Y-12 is a one-of-a-kind manufacturing complex that plays an important role in United States national security. Through Life Extension Program activities, Y-12 produces refurbished, replaced, and upgraded weapons components to modernize the enduring stockpile.

4

The Y-12 National Security Complex

Y-12, a premier manufacturing facility managed and operated by Consolidated Nuclear Security, LLC (CNS) for the National Nuclear Security Administration (NNSA), plays a vital role in the DOE Nuclear Security Enterprise. Drawing on more than 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, retrieving, and storing nuclear materials; dismantling nuclear weapons; providing fuels for use in the nation's naval reactors; and performing 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.

4.1. Description of Site and Operations

4.1.1. Mission

Charged with maintaining the safety, security, and effectiveness of the US nuclear weapons stockpile, Y-12 is a one-of-a-kind manufacturing facility that has a core mission to ensure a safe, secure, and reliable nuclear deterrent. Every weapon in the 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 nonexplosive, peaceful uses.

Y-12 secures and stores highly enriched uranium, and makes uranium available for non-weapon uses (e.g., in research reactors that produce cancer-fighting medical isotopes and for other research reactor purposes). Y-12 also processes highly enriched uranium from weapons removed from the 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 3,024 acres including 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 off-site from Y-12 and include the Central Training Facility, Alternate Emergency Operations Center, Oak Ridge Enhanced Training & Technology Center (ORETTC), Uranium Processing Facility (UPF) project laydown storage and offices, Y-12 Material Acquisition and Control Facilities, John M. Googin Technology Development Center, Test and Demonstration Facility, Commerce Park Office Complex, and Union Valley Sample Preparation Facility.

4.1.2. Modernization

Y-12 directly supports four of the five NNSA Centers of Excellence, including uranium, lithium, weapons assembly and disassembly, and safe and secure storage of strategic materials. The Y-12 strategic vision is driven by the overarching objectives that, by 2040, Y-12 will be capable of reliably fabricating any component, building any weapon, and qualifying any system on any day, as well as executing a digital transformation strategy that enables smart, real-time, data-driven operations. Today, Y-12 is not well suited to deliver this type of responsive capability. Following the end of the Cold War, operations were scaled back, and many once-reliable processes have since atrophied.

The ability to deliver a nuclear weapon without reusing components from legacy weapons and relying heavily on aging infrastructure does not exist. Additionally, Y-12 faces a unique need to reestablish capabilities and two material streams—binary and special materials—associated with the Y-12 mission. A key component to reestablishing these capabilities is accelerated planning and execution of site infrastructure improvements, including the following:

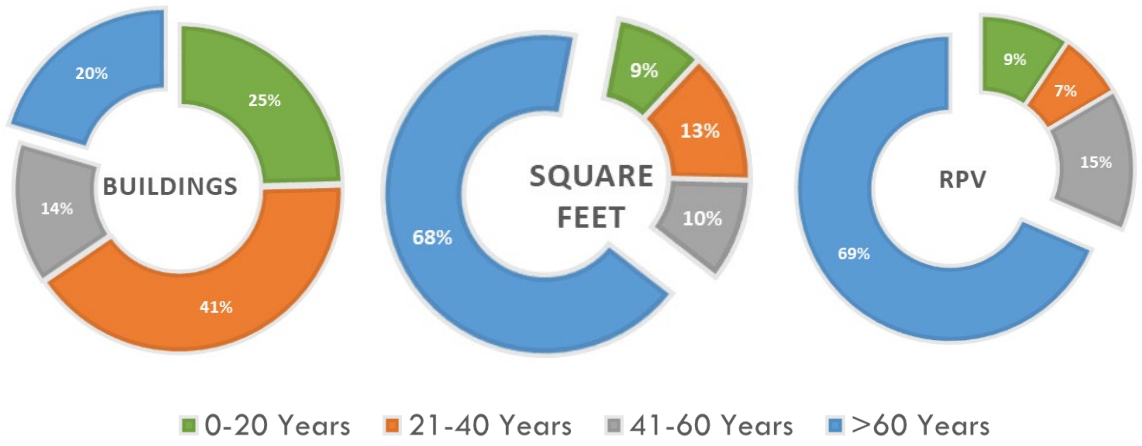
- New production facilities
- New capability and operational support facilities
- Capability bridging until new facilities are in place

Planning for the future site is designed to ensure that Y-12 will continue to provide the infrastructure needed to support the primary capabilities and materials missions with new facilities and associated technologies. In addition to new and revitalized facilities, the security posture will be strengthened by a reduced protected area footprint and revitalized security infrastructure and systems. The envisioned future Y-12 site includes the following elements:

- Major supply chains, including uranium (enriched uranium [EU], depleted uranium [DU]), and low enriched uranium) and lithium, are reestablished and/or transformed.
- The UPF, Lithium Processing Facility (LPF), Enriched Uranium Manufacturing Center, Assembly and Disassembly Center, and Depleted Uranium Manufacturing Capability are constructed.
- The security posture is sustained and improved through recapitalized and transformed footprint and security systems.
- The Mercury Treatment Facility and Environmental Management Disposal Facility are constructed, enabling approximately 2.8 million gross square feet of excess facility demolition and legacy environmental threats are remediated.
- Active participation in the Manhattan Project National Historic Park, which accommodates public tours for Y-12 historic facilities.

More than 50 percent of the Y-12 footprint is over 60 years old, as shown in Figure 4.1. To address this situation, Y-12 has been consolidating operations, modernizing facilities and infrastructure, and reducing the legacy footprint. 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.

Replacement and revitalization are key elements to modernizing Y-12. A significant number of facilities are at or beyond design life. Currently, construction activities include the UPF, Fire Station, West End Protected Area Reduction (WEPAR) project, and soon the LPF.



Acronym: *RPV = replacement plant value*

Figure 4.1. Age of facilities at Y-12, 2022

4.1.3. Production Operations

Y-12's core manufacturing and processing operations are housed in decades-old buildings near or past the end of their expected life spans. An integral part of Y-12's transformation, the UPF is being constructed as one of two main facilities at Y-12 in which EU will be stored and processed in a more centralized area.

The major production capabilities and associated facilities at Y-12 include the following:

- **EU:** Buildings 9212, 9215, and UPF (2027)
- **DU:** Buildings 9215, 9201-05N, 9201-05W, 9996, and 9998
- **Lithium:** Buildings 9204-02 and 9202
- **General manufacturing and fabrication:** Building 9201-01
- **Assembly and disassembly:** Building 9204-02E
- **Special materials:** Buildings 9225-03 (2025) and 9990-03 (2028)
- **Storage:** Buildings 9720-82, 9720-05, 9720-26, 9720-32, 9720-33, 9720-59, and 9811-01

The following major construction activities comprise the long-range vision for replacing key production operations from aging, oversized facilities:

- Building 9212 functions are to be replaced by the UPF in 2027, with some Building 9212 processes relocated to Buildings 9215 and 9204-2E.
- Building 9215 EU functions are to be replaced by the EU Manufacturing Center by 2050.
- Building 9204-02E functions are to be replaced by the Assembly and Disassembly Center by 2055.
- Building 9204-02 lithium functions are to be replaced by the LPF by 2031.
- DU and fabricating and manufacturing functions from the Building 9215 Complex, Building 9201-05N, Building 9201-05W, and Building 9201-01 are to be replaced by a phased approach line item construction, with the first phase—the Agile Rad Case and Component Capability—by 2035.

4.1.4. Support Facilities

Operations support infrastructure plays an integral role in ensuring Y-12 mission-critical work is completed. The primary missions of operations support infrastructure are to protect vital national security assets and people and enable site missions. These organizations and facilities provide the resources and infrastructure that support mission-critical production operations. Operations support facilities include the following categories:

- Security
- Emergency Services
- Development
- Analytical Chemistry
- General Storage and Warehousing
- Cybersecurity and Information Technology
- Global Security and Strategic Partnerships
- Waste Management
- Sustainability and Stewardship
- Oak Ridge Enhanced Technology and Training Center

The following major construction activities comprise the long-range vision for replacing key operations support facilities:

- Occupy the newly constructed Emergency Operations Center and Fire Station by 2023.
- Implement the WEPAR project and a new Entry Control Facility by 2025.
- Relocate some development functions from Buildings 9202 and 9203. Initially, the off-site 103 Palladium Way facility will be occupied in 2025 and then followed by phased line item construction, with the first phase—the Applied Technologies Laboratory—by 2035.
- Implement the Security Infrastructure Revitalization Program to replace the legacy Perimeter Intrusion Detection and Assessment System and secondary systems.
- Explore new construction for replacement facilities to support Analytical Chemistry operations, including phased line item construction, with the first phase—the Analytical Chemistry Laboratory—in 2037.
- Construct the Simulated Nuclear and Radiological Activities Facility at the new Oak Ridge Enhanced Technology and Training Center Strategic Partnership Program training campus.
- Construct a new Maintenance Complex through phased line item construction, with the first phase to replace the 78-year-old Building 9201-03 and other aging maintenance facilities.
- Construct a new Waste Management Complex to replace the aging West End Treatment Facilities.
- Implement a digital transformation and cybersecurity strategy.

- Refurbish existing facilities to accommodate a protected area security facility and construct a new Security Complex to accommodate growing requirements.

4.1.5. Excess Facility Disposition

Currently, 58 excess facilities at Y-12 and another 60 facilities are projected to be excessed within the next 10 years. The major excess process-contaminated facilities, including Building 9201-05, Building 9204-04, and Building 9206, will be transitioned to the DOE Office of Environmental Management (EM) for disposition. The smaller, process-contaminated, ancillary facilities associated with Buildings 9201-05, 9204-04, and 9206; Building 9212-associated facilities; and the Building 9401-03 (Steam Plant) Complex facilities are planned to be dispositioned by NNSA.

Process-contaminated facilities contain radiological and/or chemical contamination resulting from mission operations during the Manhattan Project or Cold War eras. Excess process-contaminated facilities are expected to be sufficiently managed until facility conditions meet criteria for transition to EM. Excess non-process-contaminated facilities are generally expected to be demolished by NNSA; however, some excess non-process-contaminated facilities may be demolished by EM depending on their complexity and/or proximity to process-contaminated facilities.

The Mercury Treatment Facility and the Environmental Management Disposal Facility will be constructed before any mercury-contaminated facilities can be demolished. Surveillance and maintenance activities, along with utility reroutes, unneeded material cleanout, and fluid and oil disposition, continue while the Mercury Treatment Facility and Environmental Management Disposal Facility are being constructed.

4.2. Environmental Management System

DOE Order 436.1, *Departmental Sustainability* (DOE 2011d), requires that federal facilities use a certified or conforming Environmental Management System (EMS) as a management framework to implement programs to meet sustainability goals and support the fulfillment of environmental compliance obligations. The DOE Order also requires that EMSs, covering all site activities, are certified to or conform to the International Organization for Standardization's (ISO) 14001, *Environmental Management Systems—Requirements with Guidance for Use* (ISO 2015).

In September 2021, the Y 12 EMS was declared to be in conformance with ISO 14001:2015. The audit team from the University of Tennessee Center for Industrial Services noted in the audit report that the Y-12 management and operating contract still requires the site to conform to the 2004 version of the ISO 14001 standard. The team audited the site to the revised 2015 version of the standard in anticipation that the requirement will change with the next Y-12 contract. The EMS applies to site activities and operations managed by CNS as described in Section 4.1. By design, the "plan-do-check-act" approach of the ISO 14001 standard improves environmental performance, which supports Y 12's overall mission effectiveness.

The Y-12 EMS has two areas of focus—environmental compliance and environmental sustainability. Environmental compliance consists of regulatory compliance and monitoring programs that implement federal, state, and local requirements, agreements, and permits. Environmental sustainability promotes and integrates initiatives such as energy and natural resource conservation, air pollutant emission minimization, waste minimization, and the use of sustainable products and services.

4.2.1. Integrating 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 ISMS to achieve environmental compliance, pollution prevention, waste minimization, resource conservation, and sustainability. Both 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 ISMS and the integrated EMS.

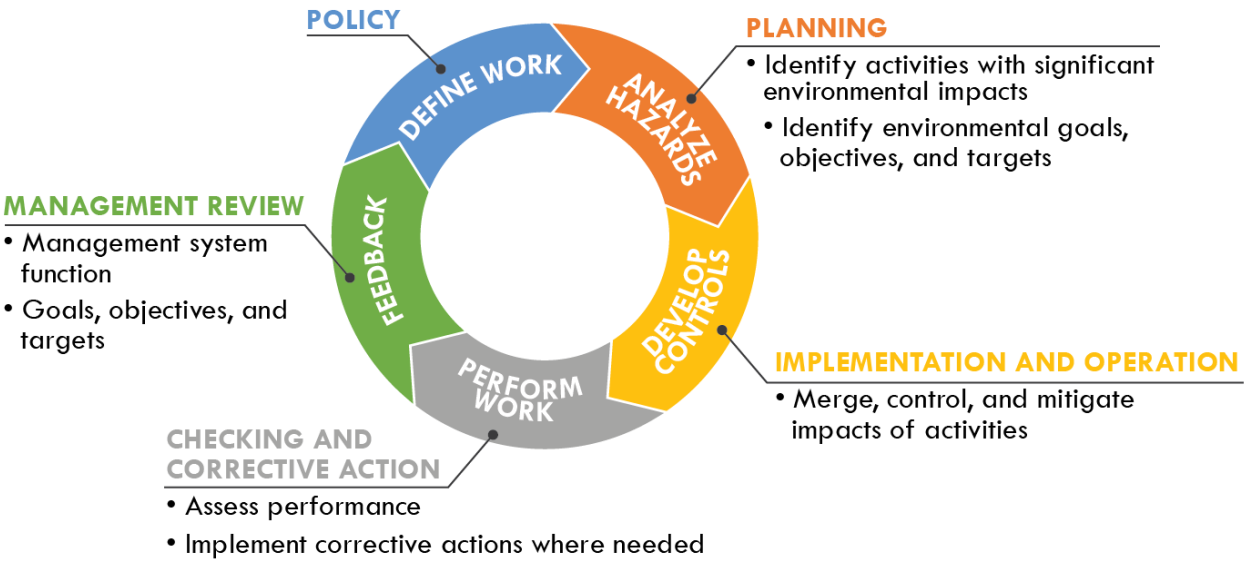


Figure 4.2. The Environmental Management System "plan-do-check-act" cycle of continual improvement

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

In addition to Y-12's ES&H policy, CNS has issued an environmental policy that is a significant component of the corporate ISMS and contributes to sustaining its imperatives of safe and secure operations. The Y-12 ES&H policy and the CNS environmental policy are communicated to and are incorporated into mandatory training for every employee and subcontractor. 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. Communication of Y-12's environmental policy and other EMS training and awareness activities foster a greater understanding of environmental issues at all levels of the organization and empowers employees to contribute to improving Y-12's environmental footprint.

4.2.3. Planning

The following sections describe planning activities conducted as part of the Y-12 EMS.

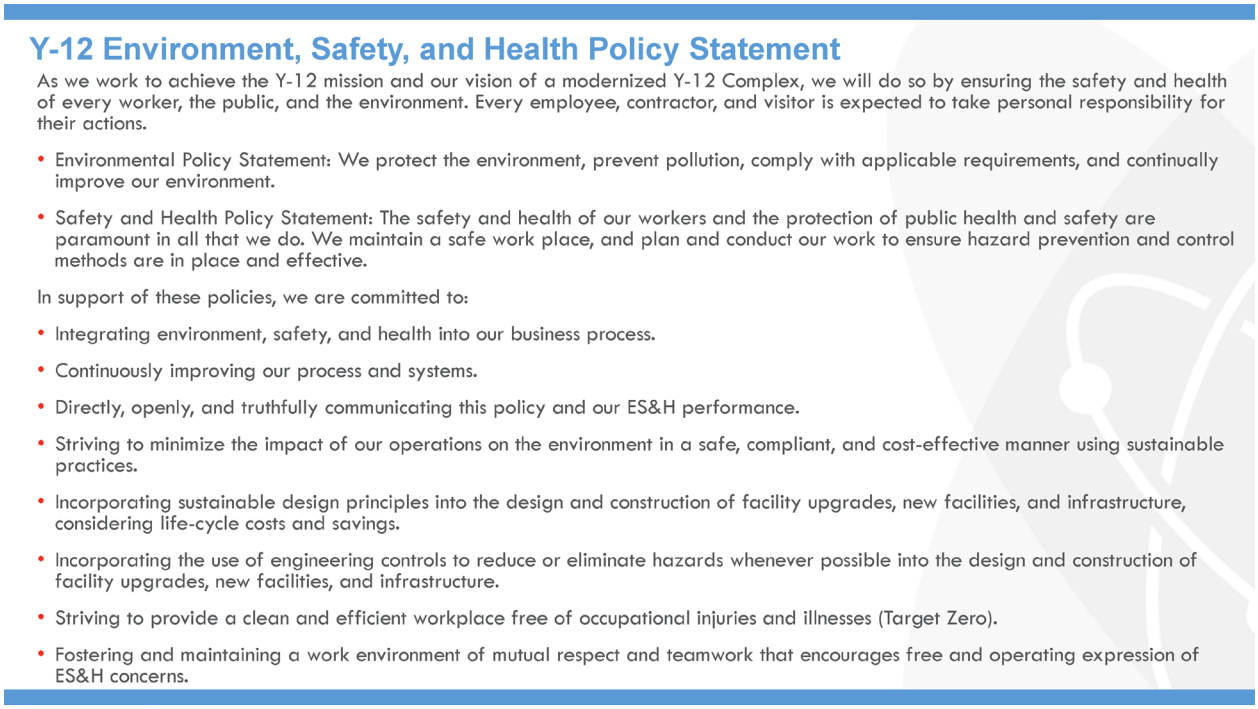
4.2.3.1. Y-12 Environmental Aspects

Environmental aspects may be thought of as potential environmental hazards associated with a

facility operation, maintenance job, or work activity. The environmental aspects and their impacts (i.e., potential risks to and 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 ensures 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 2022:

- 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



Acronym:
ES&H = environment, safety, and health

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

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 and consider 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 2022 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 provides environmental technical support services and oversees 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. The department 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 EPA. Environmental Compliance staff members administer 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.

The organization also maintains and ensures implementation of the Y-12 EMS and spearheads initiatives to 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 the site. While ensuring compliance with federal and state regulations, DOE orders, Waste Acceptance Criteria, and Y-12 procedures and policies, the 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 and disposal. The program also provides technical support to Y-12 Operations for waste planning, characterizing, packaging, tracking, reporting, and managing waste treatment and disposal subcontracts.

Sustainability and Stewardship

The Sustainability and Stewardship Program has two major missions. The first is to establish and maintain 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 and

landfill coordination, and Destruction and Recycle Facility operations. Y-12 has implemented continuous improvement activities, such as an Items Available for Reuse section on the site Property Accountability Tracking System website and a central telephone number (574-JUNK) to provide employees with 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 development of new problematic issues. Stewardship programs include Clean Sweep, Unneeded Materials and Chemicals, 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.

Unneeded materials at Y-12 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 Executive Orders, DOE orders, federal and state regulations, and NNSA expectations, as well as eliminates duplication of efforts, while providing an overall improved appearance at Y-12.

Additionally, implementing these programs supports EMS objectives and targets to disposition unneeded materials and chemicals; continually improves recycle programs by adding new recycle streams as applicable; improves sustainable acquisition (i.e., promotes the purchase of products made with recycled content and bio-based products); meets sustainable design requirements; and adheres to pollution prevention reporting requirements.

Energy Management

The Y-12 Energy Management Program incorporates energy efficient technologies across the site and positions Y-12 to meet NNSA energy requirement needs and reduction requirements as set forth by DOE. The program identifies improvements in energy efficiency in facilities, coordinates energy-related efforts across the site, is involved with energy savings and performance contracts, and promotes employee awareness of energy conservation programs and opportunities.

4.2.4. Implementing and Operating

The following sections describe activities conducted as part of the Y-12 EMS to establish, implement, and maintain good environmental practices and procedures.

4.2.4.1. Roles, Responsibility, and Authority

Safe, secure, efficient, and environmentally responsible operation of Y-12 requires the commitment of all personnel. All personnel share the responsibility for day-to-day accomplishment of work and the environmentally responsible operation of Y-12.

Environmental and Waste Management technical support personnel assist line organizations with identifying and carrying out their environmental responsibilities. Additionally, the Environmental Officer Program facilitates communication of environmental regulatory requirements and promotes EMS as a tool to drive continual environmental improvement at Y-12. Environmental officers coordinate their organizations' efforts to maintain environmental regulatory compliance and promote other proactive improvement activities.

4.2.4.2. Community 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, facilitates 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.

Local charities receive donations from funds raised by Y-12 employee aluminum beverage can recycling efforts. Since the program began in 1994, more than $94,600 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. 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. Environmental Justice

CNS endorses and implements the core value of environmental justice through charitable and educational outreach to disadvantaged communities that are located in the counties that surround the Y-12 site. These counties include Anderson, Blount, Knox, Morgan, Roane, Hamblen, and Loudon.

In 2022, the CNS Y-12 Community Investment Fund awarded grants totaling $100,000 to 30 nonprofits across East Tennessee. The fund is managed by the East Tennessee Foundation and directed by a committee that includes Y-12 employees.

CNS is also a major supporter of United Way of Anderson County and the United Way of Greater Knoxville, with corporate and employee contributions totaling hundreds of thousands of dollars.

CNS continued its efforts to build relationships with K-12 teachers, community colleges, and technical schools. CNS provided volunteers for classroom outreach and community service projects and also provided leaders who served on local committees, nonprofit boards, and area business and professional organizations. CNS continued to fund educational scholarships to residents of the Scarboro community, located in Oak Ridge. Introduce a Girl to Engineering drew attention from hundreds of young girls toward an engineering career with in-person events early in 2022.

Additional organizations that CNS supports through charitable and educational outreach include the following:

- Aid to Distressed Families of Appalachian Counties
- American Museum of Science and Energy
- Angel Tree
- Big Brothers Big Sisters
- Casting for Recovery
- Children's Museum of Oak Ridge
- Cold War Patriots
- Covenant Health
- East Tennessee Children's Hospital
- Emory Valley Center
- Free Medical Clinic
- Helen Ross McNabb Center
- Junior Achievement
- Oak Ridge Breakfast Rotary Club Foundation
- Leukemia & Lymphoma Society
- March of Dimes
- McNabb Center

- Methodist Medical Center of Oak Ridge
- Pull for Our Veterans
- Secret City Festival

4.2.4.4. 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.

The exercises, performance drills, and training drills conducted at Y-12 during FY 2022 focused on topics such as responding to an active assailant, radiological fire and release, chemical release, and a response to a criticality event. Building evacuation and accountability drills were also conducted.

4.2.5. Checking

The following sections describe activities conducted as part of the Y-12 EMS to review, assess, and monitor operations to maintain environmentally safe and compliant practices and continually improve environmental performance.

4.2.5.1. Monitoring and Measuring

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 2022 program activities are described throughout this chapter. Progress in achieving environmental goals is reported as a monthly metric on PerformanceTrack, 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 conducts 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 436.1A, *Departmental Sustainability* (DOE 2023a), 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 September 2021. The Y-12 EMS was found to fully conform, and no issues were identified. The next external verification audit is scheduled for summer 2024.

4.2.6. Performance

This section discusses EMS objectives, targets, other plans, initiatives, and successes that work together to accomplish DOE goals, reduce environmental impacts and risks, and improve effectiveness in overall mission. Y-12 uses 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.

Y-12 was given an EMS scorecard rating for FY 2022 of "green," indicating full and effective implementation of EMS requirements after submitting its DOE 2022 EMS compliance report via the DOE EMS Site Information Database.

4.2.6.1. Environmental Management System Objectives and Targets

At the end of 2022, Y-12 had achieved six of 11 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 completed a project to seal the Stack 11 basin and identified improved mission operations and improvements to air emissions.
- **Energy efficiency:** Y-12 completed a project to upgrade power lines to 13.8-kV service on Second and Third Street., as well as projects to upgrade cooling towers and heating, ventilation, and air conditioning systems in two areas.
- **Hazardous materials:** A project to disposition and ship legacy mixed waste according to the site treatment plan continued, and 50 items were shipped in FY 2022 to meet plan milestones. Unneeded materials and equipment were dispositioned from Building 9998 and two tanker trailers in FY 2022. Y-12 improved waste characterization processes and implemented real-time radiography to improve control and management of low-level radioactive waste.
- **Land, water, and natural resources:** Y-12 completed upgrading sanitary sewer networks in two areas as part of a project to protect the sanitary sewer lines from infill and infiltration. Y-12 also completed assessments on 34 aboveground inactive tanks and dikes in FY 2022.

4.2.6.2. Sustainability and Stewardship

Numerous efforts, including increased use of environmentally friendly products and processes and reductions in waste and emissions, have reduced Y-12's impact on the environment. During the past few years, these efforts have been recognized by NNSA, the community, and other stakeholders. Pollution prevention efforts at Y-12 have not only benefited the environment but have also resulted in cost efficiencies (Figure 4.4).

In FY 2022, Y-12 implemented 107 pollution prevention initiatives (Figure 4.5), with a reduction of more than 11.3 million lb of waste and projected cost efficiencies of more than $2.5 million. The completed projects include the activities described below.

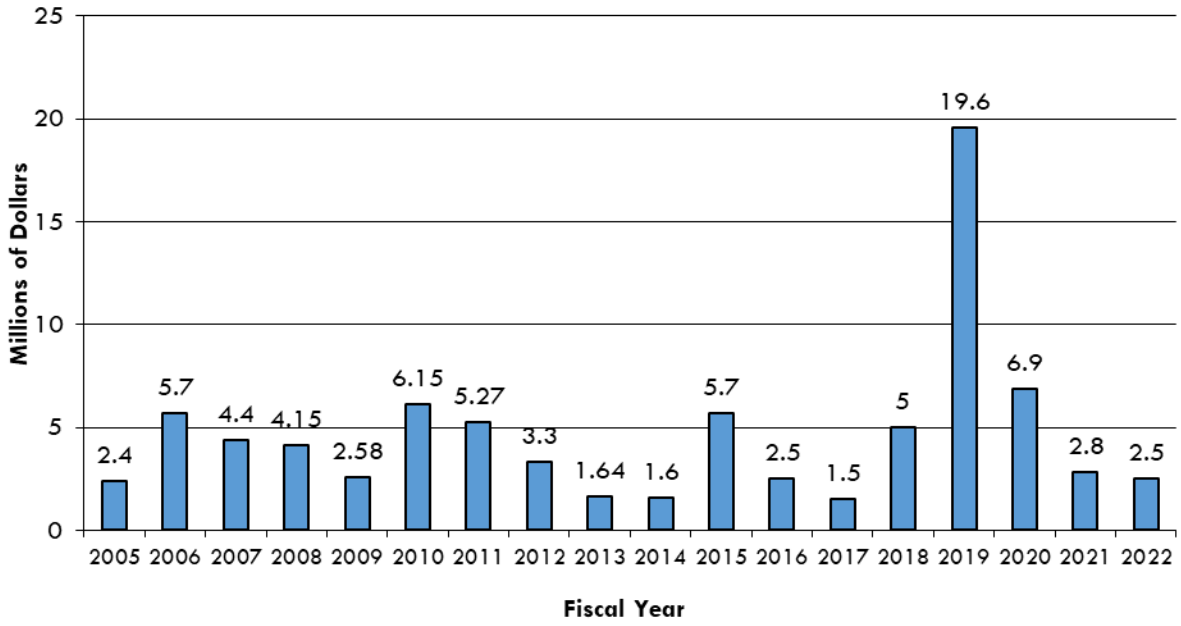


Figure 4.4. Cost efficiencies from Y-12 pollution prevention activities, 2005–2022

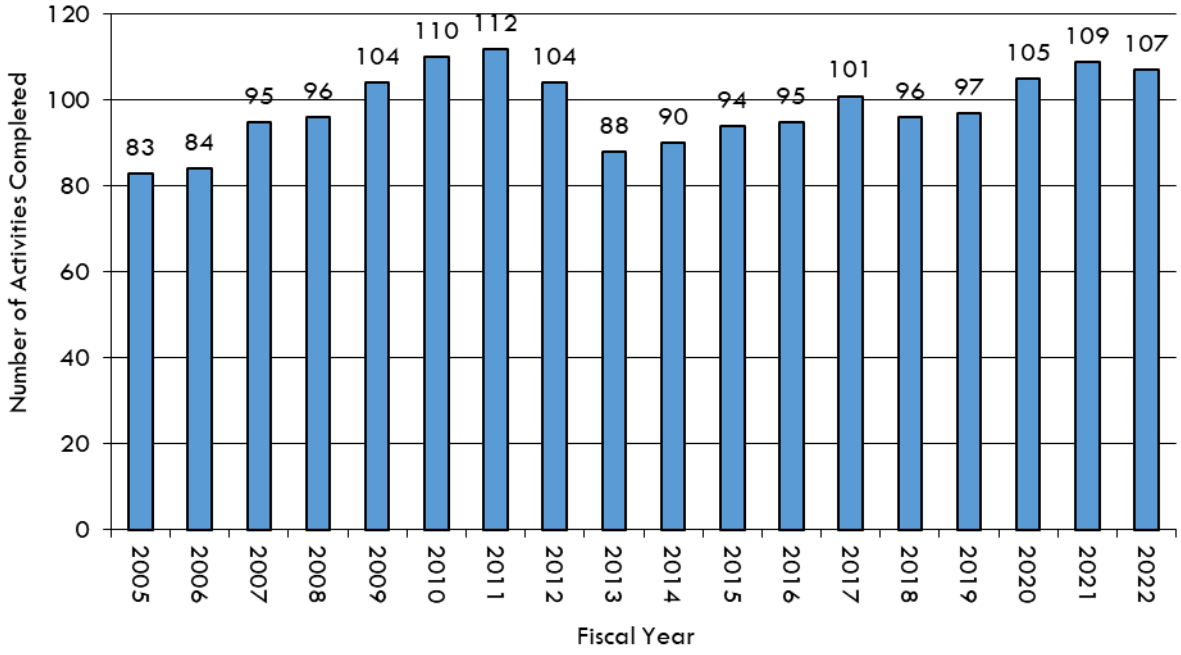


Figure 4.5. Y-12 pollution prevention initiatives, 2005–2022

Pollution Prevention and Source Reduction

Across Y-12, sustainable initiatives have been embraced 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 2022 activities highlighted in this section.

Sustainable Acquisition—Environmentally Preferable Purchasing

Sustainable products, including recycled content materials, are procured for use across Y-12. In 2022, Y-12 procured recycled content materials valued at more than $6.28 million for use at the site.

Solid Waste Reduction

Y-12 strives to minimize the generation of solid waste with a focus on waste diversion through source reduction, reuse and recycling. In 2022, Y-12 diverted 55.8 percent of municipal and 7.5 percent of construction and demolition waste from landfill disposal through reuse and recycle. Y-12 diverted more than 3.6 million lb of municipal materials from landfill disposal through source reduction, reuse, and recycling in FY 2022. More than 4.7 million lb of construction and demolition materials were diverted from landfill disposal.

