear Creek regime (shown by gray shading on Figures 4.28 through 4.31) represent the average concentrations and radioactivity between CYs 2013 and 2017. The circular icons presented on the figures represent CY 2018 monitoring results.

Nitrate

CY 2018 data indicate that nitrate in groundwater continues to exceed the drinking water standard (10 mg/L) in an area that extends west from the S-3 site. The highest nitrate concentration (2,100 mg/L) was observed at well GW-246 adjacent to the S-3 site at a depth of 19 m (62.5 ft) below ground surface. Historically elevated concentrations of nitrate (>1,000 mg/L) have been detected at greater depths (>700 ft below ground surface) near the S-3 site. In CY 2018 a concentration exceeding the drinking water standard was detected in groundwater as far as 2,438 m (8,000 ft) west of the S-3 site, from spring location SS-4 (17 mg/L).

Trace Metals

During CY 2018, barium, beryllium, cadmium, nickel, and uranium were identified as trace metal contaminants in the Bear Creek regime that exceeded primary drinking water standards. Elevated concentrations of many of the trace metals were observed at shallow depths near the S-3 site. In the Bear Creek regime, where natural geochemical conditions prevail, the trace metals may occur sporadically and in close association with source areas because conditions are typically not favorable for dissolution and migration. Disposal of acidic liquid wastes at the S-3 site reduced the pH of the groundwater, which allows the metals to remain in solution longer and migrate further from the source area.

The most prevalent trace metal contaminant is uranium. Early characterization indicated that the Boneyard-Burnyard site was the primary source of uranium contamination. In 2003, the final remedial actions at the Boneyard-Burnyard were performed. There were decreases in uranium concentration and flux in the surface water tributary downstream of the Boneyard-Burnyard (NT-3), which indicate that the remedial actions were successful. There has been a decrease in uranium in Bear Creek since 1990 (Table 4.20); however, uranium concentrations in the upper reaches of Bear Creek have been stable, indicating that this contaminant still presents an impact in surface water and groundwater.

Other trace metals observed in the Bear Creek regime are arsenic, boron, chromium, copper, lead, mercury, selenium, strontium, thallium, and zinc. Concentrations have commonly exceeded background values near source areas.

Table 4.20. Nitrate and uranium concentrations in Bear Creek

Bear Creek Monitoring station (distance from S-3 site)	Contaminant	Average concentration[a] (mg/L)					
		1990–1994	1995–1999	2000–2004	2005–2009	2010–2014	2015–2018
BCK-11.84 to 11.97	Nitrate	116	65.7	89.5	43.3	53.3	31.8
(approximately 0.5 miles downstream)	Uranium	0.203	0.112	0.129	0.112	0.172	0.186
BCK-09.20 to 09.47	Nitrate	16.1	7.8	12.1	8.4	4.4	5.7
(approximately 2 miles downstream)	Uranium	0.098	0.093	0.135	0.060	0.051	0.071
BCK-04.55	Nitrate	4.7	2.3	3.5	1.1	0.8	0.95
(approximately 5 miles downstream)	Uranium	0.034	0.030	0.033	0.020	0.016	0.018

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

Volatile Organic Compounds

VOCs are widespread in groundwater in the Bear Creek regime. The primary compounds are PCE; TCE; cis-1,2-DCE; vinyl chloride; and 1,1-dichoroethane. 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 and can extend 305 m (1,000 ft) laterally from source areas. The highest concentration observed in CY 2018 occurred in the Nolichucky Shale aquitard at the Bear Creek Burial Ground waste management area, with a maximum summed VOC concentration of 7,503 µg/L in well GW-068 (Figure 4.29); cis-1,2-DCE at 3,700 µg/L provides approximately one-half of the summed VOCs.

Near contaminant source areas, such as the Bear Creek Burial Grounds and the Oil Landfarm waste management areas, a variety of concentration trends are observed. These trends are dependent upon proximity to sources and hydrogeologic conditions. Decreasing and stable VOC trends dominate, as observed in wells GW-014 and GW-046 (Figure 4.33).

Increasing trends of VOCs are seen in GW-627 and GW-082 downgradient of the Bear Creek Burial Grounds waste management area (Figure 4.34). These trends indicate the continued presence and migration of a dense nonaqueous-phase source below the Bear Creek Burial Grounds, and a decreasing trend may indicate degradation.

