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 U.S. Department of Energy (DOE) Nuclear Security Enterprise. Drawing on more than 75 years of manufacturing excellence, Y-12 helps ensure a safe and reliable United States nuclear weapons deterrent.

Y-12's primary mission includes processing, retrieval, and storage of nuclear materials; dismantlement of nuclear weapons; providing fuels to the nation's naval reactors; and complementary work for other government and private-sector entities.

Today's environment requires Y-12 to have 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, the Y-12 site 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. Additional NNSA-related facilities are located offsite from Y-12 and include the Central Training Facility, East Tennessee Technology Park (ETTP) Emergency Operations Center (EOC), Uranium Processing Facility (UPF) project laydown storage and offices, Y-12 Material Acquisition Complex (K-1065), 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.

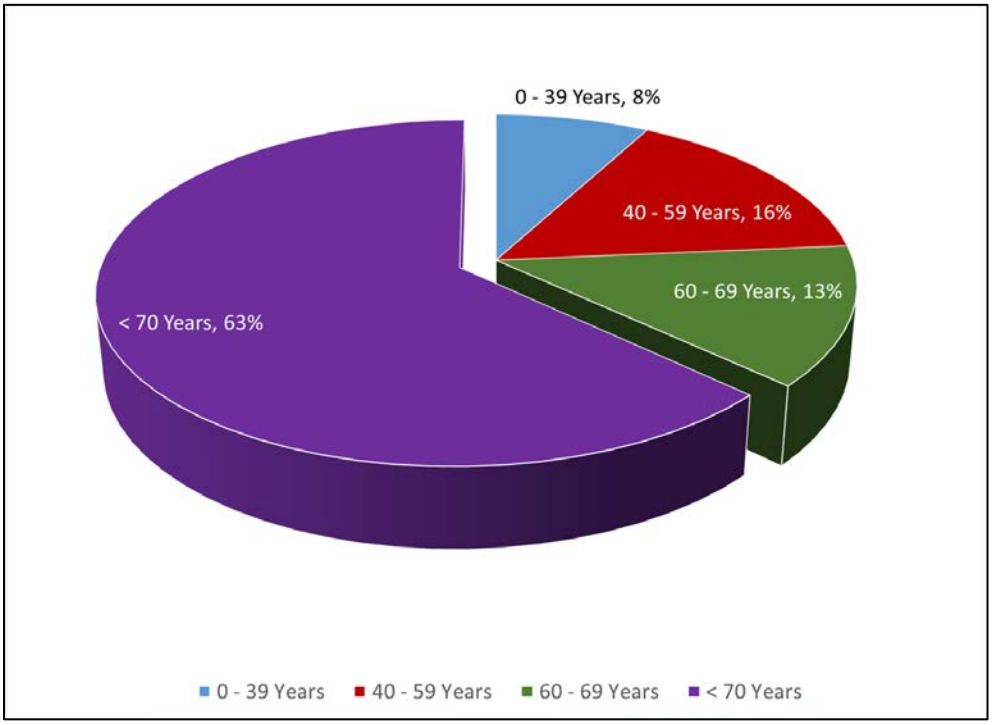


Figure 4.1. Age of mission-critical facilities at the Y-12 National Security Complex

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 enriched uranium (EU) 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 EU production functions. The remaining EU production capability will be maintained in Buildings 9215 and 9204-02E, which must be sustained to achieve the EU mission strategy. The strategy includes the following:

- Accelerating transition out of Building 9212 and into UPF to reduce nuclear safety and operational risk while maintaining EU capabilities.
- 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 nuclear safety, security, and mission continuity.

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 of 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. 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 components. Previous concerns with humidity control have improved with recent repair/replacement projects associated with kathabar equipment. Additional concrete and heating, ventilation, and air conditioning projects are underway in support of the life extension program schedules. A proposed new Lithium Processing Facility (LPF) line item project will replace the existing building and eliminate approximately $33 million in deferred maintenance.

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 Operations Center (OC) 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 backup facility (2005) located on the west end. Building K-1650 houses the Command Center/alternate EOC. A line-item project for construction of a new EOC, scheduled to begin in 2020, includes the replacement of the OC, 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.

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 Oak Ridge Reservation (ORR) roads and grounds crew. The fire department assumed occupancy of the facility in 2014 and renovated portions for crew support and vehicle staging. Relocation of the fire station away from Y-12 hazardous material facilities is necessary to ensure that the fire department can respond safely and effectively to all emergencies at Y-12. A proposed new fire station 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.

The Mercury Treatment Facility (MTF) is being constructed to remove mercury contamination from East Fork Poplar Creek (EFPC). The facility is an enabling project for the future demolition of the high-risk mercury-contaminated facilities located on the west end of Y-12. 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 (FYNSP) period:

- UPF
- EOC
- West End Protected Area reduction
- MTF
- Fire Station
- LPF
- West End Production Support Change House

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

- Applied Technologies Laboratory
- Consolidated Depleted Uranium Manufacturing Capability
- Maintenance Complex
- Non-Special Nuclear Material Storage and Staging Facility
- Waste Management Complex
- EU Manufacturing Center (Building 9215 replacement capability)
- Assembly and Disassembly Center (Building 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 72 excess DOE facilities are located on the Y-12 site, with a total of 2.8 million gross square footage. 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.

Process-contaminated excess facilities at Y-12 are owned by NNSA as well as the DOE Office of Environmental Management (EM), Office of Science, and Office of Nuclear Energy. These facilities contain radiological or chemical contamination resulting from their mission operations during the Manhattan Project or the Cold War.

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 has provided much-needed funding and resources to assist with stabilization and demolition of both process-contaminated and non-process-contaminated excess facilities at Y-12. In partnership with EM, NNSA and CNS will continue to monitor and evaluate excess facilities; prioritize their disposition, including cost and schedule; and actively work towards disposal of excess facilities.

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 436.1, *Departmental Sustainability* (DOE 2011a), provides requirements and responsibilities for managing sustainability within DOE in accordance with applicable Executive Orders (EOs). DOE Order 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 Order 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.

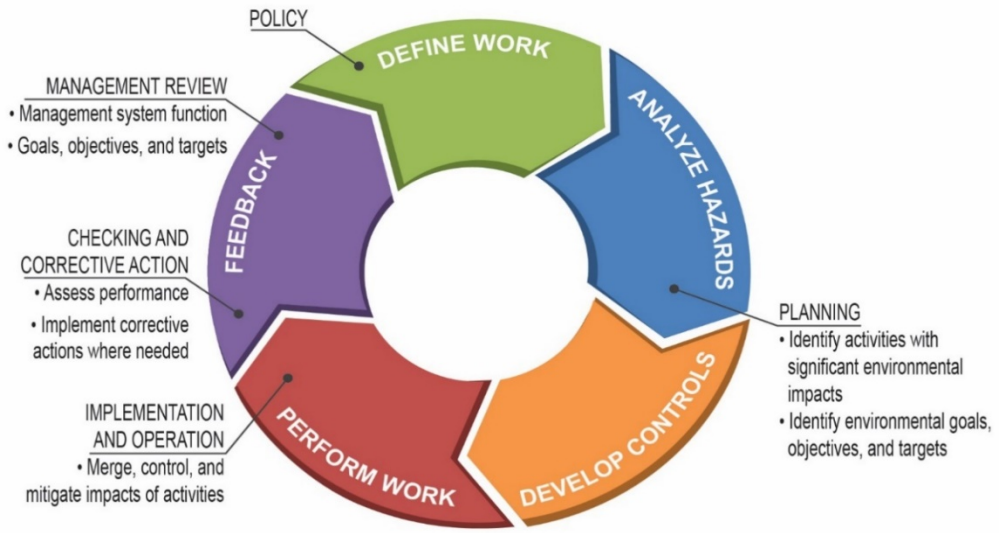


Figure 4.2. Relationship between the Y-12 National Security Complex Environmental Management System and the Integrated Safety Management System depicted in a "plan-do-check-act" cycle

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.

Y12 Environment, Safety, and Health Policy Statement

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

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

In support of these policies, we are committed to:

- Integrating Environment, Safety and Health into our business processes
- Continuously improving our processes and systems
- Directly, openly, and truthfully communicating this policy and our ES&H performance
- Striving to minimize the impact of our operations on the environment in a safe, compliant, and cost-effective manner using sustainable practices
- Incorporating sustainable design principles into the design and construction of facility upgrades, new facilities, and infrastructure considering life-cycle costs and savings
- Incorporating the use of engineering controls to reduce or eliminate hazards whenever possible into the design and construction of facility upgrades, new facilities, and infrastructure
- Striving to provide a clean and efficient workplace free of occupational injuries and illnesses (Target Zero)
- Fostering and maintaining a work environment of mutual respect and teamwork that encourages free and open expression of ES&H concerns

Figure 4.3. Y-12 National Security Complex'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 2019:

- Storm water (runoff from roofs and outdoor storage areas)
- Surface water (process water and dike emissions to creek)
- Wastewater (sanitary sewer and process water treated and disposed)
- Radiological waste
- Excess facilities and unneeded materials and chemicals
- 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 Orders, 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 the U.S. Environmental Protection Agency (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 Orders, 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 Orders, 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'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.

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 supported the Great Smoky Mountains National Park through a financial donation and through the support of Y-12 employees volunteering time to rehabilitate a number of areas in the park. Additionally, an Introduce a Girl Engineering Event was held at Y-12's New Hope Center on February 21, 2019.

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 $92,000 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 eyeglasses

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 2019. The drills and exercises focused on topics such as responding to a security condition change, criticality incident, and natural disaster with a radiological fire and release. 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 2019 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 to adhere to DOE Order 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, 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 Environmental Stewardship Scorecard gave Y-12 an EMS scorecard rating for FY 2019 of green, indicating full implementation of EMS requirements.

4.2.6.1 Environmental Management System Objectives and Targets

At the end of FY 2019, Y-12 had achieved seven of nine 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 modification of the Title V air permit to include the calciner operations.
- Energy Efficiency—Y-12 completed a project to replace the Building 9117 computer room air conditioner.
- Hazardous Materials—A project to disposition and ship legacy mixed waste per Site Treatment Plan milestones was completed in 2019, and UMC FY 2019 priorities were completed to disposition unneeded production equipment in Building 9201-5N.
- Land/Water/Natural Resources—Reroofing projects for seven buildings were completed to reduce risks to storm and surface water. In addition, phase one of a project to improve protection of the sanitary sewer drainage system from infill and infiltration was completed. Smoke testing and camera inspection of four lateral lines around alpha-three was completed to scope the future improvements required.

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).

In FY 2019, Y-12 implemented 97 pollution prevention initiatives (Figure 4.5), with a reduction of more than 68.6 million lb of waste and projected cost efficiencies of more than $19.6 million. The completed projects include the activities described below.

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 2019 activities highlighted in this section.

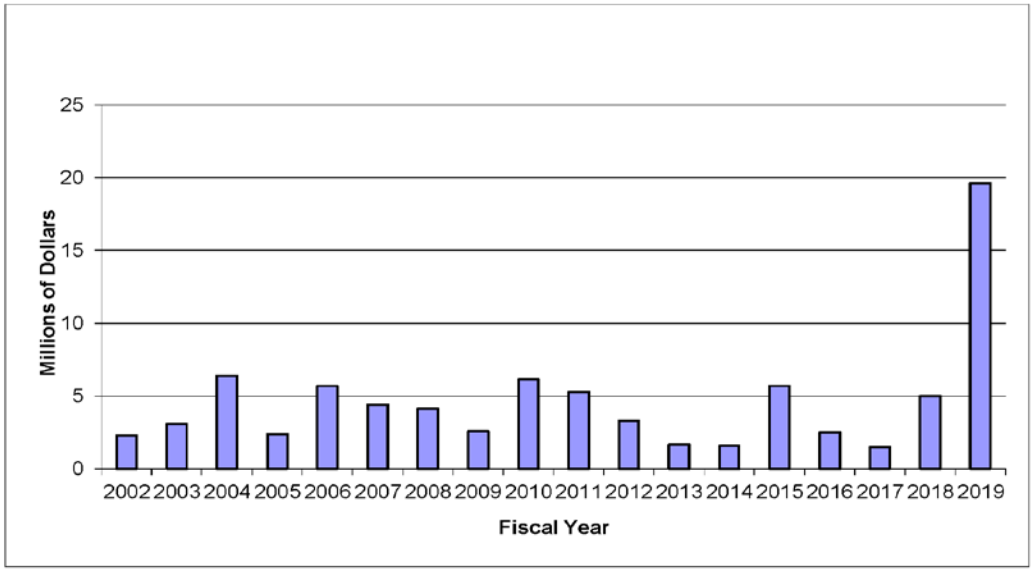


Figure 4.4. Cost efficiencies from Y-12 National Security Complex pollution prevention activities

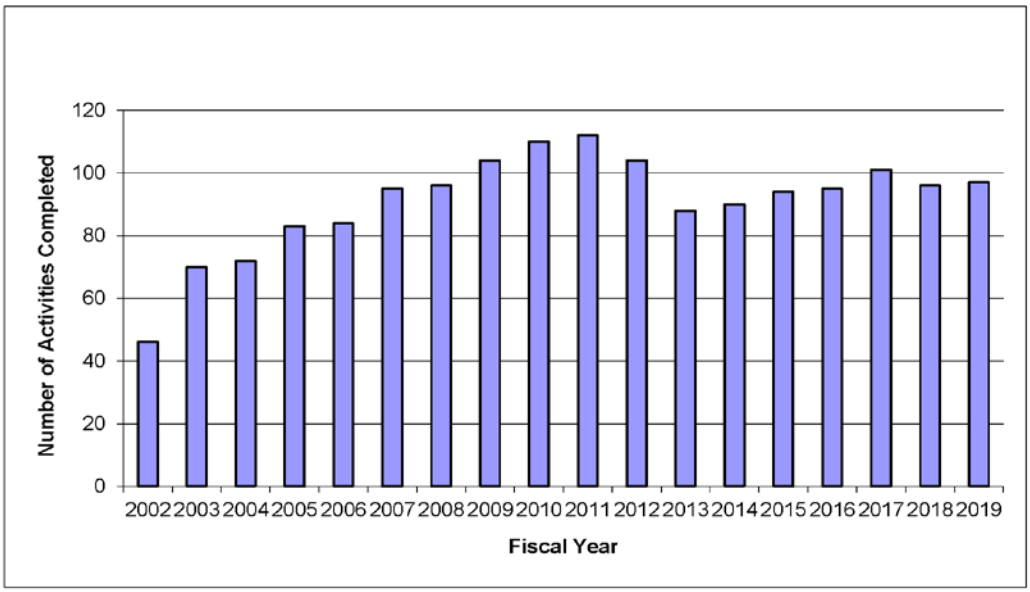


Figure 4.5. Y-12 National Security Complex pollution prevention initiatives

Sustainable Acquisition—Environmentally Preferable Purchasing

Sustainable products, including recycled-content materials, are procured for use across Y-12. In 2019, Y-12 procured recycled-content materials valued at more than $8.3 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 2019, Y-12 diverted 52.7 percent of municipal and 38.6 percent of construction and demolition waste from landfill disposal through reuse and recycle. Y-12 diverted more than 2.6 million lb of municipal materials from landfill disposal through source reduction, reuse, and recycling in FY 2019. More than 65.5 million lb of construction and demolition materials were diverted from landfill disposal in FY 2019.

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 2019, Generator Services Group personnel, rather than declaring materials as waste, reused or disseminated to other Y-12 organizations for reuse, 500 lb of various excess materials and chemicals. Production and Utilities collaborated to facilitate the reuse of approximately 385 gal of brine solution, which reduced the quantity of hazardous chemicals that were purchased to create new brine solution. The UPF Project identified an alternative non-hazardous blast media to prevent the generation of an estimated 500 lb of hazardous waste.

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 3.29 million lb of materials were diverted from landfills and into viable recycle processes during 2019. 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 Recycle Program was expanded in FY 2019 to include paper briquettes to broaden waste diversion efforts.

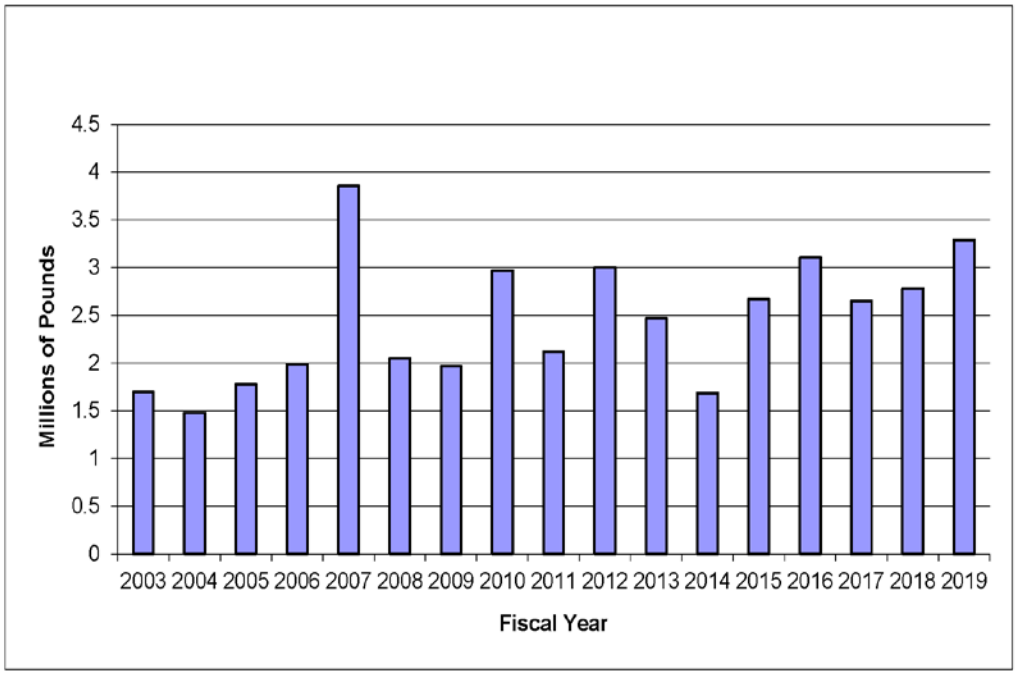


Figure 4.6. Y-12 National Security Complex recycling results

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.

Y-12 statuses Energy Management goals in accordance with EO 13834, *Efficient Federal Operations* (Executive Order 2018), and DOE Sustainability Performance Office Guidance. The FY 2019 established goal was a 30-percent energy intensity reduction by FY 2015 from a FY 2003 baseline and a 1-percent reduction each year thereafter. Y-12 had a 39-percent reduction by FY 2015, with an additional 8-percent reduction in the FY 2015 to FY 2019 timeframe, for a total reduction of 47 percent. Significant reductions have been noted with the implementation of Energy Savings Performance Contracts (ESPCs) at Y-12. Specific ESPC initiatives that aided in the reduction of energy consumption at Y-12 include:

- Completing a new, more-efficient Air Compressor Plant at the end of FY 2016.
- Upgrading light fixtures with T-8 fluorescent lighting and light-emitting diode.
- 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.

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. In 2019, 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. The Sustainability Dashboard focuses on specific sustainability goals, and Site Sustainability Plans are completed within the Dashboard. These goals are established by the DOE Sustainability Performance Office and are found in Table 4.1, along with the current Y-12 performance ratings.

Table 4.1. FY 2019 sustainability goals and performance

DOE goal	Current performance status
Energy management	
30% energy intensity (Btu per gross square foot) reduction in goal-subject buildings by FY 2015 from a FY 2003 baseline, and 1% year-to year-reduction thereafter.	**Goal met:** Y-12 achieved a 39% energy intensity reduction in FY 2015 from a FY 2003 baseline. For FY 2019, Y-12 achieved a 6% reduction from FY 2018, which exceeds the targeted 1% reduction.
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.

Table 4.1. FY 2019 sustainability goals and performance (continued)

DOE goal	Current performance status
	Water management
20% potable water intensity (gal per gross square foot) reduction by FY 2015 from a FY 2007 baseline, and 0.5% year-to-year thereafter.	**Goal met:** A 66% reduction from the 2007 baseline was achieved.
	Waste management
Reduce at least 50% of non-hazardous solid waste, excluding construction and demolition debris, sent to treatment and disposal facilities.	**Goal met:** 52.7% (1,208.4 metric tons/2,294.5 metric tons) of non-hazardous waste diverted from the landfill.
Reduce construction and demolition materials and debris sent to treatment and disposal facilities. Year-to-year reduction; no set target.	Goal not met: 38.6% (29,732.9 metric tons/77,033 metric tons) of construction and demolition materials diverted from the landfill in FY 2019 in comparison to 91.5% diverted in FY 2018. Increased Office of Environmental Management construction and demolition activities resulted in a large volume of construction and demolition debris that was not suitable for reuse and recycle.
	Clean and renewable energy
"Renewable Electric Energy" requires that renewable electric energy account for not less than 7.5% of a total agency electric consumption by FY 2013 and each year thereafter.	**Goal met:** The FY 2019 anticipated amount was 7.5%. Y-12 receives renewable energy credits from Pantex under the shared contract structure. This allows both sites to meet this goal.
Continue to increase non-electric thermal usage. Year-to-year increase; no set target but an indicator in the Office of Management and Budget scorecard.	Goal not met: Y-12 is updating buildings from steam to natural gas. This increases natural gas efficiencies and decreases steam loss.
	Green buildings
At least 15% (by count) of owned, existing buildings to be compliant with the *revised* Guiding Principles for High Performance Sustainable Building goals by FY 2020, with annual progress thereafter.	*Goal at risk:* Y-12 had one DOE-owned building compliant with the High Performance Sustainable Building goals—the LEED Gold Construction Support Building during FY 2019.
Increase regional and local planning coordination and involvement.	**Goal met:** During FY 2019, regional and local involvement included hosting the TDEC East Tennessee Regional Green Star Partnership Workshop, presenting at the DOE Precious Metals Forum, hosting an "Introduce a Girl to Engineering" event, and a Y-12 Earth Day Celebration.
	Acquisition and procurement
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring biopreferred and biobased requirements and clauses are included in all applicable contracts.	**Goal met:** All contracts issued after 10/01/13 contain the sustainable acquisition requirements.