Hazardous Chemical Minimization

Generator Services Group provides material disposition management services for generators at Y-12, which includes technical support to assist generators with determining whether the materials can be recycled, excessed, or reused rather than determining all materials received must be declared as a waste. Generator Services Group can be used by any organization or generator at Y-12. During FY 2022, Generator Services Group personnel reused, or disseminated to other Y-12 organizations for reuse, more than 5,600 lb of various excess materials and chemicals. In FY 2022, Legacy Facilities produced more than 1,545 gallons of hypochlorous acid, a safe, environmentally friendly, sustainable, and effective disinfectant on-site. Site-produced hypochlorous acid has reduced the amount of commercial disinfectants purchased to support COVID-19 prevention and response measures. Refillable containers are used to reduce the associated packaging waste materials from disinfectants.

Recycling

Y-12 has a well-established recycling program. The site 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 4.8 million lb of materials were diverted from landfills and into viable recycle processes during 2022. 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 2022 to include hard hats to broaden waste diversion efforts.

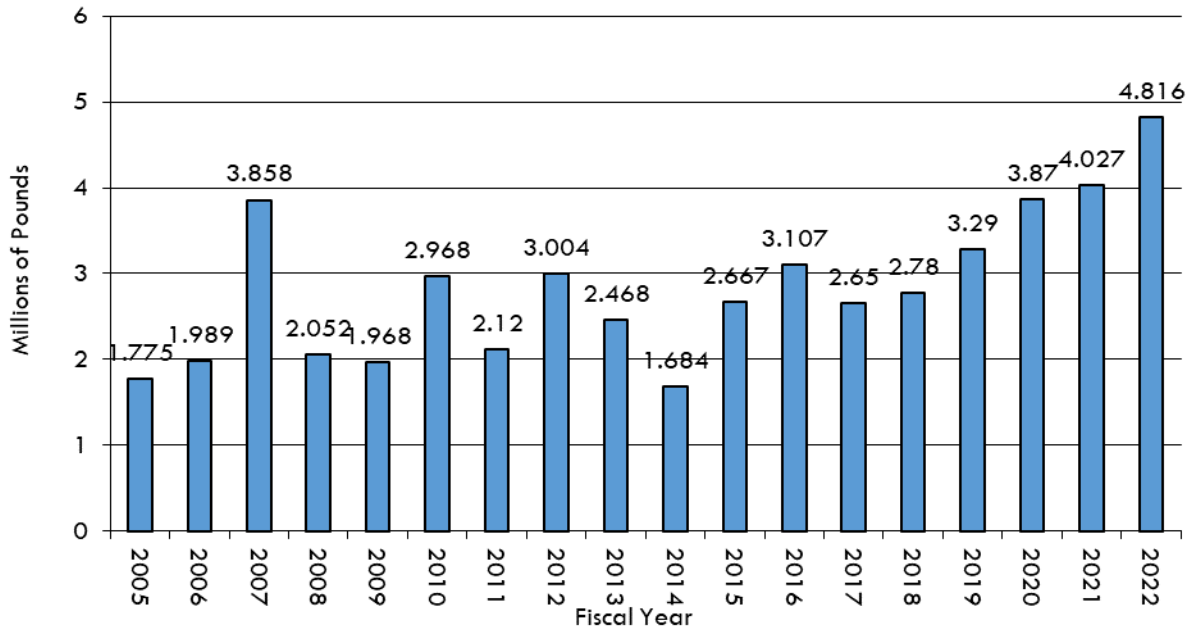
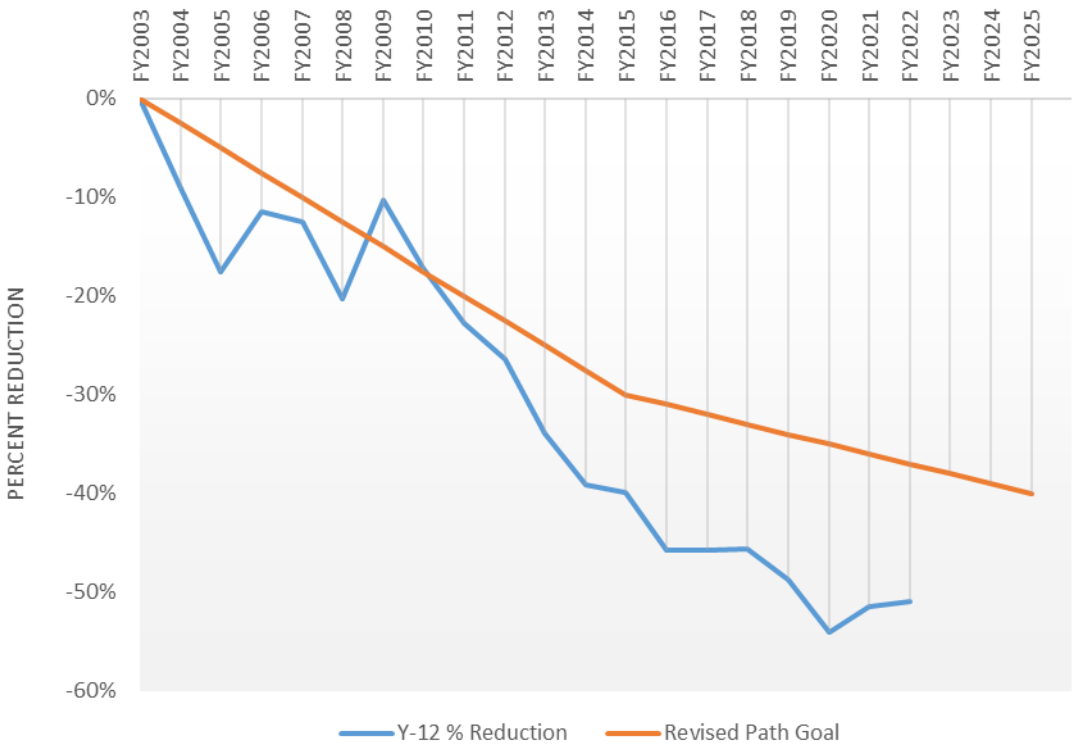


Figure 4.6. Y-12 recycling results, 2005–2022

4.2.6.3. Energy Management

Energy management activities are performed within the Energy Sustainability organization. Energy usage and intensity, Energy Independence and Security Act of 2007 (EISA) benchmarking and evaluations, facility metering/monitoring in accordance with the Energy Act of 2020, and non-fleet vehicles and equipment are components of energy-management reporting activities.

Y-12 exceeded the goal of meeting a 30 percent energy intensity (Btu per gross square foot) reduction in goal-subject buildings by FY 2015 from a FY 2003 baseline and 1 percent year-to-year reduction thereafter. During FY 2022 energy intensity was 205,343 Btu/gsf, which is a full 1.1 percent above the prior year (203,085 Btu/gsf). The upward trend in the site energy intensity figures is largely attributed to the height of the pandemic occurring during FY 2020 and then having a larger portion of the plant population returning to the site, thus increasing infrastructure use. Energy intensity reductions since FY 2018 will be further analyzed, and it is anticipated that FY 2020 and FY 2021 will be determined to be an anomaly. Compared to the FY 2003 baseline year, Y-12 has seen an energy intensity reduction of 50.93 percent as of FY 2022. Energy intensity through 2022 is shown in Figure 4.7.



Acronym: *FY = fiscal year*

Figure 4.7. Y-12 energy intensity versus baseline goal

4.2.6.4. Sustainable Goals and Performance

DOE is required to meet sustainability goals mandated by statute and related Executive Orders, including goals for GHG emissions, energy and water use, fleet optimization, green buildings, and renewable energy. In 2022, the DOE Sustainability Performance Office used its web-based Sustainability Dashboard to collect and consolidate sustainability data from all DOE sites. The Sustainability Dashboard focuses on specific sustainability goals established by the office, and site sustainability plans are completed within the dashboard. These goals, along with the current Y-12 performance ratings, are listed in Table 4.1.

Table 4.1. Fiscal year 2022 sustainability goals and performance

DOE Goal	Current Status
Energy Management	
Reduce energy use intensity (Btu per gross square foot) in goal-subject buildings.	Goal Met: Y-12 exceeded the reduction in energy intensity for goal-subject facilities by 25% by FY 2025 relative to FY 2015 baseline.
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 individual buildings for electricity, natural gas, steam, and water, where cost-effective and appropriate.	Goal Not Met: Y-12 meters all utilities; however, not all appropriate buildings are currently metered.
Water Management	
Reduce potable water use intensity (Gal per gross square foot).	Goal Met: Y-12 exceeded the goal of reduction in water intensity by 36% by FY 2025 relative to FY 2007.
Reduce non-potable freshwater consumption (gal) for industrial, landscaping, and agricultural.	Goal Not Applicable. Y-12 does not use industrial, landscaping, and agricultural water.
Waste Management	
Reduce nonhazardous solid waste sent to treatment and disposal facilities.	Goal Met: 55.8% (1,626.9 metric tons/2,913.1 metric tons) of nonhazardous waste diverted from the landfill.
Reduce construction and demolition materials and debris sent to treatment and disposal facilities.	Goal Not Met: 7.5% (2,164.9 metric tons/28,888 metric tons) of C/D materials were diverted from the landfill in FY 2022.
Fleet Management	
Reduce petroleum consumption.	Goal Not Met: Y-12 did not meet the interim target of 20% reduction in fleet petroleum consumption. There was a 9% increase from the FY 2005 baseline.
Increase alternative fuel consumption.	Goal Not Applicable: Y-12 does not have access to alternative fuels.
Acquire alternative fuel and electric vehicles.	Goal Met: Y-12 replaced 11 fleet vehicles with zero emission vehicles during FY 2022 and installed electric vehicle charging stations on-site.
Clean & Renewable Energy	
Increase consumption of clean and renewable electric energy.	Goal Met: Y-12 has exceeded the interim target and retains 15% renewable energy as a percentage of overall facility electric and thermal energy use.
Increase consumption of clean and renewable non-electric thermal energy.	Goal Not Met: Y-12 had a 1% decrease in natural gas use for FY 2022.
Sustainable Buildings	
Increase the number of owned buildings that are compliant with the Guiding Principles for Sustainable Buildings.	Goal Met: Two buildings were certified as High Performance Sustainable Buildings in FY 2022.

Table 4.1. Fiscal year 2022 sustainability goals and performance (continued)

DOE Goal	Current Status
Acquisition & Procurement	
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring all sustainability clauses are included as appropriate.	Goal Met: All eligible contracts after Oct. 1, 2013, contain the sustainable acquisition requirements. The CNS Sustainable Acquisition Program plans to work with Contracts and Procurement to review the current $150,000 contract threshold sustainable acquisition requirements to be included in subcontract languages so that future appropriate contracts will have the requirements to purchase sustainably.
Efficiency & Conservation Measure Investments	
Implement life cycle cost-effective efficiency and conservation measures with appropriated funds and/or performance contracts.	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 & Data Centers	
Electronics stewardship from acquisition, operations, to end of life.	Goal Met: Y-12 met the goal of purchasing 95% of eligible electronics as Electronic Product Environmental Assessment Tool registered products. Y-12 also power manages all mission-critical electronics and has increased the automatic duplexing to 92.9%. Y-12's electronics recycling vendor maintained R2 certification; therefore, all FY 2022 shipments were made to a R2 certified recycler. Electronics that were not recycled were electronics that could not be radiologically cleared for release. Therefore, 100% of eligible electronics were recycled to a R2 certified recycler or were donated for reuse.
Increase energy and water efficiency in high performance computing and data centers.	Goal Not Met: Y-12 data centers are not fully metered and estimates the current power usage effectiveness to be 2.4. However, as the site moves to modernized data centers, the overall energy and water efficiencies will continue to increase.
Adaptation & Resilience	
Implement climate adaptation and resilience measures.	Goal Met: Y-12 has issued a severe event emergency response plan that addresses severe natural phenomena events, extended loss of power events, and events that result in the loss of mutual aid. Additionally, the site submitted a vulnerability assessment and resilience plan, along with identified resilience solutions, that included increasing on-site renewable energy generation; solar powered equipment; new facilities; roof repairs and replacement; chiller upgrades; and heating, ventilation, and air conditioning system repairs and replacements.

Table 4.1. Fiscal year 2022 sustainability goals and performance (continued)

Multiple Categories	
Reduce Scope 1 and 2 greenhouse gas emissions.	Goal Met: Site Scope 1 and 2 emissions were reduced by 72.9% from the FY 2008 baseline, nearly doubling the interim target. Most of this can be attributed to the improvements to infrastructure through energy savings performance contract projects.
Reduce Scope 3 greenhouse gas emissions.	Goal Not Met: Site Scope 3 emissions increased by 2.4% from FY 2021 (43,142.8 $MtCO_2e$) to FY 2022 (42,106.3 $MtCO_2e$). Overall Scope 3 emissions have increased by 32% since the FY 2008 baseline (31,894.5 $MtCO_2e$). The decrease in Scope 3 emissions in FY 2022 is primarily due to ongoing telework activities.

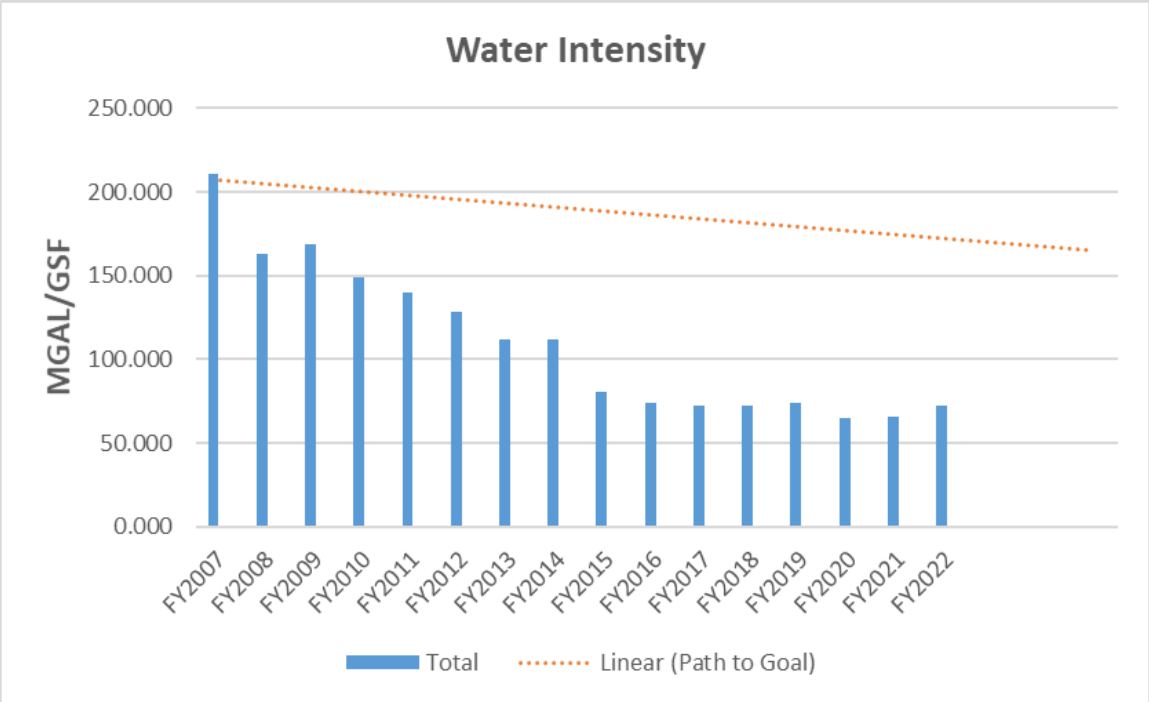
Acronyms:
CNS = Consolidated Nuclear Security
EISA = Energy Independence and Security Act
FY = fiscal year
NNSA = National Nuclear Security Administration

4.2.6.5. Water Management

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. In FY 2022, Y-12's water intensity rating was 72.070 gallons per square foot, which is a 9.36 percent decrease from the previous year and a 65.81 percent reduction from the 2007 baseline. In FY 2021, Y-12's water intensity rating was 65.323 gallons per square foot which is a 0.5 percent increase from the previous year and a 69.01 percent reduction from the 2007 baseline. This increase can be attributed to the unforeseen effects that COVID-19 had on the workforce and operations at Y-12 but also to the gradual return of the workforce to the site. The Y-12 telework policy ended most teleworking opportunities earlier this year, bringing back most personnel to the site. Comparing water intensity of FY 2022 to pre-COVID impacts in FY 2019, the reduction is 2.44 percent, which is more indicative of the expected trend for water usage for Y-12. An overview of water intensity performance is shown in Figure 4.8.

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
- Steam replacements to natural gas when possible



Acronyms:
FY = fiscal year
GSF = gross square feet
Mgal = millions of gallons

Figure 4.8. Water intensity graph from baseline 2007 through FY 2022

Internal EISA audits are conducted on covered facilities on a 4-year rotating schedule. Additionally, in FY 2016, the Pacific Northwest National Lab conducted a water assessment of the Y-12 site through the Federal Energy Management Program. These assessments have identified a number of water conservation projects that could be implemented should funding be allocated. These projects include domestic plumbing retrofits, kitchen equipment upgrades, process system upgrades, cooling tower upgrades, and steam plant upgrades. Continued reductions in water usage will be incorporated into ongoing facility repairs and renovations as funding becomes available. These efforts include:

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

4.2.6.6. Fleet Management

There are 643 vehicles in Y-12 fleet inventory, including 135 Agency-owned units, 496 leased from General Services Administration (GSA), and 12 commercially leased special purpose vehicles. The inventory consists of sedans; light-duty trucks, vans, and sport utility vehicles; medium-duty trucks, vans, and sport utility vehicles; and heavy-duty trucks such as road tractors, dump trucks, box trucks, flatbeds, wreckers, and service trucks.

During FY 2022, Y-12 exchanged 28 older GSA-leased vehicles with new units. The new GSA replacements were all ordered with alternative fuel or zero emission capabilities when available, and these new vehicles have better fuel consumption and GHG emission figures than the older vehicles that were replaced. Vehicle availability (replacements as well as additions) was a struggle during FY 2022 because less than 19 percent of the GSA vehicle replacement order was actually filled. Normally, the vast majority of those replacement orders that are placed with GSA in the December timeframe will be delivered by the end of the fiscal year in September, but manufacturer shortages had a major impact in the vehicles that actually were delivered.

The Y-12 taxi service was increased again in FY 2022 with an additional 15-passenger van, making transportation more accessible for the more than 6,500 employees. This service also helps reduce the number of overall vehicles needed, fuel consumption, and GHG emissions. The taxi service is an important asset to the overall transportation needs of the Y-12 workforce.

The Y-12 vehicle fleet achieved a 97.3 percent vehicle utilization rate for FY 2022 compared to 98.7 percent in FY 2021. Of those 17 vehicles that failed utilization, 10 achieved 80 percent or greater utilization scores. Vehicle reassignments were made multiple times throughout the year to help meet those utilization goals.

FY 2022 fuel consumption at Y-12 (diesel and gasoline) decreased by 14 percent compared with FY 2021, while miles traveled for those same vehicles was down by 16.9 percent compared to the previous year.

Y-12 continues to use a mobile fuel tanker to dispense gasoline and diesel for vehicles at the site because there is still not a new fuel station, although plans are in place to once again to build one just southwest of the existing Y-12 garage at the east end of the plant. Y-12 does not use alternative fuel (E85) because it is not available in the area, and an Epact 701 waiver (5 miles or 15 minutes away) for FY 2022 was granted to Y-12 as a result of this situation.

4.2.6.7. Electronic Stewardship

Y-12 has implemented various electronic stewardship activities, including virtualizing servers, creating virtual desktop infrastructure, procuring energy efficient computing equipment, reusing and recycling computing equipment, replacing aging computing equipment with more energy efficient equipment, and reconfiguring data centers to achieve more energy efficient operations. All of the desktop computers, laptops, monitors, and thin clients purchased or leased during FY 2022 were registered Electronic Product Environmental Assessment Tool products. Y-12's standard desktop configuration specifies the procurement of Electronic Product Environmental Assessment Tool registered and Energy Star-qualified products.

4.2.6.8. Greenhouse Gases

Compared to the FY 2008 baseline, Y-12 Scope 1 and Scope 2 GHG emissions have been reduced. 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 energy savings performance contract projects.

4.2.6.9. Storm Water Management and the Energy Independence and Security Act of 2007

The EISA 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 by 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. During 2022, the projects building the new Emergency Operation Center and Fire Station contributed to the overall prevention of storm water runoff by installing bioretention infiltration areas on the project sites.

4.3. Compliance Status

During 2022, Y-12 operations were conducted to comply with contractual and regulatory environmental requirements. Table 4.2 presents a summary of environmental audits conducted at Y-12 in 2022. The following discussions summarize the major environmental programs and activities carried out at Y-12 and provide an overview of the compliance status for the year.

4.3.1. Environmental Permits

Table 4.3 lists environmental permits in force at Y-12 during 2022. More detailed information can be found in the following sections.

Table 4.2. Summary of external regulatory audits and reviews, 2022

Date	Reviewer	Subject
February 15	TDEC	Quarterly ORR Landfill inspection ILF-V and CDL-VII
February 23	TDEC	Annual RCRA Hazardous Waste Compliance Inspection (ORR Landfill)
February 23-24	TDEC	Annual RCRA Hazardous Waste Compliance Inspection
March 11	TDEC	Quarterly ORR Landfill inspection
March 16	City of Oak Ridge	Industrial and Commercial User Wastewater Discharge Permit Inspection
March 23	TDEC	Annual Air Quality Inspection
March 24	TDEC	Quarterly ORR Landfill inspection ILF-IV
May 5	TDEC	Quarterly ORR Landfill inspection ILF-IV, ILF-V and CDL-VII and first Semi-annual inspection of Post Closure ILF-II
August 2	City of Oak Ridge	Industrial and Commercial User Wastewater Discharge Permit Inspection
August 4	TDEC	Minor Permit Modification approval ILF-V, Area 5 Buildout Design
August 9	TDEC	Quarterly ORR Landfill inspection ILF-V and CDL-VII
August 24	TDEC	Quarterly ORR Landfill inspection of ILF-IV and second Semi-annual Inspection of Closed ILF-II
August 31	TDEC	Minor Permit Modification approval CDL-VII, Seep Repairs
November 22	TDEC	Quarterly ORR Landfill inspection of ILF-V and CDL-VII
December 1	TDEC	Quarterly ORR Landfill inspection of ILF-IV

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

Table 4.3. Y-12 environmental permits, CY 2022

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[a]	DOE	DOE	CNS
CWA	Industrial and Commercial User Wastewater Discharge (Sanitary Sewer) Permit	1-91	07/20/21	03/31/26	DOE	DOE	CNS
CWA	NPDES Permit	TN0002968	08/05/22	09/30/27[b]	DOE	DOE	CNS
CWA	UPF General Storm Water Permit Y-12 (41.7 ha/103 acres)	TNR 134022	10/27/11	09/30/26	DOE	CNS	CNS
CWA	UPF NPDES General Permit for Construction Storm Water	TNR135568	08/06/18	09/30/26	DOE	BNI	BNI
CWA	Central Training Facility Berm Reinvestment Project NPDES Construction General Permit	TNR 135924	10/01/19	09/30/26	DOE	DOE	CNS
CWA	UCOR ILF-II General Storm Water Permit Y-12 (8.2 acres)	TNR 136478	08/03/21	Upon Notice of Termination	DOE	UCOR	UCOR
CWA	Y-12 Outfall 014 Repair Aquatic Resource Alteration Permit	NR1903.116	06/21/19	04/05/25	DOE	DOE	CNS
CWA	Central Training Facility Berm Aquatic Resource Alteration Permit	NR1903.096	05/15/19	04/05/25	DOE	DOE	CNS
CWA	Security Infrastructure Revitalization Program NPDES General Construction Permit	TNR 136604	11/30/21	Upon Notice of Termination	DOE	DOE	CNS
CWA	No Discharge Portal 20 Pump and Haul Permit	SOP-170-14	06/24/22	06/30/27	DOE	DOE	CNS
CWA	No Discharge Portal 23 Pump and Haul Permit	SOP-170-15	06/20/22	07/30/27	DOE	DOE	CNS
CWA	No Discharge Portal 19 Pump and Haul Permit	SOP-13031	06/26/18	06/30/23	DOE	DOE	CNS
CWA	No Discharge Environmental Management Waste Management Facility Pump and Haul Permit	SOP-01043	09/01/22	08/31/27	DOE	UCOR	UCOR
CWA	Simulated Nuclear and Radiological Activities Facility Aquatic Resource Alteration Permit	NR2003.249	01/14/21	Upon Notice of Termination	DOE	DOE	CNS
CWA	Simulated Nuclear and Radiological Activities Facility NPDES General Construction Permit	TNR136307	04/26/21	09/30/26	DOE	DOE	CNS
CWA	Y-12 Operations Center NPDES General Construction Permit	TNR136305	01/14/21	09/30/26	DOE	DOE	CNS
CWA	Y-12 Fire Station NPDES General Construction Permit	TNR136350	03/14/21	09/30/26	DOE	DOE	CNS

Table 4.3. Y-12 environmental permits, CY 2022 (continued)

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CWA	West End Protected Area Reduction NPDES General Construction Permit	TNR136382	04/26/21	09/30/26	DOE	DOE	CNS
CWA	Monitoring Station 8 and Outfalls 051 and 099 Access Improvements Aquatic Resource Alteration Permit	NR2103.288	11/08/21	04/07/25	DOE	DOE	CNS
RCRA	Hazardous Waste Transporter Permit	TN3890090001	12/05/22	01/31/24	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-184	03/05/21	03/05/31	DOE	DOE/CNS	CNS/LATS co-operator
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-127	10/06/05	10/06/15[c]	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 06/20/19	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Industrial Landfill V (operating, Class II)	IDL-01-000-0083	Permitted in 1993—most recent modification approved 08/04/22	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Construction and Demolition Landfill (overfilled, Class IV subject to CERCLA Record of Decision)	DML-01-000-0012	Initial permit 01/15/86	N/A	DOE	DOE/UCOR	UCOR

Table 4.3. Y-12 environmental permits, CY 2022 (continued)

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
Solid Waste	Construction and Demolition Landfill VI (post-closure care and maintenance)	DML-01-000-0036	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	Permitted in 1993—most recent modification approved 08/31/22	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 AND-00041	N/A	N/A	DOE	DOE	CNS

[a] *The Title V air permit renewal is still in the review process by TDEC.*
[b] *Some aspects of the current NPDES permit are currently under appeal by NNSA.*
[C] *Continue to operate in compliance pending TDEC action on renewal and reissuance.*

Acronyms:
BNI = Bechtel National Inc.
CAA = Clean Air Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CNS = Consolidated Nuclear Security, LLC
CWA = Clean Water Act
DOE = US Department of Energy
LATS = LATA-Atkins Technical Services, LLC
N/A = not applicable
NNSA = National Nuclear Security Administration
NPDES = National Pollutant Discharge Elimination System
ORR = Oak Ridge Reservation
RCRA = Resource Conservation and Recovery Act
SDWA = Safe Drinking Water Act
TDEC = Tennessee Department of Environment and Conservation
UCOR = URS\|CH2M Oak Ridge LLC (prior to May 2022) or United Cleanup Oak Ridge (after May 2022)
UPF = Uranium Processing Facility
Y-12 = Y-12 National Security Complex

4.3.2. National Environmental Policy Act

As federal agencies, DOE and NNSA comply with National Environmental Policy Act (NEPA) requirements (procedural provisions, 40 *Code of Federal Regulations* [CFR] Parts 1500 through 1508), as outlined in DOE's NEPA Implementing Procedures (10 CFR 1021). NEPA requires that all federal actions go through a review process that identifies any environmental or public consequences associated with that action. NEPA does not require that certain decisions be made or activities be rejected—it just makes sure that everything reasonably possible (related to environmental law and public protection) has been considered in the decision-making process. This evaluation process helps Y-12 and NNSA stay in compliance with many federal and state laws, regulations, and permits. Many of the NEPA documents for Y-12 can be found on the Y-12 publicly accessible website at www.y12.doe.gov.

The broadest and most complex NEPA document for Y-12 is the *Final Site-Wide Environmental Impact Statement (EIS) for the Y-12 National Security Complex* (DOE 2011a). This document takes into account the myriad activities planned for Y-12 in the foreseeable future. As changes in plans are identified or additional information becomes available, the sitewide document is updated with various supplement analyses. Following the 2011 sitewide EIS, supplement analyses were issued in 2016, 2018, and 2020 (NNSA 2016, NNSA 2018, NNSA 2020a). NNSA plans to pursue a contract for a new Supplement Analysis in 2023.

In addition to an EIS or supplement analysis, there are NEPA environmental assessments, which are prepared for larger projects that may not have been covered in the EIS or supplement analysis. In 2015, an environmental assessment and Finding of No Significant Impact (FONSI) were issued for the Y-12 Emergency Operations Center (NNSA 2015a, NNSA 2015b). In 2020, an environmental assessment and FONSI were issued for the Oak Ridge Enhanced Technology and Training Center (NNSA 2020b, NNSA 2020c). In 2021, the LPF and off-site Y-12 Development Organization facility were each addressed with an environmental assessment and FONSI (NNSA 2021a, 2021b, 2021c, 2021d). Planning for three environmental assessments (EAs) began in 2021 and 2022. These three projects are (1) Special Materials Manufacturing, (2) Depleted Uranium Program bridging or modernization, and (3) the transfer of a property parcel to the Oak Ridge Utility District. Once these EAs are completed, NNSA will determine whether to issue a FONSI or prepare an EIS.

The lowest level of NEPA documentation is a Categorical Exclusion (CX). These documents are used for smaller projects that have fewer environmental impacts and less cost than the types of activities covered by an EIS or environmental assessment. During CY 2021, 48 CX reviews/approvals were issued, with 12 of those being federal CX documents approved by the NNSA NEPA Compliance Officer (NCO). CY 2022 had 60 CX reviews/approvals with six of those being federal CX documents requiring approval by the NCO. Some of these CX documents were for new projects, and others may be revisions to older project documents based on new information or small changes in project scope.

Eight umbrella CXs were also approved by the NNSA NCO during 2022. Together, these documents provide an environmental review on differing categories of standard work activities that are common at Y-12 while also being considered low risk or low impact where environmental compliance is concerned. Any CX issued under these umbrella documents still receives a full review by subject matter experts and oversight by NPO—they just do not require NNSA to approve each project individually. The eight umbrella CX areas are: (1) routine maintenance; (2) deinventory, deactivation, decommissioning, and limited predemolition; (3) support buildings, modifications, and equipment installations; (4) analytical laboratory and research and development activities; (5) site characterization and environmental monitoring; (6) waste management, waste minimization, energy conservation, sustainability, and pollution prevention; (7) personnel safety enhancements and safety equipment improvements; and

(8) routine administrative actions, emergency preparedness training exercises, drills, and simulations.

