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 NNSA, plays a vital role in the DOE Nuclear Security Enterprise. Since 1943, Y-12 has played a key role in strengthening the country's national security and reducing the global threat from weapons of mass destruction. Y-12 has become the complex the nation looks to for support in protecting America's future and developing innovative solutions in manufacturing technologies, prototyping, and safeguards and security.

4.1. Description of Site and Operations

4.1.1. Mission

Y-12 has four mission priorities that enable the national security missions that protect the country and its allies around the world, design and deliver the nation's nuclear stockpile, forge solutions that enable global security and stability, harness the atom to power a global naval fleet, and leverage transformative technologies to address emerging challenges.

Y-12's core mission is to ensure a safe, secure, and reliable US nuclear deterrent, which is essential to national security. Production, surveillance, dismantlement, and storage are the four distinct facets of maintaining the stockpile. Every weapon in the US nuclear stockpile has components manufactured, maintained, or ultimately dismantled by Y-12.

As the nation reduces the size of its arsenal, Y-12 plays a central role in decommissioning weapons systems and providing weapons material for peacetime uses. Y-12 provides the expertise to secure highly enriched uranium that may be vulnerable to terrorists, with the highest security, both domestically and around the world. Y-12 also makes material available for non-weapons uses, such as in research reactors and for producing cancer-fighting medical isotopes and commercial power.

Y-12 provides highly enriched uranium used in the fabrication of fuel for reactors in the Navy's nuclear-powered aircraft carriers and submarines under an agreement with the NNSA Naval Reactors Office. Working with the Naval Reactors Program, Y-12 has supplied the US Navy feedstock from weapons removed from the nation's nuclear weapons stockpile to fuel nuclear-powered submarines and aircraft carriers over the past 10 years.

Located within the city limits of Oak Ridge, Tennessee, the site covers more than 3,000 acres primarily within the Bear Creek Valley, stretching 2.5 mi in length down the valley and nearly 1.5 mi in width across it. Additional NNSA-related facilities located off-site include the Central Training Facility, Alternate Emergency Operations Center, Oak Ridge Enhanced Technology and Training Center, Uranium Processing Facility (UPF) project laydown storage and offices, Y-12 Material Acquisition and Control Facilities, the John M. Googin Technology Development Facility, the Test and Demonstration Facility, the Commerce Park Office Complex, and the Union Valley Sample Preparation Facility.

4.1.2. Modernization

Approximately 34 percent of Y-12's facility footprint is more than 80 years old, and an additional 34 percent falls into the 61 to 80-year-old range. These two categories account for 22 percent of Y-12's buildings, as shown in Figure 4.1. Aging facilities, coupled with increased mission demand, necessitate a robust modernization strategy. Y-12 has been consolidating operations, modernizing facilities and infrastructure, and reducing the legacy footprint, supporting NNSA overall transformation planning.

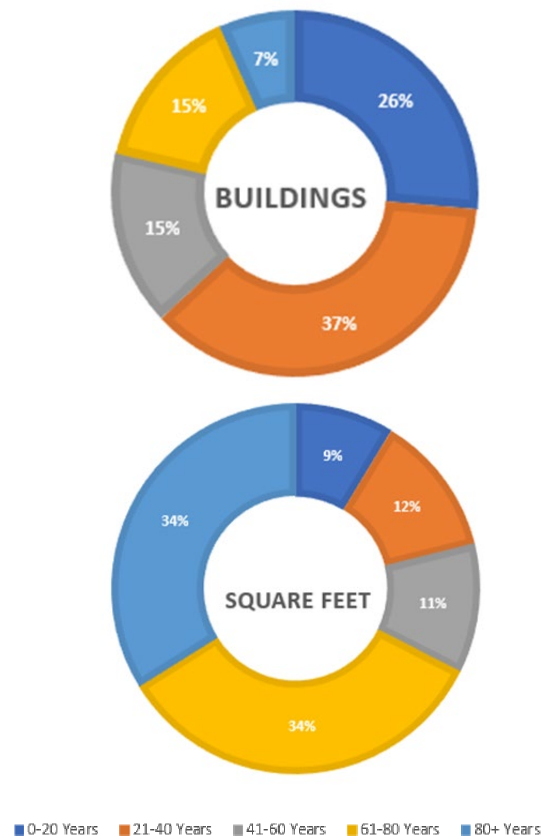


Figure 4.1. Age of facilities at Y-12

Planning for the future site ensures that Y-12 will continue to provide the infrastructure needed to support the primary capabilities and materials missions with new facilities and associated technologies. The envisioned future Y-12 site includes the following elements:

- Major supply chains, including uranium (enriched uranium, depleted uranium, and low enriched uranium) and lithium, are reestablished and/or transformed.
- 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, as well as revitalized security infrastructure and systems.
- The Mercury Treatment Facility and Environmental Management Disposal Facility are constructed, enabling approximately 2.8 million gross square feet (gsf) of excess facility demolition and legacy environmental threats to be remediated.
- A Special Materials capability is established, with operations located in renovated facilities.
- Public tours of Y-12 historic facilities and participation in the Manhattan Project National Historic Park are implemented, to the extent possible.

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. The UPF, which is an integral part of Y-12's transformation, is being constructed as one of two main facilities in which enriched uranium will be stored and processed in a more centralized area.

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

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

The following planned major construction activities are replacing key production operations currently in aging, oversized facilities. Dates of the construction activities are tentative and subject to change.

- Building 9212 functions are to be replaced by the UPF in 2032, with some Building 9212 processes relocated to Buildings 9215 and 9204-2E.
- Building 9215 enriched uranium functions are to be replaced by the Enriched Uranium 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.
- Depleted uranium fabricating and manufacturing functions from the Building 9215 Complex, Building 9201-05N, and Building 9201-05W are to be replaced by phased line item construction, with the first phase—the Agile Radiation Case Capability—by 2035.
- General manufacturing and fabrication functions from Building 9201-01 are to be replaced by the General Manufacturing Capability by 2045.

4.1.4. Support Facilities

Organization and facilities that support operations ensure Y-12 mission-critical work is completed. The primary missions of the operations support infrastructure are to protect vital national security assets and people and enable site missions. Operations support includes the following:

- Security
- Emergency Services
- Development
- Analytical Chemistry
- General Storage and Warehousing
- Cybersecurity and Information Technology

- Global Security and Strategic Partnerships
- Waste Management
- Stewardship Operations
- Oak Ridge Enhanced Technology and Training Center

The following planned major construction activities are replacing key operations support facilities:

- Complete the West End Protected Area Reduction project, including a new Entry Control Facility, by 2025.
- Construct a phased line item construction development campus, with the first phase—the Applied Technologies Laboratory—by 2037 to replace Buildings 9202 and 9203.
- Implement the Security Infrastructure Revitalization Program to upgrade and replace the legacy Perimeter Intrusion Detection and Assessment System.
- Explore new construction for replacement facilities to support Analytical Chemistry operations, including phased campus construction, beginning in 2029, and a future line item construction project—the Analytical Chemistry Laboratory—in 2033.
- Construct the Oak Ridge Institute for Global Nuclear Security at the new Oak Ridge Enhanced Technology and Training Center campus by 2026.
- Construct new maintenance facilities to support maintenance operations throughout the site, beginning in 2028.
- Construct a new waste management complex to replace the aging West End Treatment Facilities by 2040.
- Implement a digital transformation and cybersecurity strategy.
- Construct a new security complex to accommodate growing requirements by 2046.

4.1.5. Excess Facility Disposition

Currently, there are 44 excess facilities at Y-12, with another 39 buildings and trailers 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 Complex (Steam Plant) 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 will be constructed before any mercury-contaminated facilities within the West End Mercury Area can be demolished. Surveillance and maintenance activities, along with utility reroutes, unneeded material cleanout, and fluid and oil disposition, continue while these new facilities are being built.

4.2. Environmental Management System

The Y-12 environmental management system (EMS) applies to site activities and operations managed by CNS as described in Section 4.1. EMS is part of the overall management system that includes organizational structure, planning activities, responsibilities, best practices, procedures, processes, and resources by which CNS accomplishes its environmental policy. EMS applies to all personnel who perform work related to the CNS mission.

The Y-12 EMS was developed and implemented fully in 2005. CNS models the EMS structure so that it is comparable to the framework within International Organization for Standardization's (ISO) 14001, *Environmental management systems—Requirements with guidance for use* (ISO 2015). The system ensures a structured approach to identifying environmental aspects, setting and achieving environmental objectives, and monitoring environmental performance.

The Y-12 EMS has two areas of focus—environmental compliance and environmental stewardship. Environmental compliance consists of regulatory compliance and monitoring programs that implement federal, state, and local requirements, agreements, and permits. Environmental stewardship promotes and integrates initiatives such as energy and natural resource conservation, air pollutant emission minimization, waste minimization, and the use of environmentally preferable 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, workers, or the environment. EMS elements are incorporated in ISMS to achieve environmental compliance, pollution prevention, waste minimization, resource conservation, and stewardship. Both ISMS and EMS are based on a 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.

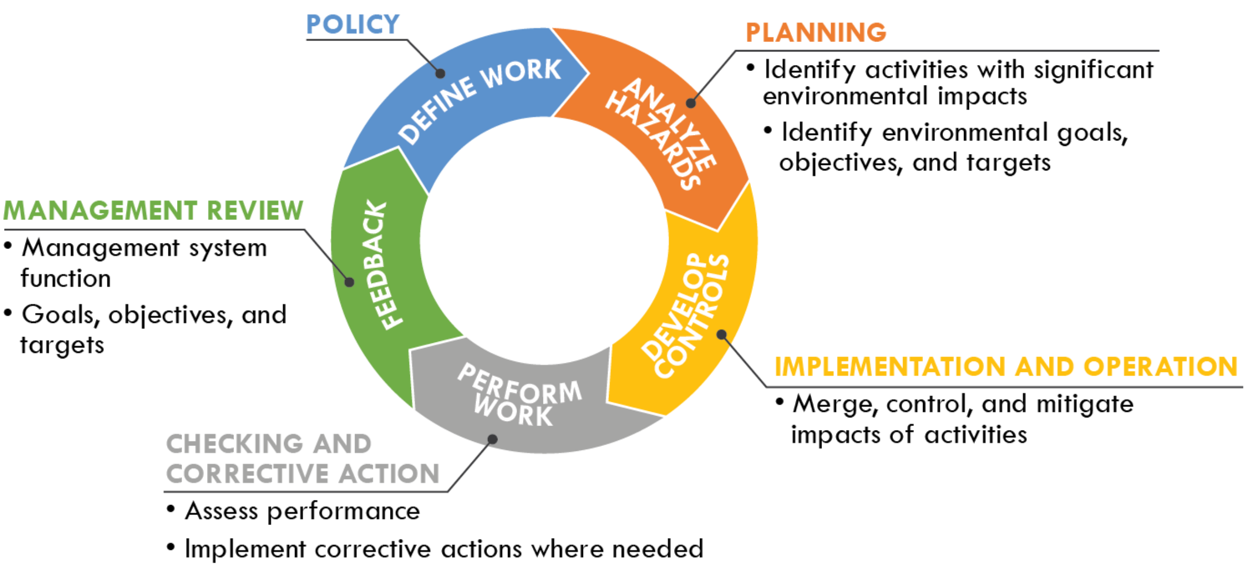


Figure 4.2. The "plan-do-check-act" cycle of continual improvement

4.2.2. Policy

Y-12's environmental policy includes commitments to prevent pollution, protect the environment, comply with applicable requirements, and continually improve the environment. Y-12's ES&H policy is outlined in Figure 4.3.

Y-12 Environment, Safety, and Health Policy Statement

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

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

In support of these policies, we are committed to:

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

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

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. 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 2024:

- Storm water (runoff from roofs and outdoor storage areas)
- Wastewater (sanitary sewer and process water treated and disposed)
- Aging infrastructure and equipment
- Legacy contamination and disturbance
- Excess facilities and unneeded materials and chemicals
- Surface water (process water and dike emissions to creek)

4.2.3.2. Legal Obligations 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 discussed in Section 4.3.

4.2.3.3. Objectives, Targets, and Environmental Action Plans

Y-12 pursues stewardship initiatives by establishing and maintaining environmental commitments, goals, targets, and action plans. Goals and commitments are established annually and consider the site's significant environmental aspects. They are consistent with Y-12's mission, budget guidance, ES&H work scope, and DOE stewardship 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 2024 environmental achievements are presented in Section 4.2.6.1.

4.2.3.4. Programs

NNSA has developed and funded several 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 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 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 the 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 maintains and ensures implementation of regulatory requirements 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.

Stewardship Operations Services

The Stewardship Operations Services plays a vital role at Y-12 by promoting pollution prevention; dispositioning materials via recycling, landfill, excess, the Destruction and Recycle facility, and generator services activities; supporting good housekeeping via the PrYde Program; and cleaning up various facility areas via the Clean Sweep Program, various projects, Stewardship/Emergent Risk, and the Unneeded Materials and Chemicals initiative. Additionally, the organization strives to minimize the impact of Y-12 operations by using viable practices for energy efficiency, fleet management, water consumption, resource conservation, and incorporation of environmentally sound design principles.

Y-12 has implemented continuous improvement activities, such as an Items Available for Reuse section on the site Property Accountability Tracking System and a central telephone number (574-JUNK) to provide employees with easy access to information and assistance related to the proper methods for disposing excess materials.

The Clean Sweep Program provides turnkey services to material generators, including segregation, staging, and materials pickup for excess, recycle, or 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 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 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, and is involved with energy performance contracting.

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

4.2.4.2. Community and Community Involvement

NNSA and CNS are committed to keeping the community informed on operations, environmental concerns, safety, and emergency preparedness. CNS is a member of Oak Ridge and East Tennessee economic development and business development agencies including the East Tennessee Economic Council, the Oak Ridge Chamber of Commerce, and the Anderson County Chamber of Commerce. CNS is also engaged in Anderson County and Oak Ridge's Leadership programs through its support of the Center for Leadership and Community Development.

Local charities receive donations from funds generated from the sale of aluminum beverage cans through the Employee Aluminum Can Recycling Program. Since the program began, more than $98,400 has been donated to local charities that were nominated by Y-12 employees and voted on by an employee committee.

Y-12 continues to promote sustainable behaviors for environmental improvements at the site and within the community.

4.2.4.3. Emergency Preparedness and Response

Local, state, and federal emergency response organizations are 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 fiscal year (FY) 2024 focused on topics such as responding to chemical, nuclear criticality, and radiological releases, as well as changing the site's Security Condition. Building evacuation and accountability drills were also conducted.

4.2.5. Checking

The following sections describe Y-12 EMS activities 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 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 2024 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). (Note: NPO was replaced by the new Y-12 Field Office [YFO] in April 2024).

4.2.5.2. Environmental Management System Assessments

To periodically verify that the 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 environmental procedures and policies 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.

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. To report performance, Y-12 uses the Federal Automotive Statistical Tool, which collects fleet inventory and fuel use, and a DOE web-based 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 of "green" for FY 2024, indicating full and effective implementation of EMS requirements after submitting its annual compliance report via the DOE EMS Site Information Database.

4.2.6.1. Environmental Management System Objectives and Targets

At the end of 2023, Y-12 had achieved nine of 12 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:

- **Energy efficiency.** Y-12 completed chiller plant improvements after obtaining a utility energy service contract and funding approval.
- **Hazardous materials.** A project to disposition and ship legacy mixed waste according to the site treatment plan continued. In 2024, 100% of site treatment plan items on the July 28, 2016, baseline inventory were shipped. This was two years ahead of schedule.
- **Land, water, and natural resources.** Y-12 upgraded sanitary sewer networks as part of a project to protect the sanitary sewer lines from infill and infiltration.

4.2.6.2. Stewardship Operations Services

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. 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 avoidances (Figure 4.4).

In FY 2024, Y-12 implemented 105 pollution prevention initiatives (Figure 4.5), with a reduction of more than 8.32 million lb of waste and projected cost avoidances of more than $4.4 million.

Pollution prevention and source reduction

Across Y-12, sustainable initiatives reduce the impact of pollution on the environment and to increase operational efficiency. Many of these initiatives have pollution prevention benefits or targets eliminating the source of pollution, including the 2024 activities highlighted in this section.

Environmentally preferable purchasing

Environmentally preferable products, including recycled content materials, are purchased for use across the site. In 2024, Y-12 bought more than $7.5 million of materials with recycled content.

Solid waste reduction

Y-12 reduces the amount of solid waste generated, often by diverting waste through source reduction, reuse, and recycling. In 2024, Y-12 diverted 59.9 percent of municipal and 2.8 percent of construction and demolition waste from landfill disposal through reuse and recycle. More than 5.9 million lb of municipal materials from landfill disposal were diverted through source reduction, reuse, and recycling, and more than 4.0 million lb of construction and demolition materials were diverted from landfill disposal.

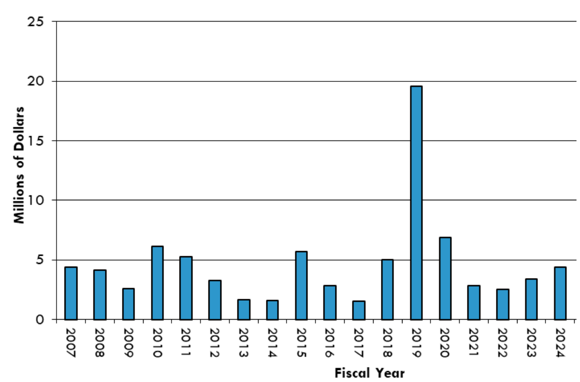


Figure 4.4. Cost avoidances from Y-12 pollution prevention activities, 2007–2024

Hazardous chemical minimization

The Generator Services group provides material disposition management services for waste generators at Y-12, including technical support to assist generators with determining whether the materials can be recycled, excessed, or reused. The Generator Services group can be used by any organization or generator at Y-12. During FY 2024, Generator Services personnel reused, or disseminated to other Y-12 organizations for reuse, various excess materials and chemicals. The Analytical Chemistry Organization implemented new laboratory procedures that reduced the generation of waste.