Table 4.1. FY 2019 sustainability goals and performance (continued)

DOE goal	Current performance status
Measures, funding, and training	
Annual targets for sustainability investment with appropriated funds and/or financed contracts to be implemented in FY 2019 and annually thereafter.	**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 98.8% (6,849/6,932) of all eligible electronic acquisitions during FY 2019 were EPEAT-registered. More than 99% (6,874/6,932) were either EPEAT-registered or Energy Star-qualified products and 98.8% (6,408/6,489) of all computers, desktops, laptops, tablets, workstations, monitors, scanners, and printers were EPEAT-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 central processing units 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 2019, more than 73.8% (4,652/6,303) 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 simplex printed materials.
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.
Multiple categories	
Year-to-year Scope 1 and Scope 2 GHG emissions reduction from a FY 2008 baseline.	**Goal met:** Site Scope 1 and Scope 2 GHG emissions have been reduced by 58% from a 2008 baseline. Contributing energy-reduction efforts can be attributed to major initiatives involving infrastructure improvements completed through Energy Savings Performance Contract projects.
Year-to-year Scope 3 GHG emissions reduction from a FY 2008 baseline.	Goal not met: Site Scope 3 emissions have increased by 13.5% since 2008. Increasing site population and business travel negatively impact this goal.

Acronyms:
Btu = British thermal unit
DOE = U.S. Department of Energy
EISA = Energy Independence and Securities Act
EPEAT = Electronic Product Environmental Assessment Tool
FY = fiscal year
GHG = greenhouse gas
LEED = Leadership in Energy and Environmental Design
NNSA = National Nuclear Security Administration
TDEC = Tennessee Department of Environment and Conservation
Y-12 = Y-12 National Security Complex

4.2.6.5 Water Conservation

The current DOE water intensity goal is a 20-percent reduction from a FY 2007 baseline by FY 2015 and year-to-year reductions of 0.5 percent thereafter. Y-12 surpassed the initial FY 2015 goal with a 62-percent reduction. In FY 2019, Y-12's water intensity rating was 73.825 gal/ft^2, which is a 2-percent increase from 2018 but still a 65-percent reduction from FY 2007. Although Y-12 is not currently meeting the year-to-year reduction goal, there are still considerable savings from the 2007 baseline. This year's increase can be largely attributed to UPF construction activities, including concrete production at the Concrete Batch Plant.

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.

4.2.6.6 Fleet Management

The Y-12 site is currently undergoing a massive construction phase, including the UPF project along with the new MTF and multiple other construction projects. The Y-12 fleet inventory tasked with supporting these projects, along with the normal day-to-day processes at the plant, is comprised of a total of 582 vehicles, which includes 91 Agency-owned units, 483 leased from the General Services Administration (GSA), and 8 commercially leased Special Purpose vehicles during FY 2019. The inventory consists of sedans, light-duty trucks/vans/sport utility vehicles, medium-duty trucks/vans/sport utility vehicles, and heavy-duty trucks. During FY 2019, Y-12 exchanged 38 older GSA-leased vehicles with new units, along with 3 heavy-duty Agency-owned trucks. The new replacements (GSA-leased and Agency-owned) were all ordered with alternative fuel capabilities when available, and these new vehicles all have better fuel consumption and GHG emission figures than the older vehicles that were replaced.

The Y-12 vehicle fleet achieved a 99-percent vehicle utilization rate for FY 2019 compared to 98 percent the previous year, and the six vehicles that did not meet that goal are being reassigned to maximize vehicle utilization at the site. Fuel consumption at Y-12 (diesel and gasoline) was reduced by 4.2 percent compared with FY 2018 figures.

Y-12 currently does not have an on-site fuel station and does not utilize alternative fuel based on a FY 2019 DOE-approved Epact 701 waiver, as alternative fuel is not available near the site. Y-12 continues to implement an interim refueling process using mobile tanker trucks to perform vehicle and

equipment fueling operations until a new fuel center is constructed at the site. The mobile tanker trucks only have capacity to provide diesel and unleaded 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. Approximately 99 percent of desktop computers, laptops, monitors, and thin clients purchased or leased during FY 2019 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 Scope 1 and Scope 2 GHG emissions have been reduced compared to the FY 2008 baseline. Emission reductions 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. 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

The Energy Independence and Security Act of 2007, 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) 2019 include the installation of a pervious pavement parking lot for UPF and another adjacent to Building 9201-03. The two lots added about 3 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 149 external environmental awards from local, state, and national agencies. The awards received in 2019 are summarized below.

4.2.7.1 Electronic Product Environmental Assessment Tool Award

In FY 2019, Y-12 received an EPEAT Purchaser 5 Star Level Award for Excellence in Green Procurement of Electronics in recognition of Y-12's procurement of sustainable information technology products. Y-12 was recognized by the Green Electronics Council at the 5 Star Level for purchasing EPEAT electronics in the following categories during FY 2018: computers and displays (including desktops, notebooks, workstations, integrated systems, and tablets), imaging equipment (copiers, scanners, multi-function devices, etc.), televisions, mobile phones, and servers.

4.2.7.2 U.S. Department of Energy and National Nuclear Security Administration Sustainability Awards

Y-12 received the following 2019 DOE Sustainability Award:

- The Sustainability Champion Award was presented to Y-12's Charlie Sexton for his role in the Y-12 Energy Program and High Performance Sustainable Building compliance.

4.3 Compliance Status

4.3.1 Environmental Permits

Table 4.2 lists environmental permits in force at Y-12 during 2019. 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). NNSA's commitment to NEPA is performed by thoroughly evaluating the potential impacts of proposed federal actions that affect the quality of the environment at Y-12. NNSA 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 (called a NEPA review), while considering other statutory requirements (NEPA is often referred to as the umbrella law; see Figure 4.7), is performed before an irreversible commitment of resources is made.

Figure 4.7. National Environmental Policy Act – an umbrella law

Table 4.2. Y-12 environmental permits, CY 2019

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	Title V Major Source Operating Permit	571832	12/01/17	11/30/22	DOE	DOE	CNS
CAA	Permit to Construct or Modify an Air Contaminant Source	974225	09/14/18	09/13/20	DOE	DOE	CNS
CWA	Industrial and Commercial User Wastewater Discharge (Sanitary Sewer) Permit	1-91	07/01/17	03/31/21	DOE	DOE	CNS
CWA	NPDES Permit	TN0002968	10/31/11	11/30/16[a]	DOE	DOE	CNS
CWA	UPF 401 Water Quality Certification/Aquatic Resource Alteration Permit Access/Haul Road	NRS10.083	06/10/10	06/09/15[b]	DOE	DOE	CNS
CWA	UPF Department of Army Section 404 CWA Permit	2010-00366	09/02/10	09/02/20	DOE	DOE	CNS
CWA	UPF General Storm Water Permit Y-12 (41.7 ha/103 acres)	TNR 134022	10/27/11	09/30/21	DOE	CNS	CNS
CWA	Central Training Facility Berm Reinvestment Project NPDES Construction General Permit	TNR 135924	10/01/19	Upon Notice of Termination	DOE	DOE	CNS
CWA	Y-12 Outfall 014 Repair Aquatic Resource Alteration Permit	NR1903.116	06/21/19	04/12/21	DOE	DOE	CNS
CWA	Central Training Facility Berm Aquatic Resource Alteration Permit	NR1903.096	05/15/19	04/06/21	DOE	DOE	CNS
CWA	No Discharge Portal 20 Pump and Haul Permit	SOP-170-14	07/08/17	07/01/22	DOE	DOE	CNS

Table 4.2. Y-12 environmental permits, CY 2019 (continued)

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CWA	No Discharge Portal 23 Pump and Haul Permit	SOP-170-15	07/08/17	07/01/22	DOE	DOE	CNS
CWA	No Discharge Portal 19 Pump and Haul Permit	SOP-130-31	06/26/18	06/30/23	DOE	DOE	CNS
CWA	No Discharge Environmental Management Waste Management Facility Pump and Haul Permit	SOP-01043	09/01/17	09/31/22	DOE	UCOR	UCOR
RCRA	Hazardous Waste Transporter Permit	TN3890090001	12/16/19	01/31/21	DOE	DOE	CNS
RCRA	Hazardous Waste Corrective Action Permit	TNHW-164	09/15/15	09/15/25	DOE	DOE, NNSA, and all ORR co-operators of hazardous waste permits	UCOR
RCRA	Hazardous Waste Container Storage Units	TNHW-122	08/31/05	08/31/15 [a]	DOE	DOE/CNS	CNS/ Navarro co-operator
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-127	10/06/05	10/06/15 [a]	DOE	DOE/CNS	CNS co-operator
Solid Waste	Industrial Landfill IV (Operating, Class II)	IDL-01-000-0075	Permitted in 1988—most recent modification approved 12/18/18	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Industrial Landfill V (Operating, Class II)	IDL-01-000-0083	Initial permit, most recent modification approved 12/18/18	N/A	DOE	DOE/UCOR	UCOR

Table 4.2. Y-12 environmental permits, CY 2019 (continued

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
Solid Waste	Construction and Demolition Landfill (overfilled, Class IV subject to CERCLA ROD)	DML-01-000-0012	Initial permit 01/15/86	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Construction and Demolition Landfill VI (post-closure care and maintenance)	DML-01-000-0036	Permit terminated by TDEC 03/15/07	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Construction and Demolition Landfill VII (operating, Class IV)	DML-01-000-0045	Initial permit most recent modification approved 11/16/18	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Centralized Industrial Landfill II (post-closure care and maintenance)	IDL-01-000-0189	Most recent modification approved 05/08/92	N/A	DOE	DOE/UCOR	UCOR
SDWA	Underground Injection Control Class V Injection Well Permit	Permit by Rule TDEC Rule 0400-45-06	03/12/02	None	DOE	DOE	CNS

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

[b] Monitoring and maintenance phase.

Acronyms:

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 = U.S Department of Energy
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
UPF = Uranium Processing Facility
Y-12 = Y-12 National Security Complex

In March 2011, the *Final Site-Wide Environmental Impact Statement for the Y-12 National Security Complex* (DOE 2011b) was issued. The Site-Wide Environmental Impact Statement (SWEIS) analyzed the potential environmental impacts of ongoing and future operations (missions) and activities at Y-12, including alternatives to changes in site infrastructure (including UPF) and levels of operation. The SWEIS and the Notice of Availability were published on March 4, 2011 (DOE-EIS-0387). NNSA issued a Record of Decision (ROD) in July 2011 (EIS-0387 ROD) (DOE 2011c). 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 July 2017, the Oak Ridge Environmental Peace Alliance, Nuclear Watch New Mexico, and the Natural Resources Defense Council and four individual plaintiffs filed a federal lawsuit asserting that NNSA had violated NEPA by failing to prepare a supplemental SWEIS. Among other things, the plaintiffs argued that NNSA should prepare a supplemental SWEIS due to significant new information that came to light after the publication of the 2011 SWEIS. More specifically, plaintiffs asserted that the seismic risk in East Tennessee had increased as evidenced by seismic hazard maps published in 2014 by the U.S. Geological Survey (USGS).

In August 2018, NNSA prepared another SA to the Y-12 SWEIS (2018 SA; DOE/EIS-0387-SA-03) (NNSA 2018), which evaluated the environmental impacts of continuing site operations against the existing Y-12 SWEIS to determine if significant changes or new information warranted a supplemental or new SWEIS. In the 2018 SA, NNSA determined that Y-12 continuing operations were not significantly different than those evaluated in the 2011 SWEIS.

On September 24, 2019, a Memorandum Opinion and Order was issued by the U.S. District Court for the Eastern District of Tennessee as a result of the July 2017 federal lawsuit (USDC 2019). The Court ruled that NNSA is not required to prepare a new or supplemental SWEIS due to the decision to construct a smaller-scale UPF project and continue some EU operations in the ELP facilities. However, the Court also ruled that "new information revealed since the 2011 SWEIS requires further analysis," and consistent with that ruling, the Court vacated the 2016 SA, the 2016 amended ROD, and the 2018 SA. Further, the Court ordered that NNSA "shall conduct further NEPA analysis—including at a minimum, a supplemental analysis—that includes an unbounded accident analysis of earthquake consequences at the Y-12 site, performed using updated seismic hazard analyses that incorporated the 2014 USGS map." The Court also ruled that 69 categorical exclusion determinations were in violation of NEPA and ordered that "the relevant exclusions should be prepared in a manner consistent with the letter of the relevant DOE regulations." Consistent with the Court Order, DOE/NNSA has appropriately revised those 14 categorical exclusion determinations for projects that were still ongoing at the time of the Court's Order.

On October 4, 2019, NNSA amended its July 2011 ROD for the Y-12 SWEIS to reflect its decision to continue to implement, on an interim basis, the hybrid approach previously approved in the vacated 2016 AROD. As the Court previously ruled in its Order, that hybrid approach, which combined elements of the two alternatives previously analyzed in the Y-12 SWEIS, was adequately analyzed within the range of alternatives considered in the Y-12 SWEIS. The 2019 AROD enables NNSA to conduct the required additional NEPA documentation which is contained in this SA, while continuing to implement safety improvements previously approved in the 2016 AROD, pending the completion of the additional analysis ordered by the Court. Once this process is completed, NNSA plans to issue a new AROD describing what, if any, changes it has decided to make in light of that analysis.

Pursuant to the Court's Order, NNSA published the *Draft Supplemental Analysis for the Site-Wide Environmental Impact Statement for the Y-12 National Security Complex, Earthquake Accident Analysis* (NNSA 2020) for public comment on April 9, 2020. The purpose of the SA was to determine whether the earthquake consequences constitute a substantial change that is relevant to environmental concerns, or if there are significant new circumstances or information relevant to environmental concerns and bearing on continued operations at Y-12 compared to the analysis in the 2011 SWEIS. The draft SA was made available for public review and comment and 142 comments were received. The final SA was issued on July 15, 2020, and NNSA determined that the potential impacts associated with an earthquake accident at Y-12 would not be significantly different than the impacts presented in the Y-12 SWEIS. Based on the results of this Final SA, NNSA determined that: (1) the earthquake consequences and risks do not constitute a substantial change; (2) there are no significant new circumstances or information relevant to environmental concerns; and (3) no additional NEPA documentation is required at this time.

During 2019, CNS completed over 50 evaluations for proposed actions at Y-12, and 40 such actions (internal NEPA reviews) were categorically excluded by the NNSA NEPA Compliance Officer and consistent with 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 modernization of facilities and equipment, 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. NEPA reviews and evaluation were conducted for the following projects under the Extended Life Program (for existing EU facilities):

- Nuclear Facility Electrical Maintenance Project (multiple electrical improvements as well as transformer upgrades)
- Fire Suppression Upgrade Project (wet pipe sprinkler head replacements and replacement of fire and potable water building laterals)
- upgrades to Building 9995 laboratories
- upgrades to multiple machining tools, equipment, and controllers

The following projects continued for FY 2019 also were reviewed:

- West End Protection Area Reduction project (including utility re-routes and disconnects)
- LPF
- bridging and sustainment of current lithium production capabilities in Building 9204-02
- Energy Savings Performance Contract, Phase III, Mod 4, CHAMP project (environmental systems and control upgrades)
- Excess Facility Disposition Program (deactivation and demolition of excess facilities and structures)

The K-1065 Material Acquisition Complex, Central Training Facility Berm Refurbishment Project, Research and Development projects for production support capabilities, Sanitary Sewer Lining Project, Culver Replacement Project, Old Salvage Yard Parking Lot Project, and the upgrade and remodeling production area change-houses and bathrooms were also evaluated in FY 2019.

Table 4.3 lists the 2019 categorically excluded determination forms approved by NPO and posted on the public website.

Table 4.3. NNSA-approved categorical exclusions

Date issued	Title
06/2019	NEPA 4869, Demolition of 9204-04 Complex Ancillary Facilities
08/2019	NEPA 4886, Energy Savings Performance Contract, Phase III, Mod 4
09/2019	Lease office space in the Oak Ridge Technical Center - Buildings 1060 and 1099 Commerce Park
11/2019	NEPA 4721, Y-12 Fire Station Construction Project
11/2019	NEPA 4779, Building 9204-2 Annex Demolition Project

Acronyms:
NEPA = National Environmental Policy Act
NNSA = National Nuclear Security Administration

In March 2018, an environmental assessment determination (EAD) was approved by NNSA for a new LPF. 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. 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 2019 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.

Over 50 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 several of the proposed projects were part of the Infrastructure Disposition Program and would have an adverse effect on 16 historic properties eligible for listing in the National Register. In accordance with the Programmatic Agreement, the required Section 106 recordation, interpretation, and documentation information was submitted to the State Historical Preservation Office for the demolition of Buildings 9401-3, 9404-13, 9404-16, 9404-17, 9404-18, 9706-2, 9710-2, 9720-17, 9722-2, 9752, 9768, 9808-2, 9803, 9804, 9977, and 9977-1. The State Historical Preservation Office reviewed and concurred that the Section 106 documentation adequately mitigated project effects upon properties eligible for listing in the National Register of Historic Places. 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 digital versatile discs 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 (see Figure 4.8) 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. A new display area highlighting current and future missions of Y-12 was also developed and installed in the New Hope Center (see Figure 4.9).

Y-12 partnered with the National Park Service during the annual Earth Day events on April 18, 2019 (see Figure 4.10). 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.

Figure 4.8. Photograph of the Y-12 History Center

Figure 4.9. Photograph of new exhibit showing Y-12 National Security Complex's current and future missions

Figure 4.10. Photographs of National Park Service personnel at Y-12 National Security Complex's Earth Day celebration

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, which establishes a baseline for park planning and interpretive activities and provides 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 2019 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 2019, 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 include 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 recordkeeping and annual and semiannual reports. More than 2,000 data points are obtained and reported each year. All reporting requirements were met during CY 2019, 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 Order 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 2019 activities conducted at Y-12 in support of the Clean Air Act (CAA).

4.3.4 Clean Water Act Compliance Status

During 2019, 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. Compliance with permit discharge limits for 2019 was 100 percent.

Approximately 2,200 data points were obtained from sampling required by the NPDES permit; no non-compliances were reported. Y-12's NPDES permit in effect during 2019 (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 (TDEC 2019), 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.

Y-12's potable water distribution system was last reviewed by TDEC in 2018 and 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 2019 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 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 Safe Drinking Water Act 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 4.11). In FY 2019, Y-12 staff completed disposition of 53 percent of the inventory of legacy mixed waste listed on the ORR Site Treatment Plan.

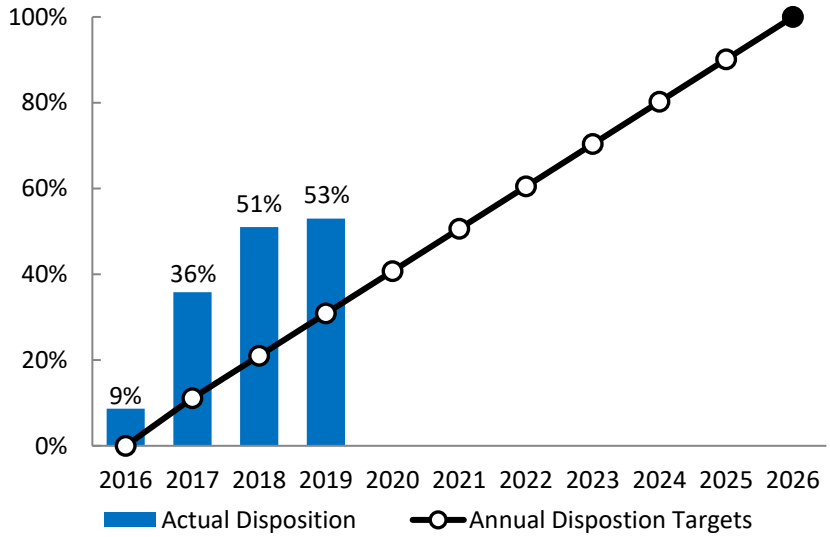


Figure 4.11. Y-12 National Security Complex's path to elimination of its inventory of legacy mixed waste as part of the Oak Ridge Reservation Site Treatment Plan by fiscal year

The quantity of hazardous and mixed wastes generated by Y-12 increased in 2019 (Figure 4.12). 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 2,412 kg of hazardous and mixed waste from the off-site Union Valley analytical chemistry laboratory and ETTP in 2019.

In addition, 475,968 kg of hazardous and mixed waste was shipped to DOE-owned and commercial treatment, storage, and disposal facilities. More than 11 million kg of hazardous and mixed wastewater was treated at on-site wastewater treatment facilities.

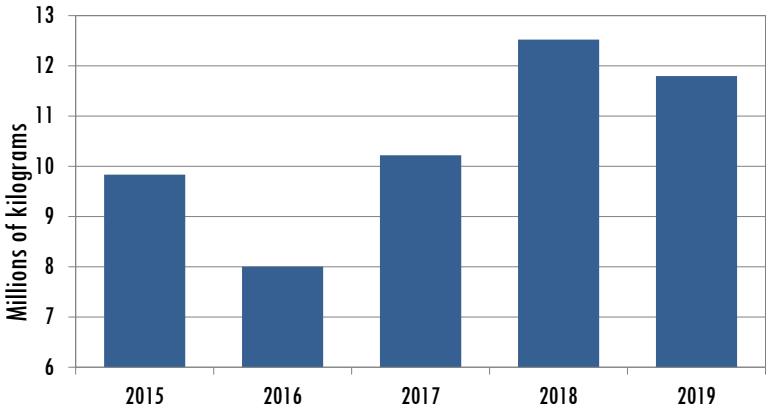


Figure 4.12. Hazardous waste generation, 2014–2019

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

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 Class IV, operating, 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/feasibility study. A CERCLA ROD for Spoil Area 1 was signed in 1997 (DOE 1997a). 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.

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.

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 12, 2019.

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 2019 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). During a routine review of chemical inventories, it was determined that nickel, Chemical Abstracts Service Number 7440-02-0, and 1,1,1,2,2,3,4,5,5,5-decafluoropentane, Chemical Abstracts Service Number 138495-42-8, exceeded the 10,000-lb reporting threshold. The product, DuPont Vertrel® XF, contains 1,1,1,2,2,3,4,5,5,5--decafluoropentane and is used as a solvent. Notifications were sent to TEMA and local emergency responders on March 21, and April 11, 2019. 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 2019.