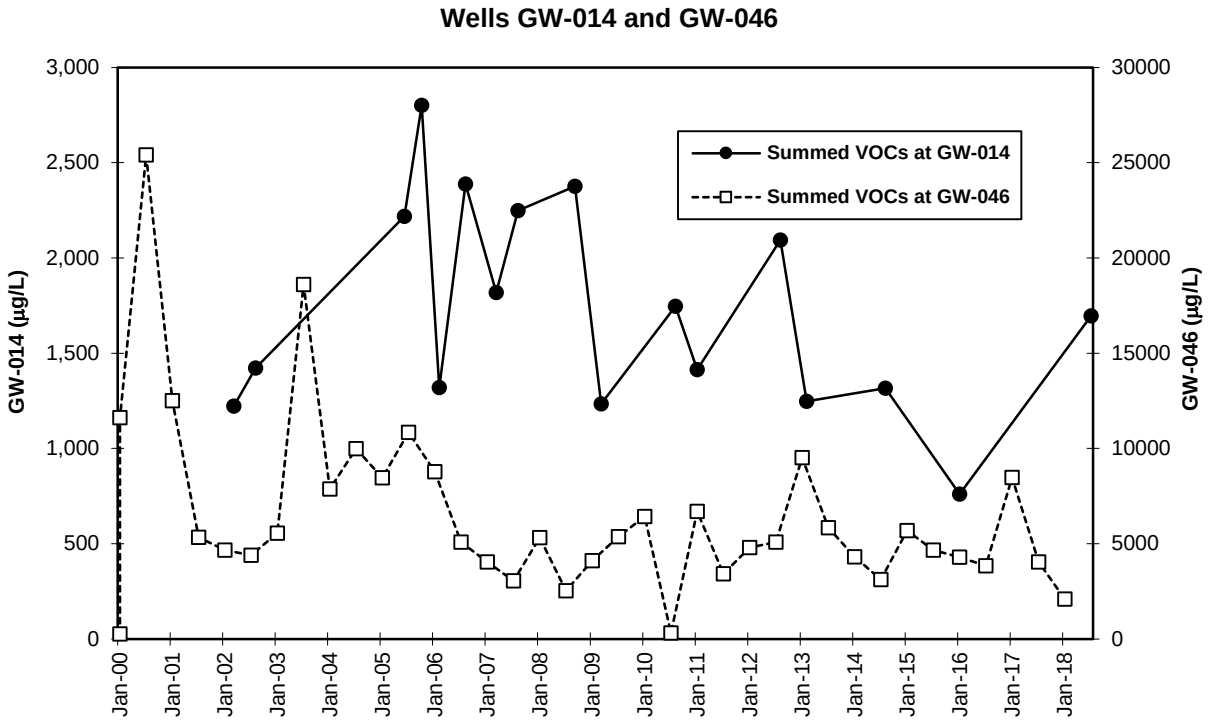


Figure 4.33. Volatile organic compounds in wells GW-014 and GW-046 at the Bear Creek Burial Grounds, 2018