The following types of documents are available at Y-12's public NEPA website (https://www.y12.doe.gov/about/environment-safety-and-health/national-environmental-policy-act-0): EIS, supplement analyses, environmental assessments, umbrella CXs, and federal CXs. Table 4.4 lists the six federal CX documents developed during 2022.

Table 4.4. National Nuclear Security Administration-approved Categorical Exclusions for 2022

Date issued	Title
03/08/2022	CRADA NFE-22-00001, Collaboration for Manufacturing Solutions and Material Applications
07/05/2022	UAS and Counter UAS, Testing and Evaluation, External Department of Energy Sites
09/19/2022	NEPA 4201.25, UPF, Security Portal 10 Demolition
09/27/2022	NEPA 4834, rev 4, West End Protected Area Reduction Project
10/18/2022	NEPA 5028, Use of Unmanned Aircraft Systems at Y-12 National Security Complex, DOE Oak Ridge Reservation, and other NNSA and DOE-owned or leased properties
12/06/2022	NEPA 5041 South Ridge Facility Dispositions

Acronyms:
NEPA = National Environmental Policy Act
UAS = unmanned aerial systems
UPF = Uranium Processing Facility

4.3.3. National Historic Preservation Act

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 2022 at Y-12 included completing Section 106 reviews of ongoing and new projects, working to develop an updated cultural resource survey of the site, and collecting and storing historic artifacts.

In 2022, 30 proposed projects were evaluated to determine whether any historic properties eligible for inclusion in the National Register of Historic Places would be adversely impacted. The proposed Integrated Facilities Disposition Project, which is planned to demolish Buildings 9201-05 and 9204-04, was determined to have adverse effects on historic properties eligible for listing in the National Register of Historic Places. In accordance with the *Programmatic Agreement Among the Department of Energy, Oak Ridge Operations Office, the National Nuclear Security Administration, the Tennessee State Historic Preservation Office, and the Advisory Council on Historic Preservation Concerning the Management of Historical and Cultural Properties at the Y-12 National Security Complex* (DOE 2003), required Section 106 recordation, interpretation, and documentation information has been prepared and submitted to the State Historic Preservation Office for concurrence to demolish these two major process facilities. The state requested that Y-12 resubmit this information after completion of the Y-12 Cultural Resource Survey, which is currently in progress.

Y/TS-1893, *National Historic Preservation Act Historic Preservation Plan for the Y-12 National Security Complex* (BWXT 2003), stipulates that the plan be reviewed every 5 years to maintain its effectiveness as a guiding document for the National Historic Preservation Act Program at Y-12. In its last review, it was determined that this document and the programmatic agreement needed to be updated to accurately reflect the

changes at Y-12 since the documents were completed in 2003. To this end, Y-12 is to update a cultural resource survey, which will evaluate all facilities currently located on the Y-12 site and constructed through 1992 to determine their eligibility for the National Register of Historic Places and inclusion within the redrawn boundaries of the Y-12 Historic District. This cultural resource survey is being developed in consultation with the State Historic Preservation Office and will inform the strategies for the updated preservation plan and programmatic agreement.

Y-12 continues to grow its collection of artifacts as employees donate items when vacating offices and buildings. In 2022, Y-12 added approximately 35 books to its library, which is located adjacent to the Y-12 History Center at the New Hope Center.

4.3.4. Clean Air Compliance Status

Permits issued by the state of Tennessee are the primary means used to impose 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 2022, and there were no exceedances during the reporting period. A surveillance in December 2022 identified that the 2021 annual preventive maintenance (oil and filter change) for one emergency engine was not completed as required. The preventive maintenance was performed in December 2022.

Ambient air monitoring, while not specifically required by any permit condition, is conducted at Y-12 to satisfy requirements in DOE Order 458.1, *Radiation Protection of the Public and the Environment* (DOE 2011b), 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 2022 activities conducted at Y-12 in support of the Clean Air Act.

4.3.5. Clean Water Act Compliance Status

During 2022, Y-12 continued its excellent record for compliance with the National Pollutant Discharge Elimination System (NPDES) water discharge permit limits. Data obtained as part of the NPDES program are provided in a monthly report to TDEC. The percentage of compliance with permit discharge limits for 2022 was 100 percent.

Approximately 3,400 data points were obtained from sampling required by the NPDES permit. Y-12's new NPDES permit was issued on August 5, 2022, and became effective on October 1, 2022. The new permit is currently under appeal in part and settlement negotiations are ongoing.

4.3.6. 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's *Public Water Systems,* Chapter 0400-45-01 (TDEC 2019a), 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 Environmental Compliance organization, with oversight by a state-certified operator.

Y-12's potable water distribution system was last reviewed by TDEC in 2021 and received a sanitary

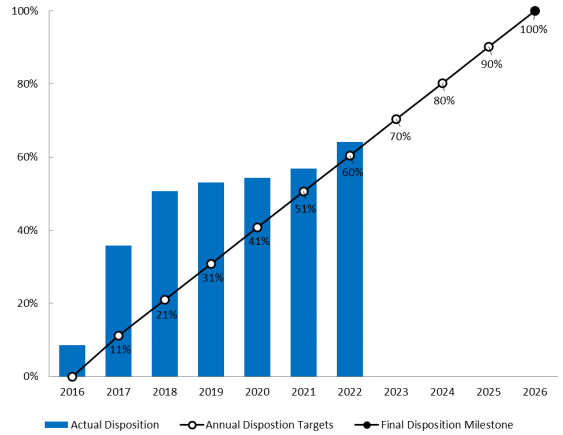
survey score of 100 out of a possible 100 points and, thus, retained its approved status as a public water system in good standing with TDEC. All total coliform samples collected during 2021 were analyzed by the state of Tennessee laboratory, and all results were negative. Analytical results for disinfectant 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 2020. These results were below TDEC and Safe Drinking Water Act limits and met established requirements.

4.3.7. 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 off-site 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 Facility Compliance Act requires that DOE work with local regulators to develop a site treatment plan to manage mixed waste. 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 that cannot be treated and disposed of in strict compliance with RCRA time limits.

The *Site Treatment Plan for Mixed Wastes on the US Department of Energy Oak Ridge Reservation* (TDEC 2022a) is updated annually and submitted to TDEC for review. The current plan documents the mixed waste inventory and describes efforts undertaken to seek new commercial treatment and disposal outlets for various waste streams. NNSA has developed a disposition schedule for the mixed waste in storage and will continue to maintain and update the plan, as a reporting mechanism, as progress is made. Y-12 has developed disposition milestones to address its remaining inventory of legacy mixed waste. Disposition milestones for the final inventory are FYs 2016 through 2026, as shown in Figure 4.9. In FY 2022, Y-12 staff dispositioned 64 percent of the legacy mixed waste inventory listed in the ORR site treatment plan.



Note: *As part of the Oak Ridge Reservation Site Treatment Plan.*

Figure 4.9. Path to eliminate Y-12's legacy mixed waste inventory by fiscal year (2016–2022)

The quantity of hazardous and mixed wastes generated by Y-12 in 2022 increased compared to the previous year, as shown in Figure 4.10. Y-12 is a state-permitted treatment, storage, and disposal facility. Under its permits, Y-12 received 3,611 kg of hazardous and mixed waste from off-site in 2022.

In addition, 557,529 kg of hazardous and mixed waste was shipped to DOE-owned and commercial treatment, storage, and disposal facilities. More than 10 million (10.993890 million kg for updating the graph) kg of hazardous and mixed wastewater was treated at on-site wastewater treatment facilities.

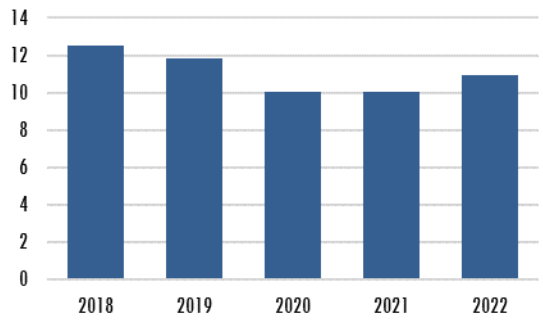


Figure 4.10. Y-12 hazardous waste generation, 2018–2022

4.3.7.1. 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 underground storage tank regulations (TN 0400 18 01).

The last two petroleum USTs at the East End Fuel Station were closed and removed in August 2012. No petroleum USTs remain at Y-12.

4.3.7.2. Resource Conservation and Recovery Act Subtitle D Solid Waste

ORR landfills operated by DOE EM are located within the Y-12 boundary. The facilities include two Class II operating industrial solid waste disposal landfills and one operating Class IV construction demolition landfill. The facilities are permitted by TDEC and accept solid waste from DOE operations on ORR. In addition, one Class IV facility (Spoil Area 1) is overfilled by 8,945 m^3 and has been the subject of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigation and feasibility study. A CERCLA Record of Decision for Spoil Area 1 was signed in 1997 (DOE 1997b). One Class II facility (Landfill II) has been closed and is subject to post-closure care and maintenance. Associated TDEC permit numbers are noted in Table 4.3. Additional information about the operation of these landfills is provided in Section 4.8.2.

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

The intent of the ORR Federal Facility Agreement (DOE 2022a) is to coordinate the corrective action processes of RCRA required under the ORR Corrective Action TNHW-164, which was renewed for a 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 2023 as an update of the previous CY 2022 activities.

4.3.9. Toxic Substances Control Act Compliance Status

Storage, handling, and use of polychlorinated biphenyls (PCBs) are regulated under the Toxic Substances Control Act (TSCA). Capacitors manufactured before 1970 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 23, 2022.

Given the widespread historical uses of PCBs at Y-12 and fissionable material requirements that must be met, EPA and DOE negotiated an agreement to assist ORR facilities in becoming compliant with TSCA regulations. This agreement, the ORR PCB Federal Facility Compliance Agreement, which became effective in 1996, provides a forum within which to address PCB compliance issues that are unique to these facilities. Y-12 operations involving TSCA-regulated materials were conducted in accordance with TSCA regulations and the agreement.

4.3.10. Emergency Planning and Community Right-to-Know Act Compliance Status

The Emergency Planning and Community Right-to-Know Act 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 2022 in accordance with requirements under Sections 303, 311, 312, and 313 of the Act.

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). Five new substances were over threshold during 2022. 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 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 47 chemicals that were over Section 312 inventory thresholds in 2022.

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 Emergency Planning and Community Right-to-Know Act 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 2022 reportable toxic releases to air, water, and land and waste transferred off-site for treatment, disposal, and recycling were 451,373 lb. Table 4.5 lists the reported chemicals for Y-12 for 2021 and 2022 and summarizes releases and off-site waste transfers for those chemicals.

Table 4.5. Emergency Planning and Community Right-to-Know Act Section 313 toxic chemical release and off-site transfer summary for Y-12, 2021–2022

Chemical	Year	Quantity[a] (lb)[b]
Chromium	2021	7,601
	2022	47,135
Cobalt	2021	Not reported
	2022	6,790
Copper	2021	331,722
	2022	14,669
Lead compounds	2021	169,300
	2022	238,655
Manganese	2021	57,735
	2022	32,070
Mercury	2021	Not reported
	2022	Not reported
Methanol	2021	44,583
	2022	51,169
Nickel	2021	5,774
	2022	60,885

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

[b] *1 lb = 0.4536 kg.*

4.3.11. Spill Prevention, Control, and Countermeasures

Clean Water Act, Section 311, regulates the discharge of oils or petroleum products to waters of the United States and requires spill prevention, control, and countermeasure plans be developed and implemented to minimize the potential for oil discharges. The major requirements for plans are contained in 40 Part 112. These regulations require that these plans be reviewed, evaluated, and amended at least once every 5 years, or earlier if significant changes occur. The 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 spill prevention, control, and countermeasure plans.

The *Spill Prevention, Control, and Countermeasure Plan for the U.S. Department of Energy Y-12 National Security Complex* (CNS 2022c) was revised in October 2022 to update general Y-12 changing site infrastructure. This plan presents the requirements to be implemented by Y-12 to prevent spills of oil 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 Y-12 Plant Shift Superintendent. Spill response materials and equipment are stored near tanks, 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.

4.3.12. Unplanned Releases

Y-12 has procedures for notifying off-site authorities of 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, certain observable oil sheens on East Fork Poplar Creek (EFPC) 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 public or worker health and safety, the environment, national security, DOE safeguards and security interests, DOE facilities functions, or DOE's reputation.

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.

During 2022, there were no reportable releases to the environment, including no reportable radiological air emission releases for Y-12.

4.3.13. Audits and Oversight

In 2022, Y-12 was inspected by federal, state, or local regulators on four occasions. Table 4.2 summarizes the results.

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 2022.

Personnel from the TDEC Division of Solid Waste Management conducted an unannounced RCRA hazardous waste compliance inspection of Y-12 on February 23, 2022. The inspections covered waste storage areas and records reviews. Eight issues were identified, including roof leak repairs that were not documented, one container exceeded 90 days in a storage area, inadequate aisle space in one area, one facility did not conduct daily inspections when hazardous waste activities occurred for a period of time, and two instances each of containers inadequately labeled for hazards and improperly closed. Immediate corrective actions were taken where possible. The issues and their causes are being reviewed to prevent recurrence.

Personnel from the TDEC Division of Air Pollution Control conducted an air quality inspection on March 23, 2022. The inspection covered 12 air emission sources, including some emergency generators, and inspections of the facilities. Title V air permit records were also reviewed. No issues were identified.

In July 2019, as the result of a self-identified issue, shipments to the Nevada National Security Site were suspended due to incomplete characterization of weapon material/weapon-related material (WM/WRM). This suspension

included the entire Waste Certification Program, affecting both WM/WRM and waste shipments.

Investigations, a series of improvement activities, and layers of self-critical audits were conducted. Additional actions to enhance the Waste Certification Program and prepare for resuming shipments were completed in FY 2021. Reinstatement of the Waste Certification Program occurred in March 2021 for waste shipments. The first shipment of waste occurred in April 2021.

Process mapping sessions for the new WM/WRM disposition program were conducted, and job analyses for roles involved in the WM/WRM disposition process were completed and issued. Procedures and manuals were updated, and Y17-014, *Characterization of Weapon Material and Weapon-Related Material*, was created. Engineering components training was developed and implemented to address identified gaps, and need-to-know issues with Sandia National Laboratories were resolved.

The suspension of the WM/WRM portion of the Waste Certification Program was lifted in October 2022.

In June 2022, real-time radiography unit 4 became operational. The unit has the capability to analyze unclassified radiologically-contaminated waste boxes and drums. Data gathered from real-time radiography images are used to verify that no non-conforming items are packaged within containers destined for Nevada.

Progress will continue on additional waste profiles, analyzing drums and boxes through real-time radiography and shipping newly generated and backlogged containers for disposition.

4.3.14. Radiological Release of Property

Releasing 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 2011b). Property consists of real property (i.e., land and structures) and personal property (i.e., property of any type except real property). At Y-12, there are three paths for releasing property to the public based on the potential for radiological contamination:

- Survey and release property potentially contaminated on the surface (Section 4.3.14.1).
- Evaluate materials with a potential to be contaminated in volume (Section 4.3.14.2).
- Evaluate using process knowledge (surface and volumetric) (Section 4.3.14.3).

Table 4.6 summarizes some examples of the property released in 2022 and their amounts. During FY 2022, Y-12 recycled more than 4.8 million lb of materials off-site for reuse, including computers, electronic office equipment, used oil, scrap metal, tires, batteries, lamps, and pallets.

The paths discussed in Sections 4.3.14.1 and 4.3.14.2 use pre-approved authorized limits as outlined in DOE Order 458.1. These limits use screening levels from American National Standards Institute/Health Physics Society (ANSI/HPS) N13.12-2013, *Surface and Volume Radioactive Standards for Clearance* (ANSI 2013). The basis of these standards is to limit the dose to any member of the public to a maximum of 1.0 mrem (0.01 mSv) per year total effective dose from clearing materials from regulatory control. These authorized limits are applicable to the release of personal property only (including recycled material). No real property was released from Y-12 in 2022.

Table 4.6. Summary of materials released in 2022

Category	Amount released
Real property (land and structures)	None
Computer equipment recycle:	82,982 lb
– Computers	
– Monitors	
– Printers	
– Mainframes	
Recycling examples:	
– Used oils	6,785 gal
– Used tires	18,240 lb
– Scrap metal	2,934,076 lb
– Lead acid batteries	65,368 lb
Public and negotiated sales:	
– Brass	5,501 lb
– Miscellaneous furniture	1,716 lb
– Vehicles and miscellaneous equipment/materials	178,280 lb
External transfers	N/A

Note: *External transfers include vehicles, miscellaneous equipment, and materials transferred to various federal, state, and local agencies for reuse during FY 2022. Y-12 transferred property with an acquisition value of approximately $138,565; however, the weight of the transferred items in pounds was unable to be quantified.*

4.3.14.1. Property Potentially Contaminated on the Surface

Property that is potentially contaminated on the surface is completely surveyed, unless it can be released based on process knowledge or through a survey plan that provides survey instructions, along with technical justification (process knowledge) for the 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* (NRC 2009). Table 4.7 lists the surface contamination limits used at Y-12 to determine whether materials and equipment (M&E) are suitable for release to the public.

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 Packaging."

4.3.14.2. Property Potentially Contaminated in Volume (Volumetric Contamination)

Materials, such as activated materials, smelted-contaminated metals, liquids, and powders, are subject to volumetric contamination (i.e., 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:

- **Unopened, sealed containers:** Material is still in an original commercial manufacturer's sealed, unopened container. A seal can be a visible manufacturer's seal (e.g., 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.
- **Process knowledge:** If contamination being able to enter a system is unlikely, then process knowledge is documented and used as the basis for release. Often, this is accompanied by confirmatory surveys.
- **Analytical:** The material is sampled, and analytical results are evaluated against the preapproved authorized limits in DOE Order 458.1. If preapproved authorized limits have not been approved, then analytical results are evaluated against measurement method critical levels or background levels from materials that have not been impacted by Y-12 activities. If results meet defined criteria, then they are documented, and the material is released.

Table 4.7. DOE Order 458.1 preapproved authorized limits for surface contamination[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, 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 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 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. Wiping techniques to measure removable contamination levels are unnecessary 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 ^{90}Sr that is present in them. It does not apply to ^{90}Sr that has been separated from other fission products or mixtures where ^{90}Sr has been enriched.*

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

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

Y-12 was granted approval to use the DOE Order 458.1 preapproved authorized limits for volumetric contamination on July 20, 2021, which is documented in NPO letter COR-NP0-60 ESH-7.20.2021-919599, "Approval to Use Pre-Approved Authorized Limits for the Release and Clearance of Volumetric Radioactivity of Personal Property" (NNSA 2021e). Table 4.8 lists these volumetric contamination limits for various groups of radionuclides. When multiple radionuclides exist in a single sample, a sum of fractions is used to verify that material meets the specified limits.

4.3.14.3. 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 (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 (Class I, NRC 2009). The process knowledge evaluation processes are outlined in Y-12 procedures.

The following are examples of M&E released without monitoring based on process knowledge; however, this does not preclude conducting verification monitoring before sale:

- All M&E from rad-free zones
- Pallets generated from noncontaminated areas
- Pallets that are returned to shipping during the same delivery trip
- Lamps from noncontaminated areas
- Drinking water filters
- M&E approved for release by radiological engineering technical review
- Portable restrooms used in noncontaminated 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, housekeeping materials, and associated waste
- Breakroom, cafeteria, and medical wastes
- Medical and bioassay samples generated in noncontaminated areas
- Subcontractor, vendor, and privately owned vehicles, tools, and equipment used in noncontaminated 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 the Central Computing Facility
- Subcontractor, vendor, and privately owned vehicles, tools, and equipment that have not been used in contaminated areas or for excavation activities
- New cardboard
- Consumer glass containers

Table 4.8. DOE Order 458.1 preapproved authorized limits for volumetric contamination[a]

Radionuclide groups[b]	SI units, volume (Bq/g)[d,e]	Conventional units, volume (pCi/g)[d,e]
Group 0: Special Case: ^{129}I[c]	0.01	0.3
Group 1: High-energy gamma, radium, thorium, transuranics, and mobile beta-gamma emitters: ^{22}Na, ^{46}Sc, ^{54}Mn, ^{56}Co, ^{60}Co, ^{65}Zn, ^{94}Nb, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{182}Ta, ^{207}Bi, ^{210}Po, ^{210}Pb, ^{226}Ra, ^{228}Ra, ^{228}Th, ^{229}Th, ^{230}Th, ^{232}Th, ^{232}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{242}Pu, ^{244}Pu, ^{241}Am, ^{243}Am, ^{245}Cm, ^{246}Cm, ^{247}Cm, ^{248}Cm, ^{249}Cf, ^{251}Cf, ^{254}Es, and associated decay chains[d], and others[b]	0.1	3
Group 2: Uranium and selected beta-gamma emitters: ^{14}C, ^{36}Cl, ^{59}Fe, ^{57}Co, ^{58}Co, ^{75}Se, ^{85}Sr, ^{90}Sr, ^{95}Zr, ^{99}Tc, ^{105}Ag, ^{109}Cd, ^{113}Sn, ^{124}Sb, ^{123m}Te, ^{139}Ce, ^{140}Ba, ^{155}Eu, ^{160}Tb, ^{181}Hf, ^{185}Os, ^{190}Ir, ^{192}Ir, ^{204}Tl, ^{206}Bi, ^{233}U, ^{234}U, ^{235}U, ^{238}U, natural uranium[e], ^{237}Np, ^{236}Pu, ^{243}Cm, ^{244}Cm, ^{248}Cf, ^{250}Cf, ^{252}Cf, ^{254}Cf, and associated decay chains[d], and others[b]	1	30
Group 3: General beta-gamma emitters: ^{7}Be,^{74}As, ^{93m}Nb, ^{93}Mo, ^{93}Zr, ^{97}Tc, ^{103}Ru, ^{114m}In, ^{125}Sn, ^{127m}Te, ^{129m}Te, ^{131}I, ^{131}Ba, ^{144}Ce, ^{153}Gd, ^{181}W, ^{203}Hg, ^{202}Tl, ^{225}Ra, ^{230}Pa, ^{233}Pa, ^{236}U, ^{241}Pu, ^{242}Cm, and others	10	300
Group 4: Low-energy beta-gamma emitters: ^{3}H, ^{35}S, ^{45}Ca, ^{51}Cr, ^{53}Mn, ^{59}Ni, ^{63}Ni, ^{86}Rb, ^{91}Y, ^{97m}Tc, ^{115m}Cd, ^{115m}In, ^{125}I, ^{135}Cs, ^{141}Ce, ^{147}Nd, ^{170}Tm, ^{191}Os, ^{237}Pu, ^{249}Bk, ^{253}Cf, and others[b]	100	3,000
Group 5: Low-energy beta emitters: ^{55}Fe, ^{73}As, ^{89}Sr, ^{125m}Te, ^{147}Pm, ^{151}Sm, ^{171}Tm, ^{185}W, and others[b]	1,000	30,000

[a] *The screening levels for clearance have been rounded to one significant figure and are assigned for volume radioactivity.*

[b] *To determine the specific group for radionuclides not shown, a comparison will be performed of the screening factors, by exposure scenario, listed in Tables B.1, C.1, and D.1 of NCRP Report No. 123 (NCRP 1996), for the radionuclides in question and the radionuclides in the general groups above and a determination of the proper group made, as described in ANSI/HPS N13.12-2013, Annex A (ANSI 2013).*

[c] *Because of potential groundwater concerns, the volume radioactivity values for 129I when disposal to landfills or direct disposal to soil is anticipated is assigned to Group 0.*

[d] *For decay chains, the screening levels represent the total activity (i.e., the activity of the parent plus the activity of all progeny) present.*

[e] *The natural uranium screening levels for clearance shall be lowered from Group 2 to Group 1 if decay-chain progeny are present (e.g., uranium ore versus process or separated uranium in the form of yellowcake). The natural uranium activity equals the activity from uranium isotopes (48.9% from 238U, plus 48.9% from 234U, plus 2.2% from 235U). This approach is consistent with summing radionuclide fractions discussed in ANSI/HPS N13.12-2013, Section 4.4.*

[f] *Each individual limit applies to the particular radionuclides, but must be summarized, and the sum of fractions must be <1.*

Acronym:

DOE = US Department of Energy

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 control of asbestos, stratospheric ozone-depleting chemicals, and fugitive emissions, and general administration of the permit. The Title V permit also contains 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 (NESHAP) (40 CFR 61) and numerous ones associated with emissions of criteria pollutants and other, nonradiological hazardous air pollutants. 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 2022:

- Initial notification report for Emergency Operations Center new stationary emergency reciprocating internal combustion engine/generator to the Title V operating air permit.
- Y-12 Major Source (Title V) Operating Air Permit renewal application was submitted to TDEC in June 2022.
- Insignificant activity exemption was completed for the existing and new electropolishing operations located in Building 9204-02E.
- Operational flexibility request to replace an old, existing nitric acid rinse system with a new nitric acid rinse system in Foundry Operations at Building 9998.
- Notification of change to CNS Responsible Official for Y-12 Major Source (Title V) Operating Air Permit 571832 to designate Diane McDaniel as the new responsible official for Y-12.
- Notification of change of Federal Responsible Office for Y-12 Major Source (Title V) Operating Air Permit 571832 to designate Glenn C. Smolens as the new responsible official for Y-12.

Demonstrating compliance with air permits conditions is a significant effort at Y-12. Key elements of maintaining compliance are maintenance and operation of control devices, monitoring, recordkeeping, and reporting.

High-efficiency particulate air filters and scrubbers are control devices used at Y-12. High-efficiency particulate air filters are found throughout the site, and in-place testing of high-efficiency particulate air 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, onetime stack sampling, and 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, including the following:

- Annual ORR Radiological NESHAP Report, which includes specific information regarding Y-12 radiological emissions.
- Annual Title V Compliance Certification Report, which indicates compliance status with all conditions of the permit.
- Title V Semiannual Report, which covers a 6-month period for some specific emission sources and consists of monitoring and recordkeeping requirements for the sources.
- 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 4.9. Actual versus allowable air emissions from the Y-12 Steam Plant, 2022

Emissions (tons/yr)[a]			
Pollutant	**Actual**	**Allowable**	**Percentage of allowable**
Particulate	2.80	41.0	6.8
Sulfur dioxide	0.22	39.0	0.6
Nitrogen oxides[b]	11.79	81.0	14.5
VOCs[b]	2.72	9.4	28.9
Carbon monoxide[b]	30.95	139.0	22.3

Note: *The emissions are based on fuel usage data for January through December 2022. The VOC emissions include VOC hazard air pollutant emissions.*

[a] *1 ton = 907.2 kg.*

[b] *When no applicable standard or enforceable permit condition exists for a pollutant, the allowable emissions are based on the maximum actual emissions calculation, as defined in Tennessee Department of Environment and Conservation Rule 1200-3-26-.02(2)(d)3 (maximum design capacity for 8,760 h/yr). Both actual and allowable emissions were calculated based on the latest US Environmental Protection Agency compilation of air pollutant emission factors (EPA 1995, 1998).*

Acronyms:

VOC = volatile organic compound *Y-12 = Y-12 National Security Complex*

Table 4.9 lists the actual emissions versus allowable emissions for the Y-12 Steam Plant.

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 managing and controlling asbestos, ozone-depleting substances, and fugitive particulate emissions.

Asbestos Control

Y-12 also has a number of general requirements applicable to removing and disposing of asbestos-containing materials, including monitoring, notifying TDEC of demolitions and renovations, and prescribed work practices for abating and disposing of asbestos materials. There was no reportable release of asbestos in 2022. There were two notifications of asbestos demolitions and renovations. Asbestos, ozone-depleting substances, and fugitive particulate emissions are notable examples.

Stratospheric Ozone Protection and Hydrofluorocarbon Phasedown

As required by the Clean Air Act Title VI Amendments of 1990, and in accordance with 40 CFR 82, actions have been implemented to comply with the prohibition against intentionally releasing ozone-depleting substances during maintenance activities performed on refrigeration equipment. During 2017, EPA enacted major revisions to the stratospheric ozone rules, including regulating non-ozone-depleting substance 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 at Y-12 that leaked refrigerant in 2022 triggering this reporting. On October 1, 2021, EPA began implementing the hydrofluorocarbon phasedown requirements of the American Innovation and Manufacturing Act of 2020, which seeks to reduce hydrofluorocarbon consumption and production to 15 percent of a 2011–2013 baseline by 2036 (EPA 2022). Sitewide use of hydrofluorocarbons is being evaluated to understand future effects of Act phasedowns.

Fugitive Particulate Emissions

As modernization reduction efforts increase at Y-12, good work practices and controls are needed to minimize fugitive dust emissions from construction and demolition activities. Y-12 personnel 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 the following:

- Where possible, using water or chemicals to control dust when demolishing existing buildings or structures, performing construction operations, grading roads, or clearing land.
- Applying asphalt, water, or suitable chemicals on dirt roads, material stockpiles, and other surfaces that can create airborne dusts.
- Installing and using 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 4.11). The particle size and solubility class of the emissions are 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 following four categories of processes or operations are considered when calculating the total uranium emissions:

- Those that exhaust through monitored stacks.
- Unmonitored processes for which calculations are performed according to 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).

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 cleaning at each source are incorporated into the respective emission point source terms. In 2022, 24 process exhaust stacks were continuously monitored, 23 of which were major sources; the remaining stack was a minor source, and its contribution to Y-12's air emissions was conservatively accounted for using Appendix D calculations. The sampling systems on the stacks have been approved by EPA Region 4.

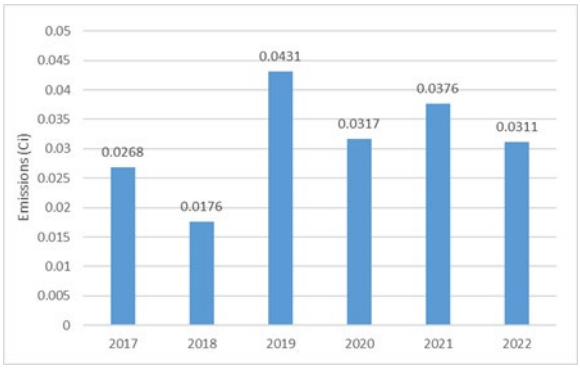


Figure 4.11. Total curies of uranium discharged from Y-12 to the atmosphere, 2017–2022

During 2022, unmonitored uranium emissions at Y-12 occurred from 41 points associated with on-site unmonitored processes and laboratories. Emission estimates for the processes and laboratory stacks were made using inventory data with emission factors provided in 40 CFR 61, Appendix D. The Y-12 source term includes an estimate of these emissions.