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 51,882 kg (114,380 lb). Table 4.4 lists the reported chemicals for Y-12 for 2018 and 2019 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 Y-12, 2018 and 2019

Chemical	Year	Quantity[a] (lb)[b]
Chromium	2018	10,513
	2019	11,361
Cobalt	2018	[c]
	2019	862
Copper	2018	4,635
	2019	4,030
Lead compounds	2018	32,472
	2019	46,346
Manganese	2018	5,245
	2019	6,052
Mercury	2018	7,466
	2019	10,435
Methanol	2018	49,191
	2019	25,945
Nickel	2018	11,501
	2019	9,349
Total	2018	121,203
	2019	114,380

[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.

Acronym:
Y-12 = Y-12 National Security Complex

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 Plant Shift Superintendent. 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 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 2019. During 2019, 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 2019, 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, 2019

Date	Reviewer	Subject	Issues
January 24	City of Oak Ridge	Semiannual Industrial Pretreatment Compliance Inspection	0
March 5-6	TDEC	Annual RCRA Hazardous Waste Compliance Inspection (Y-12)	0
April 3	TDEC	Annual Air Quality Compliance Inspection	0
May 21	TDEC	NPDES Compliance Evaluation Inspection	0
September 19	TDEC	RCRA Hazardous Waste Compliance Inspection (Union Valley)	0
October 2	City of Oak Ridge	Semiannual Industrial Pretreatment Compliance Inspection	0

Acronyms:
NPDES = National Pollutant Discharge Elimination System
RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment and Conservation
Y-12 = Y-12 National Security Complex

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 2019.

Personnel from the TDEC Division of Solid Waste Management conducted a RCRA hazardous waste compliance inspection of Y-12 on March 5 and 6, 2019. The inspections covered 50 waste storage areas and records reviews. No issues were identified. In addition, a hazardous waste compliance inspection was conducted at the Union Valley Facility, an analytical chemistry laboratory. No issues were identified.

Personnel from the TDEC Division of Air Pollution Control conducted an air quality inspection on April 3, 2019. The inspection covered 10 air emission sources, including some emergency generators, and inspections of the facilities. Title V air permit records were also reviewed. No issues were identified.

Personnel from TDEC Division of Water Resources performed an NPDES Compliance Evaluation Inspection on May 21, 2019. The inspections covered 22 outfalls, 4 wastewater treatment facilities, and outdoor storage areas. There were some areas of concern, but no issues.

In July 2019, as the result of a self-identified issue, solid waste shipments to the Nevada National Security Site were suspended due to non-compliant material being included in a weapons-related component. Consequently, investigations, a series of improvement activities, and layers of self-critical audits have been conducted. Process improvements in handling, characterization, and certification of waste are underway prior to resuming shipments to this disposal cell. Real-time radiography imaging is planned as a final check of waste that can benefit from this step.

4.3.13 Radiological Release of Property

Clearance of property from Y-12 is conducted in accordance with approved procedures that comply with DOE Order 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).
- 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 2019. During FY 2019, Y-12 recycled more than 3.8 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 2019

Category	Amount released
Real property (land and structures)	None
Computer equipment recycle	119,053 lb
–Computers, monitors, printers, and mainframes	
Recycling examples	
–Used oils	22,840 gal
–Used tires	12,560 lb
–Scrap metal	1,380,673 lb
–Lead acid batteries	67,844 lb
Public/negotiated sales[a]	
–Brass	7,979 lb
–Miscellaneous furniture	17,964 lb
–Vehicles and miscellaneous equipment	403,674 lb
External transfers[b]	23,600 lb

[a] Sales during Fiscal Year 2019.
[b] Vehicles, miscellaneous equipment, and materials transferred to various federal, state, and local agencies for reuse during Fiscal Year 2019.

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* (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.

Table 4.7. DOE 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 U.S. Department of Energy dose limits and constraints.

Acronyms:
DOE = U.S. Department of Energy
N/A = not applicable

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

Source: Vázquez 2011.

Y-12 uses an administrative limit for average and maximum 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). Y-12 also uses an administrative limit for removable activity of 240 dpm/100 cm^2 for radionuclides in Group 3 (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."

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. Materials that may be subject to volumetric contamination are evaluated for release by one of 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 process knowledge is documented and used as the basis for release. 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. Alternatively, if volumetric authorized limits exists (per DOE Order 458.1) for a specified material stream, then the analytical results are evaluated and compared with the authorized limits for potential release (NPO 2018, 2019a, 2019b).

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 Y-12 Clean Air Program.

4.4.1 Construction and Operating Permits

The following Title V permitting actions were submitted and approved in 2019:

- Minor permit modifications to remove Building 9201-1W Emission Source Operation, to remove Stack 12 Process Equipment from the Third Mill Metal Working Operations, and to add a new stationary emergency engine/generator to the Title V air permit.
- Declaration of insignificant activity to reclassified stationary emergency engines/generators and fire water pumps as an insignificant activity.
- Initial notification report for a new stationary emergency engine/generator that exceeds 500 hp.
- Notification of change to CNS Complex responsible official was submitted to the regulators.
- Air permit insignificant activity/exemption was completed for the White Sands Missile Range Mobile Uranium Facility.

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 sitewide 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 steam plant, 2019

	Emissions (tons/year)[a]		
Pollutant	Actual	Allowable	Percentage of allowable
Particulate	3.00	41.0	7.3
Sulfur dioxide	0.24	39.0	0.6
Nitrogen oxides[b]	12.62	81.0	15.6
VOCs[b]	2.17	9.4	23.1
Carbon monoxide[b]	33.12	139.0	23.8

NOTE: The emissions are based on fuel usage data for January through December 2019. The 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 U.S. Environmental Protection Agency compilation of air pollutant emission factors (EPA 1995, 1998).

Acronyms:
VOC = volatile organic compound
Y-12 = Y-12 National Security Complex

4.4.1.1 Generally Applicable Permit Requirements

Y-12, like many industrial sites, has a number of generally applicable requirements, such as those pertaining to the management and control of asbestos, ozone-depleting substances (ODSs), and fugitive particulate emissions.

Control of Asbestos

Y-12, like many industrial sites, has a number of general requirements applicable to removal and disposal of asbestos-containing materials, including monitoring, notification to TDEC of demolitions and renovations, and prescribed work practices for abatement and disposal of asbestos materials. There was no reportable release of asbestos in 2019. There were four notifications of management and control. Asbestos, ODSs, and fugitive particulate emissions are notable examples.

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. There were no appliances on Y-12 that leaked refrigerant in 2019 triggering these reporting.

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, the following:

- 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.
- Application of asphalt, water, or suitable chemicals on dirt roads, material stockpiles, and other surfaces that can create airborne dusts.
- 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 4.13). 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).

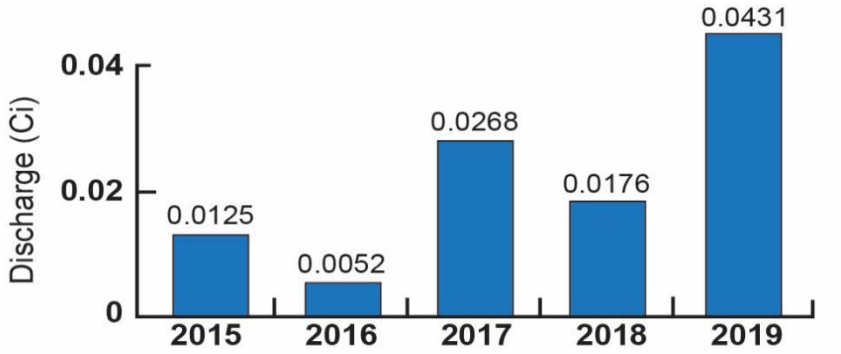


Figure 4.13. Total curies of uranium discharged from the Y-12 National Security Complex to the atmosphere, 2015–2019

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 2019, 31 process exhaust stacks were continuously monitored, 23 of which were major sources; the remaining 8 were minor sources. Monitoring for seven of these minor sources was discontinued during the first quarter of 2019, and their contributions to Y-12's air emissions were conservatively accounted for using Appendix D calculations, as noted below. The use of these conservative, calculated values, rather than actual monitored values, resulted in an increase in the reported curies of uranium discharged. The sampling systems on the stacks have been approved by EPA Region 4.

During 2019, unmonitored uranium emissions at Y-12 occurred from 43 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 mi east of Y-12, and is not within the ORR boundary. In 2019, 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. Nine emission points from room ventilation exhausts were identified in 2019 where emissions exceeded 10 percent of the derived air concentration. Six of these emission points fed to monitored stacks, and any radionuclide emissions were accounted for as noted for monitored emission points. The remaining three emission points were the result of cleanup activities only (no mechanical or chemical processes) and are considered fugitive emissions. Therefore, they are not included in the total overall source term for Y-12.

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 0.0431 Ci (33.1 kg) of uranium was released into the atmosphere in 2019 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 2019 was 0.36 mrem. This dose is well below the National Emission Standards for Hazardous Air Pollutant (NESHAP) standard of 10 mrem and is less than 0.12 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 (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 571832. 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 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. Demonstration of compliance is achieved via several activities, including monitoring the operations of control devices, limiting process input materials, and using certified readers to conduct emission evaluations of visible stacks.

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 2019 are 466.77 lb (0.233 tons) and 4,205 lb (13.88 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 2019 was 2.972 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* (EPA 2010). 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 subject to this rule. The steam plant consists of four boilers. The maximum heat input capacity of each boiler shall not exceed 99 MM British thermal unit (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 required 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. GHG emissions from Y-12 stationary fuel combustion sources

Year	GHG emissions (metric tons CO_2e)
2010	97,610.0
2011	70,187.0
2012	63,177.0
2013	61,650.0
2014	58,509.0
2015	51,706.9
2016	50,671.6
2017	50,292.7
2018	51,010.7
2019	45,971.3

Acronyms:
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 2019 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 4.4.2.1.

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 online 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* (EPA 1990). 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—new source performance standards (Title 40 CFR Part 60, Subpart IIII), and 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.

Since the above rules were adopted into the Tennessee Air Pollution Control Regulations (TAPCR) 0400-30, Chapters 38 and 39, the emergency engines/generators can be considered an insignificant activity if the potential to emit is below the significance thresholds (less than 5 tons/year of each criteria pollutant and less than 1,000 lb/year of any hazardous air pollutant evaluated at a 500-hr/year limit). There was also a change to Chapter 9 of TAPCR that allows for stationary engines to be eligible to be considered insignificant activities. Condition D14 of the Title V Operating Air Permit 571832 was amended to incorporate new language specifying stationary reciprocating internal combustion engines are eligible to be considered insignificant activities that must comply with any underlying applicable rules associated with a stationary internal combustion engine.

The emergency engines/generators are used to provide power for critical systems in the event of electrical power failures/outages at Y-12. The engines/generators operate exclusively as emergency engines/ generators. Based upon historical usage of the emergency engines/generators and fire water pumps and EPA's 500-hr default assumption (maximum hour usage), calculations verify and confirm that the potential emissions from each stationary emergency internal combustion engine less than 645 hp qualifies, or should be reclassified as an insignificant activity, because the potential to emit is well below the significance thresholds of less than 5 tons/year of each regulated air pollutant that is not an HAP, and less than 1,000 lb/year of any HAP in accordance with TAPCR 1200-03-09-.04(5)(a)4(i). Approximately 95 percent of Y-12 stationary emergency engines/generators and fire water pumps are considered and/or reclassified as an insignificant activity in accordance with TAPCR Rule 1200-03-09-.04(5)(a)4.(i). These engines are listed in Y-12's Title V Air Permit.

4.4.2 Ambient Air

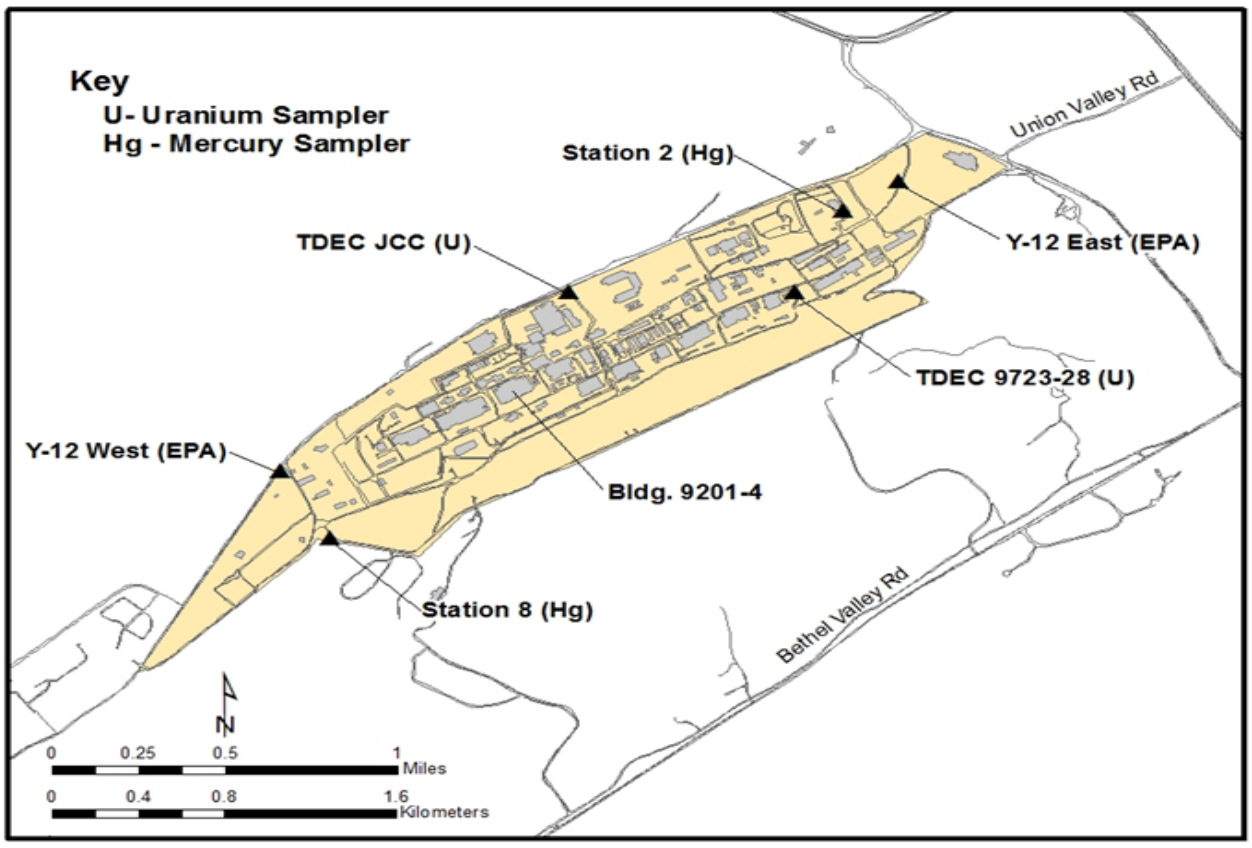
To understand the complete picture of ambient air monitoring in and around Y-12, data from on- and off-site monitoring conducted specifically for Y-12, DOE reservation-wide monitoring, and on- and off-site monitoring conducted by EPA and TDEC personnel must be considered.

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 NESHAPs regulations.

4.4.2.1 Mercury

The Y-12 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. Originally, four monitoring stations were operated at Y-12, including two within the West End Mercury Area (i.e., the former west end mercury-use area 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 4.14). 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.



Acronyms:
EPA = U.S. Environmental Protection Agency (sampler)
TDEC = Tennessee Department of Environment and Conservation
JCC = Jack Case Center

Figure 4.14. Locations of ambient air monitoring stations at 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 2019 is 0.0025 μg/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 2019 was 0.0036 μg/m^3 (N = 25), similar to levels reported for 2008 and the early 2000s.

Table 4.10. Summary of data for the Y-12 ambient air monitoring program for mercury, CY 2019

Ambient air monitoring stations	Mercury vapor concentration (μg/m^3)			
	2019 Minimum	2019 Maximum	2019 Average	1986–1988[a] Average
AAS2 (east end of Y-12)	0.0014	0.0054	0.0025	0.010
AAS8 (west end of Y-12)	0.0015	0.0061	0.0036	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.

Acronyms:
AAS = ambient air (monitoring) station
CY = calendar year
N/A = not applicable
Y-12 = Y-12 National Security Complex

Table 4.10 summarizes the 2019 mercury results, with results from the 1986 through 1988 period included for comparison. Figure 4.15 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 2019 [parts (a) and (b)] and seasonal trends at AAS8 from 1994 through 2019 [part (c)]. The dashed line superimposed on plots (a) and (b) in Figure 4.15 is the EPA reference concentration of 0.3 μg/m^3 for chronic inhalation exposure.

The large increase in mercury concentration at AAS8 observed in the late 1980s [part (b)] was thought to be related to disturbances of mercury-contaminated soils and sediments during the Perimeter Intrusion Detection Assessment System installation and storm drain restoration projects under way at that time within the West End Mercury Area. In Figure 4.15(c), a monthly moving average has been superimposed over the AAS8 data to highlight seasonal trends in mercury at AAS8 from January 1994 through December 2019, with higher concentrations generally measured during the warm weather months.

In conclusion, 2019 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).

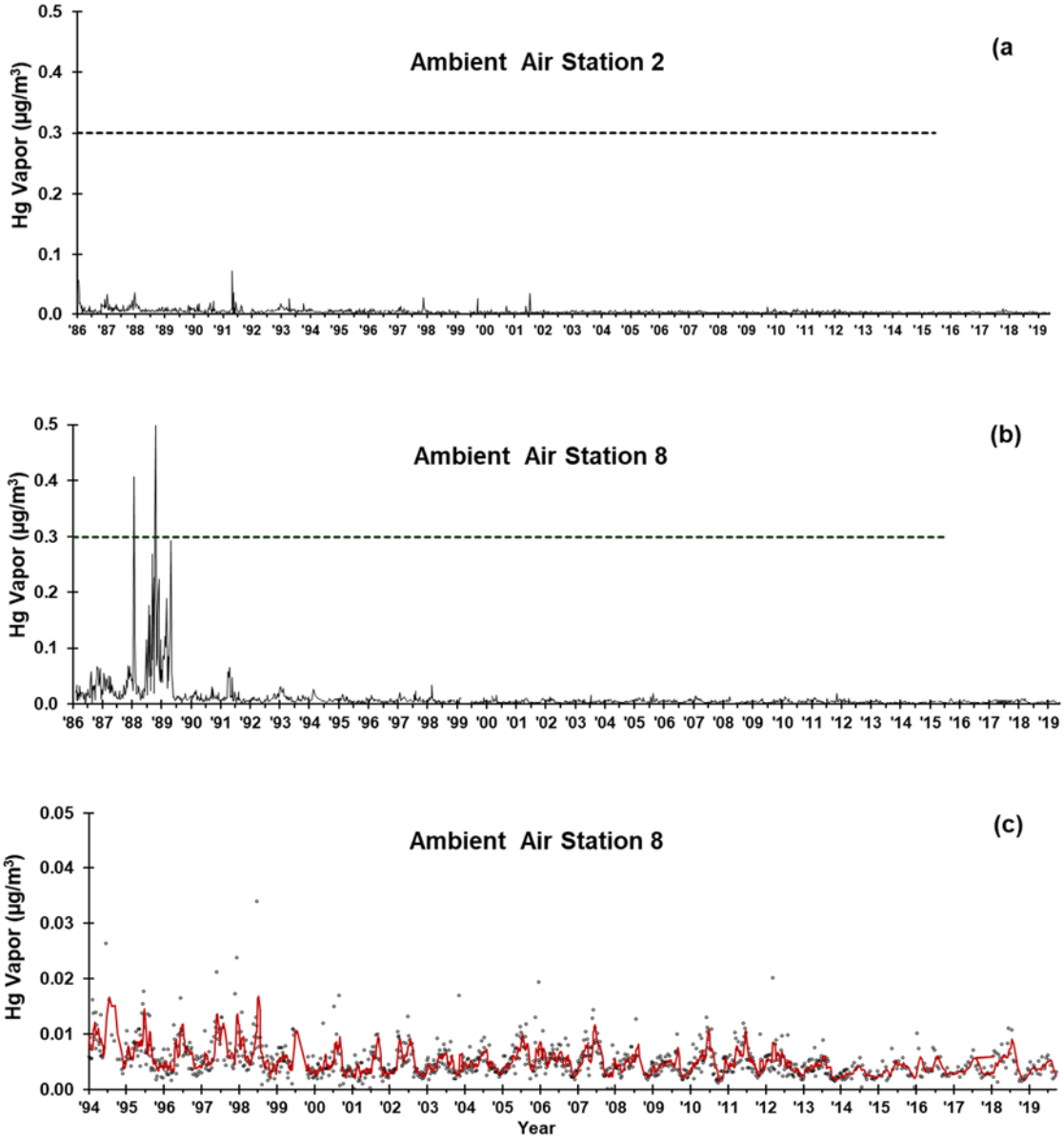


Figure 4.15. Temporal trends in mercury vapor concentration for the boundary monitoring stations at Y-12 National Security Complex, July 1986 to December 2019 [(a) and (b)] and January 1994 to December 2019 for ambient air station 8 [(c)]

4.4.2.2 Quality Control

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

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

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

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 all the way to the analytical laboratory.

A field performance evaluation is conducted annually by the project manager to ensure that sampling technicians follow proper procedures. No issues were identified in the last evaluation conducted on May 30, 2019.

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 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 4.15) 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 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.