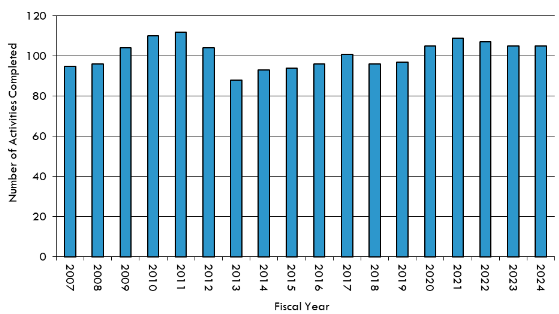


Figure 4.5. Y-12 pollution prevention initiatives, 2007–2024

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 waste disposal and into viable recycle processes during 2024. Currently, recycled materials range from office-related items 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 2024 to include refrigeration equipment to broaden waste diversion efforts.

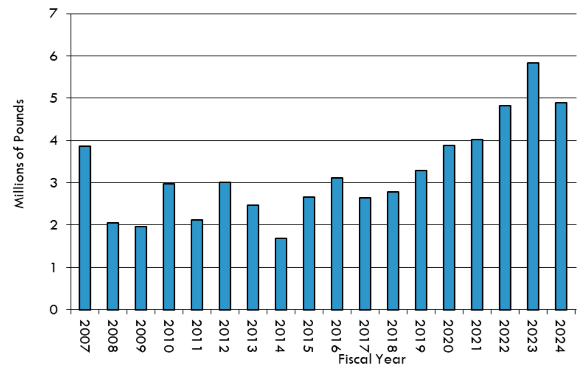


Figure 4.6. Y-12 recycling results, 2007–2024

4.2.6.3. Energy Management

The Energy Management program systematically monitors Y-12's energy and water consumption and recommends opportunities to reduce use and decrease costs. Energy and water usage and intensity, Energy Independence and Security Act of 2007 (EISA, EISA 2007) benchmarking and evaluations, facility metering and monitoring in accordance with the Energy Act of 2020 (EA 2020), and non-fleet vehicles and equipment are components of energy management reporting activities.

Y-12 surpassed DOE's initial goal of a 30 percent energy intensity (Btu/gsf) reduction in goal-subject buildings by 2015 from a FY 2003 baseline, followed by a 1 percent year-to-year reduction thereafter. Compared to the FY 2003 baseline year, Y-12 has seen an overall energy intensity reduction of 53.22 percent.

DOE revised its FY 2024 goal to reduce energy use intensity in goal-subject buildings by 50 percent by 2030 relative to the baseline year 2021. Y-12 is trending toward the goal, accomplishing a 3.61 percent decrease in energy intensity in 2024 from the baseline year, but a 6 percent average annual reduction will be needed to meet DOE's revised baseline goal of a 50 percent reduction by 2030. A significant challenge is that the new goal baseline year was a pandemic year in which a majority of the site population was teleworking. Adding to the challenge, Y-12's workforce numbers continue to grow, with the workforce increased by more than 15 percent between FY 2020 and

FY 2021 in support of increasing site missions. Continued construction on the new UPF also contributes to the energy intensity for this year.

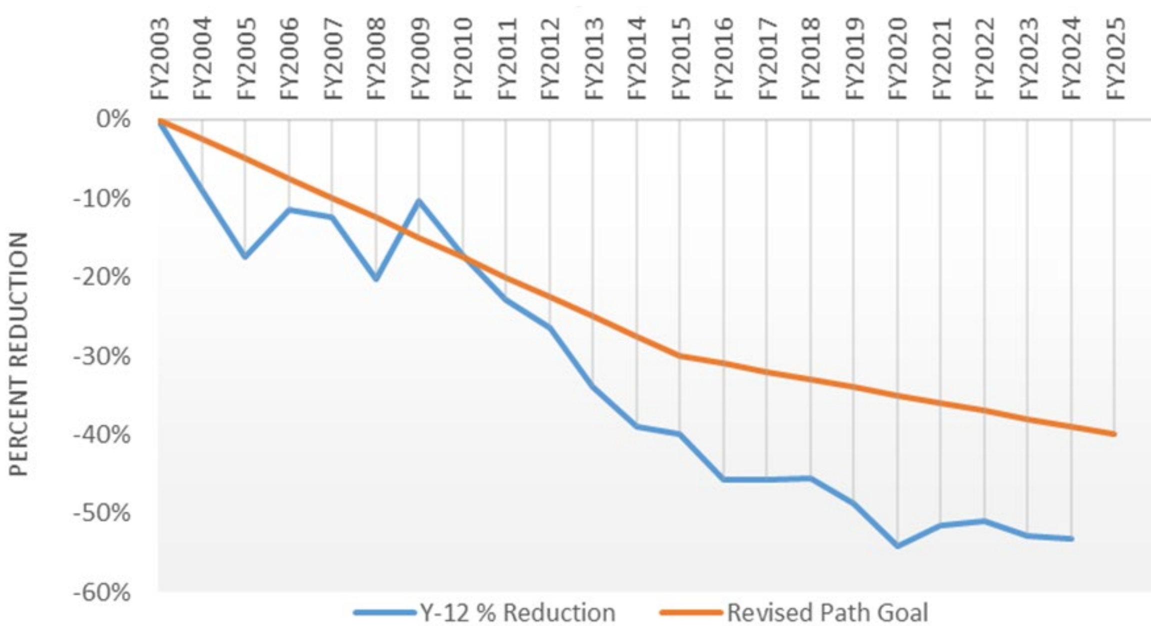
During FY 2024, energy intensity was 195,756 Btu/gsf, three-quarters of a percentage lower than the prior year's 197,270 Btu/gsf. Energy intensity through 2024 is shown in Figure 4.7 and Figure 4.8.

Y-12's modernization efforts before 2030 will lead temporarily to a greater increase in building square footage from new construction than will be compensated by demolition activities. Additionally, buildings with low water use will be dispositioned, while new construction will have significant water demand. Without notable increases in conservation and efficiency measures, modernization phasing is expected to create challenges to maintaining reductions. Yet more aggressive efforts will be needed to meet the 2030 goal.

Work undertaken under the energy savings performance contract, which began in FY 2009, has shown significant and sustained positive effects on the downward trend in energy intensity. Bringing these projects to a close, Y-12 began executing utility energy service contract projects in 2024 to deploy additional energy and water conservation and efficiency measures.

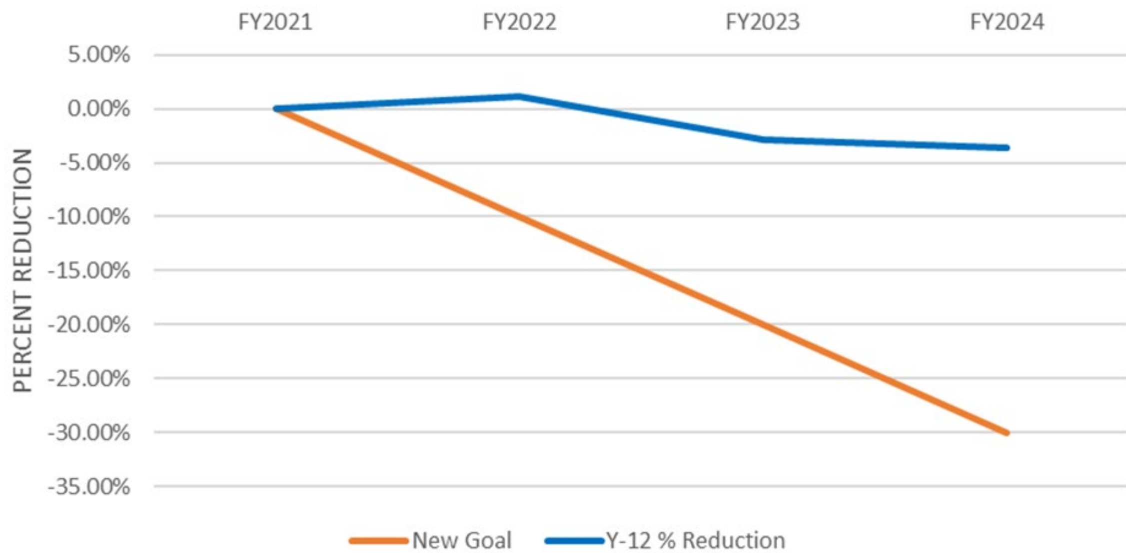
4.2.6.4. Goals and Performance

DOE is required to meet performance goals mandated by statute, including goals for GHG emissions, energy and water use, fleet optimization, green buildings, and renewable energy. In 2024, DOE used its web-based dashboard to collect and consolidate energy and water performance data from all DOE sites. The dashboard focuses on specific DOE goals, and site environmental stewardship plans are completed within the dashboard. These goals, along with the current Y-12 performance ratings, are listed in Table 4.1.



Acronym: *FY = fiscal year*

Figure 4.7. Y-12 energy intensity (Btu per gross square foot) versus 2003 baseline goal



Acronym: *FY = fiscal year*

Figure 4.8. Y-12 energy intensity (Btu per gross square foot) versus revised 2021 baseline goal

Table 4.1. Energy Management goals and performance, 2024

DOE goal	Current status
Energy management	
Reduce energy use intensity (Btu per gross square foot) in goal-subject buildings.	Goal Not Met: Y-12 reduced energy intensity by 3.61% compared to DOE's FY 2024 goal to reduce energy use intensity in goal-subject buildings by 50% by 2030 relative to the baseline year 2021. As Y-12 site population increases every year and the site transforms to meet increased scope in the outyears, energy reductions compared to baseline may not be achievable.
EISA Section 432 continuous (4-year cycle) energy and water evaluations.	Goal Met: Y-12 conducts EISA 432 energy and water 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 at a site level, but not all applicable buildings are metered. A significant metering planning project is currently underway to fully implement sitewide building-level metering.
Achieve a net-zero emissions building portfolio by 2045 through building electrification and other efforts.	Goal Not Met: Y-12 does not have a complete net-zero emissions portfolio at this time. Ongoing opportunities for building electrification are considered in capacity studies, new substation construction, and smaller utility energy service contract projects to implement energy measures.
Water management	
Reduce potable water use intensity (gal per gross square foot).	Goal Met: Y-12 exceeded the goal of reducing 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, or agricultural water.

Table 4.1. Energy Management goals and performance, 2024 (continued)

DOE goal	Current status
Waste management	
Reduce nonhazardous solid waste sent to treatment and disposal facilities.	Goal Met: 59.9% (1,629.1 metric tons/2,718.9 metric tons) of nonhazardous waste diverted from the landfill.
Reduce construction and demolition materials and debris sent to treatment and disposal facilities by 50%.	Goal Not Met: 2.8% (1,821.7 metric tons/61,794.1 metric tons) of construction and demolition materials were diverted from the landfill in FY 2024.
Fleet management	
Reduce petroleum consumption.	Goal Not Met: Y-12 did not meet the interim target of 20% reduction in fleet petroleum consumption in FY 2024 as there was a 13.3% increase from the FY 2005 baseline. Y-12 had 60 additional vehicles in the fleet inventory for FY 2024 compared to FY 2005 baseline inventory and no access to alternate fuel (E85) that would help to meet this metric.
Increase alternative fuel consumption.	Goal Not Applicable: Y-12 does not have access to alternative fuel (E85).
Achieve 100 percent zero-emission vehicle acquisitions by 2035, including 100 percent zero-emission light-duty vehicle acquisitions by 2027.	Goal Met: Y-12 ordered six vehicles with zero-emission capabilities in FY 2024 and one standard pickup for which zero-emission was not available within the U.S. General Services Administration procurement process, thus meeting the goal for the FY 2024 ordering cycle. Y-12 is working toward the goals for 2027 and 2035.
Clean & renewable energy	
Achieve 100 percent carbon pollution-free electricity on a net annual basis by 2030, including 50 percent 24/7 carbon pollution-free electricity.	Goal Not Met: Y-12 has not yet fully achieved these goals.
Increase consumption of clean and renewable non-electric thermal energy.	Goal Not Met: Separating the management and operating contracts between Y-12 and the Pantex Plant in 2024 resulted in losing shared renewable energy credits that had been originating from the Pantex Renewable Energy Project's on-site wind farm. Y-12 continues to generate renewable energy from geothermal wells and nonreflective photovoltaic array associated with a newer building, smaller renewable energy applications for site-specific use, and will purchase energy attribution certificates associated with its local sub-grid region. Y-12 had a 0.5% increase in natural gas use for FY 2024, attributed to increased site population and ongoing modernization efforts.
Sustainable buildings	
Increase the number of owned buildings that are compliant with the Guiding Principles for Sustainable Buildings.	Goal Met: One building was certified as High Performance and Sustainable Buildings in FY 2024.
Acquisition & procurement	
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring all clauses are included as appropriate.	Goal Met: All eligible contracts after Oct. 1, 2013, contain the sustainable acquisition requirements. The CNS Sustainable Acquisition Program is working with Contracts and Procurement to review the current $150,000 contract threshold for sustainable acquisition requirements to be included in subcontract languages so that future appropriate contracts will have the requirements to purchase sustainably.

Table 4.1. Energy Management goals and performance, 2024 (continued)

DOE goal	Current status
Investments: Improvement measures, workforce, & community	
Implement life-cycle cost-effective efficiency and conservation measures with appropriated funds and/or performance contracts.	Goal Met: Y-12 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	
Promote electronics stewardship from acquisition, to 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. Performance for FY 2024 was 96.4%. Y-12's electronics recycling vendor maintained Responsible Recycling certification; therefore, all FY 2024 shipments were made to a certified recycler. Electronics that were not recycled were those that could not be radiologically cleared for release; therefore, 100% of eligible electronics were recycled to a Responsible Recycling certified recycler or were donated for reuse.
Increase energy and water efficiency in high performance computing and data centers.	Goal Not Met: While data centers have been consolidated at Y-12, which has saved energy and water, they are not fully metered. Current power usage effectiveness is estimated to be 2.4. 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 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 updated its vulnerability assessment and resilience plan, along with identified resilience solutions, which include 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.
Multiple categories	
Reduce Scope 1 and 2 greenhouse gas emissions.	Goal Met: Site Scope 1 and 2 emissions were reduced by 62.6% from the FY 2008 baseline. Most of this can be attributed to infrastructure improvements through energy savings performance contract projects.

Acronyms:
DOE = US Department of Energy
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 2024, Y-12's water intensity rating was 62.45 gal/ft^2, a 6.62 percent decrease from the previous year and a 70.37 percent reduction from the 2007 baseline.

An overview of water intensity performance is shown in Figure 4.9.

The following actions have contributed to the overall reduction in potable water use:

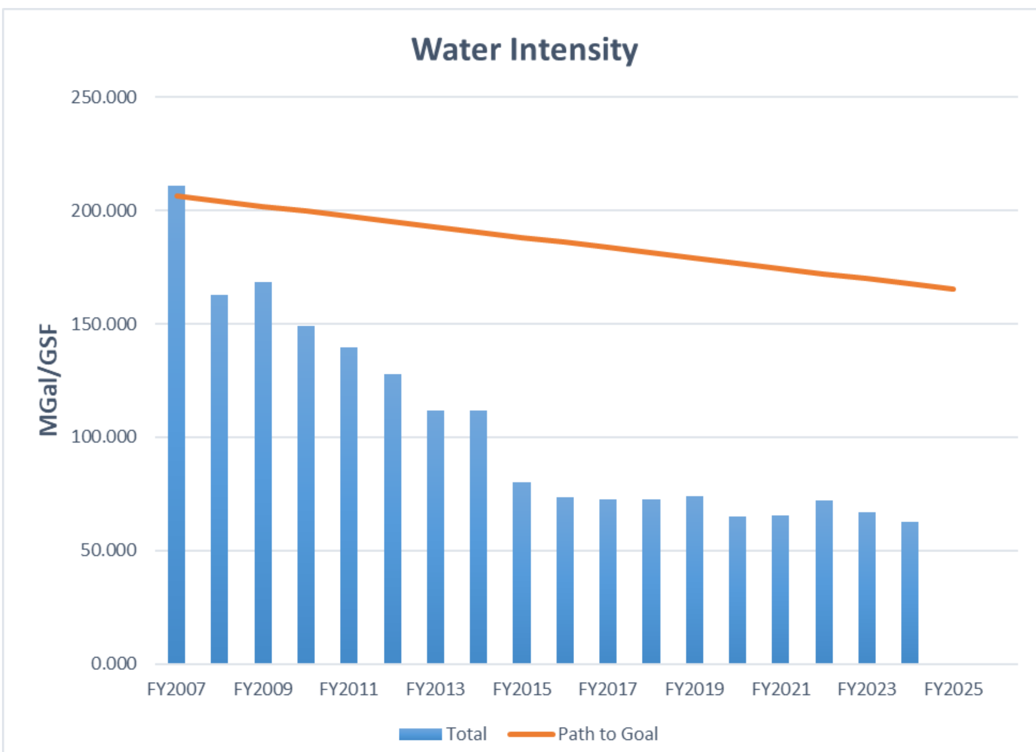
- Steam trap repairs and improvements
- Condensate return installations, repairs, and reroutes

- Replacement of once-through air handling units
- Low-flow fixture installation
- Chiller replacements
- Cooling tower replacements
- Steam replacements to natural gas when possible

Y-12 continues to be plagued by aging infrastructure and associated water line breaks and leaks that have a significant impact on the site's water use efficiency. Replacements and repairs to aging water lines are ongoing.

Internal EISA audits are conducted on covered facilities on a 4-year rotating schedule. Audit results point to continued opportunities for reductions in water usage. Water conservation measures are incorporated into ongoing facility repairs and renovations as funding becomes available. These measures include the following:

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



Acronyms:

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

Figure 4.9. Water intensity graph from baseline 2007 through FY 2024

4.2.6.6. Fleet Management

There are 648 vehicles in the Y-12 fleet, including 124 agency-owned units, 510 leased from General Services Administration (GSA), and 14 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 2024, Y-12 exchanged nine older GSA-leased vehicles with new units and dispositioned an older E-tagged vehicle through Y-12 Property Sales. The new GSA replacements were 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, which ranged from 7 to 12 years of age.

Vehicle availability was again a struggle during FY 2024. Normally, the majority of replacement orders placed with GSA in the November timeframe would be delivered by September, but manufacturer shortages and cancellations once again had major impacts with the actual vehicle delivery cycle during FY 2024. Additional vehicles will be required in the near future to support Y-12 construction projects such as the LPF and the Mercury Treatment Facility, plus additional CNS involvement and oversight with the UPF project, but the vehicle ordering with GSA is projected to be much improved for FY 2025.

The Y-12 taxi service and UPF bus service continued as transportation sources available for the more than 7,500 employees at the site. 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, especially in light of extremely tight vehicle parking availability.