Y-12's Analytical Chemistry Organization operates out of two main laboratories. One is located in Building 9995, and 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 2022, 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 *Compliance Plan, National Emission Standards for Hazardous Air Pollutants for Airborne Radionuclides on the Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE 2020a), are included in the annual source term. Annual average concentrations and design ventilation rates are used to arrive at the annual emission estimate for those areas. Two emission points from room ventilation exhausts were identified in 2022, where emissions exceeded 10 percent of the derived air concentration. Both of these emission points fed to monitored stacks, and any radionuclide emissions were accounted for as noted for monitored emission points; 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 EU and DU process emission units. A limit of 907 kg/yr- 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 radiological NESHAP compliance. An estimated 0.0311 Ci (34.0 kg) of uranium was released into the atmosphere in 2022 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 2022 was 0.5 mrem. This dose is well below the NESHAP standard of 10 mrem and is less than 0.2 percent of the roughly 300 mrem that the average individual receives from natural sources of radiation. Chapter 7 discusses how the airborne radionuclide dose was determined.

Lastly, the UPF is being designed and constructed to 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 Title V operating permit 571832. The UPF construction air permit was incorporated into the Y-12 Title V air permit on February 18, 2019. The Title V air permit was administratively extended until a new permit is issued. The UPF project will be maintained on inactive status until operational readiness and startup.

4.4.1.3. Quality Assurance

Quality assurance (QA) activities for the Radiological NESHAP Program are documented in the *Y-12 National Security Complex Quality Assurance Project Plan National Emission Standards for Hazardous Air Pollutants Radionuclide Emission Measurements* (CNS 2020). The plan satisfies the QA requirements in 40 CFR 61, Method 114, for ensuring that 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 0400-30-38, "Emission Standards for Hazardous Air Pollutants" (TDEC 2022b). 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 data quality. 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., high-efficiency particulate air 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. Actual versus allowable emissions from the steam plant are listed in Table 4.9.

Particulate emissions from point sources result from many operations throughout Y-12. Compliance is demonstrated through 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, methanol, and vertrel throughout Y-12 and volatile organic compounds (VOCs) from the steam plant are primary sources of VOC emissions. Material mass balances and engineering calculations are used to determine annual emissions. The calculated amounts of solvent 140/142 and methanol emitted for CY 2022 are 8,294.39 lb (4.15 tons) and 46,022 lb (15.25 tons), respectively.

4.4.1.5. Mandatory Reporting of Greenhouse Gas Emissions Under 40 CFR 98

40 CFR 98, "Mandatory Reporting of Greenhouse Gases," establishes mandatory 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 rule requires reporting annual emissions of carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons, perfluorochemicals, and other fluorinated gases (e.g., nitrogen trifluoride and hydrofluorinated ethers). These gases are often expressed in metric tons of carbon dioxide equivalent (CO_2e).

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

The Y-12 Steam Plant is subject to this rule. The steam plant consists of four boilers. The maximum heat input capacity of each boiler does not exceed 99 million Btu/h. Natural gas is the primary fuel source for the boilers; Number 2 fuel oil is a backup fuel source. Other limited, stationary combustion sources are metal forming operations and production furnaces that use natural gas. In Building 9212, a gas-fired furnace used for drying wet residues and burning solids in a recovery process has a maximum heat input of 700,000 Btu/h. In Building 9215, 10 natural gas torches, each at 300 standard ft^3/h, are used to preheat tooling associated with a forging and forming press. In Building 9204-02, natural gas is used to heat two electrolytic cells. The maximum rated heat input to the burners on each cell is 550,000 Btu/h.

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

The emissions report is submitted electronically in a format specified by the EPA. 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 4.10. 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 became operational. The slight increase in

CO_2e emissions was because fuel oil was burned for a few days in December 2018. A slightly decrease in CO_2e emissions in 2022 was primarily due to no oil and less natural gas being burned in the steam plant boilers.

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

Year	GHG emissions (metric tons CO_2e)
2010	97,610
2011	70,187
2012	63,177
2013	61,650
2014	58,509
2015	51,706
2016	50,671
2017	50,292
2018	51,010
2019	45,971
2020	46,126
2021	43,812.7
2022	43,224.2

Acronyms:
CO_2e = CO_2 equivalent
GHG = greenhouse gas
Y-12 = Y-12 National Security Complex

4.4.1.6. Hazardous Air Pollutants (Nonradiological)

Beryllium emissions from machine shops are regulated under a state-issued permit and are subject to a limit of 10 g/24 h. Compliance is demonstrated through a onetime 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 2022 and were found to be operating properly.

Methanol is released as fugitive emissions (e.g., pump and valve leaks) as part of the brine and methanol system. Methanol is subject to state air permit requirements; however, due to the nature of its release (fugitive emissions only), no specific emission limits or mandated controls exist.

Mercury is a significant legacy contaminant at Y-12, and cleanup is being addressed by DOE EM. 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 as discussed in Section 4.4.2.1.

In 2007, EPA vacated a proposed Maximum Achievable Control Technology standard that was intended to minimize hazardous air pollutant emissions. At that time, a case-by-case Maximum Achievable Control Technology review was conducted as part of the construction-permitting process for the Y-12 replacement steam plant. The new natural gas-fired steam plant became operational on April 20, 2010, and coal is no longer combusted. Specific conditions aimed at minimizing hazardous air pollutant emissions from the new steam plant were incorporated into the operating permit issued on January 9, 2012, as discussed in Section 4.4.1. In addition, the boiler Maximum Achievable Control Technology 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 Maximum Achievable Control Technology requirements. The new requirements (work practice standards) include conducting annual tune-ups and a onetime energy assessment of the boilers to meet these requirements.

The steam plant has no numeric emission limit requirements. The new rule requires that a onetime 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 February 21 and 22, 2022.

Unplanned releases of hazardous air pollutants are regulated through 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 Clean Air Act, Title III, Section 112(r), "Accidental Release Prevention/Risk Management Plan Rule." 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 regulations to reduce air emissions from reciprocating internal combustion engines. Two types of federal air standards are applicable to reciprocating internal combustion engines—new source performance standards (40 CFR 60, Subpart IIII), and NESHAP (40 CFR 63, Subpart DDDDD). The compression ignition engines and generators located at Y-12 are subject to these rules. EPA is concerned how reciprocating internal combustion engines are used and the emissions generated from these engines in the form of both hazardous air pollutants and criteria pollutants.

All previous stationary, emergency engines and 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 hazardous air pollutants. Regardless of engine size, the rules apply to any existing, new, or reconstructed stationary reciprocating internal combustion engine located at a major source of hazardous air pollutant emissions.

To comply with the rules, Y-12 prepared a significant permit modification to its Title V (Major Source) Operating Air Permit to add numerous stationary, emergency use engines and 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 40 CFR 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 and generators. Compliance for the engines and generators is determined through monthly records of the operation of the engines and generators that are recorded through a nonresettable hour meter on each engine and generator. Documentation of how many hours are spent for emergency operation, maintenance checks and readiness testing, and nonemergency operation must be maintained. Each engine and generator must use only diesel fuel with low sulfur content (15 parts per million) and an acetane index of 40. The vendor, Rogers Petroleum, supplied a onetime statement certifying that all diesel fuel will contain no more than 15 parts per million of sulfur by weigh; and will either have a minimum cetane index of 40 or a maximum aromatic content of 35 volume percent.

Since the above rules were adopted into Tennessee Air Pollution Control Regulations 0400-30, Chapters 38 and 39, the emergency engines and generators can be considered an insignificant activity if the potential to emit is below the significance thresholds (less than 5 tons/yr of each criteria pollutant and less than 1,000 lb/yr of any hazardous air pollutant evaluated at a 500 h/yr limit). There was also a change to Chapter 9 of Tennessee Air Pollution Control Regulations 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 and generators are used to provide power for critical systems in the event of electrical power failures and outages at Y-12. The engines and generators operate exclusively as emergency engines and generators. Based upon historical usage of the emergency engines,

generators, and fire water pumps, and EPA's 500 h default assumption (maximum hour usage), calculations verify and confirm that 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/yr of each regulated air pollutant that is not a hazardous air pollutant, and less than 1,000 lb/yr of any hazardous air pollutant, in accordance with Tennessee Air Pollution Control Regulations 1200-03-09-.04(5)(a)4(i). Approximately 95 percent of Y-12's stationary, emergency engines, generators, and fire water pumps are considered and/or reclassified as an insignificant activity in accordance with the regulation. 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 must be considered 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.

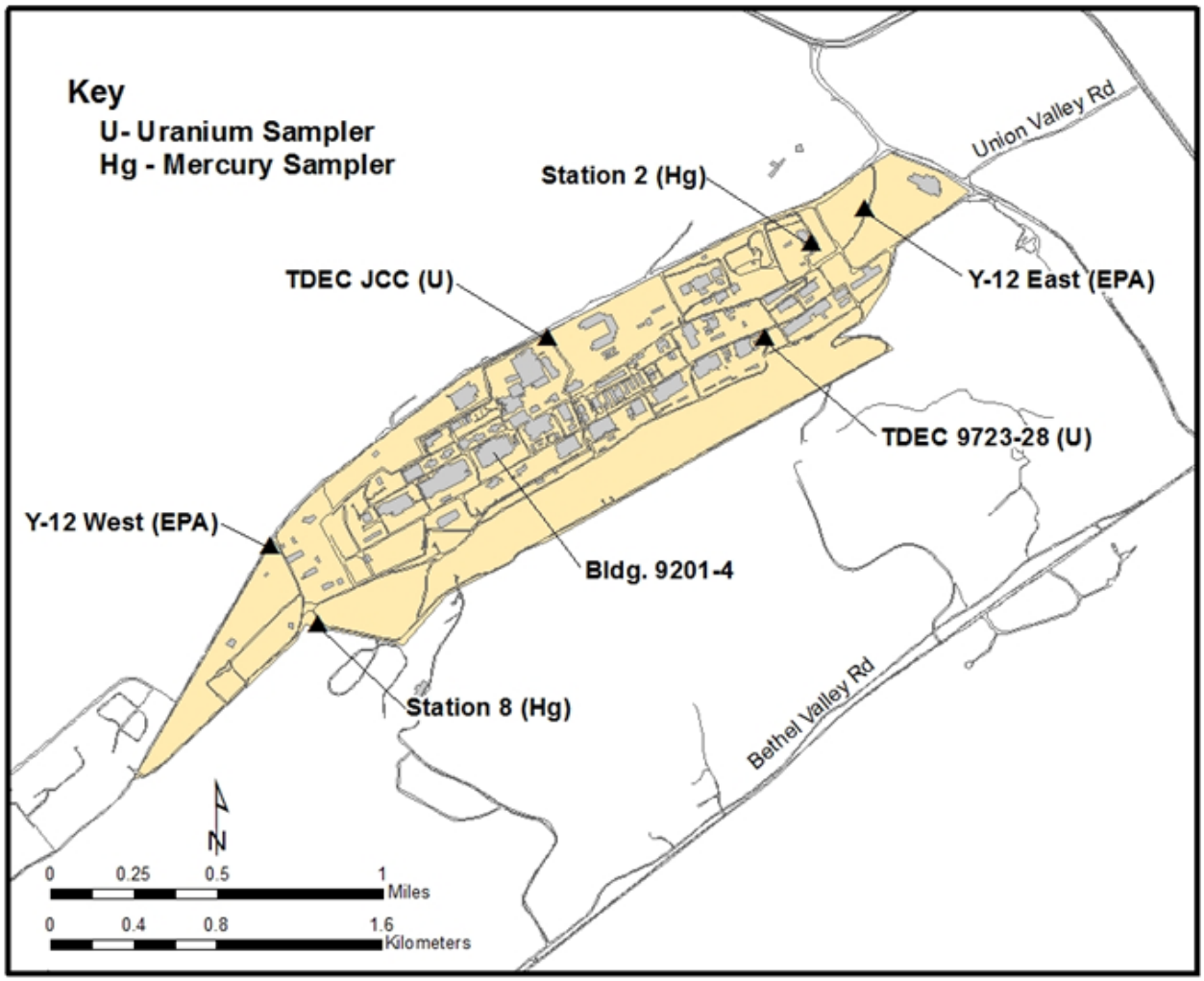
No federal regulations, state regulations, or DOE orders require ambient air monitoring within the Y-12 boundary; however, on-site ambient air monitoring for mercury and radionuclides is conducted as a best management practice. With the reduction of plant operations and improved emission and administrative controls, levels of measured pollutants have decreased significantly during the past several years. In addition, major processes that emit EU and DU are equipped with stack samplers that have been reviewed and approved by EPA to meet requirements of the NESHAP regulations.

4.4.2.1. Mercury

The Y-12 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. Originally four monitoring stations were operated at Y-12, including two within the former West End Mercury Area at Y-12. The two atmospheric mercury monitoring stations currently operating at Y-12—AAS2 and AAS8—are located near the east and west boundaries, respectively (Figure 4.12). 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.

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 about 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.



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

Figure 4.12. Locations of ambient air monitoring stations at Y-12

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 4.11). Average mercury concentration at the AAS2 site for 2022 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 demolition and decommissioning work on the west end, the average concentration at AAS8 for 2022 was 0.0025 µg/m^3 (N = 25), similar to levels reported since 2008 and the early 2000s.

Table 4.11 summarizes the 2022 mercury results with results from the 1986 through 1988 period included for comparison. Figure 4.20 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 2022 [parts (a) and (b)] and seasonal trends at AAS8 from 1994 through 2022 [part (c)]. The dashed line superimposed on the plots in Figure 4.13(a) and (b) is the EPA reference concentration of 0.3 µg/m^3 for chronic inhalation

exposure. The large increase in mercury concentration at AAS8 observed in the late 1980s [part (b)] was thought to be related to disturbances of mercury-contaminated soils and sediments during installation of the Perimeter Intrusion Detection and Assessment System and storm drain restoration projects underway at that time within the West End Mercury Area. In Figure 4.13(c), a monthly moving average has been superimposed over the AAS8 data to highlight seasonal trends in mercury at AAS8 from January 1994 through 2022.

Table 4.11. Summary of data for the Y-12 Ambient Air Monitoring Program for mercury, CY 2022

Ambient air monitoring stations	Mercury vapor concentration (µg/m³)			
	2022 Minimum	2022 Maximum	2022 Average	1986–1988[a] Average
AAS2 (east end of the Y-12 Complex)	0.0001	0.0045	0.0025	0.010
AAS8 (west end of the Y-12 Complex)	0.0010	0.0049	0.0025	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

In conclusion, 2022 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/m³, time-weighted average for up to a 10-h workday, 40-h workweek; the American Conference of Governmental Industrial Hygienists workplace threshold limit value of 25 µg/m³ as a time-weighted average for a normal 8-h workday and 40-h workweek; and the current EPA reference concentration of 0.3 µg/m³ for elemental mercury for a continuous inhalation exposure to the human population without appreciable risk of harmful effects during a lifetime).

4.4.2.2. Quality Control

A number of QA/quality control (QC) steps are taken to ensure the quality of the data for Y-12 mercury in the Ambient Air Monitoring Program.

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

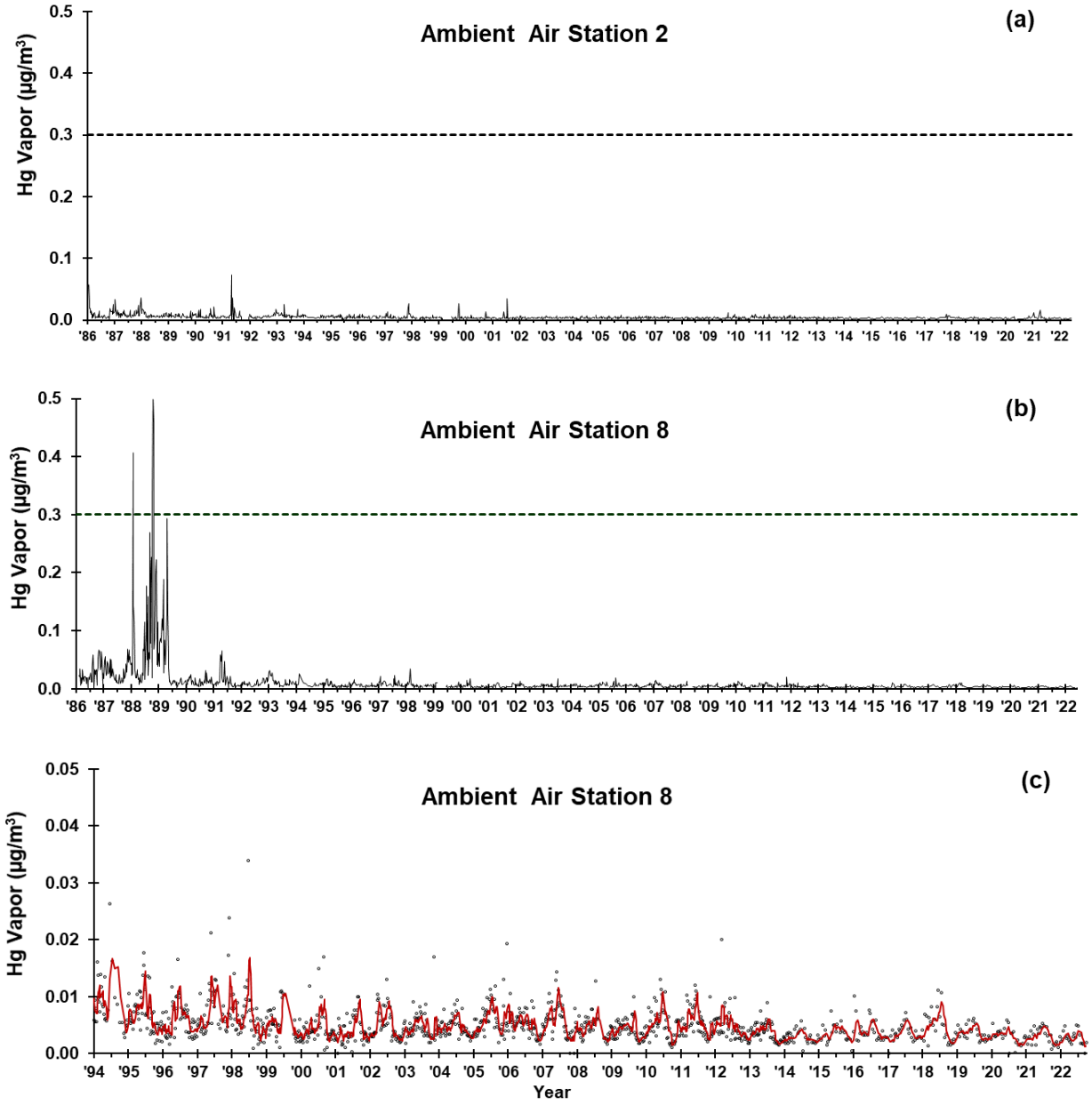


Figure 4.13. Temporal trends in mercury vapor concentration for the boundary monitoring stations at Y-12, July 1986 to December 2022 [(a) and (b)] and January 1994 to December 2022 for ambient air station 8 [(c)]

In Figure 4.13, the dashed lines superimposed on (a) and (b) represent the EPA reference concentration of 0.3 µg/m^3 for chronic inhalation exposure. In (c) (note different concentration scale), a monthly moving average has been superimposed over the data to highlight seasonal trends in mercury at AAS8 from January 1993 to December 2021, with higher concentrations generally measured during the warm weather months.

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 percent 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 proper procedures are followed by the sampling technicians. No problems were noted during sample collection at time of evaluation. The evaluation was conducted on November 22, 2022.

Analytical QA/QC requirements include the following:

- Use of prescreened and/or laboratory purified reagents.
- Analysis of at least two method blanks per batch.
- Analysis of standard reference materials.
- Analysis of laboratory duplicates (one per 10 samples; any laboratory duplicates differing by more than 10 percent at five 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 Ambient Air Monitoring

Ambient air monitoring is conducted at multiple locations near ORR to measure radiological and other selected parameters. These monitors are operated in accordance with DOE orders. Their locations were selected so that areas of potentially high exposure to the public are monitored continuously for parameters of concern. This monitoring provides direct measurement of airborne concentrations of radionuclides and other hazardous air pollutants, allows facility personnel to determine the relative level of contaminants at the monitoring locations during an emergency, verifies that the contributions of fugitive and diffuse sources are insignificant, and serves as a check on dose-modeling calculations. As part of the ORR network, an ambient air station 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 city Country Club Estates neighborhood (Station 37).

In addition to this monitoring, 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 monitor 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 three additional high volume samplers (Figure 4.12) are now being used by TDEC to provide isotopic uranium monitoring capability. These are located at Station 2, 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. This monitoring station was relocated near Station 8, as depicted in Figure 4.12.

In addition, TDEC DOE Oversight Division air quality monitoring includes several other types of monitoring on ORR, such as the following:

- RADNet air monitoring
- Fugitive radioactive air emission monitoring
- Ambient VOC air monitoring
- Perimeter air monitoring
- Real-time monitoring of gamma radiation
- Ambient gamma radiation monitoring using external dosimetry
- Program-specific monitoring associated with infrastructure-reduction activities

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

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

4.5. Water Quality Program

Water quality is monitored at Y-12 to satisfy the NPDES permit and the Industrial Wastewater Discharge Permit. It is also monitored in real time to indicate potential adverse conditions that could be causing an impact on water quality in Upper EFPC.

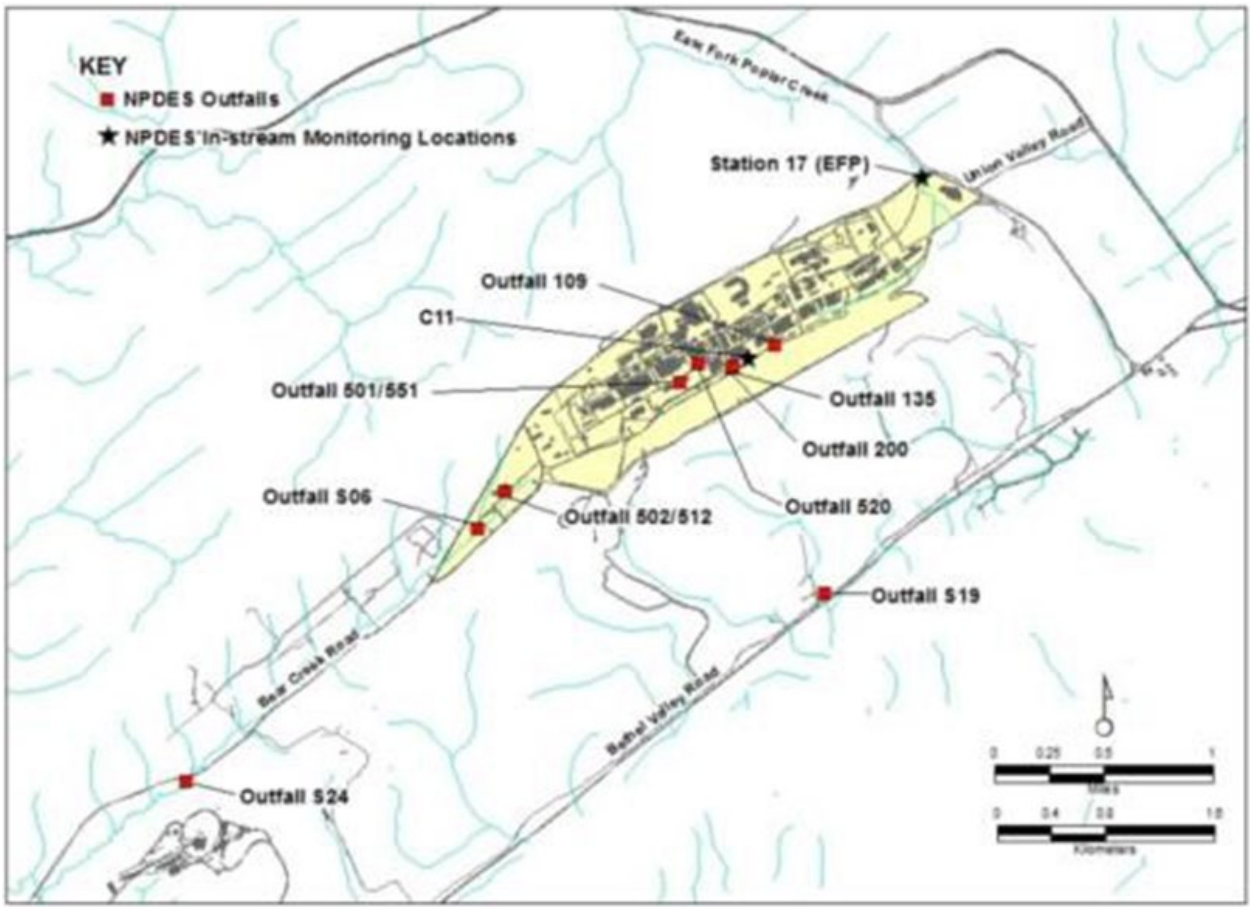
4.5.1. National Pollutant Discharge Elimination System Permit and Compliance Monitoring

For January through September 2022, the Y-12 NPDES permit (TN0002968) required sampling, analysis, and reporting for about 56 outfalls. Major outfalls are shown in Figure 4.14. A new NPDES permit became effective October 1, 2022. (The new permit is currently under appeal in part. Y-12 is working with the regulators to resolve.) The number of outfalls changes as they are eliminated or consolidated or if permitted discharges are added. Currently, Y-12 has outfalls and monitoring points in 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 sampling and analyzing 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 near 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 Clinch River. Bear Creek water quality is affected by area source runoff and groundwater discharges. The NPDES permit requires regular monitoring and storm water characterization in Bear Creek and several of its tributaries.

Requirements of the NPDES permit for 2022 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 2022 was 100 percent, as shown in Tables 4.12 and 4.13.



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

Figure 4.14. Major Y-12 National Pollutant Discharge Elimination System outfalls and monitoring locations

Table 4.12. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, January–September 2022

Discharge point	Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Outfall 501 (Central Pollution Control)							
	pH, standard units			[a]	9.0	[b]	0
	Total suspended solids			31.0	40.0	[b]	0
	Total toxic organic				2.13	[b]	0
	Hexane extractables			10	15	[b]	0
	Cadmium	0.16	0.4	0.07	0.15	[b]	0
	Chromium	1.0	1.7	0.5	1.0	[b]	0
	Copper	1.2	2.0	0.5	1.0	[b]	0
	Lead	0.26	0.4	0.1	0.2	[b]	0
	Nickel	1.4	2.4	2.38	3.98	[b]	0
	Nitrate/Nitrite				100	[b]	0
	Silver	0.14	0.26	0.05	0.05	[b]	0
	Zinc	0.9	1.6	1.48	2.0	[b]	0
	Cyanide	0.4	0.72	0.65	1.2	[b]	0
	PCB				0.001	[b]	0
Outfall 502 (West End Treatment Facility)							
	pH, standard units			[a]	9.0	100	1
	Total suspended solids		31		40	100	1
	Total toxic organic				2.13	100	1
	Hexane extractables			10	15	100	1
	Cadmium		0.4		0.15	100	1
	Chromium		1.7		1.0	100	1
	Copper		2.0		1.0	100	1
	Lead		0.4		0.2	100	1
	Nickel		2.4		3.98	100	1
	Nitrate/Nitrite				100	100	1
	Silver		0.26		0.05	100	1
	Zinc		0.9		1.48	100	1
	Cyanide		0.72		1.20	100	1
	PCB				0.001	100	1
Outfall 512 (Groundwater Treatment Facility)							
	pH, standard units			[a]	9.0	100	9
	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	40
	Hexane extractables			10	15	100	10
	Cadmium			0.001	0.023	100	9

Table 4.12. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, January–September 2022 (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
	IC_{25} *Ceriodaphnia*			37% Minimum		100	1
	IC_{25} *Pimephales*			37% Minimum		100	1
	Total residual chlorine			0.024	0.042	100	9
Outfall 551							
	pH, standard units			[a]	9.0	100	39
	Mercury			0.002	0.004	100	39
Outfall C11							
	pH, standard units			[a]	9.0	100	10
Outfall 135							
	pH, standard units			[a]	9.0	100	10
	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	3
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	3
Outfall EFP							
	pH, standard units			[a]	9.0	100	10
Category I outfalls							
	pH, standard units			[a]	9.0	100	34
Category II outfalls							
	pH, standard units			[a]	9.0	100	12
	Total residual chlorine				0.5	100	13
Category III outfalls							
	pH, standard units			[a]	**9.0**	**100**	**6**
	Total residual chlorine			[a]	**0.5**	**100**	**6**

[a] *Not applicable.*
[b] *No discharge.*
Acronyms:
IC_{25} = 25-percent inhibition concentration
PCB = polychlorinated biphenyl
Y-12 = Y-12 National Security Complex

Table 4.13. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, October–December 2022

Discharge point	Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Outfall 501 (Central Pollution Control)							
	pH, standard units			[a]	9.0	[b]	0
	Total suspended solids			31.0	40.0	[b]	0
	Total toxic organic				2.13	[b]	0
	Hexane extractables			10	15	[b]	0
	Cadmium	0.16	0.4	0.07	0.15	[b]	0
	Chromium	1.0	1.7	0.5	1.0	[b]	0
	Copper	1.2	2.0	0.5	1.0	[b]	0
	Lead	0.26	0.4	0.1	0.2	[b]	0
	Nickel	1.4	2.4	2.38	3.98	[b]	0
	Nitrate/Nitrite				100	[b]	0
	Silver	0.14	0.26	0.05	0.05	[b]	0
	Zinc	0.9	1.6	1.48	2.0	[b]	0
	Cyanide	0.4	0.72	0.65	1.2	[b]	0
	PCB				0.001	[b]	0
Outfall 502 (West End Treatment Facility)							
	pH, standard units			[a]	9.0	100	0
	Total suspended solids		31		40	100	0
	Total toxic organic				2.13	100	0
	Hexane extractables			10	15	100	0
	Cadmium		0.4		0.15	100	0
	Chromium		1.7		1.0	100	0
	Copper		2.0		1.0	100	0
	Lead		0.4		0.2	100	0
	Nickel		2.4		3.98	100	0
	Nitrate/Nitrite				100	100	0
	Silver		0.26		0.05	100	0
	Zinc		0.9		1.48	100	0
	Cyanide		0.72		1.20	100	0
	PCB				0.001	100	0
Outfall 512 (Groundwater Treatment Facility)							
	pH, standard units			[a]	9.0	100	3
	PCB				0.001	100	0
Outfall 551							
	pH, standard units			[a]	9.0	100	12
	Mercury			0.002	0.004	100	12

Table 4.13. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, October–December 2022 (continued)

Discharge point	Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Outfall C11 (Instream EFPC)							
	Temperature				30.5	100	1
	pH			[a]	9.0	100	1
	Ammonia (as N) Summer			1.01	2.02	100	1
	Ammonia (as N) Winter			1.92	3.84	100	0
	Cyanide			0.0052	0.022	100	1
	Cadmium			0.0043	0.0118	100	1
	Copper			0.0407	0.064	100	1
	Lead			0.0244	0.6265	100	1
	Nickel			0.189	1.705	100	1
	Silver				0.0081	100	1
	Zinc			0.646	0.641	100	1
	Selenium			0.0031	0.020	100	1
	Total Residual Chlorine			0.011	0.019	100	1
Outfall C03 (Instream EFPC)							
	Temperature				30.5	100	1
	pH			[a]	9.0	100	1
	Ammonia (as N) Summer			1.01	2.02	100	1
	Ammonia (as N) Winter			1.92	3.84	100	0
	Cyanide			0.0052	0.022	100	1
	Cadmium			0.0043	0.0118	100	1
	Copper			0.0407	0.064	100	1
	Lead			0.0244	0.6265	100	1
	Nickel			0.189	1.705	100	1
	Silver				0.0081	100	1
	Zinc			0.646	0.641	100	1
	Selenium			0.0031	0.020	100	1
	Total Residual Chlorine			0.011	0.019	100	1

Table 4.13. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, October–December 2022 (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 EFP (Station 17)							
	Temperature				30.5	100	1
	pH			[a]	9.0	100	1
	Ammonia (as N) Summer			1.01	2.02	100	1
	Ammonia (as N) Winter			1.92	3.84	100	0
	Cyanide			0.0052	0.022	100	1
	Cadmium			0.0043	0.0118	100	1
	Copper			0.0407	0.064	100	1
	Lead			0.0244	0.6265	100	1
	Nickel			0.189	1.705	100	1
	Silver				0.0081	100	1
	Zinc			0.646	0.641	100	1
	Selenium			0.0031	0.020	100	1
	Total Residual Chlorine			0.011	0.019	100	1

**Limits are under appeal.*
[a] *Not applicable.*
[b] *No discharge.*
Acronyms:
IC25 = 25-percent inhibition concentration
PCB = polychlorinated biphenyl
Y-12 = Y-12 National Security Complex

4.5.2. Radiological Monitoring Plan and Results

Y-12 has a radiological monitoring plan to address compliance with DOE orders that is provided to TDEC as a matter of comity under NPDES Permit TN0002968. Y-12 submitted 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. In October 2022, the new NPDES permit became effective, and the requirement for a radiological monitoring plan was removed. 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 four types of locations: treatment facilities, other point source and area source discharges, instream locations, and storm water runoff from production area roofs. Operational history and past monitoring results provide a basis for parameters routinely monitored under the plan (Table 4.14). The *Radiological Monitoring Plan for the Oak Ridge Y-12 National Security Complex: Surface Water* (B&W Y-12 2012) was revised and reissued in January 2012 and again in October 2020. The revised plan was implemented on November 1, 2020. This revision added Outfall 109 and roof runoff from production areas.