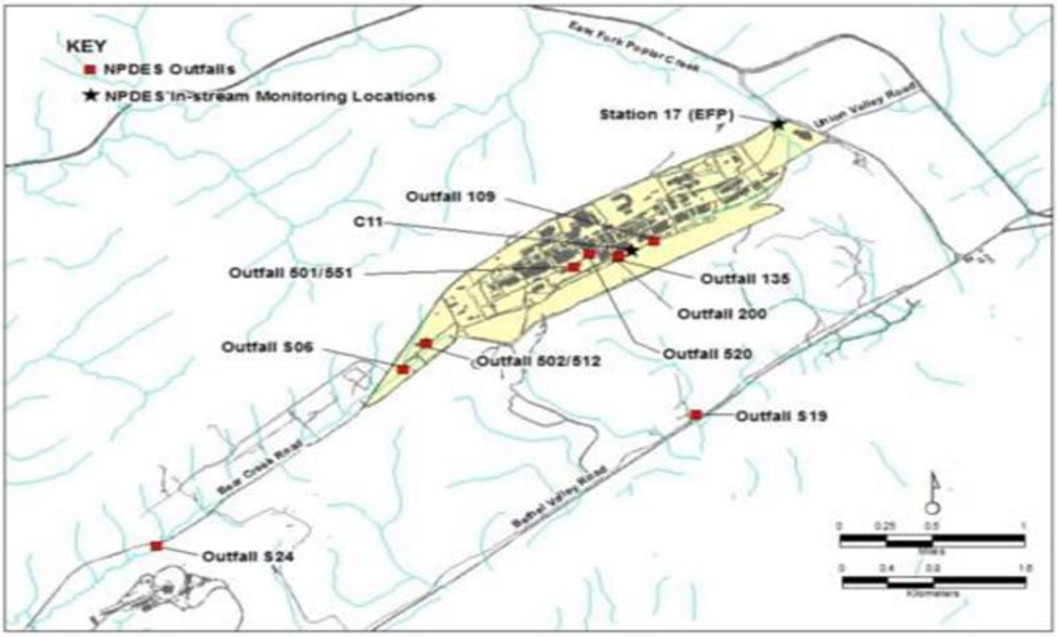
4.5 Water Quality Program

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 4.16. 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.

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.



Acronyms: EFP = East Fork Poplar NPDES = National Pollutant Discharge Elimination System

Figure 4.16. Major Y-12 National Security Complex National Pollutant Discharge Elimination System outfalls and monitoring locations

Requirements of the NPDES permit for 2019 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 2019 was 100 percent (see Table 4.11).

Table 4.11. NPDES compliance monitoring requirements and record for Y-12, January–December 2019

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

Table 4.11. NPDES compliance monitoring requirements and record for Y-12, January–December 2019 (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 502 (West End Treatment Facility)	pH, standard units			*a*	9.0	100	2
	Total suspended solids		31		40	100	2
	Total toxic organic				2.13	100	2
	Hexane extractables			10	15	100	2
	Cadmium		0.4		0.15	100	2
	Chromium		1.7		1.0	100	2
	Copper		2.0		1.0	100	2
	Lead		0.4		0.2	100	2
	Nickel		2.4		3.98	100	2
	Nitrate/Nitrite				100	100	2
	Silver		0.26		0.05	100	2
	Zinc		0.9		1.48	100	2
	Cyanide		0.72		1.20	100	2
	PCB				0.001	100	2
Outfall 512 (Groundwater Treatment Facility)	pH, standard units			*a*	9.0	100	12
	PCB				0.001	100	1
Outfall 520	pH, standard units			*a*	9.0	*b*	0
Outfall 200 (North/South pipes)	pH, standard units			*a*	9.0	100	55
	Hexane extractables			10	15	100	13
	Cadmium			0.001	0.023	100	12
	IC_{25} *Ceriodaphnia*			37% Minimum		100	1
	IC_{25} *Pimephales*			37% Minimum		100	1
	Total residual chlorine			0.024	0.042	100	12
Outfall 551	pH, standard units			*a*	9.0	100	53
	Mercury			0.002	0.004	100	53
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	32
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.

Acronyms:
IC_{25} = 25% inhibition concentration
NPDES = Nation Pollutant Discharge Elimination System
PCB = polychlorinated biphenyl
Y-12 = Y-12 National Security Complex

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—treatment facilities, other point-source and area-source discharges, and 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 Y-12, 2019

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.

Acronym:
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 2019 are noted on Figure 4.17. 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 2019. Radiological data were well below the allowable DCS.

In 2019, the total mass of uranium and associated curies released from Y-12 at the easternmost monitoring station, Station 17 on Upper EFPC, was 203 kg or 0.079 Ci (Table 4.14).

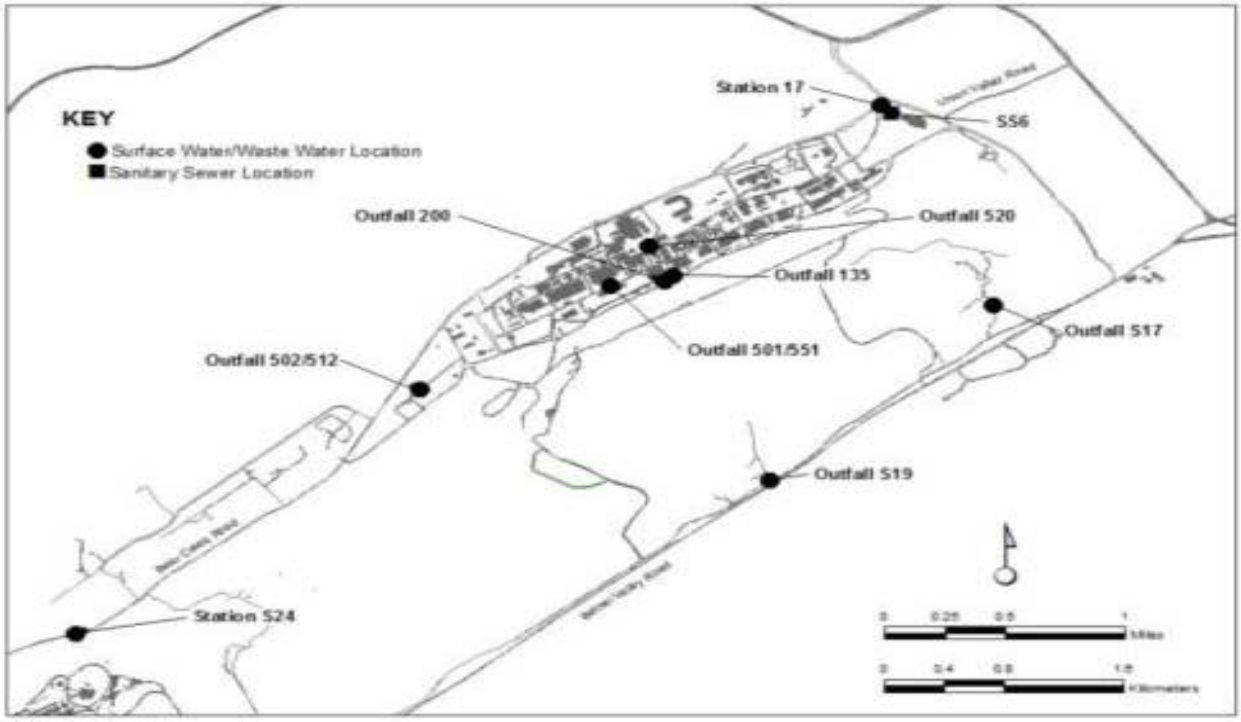


Figure 4.17. Surface water and sanitary sewer radiological sampling locations at Y-12 National Security Complex

Table 4.13. Summary of Y-12 radiological monitoring plan sample requirements and 2019 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	69.4
Groundwater Treatment Facility	4/year	24-hr composite	2.91
Steam	1/year	Grab	No flow
Central Mercury Treatment Facility	4/year	24-hr composite	0.41
Other Y-12 point- and area-source discharges			
Outfall 135	4/year	24-hr composite	3.42
Kerr Hollow Quarry	1/year	24-hr composite	0.45
Rogers	1/year	24-hr composite	0.91
Y-12 instream locations			
Outfall S24	1/year	7-day composite	3.8
East Fork Poplar Creek, complex exit (east)	1/month	7-day composite	1.9
North/south	1/month	24-hr composite	3.8
Y-12 sanitary sewer			
East End Sanitary Sewer Monitoring Station	1/year	7-day composite	12.9

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

Table 4.14. Release of uranium from Y-12 to the off-site environment as a liquid effluent, 2013–2019

Year	Quantity released	
	Ci[a]	kg
	Station 17	
2014	0.061	90
2015	0.068	116
2016	0.045	88
2017	0.080	154
2018	0.084	205
2019	0.079	203

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

Acronym:
Y-12 = Y-12 National Security Complex

Figure 4.18 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). Converting units and multiplying by 365 days per year yields the calculated discharge.

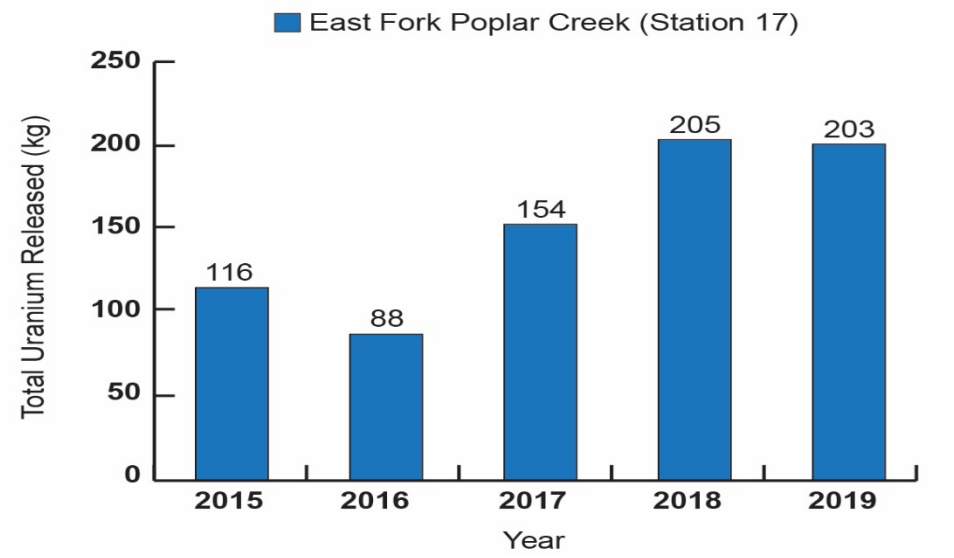


Figure 4.18. Five-year trend of Y-12 National Security Complex releases of uranium to East Fork Poplar Creek

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 2019 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 and 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 2019 during rain events that occurred on April 8, June 5, October 16, and October 30. Results were published in the *Annual Storm Water Report* (CNS 2019), which was submitted to TDEC, Division of Water Pollution Control in January 2020. 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 4.19).

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 or 2019 due to the degraded condition of the outfall piping and the inability to gather reliable flow rate data. This outfall has since been repaired, and storm water monitoring is currently scheduled to resume in 2020. Data collected to date are presented in Table 4.15.

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 was unknown. Additional sampling and analysis for this contaminant occurred in 2019, and concentrations returned to pre-2018 levels.

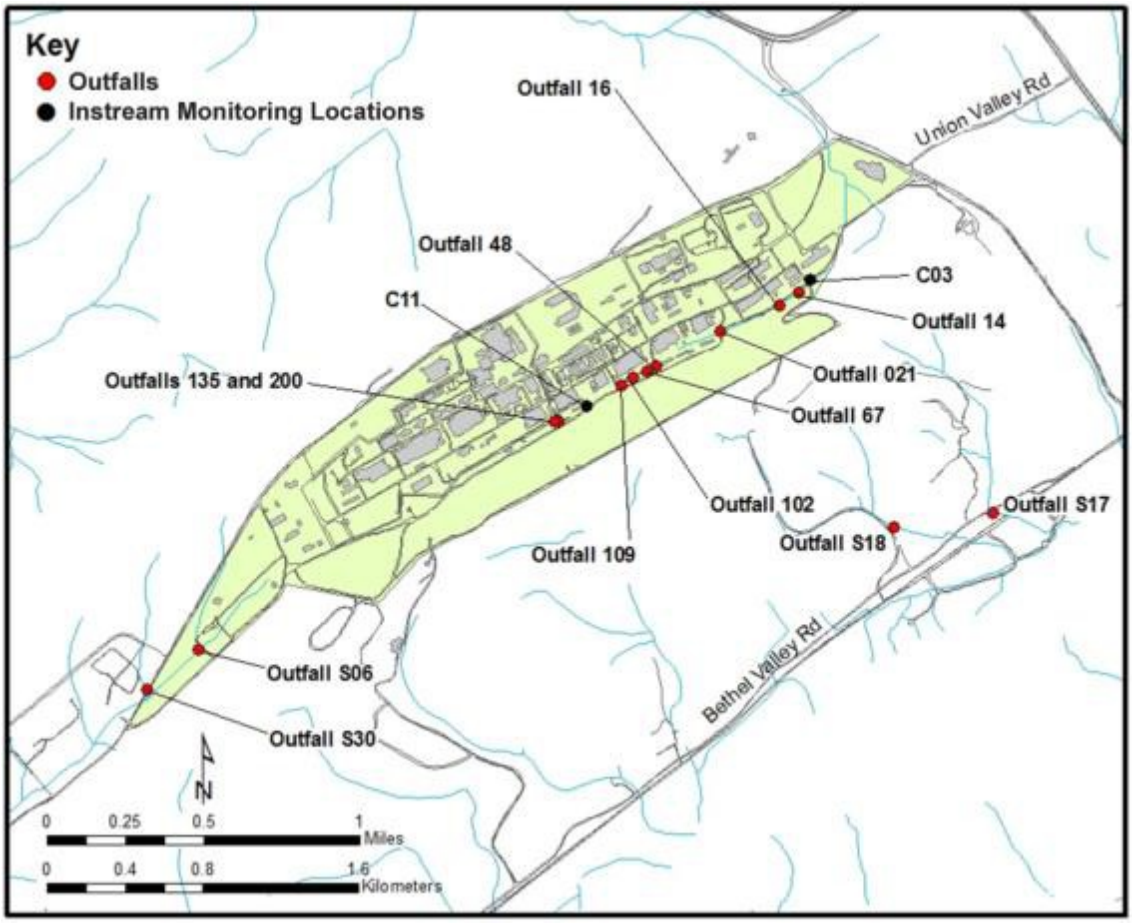


Figure 4.19. Y-12 National Security Complex storm water monitoring locations, East Fork Poplar Creek

Table 4.15. Mercury concentrations at Outfall 014

Calendar year	2013	2014	2015	2016	2017	2018	2019
Mercury concentration (µg/L)	7.12	0.892	9.11	0.49	0.237	N/A	N/A

Acronym:
N/A = not available

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 4.20. 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.

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).

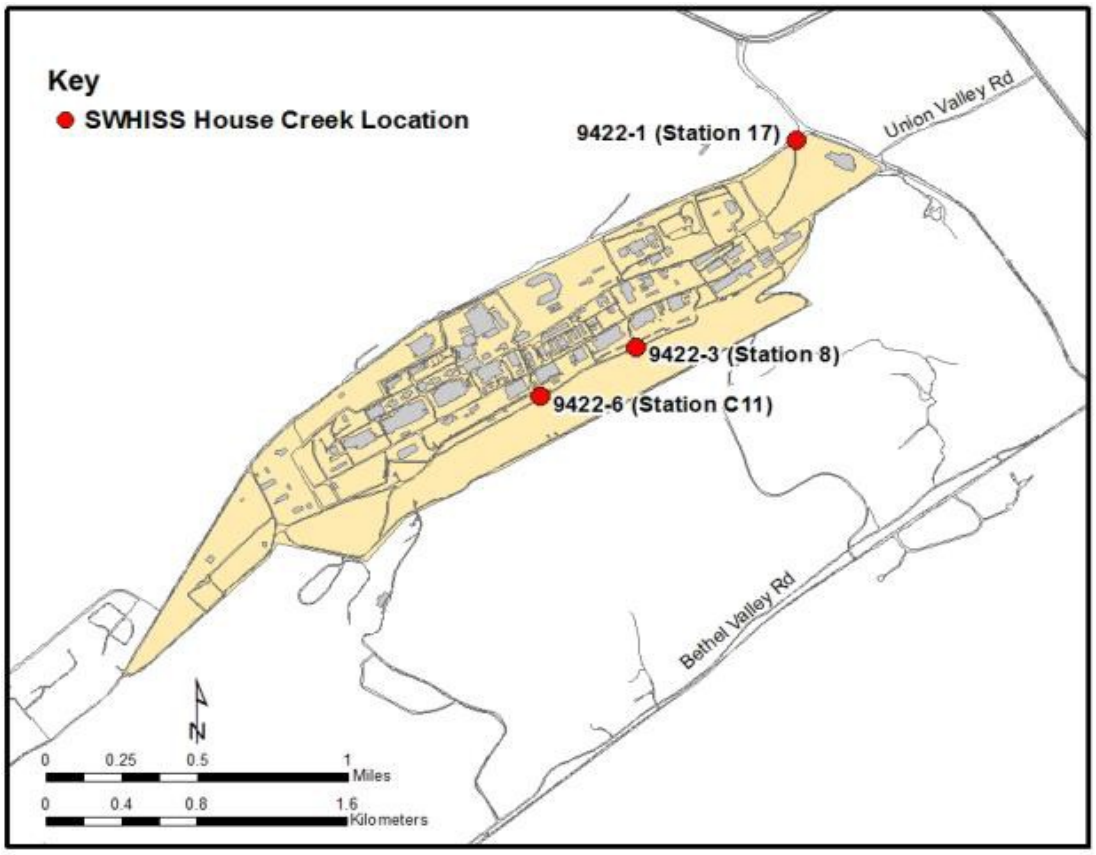


Figure 4.20. Surface Water Hydrological Information Support System monitoring locations

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

Monitoring results from 2019 are contained in Table 4.16. There were a total of three exceedances of permit limits in 2019—two exceedances of the 2,100-gal per min instantaneous limit; and one exceedance of the average daily flow limit.

Table 4.16. Y-12 discharge point SS6 (Sanitary Sewer Station 6), CY 2019 (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	2
Flow (average kgpd) January through March	90	530.2	N/A	500	1
Flow (average kgpd) April through June	91	327.5	N/A	500	0
Flow (average kgpd) July through September	92	303.3	N/A	500	0
Flow (average kgpd) October through December	92	367.0	N/A	500	0
pH (standard units)	27	N/A	N/A	9/6[b]	0
Biochemical oxygen demand	14	120.6	N/A	200	1
Kjeldhal nitrogen	16	30.7	N/A	45	0
Phenols—total recoverable	14	<0.053	N/A	0.15	0
Oil and grease	14	<9.1	N/A	25	0
Suspended solids	16	108.3	N/A	200	0
Cyanide	19	<0.0037	N/A	0.005	0
Arsenic	14	<0.005	N/A	0.010	0
Cadmium	14	<0.0005	N/A	0.0033	0
Chromium, hexavalent	13	0.0054	N/A	0.053	0
Copper	14	0.029	N/A	0.14	0
Iron	14	0.683	N/A	10	0
Lead	14	<0.0025	N/A	0.049	0
Mercury	14	0.00081[d]	N/A	0.035[c]	0
Nickel	14	<0.005	N/A	0.021	0
Silver	14	0.0047	N/A	0.05	0
Zinc	14	0.1358	N/A	0.35	0
Molybdenum	14	0.0538	N/A	0.05[d]	N/A
Selenium	14	<0.01	N/A	0.01[d]	N/A
Toluene	4	0.005	N/A	0.005[d]	N/A
Ammonia	4	14.1	N/A	0.10[d]	N/A
Methanol	4	0.985	N/A	1.0[d]	N/A
Benzene	4	0.005	N/A	0.005[d]	N/A
1,1,1-Trichloroethane	4	0.005	N/A	0.005[d]	N/A
Ethylbenzene	4	0.005	N/A	0.005[d]	N/A
Carbon tetrachloride	4	0.005	N/A	0.005[d]	N/A
Chloroform	4	0.0035	N/A	0.005[d]	N/A
Tetrachloroethene	4	0.0038	N/A	0.005[d]	N/A
Trichloroethene	4	0.005	N/A	0.005[d]	N/A
trans-1,2-Dichloroethylene	4	0.005	N/A	0.005[d]	N/A
Methylene chloride	4	0.005	N/A	0.005[d]	N/A

[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.
[d] Average value and effluent limit are pounds per day.

Acronyms:
CY = calendar year
gpm = gallons per minutes
kgpm = thousand gallons per minute
N/A = not applicable
Y-12 = Y-12 National Security Complex

An Industrial Waste Water Survey (Permit Application) was submitted to the City of Oak Ridge in December 2019. A new Industrial Waste Water Permit is expected to be issued to Y-12 sometime in the first half of 2020.

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 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 2019 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).

Table 4.18. Y-12 biomonitoring program summary information for Outfalls 200 and 135, 2019[a]

Water collection dates	Outfall	Test type	Test organism	End point	Metric	IC_{25}[b] (%)
02/12/19–02/17/19	200	Chronic	Fathead minnow (*Pimephales promelas*)	Survival	IC_{25}	>100%
				Growth	IC_{25}	>100%
			Water fleas (*Ceriodaphnia dubia*)	Survival	IC_{25}	>100%
				Reproduction	IC_{25}	>100%
07/16/19–07/22/19	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%
07/16/19–07/22/19	200	Chronic	Water fleas (*Ceriodaphnia dubia*)	Survival	IC_{25}	>100%
				Reproduction	IC_{25}	>100%
			Fathead minnow (*Pimephales promelas*)	Survival	IC_{25}	>100%
				Growth	IC_{25}	>100%

[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.

Acronyms:
IC_{25} = 25% inhibition concentration
Y-12 = Y-12 National Security Complex

In July 2018, toxicity was observed in Outfall 200 effluent, and a toxicity identification/evaluation reduction (TIE/TRE) plan was conducted (Mathews et al. 2019). The observed toxicity in 2018 appears to be the result of a one-time flux of mercury that occurred during construction and demolition activities at the west end of Y-12. The final test from the TIE/TRE plan was conducted in February 2019, and no toxicity was observed (Table 4.18), which placed the chronic testing schedule back to an annual event.