The Y-12 vehicle fleet achieved a 98.5 percent vehicle utilization rate for FY 2024 compared to 98.3 percent in FY 2023. Of the vehicles that failed the utilization rate, all achieved 80 percent or greater utilization scores. Vehicle reassignments were made multiple times throughout the year to help meet utilization goals.

FY 2024 fuel consumption at Y-12 (diesel and gasoline) as reported by GSA decreased by 18.9 percent compared with FY 2023, while miles traveled for those same vehicles was down by 2.88 percent compared to the previous year.

Y-12 continues to use mobile fuel tankers as needed to dispense gasoline and diesel for vehicles because the site lacks a new fuel station, but site preparation has begun 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. Because of this, an Epact 701 waiver (5 miles or 15 minutes away) was granted to Y-12.

4.2.6.7. Electronic Stewardship

Y-12 has 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. More than 96 percent of the desktop computers, laptops, monitors, and thin clients purchased or leased during FY 2024 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 (on-site fuel burning) and Scope 2 (purchased electricity) GHG emissions have been reduced. Emission reductions can be attributed primarily to decreased Scope 1 emissions due to more efficient steam generation and decreased Scope 2 emissions due to energy efficiency projects.

Purchased electricity is by far the biggest contributor to Y-12's GHG footprint. Energy reduction initiatives involving production facilities and utility infrastructure have been completed through energy savings performance contract projects and continue in FY 2024 and FY 2025 through utility energy service contracts.

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

Section 438 of the EISA requires federal agencies 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. Several green infrastructure initiatives have been implemented to reduce the size and number of impervious surfaces through sustainable vegetative practices and porous pavements.

4.3. Compliance Status

During 2024, Y-12 operations complied with contractual and regulatory environmental requirements. Table 4.2 summarizes the environmental audits conducted at Y-12 in 2024. This section discusses the major environmental programs and activities at the site and provides 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.

Table 4.2. Summary of external regulatory audits and reviews, 2024

Date	Reviewer	Subject
March 21	TDEC	Quarterly ORR Landfill Inspections of ILF-V, ILF-IV, CDL-VII, and Semiannual Post Closure Inspection of ILF-II
March 26	City of Oak Ridge	Sanitary Sewer Inspection
April 11	TDEC	Quarterly ORR Landfill Inspections of ILF-II, ILF-V, and CDL-VII
May 21–22	TDEC/EPA	Annual RCRA Hazardous Waste Compliance Inspection
July 10	TDEC	Air Quality Inspection
August 1	TDEC/City of Oak Ridge	ORR Landfill Inspection of ILF-V and CDL-VII Leachate Collection Systems
August 1	TDEC, City of Oak Ridge	Sanitary Sewer Inspection
August 19	TDEC	Quarterly ORR Landfill Inspection of ILF-V and CDL-VII
September 19	TDEC	Quarterly ORR Landfill Inspection of ILF-IV
November 22	TDEC	Quarterly ORR Landfill Inspections of ILF-V and CDL-VII. Second Semiannual Post Closure Inspection of ILF-II
December 12	TDEC	Quarterly ORR Landfill Inspection of ILF-IV

Acronyms:

CDL = Construction Demolitions Landfill
EPA = Environmental Protection Agency
ILF = Industrial Landfill
ORR = Oak Ridge Reservation
RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment and Conservation

Table 4.3. Y-12 environmental permits, 2024

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)	TNR134022	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	UCOR ILF-II General Storm Water Permit Y-12 (8.2 acres)	TNR136478	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	Security Infrastructure Revitalization Program NPDES General Construction Permit	TNR136604	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-130-31	07/01/23	06/30/28	DOE	DOE	CNS
CWA	No Discharge Environmental Management Waste Management Facility Pump and Haul Permit	SOP-010-43	09/01/22	08/31/27	DOE	UCOR	UCOR
CWA	Oak Ridge Institute for Global Security Aquatic Resource Alteration Permit	NR2003.249	01/14/21	Upon Notice of Termination	DOE	DOE	CNS
CWA	Oak Ridge Institute for Global Security NPDES General Construction Permit	TNR136307	04/26/21	09/30/26	DOE	DOE	CNS
CWA	Y-12 National Security Complex LPF Permit	TNR137245	07/21/23	Upon Notice of Termination	DOE	DOE	CNS
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

Table 4.3. Y-12 environmental permits, 2024 (continued)

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
RCRA	Hazardous Waste Transporter Permit	TN3890090001	12/20/24	01/31/26	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-191	09/21/23	09/21/33	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
Solid Waste	Construction and Demolition Landfill VI (post-closure care and maintenance)	DML-01-000-0036	Permit terminated by TDEC 03/15/07				

Table 4.3. Y-12 environmental permits, 2024 (continued)

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
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	.81
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.*

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
LPF = Lithium Processing Facility
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

4.3.2. National Environmental Policy Act

As federal agencies, DOE and NNSA comply with National Environmental Policy Act (NEPA) requirements as outlined in 10 CFR 1021, *National Environmental Policy Act Implementing Procedures*. NEPA requires reviews of all federal actions to identify 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 federal agencies evaluate environmental and related social and economic impacts in the decision-making process. This evaluation helps Y-12 and NNSA stay in compliance with many federal and state laws, regulations, and permits.

The broadest and most complex NEPA document for Y-12 is DOE/EIS-0387, *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 2020). NNSA began a contract for a new supplement analysis in 2024.

NEPA environmental assessments are prepared for larger projects that may not have been covered in the EIS or supplement analysis. Two environmental assessments were completed in 2024:

- DOE/EA-2218, *Environmental Assessment for Activities in Support of the Y-12 National Security Complex Materials Manufacturing Mission*, and its associated Finding of No Significant Impact were completed in January 2024 (NNSA 2024a, NNSA 2024b)
- DOE/EA-2252, *Environmental Assessment for Off-Site Depleted Uranium Manufacturing*, and its associated Finding of No Significant Impact were completed in October and November (NNSA 2024c, NNSA 2024d).

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.

There were 31 environmental reviews in 2024, with one of these resulting in development of a federal CX document requiring approval by the NNSA NEPA Compliance Officer [NEPA 5092, *East End Substation Construction* (DOE 2024b)]. Some of these environmental reviews against existing NEPA documentation were for new projects, and others may be revisions to older project documents based on new information or small changes in project scope.

The EIS, supplement analyses, environmental assessments, and federal CXs documents are available at the Y-12 publicly accessible website (www.y12.doe.gov) on the Environment, Safety, and Health page under the About tab.

4.3.3. National Historic Preservation Act

In accordance with the National Historic Preservation Act (NHPA, NHPA 1966), NNSA is committed to identifying, preserving, enhancing, and protecting its cultural resources. Compliance activities in 2024 at Y-12 included completing Section 106 reviews of ongoing and new projects to ensure preservation of historic properties, coordinating with the Tennessee State Historic Preservation Office (SHPO) toward the execution of an updated cultural resource survey and a programmatic agreement, as well as collecting and storing historic artifacts.

Y-12 is on approximately 3,500 acres within the northern portion of the 33,316 acres of the ORR. Archaeological surveys in 1992 and 1999 determined that the potential for preserved prehistoric or historic archaeological sites is virtually nonexistent due to the previous amount of disturbance during Manhattan Project-era and later construction. Y-12 continues to conduct archaeological surveys as necessary to comply with NHPA and facilitated surveys in December 2024 of the eastern portion of Pine

Ridge in support of upcoming projects by the Tennessee Valley Authority within the Y-12 footprint.

Y/TS-1983, *Y-12 National Security Complex National Historic Preservation Act Historic Preservation Plan* (BWXT 2003), is reviewed every 5 years to maintain its effectiveness as a guiding document for the NHPA Program at Y-12. In its last review, it was determined that the plan and associated 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 updating its cultural resource survey, which evaluates all site facilities 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. The proposed survey includes a total of 273 surveyed properties out of 352, including 119 properties assessed in the previous survey and 195 buildings constructed after 1958, which is the end of the period of significance for the previous 1999 survey. The new proposed period of significance extends to 1992 and includes Y-12's role in the Manhattan Project (1943–1945/1946), post-World War II (1945/1946–1950), the Cold War (1950–1992), and peacetime research and development (1950–1992). Work has also begun updating Y-12's programmatic agreement to reflect information provided in the draft cultural resource survey and during consultation with the SHPO.

The NHPA program works through the NEPA process to ensure that the proper level of environmental review is performed before an irreversible commitment of resources is made. In 2024, 27 proposed projects were evaluated to determine whether any historic properties eligible for inclusion in the National Register of Historic Places would be adversely impacted. One building newly recommended as eligible for the National Register of Historic Places was scheduled for demolition in late 2024. Because demolishing a building eligible for the National Register of Historic Places is considered an adverse effect, the SHPO was made aware of the building's demolition status before action was taken. Section 106 documentation for the buildings has been submitted to the SHPO, and Y-12 is consulting with the SHPO to add the building to the NHPA memorandum of agreement between DOE, NNSA, and Y-12 regarding the demolition of excess buildings at Y-12.

4.3.4. Clean Air Compliance Status

The state of Tennessee issues permits as the primary means 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 2024, and there were no exceedances during the reporting period.

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 to provide evidence of sufficient programmatic control of certain emissions. The 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 additional information about Clean Air Act (CAA) activities conducted at Y-12.

4.3.5. Clean Water Act Compliance Status

During 2024, Y-12 continued 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 2024 was 100 percent.

Approximately 4,200 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.

On July 17, 2024, a Notice of Violation was received from TDEC for a fish kill resulting from a potable water line break on June 20, 2024.

On October 1, 2024, a fish kill occurred when controlled low-strength material (concrete mix) from UCOR pre-demolition activities entered East Fork Poplar Creek (EFPC) through an abandoned drain line from the basement of Building 9201-02. The discharge resulted in high turbidity, elevated pH and the death of approximately 1,300 fish and other aquatic organisms.

On July 28, 2024, the instantaneous flow rate in the sanitary sewer peaked at approximately 4,000 gpm, exceeding the 2,100-gpm limit. This was a result of a 2.2-inch rainfall in 2.5 hours.

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.

TDEC water resource regulation Chapter 0400-45-01, "Public Water Systems," (TDEC 2019) sets limits for biological contaminants, chemical activities, and chemical contaminants. Sampling for total coliform, chlorine residuals, lead, copper, and disinfectant byproducts is conducted by Y-12's 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 2024 were analyzed by the state of Tennessee laboratory, and all results were negative.

The 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 sampled triennially for lead and copper. The system was last sampled in 2024. The results were below TDEC and Safe Drinking Water Act limits and met established requirements.

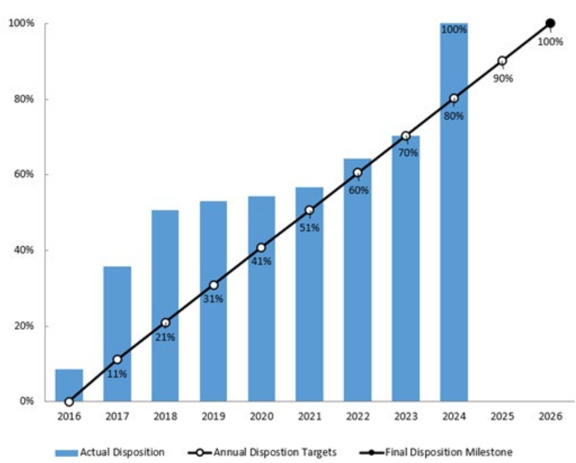
4.3.7. Resource Conservation and Recovery Act Compliance Status

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 (FFCA 1992). The plan identifies available treatment technologies and disposal facilities (federal or commercial) that can manage mixed waste produced at federal facilities and outlines 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 2024c) is updated annually and submitted to TDEC for review. Site treatment plan-listed mixed waste is documented, as well as efforts 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 the plan, as a reporting mechanism, as progress is made.

In August 2016, NNSA formally requested, and TDEC provided concurrence for, the addition of 81 mixed low-level radioactive waste containers to the ORR site treatment plan. Disposition milestones to address this mixed waste were developed for FYs 2016 through 2026, as shown in Figure 4.10. In FY 2024, Y-12 staff dispositioned 100 percent of this inventory. In FYs 2023 and 2024, 14 containers of mixed transuranic waste and 25 containers of mixed low-level radioactive waste were added to the site treatment plan.



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

Figure 4.10. Disposition of Y-12 legacy mixed waste inventory by fiscal year, 2016–2024

The quantity of hazardous and mixed wastes generated by Y-12 in 2024 decreased compared to the previous year, as shown in Figure 4.11. Y-12 is a state-permitted treatment, storage, and disposal facility. Under its permits, Y-12 received 5,400 kg of hazardous and mixed waste from off-site in 2024. The 5,400 kg of hazardous waste received at Y-12 was generated from CNS activities at the Union Valley Facility and ETTP. Waste from these facilities is shipped to Y-12, where it is aggregated to allow economical shipments to disposal facilities. The majority (70 percent) was generated as a result of analytical chemistry laboratory operations at the Union Valley Facility. Hazardous waste was also generated from UPF project operations at ETTP.

In addition, 840,321 kg of hazardous and mixed waste was shipped to DOE-owned and commercial treatment, storage, and disposal facilities. More than 8 million kg of hazardous and mixed wastewater was treated at on-site wastewater treatment facilities.

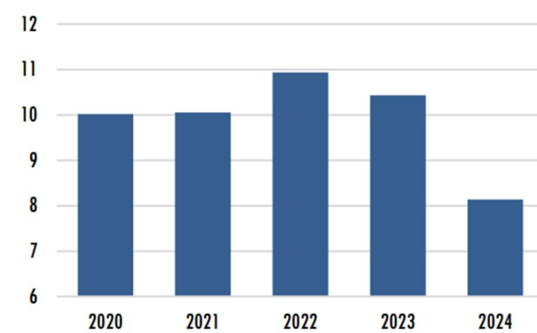


Figure 4.11. Y-12 hazardous waste generation (in million kg), 2020–2024

4.3.7.1. Resource Conservation and Recovery Act Underground Storage Tanks

Y-12 has no active petroleum underground storage tanks.

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 1997). One Class II facility (Landfill II) has been closed and is subject to post-closure care and maintenance.

Associated TDEC permit numbers are noted in Table 4.3. Additional information about the operation of these landfills is provided in Section 4.8.2.

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

The ORR Federal Facility Agreement (DOE 1992) is used 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 2024 as an update of the previous year's 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 25, 2024.

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 (DOE 2012). This agreement, known as the ORR PCB Federal Facility Compliance Agreement, addresses 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 facilities to 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 (EPCRA 1986). Y-12 submitted reports for reporting year 2024 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. (Section 4.3.11 provides additional information.) 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 seven extremely hazardous substances and 47 hazardous substances over Section 312 inventory thresholds in 2024. Nine hazardous substances were over threshold during 2024 and were not reported in 2023.

In 2024, the Central Training Facility had one extremely hazardous substance over threshold and was reported through the E-Plan system.

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 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. Seven chemicals were reported for 2024 on the Toxic Release Inventory report. Table 4.4 lists the reported chemicals for Y-12 and Central Training Facility for 2023 and 2024.

4.3.11. Spill Prevention, Control, and Countermeasures

Section 311 of the Clean Water Act 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 (CWA 1972). 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. Specific facilities are required to prepare, amend, and implement spill prevention, control, and countermeasure plans.

Y/SUB/02-001091/9, *Spill Prevention, Control, and Countermeasure Plan for the U.S. Department of Energy Y-12 National Security Complex* (CNS 2024) 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 Operations Center. Spill response materials and equipment are stored near tanks, drum storage areas, and other strategic areas 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 Emergency Management Agreement. As an example, certain observable oil sheens on EFPC must be reported to the EPA National Response Center, among others. 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 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 2024, there were no reportable releases to the environment, including no reportable radiological air emission releases for Y-12.

Table 4.4. Emergency Planning and Community Right-to-Know Act Section 313 toxic chemical release and chemicals manufactured, processed, or otherwise used for Y-12 and the Central Training Facility

Report	Chemical/ Compound	2023			2024			Comments
		Manufactured (lb)	Processed (lb)	Otherwise used (lb)	Manufactured (lb)	Processed (lb)	Otherwise used (lb)	
Y-12	Chromium/ Chromium Compounds	0	169,521	17,475	0	406,877	9,691	2024 increased amount recycled and metal processed; decreased UPF construction materials otherwise used.
Y-12	Cobalt	0	40,072	2,912	0	25,366	1,921	2024 decreased amount recycled; decreased UPF construction materials otherwise used.
Y-12	Copper	0	250,743	13,880	0	249,700	6,356	2024 similar amounts recycled; continued decreased UPF construction materials otherwise used.
Y-12	Lead/Lead Compounds	0	91,984	35,435	0	110,754	11,089	2024 slight increase amount recycled; decreased construction materials otherwise used. Central Training Facility lead counts for ammunition are not included in the Y-12 report but in a standalone report for 2024.
Y-12	Manganese	0	117,437	9,172	0	98,391	2,098	2024 slight decrease amount of recycled and metal processed; decreased UPF construction materials otherwise used.
Y-12	Methanol[a]	0	0	6,372	0	0	2,412	Not reportable under threshold for 2023 or 2024. Building 9767-4 no longer in use for the brine system.
Y-12	Nickel	0	409,514	26,664	0	405,568	6,221	2024 amount recycled and metal processed close to 2023; decreased UPF construction materials otherwise used.
Central Training Facility	Lead/Lead Compounds	0	0	1,109	0	0	832	2024 data is reported separately from Y-12 because the facility is not adjacent/adjoining to the Y-12 site. Slight decrease in amount of ammunition used for 2024.

[a] *Not reported during 2024*

Acronyms:

UPF = Uranium Processing Facility

4.3.13. Audits and Oversight

In 2024, Y-12 was inspected by federal, state, or local regulators on 11 occasions, as listed in Table 4.2.

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 2024.

Personnel from the TDEC Division of Solid Waste Management and the EPA RCRA Enforcement Section conducted an unannounced RCRA hazardous waste compliance inspection of Y-12 on May 21–22, 2024. The inspections covered waste storage areas and records reviews. One issue was identified—a 10-gal container of hazardous waste was not labeled with the accumulation start date. This was corrected immediately. The issue and its causes were reviewed to prevent recurrence.

Personnel from the TDEC Division of Air Pollution Control conducted an air quality inspection on July 10, 2024. The inspection covered 10 air emission sources, including some emergency generators, and inspections of the facilities. Title V air permit records were also reviewed. No issues were identified.