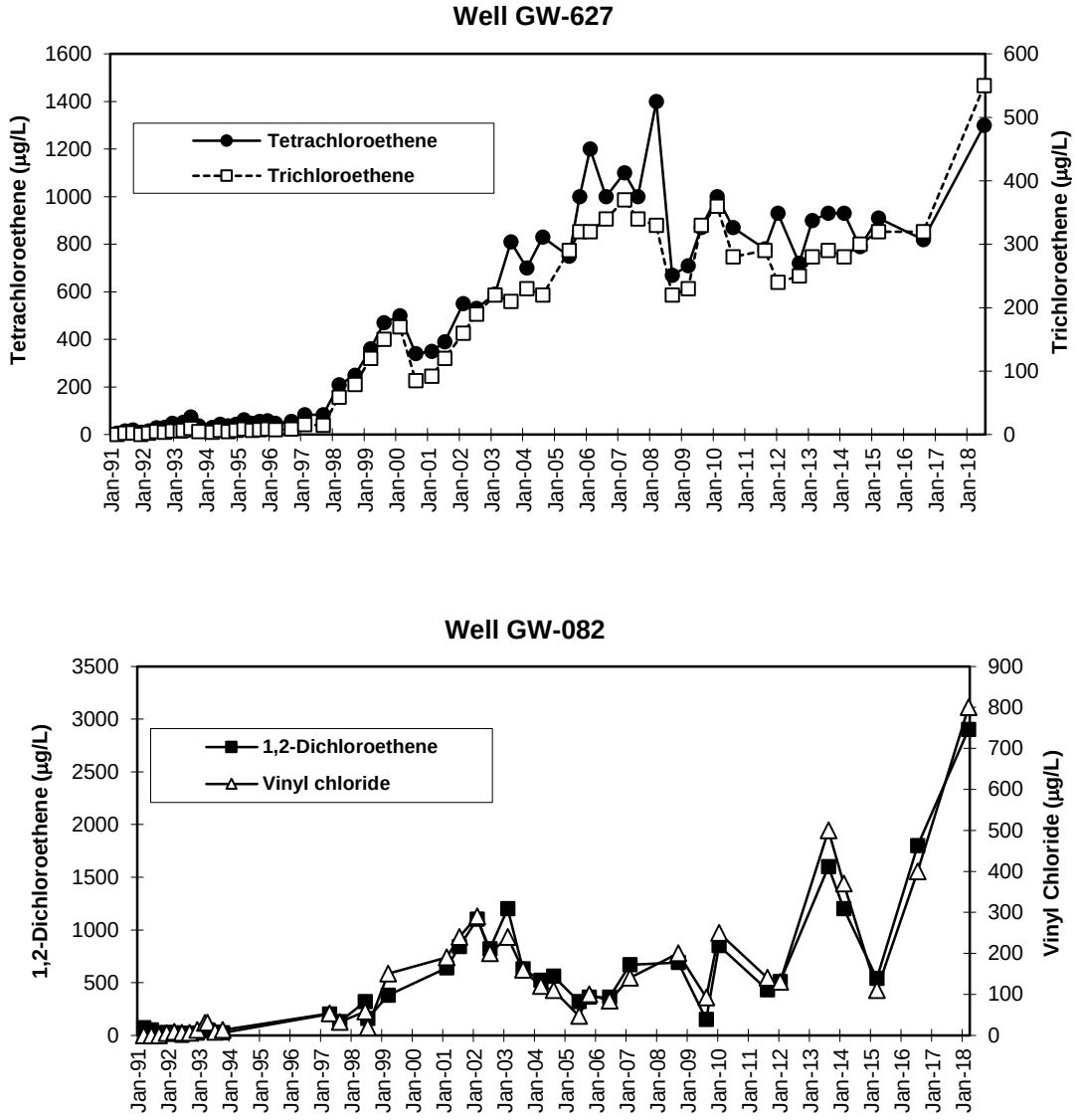


Figure 4.34. Volatile organic compounds in wells GW-627 and GW-082 at the Bear Creek Burial Grounds, 2018

CY 2014 data from well GW-729-44 showed that, in the intermediate-deep groundwater interval (98 m [320 ft] below ground surface), a 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. In CY 2018, wells at exit pathway transect W (Figure 4.25) showed a trace concentration (0.32 µg/L) of TCE (below drinking water standards), thus indicating migration of contaminants through the Maynardville Limestone a distance of 4,785 m (15,700 ft) from the S-3 Ponds.

Radionuclides

As in the EFPC regime, the primary radionuclides identified in the Bear Creek regime are isotopes of uranium and ^{99}Tc. Neptunium, americium, radium, strontium, thorium, plutonium, and tritium are secondary and less-widespread radionuclides that have been observed historically near the S-3 site.

The extent of radionuclides in groundwater in the Bear Creek regime during CY 2018 was based primarily on measurements of gross-alpha and gross-beta activity. If the gross-alpha activity in 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 and, at certain monitoring locations, is evaluated isotopically. A similar rationale is used for 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 gross-alpha activity occurs near the S-3 site and the Oil Landfarm waste management area. In the bedrock interval, gross-alpha activity has exceeded 15 pCi/L in groundwater in the fractured bedrock of the aquitard units only near source areas (Figure 4.30).