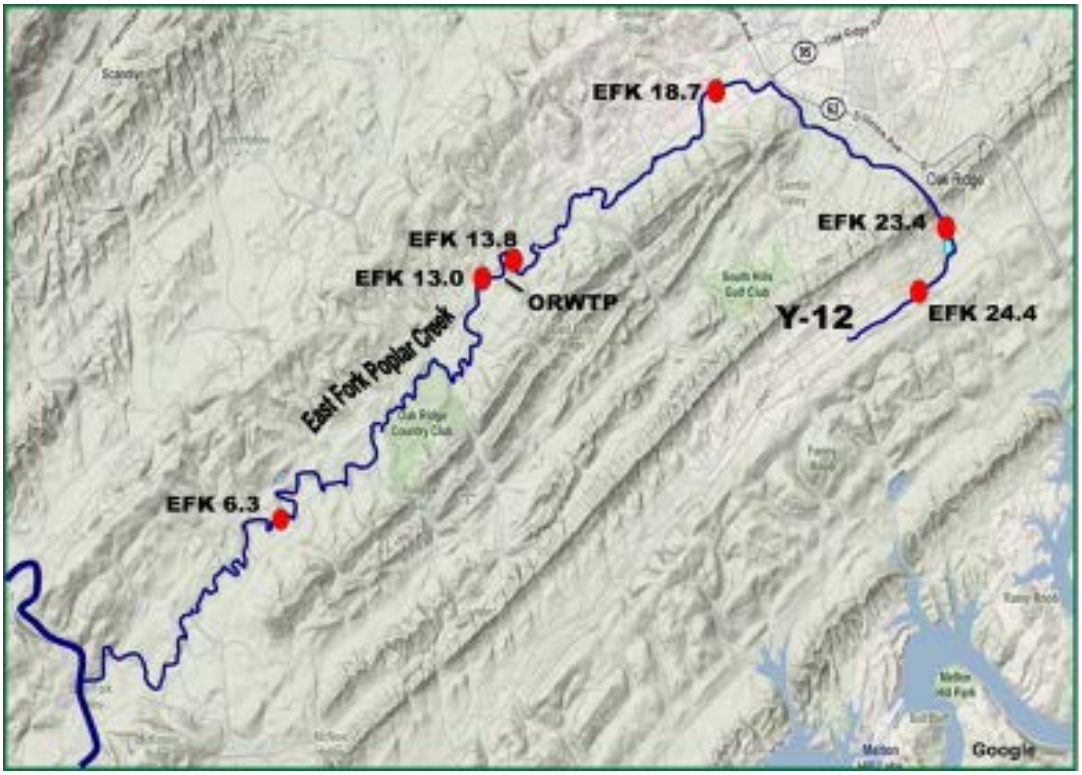
Annual NPDES permit testing was conducted in July 2019 with effluent from Outfall 200 and Outfall 135. Effluent from Outfall 135 did not reduce fathead minnow (*Pimephales promelas*) survival or growth of water fleas (*Ceriodaphnia dubia*) survival or reproduction by 25 percent or more at any of the tested concentrations. For both species, the IC_{25} for survival, growth, or reproduction was greater than 36 percent (the highest concentration of this effluent that was tested) (Table 4.18). Effluent from Outfall 200 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 greater than 100 percent (Table 4.18).

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 2019 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.

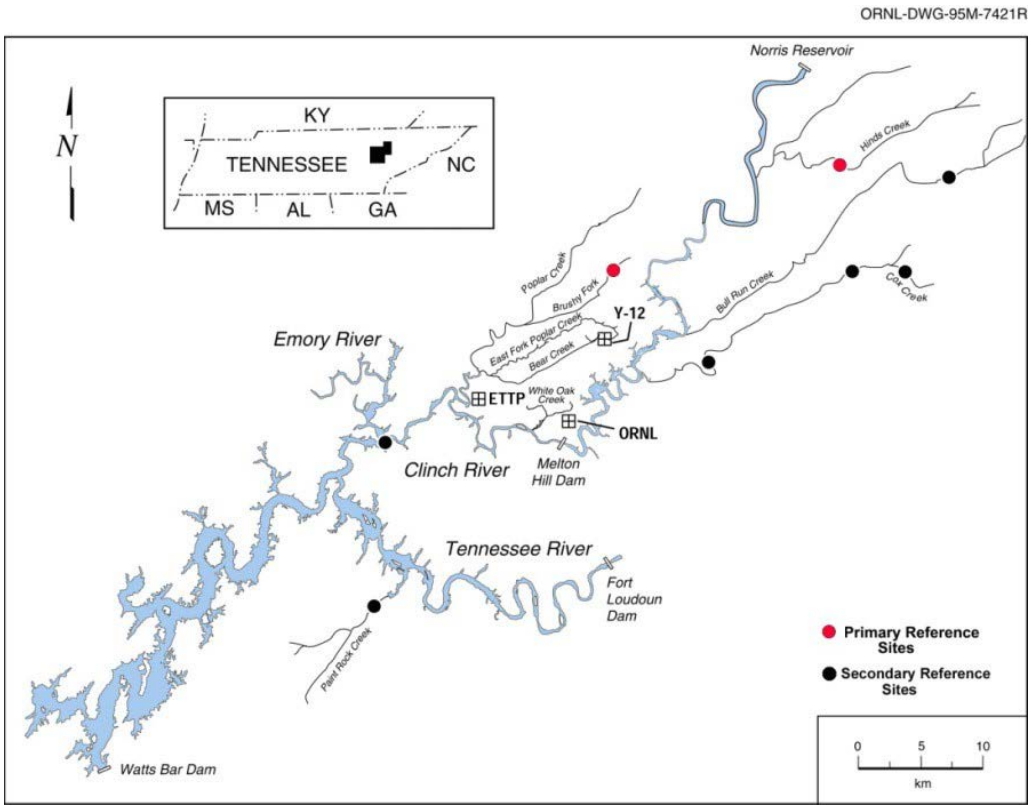
Monitoring is currently being conducted at five primary EFPC sites, although sites may be excluded or added depending on the specific objectives of the various tasks. The primary sampling sites include Upper EFPC at EFPC kilometers (EFKs) 24.4 and 23.4 (upstream and downstream of Lake Reality, respectively); 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 4.21). 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 4.22).



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

Figure 4.21. Locations of biological monitoring sites on East Fork Poplar Creek in relation to 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.



Acronyms:

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

Figure 4.22. Locations of biological monitoring reference sites in relation to Y-12 National Security Complex

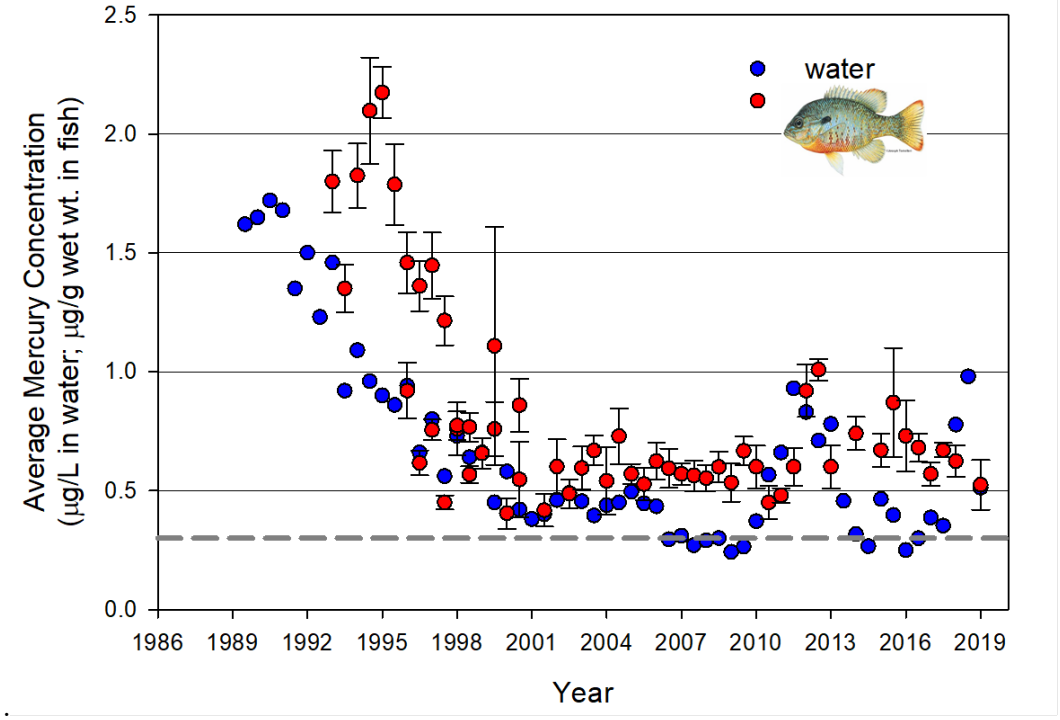
4.5.8.1 Bioaccumulation Studies

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 4.23). Mercury concentrations remained higher in fish from EFPC in 2019 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.

Figure 4.23 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 4.23). 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). In July 2018, aqueous mercury concentrations spiked as a result of a one-time flux of mercury that occurred during construction and demolition activities at the west end of Y-12. The elevated mercury concentrations were associated with toxicity (Section 4.5.7) and a fish kill (Mathews et al. 2019) such that no fish were available for collection at the EFK 24.4 site in fall 2018. The fish that were collected in spring 2019 were generally smaller than those routinely encountered, and mercury concentrations in these fish were slightly lower than in 2018, averaging 0.52 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).

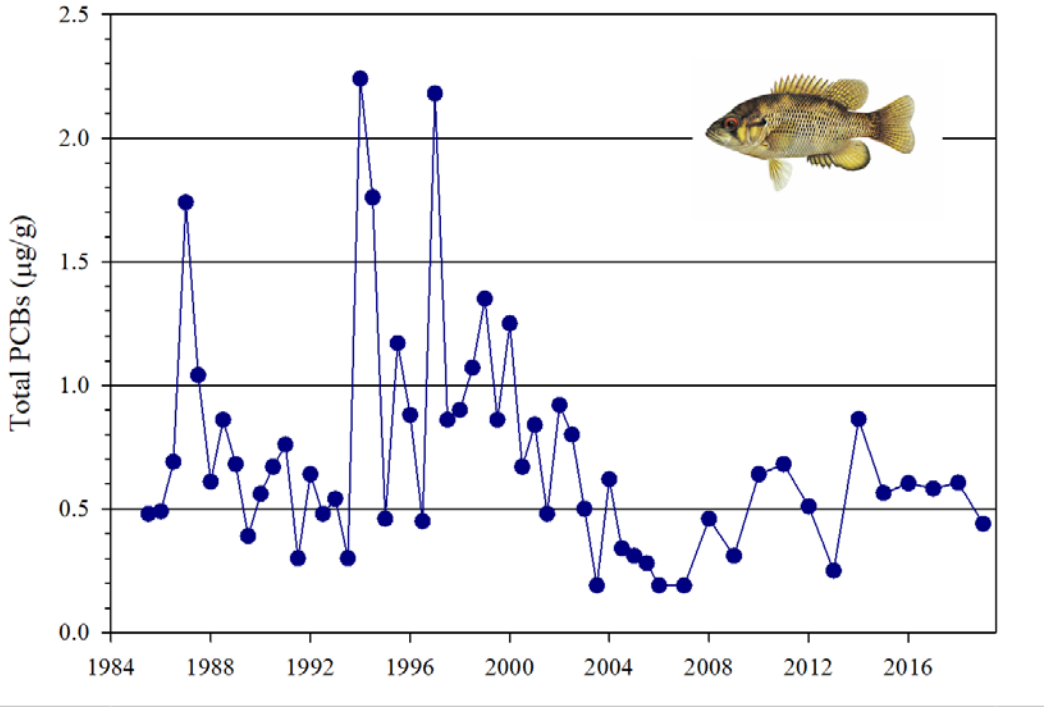


Dashed grey line represents the ambient water quality criterion for methylmercury in fish fillets (0.3 µg/g)

Figure 4.23. 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 2019

The observation 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 0.44 µg/g in FY 2019, slightly lower than concentrations seen FY 2018 (0.61 µg/g) (Figure 4.24). 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).



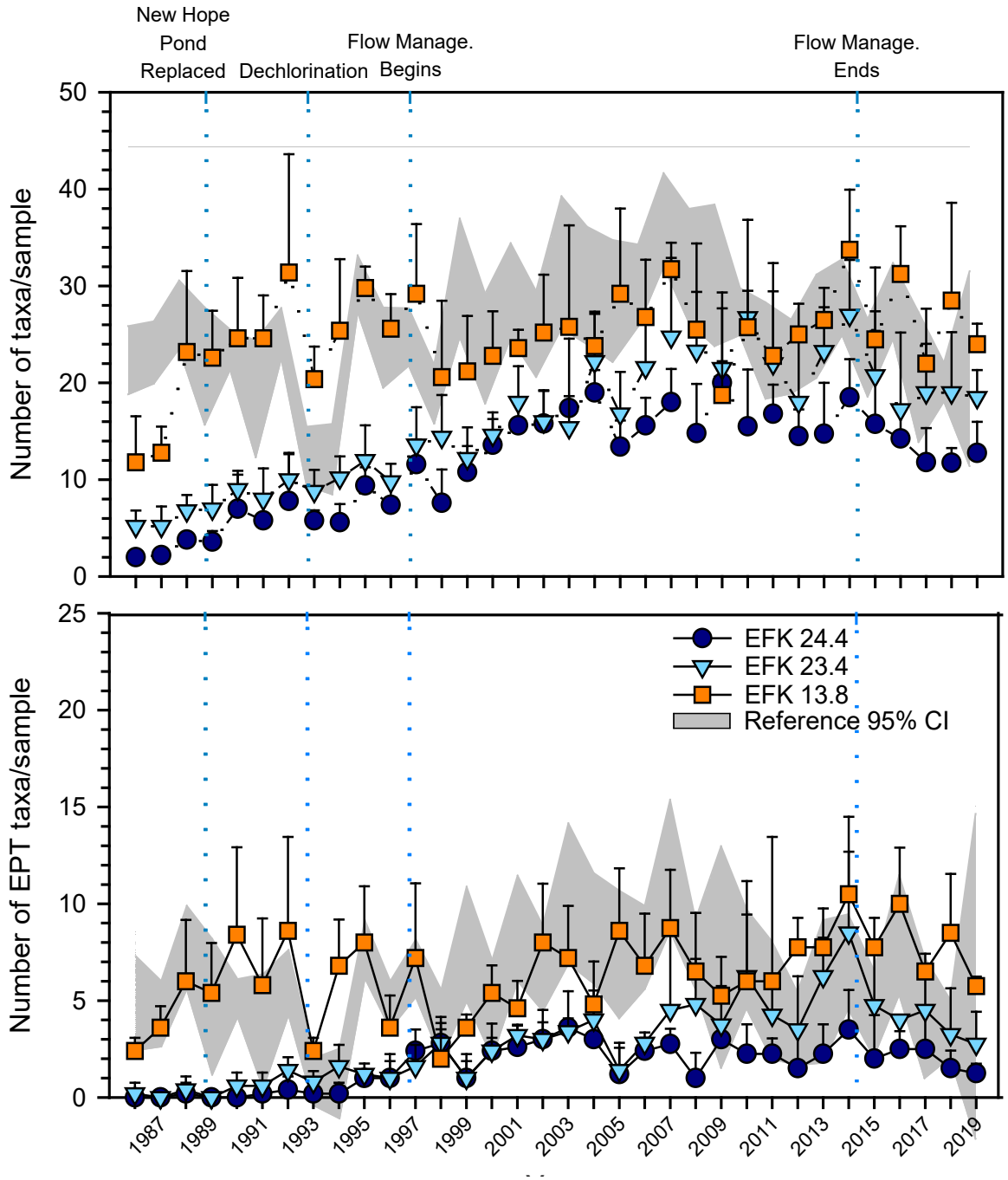
Acronym: PCB = polychlorinated biphenyl

Figure 4.24. Annual mean concentrations of polychlorinated biphenyls in rock bass muscle fillets at East Fork Poplar Creek kilometer 23.4, Fiscal Year 2019

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 U.S. 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 2019 at three sites in EFPC and at two reference streams (Brushy Fork and Hinds Creek). There have been long-term changes in the macroinvertebrate community at EFPC sites since the start of monitoring (1986) (Figure 4.25).



NOTE: (top) total taxonomic richness (mean number of taxa per sample plus 95 percent confidence interval), and (bottom) taxonomic richness of the pollution-intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera (mean number of Ephemeroptera, Plecoptera, and Trichoptera taxa per sample plus 95 percent confidence interval), April, 1986–2019. The timing of various activities within the watershed is shown in vertical blue lines.

Acronym: EFK = East Fork Poplar Creek kilometer; EPT = Ephemeroptera, Plecoptera, and Trichoptera

Figure 4.25. Benthic macroinvertebrate communities in three sites along East Fork Poplar Creek and the 95 percent confidence interval for two nearby reference streams (Brushy Fork and Hinds Creek)

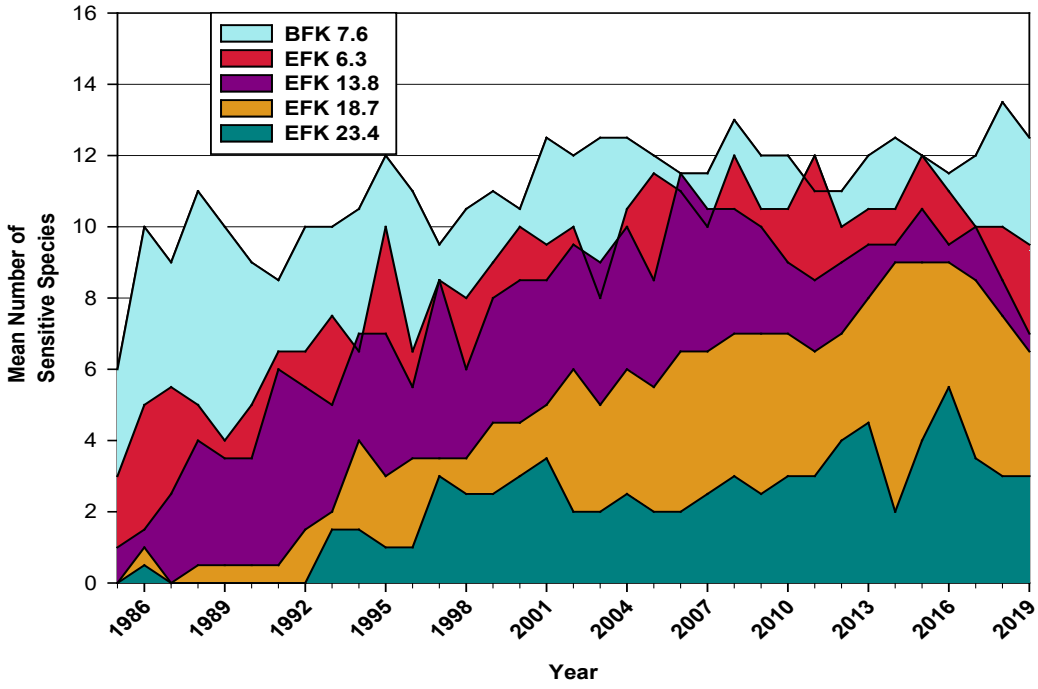
Total taxa richness (number of taxa/sample) increased at EFK 24.4 from 1986 until the mid 2000s, and then remained steady for approximately 14 years (Figure 4.25). After flow management ended in 2014, total taxa richness decreased at EFK 24.4 and has remained at these lower values since that time. Total taxa richness at EFK 23.4 steadily increased since monitoring began, and values also decreased after flow management ceased (Figure 4.25). Total taxa richness at EFK 13.8 and the reference sites have been fairly consistent over the entire monitoring period, except for lower total taxa richness values during the first two monitoring years at EFK 13.8 (Figure 4.25). Total taxa richness at EFK 24.4 has consistently been lower than reference sites throughout the monitoring period, while total taxa richness at EFK 13.8 has almost always been within or above the 95-percent confidence interval (CI) of reference site values (Figure 4.25). Total taxa richness at EFK 23.4 was lower than the 95-percent CI of the reference sites from 1986 to 2009 but since then, richness has mostly been within the 95-percent CI of the reference sites (Figure 4.25).

Temporal patterns in the number of pollution-intolerant taxa (Ephemeroptera, Plecoptera, and Trichoptera [EPT] taxa richness) were similar to those observed for total taxa richness (Figure 4.25). EPT taxa richness at EFK 24.4 was very low (less than 1 EPT taxa/sample) from 1986 until 1994 (Figure 4.25). EPT taxa richness then increased slightly (greater than 1 but less than 5 taxa/sample) until 2014. EPT taxa richness has been slightly lower since 2014 compared to values in previous years (Figure 4.25). EPT richness at EFK 23.4 has steadily increased since 1986, but decreased after flow management ended (Figure 4.25). EPT taxa richness at EFKs 24.4 and 23.4 have typically been lower than the 95-percent CI of EPT taxa richness at reference streams, indicative of degraded conditions. However, EPT taxa richness at EFK 23.4 has been within the lower bounds of the 95-percent CI of reference streams within the past decade, suggesting some improvement in site conditions. The number of pollution-intolerant taxa at EFK 13.8 has continued to exceed the upper bound of the reference site confidence limits since 2012 (except for the most recent year; 2019) (Figure 4.25).

The implications of ending flow management in 2014 on invertebrate communities in EFPC are still uncertain. After flow augmentation ceased, EPT taxa richness at EFK 23.4 has consistently declined (Figure 4.25). EPT taxa richness at EFK 24.4 has also shown a slight decrease since flow augmentation ended; a more substantial decrease was observed in total taxa richness (Figure 4.25). 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.

4.5.8.3 Fish Community Monitoring

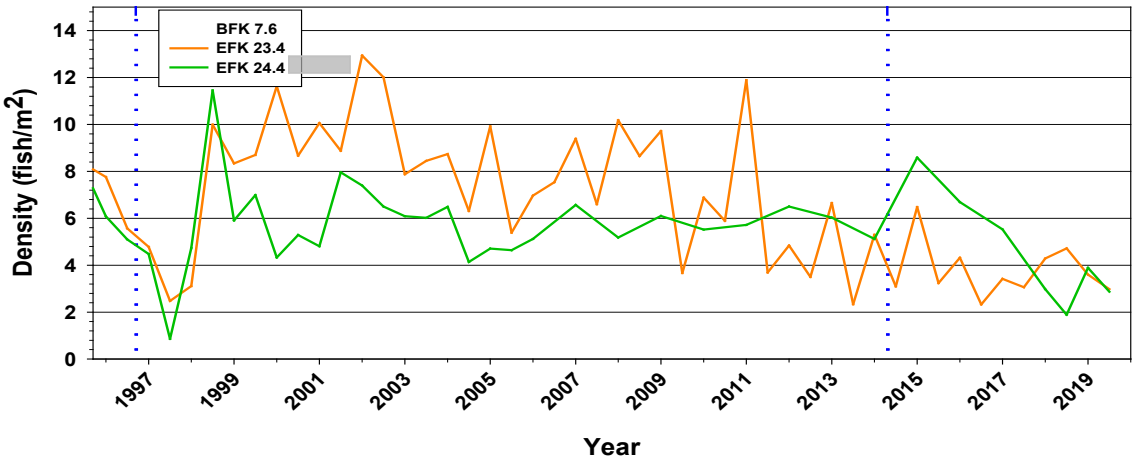
Fish communities were monitored in the spring and fall of 2019 at six sites along EFPC and at a comparable local reference stream (Brushy Fork). In the past three decades, overall species richness, density, biomass, and number of pollution-sensitive fish species improved at all sampling locations below Lake Reality. Some seasonal conditions, such as flooding and drought, can cause minor fluctuations in values but rarely cause long-term impacts on larger systems such as EFPC. However, 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 4.26, 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).