Table 4.14. Radiological parameters monitored at Y-12, 2020

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.
	^{3}H	Tritium is not expected to be high in fuel elements, because tritium is produced primarily as an activation product in reactor coolants. Tritium is highly mobile and is detected in groundwater samples associated with the S-3 Site.
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 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-d composite sample for radiological parameters taken at Station 17 on EFPC likely includes rain events.

Radiological monitoring plan locations sampled in 2022 are noted on Figure 4.15. Table 4.15 identifies the monitored locations, the frequency of monitoring, and the sum of the percentages of the derived concentration standards for radionuclides measured in 2022. Radiological data were well below the allowable derived concentration standards.

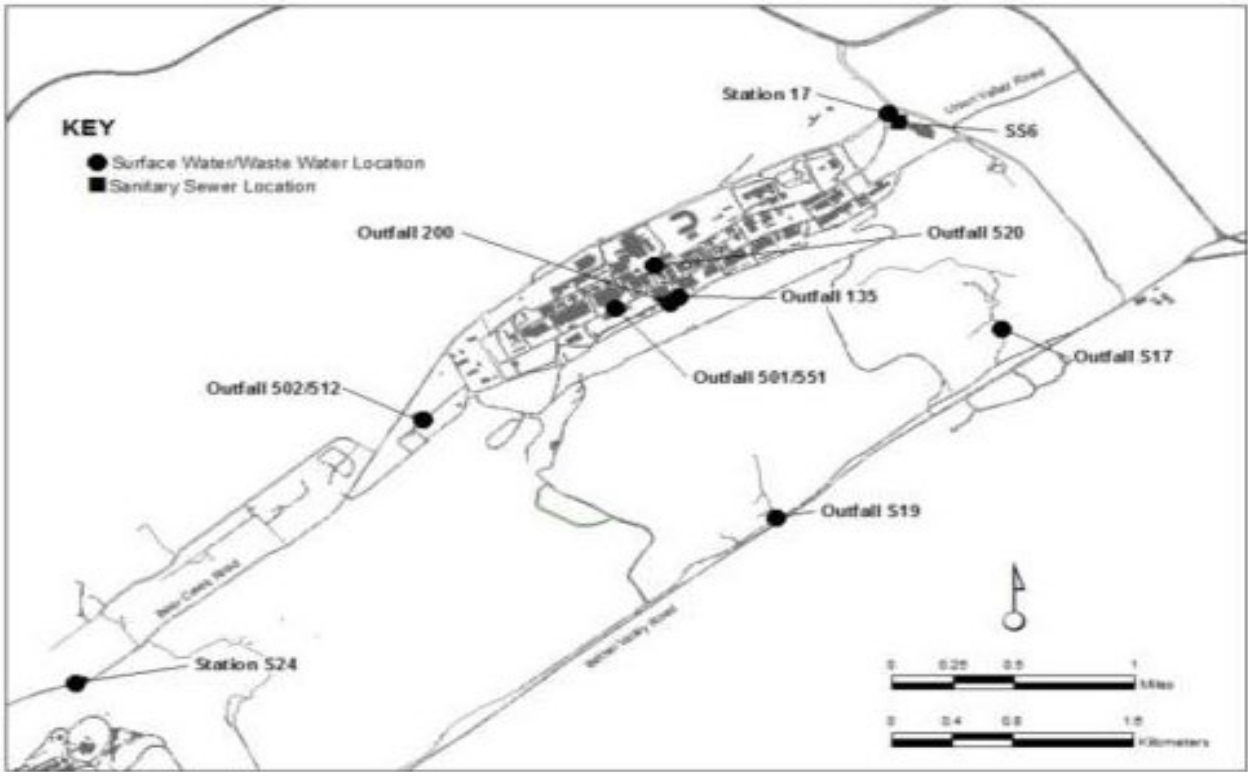


Figure 4.15. Surface water and sanitary sewer radiological sampling locations at Y-12

Table 4.15. Summary of Y-12's radiological monitoring plan sample requirements and 2022 results

Location	Sample frequency	Sample type	Sum of derived concentration standards 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-h composite	0.45
Groundwater Treatment Facility	4/yr	24-h composite	1.5
Central Mercury Treatment Facility	4/yr	24-h composite	0.33
Other Y-12 point and area source discharges			
Outfall 109	4/yr	24 h composite	1.3
Outfall 135	4/yr	24-h composite	0.53
Kerr Hollow Quarry	1/yr	24-h composite	0.18
Rogers Quarry	1/yr	24-h composite	0.044
Y-12 instream locations			
Outfall S24	1/yr	7-d composite	4.4
East Fork Poplar Creek, complex exit (east)	1/month	7-d composite	0.86
North/south pipes	1/month	24-h composite	1.6
Y-12 Production roof runoff			
9215 Fan Room	4/yr	Grab during rain	16
Stack 47	4/yr	Grab during rain	33

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

In 2022, the total mass of uranium and associated curies released from Y-12 at the easternmost monitoring station, Station 17 on Upper EFPC, was 167 kg or 0.071 Ci, as shown in Table 4.16.

Table 4.16. Uranium release from Y-12 to the off-site environment as liquid effluent, 2014–2022

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
2020	0.082	173
2021	0.063	139
2022	0.071	167

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

Acronym:

Y-12 = Y-12 National Security Complex

Figure 4.16 illustrates a 6-year trend of these releases. The total release is calculated by multiplying the average concentration (g/L) by the average flow (million gal/d). Converting units and multiplying by 365 d/yr yields the calculated discharge.

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, although no city-established radiological limits exist. 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 2022 quarterly monitoring reports.

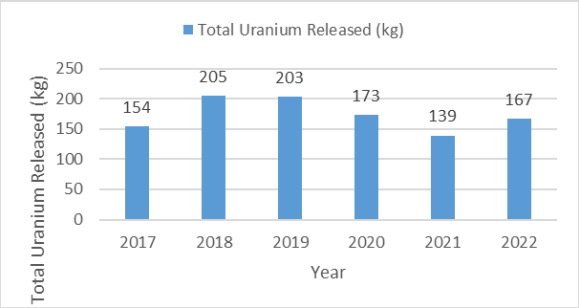


Figure 4.16. Six-year trend of Y-12 uranium releases to East Fork Poplar Creek

4.5.3. Storm Water Pollution Prevention

A new NPDES permit was issued to Y-12 with an effective date of October 2022. The October 2022 NPDES permit implements several changes to the storm water program. The changes include new requirements for the storm water pollution prevention as well as new sampling requirements and locations.

The new permit requirements are reflected in the Y-12 storm water pollution prevention plan, which 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 characterizing storm water by sampling during storm events, implementing measures to reduce storm water pollution, facility inspections, and employee training.

The new permit sampling requirements include a major change in the removal of sector benchmarks comparisons for storm water sampling results and the introduction of permit-specific benchmarks and alert values. For the October 2022 NPDES permit, storm water monitoring will be performed in 2023 on two levels—category outfalls and wet weather locations. Y-12 also completed the storm water monitoring under the previous permit requirements that were initiated at the beginning of 2022. The prior NPDES permit defined Y-12 as a fabricated metal products industry and required storm water monitoring be conducted for three additional "sectors." These sectors are defined in

the Tennessee Storm Water Multi-Sector General Permit for Industrial Activities, Permit No. TNR050000, effective July 19, 2020. Some sectors have prescribed benchmark values. The benchmark and median values used for comparison purposes in this report are provided in the prior Y-12 NPDES permit.

Storm water sampling was conducted in 2022 during rain events that occurred on April 5, 2022; July 18, 2022; and November 11, 2022. Results were published in the *Annual Stormwater Report for the Y-12 National Security Complex* (CNS, 2022a), which was submitted to TDEC Division of Water Resources in January 2023. 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 4.16).

Sampling conducted in 2022 revealed the following:

- Outfall 014: The aluminum concentration was above the benchmark value. The exact cause of the aluminum result being above the benchmark for Outfall 014 is unknown; however, it is noteworthy that construction activity for a new Fire Station is underway on the Outfall 014 network.
- Outfall 067: The aluminum and nitrate plus nitrite nitrogen were both slightly above the benchmark values. The cause of the elevated results is unknown.
- Outfall S30: The total suspended solids and copper values were above the benchmark values but well below the sector median values. The cause of the elevated results is unknown.
- Outfall S17: The total suspended solids value was above the sector median value. The cause of the elevated result is unknown.
- Outfall S18: The total suspended solids value was above the sector median value. Operations at the ORR Landfill are likely the cause of the elevated result.
- Outfall S06: The magnesium concentration exceeds both the benchmark and sector median values, and the cyanide concentration is slightly above the sector median value. The geology of this portion of the Tennessee valley typically results in abnormally high levels of magnesium, and the cause of the elevated cyanide result is unknown.

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, no monitoring was conducted in 2018 or 2019 due to the degraded condition of the outfall piping and the inability to gather reliable flow rate data. Maintenance work on Outfall 014 has now been completed, and sampling was resumed in 2020. Data collected to date are presented in Table 4.17.

Table 4.17. Mercury concentrations at Outfall 014

CY	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Mercury concentration (µg/L)	7.12	0.892	9.11	0.49	0.237	N/A	N/A	1.66	4.5	1.03

Acronyms: *CY = calendar year N/A = not available*

4.5.4. Ambient Surface Water Quality

A network of real-time monitors located at three instream locations along Upper EFPC is used to monitor key indicators of water quality. The Surface Water Hydrological Information Support System is available for real-time water quality measurements, such as pH, temperature, dissolved oxygen, conductivity, and chlorine. The locations are shown in Figure 4.17. The primary function of the Surface Water Hydrological Information Support System is to indicate

potential adverse conditions that could be causing an impact on water quality 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 to monitor trends throughout the three hydrogeologic regimes (see Section 4.6).

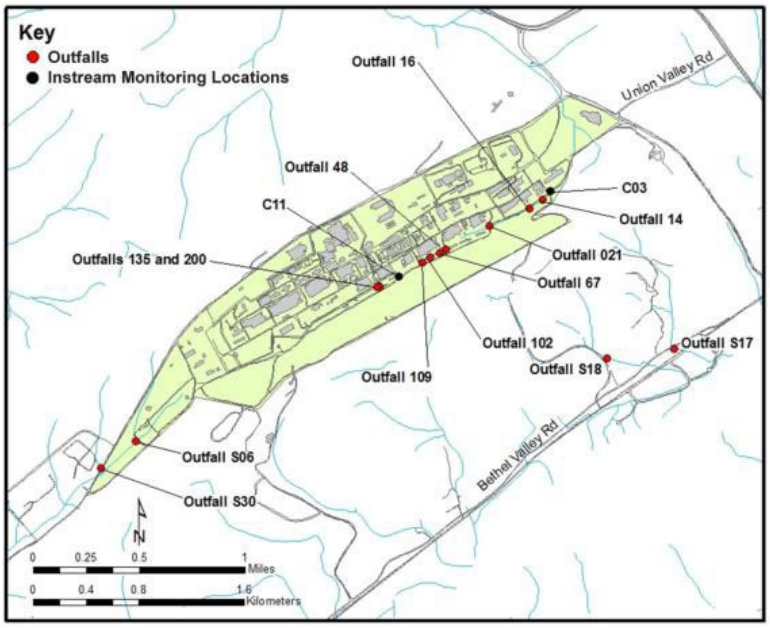


Figure 4.17. Y-12 storm water monitoring locations, East Fork Poplar Creek

4.5.5. Industrial Wastewater Discharge Permit

Industrial and Commercial User Wastewater Discharge Permit 1-91 defines requirements for discharging 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 and gross-beta are taken in a weekly 24-h composite sample. The sample is analyzed for uranium if the alpha or beta values exceed certain levels. Other parameters (including oil and grease, solids, and biological oxygen demand) are monitored on a monthly basis. Metals and 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 use the east end monitoring station (also known as SS6) to conduct compliance monitoring as required by the pretreatment regulations. City personnel also conduct compliance inspections twice a year.

Monitoring results from 2022 are listed in Table 4.18. Two permit limits were exceeded in 2022. There was one exceedance of the 2,100-gal/min instantaneous flow limit and one exceedance of the 500,000 gpd quarterly flow limit. To reduce storm water inflow and infiltration, a project has been initiated to evaluate and rehabilitate approximately 15,000 linear feet of the Y-12 sewage collection system. The project has evaluated the collection system via smoke tests and video inspection and is now performing needed repairs identified during the evaluation. The collection system refurbishment involves manhole relining, pipe bursting, installing cured in place piping, and other repairs. The repair work was completed in the B-449 and C-409A networks. Flow data evaluation indicates this project has reduced inflow and infiltration.

Table 4.18. Y-12 discharge point SS6

Effluent parameter	Number of samples	Average value	Daily maximum (gal/min)[a]	Monthly average (effluent limit)[a]	Number of limit exceedances
Max flow rate (gal/min)	Continuous	N/A	2,100	N/A	1
Flow (average kgpd) January through March	90	550	N/A	500[b]	1
Flow (average kgpd) April through June	91	374	N/A	500[b]	0
Flow (average kgpd) July through September	92	398	N/A	500[b]	0
Flow (average kgpd) October through December	92	413	N/A	500[b]	0
pH (standard units)	19	N/A	N/A	9 and 6[c]	0
Biochemical oxygen demand	14	<36	N/A	300	0
Kjeldhal nitrogen	13	24.7	N/A	45	0
Phenols—total recoverable	19	<0.072	N/A	0.15	0
Oil and grease	13	<8.4	N/A	25	0
Suspended solids	13	63	N/A	200	0
Cyanide	13	0.0043	N/A	0.006	0
Arsenic	5	<0.0011	N/A	0.01	0
Cadmium	5	<0.0004	N/A	0.0033	0
Chromium, hexavalent	4	<0.006	N/A	0.053	0
Copper	5	0.022	N/A	0.14	0
Iron	5	0.670	N/A	10	0
Lead	5	<0.002	N/A	0.049	0
Mercury	12	0.00104[d]	N/A	0.035[d]	0
Nickel	5	<0.004	N/A	0.021	0
Silver	5	<0.0057	N/A	0.05	0
Zinc	5	0.131	N/A	0.35	0
Molybdenum	5	0.0246	N/A	0.05[e]	N/A
Selenium	5	<0.002	N/A	0.01[e]	N/A
Toluene	4	<0.005	N/A	0.005[e]	N/A
Ammonia	5	19.8	N/A	0.10[e]	N/A
Methanol	4	<1.0	N/A	1.0[e]	N/A
Benzene	4	<0.005	N/A	0.005[e]	N/A
1,1,1-Trichloroethane	4	<0.005	N/A	0.005[e]	N/A
Ethylbenzene	4	<0.005	N/A	0.005[e]	N/A
Carbon tetrachloride	4	<0.005	N/A	0.005[e]	N/A
Chloroform	4	0.005	N/A	0.005[e]	N/A
Tetrachloroethene	4	0.0043	N/A	0.005[e]	N/A
Trichloroethene	4	<0.005	N/A	0.005[e]	N/A
trans-1,2-Dichloroethene	4	<0.005	N/A	0.005[e]	N/A
Methylene chloride	4	<0.005	N/A	0.005[e]	N/A

[a] *Industrial and commercial user wastewater permit limits.*
[b] *Average daily flow allowed in gal/d.*
[c] *Maximum and minimum value.*
[d] *Units are lb/d.*
[e] *This parameter does not have a permit limit. This value is the required detection limit. All units are mg/L unless noted otherwise.*

Acronyms: *kgpd = thousand gallons per day N/A = not applicable Y-12 = Y-12 National Security Complex*

4.5.6. Quality Assurance and Quality Control

The Environmental Monitoring Management Information System is used to manage surface water monitoring data at Y-12. It 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:

- Using standard operating procedures for sample collection and analysis.
- Using chain-of-custody and sample identification, customized chain-of-custody documents, and sample labels provided by the Environmental Monitoring Management Information System.
- Standardizing, calibrating, and verifying instruments.
- Training sample technicians.
- Preserving, handling, and decontaminating samples.
- Using QC samples (i.e., 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. The Environmental Monitoring Management Information System 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 monitoring and trending of data over time. Field information on all routine samples taken for surface water monitoring is entered in the Environmental Monitoring Management Information System, which also retrieves data nightly from the analytical laboratory. The system then performs numerous data checks, 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 to determine whether the effluent is contributing chronic toxicity to the receiving water. Prior to October 2022, these tests were required annually at Outfalls 135 and 200. A new permit became effective on October 1, 2022, increasing the testing frequency to quarterly, reducing testing to only Outfall 200, and changing the permit limits. Chronic toxicity testing is to be performed using 100 percent effluent and the dilution series shown in Table 4.19, where both the previous and current permit requirements are detailed.

Table 4.20 summarizes the results of the 2022 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. The permit limit for the previous permit was 9-percent whole effluent for Outfall 135 and 37-percent whole effluent for Outfall 200, and the permit limit for the current permit (effective October 1, 2022) is 50-percent whole effluent for Outfall 200.

Table 4.19. Serial dilutions for whole effluent toxicity testing, as a percent of effluent, before October 2022 and after October 1, 2022, with the new permit

Before October 2022						
Outfall 200	Control	0.25 x Permit limit	0.50 x Permit limit	Permit limit	(100+Permit limit)/2	100% Effluent
	0	9.3	18	37	74	100
Outfall 135	Control	0.25 x Permit limit	0.50 x Permit limit	Permit limit	2 x Permit limit	4 x Permit limit
	0	2.3	4.5	9	18	36
Starting October 1, 2022						
Outfall 200	Control	0.25 x Permit limit	0.50 x Permit limit	Permit limit	(100+Permit limit)/2	100% Effluent
	0	12.5	25	50	75	100

Note: *The effluent water is diluted with control laboratory water.*

Table 4.20. Y-12 biomonitoring program summary information for Outfalls 200 and 135, 2022

Water collection dates	Outfall	Test type	Test organism	End point	Metric[a]	IC_{25}[b] (%)
Annual test on previous permit, July 2022						
07/13/22–07/20/22	135	Chronic	Fathead minnow (*Pimephales promelas*)	Survival Growth	IC_{25} IC_{25}	>36% >36%
			Water fleas (*Ceriodaphnia dubia*)	Survival Reproduction	IC_{25} IC_{25}	>36% >36%
07/13/22–07/20/22	200	Chronic	Water fleas (*Ceriodaphnia dubia*)	Survival Reproduction	IC_{25} IC_{25}	>100% >100%
			Fathead minnow (*Pimephales promelas*)	Survival Growth	IC_{25} IC_{25}	>100% >100%
First quarterly test on current permit, November 2022						
11/02/22–11/09/22	200	Chronic	Water fleas (*Ceriodaphnia dubia*)	Survival Reproduction	IC_{25} IC_{25}	>100% >100%
			Fathead minnow (*Pimephales promelas*)	Survival Growth	IC_{25} IC_{25}	>100% >100%

[a] *IC25 is summarized for the discharge monitoring locations (Outfalls 200 and 135).*

[b] *IC25 as a percentage of full-strength effluent from Outfalls 200 and 135 diluted with laboratory control water. IC25 is the concentration that causes a 25-percent reduction in water fleas (Ceriodaphnia dubia) survival or reproduction or fathead minnow (Pimephales promelas) survival or growth; 36 percent is the highest concentration of Outfall 135 tested.*

Acronyms:

IC25 = 25-percent inhibition concentration

Y-12 = Y-12 National Security Complex

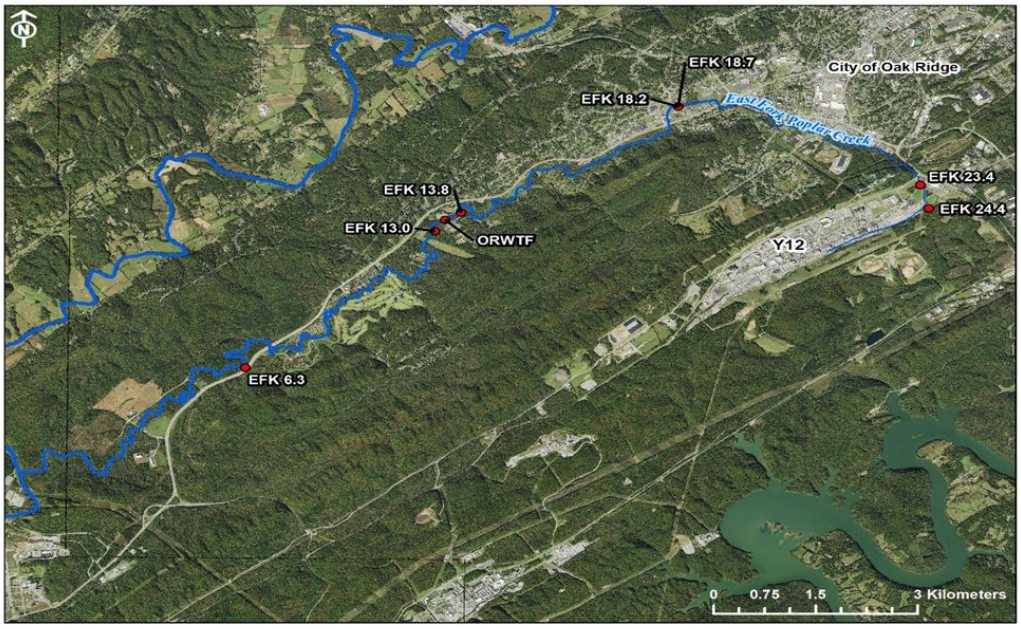
Note: *Annual NPDES permit testing was conducted in July 2022 with effluent from Outfalls 200 and 135. Effluent from Outfall 135 did not reduce fathead minnow (Pimephales promelas) survival or growth or water fleas' (Ceriodaphnia dubia) survival or reproduction by 25 percent or more at any of the tested concentrations compared to the control treatment. 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 4.19). Effluent from Outfall 200 did not reduce fathead minnow (Pimephales promelas) survival or growth or 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 4.19). With the current permit (effective October 1, 2022), quarterly NPDES permit testing was conducted in November 2022 with effluent from Outfall 200. Effluent from Outfall 200 did not reduce fathead minnow (Pimephales promelas) survival or growth or 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 4.19).*

4.5.8. Biological Monitoring and Abatement Program

The NPDES permit issued for Y-12 mandates a Biological Monitoring and Abatement Program, with the objective of demonstrating that the effluent limitations established for the facility protect the classified uses of the receiving stream—EFPC. The 2022 program sampling efforts reported in this chapter follow the NPDES-required *Y-12 Biological Monitoring and Abatement Program Plan* (Brandt et al. 2013). Y-12's program, 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—bioaccumulation monitoring, benthic macroinvertebrate community monitoring, and fish community monitoring. Data collected on contaminant bioaccumulation and the composition and abundance of communities of aquatic organisms directly evaluate the effectiveness of abatement and remedial measures in improving ecological conditions in the stream.

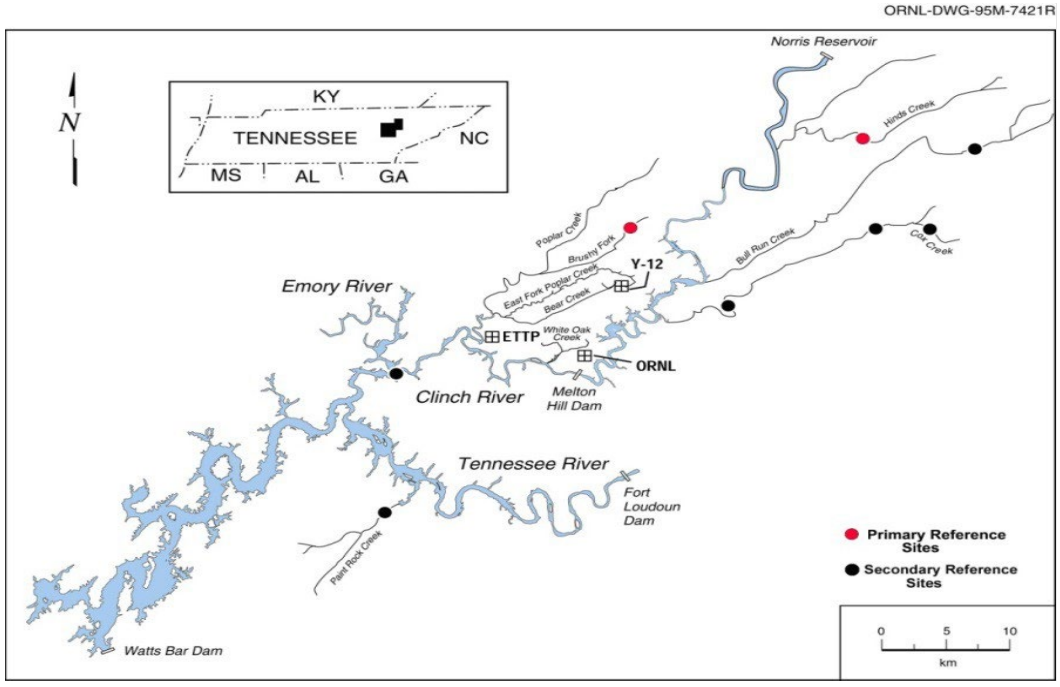
Monitoring is currently being conducted at seven primary EFPC sites (Figures 4.18 and 4.19), although sites may be excluded or added depending on the specific objectives of the various tasks. The primary sampling sites include Upper EFPC at EFPC kilometers (EFKs) 24.4 and 23.4, located upstream and downstream of Lake Reality, respectively; EFKs 18.7 and 18.2, located off ORR and below an area of intensive commercial and light industrial development, respectively; EFKs 13.8 and 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 4.22). Brushy Fork at Brushy Fork kilometer 7.6 is used as a reference stream in two Biological Monitoring and Abatement Program tasks (fish and macroinvertebrate community tasks). Hinds Creek at Hinds Creek kilometer 20.6 is also used as a reference for the macroinvertebrate community monitoring task.

Generally, the number of invertebrate and fish species in EFPC has increased over the last three decades (primarily in the upstream sites), demonstrating 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:
EFK = East Fork Poplar Creek kilometer
ORWTP = Oak Ridge Wastewater Treatment Plant
Y-12 = Y-12 National Security Complex

Figure 4.18. Biological monitoring sites in East Fork Poplar Creek relative to Y-12



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

Figure 4.19. Biological monitoring reference site locations relative to Y-12

4.5.8.1. Bioaccumulation Studies

Historically, mercury and PCB concentrations 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.