Exit pathway monitoring stations sampled during CY 2018 show that gross-alpha activity in the Maynardville Limestone and in the surface waters of Bear Creek exceeds the drinking water standard for over 3,353 m (11,000 ft) west of the S-3 site (SS-5, 19 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 2018 (110 pCi/L in well GW-246, Figure 4.30).

In CY 2018, the highest gross-beta activity in groundwater in the Bear Creek regime was also observed at well GW-246 (8,600 pCi/L, Figure 4.31).

Exit Pathway and Perimeter Monitoring

Bear Creek, which flows along the Maynardville Limestone (the primary exit pathway for groundwater) in much of the Bear Creek regime, is the principal exit pathway for surface water. 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 designation for the Bear Creek regime (Figure 4.25).

Exit pathway monitoring consists of continued monitoring at four well transects (pickets) and selected springs and surface water stations. Data obtained during CY 2018 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 4.35).

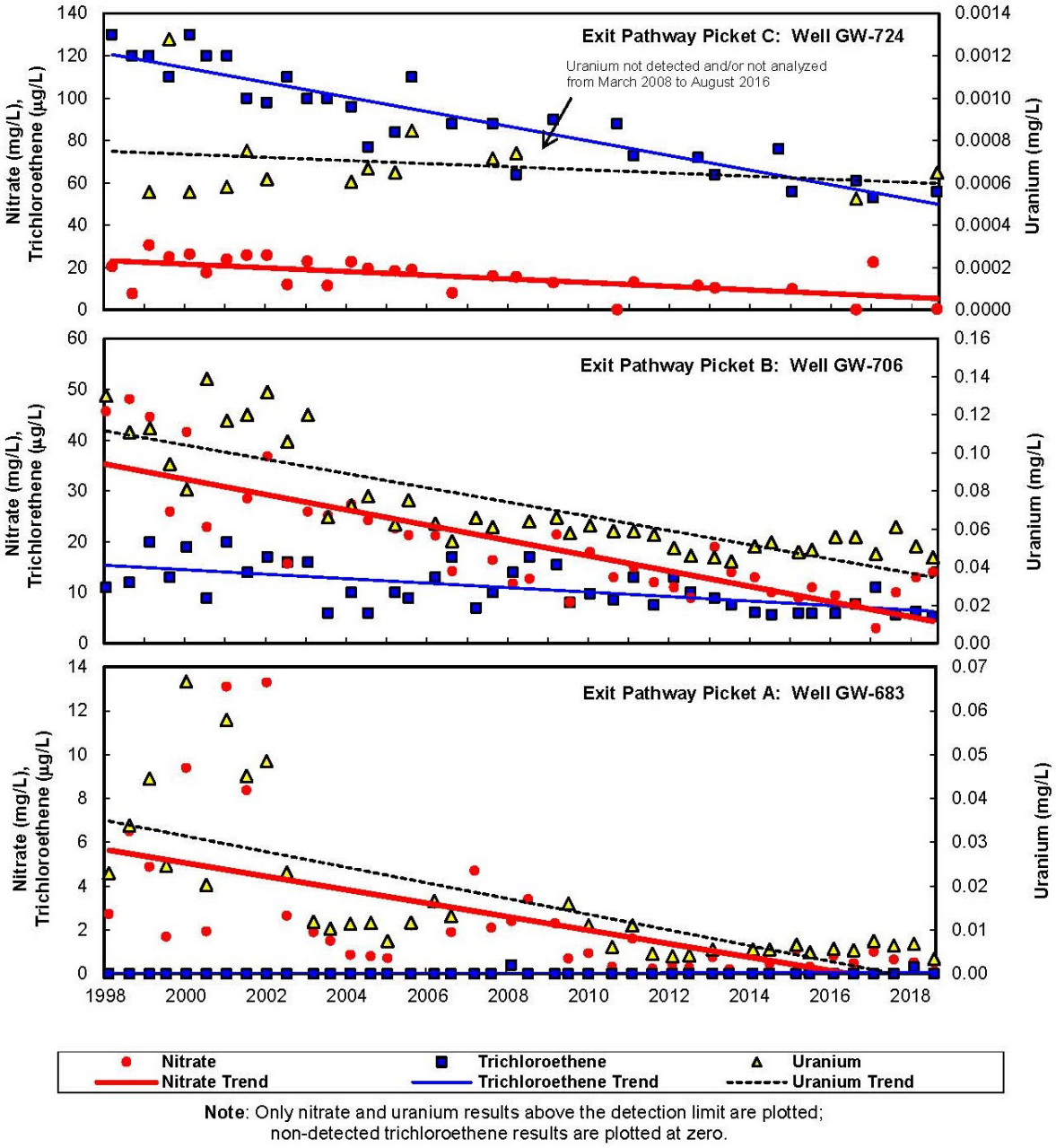


Figure 4.35. Calendar Year 2018 concentrations of selected contaminants in exit pathway monitoring wells in the Bear Creek hydrogeologic regime

Surface water samples collected during CY 2018 indicate that water in Bear Creek contains many of the same 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).

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 4.25). 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. Descriptions of waste management sites in the Chestnut Ridge regime and shown on Figure 4.24 have been provided in previous year ASERs and are not repeated this year.

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.

Plume Delineation

The extent of the VOC plume at the Chestnut Ridge Security Pits (CRSP) is reasonably well defined in the water table and shallow bedrock zones. With two exceptions, mentioned in the next paragraph, historical monitoring indicates that the VOC plume from the CRSP has not migrated very far in any direction (<305 m [<1,000 ft]).

Data obtained during CY 2018 indicate that the western lateral extent of the plume of VOCs at the site has not changed significantly. VOC contaminants at a well about 458 m (1,500 ft) southeast and downgradient of the CRSP (well GW-798; Figure 4.29) continue to show that some migration of the eastern plume has occurred. Additionally, previously performed dye tracer test results and the intermittent detection of trace concentrations of VOCs (similar to those found in wells adjacent to the CRSP) and at a natural spring (SCR7.8SP) about 2,745 m (9,000 ft) to the east and along geologic strike may suggest that CRSP contaminants have migrated further than the monitoring well network indicates. No VOCs were detected at SCR7.8SP in 2018.