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

Figure 4.26. Comparison of mean sensitive species richness (number of species) collected each year (1985–2019) from four sites in East Fork Poplar Creek and a reference site (Brushy Fork)

Fish communities in Upper EFPC in 2019 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 4.27). 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.



Acronyms: 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 4.27. Fish density (number of fish per square meter) for two sites in Upper East Fork Poplar Creek and a reference site (Brushy Fork), 1996–2019

The fish communities in Upper EFPC were impacted in 2019 by one incident that resulted in a fish kill. On October 14, 2019, a chlorine spike at Outfall 200 occurred and seven dead fish were collected just downstream. No further fish kills occurred in 2019.

A larger fish kill incident in 2018 resulted in the need for additional monitoring of the communities in Upper EFPC. Fish community surveys were conducted in fall (August) 2018 and again in spring and fall of 2019 to assess the potential impact of the fish kill and current status of the communities. These surveys initially indicated that the fish community in Upper EFPC (EFK 25.1 and EFK 24.4) was considerably lower than in spring 2018. However, spring 2019 samples were within the expected variability of this community as observed since flow augmentation was turned off in 2014. There is little evidence that either of these events will have long-term impacts on the community. Future monitoring of these sites will provide additional insight into the condition of these fish communities and any unforeseen impacts.

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.

The five remediated wetlands had the hydrologic, vegetative, and soil characteristics to be considered wetlands in 2019. The wetlands have responded as intended, only requiring minimal alterations in two of the wetlands. Data from Wetlands 1 and 7 had been showing a trend of decreasing plant coverage as water levels increased. To remedy this, 1500 plants representing a dozen species were planted into Wetlands 1 and 7 in 2019. In addition, a clogged gabion structure was removed from Wetland 1, and a temporary pond leveler was placed in the beaver dam in Wetland 7. These actions successfully lowered water levels by approximately 2 ft, helping the new planting survive and allowing for natural revegetation in the wetlands.

The monitoring conducted in 2019 marks the end of wetland monitoring for this project. One wetland remains to be created in the future. Overall, the wetland mitigation sites are successful and have shown remarkable increases in wetland plant coverage and diversity over the years. 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 the following years' 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. There are 160 known or potential sources of contamination identified in the FFA for the Y-12 National Security Complex (DOE 2020a). 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 4.28 depicts the major areas for which groundwater monitoring is performed.

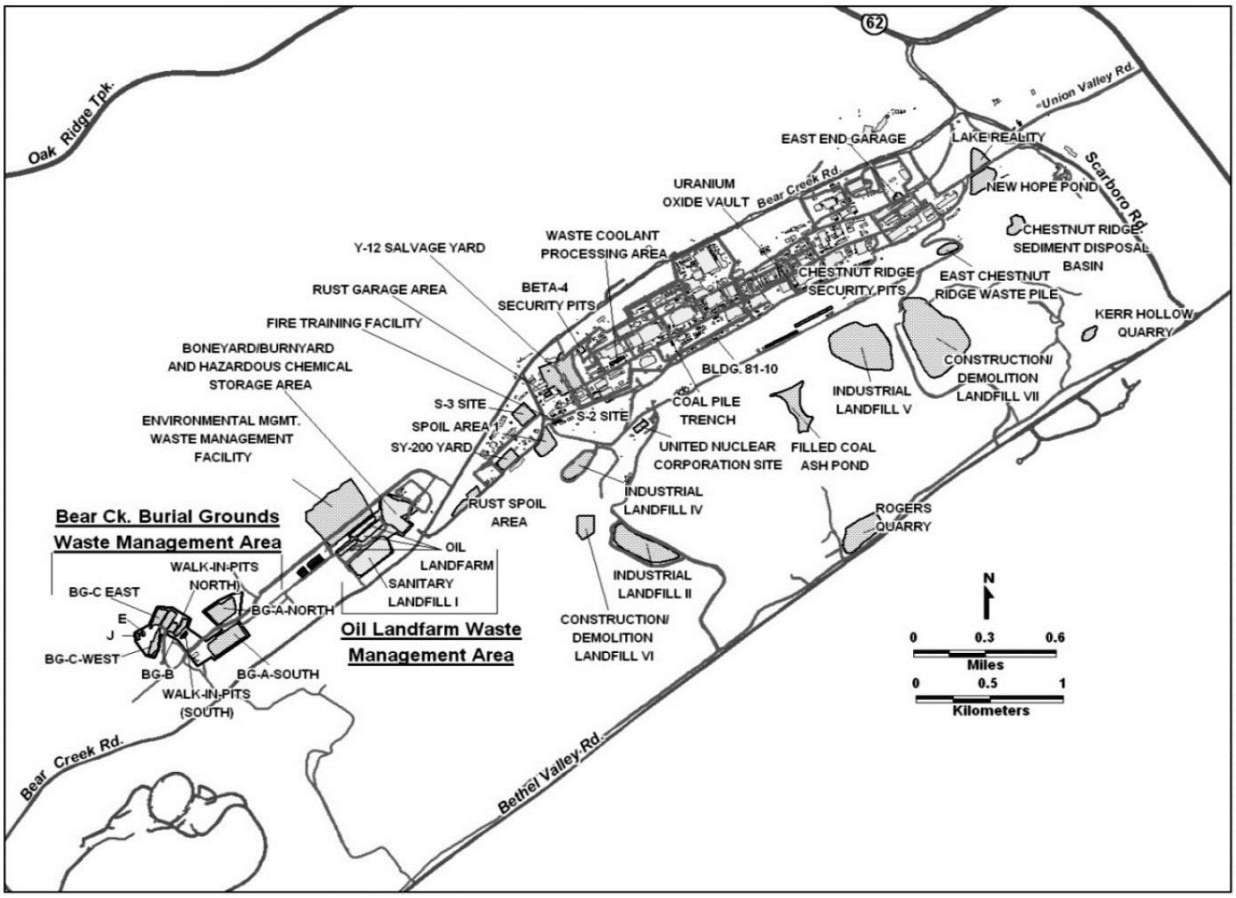
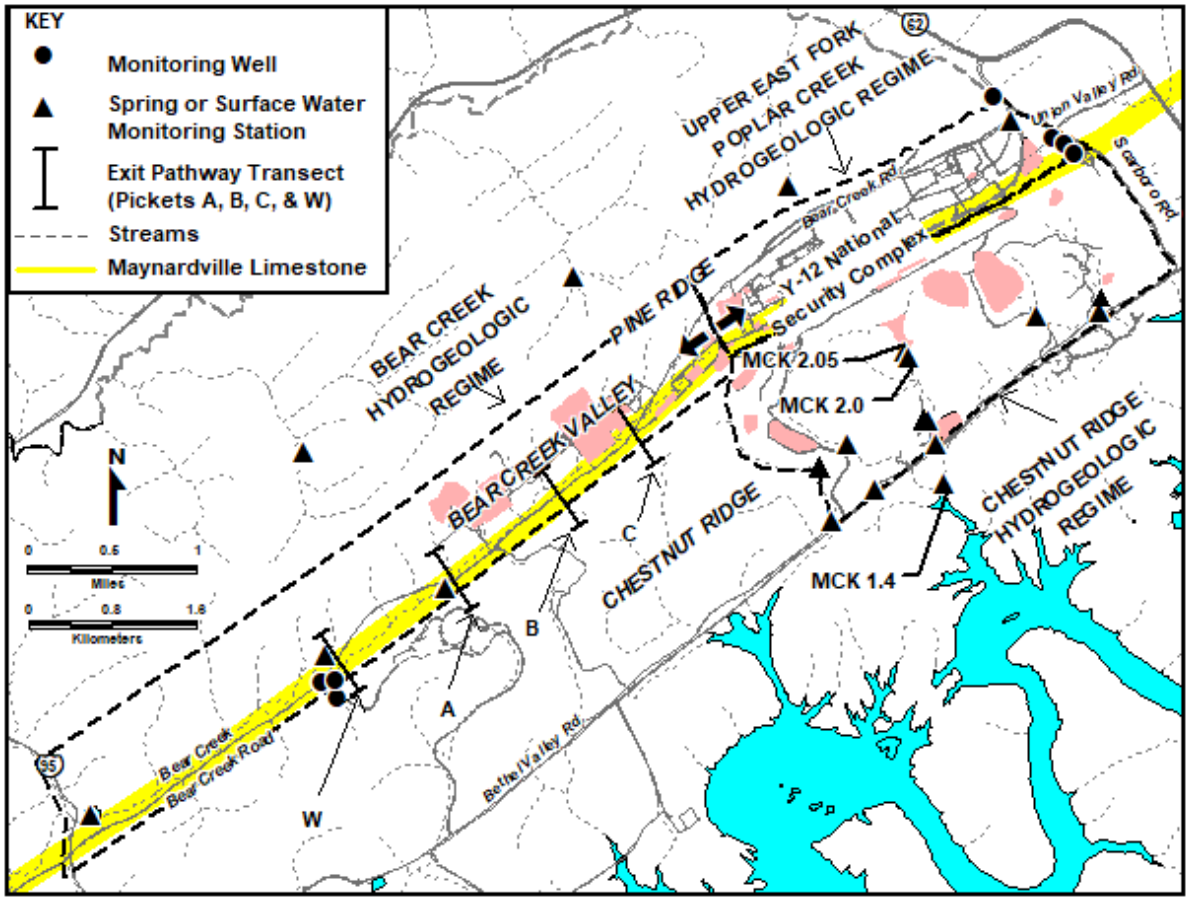


Figure 4.28. Known or potential contaminant sources for which groundwater monitoring is performed at the Y-12 National Security Complex

4.6.1 Hydrogeologic Setting

Y-12 is divided into three hydrogeologic regimes (Bear Creek, Upper EFPC, and Chestnut Ridge) (Figure 4.29). 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.



Acronyms: MCK = McCoy Branch kilometer

Figure 4.29. Hydrogeologic regimes; flow directions; and perimeter/exit pathway wells, springs, and surface water monitoring stations, and the position of the Maynardville Limestone in Bear Creek Valley at the Y-12 National Security Complex

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 4.30). 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. The groundwater sampling technician shown in Figure 4.31 is taking water quality samples from a well on the northern flank of Chestnut Ridge with the heart of the Y-12 industrial plant in Bear Creek Valley in the background below and the crest of Pine Ridge at the top of the photograph. (View direction is to the northwest.)

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 4.29). 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).

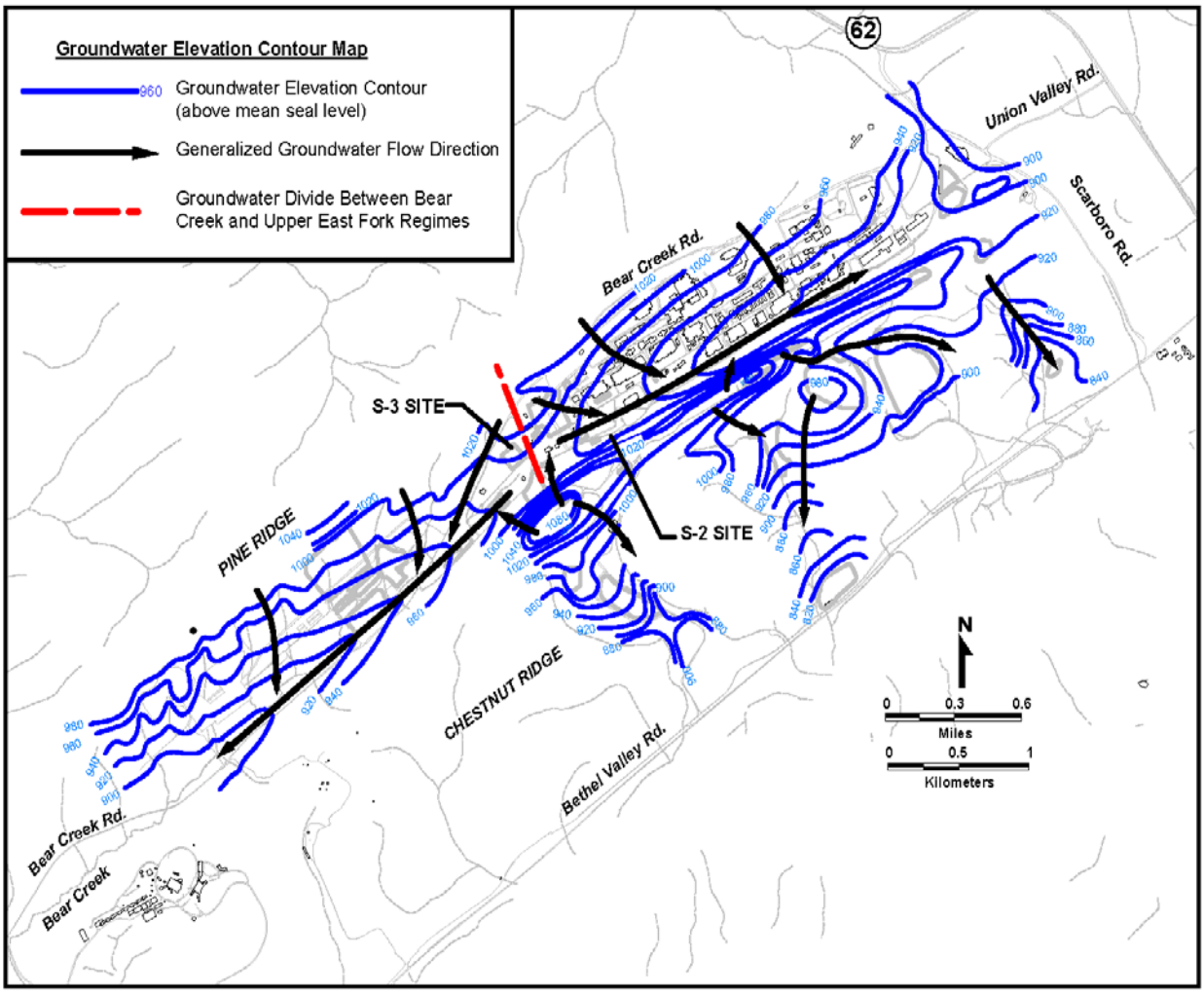


Figure 4.30. Groundwater elevation contours and flow directions at the Y-12 National Security Complex

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 Y-12's industrial area. 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. VOCs (e.g., petroleum products, coolants, and solvents) in groundwater within the fractured bedrock of the aquitard units 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 aquifer. Discharge points for intermediate and deep flow are not well known. However, 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

No wells were installed and no wells were plugged and abandoned in CY 2019.

4.6.3 Calendar Year 2019 Groundwater Monitoring

Groundwater monitoring in CY 2019 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 183 wells and 50 surface water locations and springs (Table 4.19). (Locations sampled for research projects [not compliance requirements] are shown in column D of Table 4.19 and are not included in the totals in the previous sentence.) Specific wells of interest based on the CY 2019 data are called out later in this section. However, Figure 4.29 shows the locations of perimeter/exit pathway stations that are monitored closely because they are the locations closest to the reservation boundaries.

Water quality results of groundwater monitoring activities in CY 2019 are presented in the *Calendar Year 2019 Groundwater Monitoring Report* (CNS 2020).

Monitoring efforts performed specifically for CERCLA baseline and remediation evaluation are published in the FY 2019 and FY 2020 Water Resources Restoration Program Sampling and Analysis Plans (UCOR 2018, 2019, respectively) and the Annual CERCLA Remediation Effectiveness Reports (DOE 2019, 2020b).

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

Figure 4.31. Groundwater monitoring well sampling at the Y-12 National Security Complex

Table 4.19. Summary of groundwater monitoring at the Y-12 National Security Complex, 2019

	Purpose for which monitoring was performed				
	Restoration[a]	Waste management[b]	Surveillance[c]	Other[d]	Total
Number of active wells	50	33	100	36	219
Number of other monitoring stations (e.g., springs, seeps, and surface water)	29	6	15	3	53
Number of samples taken[e]	166	116	122	9,044	9,448
Number of analyses performed	8,348	8,845	10,017	70,005	97,215
Percentage of analyses that are non- detects	65.5	84.8	81.4	16.6	33.7
Ranges of results for positive detections, VOCs (µg/L)[f]					
Chloroethenes	0.19-2,600	0.39-17.6	1–37,000	NA	
Chloroethanes	0.22–250	0.71-81.7	1–1,500	NA	
Chloromethanes	0.3–1,500	ND	1–660	NA	
Petroleum hydrocarbons	0.35–4,700	ND	1–840	NA	
Uranium (mg/L)	0.00011–0.51	0.000101–0.0371	0.000513–0.226	0.00261–2323.5	
		0.00392	0.397	1.71555	
Nitrates (mg/L)	0.0043–470	0.783–1.4	0.0502–10,200	3.81–119.1	
Ranges of results for positive detections, radiological parameters (pCi/L)[g]					
Gross-alpha activity	2.87–302	1.15–5.77	5.1–86	NA	
Gross-beta activity	3.13–44.8	2.68–14.1	11-780	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 = 3.7×10^{-2} Bq

Acronyms:
Bq = becquerel
NA = not analyzed
ND = not detected
pCi/L = picocuries per liter
VOC = volatile organic compound

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 4.28 were provided in previous year ASERs (e.g., for CY17 and before) 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 2019 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 4.32 through 4.35) 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.

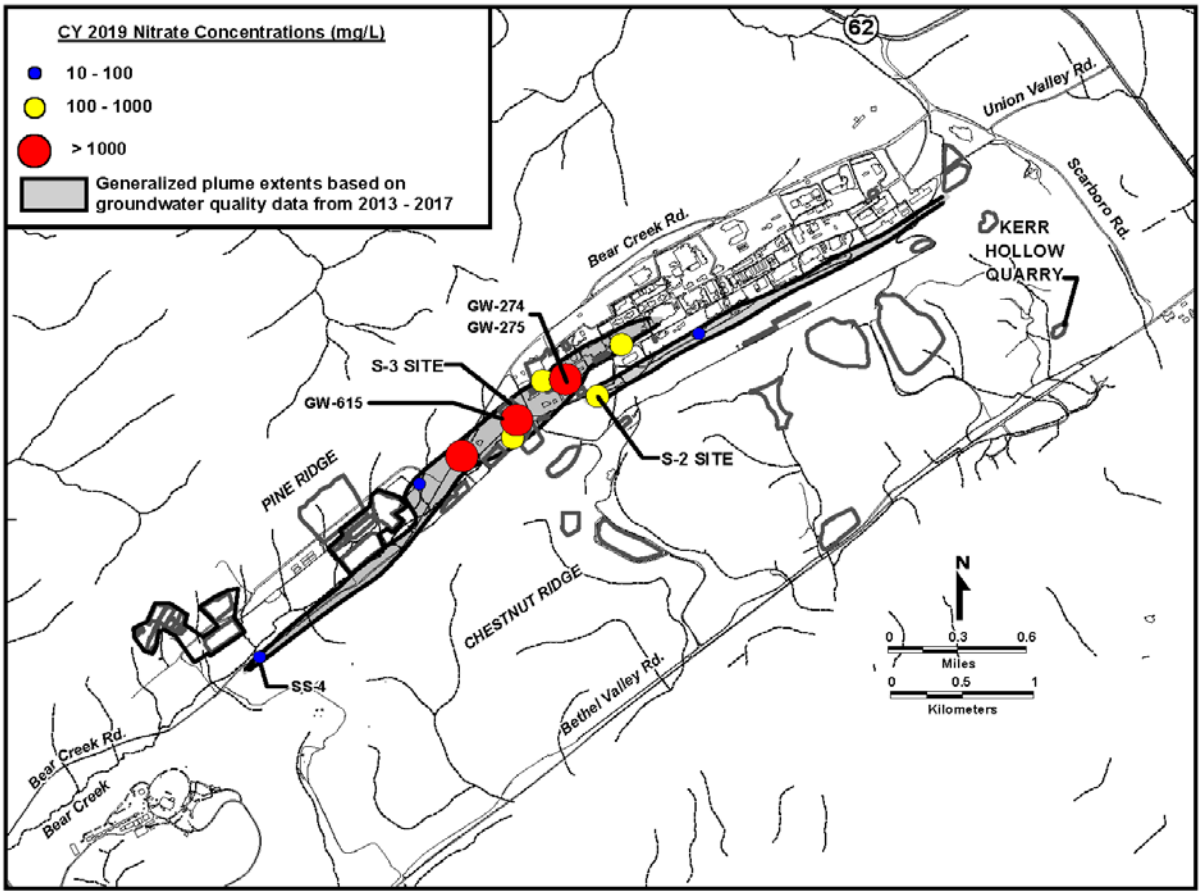
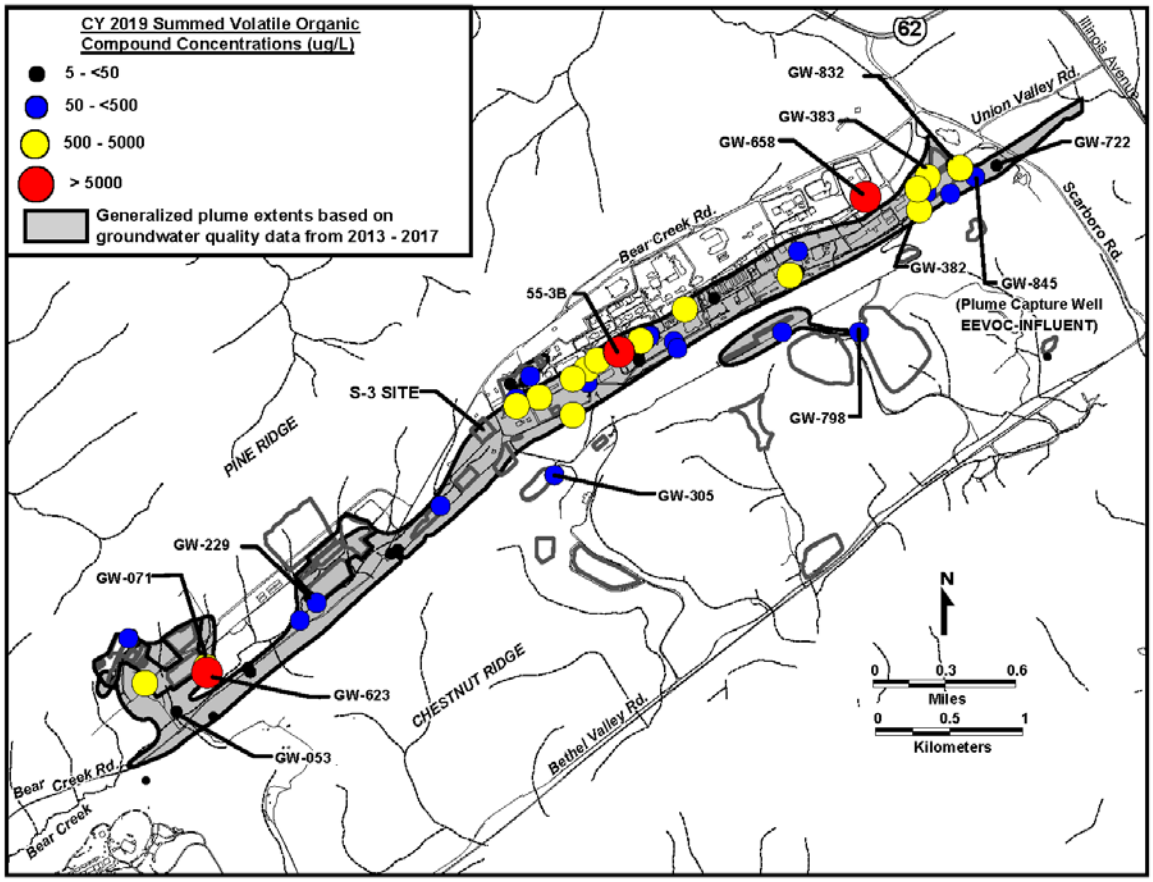


Figure 4.32. Nitrate in groundwater at the Y-12 National Security Complex, 2019

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 4.32 through 4.35) represent CY 2019 monitoring results for the Upper EFPC regime (discussed in this section), the Bear Creek regime (discussed in Section 4.6.4.2), and the Chestnut Ridge regime (discussed in Section 4.6.4.2).