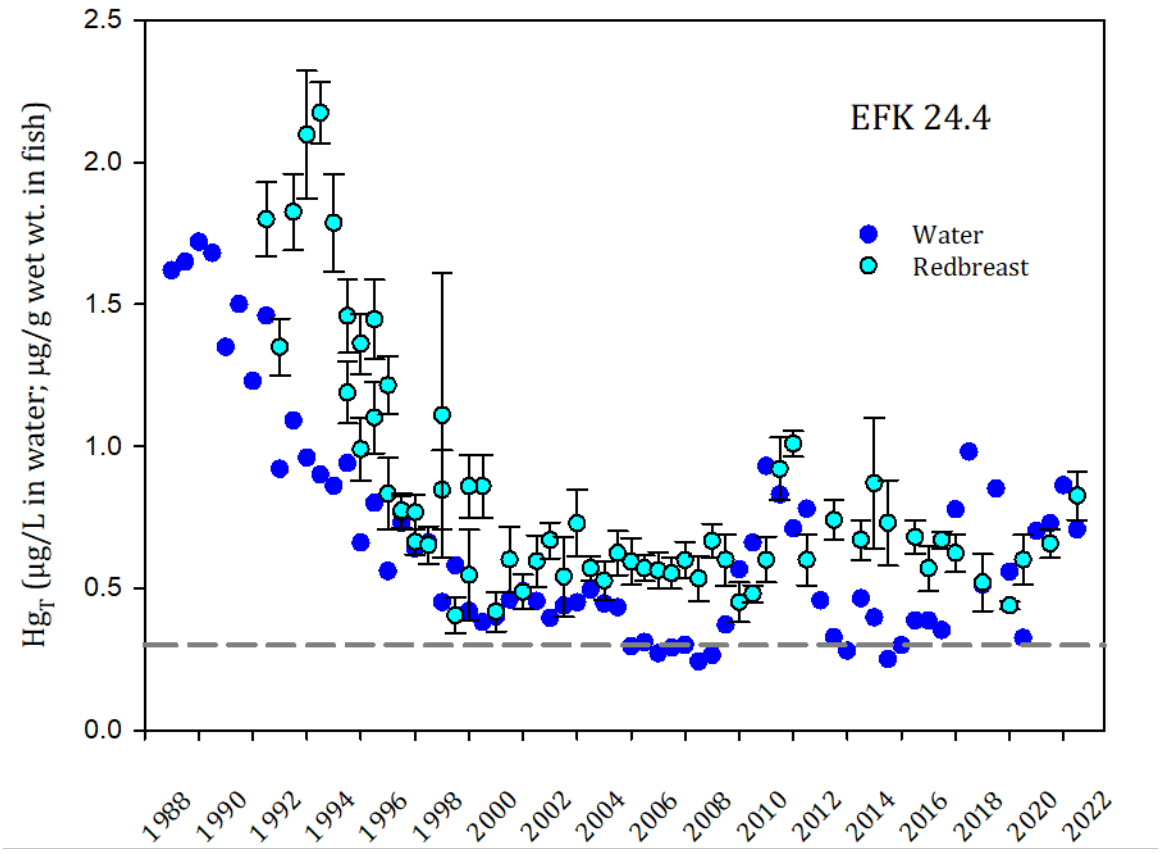
As part of this monitoring effort, redbreast sunfish (*Lepomis auritus*) and rock bass (*Ambloplites rupestris*) are collected from five sites throughout the length of EFPC and are analyzed for tissue concentrations of mercury (twice yearly) (Figure 4.20) and PCBs (annually) (Figure 4.21). Mercury concentrations remained higher in fish from EFPC in 2022 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 4.20 shows temporal trends for mercury concentrations in water collected from EFK 23.4 (Station 17) and in fish collected just upstream of this monitoring station at EFK 24.4. Waterborne mercury concentrations in the upper reach of EFPC have decreased substantially over the years in response to various remedial actions, first over the 1990s time period and then again in response to the Big Springs Treatment System in 2006. 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. In July 2018, aqueous mercury concentrations spiked as a result of a onetime 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 and a fish kill (Mathews et al. 2019, 2020). Aqueous mercury concentrations at Station 17 were elevated in 2022, and mean mercury concentrations in fish collected at EFK 24.4 increased slightly in 2022 (0.83 μg/g), remaining above the EPA-recommended ambient water quality criterion for mercury (0.3 μg/g mercury as methylmercury in fish fillet).

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 0.17 μg/g in FY 2022, slightly lower than concentrations seen in FY 2021 (0.20 μg/g) (Figure 4.21). 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 criterion for both individual Aroclors and total PCBs is 0.00064 μg/L under the recreation designated-use classification and is the target for PCB focused total maximum daily loads, including for local reservoirs (Melton Hill, Watts Bar, and Fort Loudoun; TDEC 2010a, 2010b, 2010c).

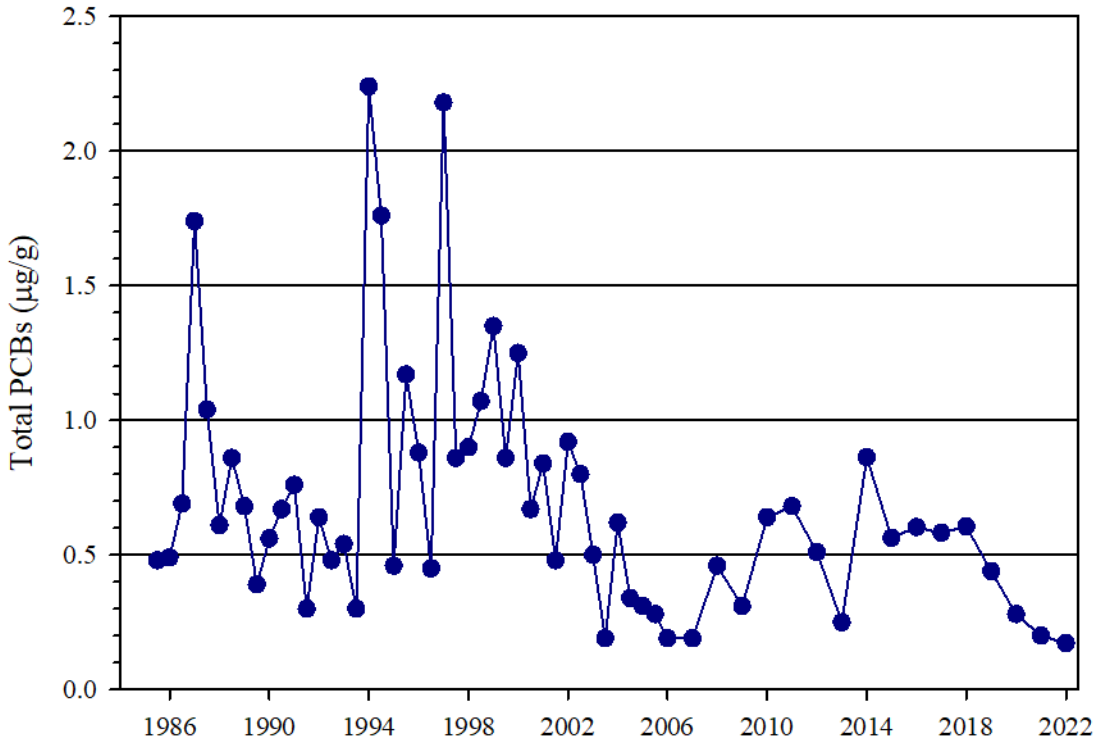
In the state of Tennessee, assessments of impairment for water body segments, as well as public fishing advisories, are based on fish tissue concentrations. Historically, the US Food and Drug Administration threshold limit of 2-μg/g PCBs in fish fillets was used for advisories, and then for many years, an approximate range of 0.8 to 1 μg/g was used, depending on the data available and factors such as the fish species and size. Most recently, the water quality criterion has been used to calculate the fish tissue concentration triggering impairment and a total maximum daily load (TDEC 2019b). This concentration is 0.02-μg/g PCBs in fish fillets (TDEC 2010a, 2010b, 2010c). The mean fish PCB concentration in Upper EFPC, 0.20 μg/g in fish fillets, is well above this concentration.



Notes:
1. *Dashed gray line represents the ambient water quality criterion for methylmercury in fish fillets (0.3 µg/g).*
2. *Water: At East Fork Poplar Creek kilometer 23.4.*
3. *Fish: At East Fork Poplar Creek kilometer 24.4.*

Acronym:
EFK = East Fork Poplar Creek kilometer

Figure 4.20. Semiannual average mercury concentration in muscle fillets of redbreast sunfish and water from East Fork Poplar Creek, 1988–2022



Note: *At East Fork Poplar Creek kilometer 23.4.*
Acronym:
PCB = polychlorinated biphenyl

Figure 4.21. Annual mean concentrations of polychlorinated biphenyls in rock bass muscle fillets, 1986–2022

4.5.8.2. Benthic Invertebrate Surveys

Monitoring the benthic macroinvertebrate community continued in the spring of 2022 at three sites in EFPC and at one reference stream (Hinds Creek). There have been long-term changes in the macroinvertebrate community at EFPC sites since monitoring began in 1986 (Figure 4.22).

Total taxa richness (number of taxa and sample) increased at EFK 24.4 from 1986 until the mid-2000s and then remained steady for approximately 14 years (Figure 4.22). After flow management ended in 2014, total taxa richness decreased at EFK 24.4 and has remained at these lower values since that time, with the exception of an increase in 2021 to a value similar to that measured before 2014, before decreasing again in 2022.

Total taxa richness at EFK 23.4 steadily increased since monitoring began, and values also decreased after flow management ceased (Figure 4.22). In 2022, total taxa richness increased at EFK 23.4, reaching a value comparable to values observed from 2015 to 2019.

Total taxa richness at EFK 13.8 and the reference sites has been fairly consistent over the entire monitoring period (Figure 4.22). Total taxa richness at EFK 24.4 has consistently been lower than at the reference sites throughout the monitoring period, while total taxa richness at EFK 13.8 has generally fallen within or above the 95-percent confidence interval of reference site values, especially in the past decade (Figure 4.22). Total taxa richness at EFK 23.4 was lower than the 95-percent confidence interval of the reference sites from 1986 to 2009, but since then total taxa richness has mostly been within the 95-percent

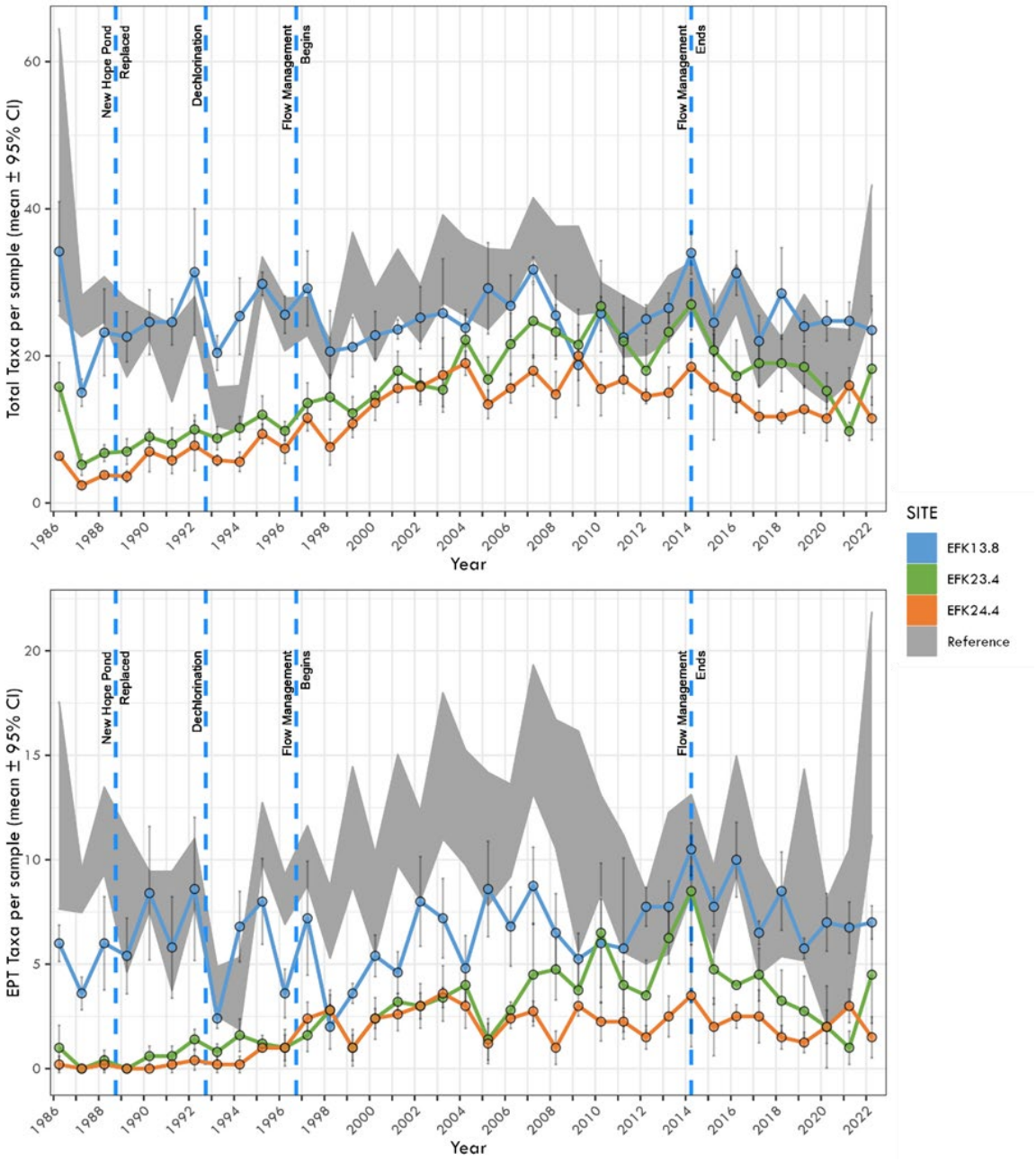
confidence interval of the reference sites (Figure 4.22).

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 4.22). EPT taxa richness at EFK 24.4 was very low (less than 1 EPT taxa and sample) from 1986 until 1994 and then increased slightly (greater than 1 but less than 5 taxa per sample) until 2014. Since 2014, EPT taxa richness has generally been slightly lower, with values in 2022 decreasing from the highest values observed in the past 8 years during 2021 (Figure 4.22).

EPT taxa richness at EFK 23.4 steadily increased since 1986 but decreased after flow management ended (Figure 4.22). In 2022, EPT taxa richness at EFK 23.4 increased to values comparable to those observed from 2017 to 2019 following the lowest values observed in recent years in 2021 (Figure 4.22). EPT taxa richness at EFKs 24.4 and 23.4 has typically been lower than the 95-percent confidence interval of EPT taxa richness at the reference streams, indicative of degraded conditions.

The number of pollution-intolerant taxa at EFK 13.8 has remained fairly steady during the monitoring period, although with large interannual variation. EPT taxa richness values at EFK 13.8 have been within the reference site confidence limits since 2012, with the exception of 2022, which was below the confidence limits (Figure 4.22).

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 until 2022 (Figure 4.22). EPT taxa richness at EFK 24.4 has also shown a slight decrease since flow augmentation ended, with some recovery evident in 2020 and 2021, though this recovery was erased in 2022 (Figure 4.22). The effects of ending flow augmentation on Lower EFPC (EFK 13.8) do not seem as evident, which makes sense as flow augmentation contributed a smaller percentage of total discharge at downstream sites. The long-term effects of ending flow management on the invertebrate community in EFPC will become more evident as conditions stabilize and additional data become available.



Notes:

1. *Top: Total taxonomic richness (mean number of taxa per sample with 95 percent confidence interval).*
2. *Bottom: Taxonomic richness of the pollution-intolerant taxa (ephemeroptera, plecoptera, and trichoptera [EPT]) (i.e., mean number of EPT taxa per sample with 95 percent confidence interval). April 1986–2022.*
3. *The timing of various activities within the watershed is shown with vertical blue lines.*
4. *Reference streams are Brushy Fork and Hinds Creek; however, Brushy Fork was not sampled in 2002 due to lack of access to the survey site.*

Acronyms:

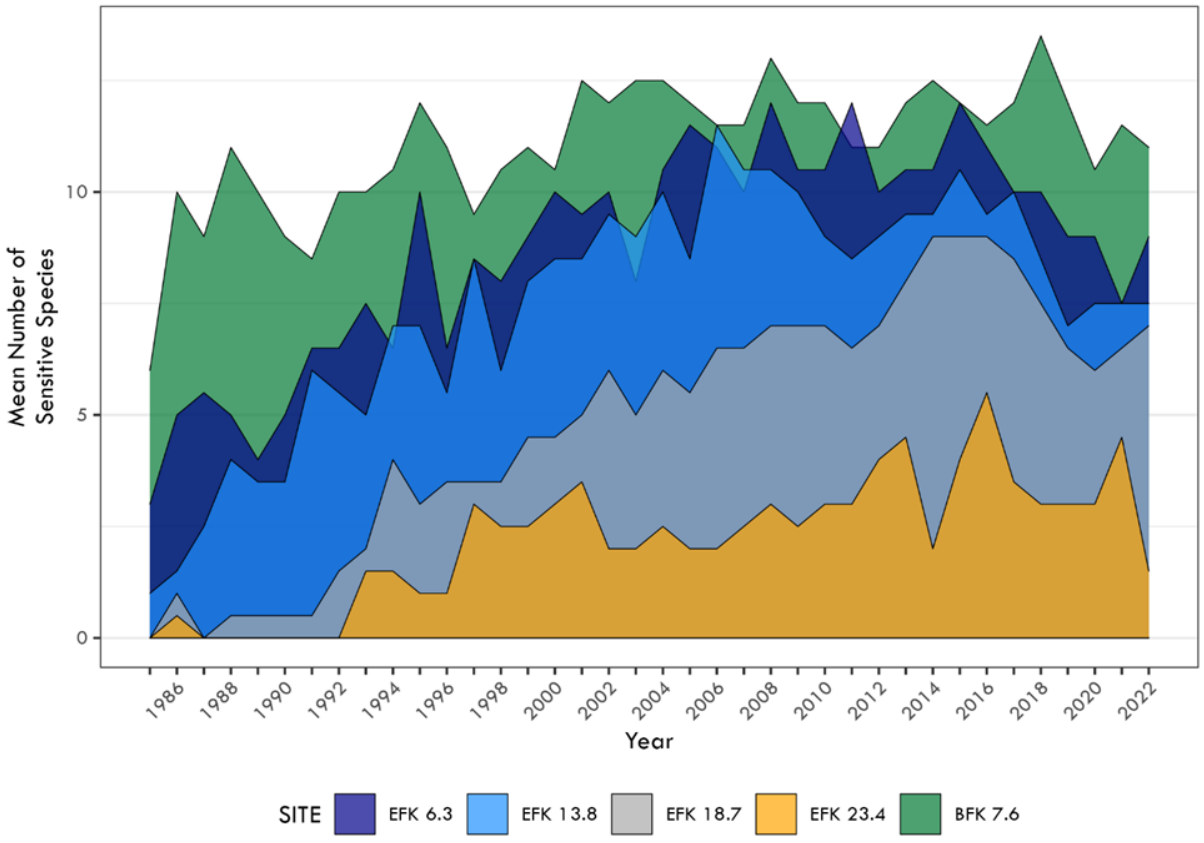
EFK = East Fork Poplar Creek kilometer

EPT = ephemeroptera, plecoptera, and trichoptera

Figure 4.22. Benthic macroinvertebrate communities in three sites along East Fork Poplar Creek and the 95 percent confidence interval for two nearby reference streams

4.5.8.3. Fish Community Monitoring

Fish communities were monitored in the spring and fall of 2022 at five sites along EFPC and at a comparable local reference stream (Brushy Fork). In the past three decades, overall species richness, density, biomass, and number of pollution-sensitive fish species improved at all sampling locations below Lake Reality. Some 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, 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 4.23, dramatically highlighting major improvements in the fish community in the middle to lower sections (EFKs 6.3 and 13.8) of the stream. However, the EFPC fish community continues to lag behind the reference stream community (Brushy Fork kilometer 7.6) in the most important metrics of fish diversity and community structure, especially at the monitoring sites closest to Y-12 (EFKs 23.4 and 24.4).



Notes:

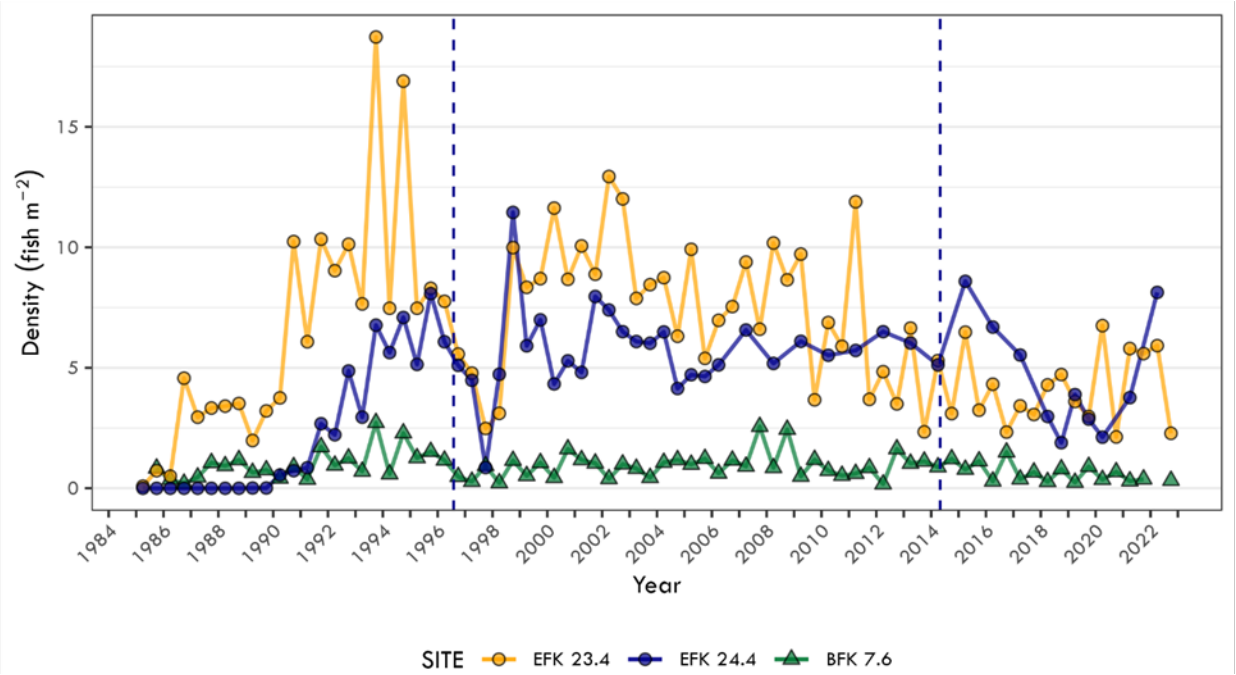
1. *Mean sensitive species richness refers to the number of species.*
2. *Reference site is Brushy Fork.*

Acronyms:

3. *BFK = Brushy Fork kilometer* *EFK = East Fork Poplar Creek kilometer*

Figure 4.23. Comparison of mean sensitive species richness collected each year from four sites in East Fork Poplar Creek and a reference site, 1985–2022

Fish communities in Upper EFPC in 2022 continued to fluctuate in density. Reduced stream flows associated with the termination of flow augmentation from Melton Hill in April 2014 and occasional unexpected fish kills are likely factors driving the decrease in fish densities in these upper sites (Figure 4.24). Despite this, 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.



Notes:

1. *Access to the Brushy Fork site was restricted in spring 2022, and no samples were collected.*
2. *The interval of time between the dashed lines represents the period of flow management in East Fork Poplar Creek.*
3. *Fish density refers to the number of fish per m^2.*
4. *Reference site is Brushy Fork.*

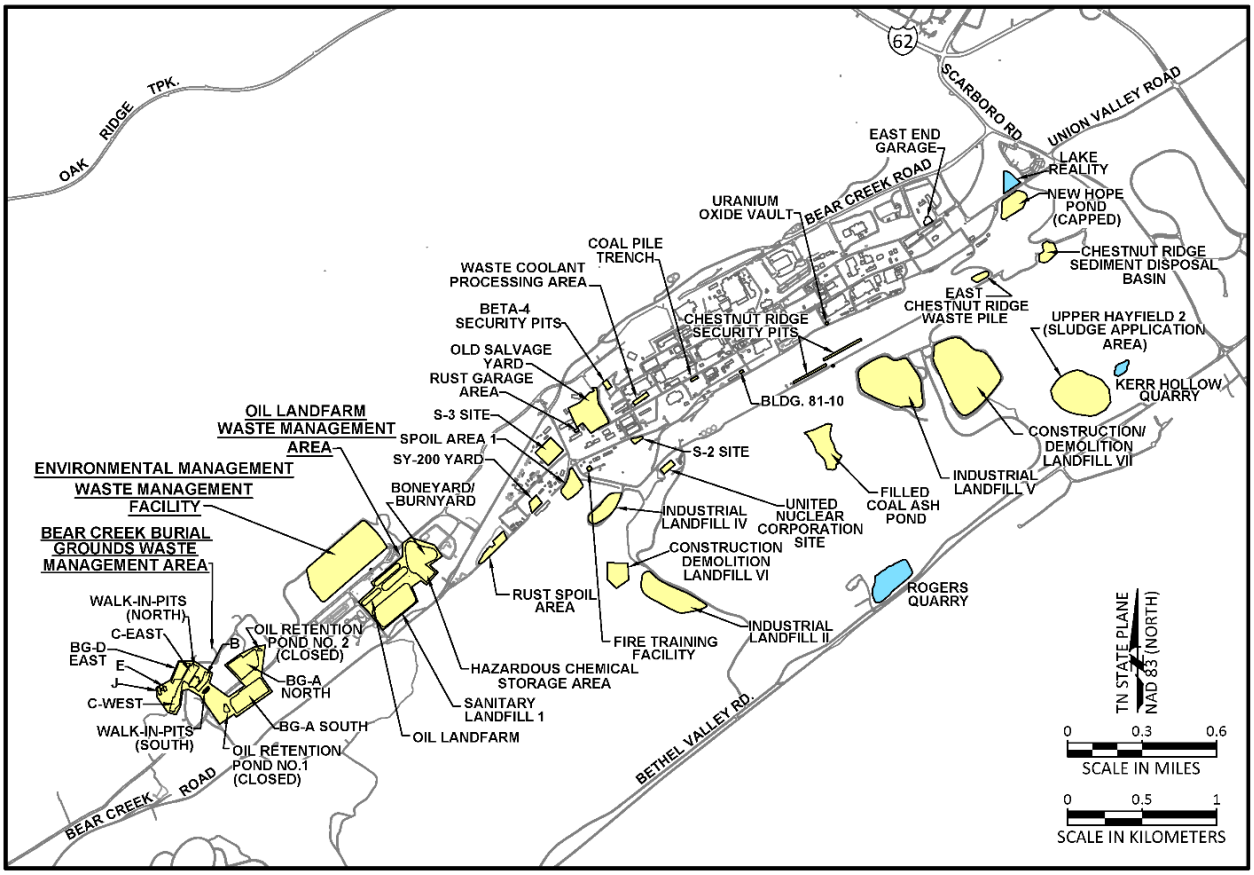
Acronyms:

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

Figure 4.24. Fish density for two sites in Upper East Fork Poplar Creek and a reference site, 1996–2022

4.6. Groundwater at the Y-12 National Security Complex

Groundwater is monitored to comply with federal, state, and local requirements and to determine the environmental impact from legacy and current operations. There are approximately 190 known or potential sources of contamination identified in the Federal Facility Agreement for Y-12 (DOE 2022a). Groundwater monitoring provides information on the nature and extent of contamination, which is used to identify actions needed to protect the worker, public, and environment. Figure 4.25 depicts major source areas where groundwater is monitored.



Acronyms: *BLDG. = Building RD = Road*

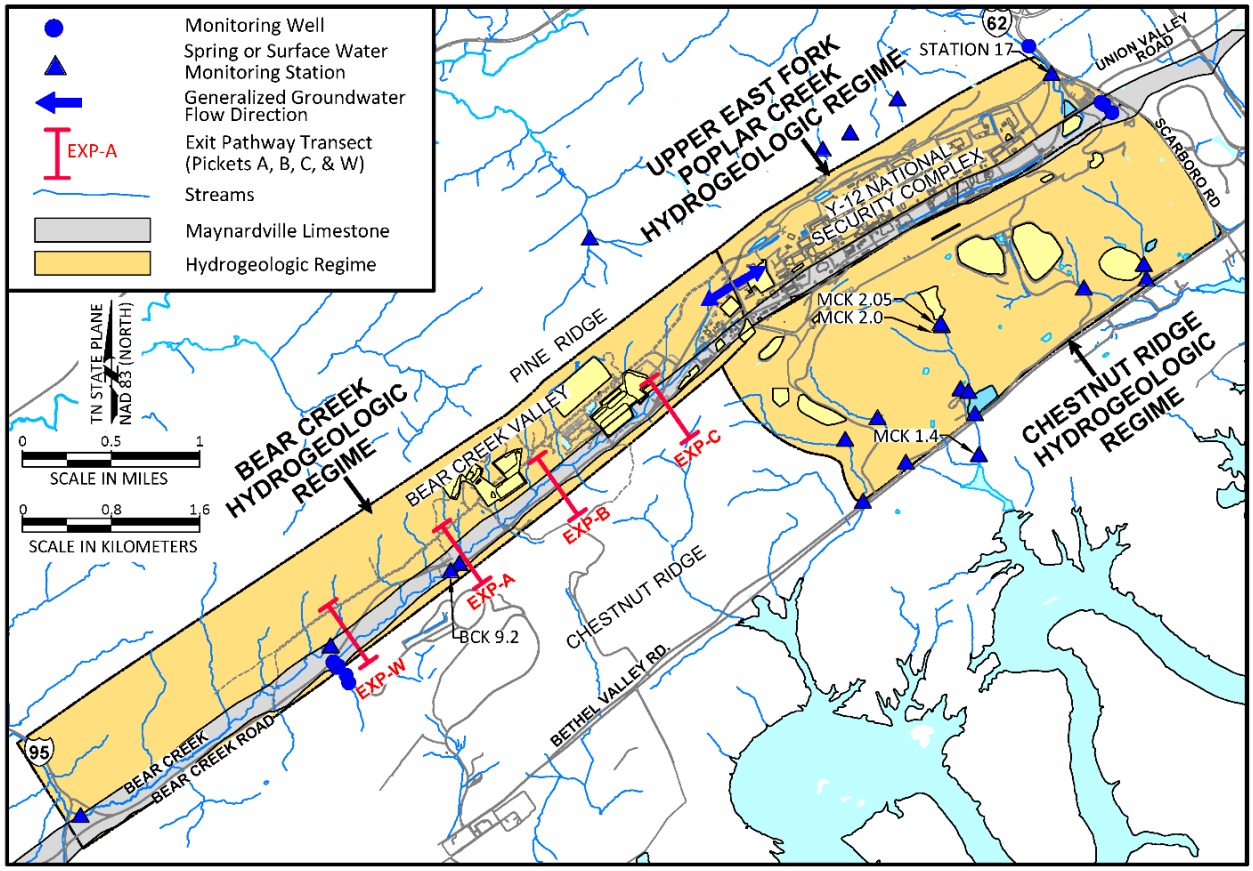
Figure 4.25. Known or potential contaminant source areas where groundwater is monitored at Y-12

4.6.1. Hydrogeologic Setting

Y-12 is divided into three hydrogeologic regimes—Bear Creek, Upper EFPC, and Chestnut Ridge (Figure 4.26). 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.

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 4.27). Shallow flow in the Bear Creek and Upper EFPC regimes diverges from a topographic and groundwater divide located near the western end of Y-12. In the Chestnut Ridge regime, a groundwater divide nearly coincides with the crest of the ridge. On Chestnut Ridge, shallow groundwater flow tends to be toward either flank of the ridge, with discharge primarily to surface streams and springs in Bethel Valley to the south and Bear Creek Valley to the north.

In Bear Creek Valley, groundwater in the intermediate and deep intervals moves through fractures in the aquitard, converging on and then moving through fractures and solution conduits in the Maynardville Limestone (Figure 4.26). Karst development in the Maynardville Limestone has a significant impact on groundwater flow 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/yr) but can be quite rapid within solution conduits in the Maynardville Limestone (10 to 5,000 ft/d).