The CRSP plume in the Chestnut Ridge regime (shown by gray shading on Figure 4.29) represents the average VOC concentrations between CYs 2013 and 2017. The circular icons presented on the figure represent CY 2018 monitoring results.

Nitrate

In CY 2018, nitrate concentrations were below the drinking water standard at all monitoring stations in the Chestnut Ridge regime.

Trace Metals

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 2018b). Under the ROD, migration of contaminated effluent from the Filled Coal Ash Pond is being reduced by a constructed wetland area. During CY 2018, elevated arsenic levels were detected both upgradient (McCoy Branch kilometer [MCK] 2.05) and downgradient (MCK 2.0) of this wetland area (Figure 4.25). The passive wetland treatment area reduced dissolved arsenic by about 50 percent in the wet-season sample, but there was a small increase in total arsenic at the downgradient location. During the dry season, the passive wetland treatment area reduced total arsenic by 35 percent and dissolved arsenic by 60 percent (DOE 2019). 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 2018; arsenic was detected below drinking water standards.

Volatile Organic Compounds

Concentrations of VOCs in groundwater at the CRSPs have decreased since 1988. However, stable to increasing trends in VOCs from well GW-798 (Figure 4.29) have been developing since CY 2000. The

maximum summed VOC concentration observed at well GW-798 during CY 2018 was 12.33 µg/L. The VOCs detected in well GW-798 continue to be characteristic of the CRSP plume.

In CY 2018, the highest summed VOC in the Chestnut Ridge regime was in another well at the CRSP, GW-322 with 66 µg/L (Figure 4.29).

At Industrial Landfill IV, VOCs have been observed in the groundwater since 1992. Well GW-305, located immediately to the southeast of the facility, continues to exhibit increasing trends in summed VOCs with the CY 2018 summed VOC concentration at 86 µg/L, slightly lower than CY 2017. Because samples from this well exceeded the drinking water standard for 1,1-DCE (7 µg/L), quarterly monitoring was initiated in CY 2 015 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. And again in CY 2017, only one quarterly sample exceeded the drinking water standard for 1,1-DCE at a concentration of 7.17 µg/L. In CY 2018, no sample exceeded the drinking water standard at this well.