Acronym: EEVOC = east end volatile organic compound

Figure 4.33. Summed volatile organic compounds in groundwater at the Y-12 National Security Complex, 2019

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 2019, there was a maximum nitrate concentration of 9,200 mg/L in well GW-275. This well, which also showed the maximum concentration in CY 2018 (9,250 mg/L), 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 4.32). The next highest nitrate concentration was found in GW-274 at 535 mg/L. This well is near GW-275, but is screened at 31 ft bgs. The complex nature of the subsurface in Bear Creek Valley is represented by the fact that over the last two decades the deeper well (GW-275) has shown an increasing trend (from ~7,000 mg/L to ~9,000 mg/L), while the nearby shallow well (GW-274) has a decreasing trend (from ~5,500 mg/L to ~500 mg/L).

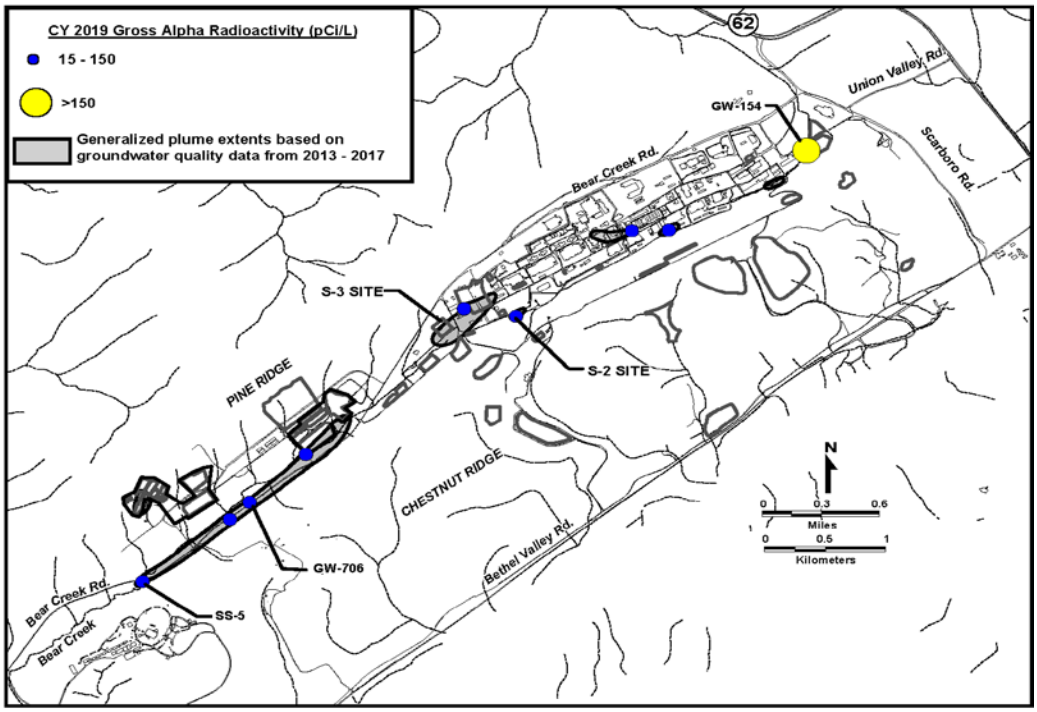


Figure 4.34. Gross-alpha activity in groundwater at the Y-12 National Security Complex, 2019

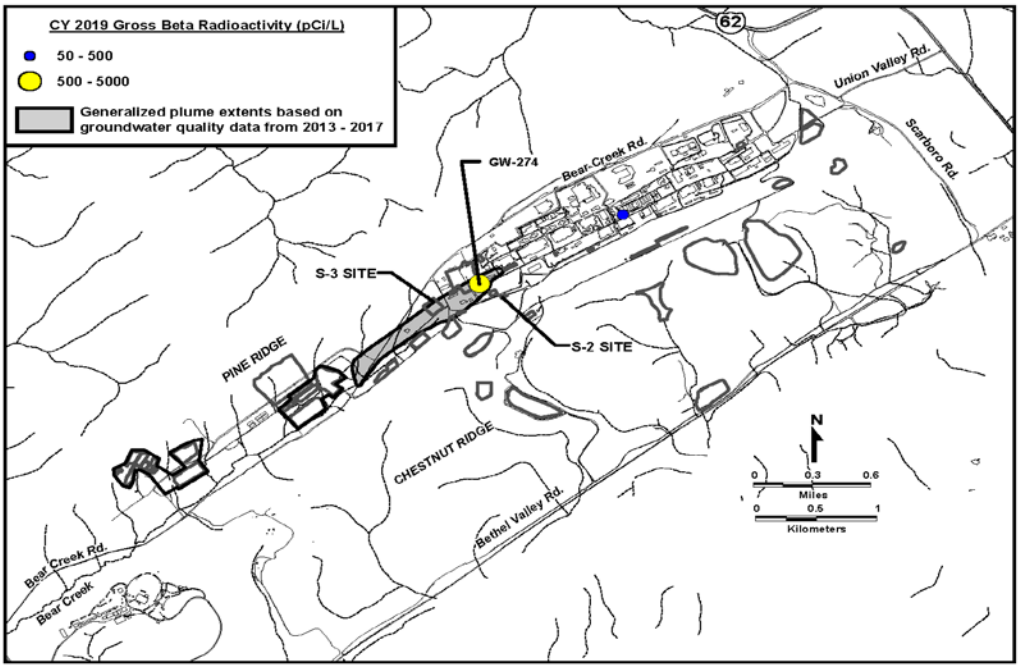


Figure 4.35. Gross-beta activity in groundwater at the Y-12 National Security Complex, 2019

Trace Metals

In CY 2019, antimony, barium, beryllium, cadmium, chromium, copper, nickel, thallium, and uranium exceeded primary drinking water standards in groundwater samples across the Upper EFPC regime, but

for uranium predominately at and downgradient of the S-2, S-3, and NHP 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)

VOCs are the most widespread contaminants in the Upper EFPC regime. VOC contaminants in the regime primarily consist of chlorinated and petroleum hydrocarbons. In CY 2019, the highest summed concentration of dissolved chlorinated hydrocarbons (44,103 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 (11,360 µg/L) was, again, from well GW-658 at the closed East End Garage; however the concentration was ~5,000 µg/L lower than that measured in CY 2018.

Most monitoring results are consistent with data from the previous years because a dissolved plume of legacy VOCs in the bedrock zone extends eastward from the S-3 site over the entire length of the regime (Figure 4.33). 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 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. While data from most of the monitoring wells have remained relatively constant since the late 80s/early 90s, some wells show encouraging trends in recovery from legacy contamination. In Figure 4.36 note that GW-382 (the shallow well) has remained constant for summed VOCs for 28 years, but the adjacent GW-383 (screened at 250 ft bgs) has shown a marked decrease in summed VOCs for most of that same time. These 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. However, in addition to the factors mentioned above, in October 2000, plume capture well GW-845 began pumping operations to capture the east end VOC plume, thus mitigating migration off ORR into Union Valley (see additional information in the Exit Pathway and Perimeter Monitoring section below).

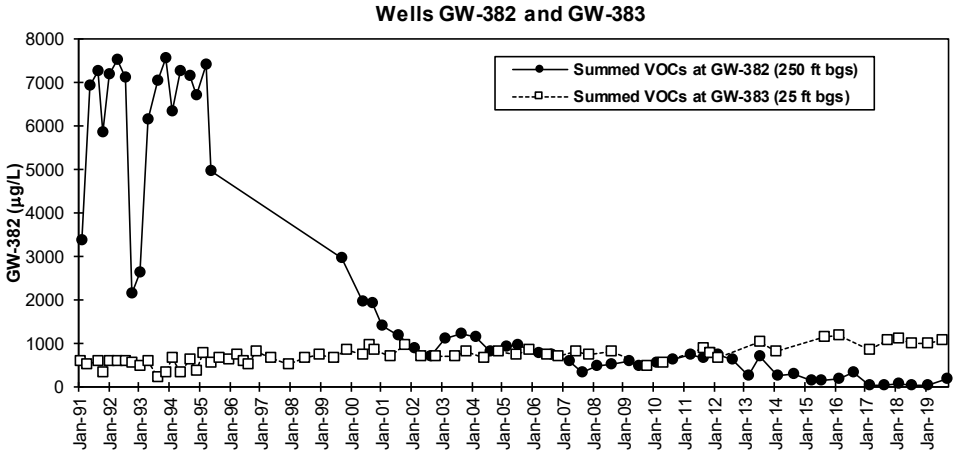


Figure 4.36. Summed volatile organic compounds for GW-382 and GW-383 in the East Fork Regime

Alternatively, increasing trends have been observed in wells associated with the Rust Garage, and S-3 site; some legacy sources at production/process facilities in central areas; and even the east end VOC plume. See Figure 4.37. These trends near the east end VOC plume show that contaminants in wells located perpendicular to strike/across lithologic units from the plume capture system installed in GW-845 may be mobilized by the system. However, no downgradient detection of these compounds is apparent; therefore, migration is limited.

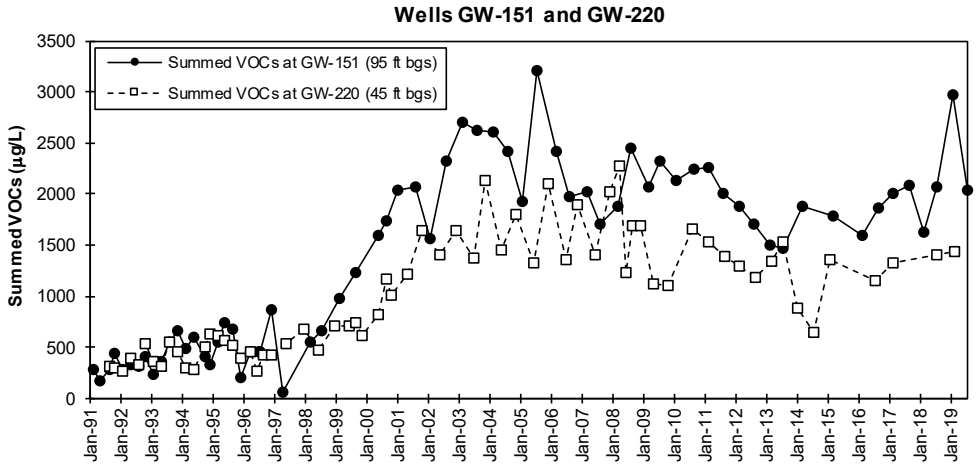


Figure 4.37. Summed volatile organic compounds for GW-151 and GW-220 in the East Fork Regime

Radionuclides

The primary alpha-emitting radionuclides found in the Upper EFPC regime during CY 2019 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 2019, the maximum occurrence of gross-alpha activity in groundwater in the Upper EFPC regime was 302 pCi/L, again at well GW-154 near the former oil skimmer basin.

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 2019 from well GW-274 (780 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 in 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 well GW-845 (shown on Figure 4.33) and began continuous operation in October 2000. 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. The effectiveness of this system is reported annually in Remediation Effectiveness Reports published by DOE-EM (DOE 2019, DOE 2020b).

As explained in the previous section for GW-382 and GW-383, monitoring wells near the plume capture system continue to show an encouraging response. Another example can be observed in the Westbay system installed in well GW-722 downgradient of the system. This multiport well permits sampling of several vertically discrete zones within the Maynardville Limestone. Monitoring results from well GW-722 indicate reductions in VOCs due to the plume capture system from summed VOC levels above 1,000 µg/L before the treatment system was installed to below 50 µg/L in CY 2019.

Five zones in well GW-722 were sampled in CY 2019, with four of the five zones showing summed VOCs greater than 5 µg/L. Only four zones exceeded individual drinking water standards (from carbon tetrachloride and PCE, the highest of which was 33 µg/L of carbon tetrachloride and 7.1 µg/L of PCE, both at zone 20 at a depth of 333 ft bgs).

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 2019, the observed concentrations of VOCs at the New Hope Pond distribution channel underdrain remained low (26.9 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 this exit pathway. One well was monitored in CY 2019, and the only detection was a gross alpha activity (6.7 +/- 4 pCi/L) which is less than the drinking water standard.

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 ORR into those communities.

Union Valley Monitoring

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

In CY 2019, monitoring of locations in Union Valley continued, showing overall decreasing or low concentration stable trends. Vinyl chloride at 1.5 µg/L (below the maximum contaminant level of 2 mg/L) was detected at monitoring well GW-230, located east of Illinois Avenue in the University of Tennessee Arboretum (off the map and approximately 3,500 ft east of the ORR boundary). A groundwater flow divide west of well GW-230, coincident with Scarboro Creek, Illinois Ave, and a gap in Chestnut Ridge, probably restricts transport of VOCs from ORR further east (MMES 1995). This would indicate that the VOCs observed in the well are from a source other than Y-12.

Under the terms of an Interim ROD, administrative controls such as restrictions on potential future groundwater use have been established and maintained. Additionally, the previously discussed plume

capture system (well GW-845) was installed to mitigate the migration of groundwater contaminated with VOCs into Union Valley (DOE 1997b).

In July 2006, the Agency for Toxic Substances and Diseases Registry, the principal federal public health agency charged with evaluating the human health effects of exposure to hazardous substances in the environment, published a report in which groundwater contamination across ORR was evaluated (ATSDR 2006). In the report, it was acknowledged that groundwater contamination exists throughout ORR, but the authors concluded that there is no public health hazard from exposure to contaminated groundwater originating on 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 4.28 were provided in previous year ASERs (e.g., in CY 2017 and previous) 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 in groundwater 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).

The plumes in the Bear Creek regime (shown by gray shading on Figures 4.32 through 4.35) represent the average concentrations and radioactivity between CYs 2013 and 2017. The circular icons presented on the figures represent CY 2019 monitoring results.

Nitrate

CY 2019 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 (10,200 mg/L) was observed at well GW-615 adjacent to the S-3 site at a depth of 75m (245 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 2019 (and 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, both years). However, encouraging trends in both nitrate and gross beta contamination are evident in the aquitard (the Nolichucky Formation) approximately 910 m (2,985 ft) west of the S-3 Site (see Figure 4.38).

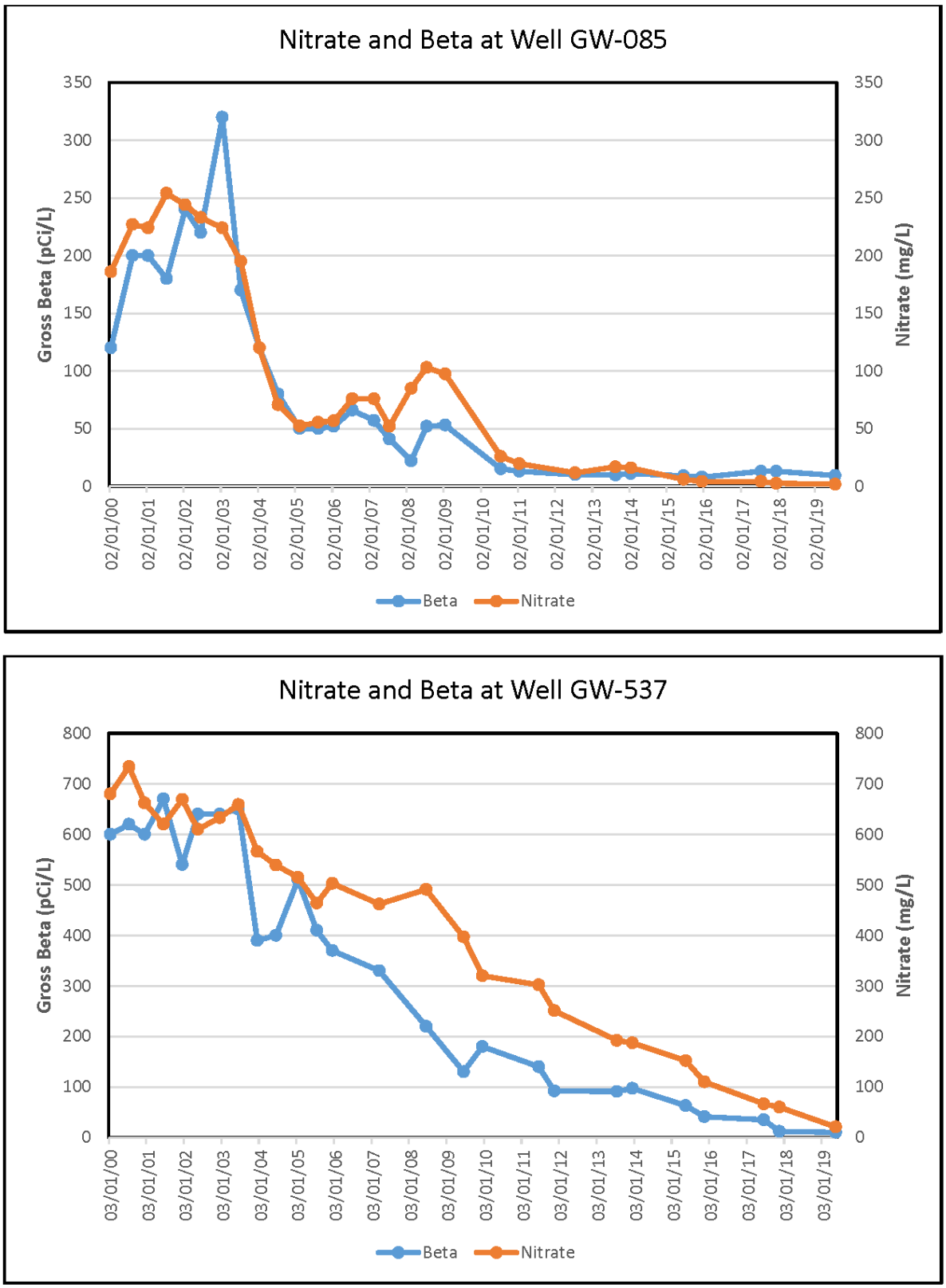


Figure 4.38. Nitrate and gross-beta trends for GW-085 and GW-537 in the Bear Creek Regime

Trace Metals

During CY 2019, antimony, arsenic, barium, chromium, 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. 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. In other areas of 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.

The most prevalent trace metal contaminant is uranium. 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.

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	2015–2019
BCK-11.84 to 11.97 (approximately 0.5 miles downstream)	Nitrate	116	65.7	89.5	43.3	53.3	29.4
	Uranium	0.203	0.112	0.129	0.112	0.172	0.199
BCK-09.20 to 09.47 (approximately 2 miles downstream)	Nitrate	16.1	7.8	12.1	8.4	4.4	5.1
	Uranium	0.098	0.093	0.135	0.060	0.051	0.070
BCK-04.55 (approximately 5 miles downstream)	Nitrate	4.7	2.3	3.5	1.1	0.8	1.12
	Uranium	0.034	0.030	0.033	0.020	0.016	0.020

[a] Excludes results that do not meet data quality objectives.

Acronym:
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. VOCs that occur in groundwater of the fractured bedrock aquitard units are found within about 305 m (1,000 ft) laterally of source areas.

The highest concentration observed in CY 2019 occurred in the Nolichucky Shale aquitard at the Bear Creek Burial Ground waste management area, with a maximum summed VOC concentration of 8,342 µg/L in well GW-623 (Figure 4.33; TCE at 4,400 µg/L, PCE at 1,900 µg/L, and 1,1-dichloroethane at 1,500 µg/L comprised most of the summed total.

Near contaminant source areas, such as the Bear Creek Burial Grounds waste management area, 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-053 and GW-071 (Figure 4.39).

Increasing trends of VOCs have been seen in GW-229 downgradient of the Oil Landfarm waste management area (Figure 4.40). However, the most recent data show levels of VOCs are decreasing.