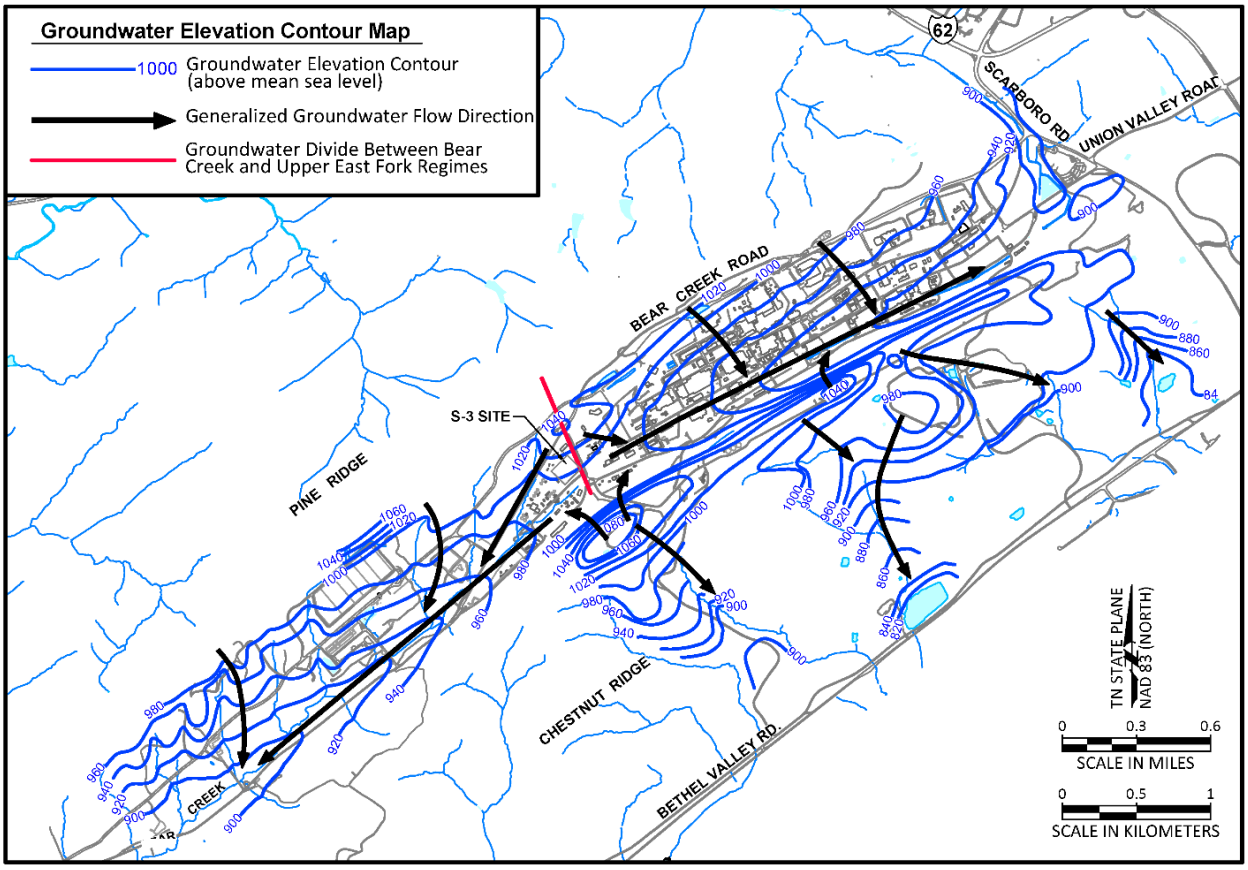


Acronym: *MCK = McCoy Branch kilometer*

Figure 4.26. Hydrogeologic regimes, flow directions, perimeter/exit pathway locations, and position of Maynardville Limestone at Y-12

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. Extensive 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 for long durations. This is because they tend to adsorb to the bedrock matrix, diffuse into pore spaces within the matrix, and very slowly diffuse back out of the matrix when concentration gradients change 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.



Acronym: *RD = Road*

Figure 4.27. Groundwater elevation contours and flow directions at Y-12

4.6.2. Groundwater Monitoring

Groundwater monitoring in CY 2022 was performed as part of Y-12's Groundwater Protection Program, DOE EM programs such as the Water Resources Restoration Program, and other projects. Compliance requirements were met by monitoring 200 wells and 58 surface water locations and springs (Table 4.21). (Locations sampled for research projects are not included in the wells and locations monitored for compliance requirements.)

Specific wells of interest, based on CY 2022, data are discussed later in this section. Figure 4.38 shows the locations of perimeter/exit pathway stations that are routinely monitored.

Table 4.21. Summary of groundwater monitoring at the Y-12 National Security Complex, 2022

Purpose for which monitoring was performed					
	Restoration[a]	Waste management[b]	Surveillance[c]	Other[d]	Total
Number of active wells	57	33	110	42	242
Number of other monitoring stations (e.g., springs, seeps, and surface water)	36	7	15	3	61
Number of samples taken[e]	289	289	137	23	738
Number of analyses performed	11,572	7,708	15,108	1,650	36,038
Percentage of analyses that are non-detects	61.0	87.8	69.3	NA	70.7
Ranges of results for positive detections, VOCs (µg/L)[f]					
Chloroethenes	0.11-3700	6.1-6.93	1-52,000	NA	
Chloroethanes	0.14-310	71.6-72.6	1-1,400	NA	
Chloromethanes	0.34-1100	0.52-1.82	1-880	NA	
Petroleum hydrocarbons	0.27-5500	ND	1-560	NA	
Uranium (mg/L)	0.000075-0.4	0.00007-0.00677	0.000514-72.8	NA	
Nitrates (mg/L)	0.022-4900	ND	0.0591-9,150	73-1,100	
Ranges of results for positive detections, radiological parameters (pCi/L)[g]					
Gross-alpha activity	0.99-360	1.52-13.5	0-30,000	NA	
Gross-beta activity	0.58-4000	2.66-44.3	0-19000	NA	

[a] *Monitoring to comply with Comprehensive Environmental Response, Compensation, and Liability Act requirements.*
[b] *Solid waste landfill detection monitoring and CERCLA landfill detection monitoring.*
[c] *DOE Order surveillance monitoring.*
[d] *Research-related groundwater monitoring associated with activities of the DOE Oak Ridge Field Research Center and 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:
NA = not analyzed
ND = not detected
VOC = volatile organic compound

Water quality results of groundwater monitoring activities in CY 2022 are presented in the 2022 groundwater monitoring report (CNS 2023). The groundwater sampling technicians shown in Figure 4.28 are taking water quality samples from a well in the East Fork regime near the former New Hope Pond site.

Monitoring efforts performed specifically for CERCLA baseline and remediation evaluation are published in the FYs 2022 and 2023 Water Resources Restoration Program sampling and analysis plans (UCOR 2021, 2022b, respectively) and the annual CERCLA remediation effectiveness reports (DOE 2022b, 2023).

Six monitoring wells were installed near the S-3 Site by Ecosystems and Networks Integrated with Genes and Molecular Assemblies (ENIGMA) research group in 2022. No wells were plugged and abandoned in 2022.

Figure 4.28. Groundwater monitoring well sampling at Y-12

4.6.3. 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 ^{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.

4.6.3.1. 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 4.25 were provided in previous year ASERs and are not repeated this year.) Contaminants from the S-3 site (nitrate and ^{99}Tc) and VOCs from multiple source areas are observed in 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 2022 include the S-2 site, Fire Training Facility, S 3 site, Waste Coolant Processing Facility, former petroleum USTs, New Hope Pond, Old Salvage Yard, and process/production buildings throughout Y-12.

The S-3 site is near the hydrologic divide that separates the Upper EFPC regime from the Bear Creek regime and has contributed groundwater contamination to both regimes. Contaminant plumes in both regimes (shown in orange shading on Figures 4.41, 4.43, 4.44, and 4.45) are elongated as a result of preferential transport of contaminants parallel to strike (parallel to the valley axis) in both the Knox aquifer and the fractured bedrock of the aquitard.

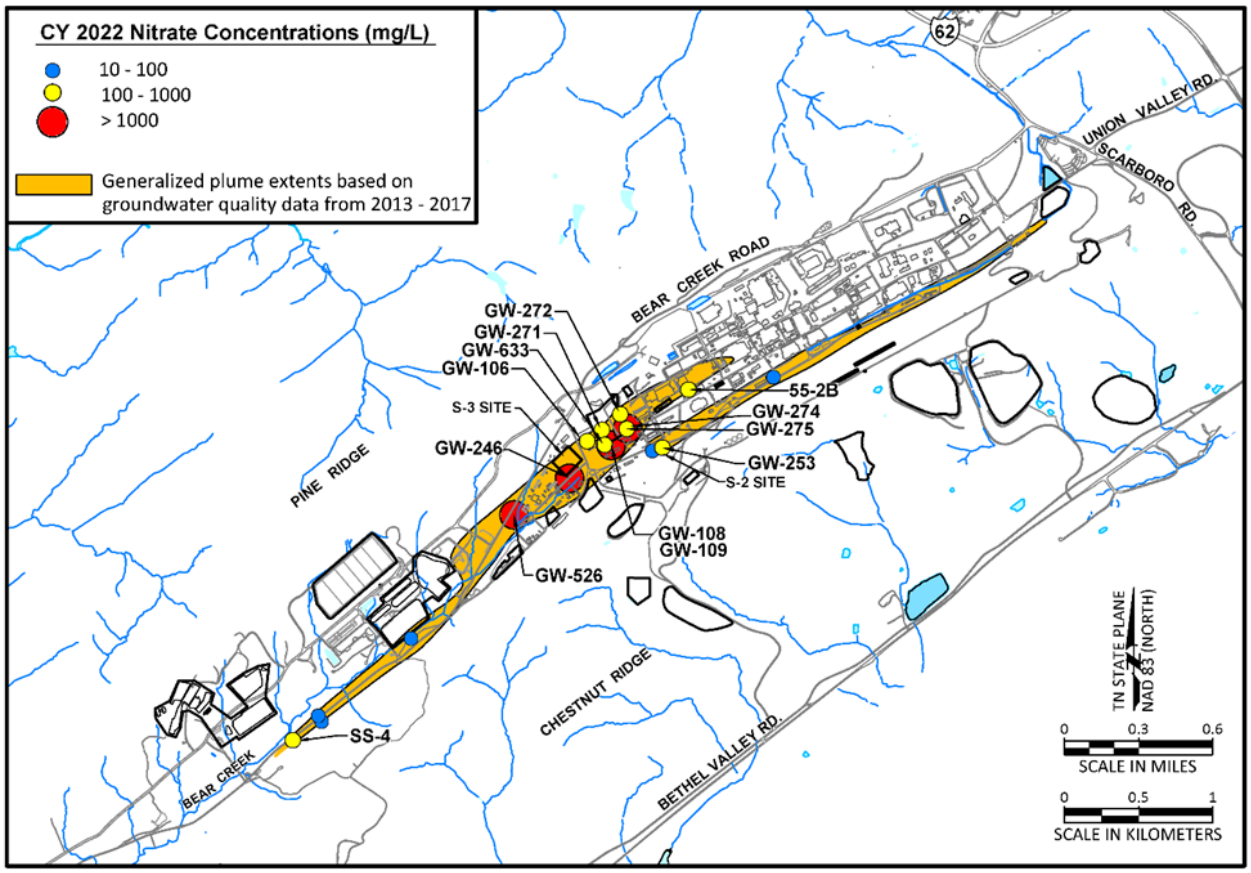
The plumes depicted reflect the average concentrations and radioactivity in groundwater between CYs 2013 and 2017. The circular icons presented on the plume maps (Figures 4.29, 4.31, 4.32, and 4.33) represent CY 2022 monitoring results for the Upper EFPC regime (discussed in this section), the Bear Creek regime (discussed in Section 4.6.3.2), and the Chestnut Ridge regime (discussed in Section 4.6.3.3).

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. Formerly, these were ponds that received large quantities of nitric acid wastes. In CY 2022, there was a maximum nitrate concentration of 9,150 mg/L in well GW 275. This well is located approximately 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 4.29).

Increasing concentration trends are indicated by the nitrate data for wells 55-2A, 55-2B, 55-2C, and GW-275 in the East Fork regime (Figure 4.30). Considering the mobility of nitrate, the increasing trends suggest increased flux of nitrate via some of the fracture flowpaths in the Nolichucky Shale east of the S-3 site. This is consistent with both the heterogeneous transport characteristics of the groundwater flow system as well as described in the conceptual model for contaminant transport from the S-3 site, whereby the center of mass of the nitrate (and other intermixed contaminants) plume in the Nolichucky Shale east of the site continues to slowly move eastward via permeable flowpaths (e.g., bedding plane fractures) that parallel geologic strike (DOE 1998).

The nitrate trends for wells 55-2A/55-2B/55-2C appear fairly stable since CY 2010, and the nitrate trend at well GW-275 appears to be decreasing since 2017, which demonstrates the continued eastward strike-parallel migration of the nitrate plume. Nitrate trends in the groundwater at well clusters reflect conditions at different depth intervals at the same location. Whereas wells 55-2A/55-2B/ 55-2C show similar nitrate trends, divergent nitrate trends occur at wells GW-274/GW-275 (decreasing and increasing). The decreasing trend at well GW-274 likely reflects higher groundwater flow (flushing) in the shallow groundwater system.



Acronyms: *CY = calendar year Rd = Road*

Figure 4.29. Nitrate in groundwater at Y-12, 2022

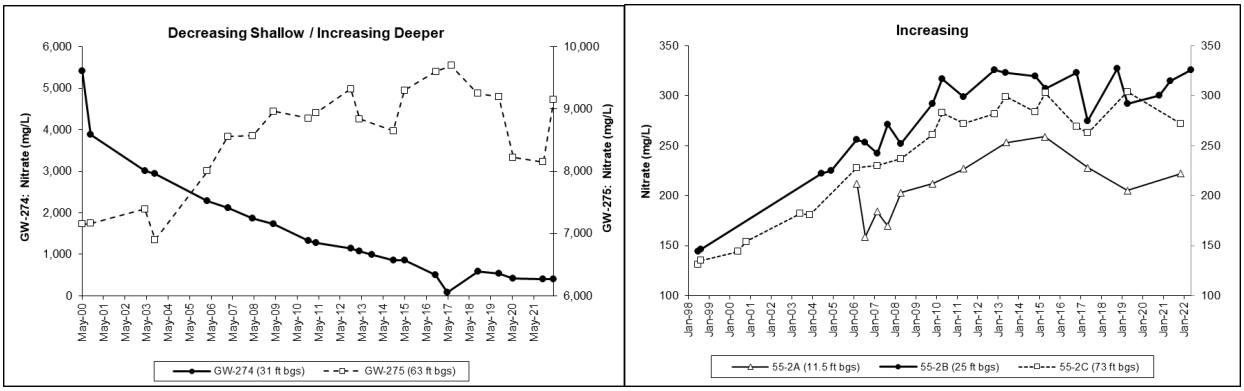


Figure 4.30. Nitrate concentration trends in surveillance monitoring wells GW-274/GW-275 and 55-2A/55-2B/55-2C in the East Fork regime

Trace Metals

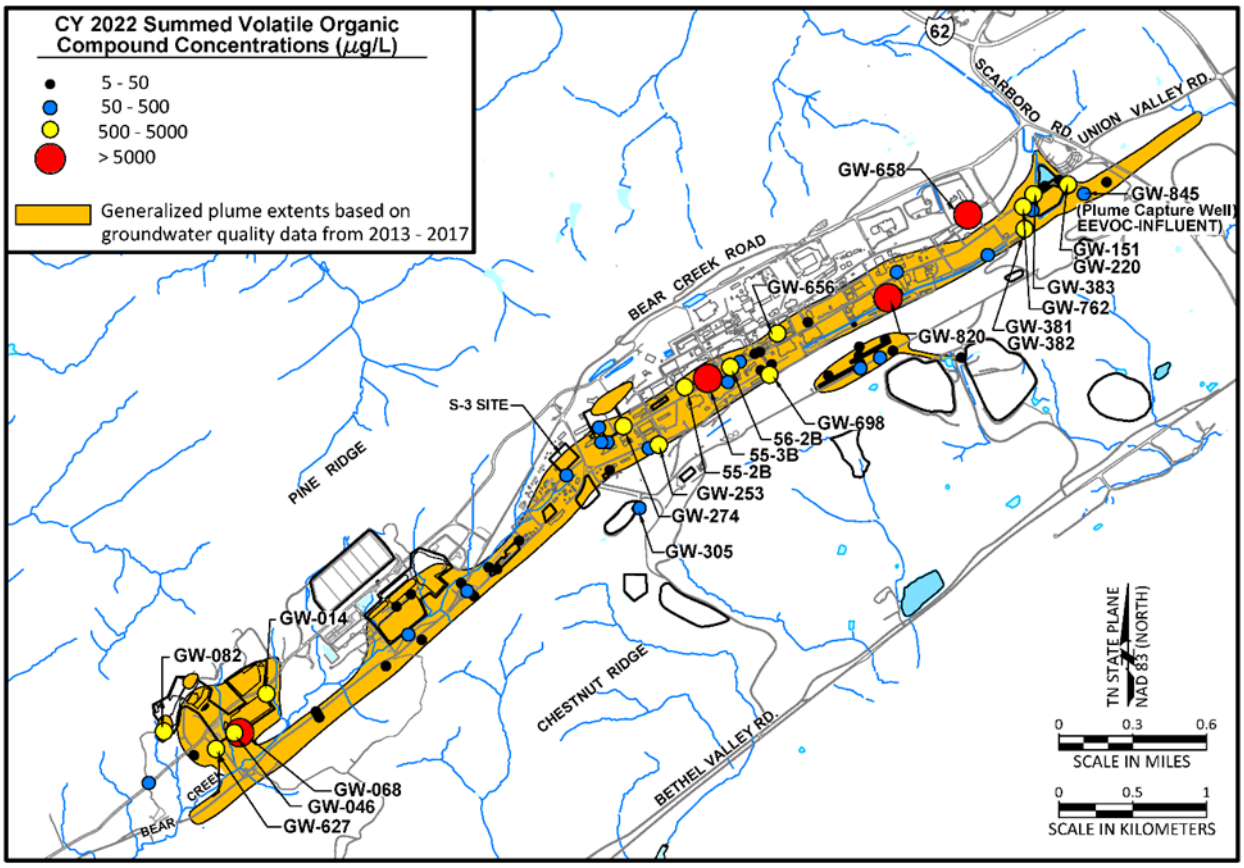
In CY 2022, barium, beryllium, cadmium, chromium, copper, nickel, thallium, and uranium exceeded primary drinking water standards in groundwater in the Upper EFPC regime. Uranium was found predominately downgradient of the S-2, S-3, and New Hope Pond sites. Trace metal concentrations above standards occur adjacent to source areas because of their low solubility and high adsorption to the clay-rich soils and bedrock.

VOCs

VOCs, the most widespread contaminants in the Upper EFPC regime, consist of chlorinated and petroleum hydrocarbons. In CY 2022, the highest summed concentration of dissolved chlorinated hydrocarbons (60,696 µg/L) was again at well 55-3B in the western portion of Y-12, adjacent to currently inactive manufacturing facilities. The highest dissolved concentration of petroleum hydrocarbons was again at well GW-658 (11,358 µg/L) at the closed East End Garage.

Most monitoring results are consistent with data from 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 4.31). 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 the Upper East Fork regime. 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 the regime.



Acronyms:
CY = calendar year
Rd = road
EEVOC = East End Volatile Organic Compound

Figure 4.31. Summed volatile organic compounds in groundwater at Y-12, 2022

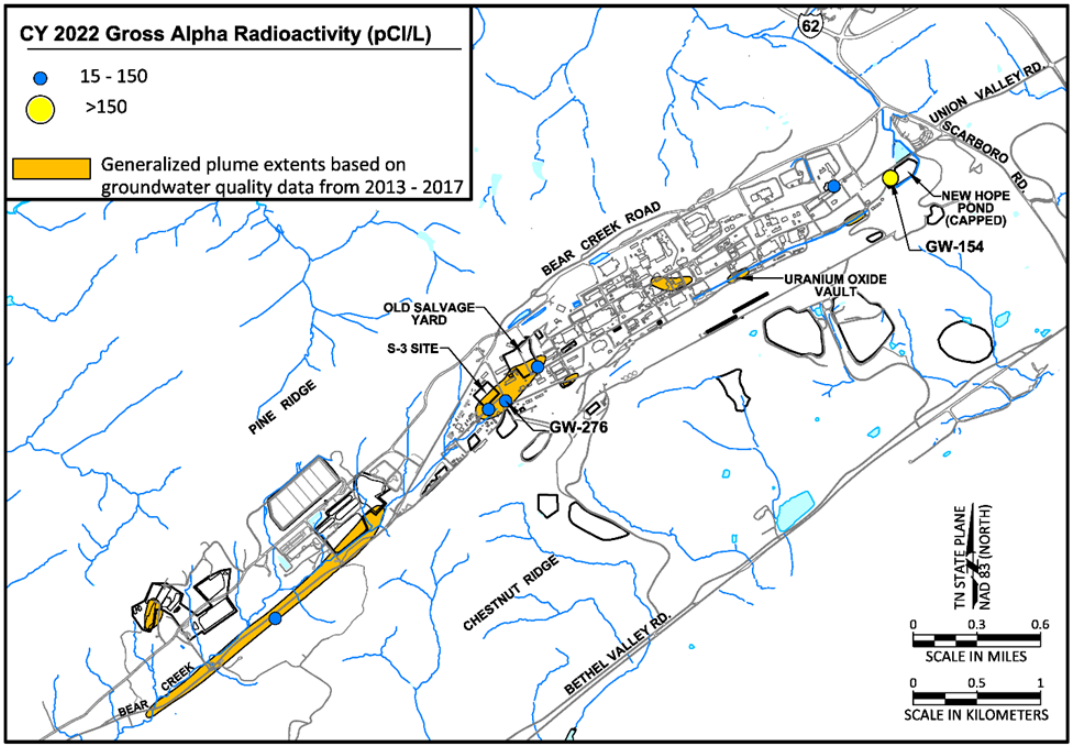
Variability in concentration trends of chlorinated and petroleum VOCs is seen within the Upper EFPC regime. Increasing trends have been observed in wells associated with the Rust Garage, Old Salvage Yard, and S-3 site; and some legacy sources at production/process facilities in central areas. While data from most monitoring wells have remained relatively constant since the late 1980s/early 1990s, some wells show trends in recovery from legacy contamination, especially where petroleum hydrocarbons are the predominant contaminant. For example, while GW-658 has the highest dissolved concentration of petroleum hydrocarbons in the regime, the concentration is an order of magnitude lower than measured in the same well in 1992 and 1993 (>100,000 mg/l).

Radionuclides

The primary alpha-emitting radionuclides found in the Upper EFPC regime during CY 2022 are isotopes of uranium. Exceedances of the drinking water standard for gross-alpha (15 pCi/L) have been observed near the S-3 site, Old 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 New Hope Pond, which was capped in 1988. In CY 2022, the maximum occurrence of gross-alpha activity in groundwater in the Upper EFPC regime was 360 pCi/L, again at well GW-154 near the former oil skimmer basin as shown in Figure 4.32.

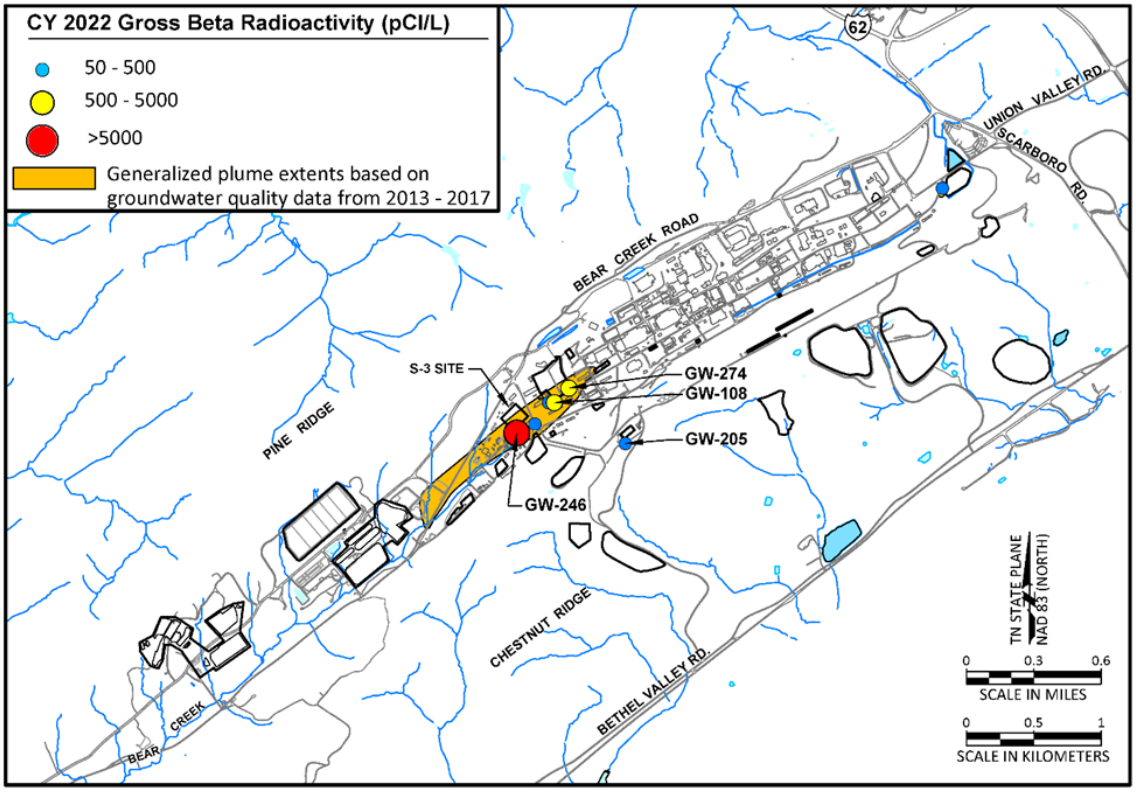
The primary beta-emitting radionuclides observed in the Upper EFPC regime are ^{99}Tc and isotopes of uranium. Historically, elevated gross-beta activity in groundwater shows a pattern similar to that observed for gross-alpha activity as shown in Figure 4.33.

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 2022 from well GW-108 (4,000 pCi/L), lower than the 4,750 pCi/L measured in CY 2021 and down from a maximum gross-beta (21,300 pCi/L) in the same well.



Acronyms: *CY = calendar year Rd = road*

Figure 4.32. Gross-alpha activity in groundwater at Y-12, 2022



Acronyms: *CY = calendar year Rd = road*

Figure 4.33. Gross-beta activity in groundwater at Y-12, 2022

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 off-site to the east of Y-12.

Because of off-site migration of contaminants, a plume capture system (the East End VOC Treatment System) was constructed in and around well GW-845 (shown on Figure 4.31) and began continuous operation in October 2000. Groundwater is 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 2022b, 2023).

Monitoring wells near the plume capture system continue to show an encouraging response. The trends near the East End VOC plume show that contaminants in shallow-intermediate 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. An example is observed in the Westbay system installed in well GW-722. This multiport well, located downgradient from the East End VOC Treatment System, allows 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, derived from summed VOC levels above 1,000 µg/L before the treatment system was installed to below 50 µg/L in the last 4 years.

Five zones in well GW-722 were sampled in CY 2022, with four zones showing summed VOCs

greater than 5 µg/L. Four zones exceeded the drinking water standard for carbon tetrachloride, with the highest concentration (27 µg/L) measured at zone 722-17 (385 ft below ground surface). Zone 722-20 (333 ft below ground surface) also exceeded the drinking water standard for PCE at 6.4 µg/L.

In addition to the deep system in the eastern portion of the Upper EFPC regime, VOCs have also been observed in 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 former New Hope Pond. During CY 2022, the summed concentrations of VOCs at the New Hope Pond distribution channel underdrain remained low (20.2-29.2 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 in this pathway gap was monitored in CY 2022, and no groundwater contaminants were observed above primary drinking water standards.

Perimeter sampling locations continue to be monitored north and northwest of Y-12 to evaluate possible contaminant transport, even though those locations are considered unlikely contaminant exit pathways. One of the stations monitored is a tributary that drains the north slope of Pine Ridge and discharges into the adjacent Scarboro community. One location monitors an upper reach of Mill Branch, which discharges into the residential areas along Wiltshire Drive. The remaining location monitors Gum Hollow Branch as it flows adjacent to the Country Club Estates community. There were no indications that contaminants were being discharged from the ORR into those communities.

Union Valley Monitoring

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

In CY 2022, monitoring locations in Union Valley continued, showing overall decreasing or low concentration stable trends. Vinyl chloride at 1.7 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 Avenue, and a gap in Chestnut Ridge, probably restricts transport of VOCs from the 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 Record of Decision, administrative controls (i.e., 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 groundwater migration contaminated with VOCs into Union Valley (DOE 1997a).

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 *Public Health Assessment: Evaluation of Potential Exposures to Contaminated Off-Site Groundwater from the Oak Ridge Reservation*, in which groundwater contamination across the ORR was evaluated (ATSDR 2006). In the report, it was acknowledged that groundwater contamination exists throughout the ORR, but the authors concluded there is no public health hazard from exposure to contaminated groundwater originating on the ORR. At that time, 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 institutional and administrative controls established in the Record of Decision do not provide for reduction in toxicity, mobility, or volume of contaminants of

concern, but it concluded the controls protect public health to the extent that they limit or prevent community exposure to contaminated groundwater in Union Valley.

4.6.3.2. 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 4.25 were provided in previous year ASERs and are not repeated this year.

Plume Delineation

The primary contaminants in the Bear Creek regime are nitrate, trace metals, VOCs, and radionuclides. The S-3 site is a source of all four contaminants. The Bear Creek Burial Grounds and 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 (Figures 4.29, 4.31, 4.32, and 4.33) represent the average concentrations and radioactivity between CYs 2013 and 2017. The circular icons presented on the figures represent CY 2022 monitoring results.

Nitrate

CY 2022 data indicate nitrate in groundwater continues to exceed the drinking water standard (10 mg/L) in an area that extends west from the S-3 site. The highest nitrate concentration (2,040 mg/L) was observed at well GW-246 adjacent to the S-3 site at a depth of 76.5 ft below ground surface. Historically, elevated concentrations of nitrate (>1,000 mg/L) have been detected at greater depths (>700 ft below ground surface) near the S-3 site.

In CY 2022, 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 (500 mg/L). However, this value is considered an outlier, as this is over an order of magnitude higher than previous concentrations of nitrate found at the spring. The spring was resampled in the summer and fall of CY 2022 and returned to previous concentrations levels at 12 mg/L and 11 mg/L, respectively.

Natural attenuation processes have reduced nitrate levels in the shallow groundwater downgradient of the site, as illustrated by the low CY 2022 nitrate result (7.24 mg/L) for aquitard well GW-537, which had nitrate concentrations above the drinking water maximum contaminant level until CY 2021, as shown in Figure 4.34. This indicates more efficient natural attenuation of nitrate in the shallow flow system, including seasonal discharge of nitrate-contaminated groundwater to the surface drainage network in Bear Creek Valley, compared to the substantially slower attenuation of nitrate in less permeable groundwater flow/contaminant transport pathways deeper in the bedrock.