Radionuclides

In CY 2018, no gross-alpha or gross-beta activity above the drinking water standard of 15 and 50 pCi/L, respectively, was observed in the Chestnut Ridge hydrogeologic regime.

Exit Pathway and Perimeter Monitoring

Contaminant and groundwater flow paths in the karst bedrock underlying the Chestnut Ridge regime have not been well characterized. 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 Y-12 that is a known or potential groundwater contaminant source. Water quality from springs along Scarboro Creek is monitored, and trace concentrations of VOCs are intermittently detected. The detected VOCs are suspected to originate from the CRSP; however, this has not been confirmed. In CY 2018, two springs were sampled with no detected concentrations of VOCs.

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 2018. No contaminants at any of these monitoring stations were detected at levels above primary drinking water standards.

4.7 Quality Assurance Program

Y-12's QA Program establishes a quality policy and requirements for the overall QA Program for the Y-12 site. Management requirement E-SD-0002, *Quality Assurance Program Description*, details the methods used to carry out work processes safely and securely and in accordance with established procedures (CNS 2017). 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.
- Use of QC samples, such as field and trip blanks, duplicates, and equipment rinses.

Y-12's Environmental Sampling Services perform field sampling, sample preservation and handling, and chain-of-custody and take field control (QC) samples in accordance with Y-12 Environmental Compliance's internal procedures. Environmental Sampling Services developed a Standards and Calibration Program that conforms to ISO/International Electrotechnical Commission (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. The Standards and Calibration Program ensures measurements are made using appropriate, documented methods; traceable standards; appropriate measurement and test equipment 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 Y-12 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; include frequent use of check sources and background counts, replicate and spiked sample analyses, and matrix and reagent blanks; and include 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.

Y-12's ACO QA Manual describes QA program elements that are based on Y-12's QA Program; customer-specific requirements; certification program requirements; ISO/IEC 17025, *General Requirements for Competence of Testing and Calibration Laboratories*; federal, state, and local regulations (ISO 2017); 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 2011d).

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 using technically validated and properly documented methods.

Y-12's 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 97 percent.

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 the Y-12 National Security Complex, East Fork Poplar Creek

Mercury remediation in the Oak Ridge, Tennessee, 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.

Research and technology development activities to date have focused 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. 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. The early efforts to understand the watershed have added significantly to our understanding of key mercury sources areas and mercury transformations and processes. The watershed-scale mercury information is informing conceptual and dynamic models that can be used for future technology development and remedial decision-making in lower EFPC.

In FY 2018, technology development activities centered on developing strategies and technologies 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 narrowing the source zones for mercury and methylmercury flux in the watershed, developing sorbents that might be effective in sequestering mercury, and adding filtering organisms such as mussels that might help change instream chemistry to limit mercury transport on particles or algae. To advance the scale of remediation technology testing beyond the bench scale, preparations are underway to conduct flow-through studies of EFPC water at ORNL's Aquatic Ecology Laboratory.

The multi-year 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.

Additionally, an analysis of promising technologies and technical approaches to enable the successful completion of Y-12 mercury-use facility demolition and mercury-contaminated waste disposition was completed. The evaluation encompassed techniques for in-situ and ex-situ treatment of debris, mercury measurement techniques, and decontamination methods. The selected technologies and approaches will be evaluated and further refined through the technology development process using bench or pilot-scale studies. The technology development activities and their ultimate outcomes, ideally technologies and methods that can be successfully used at Y-12, will be integrated with the planning for deactivation and demolition. Successful deactivation and demolition of Y-12 mercury-use facilities will ultimately reduce mercury-related ecological risks in EFPC and the overall environment.

4.8.2 Excess Facilities

DOE is preparing to remove five high-risk excess contaminated facilities, known as the Biology, at Y-12. The 350,000-ft^2 area poses asbestos hazards as well as structural deterioration risks. Demolition of these facilities is part of a nationwide effort to eliminate excess contaminated facilities throughout the DOE.

Originally constructed in the 1940s to recover uranium from process streams, the Biology Complex later housed DOE's research on the genetic effects of radiation. The facilities once housed more individuals with doctorates than anywhere in the world. The complex originally consisted of 11 buildings until OREM demolished 4 of them in 2010 as part of the American Recovery and Reinvestment Act of 2009.