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. Property consists of real property (i.e., land and structures) and personal property (i.e., property of any type except real property) (DOE 2011b).

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 4.5 summarizes some examples of the property released in 2024 and their amounts. Y-12 recycled more than 4.88 million lb of materials off-site for reuse, including computers, electronic office equipment, used oil, scrap metal, tires, batteries, lamps, and pallets.

Table 4.5. Summary of materials released in 2024

Category	Amount released
Real property (land and structures)	None
Computer equipment recycle:	39,768 lb
– Computers	
– Monitors	
– Printers	
– Mainframes	
Recycling examples:	
– Used oils	61,191 gal
– Used tires	39,680 lb
– Scrap metal	3,887,733 lb
– Lead acid batteries	99,480 lb
Public and negotiated sales:	
– Brass	5,841 lb
– Miscellaneous furniture	10,332 lb
– Vehicles and miscellaneous equipment/materials	635,430 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 2024. Y-12 transferred property with an acquisition value of approximately $2,628,244; however, the weight of the transferred items in pounds was unable to be quantified.*

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. 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 2024.

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 NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual* (NRC 2000) and NUREG-1575, Supplement 1, *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual* (NRC 2009). Table 4.6 lists the surface contamination limits used at Y-12 to determine whether materials and equipment (M&E) are suitable for release to the public.

As noted in Table 4.6, 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. Y-12 also uses an administrative limit for removable activity of 240 dpm/100 cm^2 for radionuclides in Group 3. Using 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

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 in an original manufacturer's sealed, unopened container. A seal can be visible (e.g., lock tabs, heat shrink) or unseen (e.g., unbroken fluorescent bulbs, sealed capacitors), as long as the container remains unopened.
- **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 the results are evaluated against the preapproved authorized limits in DOE Order 458.1. If preapproved authorized limits have not been obtained, 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.

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 2021). Table 4.7 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.

Table 4.6. 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. 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:

N/A = not applicable

Table 4.7. DOE Order 458.1 preapproved authorized limits for volumetric contamination[a]

Radionuclide groups[b]	**SI units, volume (Bq/g)[f]**	**Conventional units, volume (pCi/g)[f]**
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[b]	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 of the screening factors, by exposure scenario, listed in Tables B. 1, C.1, and D.1 of NCRP Report No. 1231 (NCRP 1996) for the radionuclides in question and the radionuclides in the general groups above will be performed and a determination of the proper group made, as described in ANSI/HPS N13.12-2013, Surface and Volume Radioactivity Standards for Clearance, Annex A (HPS 2013).*

[c] *Because of potential ground-water concerns, the volume radioactivity values for ^{129}I 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 (i.e., uranium ore versus process or separated uranium, for example, in the form of yellowcake). The natural uranium activity equals the activity from uranium isotopes (48.9 percent from ^{238}U, plus 48.9 percent from ^{234}U, plus 2.2 percent from ^{235}U). This approach is consistent with summing radionuclide fractions discussed in ANSI/HPS N13.12-2013, Section 4.4 (HPS 2013).*

[f] *Each individual limit applies to the particular radionuclides, but must be summarized and the Sum of Fractions must be ≤ 1.*

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 for excavation activities
- New cardboard
- Consumer glass containers

4.4. Air Quality Program

Sections of Y-12's Title V Permit 571832 contain requirements that are generally applicable to most industrial sites. Examples include requirements associated with control of asbestos, stratospheric ozone-depleting chemicals, and fugitive emissions.

The Title V permit contains specific requirements directly applicable to individual sources of air emissions at Y-12. Major requirements in that section include 40 CFR 61, *National Emission Standards for Hazardous Air Pollutants* (NESHAP), and numerous requirements 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 2024:

- An insignificant activity exemption was completed for the Dismantlement Glovebox GB01 operation in Building 9204-2E.

- A minor permit modification request was made to remove non-operational stationary emergency engines/generators from the Title V air permit.
- An insignificant activity exemption was completed for the walk-in hood process in Building 9204-2E.
- A minor permit modification request was made to add a direct chip melt bottom load furnace operation to Stack 1 processes in Building 9215.
- An operational flexibility request was made to add a new computer numerical control turning and milling machine to the Graphite Carbon Machine Shop in Building 9201-1.
- An insignificant activity request determination was made to add a stationary emergency use internal combustion engine/generator at Building 9103 to the insignificant section of the Title V air permit.
- An insignificant activity exemption was complete for the existing and new electron beam welding operations in Building 9204-2E.
- A minor permit modification request was made to add site remediation activities to the Title V operating air permit.
- A minor permit modification request was made to add a new stationary emergency/standby engine/generator at Building 9225-03 to the Title V air permit.
- An initial notification report for the new stationary emergency/standby engine/generator at Building 9225-03 was made.
- An insignificant activity exemption was completed for the electropolishing operation in Building 9202.
- An insignificant activity exemption was completed for the Room 239 process in Building 9202.
- An insignificant activity exemption was completed for the Development prototype process in Building 9202.
- An insignificant activity request determination was made to add a stationary emergency use internal combustion engine/generator at Building 9949-C1 to the insignificant section of the Title V air permit.

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

High-efficiency particulate air filters and scrubbers are control devices used throughout Y-12. In-place testing 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. The radiological stack monitoring systems on numerous sources throughout Y-12 are part of continuous stack sampling efforts.

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 annually.

Table 4.8 lists the actual emissions versus allowable emissions for the Y-12 Steam Plant.

Table 4.8. Actual versus allowable air emissions from the Y-12 Steam Plant, 2024

Emissions (tons/yr)[a]			
Pollutant	**Actual**	**Allowable**	**Percentage of allowable**
Particulate	2.64	41.0	6.40
Sulfur dioxide	0.21	39.0	0.54
Nitrogen oxides[b]	11.12	81.0	13.70
VOCs[b]	1.91	9.4	20.30
Carbon monoxide[b]	29.19	139.0	21.00

[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 TDEC Rule 1200-3-26-.02(2)(d)3 (maximum design capacity for 8,760 h/yr) (TDEC 2024a). Both actual and allowable emissions were calculated based on the latest EPA compilation of air pollutant emission factors (EPA 1995, 1998).*

Note: *The emissions are based on fuel usage data for January through December 2024. The VOC emissions include VOC hazard air pollutant emissions.*

Acronym:

TDEC = Tennessee Department of Environment and Conservation
VOC = volatile organic compound

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 2024. There were six notifications and six revisions 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 1990 CAA Amendment Title VI, *Stratospheric Ozone Protection,* and in accordance with 40 CFR 82, *Protection of Stratospheric Ozone,* actions have been implemented to comply with the prohibition against intentionally releasing ozone-depleting substances during maintenance activities performed on refrigeration equipment. EPA enacted major revisions to the stratospheric ozone rules in 2017, 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 2024 to trigger 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 (AIM 2020). In accordance with 40 CFR 84, *Phasedown of Hydrofluorocarbons,* 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, there is a mature project planning process to review, recommend, and implement appropriate work practices and controls to minimize fugitive dust emissions. The following precautions are used to prevent particulate matter from becoming airborne:

- Where possible, water or chemicals are used to control dust when demolishing existing buildings or structures, performing construction operations, grading roads, or clearing land.
- Asphalt, water, or suitable chemicals are applied on dirt roads, material stockpiles, and other surfaces that can create airborne dusts.
- Hoods, fans, and fabric filters are installed and used 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 4.12). 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 2024, 24 process exhaust stacks were continuously monitored, 23 of which were major sources, and the remaining stack was a minor source. The sampling systems on the stacks have been approved by EPA Region 4.

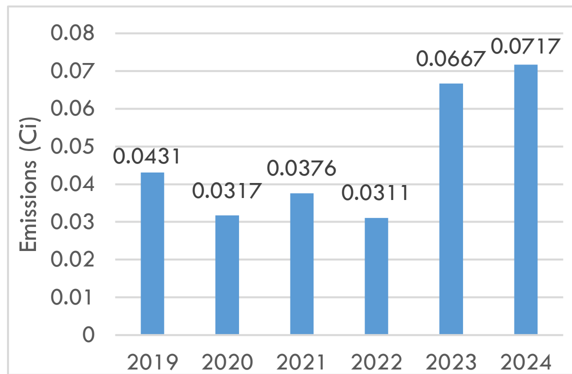


Figure 4.12. Total curies of uranium discharged from Y-12 to the atmosphere, 2019–2024

During 2024, unmonitored uranium emissions occurred from 45 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.

The Analytical Chemistry organization operates 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 outside the ORR boundary. In 2024, 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 2020), are included in the annual source term. Annual average concentrations and design ventilation rates are used to calculate the annual emission estimate for those areas. Four emission points from room ventilation exhausts were identified in 2024 where emissions exceeded 10 percent of the derived air concentration. All 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.

The Y-12 Title V (Major Source) operating permit contains a sitewide, streamlined alternate emission limit for enriched uranium and depleted uranium process emission units. A particulate limit of 907 kg/yr 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 0.0717 Ci (34.8 kg) of uranium was released into the atmosphere in 2024 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 2024 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, UPF currently is being constructed to house some of the processes that are in existing production buildings. The UPF project was included in the 2018 update of the Y-12 Site Title V Operating Permit, and the facility will be maintained on the Title V Permit as inactive until operations commence.

4.4.1.3. Quality Assurance

Quality assurance (QA) activities for the radiological NESHAP program are documented in Y/TS 874, *Y-12 Plant Quality Assurance Project Plan for National Emission Standards for Hazardous Air Pollutants (NESHAP) Radionuclide Emission Measurements*, which 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 (CNS 2020a).

The requirements are also referenced in TDEC Regulation 0400-30-38, “Emission Standards for Hazardous Air Pollutants” (TDEC 2022). 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 control devices, such as high-efficiency particulate air filters and scrubbers, helps control 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 4.8.

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 2024 are 8,336.54 lb (4.17 tons) and 220 lb (0.73 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 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 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 monitoring and reporting by sources emitting above the 25,000 CO_2e threshold level.

The Y-12 Steam Plant is subject to this rule. The steam plant has 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 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 the EPA-specified format. Each report is signed by a designated representative of the owner or operator, certifying under penalty of law that the report has been prepared in accordance with the requirements of the rule. The total amount of GHGs, subject to the mandatory reporting rule, emitted from Y-12, is shown in Table 4.9. The decrease in emissions from 2010 to 2017 is because 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 2024 was primarily due to no oil and less natural gas being burned in the steam plant boilers.

Table 4.9. Greenhouse gas emissions from stationary fuel combustion sources

Year	Greenhouse gas 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	46,126.8
2021	43,812.7
2022	43,224.2
2023	42,083.1
2024	40,769.0

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 monitoring control device operations. Hydrogen fluoride is used at one emission source, and emissions are controlled through scrubber systems. The beryllium control devices and the scrubber systems were monitored during 2024 and 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. It 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 be completed on or after January 1, 2008. The new rule requires that tune-ups for the boilers must be completed 13 months from 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. Tune-ups for Boilers 1, 3, and 4 were completed on March 5, 2024. Boiler 2 was placed back into service on August 20, 2024. The tune-up was completed for Boiler 2 on September 18, 2024, within the required 30 calendar days of startup, as outlined by the Title V air permit.

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 CAA, 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 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 federal air standards are applicable to these engines: 40 CFR 60, *Standards of Performance for New Stationary Sources*, Subpart IIII, and 40 CFR 63, *National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters*, 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 the site. The permit application was submitted to TDEC on May 6, 2013. TDEC downgraded the significant modification to a minor modification according to 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, "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines," as 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 operational records that are recorded through a nonresettable hour meter on each engine and generator. The number of hours spent for emergency operation, maintenance checks and readiness testing, and nonemergency operation must be documented. Each engine and generator must use only diesel fuel with low sulfur content (15 ppm) 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 ppm of sulfur by weight and will either have a minimum acetane index of 40 or a maximum aromatic content of 35 volume percent.

Since the above rules were adopted into Tennessee Air Pollution Control regulations, 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 the Tennessee Air Pollution Control regulations that allows for stationary engines to be eligible to be considered insignificant activities. Condition D14 of the Title V permit 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 Regulation 1200-03-09-.04(5)(a)4(i) (TDEC 2024d). Approximately 95 percent of Y-12's stationary, emergency engines, generators, and fire water pumps are considered and/or are reclassified as an insignificant activity in accordance with the regulation. These engines are listed in Y-12's Title V air permit.

4.4.1.7. Site Remediation Activities Under the National Emission Standards for Hazardous Air Pollutants (40 CFR 63, Subpart GGGGG)

The Site Remediation Rule (40 CFR 63, Subpart GGGGG) was originally promulgated and effective on October 8, 2003, under the CAA. The rule was aimed at controlling hazardous air pollutants (HAPs) from site remediation. The final rule included an exemption for CERCLA and RCRA corrective action.

After the 2003 rule was issued, the Sierra Club and other environmental groups petitioned the EPA to reconsider the rule and challenged that the agency did not have the authority to exempt CERCLA/RCRA sites under the CAA. On May 13, 2016, EPA proposed amendments to the NESHAP for emissions resulting from site remediations, which are codified at 40 CFR 63, Subpart GGGGG. The proposed amendments were to remove exemptions from the rule for site remediation activities performed under the authority of CERCLA and RCRA corrective action or other required RCRA order.

In 2019, the EPA recommended further amendments to the NESHAP to reflect over a decade of technological advancements that would enable stricter standards. On March 12, 2020, the EPA finalized amendments to the 2003 NESHAP rule for site remediation, and on December 22, 2022, the EPA finalized amendments to the NESHAP for the site remediation source category (40 CFR 63, Subpart GGGGG), which removed exemptions for remediation activities performed under the authority of the CERCLA and RCRA corrective action. Subpart GGGGG applies to active remediation operations at sites that are major sources of HAPs and are co-located at a facility regulated by another NESHAP.

This rule establishes national emissions limitations and work practices standards for HAPs emitted from site remediation activities. It also establishes requirements to demonstrate initial and continuous compliance with the emissions limitations and work practice standards [i.e., sets requirements for volatile organic HAPs (VOHAPs)]. The rule lists more than 90 VOHAPs.

The rule applies to facilities that meet all three of the following conditions as specified in paragraphs (a)(1) through (3) of §63.7881 of the subpart:

(1) Facility conducts site remediation;

(2) Site remediation is co-located with HAP sources; and

(3) Facility is a major HAP source.

Y-12 meets all three requirements listed above. Since the EPA has removed the CERCLA and RCRA exemptions, Y-12 is no longer exempt from the requirements of this rule.

Although the requirements now apply to site remediation activities, Y-12 site remediation activities are only subject to the recordkeeping requirements in §63.7881(c), provided the following criteria are met:

- Determine that the total quantity of the HAP (as listed in the rule) contained in the remediation material excavated, extracted, pumped, or otherwise removed during all of the site remediation conducted is less than 1 megagram (about 2,205 lb) on an annual basis.
- Prepare and maintain written documentation to support the determination that the total HAP quantity is less than 1 megagram (about 2,205 lb) on an annual basis.

- The requirement must be included in the Title V air permit when it is reopened or revised for any reason.

The proposed rule was finalized and issued on December 22, 2022. A site has 18 months from the effective date of the final rule to comply with the requirements.

If the remediation source commenced construction on or before May 13, 2016, the site must comply with the requirements of Subpart GGGGG no later than December 22, 2022, or upon initial startup, whichever is later. If the remediation source commenced construction on or before May 13, 2016, the site must comply with the requirements of Subpart GGGGG no later than June 24, 2024.

The average total VOHAP concentration of a remediation material must be determined by using direct measurement or by knowledge as specified in the rule. The following methods may be used to determine the average VOHAP concentration of any material listed.

- **Direct measurement.** The average total VOHAP concentration of a remediation material must follow the procedures in §63.7943(b)(1) through (3). Direct measurement can be done by sampling, analysis, and calculations of each material.
- **Knowledge of the material.** The average total VOHAP concentration of a remediation material must follow the procedures in §63.7943(c)(1) through (3). Documentation must be prepared that presents the information used as the basis for a person's knowledge of the material stream's average VOHAP concentration.

All samples must be collected and handled according to written procedures prepared and document in a site sampling plan. The plan must describe the procedure by which representative samples of the material streams are collected such that a minimum loss of organics occurs throughout the sample collection and handling process and by which sample integrity is maintained. A copy of the written sampling plan must be maintained on-site in the facility operating records.

The following Y-12 facilities are impacted:

- Liquid Storage Facility/Groundwater Treatment Facility
- East End Volatile Organic Compound Treatment Facility
- Central Mercury Treatment Facility
- Big Spring Water Treatment System
- Outfall 200/Mercury Treatment Facility (future)

In 2024, four separate sampling periods/events were conducted at each of these treatment facilities in accordance with Subpart GGGGG. The average total VOHAP concentration was calculated, resulting in total VOHAP of 0.16 megagram per year, which is well below the 1 megagram limit. Therefore, Y-12 is not subject to the requirements of the rule, except for recordkeeping, provided that Y-12 meets the rule's criteria. Samples at the treatment facilities will continue to be taken every quarter for continuous compliance of the rule.

4.4.2. Ambient Air

To understand the ambient air monitoring in and around Y-12, monitoring is conducted specifically for Y-12, the ORR perimeter, and by TDEC Division of Remediation, Oak Ridge, 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. In addition, major processes that emit enriched uranium and depleted uranium are equipped with stack samplers that have been approved by EPA to meet NESHAP requirements.

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. There are two atmospheric mercury monitoring stations currently operating at Y-12—Ambient Air Station 2 (AAS2) and Ambient Air Station 8 (AAS8)—which are located near the east and west boundaries, respectively, as shown in Figure 4.13. AAS2 and AAS8 have monitored mercury in ambient air continuously since 1986, with the exception of short intervals of downtime because of electrical or equipment outages.