Under the conceptual model for contaminant transport in the valley, elevated nitrate concentrations in the shallow groundwater from well GW-537 (1,285 in CY 1992 and 8.44 mg/L in CY 2020) were sustained by nitrate-contaminated groundwater upwelling from deeper flowpaths in the Nolichucky Shale (DOE 1997a).

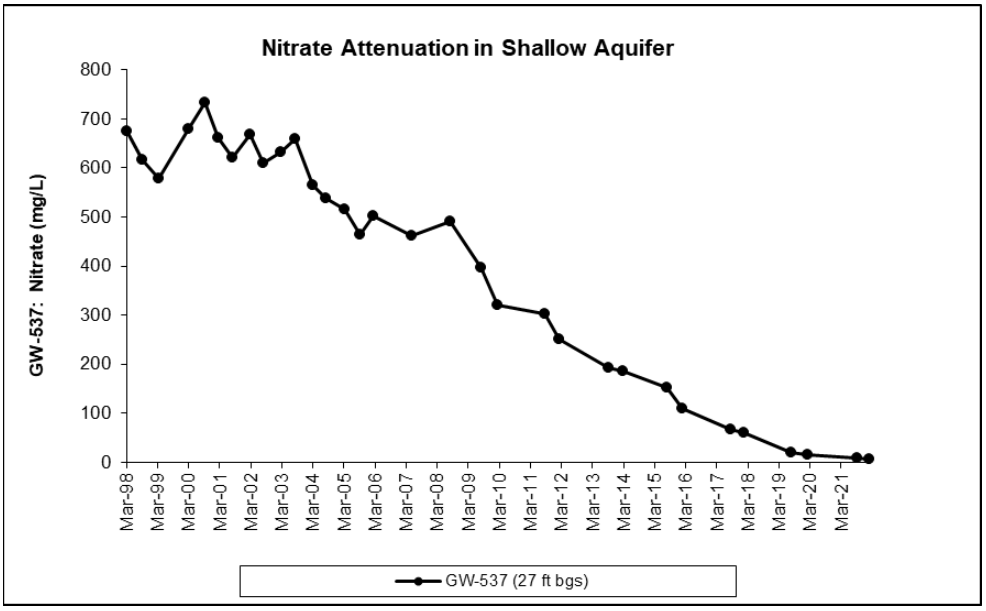


Figure 4.34. Nitrate trend in surveillance monitoring well GW-537, Bear Creek Regime, 1998–2022

Trace Metals

During CY 2022, barium, beryllium, cadmium, nickel, and uranium were identified as trace metal contaminants in the Bear Creek regime that exceeded primary drinking water standards. Elevated concentrations of many of the trace metals were observed at shallow depths near the S-3 site. 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 4.22); however, uranium concentrations in the upper reaches of Bear Creek have been stable, indicating that this contaminant still presents an impact to surface water and groundwater.

Table 4.22. Nitrate and uranium concentrations in Bear Creek

Bear Creek Monitoring Station (distance from S-3 site)	Contaminant	Average Concentration[a] (mg/L)			
		1990–1999	2000–2009	2010–2019	2020–2022
BCK[b]-11.84 to 11.97	Nitrate	91.9	75.2	43.4	26.0
(~0.5 miles downstream)	Uranium	1.61	0.124	0.183	0.162
BCK-09.20 to 09.47	Nitrate	12.4	11.3	4.8	2.68
(~2 miles downstream)	Uranium	0.096	0.115	0.061	0.052
BCK-04.55	Nitrate	3.8	2.5	0.96	2.98
(~5 miles downstream)	Uranium	0.033	0.028	0.018	0.015

[a] *Excludes results that do not meet data quality objectives.*
[b] *BCK = Bear Creek kilometer, measured upstream from the confluence with East Fork Poplar Creek.*

VOCs

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 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 2022 occurred in the Nolichucky Shale aquitard at the Bear Creek Burial Ground waste management area, with a maximum summed VOC concentration of 6,580 µg/L in well GW-068; cis 1,2-dichloroethene at 2,900 µg/L, 1,1-dichloroethane at 1,400 µg/L, and vinyl chloride at 1,200 µg/L comprised most of the summed total. The summed VOC concentrations of GW-626 show wide temporal concentration fluctuations that do not display any consistently increasing or decreasing long-term trend.

The indeterminate long-term trends probably reflect the combined influence of (1) the large volume of VOC in the subsurface at the Bear Creek Burial Ground source area, (2) low permeability of the groundwater flow/transport pathways monitored by the wells, and (3) minimal natural attenuation of the VOCs during residence/transport in the subsurface. The relative significance of the increasing trend for GW-627 shown in Figure 4.35 depends on a combination of multiple variable factors, notably the permeability and connectivity of the flowpaths that could allow influx of VOCs from sources areas located in the shallow aquifer.

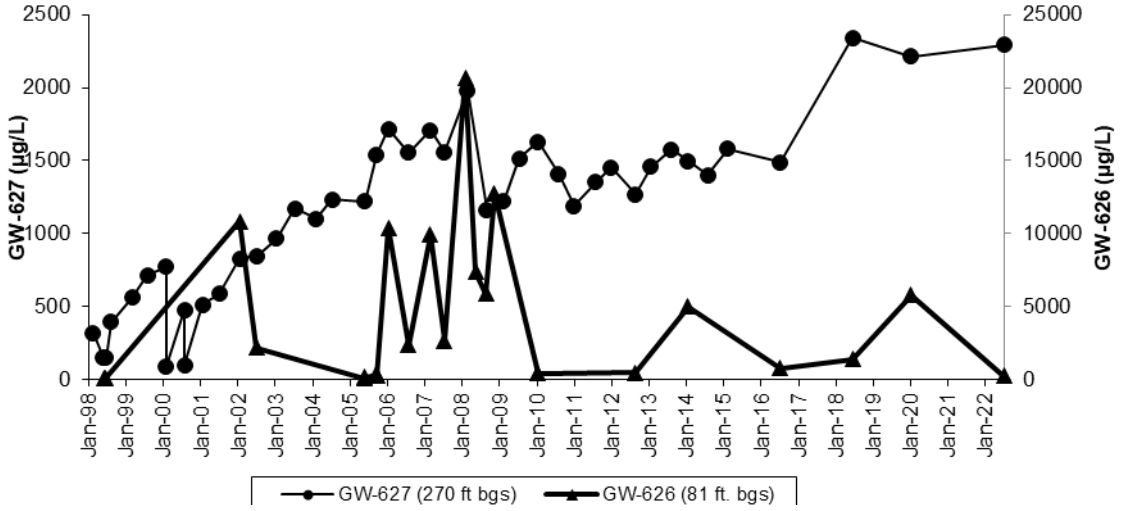


Figure 4.35. Indeterminate and increasing VOC trends in surveillance monitoring wells GW-626 and GW-627, Bear Creek Regime

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 2022 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 areas. 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 4.33).

In CY 2022, the highest gross-alpha activity observed in a monitoring well in the Bear Creek regime (79 pCi/L) was in GW-276, which is adjacent to the S-3 site (see Figure 4.32).

In CY 2022, the highest gross-beta activity in groundwater in the Bear Creek regime was at well GW-246 (8,700 pCi/L) which is also adjacent to the S-3 site (see Figure 4.33).

Exit Pathway and Perimeter Monitoring

Bear Creek, which flows over 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 the surface water in Bear Creek, the springs along the valley floor, and the groundwater in the Maynardville Limestone are hydraulically connected. Surveys have identified gaining (groundwater discharging into surface waters) and losing (surface water discharging into a groundwater system) reaches of Bear Creek. The western exit pathway monitoring well transect (EXP-W) serves as the perimeter well location for the Bear Creek regime (Figure 4.26).

Exit pathway monitoring continues at four Exit Pathway Transects (A, B, C, and W; see Figure 4.26) also referred to as pickets, and selected springs and surface water stations. Data obtained during CY 2022 indicate groundwater is contaminated above drinking water standards in the Maynardville Limestone as far as Picket W. The drinking water standard for gross-alpha was exceeded (26 pCi/L) in deep well GW-710. Historically, this well has presented elevated levels of gross-alpha activity. At 164.6 m (540 ft) below ground surface, the well is affected by deep brine water that likely contains radium and radon, which could account for the elevated gross-alpha activity. Concentration trends throughout the exit pathway continue to be generally stable to decreasing, as shown in Figure. 4.36.

In CY 2022, GW-713 in exit pathway transect W showed a trace concentration (0.48 µg/L) of TCE (below drinking water standards), thus indicating migration of contaminants potentially thousands of feet from likely sources areas to the east (e.g., Boneyard/Burnyard, the S-3 site, or Spoil Area 1). TCE is sporadically detected in GW-713 but has never been detected above drinking water standards.

Surface water samples collected in CY 2022 indicate 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).

Exit pathway monitoring stations sampled in CY 2022 show that gross-alpha activity in the Maynardville Limestone and the surface waters of Bear Creek was undetectable at SS-5. This location is over 3,353 m (11,000 ft) west of the S-3 site and, in the recent past, has shown activities of 31 pCi/L in CY 2017, 19 pCi/L in CY 2018, 17 pCi/L in CY 2019, and 16 pCi/L in CY 2021, continuing with the decreasing trend.

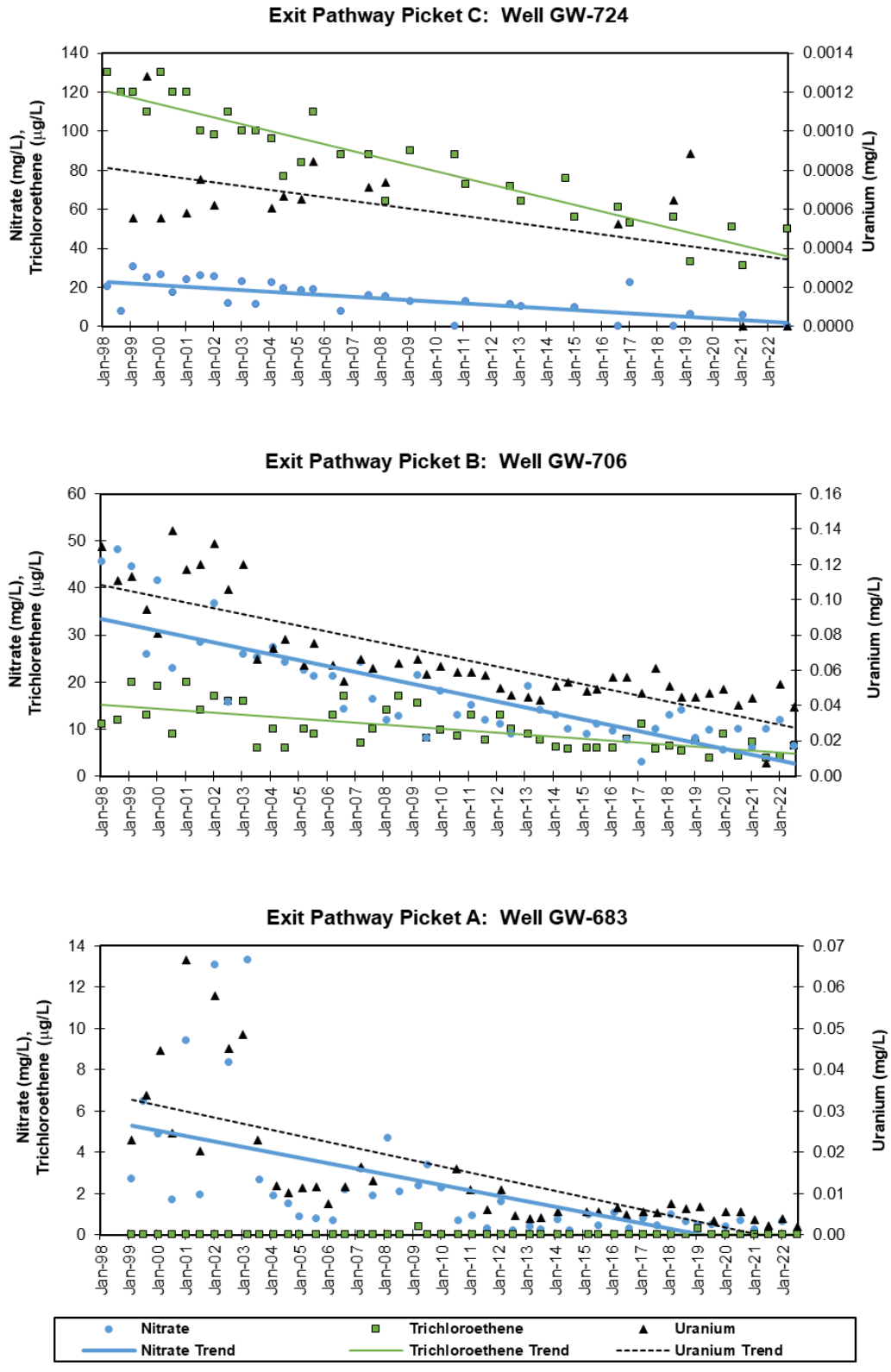


Figure 4.36. Concentrations of selected contaminants in exit pathway monitoring wells in the Bear Creek hydrogeologic regime, 2022

4.6.3.3. Chestnut Ridge Hydrogeologic Regime

The Chestnut Ridge hydrogeologic regime is flanked to the north by Bear Creek Valley and to the south by Bethel Valley Road (Figure 4.25). The regime encompasses the portion of Chestnut Ridge extending from Scarboro Road, east of the complex, to Dunaway Branch, located just west of Industrial Landfill II. Descriptions of waste management sites in the Chestnut Ridge regime and shown on Figure 4.26 were provided in previous year ASERs and are not repeated this year.

The Chestnut Ridge Security Pits area is the primary source of groundwater contamination in the regime. Contamination from the security pits is distinct and does not mingle with plumes from other sources.

Plume Delineation

The extent of the VOC plume at the Chestnut Ridge Security Pits is reasonably well defined in the water table and shallow bedrock zones. With two possible exceptions, historical monitoring indicates the VOC plume from the Chestnut Ridge Security Pits has shown minimal migration in any direction (<305 m [<1,000 ft]).

Data obtained during CY 2022 indicate the western lateral extent of the VOCs plume at the site has not changed significantly. VOC contaminants at a well about 458 m (1,500 ft) southeast and downgradient of the Chestnut Ridge Security Pits continue to show 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 Chestnut Ridge Security Pits) at a natural spring about 2,745 m (9,000 ft) to the east and along geologic strike may suggest that Chestnut Ridge Security Pits contaminants have migrated further than the monitoring well network indicates. However, as in CY 2020 and CY 2021, no VOCs were detected at this spring in CY 2022.

The Chestnut Ridge Security Pits plume in the Chestnut Ridge regime (shown by orange shading on Figure 4.31) represents the average VOC concentrations between CYs 2013 and 2017. The circular icons presented on the figure represent CY 2022 monitoring results.

Nitrate

Nitrate concentrations continue to be below the drinking water standard at all monitoring stations in the Chestnut Ridge regime in CY 2022.

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 Record of Decision (DOE 1996). Under the decision, migration of contaminated effluent from the Filled Coal Ash Pond is reduced by a constructed wetland area. In recent years, it became apparent the wetland efficiency was decreasing, in part, because of erosion channels forming around the wetland. During CY 2019, a 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. The elevated arsenic levels were detected both upgradient (McCoy Branch kilometer [MCK] 2.05) and downgradient (MCK 2.0) of this wetland area. In CY 2022, the passive wetland treatment area continued to be effective in reducing arsenic.

VOCs

Overall, concentrations of VOCs in groundwater at the Chestnut Ridge Security Pits have decreased since 1988. Summed VOC concentrations above the drinking water standard were observed at five monitoring wells associated with the Chestnut Ridge Security Pits—GW-176 (20 µg/L), GW-179 (9 µg/L), GW-180 (11 µg/L), GW-322 (18 µg/L), and GW-612 (13 µg/L) during CY 2022.

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 4.31), exhibited increasing trends of summed VOCs from 1992 to 2014 but have stabilized since with the CY 2022 concentration at

78.53 µg/L. GW-305 was sampled in January and July 2022 with results for 1,1 DCE of 6.1 µg/L and 6.93 µg/L, respectively. Both were below the drinking water standard (7 µg/L).

Radionuclides

In CY 2022, no gross-alpha above the drinking water standards of 15 pCi/L was observed in the Chestnut Ridge hydrogeologic regime. However, gross-beta was detected above the drinking water standard of 50 pCi/L at monitoring well GW-205 (51pCi/L). This well is associated with the United Nuclear Corporation Site.

Exit Pathway and Perimeter Monitoring

Contaminant and groundwater flowpaths 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 (approximately 9,000 ft from the Chestnut Ridge Security Pits) 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 Chestnut Ridge Security Pits; however, this has not been confirmed. In CY 2022, three springs along Scarboro Creek 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. Five springs and three surface water monitoring locations were sampled during CY 2022. No contaminants at any of these monitoring stations were detected at levels above primary drinking water standards.

4.6.4. Emerging Contaminants

Per- and polyfluoroalkyl substances (PFAS) are emerging contaminants that constitute a large family of fluorinated chemicals. The persistence and mobility of some PFAS, combined with decades of widespread use in industrial processes, certain types of firefighting foams, and consumer products, have resulted in their being present in environmental media at trace levels across the globe. It was not until the early 2010s that analytical methods to detect a limited number of PFAS became widely available and had detection limits in water low enough to be commensurate with levels of potential human health effects. Toxicological studies have raised concerns regarding the bioaccumulative nature and potential health concerns of some PFAS (CNS 2022a).

The following actions and activities were conducted at Y-12 during CY 2022 to address these emerging contaminants of concern:

- Y-12 remained compliant with new DOE requirements pertaining to PFAS storage, use, and disposal during CY 2022 (DOE, 2021a, DOE 2021b).
  - No PFAS-containing aqueous film-forming foam (AFFF) was used for training purposes, and no new AFFF systems were installed in CY 2022. Existing AFFF systems are only approved for use in fire emergencies.
  - Measures were taken to minimize fire protection personnel and the environment from exposure to PFAS-containing AFFF.
  - PFAS-containing AFFF is stored in accordance with DOE orders and directives, laws, and regulations. No disposal of PFAS-containing AFFF occurred during CY 2022.
  - No new releases or spills of PFAS-containing AFFF occurred in CY 2022.

- Current and historic uses of 176 PFAS or PFAS-related substances are being tracked using the Y-12 Hazardous Material Information System. No PFAS substances were used in excess of the EPCRA TRI reporting threshold during CY 2022.
- One waste storage building (9720-09) has an AFFF fire suppression system.
- Y-12 has a fire department and fire training facility on-site. The Y-12 Fire Department has one firetruck with a foam induction system that uses a fluorine-free foam.
- 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 laboratories and in the Development facilities.

4.7. Quality Assurance Program

Y-12's QA Program establishes a quality policy and requirements 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 2022b). 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 recordkeeping. QA programs are designed to minimize these sources of variability and 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:

- Using work control processes and standard operating procedures for sample collection and analysis.
- Using chain-of-custody and sample identification procedures.
- Standardizing, calibrating, and verifying instruments.
- Training sample technicians and laboratory analysts.
- Preserving, handling, and decontaminating samples.
- Using QC samples, such as field and trip blanks, duplicates, and equipment rinses.

Y-12 Environmental Sampling Services are responsible for field sampling activities, sample preservation and handling, chain-of-custody, and field QC sample transport in accordance with Y-12 Environmental Compliance internal procedures. Environmental Sampling Services developed a Standards and Calibration Program that conforms to ISO/IEC 17025, *General Requirements for the Competence of Testing and Calibration Laboratories* (ISO 2017), 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 Analytical Chemistry Organization QA Manual describes QA Program elements; customer-specific requirements; certification program requirements; federal, state, and local regulations; and waste acceptance criteria. As a government-owned, contractor-operated laboratory that performs work for DOE, the Analytical Chemistry Organization laboratory operates in accordance with DOE Order 414.1D, *Quality Assurance* (DOE 2011c).

Other internal practices used to ensure 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; recordkeeping; maintaining and calibrating instruments; and using technically validated and properly documented methods.

Y-12's Analytical Chemistry Organization participated in both Mixed Analyte Performance Evaluation Program studies conducted in 2021 for water, soil, and air filter matrices for metals, organics, and radionuclides. The overall acceptability rating from both studies was 97.8 percent.

Verification and validation of environmental data are performed as components of the data-collection process, which includes planning, sampling, analyzing, and performing 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 to check whether data have been accurately transcribed and recorded, appropriate procedures have been followed, electronic and hard copy data show one-to-one correspondence, and 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 identifying 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.

A due diligence analysis is performed for facilities used for the treatment, storage, or disposal of radiological and hazardous waste to ensure that each facility is well operated and maintained; has minimal environmental issues and impacts; employs personnel that are properly trained, competent, and work safely; is in compliance with regulatory requirements; and is adequately insured against personal and environmental liabilities.

This evaluation includes a review of information on the facility's compliance history, design, operations, recordkeeping and reporting requirements, emergency response procedures, closure/post-closure plans, and insurance coverage, as well as any environmental issues, remediation, litigation or regulatory agency concerns related to the facility. Y-12 is committed to limiting the number of facilities used and avoiding or discontinuing the use of facilities that present significant environmental and/or safety liability. This evaluation may rely on results of third-party accreditation assessments reported under the DOE Consolidated Audit Program.

Table 4.23 lists treatment, storage, and disposal facilities used in 2022 for the disposition of radiological and hazardous waste.

Table 4.23. Treatment, storage, and disposal facilities used to disposition radiological and hazardous waste, 2022

Facility Name	Location	Identification Number
Clean Harbors Cincinnati (Spring Grove) Facility	Cincinnati, Ohio	OHD000816629
Clean Harbors Cleveland Technical Services	Cleveland, Ohio	OHD000724153
Clean Harbors Colfax Facility	Colfax, Louisiana	LAD981055791
Clean Harbors Deer Park Incineration Facility	La Porte, Texas	TXD055141378
Clean Harbors El Dorado Incineration Facility	Ed Dorado, Arkansas	ARD069748192
Clean Harbors Grassy Mountain Landfill Facility	Clive, Utah	UTD991301748
Clean Harbors La Porte Technical Services	La Porte, Texas	TXD982290140
Clean Harbors Lone Mountain Facility	Waynoka, Oklahoma	OKD065438376
Diversified Scientific Services, Inc.	Kingston, Tennessee	TND982109142
Energy Solutions Bear Creek Processing Facility	Kingston, Tennessee	TND982157570
EnergySolutions Clive Disposal Facility	Grantsville, Utah	UTD982598898
Nevada National Security Site	Mercury, Nevada	NV3890090001
Perma-Fix of Florida, Inc.	Gainesville, Florida	FLD980711071
Safety-Kleen Systems	Smithfield, Kentucky	KYD053348108

4.8. Environmental Management and Waste Management Activities

The three sites on ORR have a rich history of research, innovation, and scientific discovery that shaped the course of the world. Unfortunately, despite their vitally important missions, they are hindered by environmental legacies remaining from past operations. The contaminated portions of ORR are on the EPA National Priorities List, which includes hazardous waste sites across the nation that are to be cleaned up under CERCLA. Areas that require cleanup or further action on ORR have been clearly defined, and DOE EM is working to clean those areas under the Federal Facility Agreement with the EPA and TDEC. The *2022 Cleanup Progress: Annual Report on Oak Ridge Reservation Cleanup* (UCOR 2022a) provides detailed information on DOE EM cleanup activities.

4.8.1. Environmental Management Activities

At Y-12, DOE EM is working to address excess and contaminated facilities, remove mercury soil and groundwater contamination, and enable modernization that allows NNSA to continue its crucial national security and nuclear nonproliferation responsibilities.

Criticality Experiment Laboratory Demolished

Seventy-three years after it was built, the Criticality Experiment Laboratory (Building 9213) and all of its ancillary facilities have been demolished. Beginning in May 2022, crews worked the hot and rainy summer to demolish the 24,000-square-foot facility, which had been home to a variety of missions since its construction in 1949.

During the first decade of the building's operation, more than 9,700 experiments were conducted. Later, it supported the ORNL High Flux Isotope Reactor program. The building has been closed since 1992.

More than 4,500 cubic yards (525 truckloads) of waste was disposed. During the nearly two years of deactivation, crews prepared the building for demolition by removing, packaging, and shipping 1,496 linear feet of asbestos-insulated piping, 323 linear feet of process piping, and 8,540 square feet of other asbestos-containing material.

Biology Complex Slab Removed

Workers have finished removing the remaining slabs at the now demolished Biology Complex, readying the land for transfer to Y-12. The land is expected to be the site of the new LPF.

Dating back to the 1940s, the Biology Complex originally consisted of 11 buildings. It was constructed for recovering uranium from process streams and later used for research that led to strides in understanding genetics and the effects of radiation.

Crews completed backfilling and seeding the portion of the site where the last two buildings (Buildings 9207 and 9210) once stood. In subsequent months, slabs remaining from previous demolition of buildings at the location were removed and their footprints backfilled and graveled. Between removal of those slabs and the slabs at Buildings 9207 and 9210, more than 6,141 yd^3 of waste and debris were removed.

New Technologies Evaluated for Mercury Cleanup

DOE EM is developing new remediation technologies to address mercury releases into the environment from past operations. These technologies will support demolition of Y-12's mercury-contaminated facilities as well as soil remediation and reduction of mercury-related ecological risks.

At the Aquatic Ecology Laboratory, workers test the effectiveness of remediation technologies in a flow-through system using water from EFPC.

Researchers have conducted studies 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 for reducing mercury in the water column. Scientists prepared a report titled *Mercury Remediation Technology Development for Lower East Fork Poplar Creek—FY 2022 Update* (Mathews 2022) that provides findings from FY 2022 studies. Field characterization and research undertaken from 2015 to 2022 will support an evaluation of remediation alternatives for the creek in the mid-2020s.

In 2022, unmanned aerial vehicles equipped with sensors took various measurements to evaluate how organisms such as some algae, bacteria, fungi, and a variety of invertebrates (periphyton) interact in stream environments. These periphyton have been recognized to play a major role in mercury methylation and accumulation in other living organisms.

A new support tool was developed that uses watershed models to simulate remediation scenarios. With a better understanding of mercury transport in the watershed system, specific technologies and strategies can be assessed and implemented.

There have also been increased efforts to identify and demonstrate emerging technologies that will aid in addressing Y-12 mercury remediation challenges. A Mercury Review Committee consisting of members from DOE, its contractors, and subject matter experts serves as the primary resource to evaluate and select proposed new technologies. Contracting for the first technology demonstration began in 2022.

As part of the technology demonstration initiative, establishing a facility for demonstrating mercury-related technologies is being evaluated. A conceptual report was prepared that outlines the modifications needed to be able to use an existing facility on the ORR as a location for technology demonstrations. The facility modification design is in progress.

Mercury Treatment Facility Construction Progressing

Progress continued on construction of the Outfall 200 Mercury Treatment Facility. Shoring and major excavations were completed at the headworks site. Crews continued placing concrete pads and walls of the treatment plant. Crews also began erecting structural steel and continued installing underground utilities.

The facility is the linchpin for DOE EM's cleanup strategy at Y-12. This vital piece of infrastructure will open the door for demolition of Y-12's large, deteriorated, mercury-contaminated facilities and subsequent soil remediation by providing a mechanism to limit potential mercury releases into the Upper EFPC.

When operational, the facility will be able to treat 3,000 gallons of water per minute and help DOE meet regulatory limits in compliance with EPA and state of Tennessee requirements. The facility is slated to be operational in 2025.

Uranium Processing Facilities Being Deactivated

Three large former uranium processing facilities were being deactivated in FY 2022. Those facilities—Building 9201-02, Building 9201-04, and Building 9204-01—were home to the historic calutron (mass spectrometer) racetracks used for separating isotopes of uranium.

Deactivation work in these large facilities is the heavy lift leading up to demolition and is focused on removing potential hazards and environmental risks. It can take months, sometimes years, to complete all of the aspects of deactivation.

- **Building 9201-02.** The three-story facility has a footprint of 107,619 square feet. Since bringing the building to the cold and dark stage in the summer of 2021, workers have been steadily deactivating the facility. In addition to removing asbestos-contaminated materials and hazardous and universal waste, workers have drained tens of thousands of gallons of oil from large pieces of electrical equipment and, to date, have removed 184,569 pounds of lead blocks from shields that were used to support fusion experiments.
- **Building 9201-04.** With a footprint of more than 174,000 square feet, the four-story building is one of Y-12's largest high-risk facilities, with elemental mercury contaminating much of the structure.

  During the fiscal year, workers completed deactivation of the adjacent East Column Exchange equipment, which involved retrieving 2.3 tons of mercury from the processing structure's pipes and tanks. That amount is in addition to the 4.19 tons that were recovered from the West Column Exchange equipment, when it was demolished in 2018. A combined total of 6.49 tons was recovered from the East and West Column Exchange equipment, which significantly reduces potential releases to the environment at Y-12.

  As the fiscal year was ending, crews were beginning work to make Building 9201-04 cold and dark. That work includes isolating mechanical and electrical power sources so that crews can safely remove hazardous waste and prep the facility for demolition.

- **Building 9204-01.** Next to Building 9201-02 is the multi-level Building 9204-1, with a footprint of 75,012 square feet. During the fiscal year, crews removed asbestos-containing materials (e.g., floor and ceiling tile, ductwork, piping) as well as hazardous and legacy waste.

  A challenge for deactivation crews in the building is to pump out tens of thousands of gallons of water from the basement in order to perform deactivation activities there. Crews performed an infiltration study in the spring to support design of a water treatment skid to treat and discharge approximately 3 million gallons of water starting in the late winter/early spring FY 2023.

4.8.2. Waste Management Activities

Waste management is performed at multiple locations on the ORR for both solid and liquid wastes, including landfills and water treatment facilities.

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

Most of the waste generated during FY 2022 cleanup activities in Oak Ridge went to disposal facilities on the ORR. The Environmental Management Waste Management Facility received 7,172 waste shipments, totaling 58,404 yd^3, from cleanup projects at ETTP, ORNL, 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 known as the ORR Landfills. In FY 2022, these three active landfills received 11,146 waste shipments, totaling 155,039 yd^3 of waste.

4.8.2.3. Wastewater Treatment

Safe and compliant treatment of more than 35.6 million gallons of wastewater and groundwater generated from both production and environmental cleanup activities was provided at various facilities during 2022:

- The West End Treatment Facility and the Central Pollution Control Facility at Y-12 processed approximately 400,000 gallons of wastewater, primarily in support of NNSA operational activities.
- The Big Springs Water Treatment System treated more than 19 million gallons of mercury-contaminated groundwater.
- The East End VOC Treatment System treated 12 million gallons of VOC-contaminated groundwater.
- The Liquid Storage Facility and Groundwater Treatment Facility treated more than 2.7 million gallons of leachate from burial grounds and well purge waters from remediation areas.
- The Central Mercury Treatment System treated approximately 1.6 million gallons of mercury-contaminated sump waters from Building 9201-04.

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