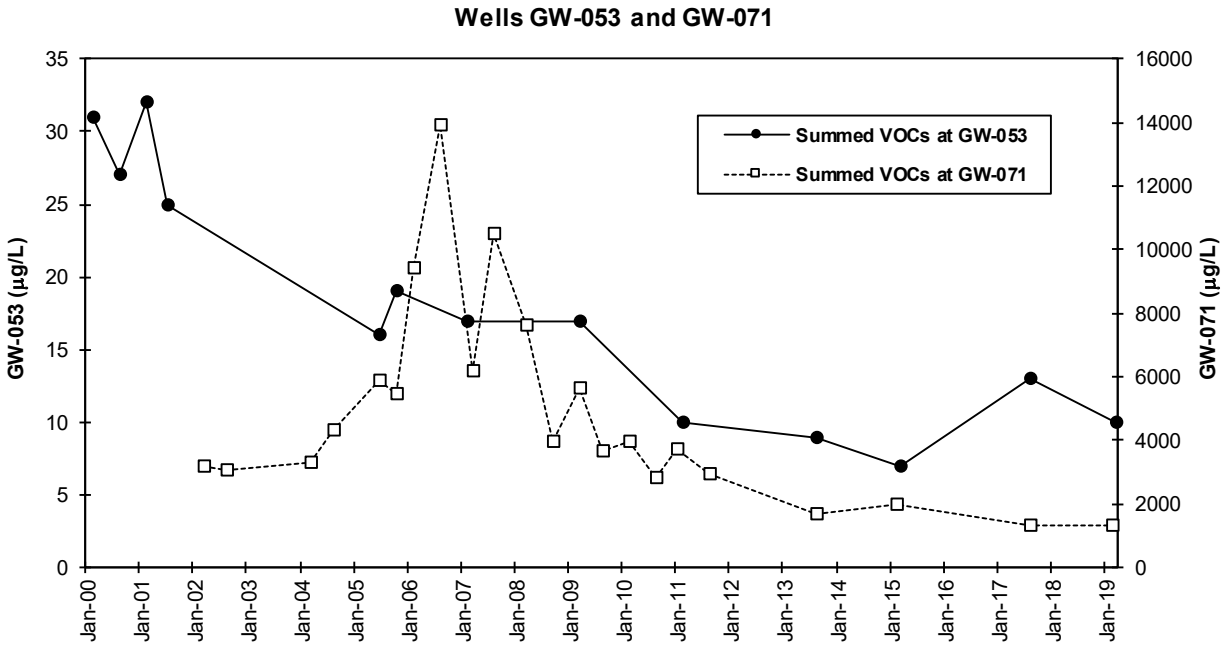


Figure 4.39. Volatile organic compounds in wells GW-053 and GW-046-71 at the Bear Creek Burial Grounds, 2019

In CY 2019, wells at exit pathway transect W (Figure 4.29) showed a trace concentration (0.54 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.

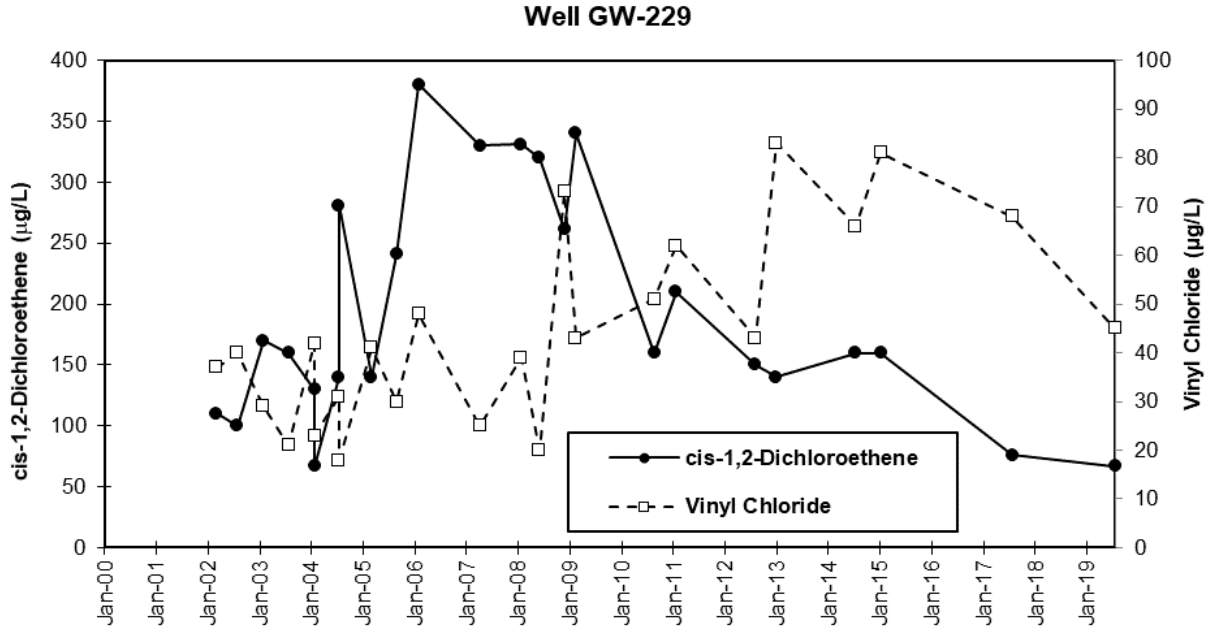


Figure 4.40. Volatile organic compounds in GW-229 at the Oil Landfarm, 2019

Radionuclides

As in the EFPC regime, the primary radionuclides identified in the Bear Creek regime are isotopes of uranium and ^{99}Tc. The extent of radionuclides in groundwater in the Bear Creek regime during CY 2019 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 4.34).

Exit pathway monitoring stations sampled in CY 2019 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, 17 pCi/L). In CY 2019 the highest gross-alpha activity observed in a monitoring well in the Bear Creek Regime (24.6 pCi/L) was in GW-706 Transect B (Figure 4.34). No sampling locations in the Bear Creek regime exceeded the drinking water standard for gross-beta activity. Figure 4.38 shows the decreasing trend for gross beta at two wells in the Bear Creek regime.

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 4.29).

Exit pathway monitoring consists of continued monitoring at four well transects (pickets) and selected springs and surface water stations. Data obtained during CY 2019 indicate that groundwater is contaminated above drinking water standards in the Maynardville Limestone between Pickets A and C. Total antimony and radium alpha results from the two deepest (666 and 744 ft below ground surface, respectively) monitoring wells at Picket W have exceeded their respective drinking water standards. Considering the depths and the geochemistry of the groundwater, these elements are considered to be of natural origin rather than being attributable to man-made sources or wastes (DOE 2020b). Trends continue to be generally stable to decreasing (Figure 4.41).

Surface water samples collected in CY 2019 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).

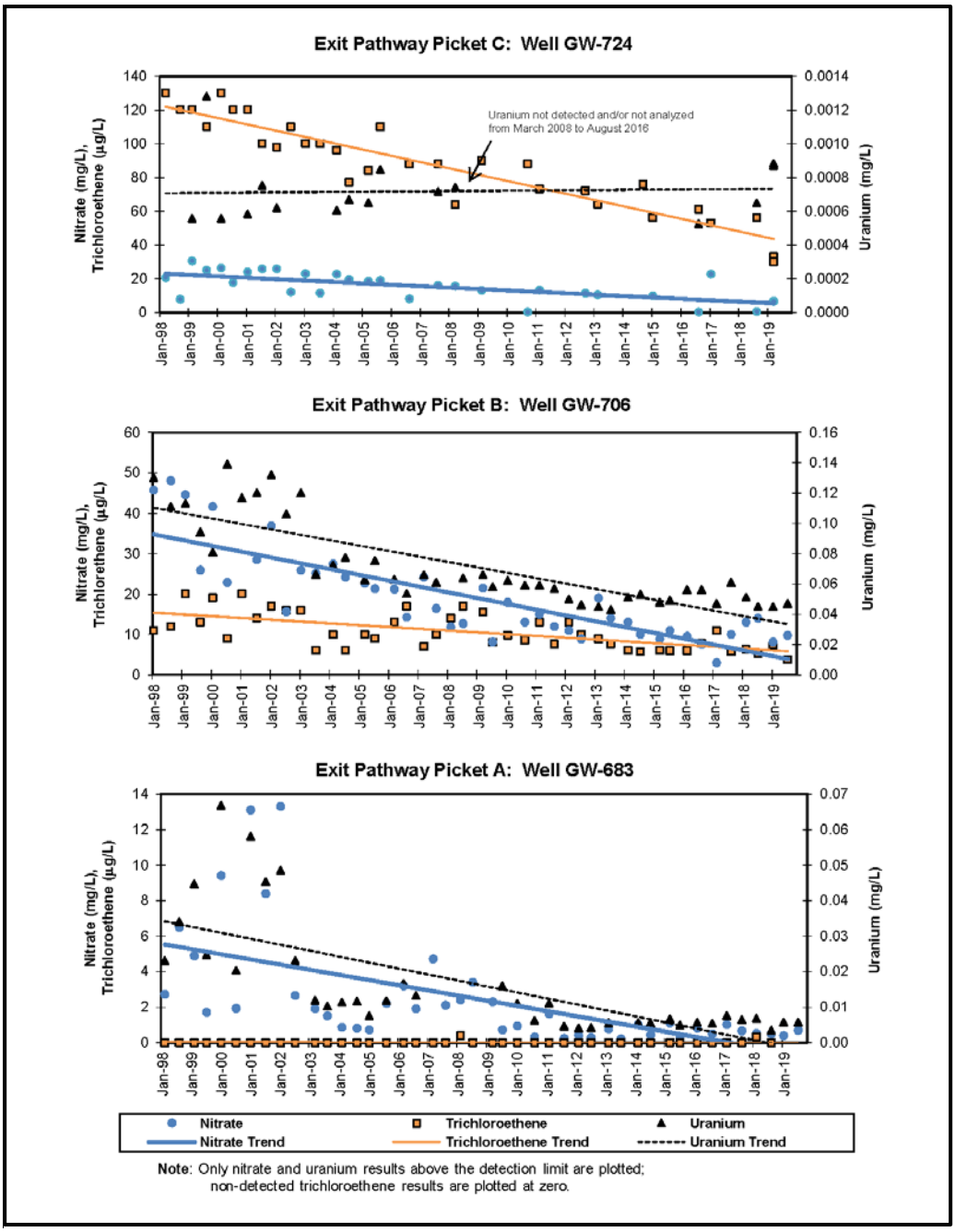


Figure 4.41. Calendar Year 2019 concentrations of selected contaminants in exit pathway monitoring wells in the Bear Creek hydrogeologic regime

4.6.4.3 Chestnut Ridge Hydrogeologic Regime

The Chestnut Ridge hydrogeologic regime is flanked to the north by Bear Creek Valley and to the south by Bethel Valley Road (Figure 4.29). 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 4.28 were provided in previous year ASERs (i.e., CY 2017 and previous) 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 shown minimal migration in any direction (<305 m [<1,000 ft]).

Data obtained during CY 2019 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 at 65.66 µg/L summed total VOCs; Figure 4.33) 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 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. However, as in CY 2018, no VOCs were detected at this spring in CY 2019.

The CRSP plume in the Chestnut Ridge regime (shown by gray shading on Figure 4.33) represents the average VOC concentrations between CYs 2013 and 2017. The circular icons presented on the figure represent CY 2019 monitoring results.

Nitrate

As in CY 2018, nitrate concentrations were below the drinking water standard at all monitoring stations in the Chestnut Ridge regime again in CY 2019.

Trace Metals

Concentrations of arsenic above drinking water standards have been observed in two surface water monitoring locations downstream from the Filled Coal Ash Pond, which is monitored under a CERCLA ROD (DOE 1996). Under the ROD, migration of contaminated effluent from the Filled Coal Ash Pond is being reduced by a constructed wetland area. In recent years it became apparent that the wetland efficiency was decreasing, in part, because of erosion channels forming around the wetland. During CY 2019 a significant maintenance activity was conducted at the site to improve the aquatic habitat for plant growth and to increase retention time for water within the wetland. (DOE 2020b). The elevated arsenic levels were detected both upgradient (McCoy Branch kilometer [MCK] 2.05) and downgradient (MCK 2.0) of this wetland area (Figure 4.29). In CY 2019 the passive wetland treatment area reduced dissolved arsenic by about 69 percent and total arsenic by 78%. 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 2019; arsenic was detected below drinking water standards at 0.0039 mg/L in both February and August. These results are below the drinking water standard of 0.010 mg/L and are about an order of magnitude below the MCK 2.0 and MCK 2.05 locations.

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 4.33) have been developing since CY 2000. The maximum summed VOC concentration observed at well GW-798 during CY 2019 was 65.66 µg/L. The VOCs detected in well GW-798 continue to be characteristic of the CRSP.

At Industrial Landfill IV, VOCs have been observed in the groundwater since 1992. Well GW-305, located immediately to the southeast of the facility (Figure 4.33), continues to exhibit increasing trends of summed VOCs with the CY 2019 concentration at 96.57 µg/L being the highest concentration in CR in CY 2019. Because samples from this well exceeded the drinking water standard for 1,1-DCE (7 µg/L), quarterly monitoring was initiated in CY 2015 to further evaluate the trend. In CY 2019 one sample at 8.15 µg/L for 1,1-DCE exceeded the drinking water standard. Quarterly sampling ended at this well in July 2019 and the well will be sampled semiannually beginning in 2020.

Radionuclides

In CY 2019, 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. Springs along Scarboro Creek are monitored for water quality, 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 2019, 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 2019. No contaminants at any of these monitoring stations were detected at levels above primary drinking water standards.

PFAS

No groundwater or surface water sampling activities were conducted in CY 2019 for per- and polyfluoroalkyl substances (PFAS); however, the following information has been obtained and the following actions have been taken in preparation to address these emerging contaminants of concern:

- Tracking or monitoring of current and historic usage of 172 PFAS or PFAS-related substances is being performed using the Y-12 Hazardous Material Information System (HMIS).
- Identification of potential PFAS sources at two waste storage buildings (9720-09 and 9720-58) which had Aqueous Film Forming Foam (AFFF) fire suppression systems installed in 1995. AFFF is a common source of PFAS contamination in soils, groundwater, and surface waters.
    - The AFFF system in building 9720-09 is currently operational and there have been three unintentional system activations resulting in a release of AFFF (2000, 2007, and 2008). The AFFF was contained within the building during the 2007 and 2008 events. It is unknown whether containment was achieved during the 2000 event.
    - In 2018 the AFFF system in Building 9720-58 was removed and replaced with a water-based dry pipe fire suppression system. In 1995 there was an unintentional system activation. It is unknown if the AFFF released during this activation was contained within the building.

- In addition to the buildings mentioned above with fire suppression systems, the Y-12 Plant has a fire department and fire training facility on site. The Y-12 Fire Department has one firetruck with a foam induction system for using AFFF. The AFFF used contains PFAS. AFFF is stored at the Fire training Facility (Building 9718-2) and at the West End Fire Hall (Bldg 2005) south of the S-3 Ponds parking lot. There are three known events where AFFF has been discharged by the Y-12 Fire Department since 2000. It is unknown if it has ever been used during training.
- No production related activities, equipment, or processes are known to have generated or released PFAS to the environment. However, a number of products/chemicals containing PFAS have been used in small quantities, primarily in the Analytical Chemistry Organization laboratories and in the Development Organization Facilities.
- Disposal of AFFF can be tracked through the Y-12 Waste Management Database, SAP-WASTE.
- Coordination between the DOE EM contractor's WRRP and Y-12 GWPP personnel. A tiered sampling approach is planned by the WRRP. Preliminary sampling at strategic locations may occur in CY 2020 and/or 2021.

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 2019b). 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 National Institute of Standards and Technology, 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 Order 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 2019 for water, soil, and air filter matrices for metals, organics, and radionuclides. The overall acceptability rating from both studies was greater than 98 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:

- Data have been accurately transcribed and recorded
- Appropriate procedures have been followed
- Electronic and hard copy data show one-to-one correspondence
- Data are consistent with expected trends.

Typically, routine data verification actions alone are sufficient to document the validity and accuracy of environmental reports. For restoration projects, routine verification activities are more contractually oriented and include checks for data completeness, consistency, and compliance with a predetermined standard or contract.

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

4.8 Environmental Management and Waste Management Activities

4.8.1 Environmental Management

4.8.1.1 Mercury Technology Development Activities

Mercury remediation is OREM's highest priority at Y-12 due to the large historical losses of the element in buildings, soils, and surface waters. Mercury contamination in the environment poses significant technical and regulatory challenges and can benefit from development of new tools and approaches that might be more effective, reduce costs, and accelerate cleanup schedules.

The importance of technology development was highlighted by Secretary of Energy Rick Perry and Undersecretary Paul Dabbar during a visit to Oak Ridge National Laboratory's Aquatic Ecology Laboratory on May 6, 2019. OREM is making significant investments into the development of new remediation technologies to help address the complex mercury challenge in Oak Ridge. In the near term, mercury technology development activities will support the successful completion of the demolition of Y-12's mercury-contaminated facilities and soils remediation, waste disposition, and reduction of mercury-related ecological risks in EFPC.

In the downstream environment, field characterization and research during the 2015–2020 time period will support an evaluation of potential remediation alternatives for the creek in the mid-2020s. Activities to modernize Oak Ridge National Laboratory's Aquatic Ecology Laboratory will allow for mesocosm testing of various remediation technologies, more closely simulating creek conditions in the laboratory. With a better understanding of mercury transport processes in the watershed system, specific technologies and strategies can be assessed and implemented to aid future cleanup. Quantitative modeling was initiated in FY 2018–2019 to simulate various remediation and technology development scenarios and better inform future remedial decision-making.

Studies have been conducted to evaluate alternative treatment chemicals on mercury flux, the effect of sorbents on mercury and methylmercury concentrations in the presence of dissolved organic matter, and the use of mussels as a tool for reducing particle-associated mercury in the water column. Oak Ridge National Laboratory scientists have prepared a report titled "Mercury Remediation Technology Development for Lower EFPC—FY 2019 Update," which provides a detailed description of each of the study areas and findings from studies performed in FY 2019.

4.8.1.2 Mercury Removed from COLEX

At the Alpha-4 building, workers removed more than a ton of mercury from the building's east Column Exchange (COLEX) equipment. Combined with the mercury previously removed from the West COLEX equipment, more than 4.6 tons of mercury have been removed.

The four-story, 500,000-ft^2 Alpha-4 facility was used for uranium separation from 1944 to 1945. Workers finished installing the COLEX equipment in 1955 for lithium separation, a process that required large amounts of mercury. A significant amount of the element was lost into the equipment, buildings, and surrounding soils, and its cleanup is one of OREM's top priorities.

Workers have completed the East COLEX risk reduction project, including activities to tap and drain the East COLEX piping and inspect, clean, and characterize 22 tanks. The COLEX mercury removal project is part of a broader initiative to address large quantities of mercury resulting from decades of Y-12 operations.

4.8.1.3 Major Soil Disposition Project Completed

Workers disposed of 4,071 yd^3 of soil that had been in storage since 1989, resulting from the closure of oil retention ponds. The ponds were constructed decades earlier to collect oils, preventing them from seeping from below-ground waste sites to nearby surface streams. The project was completed for $1.2 million—nearly $75 million under its original estimated budget.

During the closure project in 1989, the soil from the oil retention ponds was labeled as containing solvents based on the contents of the below-ground waste sites near the soil retrieval location. The presence of solvents would require treatment and disposal offsite, a significant cost reflected in the original budget.

Years later, reviews of the original sampling data revealed the need for new samples and analysis to determine the appropriate path to address the soil. OREM contracted with small business Alliant Corporation to conduct that work. Results of the sampling revealed that the soil, spanning a facility the size of an Olympic-sized swimming pool, did not contain solvents.

EPA and TDEC agreed with OREM's technical basis for eliminating the previous requirements to treat the soil and allowed OREM to safely dispose of most of it onsite. With the change, OREM awarded a contract to small business Cherokee National Environmental Solutions to complete the soil disposal project.

The removal of soil paves the way for OREM to reuse the building where the soil was stored. Workers conducted sampling to confirm the facility is safe for future projects. OREM expects to use the facility for research on waste treatment and cleanup at Y-12.

4.8.1.4 Biology Complex Deactivation

OREM is preparing to remove five high-risk excess contaminated facilities, known as the Biology Complex, 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 an effort to eliminate excess contaminated facilities throughout the DOE complex. Asbestos abatement and material removal were initiated in FY 2019.

Originally constructed in the 1940s to recover uranium from process streams, the 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.

4.8.1.5 Mercury Treatment Facility

Construction is underway on the Outfall 200 MTF. It will reduce mercury in water exiting the site through EFP. Outfall 200 is the point where the west end of the Y-12 storm drain system creates the headwaters of Upper EFPC.

The MTF will help OREM achieve compliance with regulatory criteria for EFP. It also facilitates 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 2019, OREM completed early site preparation activities ahead of the treatment facility construction. Early site preparation activities began in 2018 and included construction of utilities necessary for the treatment facility, installation of secant pile walls near EFPC, and relocation and demolition of existing infrastructure and structures to prepare the site for construction of the MTF.

4.8.2 Waste Management

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

Most of the waste generated during FY 2019 cleanup activities in Oak Ridge went to disposal facilities on ORR. The Environmental Management Waste Management Facility received 10,555 waste shipments, totaling 75,074 yd^3, from cleanup projects at ETTP, Oak Ridge National Laboratory, and Y-12. This engineered landfill consists of six disposal cells that only accept low-level radioactive and hazardous waste meeting specific criteria. These wastes include soil, dried sludge and sediment, building debris, and personal protective equipment.

4.8.2.2 Solid Waste Disposal

DOE operates and maintains solid waste disposal facilities called the ORR Landfills. In FY 2019, these three active landfills received 11,100 waste shipments, totaling 123,376 yd^3 of waste.

In FY 2019, OREM also completed improvements to the sediment control ponds and erosion controls at the ORR Landfills. These actions significantly reduce the amount of sediment released from these landfills.

4.8.2.3 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 2019:

- The West End Treatment Facility and the Central Pollution Control Facility at Y-12 processed approximately 499,000 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 2.0 million gal of mercury-contaminated sump waters from the Alpha-4 building.

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