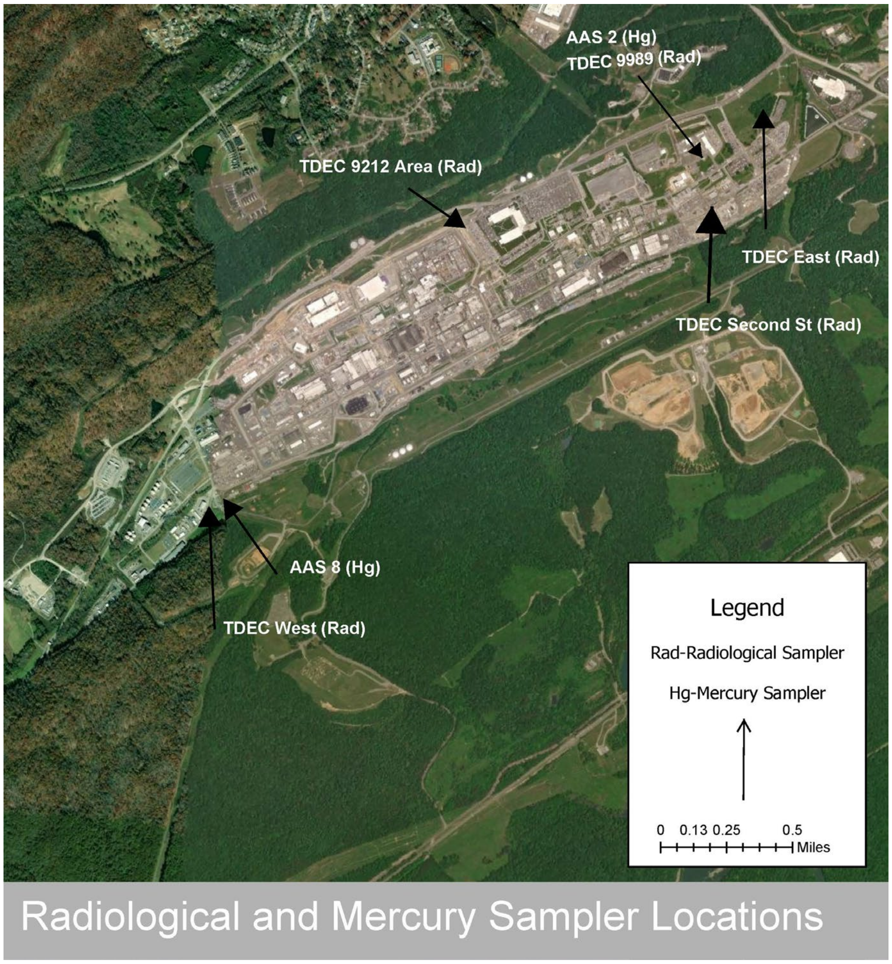
In addition to the Y-12 monitoring stations, two additional monitoring sites have been operated. A reference site (Rain Gauge 2) was developed on Chestnut Ridge in the Walker Branch Watershed for a 20-month period in 1988 and 1989 to establish a reference concentration, and a site was operated at New 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 changing 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.

Average mercury concentration at the ambient air monitoring sites has declined significantly since the late 1980s. Recent average annual concentrations at the two boundary stations are comparable to concentrations measured in 1988 and 1989 at the Chestnut Ridge reference site (Table 4.10). Average mercury concentration at AAS2 for 2024 is 0.0030 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, possibly due to increased demolition and decommissioning work on the west end, the average concentration at AAS8 for 2024 was 0.0033 μg/m^3 (N = 25), similar to levels reported since 2008 and the early 2000s.

Table 4.10 summarizes the 2024 mercury results with data from 1986 through 1988 included for comparison. Figure 4.14 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 2024 (parts [a] and [b]) and seasonal trends at AAS8 from 1994 through 2024 (part [c]). The dashed line superimposed on the plots in Figure 4.14(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 Perimeter Intrusion Detection and Assessment System installation and storm drain restoration projects underway at that time within the West End Mercury Area. In Figure 4.14(c), a monthly moving average has been superimposed over the AAS8 data to highlight seasonal trends in mercury at AAS8 from January 1994 through 2024.



Acronyms:

AAS = Ambient Air Station

TDEC = Tennessee Department of Environment and Conservation

Figure 4.13. Locations of ambient air monitoring stations at Y-12

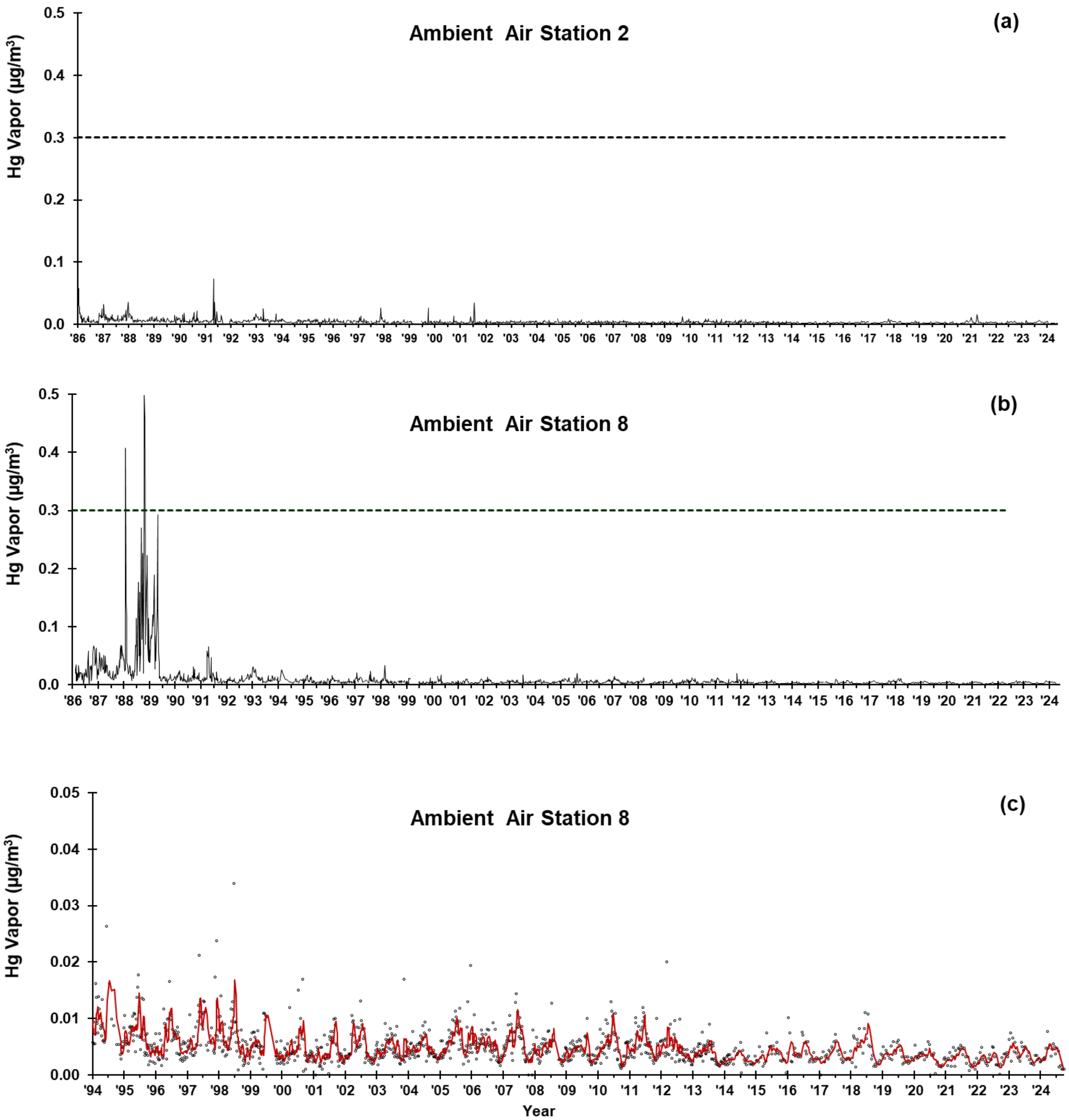
Table 4.10. Summary of data for the Y-12 Ambient Air Monitoring Program for mercury, 2024

Ambient air monitoring stations	Mercury vapor concentration (µg/m³)			
	2024 Minimum	2024 Maximum	2024 Average	1986–1988[a] Average
AAS2 (east end of the Y-12 Complex)	0.0012	0.0064	0.0030	0.010
AAS8 (west end of the Y-12 Complex)	0.0009	0.0077	0.0033	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.*



Note: *The dashed line superimposed on the plots in (a) and (b) is the EPA reference concentration of 0.3 µg/m³ for chronic inhalation exposure. A monthly moving average has been superimposed in (c) over the AAS8 data to highlight seasonal trends in mercury at AAS8 from January 1994 through 2024. Note the different concentration scale on (c).*

Figure 4.14. Temporal trends in mercury vapor concentration for the boundary monitoring stations at Y-12 Complex, July 1986 to December 2024 [(a) and (b)] and January 1994 to December 2024, for Ambient Air Station 8 (c).

The average mercury concentrations at the two mercury monitoring sites in 2024 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 as determined by the National Institute for Occupational Safety and Health, the American Conference of Governmental Industrial Hygienists, and the EPA.

4.4.2.2. Quality Control

A number of QA and quality control (QC) steps are taken to ensure the quality of the data for 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.

A Gilmont correlated flowmeter is used for measuring flows through the sampling train. Because these flowmeters have been discontinued, they are shipped back to the manufacturer annually for recalibration 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 to the analytical laboratory.

A field performance evaluation was conducted on June 25, 2024, to ensure that proper procedures are followed by the sampling technicians. No abnormalities or problems were noted at the time. Samplers completed all tasks set forth in the sampling procedures.

Sampling station AAS2 experienced a vacuum pump malfunction between July 23, 2024, and August 6, 2024. The pump was removed from service and replaced with a new unit on August 6, 2024.

Sampling station AAS8 experienced a vacuum pump malfunction between April 30, 2024, and May 14, 2024. The pump was removed from service and replaced with a new unit on May 14, 2024.

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 must be rerun [third duplicate] to resolve the discrepancy.)
- Archival of all primary laboratory records for at least 1 year

4.4.2.3. Complementary Ambient Air Monitoring

ORR ambient air monitoring is conducted at multiple locations near the ORR perimeter to measure radiological parameters. Atmospheric dispersion modeling was used to select appropriate sampling locations likely to be affected most by releases from the Oak Ridge facilities. This monitoring provides direct measurement of airborne concentrations of radionuclides, 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 on the east end of Y-12 (Station 40) measures off-site impacts of Y-12 operations. This station is located near the location of the maximally exposed individual member of the public as determined through dose modeling. ORR network stations are also located in the Scarboro community (Station 46) and just south of the city in the Country Club Estates neighborhood (Station 37).

In addition to this monitoring, multiple high-volume samplers (Figure 4.13) are being used by TDEC's Fugitive Radiological Air Sampling project to monitor air at Y-12. One is located at the west end of the plant, one is east of Building 9212, one is north of Second Street, one is located near AAS2, and one is located on the east end of the plant near the intersection of Scarboro Road and Bear Creek Road.

TDEC also performs ambient air monitoring via precipitation. The EPA RadNet Precipitation Program at the east end of the plant next to the east-end TDEC fugitive air monitor and near ORR perimeter station 40.

Results from TDEC's air monitoring projects at Y-12 and other locations on the ORR are summarized in annual environmental monitoring reports issued by the TDEC Division of Remediation, Oak Ridge Office, and posted on its website **here**.

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 2024, the Y-12 NPDES permit (TN0002968) required sampling, analysis, and reporting for about 62 outfalls. Major outfalls are shown in Figure 4.15. The NPDES permit became effective October 1, 2022. (The 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 the site. 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 permit for 2024 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 2024 was 100 percent, as shown in Table 4.11.

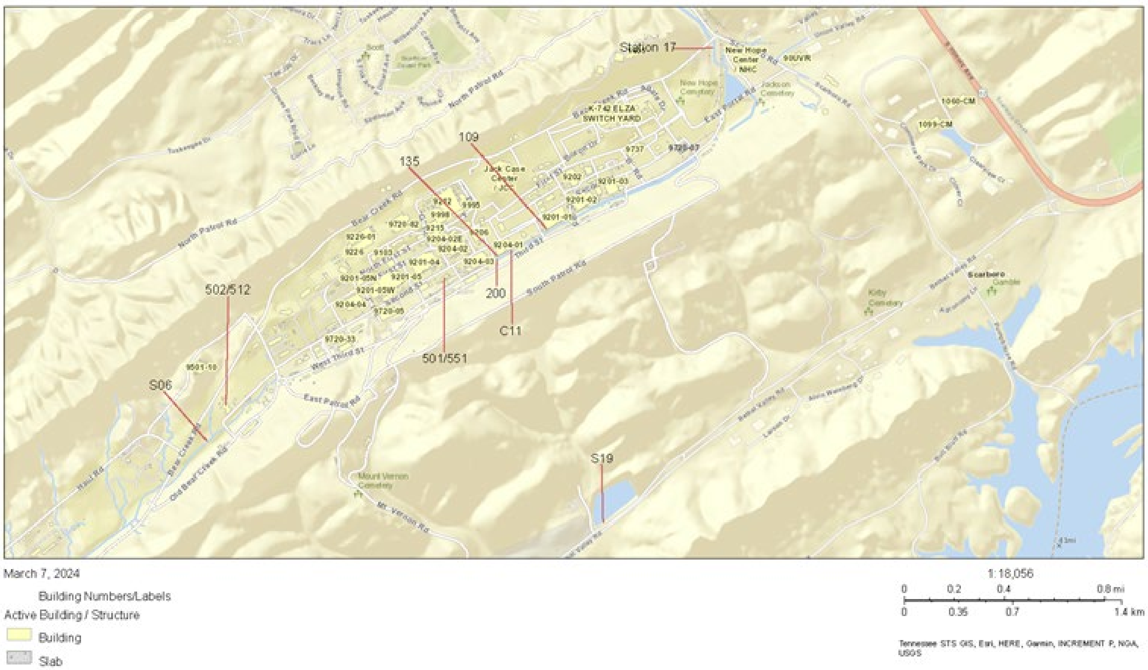


Figure 4.15. Major Y-12 National Pollutant Discharge Elimination System outfalls and monitoring locations

Table 4.11. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, 2024

Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Outfall 200 (North/South pipes)						
pH, standard units			*a*	9.0	100	14
Temperature, deg C				30.5	100	14
Hexane extractables			10	15	100	13
Cyanide			0.0052	0.022	100	13
Cadmium			0.0043	0.0118	100	13
Silver				0.0081	100	13
Selenium			0.0031	0.02	100	13
PCB, Total				0.00000064	100	12
Total residual chlorine			0.011	0.019	100	13
Ammonia (as N) Summer			1.01	2.02	100	6
Ammonia (as N) Winter			1.92	3.84	100	7
IC_{25} Ceriodaphnia			50% Minimum		100	4
IC_{25} Pimephales			50% Minimum		100	4
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

Table 4.11. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, 2024 (continued)

Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
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	12
PCB				0.001	100	1
Outfall 551						
pH, standard units			*a*	9.0	100	49
Mercury			0.002	0.004	100	49
Non-Process Outfalls (Dry Weather Sampling) (014, 021, 034, 042,047, 048, 067, 071, 088, 099, 109, 135)						
Temperature				30.5	100	25
pH, standard units			*a*	9.0	100	28
Ammonia (as N) Summer			1.01	2.02	100	2
Ammonia (as N) Winter			1.92	3.84	100	2
Total Residual Chlorine				0.019	100	28
Outfall 200 (North/South pipes) Wet Weather Flow						
pH, standard units			*a*	9.0	100	1
Temperature, deg C				30.5	100	1
Ammonia (as N) Summer				2.02	100	0
Ammonia (as N) Winter				3.84	100	1
Cyanide				0.022	100	1
Cadmium				0.0118	100	1
Copper				0.064	100	1
Lead				0.6265	100	1
Nickel				1.705	100	1
Silver				0.0081	100	1
Zinc				0.641	100	1
Selenium				0.02	100	1
Outfall C11 (Instream EFPC) Wet Weather						
Temperature				30.5	100	1
pH			*a*	9.0	100	1

Table 4.11. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, 2024 (continued)

Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Ammonia (as N) Summer				2.02	100	0
Ammonia (as N) Winter				3.84	100	1
Cyanide				0.022	100	1
Cadmium				0.0118	100	1
Copper				0.064	100	1
Lead				0.6265	100	1
Nickel				1.705	100	1
Silver				0.0081	100	1
Zinc				0.641	100	1
Selenium				0.020	100	1
Outfall C03 (Instream EFPC) Wet Weather						
Temperature				30.5	100	1
pH			*a*	9.0	100	1
Ammonia (as N) Summer				2.02	100	0
Ammonia (as N) Winter				3.84	100	1
Cyanide				0.022	100	1
Cadmium				0.0118	100	1
Copper				0.064	100	1
Lead				0.6265	100	1
Nickel				1.705	100	1
Silver				0.0081	100	1
Zinc				0.641	100	1
Selenium				0.020	100	1
Outfall EFP (Station 17) Wet Weather						
Temperature				30.5	100	1
pH			*a*	9.0	100	1
Ammonia (as N) Summer				2.02	100	0
Ammonia (as N) Winter				3.84	100	1
Cyanide				0.022	100	1
Cadmium				0.0118	100	1
Copper				0.064	100	1
Lead				0.6265	100	1
Nickel				1.705	100	1
Silver				0.0081	100	1
Zinc				0.641	100	1
Selenium				0.020	100	1

Table 4.11. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, 2024 (continued)

Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Outfall S06 Wet Weather						
Temperature				30.5	100	1
pH			*a*	9.0	100	1
Ammonia (as N) Summer				2.02	100	0
Ammonia (as N) Winter				3.84	100	1
Cyanide				0.022	100	1
Cadmium				0.0188	100	1
Copper				0.103	100	1
Lead				1.063	100	1
Nickel				2.604	100	1
Silver				0.0191	100	1
Zinc				0.979	100	1
Selenium				0.020	100	1
Outfall S24 Wet Weather						
Temperature				30.5	100	1
pH			*a*	9.0	100	1
Ammonia (as N) Summer				2.02	100	0
Ammonia (as N) Winter				3.84	100	1
Cyanide				0.022	100	1
Cadmium				0.0188	100	1
Copper				0.103	100	1
Lead				1.063	100	1
Nickel				2.604	100	1
Silver				0.0191	100	1
Zinc				0.979	100	1
Selenium				0.020	100	1
Outfall S06 Dry Weather						
Temperature				30.5	100	1
pH			*a*	9.0	100	1
Ammonia (as N) Summer				2.02	100	0
Ammonia (as N) Winter				3.84	100	1
Cyanide				0.022	100	1
Cadmium				0.0188	100	1
Copper				0.103	100	1
Lead				1.063	100	1
Nickel				2.604	100	1

Table 4.11. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, 2024 (continued)

Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Silver				0.0191	100	1
Zinc				0.979	100	1
Selenium				0.020	100	1
Outfall S24 Dry Weather						
Temperature				30.5	100	1
pH			*a*	9.0	100	1
Ammonia (as N) Summer				2.02	100	0
Ammonia (as N) Winter				3.84	100	1
Cyanide				0.022	100	1
Cadmium				0.0188	100	1
Copper				0.103	100	1
Lead				1.063	100	1
Nickel				2.604	100	1
Silver				0.0191	100	1
Zinc				0.979	100	1
Selenium				0.020	100	1
Outfall C11 (Instream EFPC) Dry Weather						
Temperature				30.5	100	4
pH			*a*	9.0	100	4
Ammonia (as N) Summer			1.01	2.02	100	2
Ammonia (as N) Winter			1.92	3.84	100	2
Cyanide			0.0052	0.022	100	4
Cadmium			0.0043	0.0118	100	4
Copper			0.0407	0.064	100	4
Lead			0.0244	0.6265	100	4
Nickel			0.189	1.705	100	4
Silver				0.0081	100	4
Zinc			0.646	0.641	100	4
Selenium			0.0031	0.020	100	4
Total Residual Chlorine			0.011	0.019	100	4
Outfall C03 (Instream EFPC) Dry Weather						
Temperature				30.5	100	4
pH			*a*	9.0	100	4
Ammonia (as N) Summer			1.01	2.02	100	2
Ammonia (as N) Winter			1.92	3.84	100	2
Cyanide			0.0052	0.022	100	4

Table 4.11. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, 2024 (continued)

Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Cadmium			0.0043	0.0118	100	4
Copper			0.0407	0.064	100	4
Lead			0.0244	0.6265	100	4
Nickel			0.189	1.705	100	4
Silver				0.0081	100	4
Zinc			0.646	0.641	100	4
Selenium			0.0031	0.020	100	4
Total Residual Chlorine			0.011	0.019	100	4
Outfall EFP (Station 17) Dry Weather						
Temperature				30.5	100	4
pH			a	9.0	100	4
Ammonia (as N) Summer			1.01	2.02	100	2
Ammonia (as N) Winter			1.92	3.84	100	2
Cyanide			0.0052	0.022	100	4
Cadmium			0.0043	0.0118	100	4
Copper			0.0407	0.064	100	4
Lead			0.0244	0.6265	100	4
Nickel			0.189	1.705	100	4
Silver				0.0081	100	4
Zinc			0.646	0.641	100	4
Selenium			0.0031	0.020	100	4
Total Residual Chlorine			0.011	0.019	100	4

[a] Not applicable

[b] No discharge

Acronyms:

IC_{25} = 25-percent inhibition concentration

PCB = polychlorinated biphenyl

4.5.2. Radiological Monitoring Plan and Results

Y-12 has a radiological monitoring plan to address compliance with DOE orders that was 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, as listed in Table 4.12. Y/TS-1704, *Radiological Monitoring Plan for the Oak Ridge Y-12 National Security Complex: Surface Water* was revised and issued in 2020 (CNS 2020b). This revision added Outfall 109 and roof runoff from production areas.

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 2024 are noted on Figure 4.16. Table 4.13 identifies the monitored locations, the frequency of monitoring, and the sum of the percentages of the derived concentration standards for radionuclides measured in 2024. Radiological data were well below the allowable derived concentration standards.

Table 4.12. Radiological parameters monitored at Y-12

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.

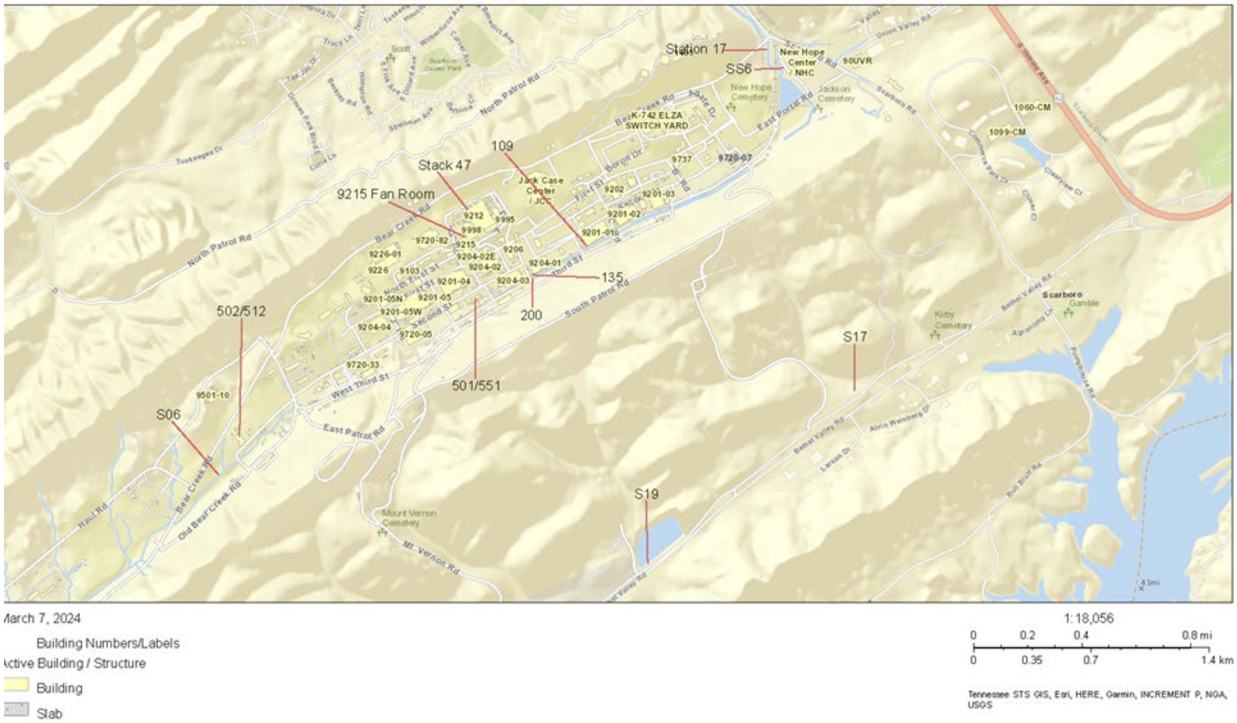


Figure 4.16. Radiological sampling locations at Y-12

Table 4.13. Summary of Y-12's radiological monitoring plan sample requirements and results, 2024

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	6.2
Groundwater Treatment Facility	4/yr	24-h composite	1.0
Central Mercury Treatment Facility	4/yr	24-h composite	1.6
Other Y-12 point and area source discharges			
Outfall 109	4/yr	24 h composite	0.31
Outfall 135	4/yr	24-h composite	0.53
Kerr Hollow Quarry	1/yr	24-h composite	0.10
Y-12 instream locations			
Outfall S24	1/yr	7-d composite	4.0
East Fork Poplar Creek, complex exit (east)	1/month	7-d composite	0.84
North/south pipes	1/month	24-h composite	1.70
Y-12 Production roof runoff			
9215 Fan Room	4/yr	Grab during rain	7.50
Stack 47	4/yr	Grab during rain	14.30

In 2024, the total mass of uranium and associated curies released from Y-12 at the easternmost monitoring station—Station 17 on Upper EFPC—was 118 kg or 0.092 Ci, as shown in Table 4.14.

Figure 4.17 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.

Table 4.14. Uranium release from Y-12 to the off-site environment as liquid effluent

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
2023	0.092	118
2024	0.177	192

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

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 quarterly monitoring reports.

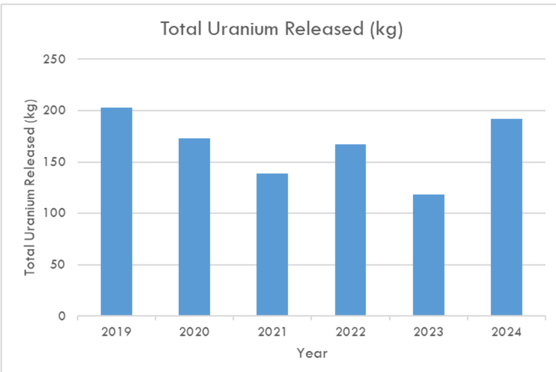


Figure 4.17. Y-12 uranium releases to East Fork Poplar Creek, 2019–2024

4.5.3. Storm Water Pollution Prevention

Y-12 has implemented a storm water pollution prevention program in alignment with the requirements of NPDES Permit TN0002968. program focuses primarily on storm water pollution prevention and continual improvement. It protects the quality of storm water runoff through identifying and properly managing outdoor storm water pollutant sources, implementing best management practices, sampling storm water and interpreting data to evaluate efficacy of pollutant controls, and conducting routine storm water inspections and surveillances.

For the Y-12 NPDES permit, storm water monitoring is performed at category outfalls and wet weather locations. These are described as follows:

- **Category 1 Storm Water Outfalls.** Annual monitoring of pH at Outfalls 002, 003, 004, 006, 007, 008, 009, 010, 011, 017, S17, S18, 019, 020, 033, 041, 044, 045, 046, 054, 057, 058, 062, 063, 064, 086, 087, 110, 114, 125, 126, 134.
- **Category 2 Storm Water Outfalls.** Annual monitoring of pH and total residual chlorine at Outfalls 034, 042, 071, 083, 088, 099, 113.
- **Sector AA Outfalls.** Annual monitoring of pH, nitrite plus nitrate (as N), total iron, total zinc, total aluminum, total mercury, and flow at Outfalls 014, 016, 047, 048, 067, 102, 135.
- **Other Wet Weather.** Annual monitoring as prescribed in the permit tables at Outfalls 200 and S30; Instream EFPC Locations C03, C11, EFP (Station 17); and Instream Bear Creek Locations S06 and S24.

Y-12 completed the storm water sampling scheduled for sampling year 2024. All storm water samples were collected as required in the current NPDES permit. The results were compared to the applicable permit table alert values and daily maximum benchmark values. The 2024 sampling year ran from October 2023 to the end of September 2024.

The following are the results for the storm water sampling conducted in 2024:

- **Category 1 Storm Water Outfalls.** All water sample results were within the typical NPDES permit range for pH of 6.0 and 9.0 standard units.
- **Category 2 Storm Water Outfalls.** All water sample results were within the typical NPDES permit range for pH of 6.0 and 9.0 standard units and were less than 0.05 mg/L for total residual chlorine.
- **Sector AA Storm Water Outfalls.** None of the results exceeded the applicable surface water daily maximum benchmarks as described in the permit.
- **Other Wet Weather Samples.** None of the results exceeded the applicable surface water daily maximum benchmarks or alerts as described in the permit.

An area of concern continues to be on-site construction activities; however, site surveillances continue to identify issues, and they are addressed before they cause an impact to storm water runoff. In addition, overall, the housekeeping and general conditions that could impact storm water continue to improve. Based upon the results of the storm water sampling and site surveillances, the Y-12 storm water pollution prevention program is effective at protecting the surface waters at Y-12 from storm water pollution. Y-12 will continue to seek opportunities for additional improvement to storm water protections.

4.5.4. Ambient Surface Water Quality

A network of real-time monitors located at 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 4.18. The system is used 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, as discussed in Section 4.6.

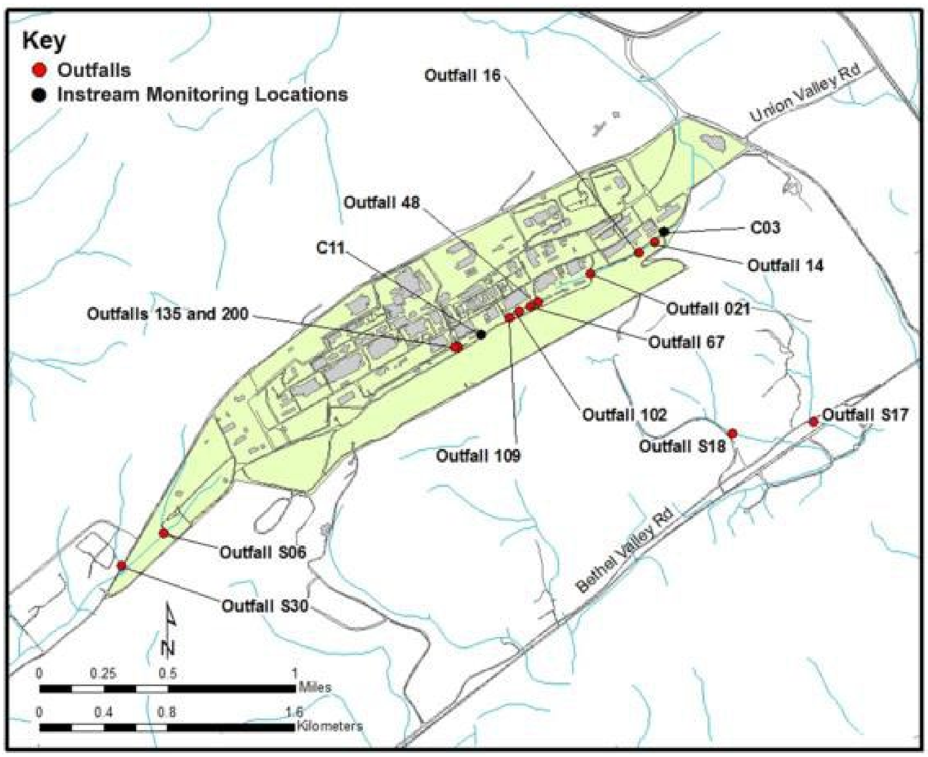


Figure 4.18. Y-12 storm water monitoring locations along East Fork Poplar Creek

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 2024 are listed in Table 4.15. One permit limit was exceeded—the 2,100-gal/min instantaneous flow limit. To reduce storm water inflow and infiltration, a project is evaluating approximately 15,000 linear feet of the Y-12 sewage collection system via smoke tests and video inspection. The project also performs needed repairs identified during the evaluation, including manhole relining, pipe bursting, and installing cured-in-place piping. Repair work was completed in the B-449, C-409A, and B408A networks. Flow data evaluation indicates this project has reduced inflow and infiltration.

Table 4.15. Discharge point SS6 monitoring results, 2024

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	91	413	N/A	500[b]	0
Flow (average kgpd) April through June	91	365	N/A	500[b]	0
Flow (average kgpd) July through September	92	360	N/A	500[b]	0
Flow (average kgpd) October through December	92	371	N/A	500[b]	0
pH (standard units)	27	7.7	N/A	9 and 6[c]	0
Biochemical oxygen demand	12	59.7	N/A	300	0
Kjeldhal nitrogen	12	29.2	N/A	45	0
Phenols—total recoverable	12	<0.038	N/A	0.15	0
Oil and grease	12	<9.3	N/A	25	0
Suspended solids	14	108.9	N/A	200	0
Cyanide	12	<0.0032	N/A	0.006	0
Arsenic	4	<0.0012	N/A	0.01	0
Cadmium	4	<0.0005	N/A	0.0033	0
Chromium, hexavalent	4	0.005	N/A	0.053	0
Copper	4	0.0213	N/A	0.14	0
Iron	4	0.6125	N/A	10	0
Lead	4	<0.0025	N/A	0.049	0
Mercury	24	0.0052[d]	N/A	0.035[d]	0
Nickel	4	<0.005	N/A	0.021	0
Silver	4	0.0013	N/A	0.05	0
Zinc	4	0.0927	N/A	0.35	0
Molybdenum	4	0.0248	N/A	0.05[e]	N/A

Table 4.15. Discharge point SS6 monitoring results, 2024 (continued)

Effluent parameter	Number of samples	Average value	Daily maximum (gal/min)[a]	Monthly average (effluent limit)[a]	Number of limit exceedances
Selenium	4	<0.0025	N/A	0.01e	N/A
Toluene	4	0.002	N/A	0.005[e]	N/A
Ammonia	4	17.9	N/A	0.10[e]	N/A
Methanol	4	1.075	N/A	1.0[e]	N/A
Benzene	4	0.003	N/A	0.005[e]	N/A
1,1,1-Trichloroethane	4	0.003	N/A	0.005[e]	N/A
Ethylbenzene	4	0.003	N/A	0.005[e]	N/A
Carbon tetrachloride	4	0.003	N/A	0.005[e]	N/A
Chloroform	4	0.0047	N/A	0.005[e]	N/A
Tetrachloroethene	4	0.0034	N/A	0.005[e]	N/A
Trichloroethene	4	0.003	N/A	0.005[e]	N/A
trans-1,2-Dichloroethene	4	0.003	N/A	0.005[e]	N/A
Methylene chloride	4	0.004	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*

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, such as field and trip blanks, duplicates, and equipment rinses

Surface water data are entered directly by the analytical laboratory into the Laboratory Information Management System on the day of approval. 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 automatically flag 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 comparing individual results against any applicable screening criteria, regulatory thresholds, compliance limits, best management practices, or other water quality indicators, and then 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. The permit requires quarterly chronic testing of Outfall 200, which is performed using 100 percent effluent and the dilution series shown in Table 4.16.

Table 4.17 summarizes the results of the 2024 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 is 50-percent whole effluent for Outfall 200.