Buildings 9743-2 and 9770-2 were demolished in FY 2018, and mobilization started for the demolition of the remaining buildings. The completion of this project will clear land for important future national security missions.

4.8.3 Mercury Treatment Facility

OREM has broken ground on the Outfall 200 Mercury Treatment Facility at Y-12. The facility will reduce mercury in water exiting the site through EFPC. Outfall 200 is the point where the west end of the Y-12 storm drain system creates the headwaters of the upper EFPC.

The mercury treatment facility will help OREM achieve compliance with regulatory criteria for EFPC. It also supports and opens the door for large-scale facility demolition to begin at Y-12 by helping to control potential mercury releases that could occur when disturbing the mercury-contaminated buildings and soil.

In FY 2018, OREM began early site preparation ahead of the planned facility construction. Early site preparation includes construction of the necessary utilities, installation of secant piles, and demolition of

existing structures in the area to prepare the site for construction of the mercury treatment facility. OREM anticipates completing early site preparation and beginning construction of the mercury treatment facility in 2019.

4.8.4 Waste Management

4.8.4.1 Comprehensive Environmental Response, Compensation, and Liability Act Waste Disposal

During FY 2018, the Environmental Management Waste Management Facility received 6,305 waste shipments, accounting for 73,510 tons, primarily from soil remediation activities and several smaller cleanup projects at ETTP and Y-12. The Environmental Management Waste Management Facility, 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.

4.8.4.2 Solid Waste Disposal

DOE operates and maintains solid waste disposal facilities called the ORR Landfills, three of which are active. In FY 2018, approximately 39,990 yd^3 of waste were disposed in the landfills, which marks a 26-percent decrease from FY 2017 volumes. Clean spoils receipts in FY 2018 were approximately 10,241 yd^3, a 2,315-percent increase from FY 2017. Clean spoils have the potential for being reused and are segregated to avoid taking up valuable landfill space. Several projects will continue to generate large spoils campaigns for FY 2019.

Operation of the ORR Landfills generated approximately 2.7 million gal of leachate that was collected, monitored, and discharged into the Y-12 sanitary sewer system.

4.8.4.3 Wastewater Treatment

NNSA at Y-12 treats wastewater generated from both production activities and environmental cleanup activities. Safe and compliant treatment of more than 127 million gal of wastewater was provided at various facilities during CY 2018:

- The West End Treatment Facility and the Central Pollution Control Facility at Y-12 processed more than 728,000 gal of wastewater, primarily in support of NNSA operational activities.
- The Big Springs Water Treatment System treated more than 109 million gal of mercury-contaminated groundwater. The EEVOCTS treated 12.7 million gal of VOC-contaminated groundwater.
- The Liquid Storage Facility and Groundwater Treatment Facility treated more than 2.7 million gal of leachate from burial grounds and well purge waters from remediation areas.
- The Central Mercury Treatment System treated approximately 1.9 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 for Radionuclide Emission Measurements*, Y/TS-874. Babcock & Wilcox Technical Services Y-12, LLC, Oak Ridge, Tennessee.

B&W Y-12. 2012a. *National Environmental Policy Act General Categorical Exclusion, Appendix B to Subpart D of Part 1021*, Y/TS-2312. Babcock & Wilcox Technical Services Y-12, LLC, Oak Ridge, Tennessee.

B&W Y-12. 2012b. *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.

CNS. 2015. *Spill Prevention, Control, and Countermeasure Plan for the U.S. Department of Energy Y-12 National Security Complex, Oak Ridge, Tennessee*, Y/SUB/02-001091/6. September.

CNS. 2017. *Quality Assurance Program Description*, E-SD-0002. Consolidated Nuclear Security, LLC, Y-12 National Security Complex, Oak Ridge, Tennessee.

CNS. 2018. *Annual Storm Water Report for the Y-12 National Security Complex, Oak Ridge, Tennessee*, Y/TS-2035/R12.

CNS. 2019. *Calendar Year 2018 Groundwater Monitoring Report*, Y/SUB/19-158258/1. 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, DC.