Table 4.16. Serial dilutions for whole effluent toxicity testing, as a percent of effluent serial dilutions for whole effluent toxicity testing, as a percent of effluent

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

Notes:

1. *Under permit effective Oct. 1, 2022.*
2. *The effluent water is diluted with control laboratory water.*

Table 4.17. Biomonitoring program summary information for Outfall 200, 2024

Toxicity testing dates	Test type	Test organism	End point	Metric[a]	IC_{25}[b] (%)
2/21/24–2/28/24	Chronic	Water fleas (*Ceriodaphnia dubia*)	Survival	IC_{25}	>100%
			Reproduction	IC_{25}	>100%
		Fathead minnow (*Pimephales promelas*)	Survival	IC_{25}	>100%
			Growth	IC_{25}	>100%
6/26/24–7/3/24	Chronic	Water fleas (*Ceriodaphnia dubia*)	Survival	IC_{25}	>100%
			Reproduction	IC_{25}	>100%
		Fathead minnow (*Pimephales promelas*)	Survival	IC_{25}	>100%
			Growth	IC_{25}	>100%
8/21/24–8/28/24	Chronic	Water fleas (*Ceriodaphnia dubia*)	Survival	IC_{25}	>100%
			Reproduction	IC_{25}	>100%
		Fathead minnow (*Pimephales promelas*)	Survival	IC_{25}	>100%
			Growth	IC_{25}	>100%
12/4/24–12/11/24	Chronic	Water fleas (*Ceriodaphnia dubia*)	Survival	IC_{25}	>100%
			Reproduction	IC_{25}	>100%
		Fathead minnow (*Pimephales promelas*)	Survival	IC_{25}	>100%
			Growth	IC_{25}	>100%

[a] *IC_{25} is summarized for the discharge monitoring location (Outfall 200).*

[b] *IC_{25} as a percentage of full-strength effluent from Outfall 200 diluted with laboratory control water. IC_{25} 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.*

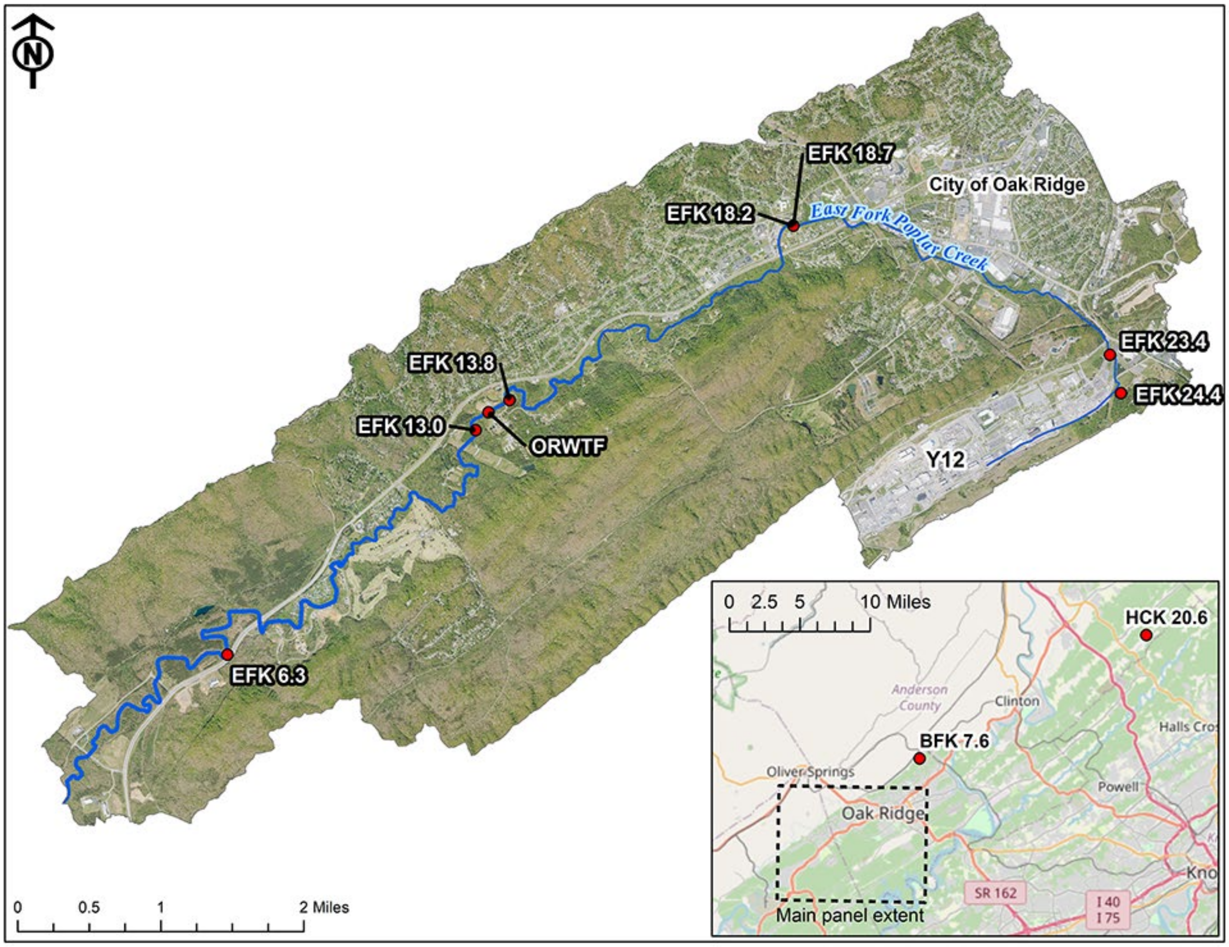
4.5.8. Biological Monitoring and Abatement Program

The NPDES permit issued for Y-12 mandates a biological monitoring and abatement program to demonstrate that the effluent limitations established for the facility protect the classified uses of the receiving stream—EFPC. The 2024 program sampling efforts follow the NPDES-required *Y-12 National Security Complex Biological Monitoring and Abatement Program Plan* (ORNL 2013).

Y-12's program, which has been monitoring the ecological health of EFPC since 1985, consists of three major tasks that reflect complementary approaches to evaluating the effects of Y-12 discharges on the aquatic integrity of EFPC—bioaccumulation studies, benthic macroinvertebrate community surveys, 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 conducted at seven primary EFPC sites (Figure 4.19), although sites may be excluded or added depending on the specific objectives of the various tasks. The primary sampling sites include the following:

- 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
- EFK 6.3, located about 1.4 km downstream of the ORR boundary



Note: *BFK 7.6 and HCK 20.6 are reference sites.*

Acronyms:

BFK = Brushy Fork kilometer
EFK = East Fork Poplar Creek kilometer
Y12 = Y-12 National Security Complex
HCK = Hinds Creek kilometer
ORWTF = Oak Ridge Wastewater Treatment Facility

Figure 4.19. Biological monitoring sites in East Fork Poplar Creek relative to Y-12

Brushy Fork at kilometer 7.6 was used as a reference stream for the fish and macroinvertebrate community tasks until 2022 when the site was dropped because of limitations in site access and degraded ecological conditions.

Hinds Creek at kilometer 20.6 is used as a reference for the bioaccumulation as well as the macroinvertebrate and fish community monitoring tasks.

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, since the end of flow augmentation in 2014, the richness of pollution-intolerant invertebrate and fish taxa at some sites in EFPC has declined. Further, the pace of improvement in Upper EFPC near Y-12 has slowed in recent years, and fish and invertebrate communities continue to have fewer species than the corresponding communities in reference streams.

4.5.8.1. Bioaccumulation Studies

Historically, mercury and PCB 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/or rock bass (*Ambloplites rupestris*) are collected from five sites throughout the length of EFPC and are analyzed twice a year for tissue concentrations of mercury (Figure 4.20) and annually for PCBs (Figure 4.21). Mercury concentrations remained higher in fish from EFPC in 2024 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.

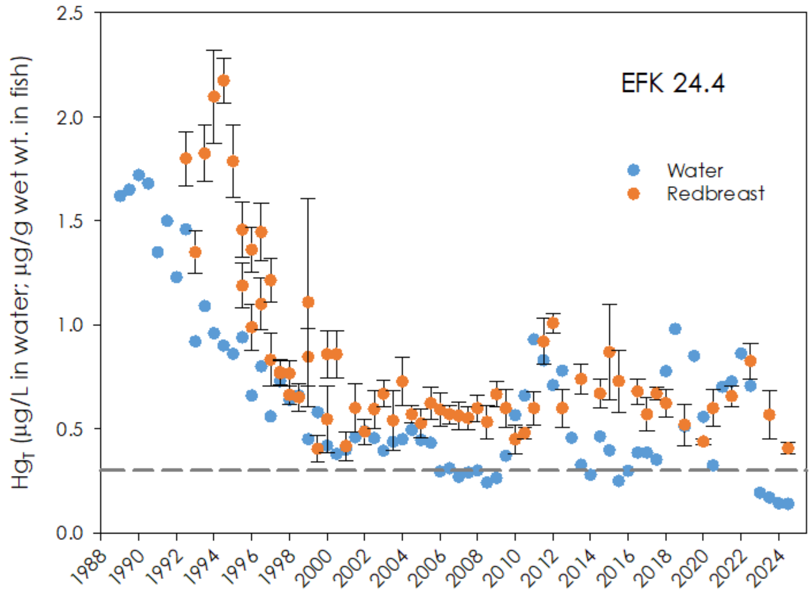
While the 1990s and early 2000s showed significant decreases in aqueous mercury concentrations at Station 17, various activities since 2009 (e.g., storm drain relining and cleanout) have led to significant fluctuations in aqueous mercury concentrations.

Aqueous mercury concentrations at Station 17 decreased significantly in 2024, and mean mercury concentrations in fish collected at EFK 24.4 decreased (0.41 µg/g) but remained 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 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 0.25 µg/g in FY 2024, similar to concentrations seen in FY 2023 (0.26 µg/g) (Figure 4.21). Regulatory guidance and human health risk levels vary 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, such as Melton Hill, Watts Bar, and Fort Loudoun (TDEC 2010a, 2010b, 2010c).

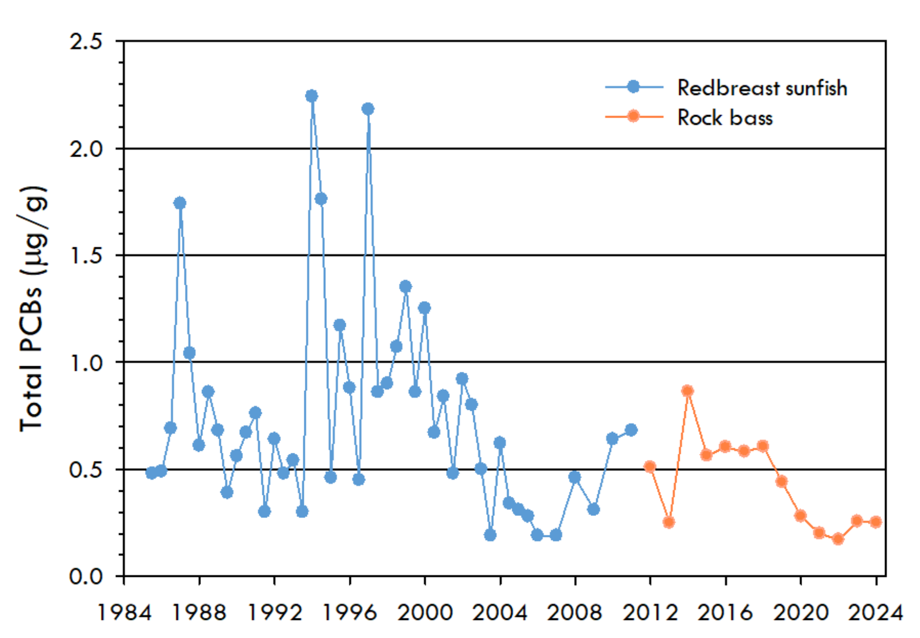
In the state of Tennessee, assessments of impairment for water body segments, as well as public fishing advisories, are based on fish tissue concentrations. Historically, the US Food and Drug Administration threshold limit of 2-µg/g PCBs in fish fillets was used for advisories. For many years, an approximate 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 2024b). This concentration is 0.02-µg/g PCBs in fish fillets (TDEC 2010a, 2010b, 2010c). The mean fish PCB concentration in Upper EFPC 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.*

Figure 4.20. Semiannual average mercury concentration in muscle fillets of redbreast sunfish and water from East Fork Poplar Creek, 1988–2024



Note: *At East Fork Poplar Creek kilometer 23.4.*

Acronym:

PCB = polychlorinated biphenyl

Figure 4.21. Annual mean concentrations of polychlorinated biphenyls in sunfish fillets, 1986–2024

4.5.8.2. Benthic Invertebrate Surveys

Monitoring the benthic macroinvertebrate community continued in the spring of 2024 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 2024, total taxa richness declined from 2023 values at EFK 23.4, but still remains higher than the recent low value observed in 2021.

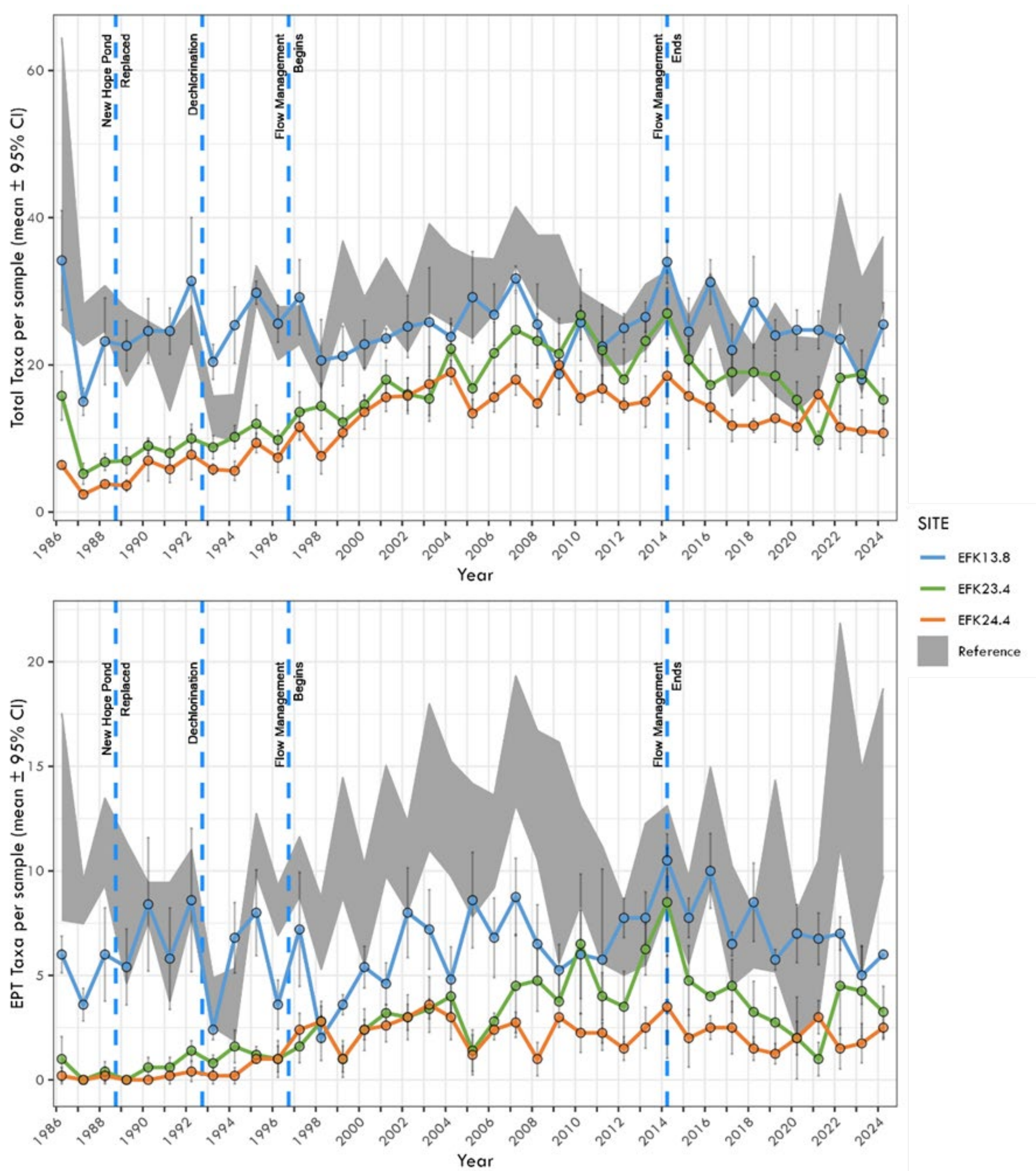
Total taxa richness at EFK 13.8 and the reference sites has been fairly consistent over the entire monitoring period. In 2024, total taxa richness increased relative to 2023, returning to a value more similar to the long-term average at the site (Figure 4.22).

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, although this value did increase in 2024 (Figure 4.22).

EPT taxa richness at EFK 23.4 steadily increased since 1986 but decreased after flow management ended (Figure 4.22). In 2024, EPT taxa richness at EFK 23.4 decreased relative to values observed in 2023 and comparable to those observed from 2018 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 and 2024, which were below the confidence limits (Figure 4.22).



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).*
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 has not been sampled since 2021due 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

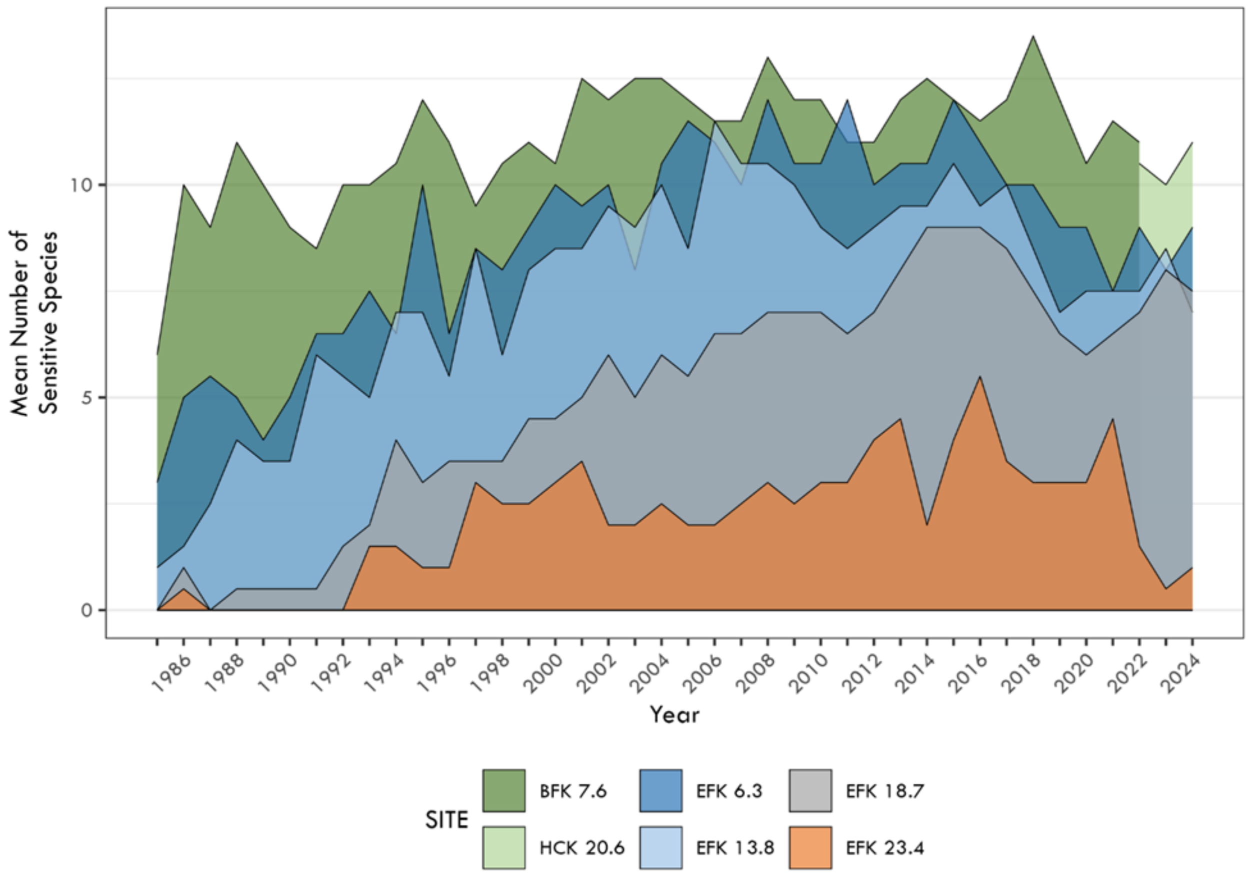
The implications of ending flow management in 2014 on invertebrate communities in EFPC are still uncertain. After flow augmentation ceased, EPT taxa richness at EFK 23.4 has consistently declined until 2022, although the improvement observed in 2022 may again be trending downward (Figure 4.22). EPT taxa richness at EFK 24.4 has also shown some minor variability since flow augmentation ended, but has generally remained similar to the last 10 years (Figure 4.22). The effects of ending flow augmentation on Lower EFPC (EFK 13.8) are less evident than at EFK 23.4, which makes sense as flow augmentation contributed a smaller percentage of total discharge at downstream sites. However, there has been a general downward trend over the past 10 years, although EPT taxa richness still remains higher at EFK 13.8 than either of the upstream 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.