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. 2011a. *Departmental Sustainability*, DOE Order 436.1. Approved May 2, 2011. US Department of Energy, Washington, DC.

DOE. 2011b. *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. Final.

DOE. 2011c. *Record of Decision 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. Final.

DOE. 2011d. *Quality Assurance*, DOE Order 414.1D. Approved April 25, 2011. US Department of Energy, Washington, DC.

DOE. 2011e. *Radiation Protection of the Public and the Environment*, DOE Order 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 Revision 1. US Department of Energy, Washington, DC.

DOE. 2016a. *Supplement Analysis for the Site-Wide Environmental Impact Statement for the Y-12 National Security Complex*, DOE/EIS-0387-SA-01. National Nuclear Security Administration, Y-12 Site Office, Oak Ridge, Tennessee.

DOE. 2016b. *Amended Record of Decision for the Continued Operations of the Y-12 National Security Complex*. National Nuclear Security Administration, Federal Register, Volume 81, Number 133. Approved July 7, 2016.

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.

DOE. 2018a. *Supplemental Analysis for the Site-Wide Environmental Impact Statement for the Y-12 National Security Complex*, DOE/EIS-0387-SA-03.

DOE. 2018b. *Federal Facility Agreement for the Oak Ridge Reservation, Appendix C, Latest Revision—* FFA-PM/18-011, DOE/OR-1014. US Department of Energy, Office of Environmental Management, Oak Ridge, Tennessee. Available online at: http://www.ucor.com/docs/ffa/appendices/AppendixC.pdf.

DOE. 2018c. *Remediation Effectiveness Report for the US Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-2757&D2. US Department of Energy, Office of Environmental Management, Oak Ridge, Tennessee.

DOE. 2019. *Remediation Effectiveness Report for the US Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-2787&D1. US Department of Energy, Office of Environmental Management, Oak Ridge, Tennessee.

Executive Order 13693. *Planning for Federal Sustainability in the Next Decade*. March 25, 2015. Federal Register Volume 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.

EPA. 2010. *Mandatory Reporting of Greenhouse Gases*. 40 Code of Federal Regulations Part 98.

EPA. 2013. *National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters*. 40 Code of Federal Regulations Part 63, Subpart DDDDD.

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.

ISO. 2017. *General Requirements for the Competence of Testing and Calibration Laboratories*. ISO/IEC 17025:2017. 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, Revision 1/EPA 402-R-97-016, Revision 1/DOE/EH-0624, Revision 1. US Nuclear Regulatory Commission, US 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.

ORNL. 2014. *Report of the Committee to Recommend Alternatives to the Uranium Processing Facility Plan in Meeting the Nation's Enriched Uranium Strategy*. Final.

Peterson, M.J., T.J. Mathews, M.G. Ryon, J.G. Smith, S.W. Christensen, M.S. Greeley, Jr., W.K. Roy, C.C. Brandt, K.A. Sabo. 2013. *Y-12 National Security Complex Biological Monitoring and Abatement Program Plan*, ORNL/TM-2012/171.

TDEC. 2007. State of Tennessee Water Quality Standards, Chapter 1200-4-3, "General Water Quality Criteria," October 2007. Division of Water Pollution Control. Approved March 2008.

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.*

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.*

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.*

TDEC. 2017. *Site Treatment Plan for Mixed Wastes on the US Department of Energy Oak Ridge Reservation*, TDEC-REV. 22.0.

UCOR. 2017. *Sampling and Analysis Plan for the Water Resources Restoration Program for Fiscal Year 2018 Oak Ridge Reservation, Oak Ridge, Tennessee*, UCOR-4887-R3. URS │CH2M Oak Ridge, LLC, Oak Ridge, Tennessee.

UCOR. 2018a. *Calendar Year 2017, Resource Conservation and Recovery Act Annual Monitoring Report for the US Department of Energy Y-12 National Security Complex, Oak Ridge, Tennessee*, UCOR-5071. URS │CH2M Oak Ridge, LLC, Oak Ridge, Tennessee.

UCOR. 2018b. *Sampling and Analysis Plan for the Water Resources Restoration Program for Fiscal Year 2019 Oak Ridge Reservation, Oak Ridge, Tennessee*, UCOR-4587-R4. 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.