4.5.8.3. Fish Community Monitoring

Fish communities were monitored in the spring and fall of 2024 at sites along EFPC and at Hinds Creek, a comparable local reference stream. 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 streams 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 reference stream communities (Brushy Fork kilometer 7.6 and Hinds Creek kilometer 20.6) 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).

Fish communities in Upper EFPC continued to fluctuate in density during 2024. 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). Upper EFPC experienced two fish kills in 2024. In June, an incident associated with a potable water line break resulted in the mortality of more than 8,000 fish, and in October, an incident associated with demolition activities resulted in the mortality of more than 1,200 fish.

Despite these impacts, fish richness values remained relatively consistent at most sites when sampled in September 2024. 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 in 2025 will provide additional insight into these variabilities and possible long-term impacts.



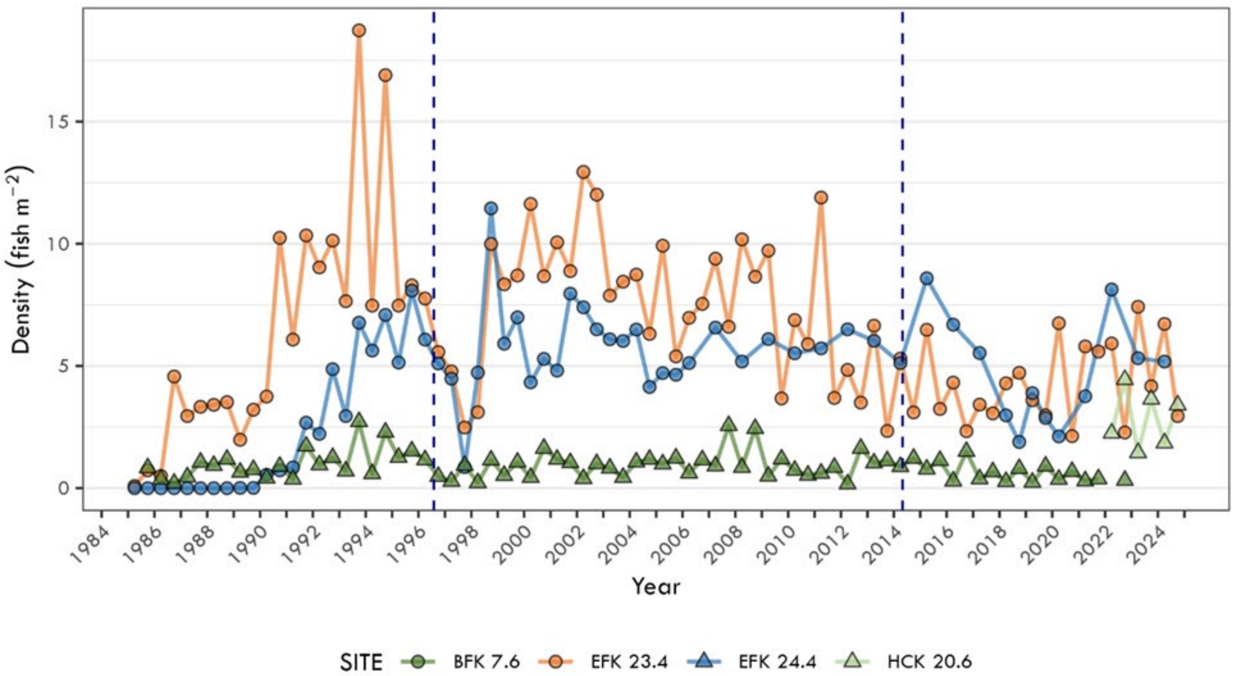
Notes:

1. *Mean sensitive species richness refers to the number of species.*
2. *Reference sites are Brushy Fork kilometer 7.6 and Hinds Creek kilometer 20.6.*
3. *No sensitive fish species have been observed at EFK 24.4 since monitoring began at this location.*

Acronyms:

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

Figure 4.23. Comparison of mean sensitive fish species richness collected from East Fork Poplar Creek and reference sites, 1985–2024



Notes:

1. *Access to the Brushy Fork site (BFK 7.6) has been restricted since 2022, and no samples have been collected. A comparable reference site was sampled beginning in spring 2022.*
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 sites are Brushy Fork (BFK 7.6) and Hinds Creek (HCK 20.6).*

Acronyms:

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

Figure 4.24. Fish density for two sites in Upper East Fork Poplar Creek and reference sites, 1985–2024

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 1992). 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.

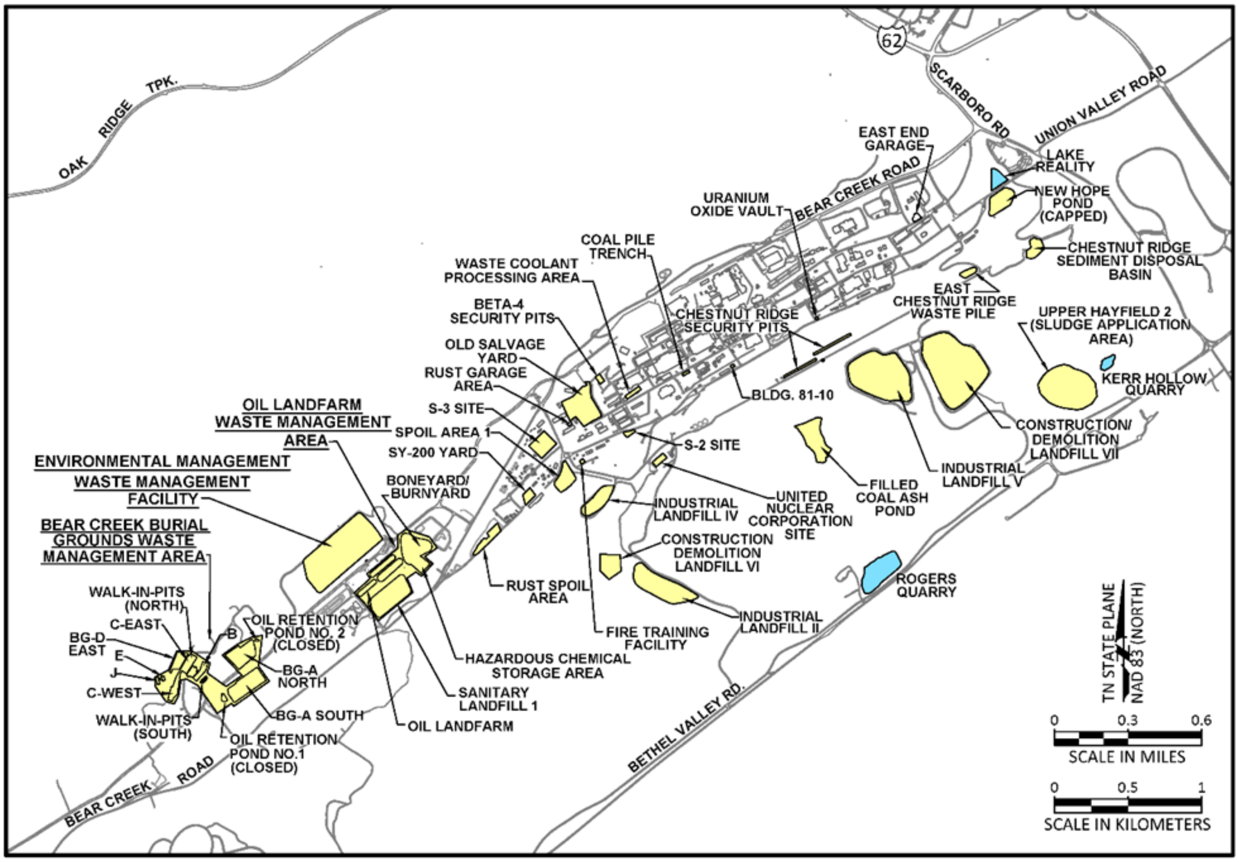


Figure 4.25. Known or potential contaminant source areas where groundwater is monitored at Y-12

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).

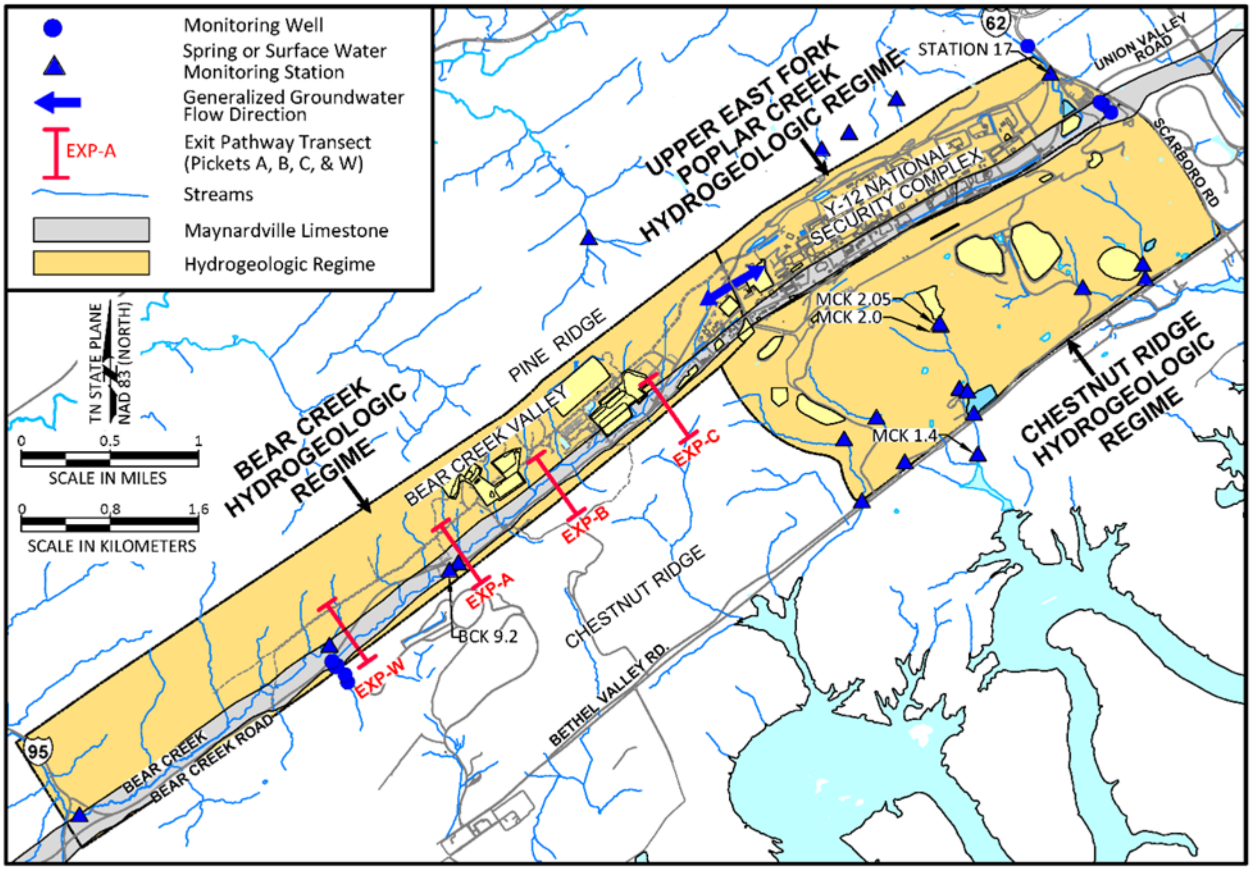


Figure 4.26. Hydrogeologic regimes, flow directions, perimeter/exit pathway locations, and position of Maynardville Limestone at Y-12

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-3 site 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. The 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 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.

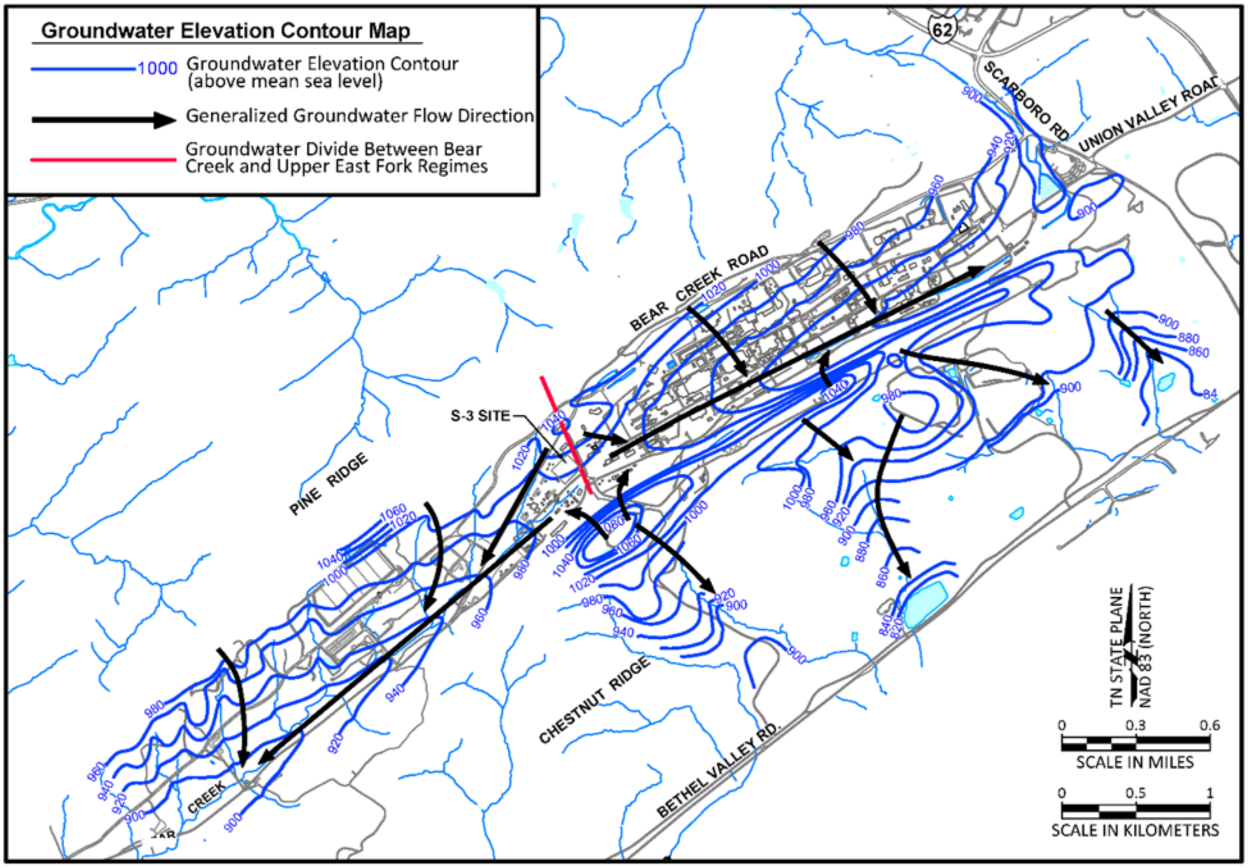


Figure 4.27. Groundwater elevation contours and flow directions at Y-12

4.6.2. Groundwater Monitoring

Groundwater monitoring in 2024 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 222 wells and 61 surface water locations and springs (Table 4.18). (Locations sampled for research projects are not included in the wells and locations monitored for compliance requirements.)

Specific wells of interest, based on 2024 data, are discussed later in this section. Figure 4.26 shows the locations of perimeter/exit pathway stations that are routinely monitored.

Table 4.18. Summary of groundwater monitoring at the Y-12 National Security Complex, 2024

	Restoration[a]	Waste management[b]	Surveillance[c]	Other[d]	Total
Purpose for which monitoring was performed					
Number of active wells	57	33	132	77	299
Number of other monitoring stations (e.g., springs, seeps, and surface water)	37	7	17	3	64
Number of samples taken[e]	315	315	175	82	887
Number of analyses performed	12,695	7,659	19,682	2,226	42,262
Percentage of analyses that are non-detects	64.6	87.2	70.6	NA	74.1
Ranges of results for positive detections, VOCs (µg/L)[f]					
Chloroethenes	0.15-2,040	3.76-7.39	0.35-93,900	NA	
Chloroethanes	0.16-200	57.78-73.8	0.39-1,930	NA	
Chloromethanes	0.2-1,100	0.76-1.32	0.46-574	NA	
Petroleum hydrocarbons	0.16-7,000	ND	1-490	NA	
Uranium (mg/L)	0.000037-0.36	0.0000161-0.0467	0.000501-0.26	NA	
Nitrates (mg/L)	0.057-3,700	ND	0.0349-9,250	NA	
Ranges of results for positive detections, radiological parameters (pCi/L)[g]					
Gross-alpha activity	0.79-350	1.45-13.2	0-36	NA	
Gross-beta activity	0.41-2,500	2.28-23.2	0-11,000	NA	

[a] Monitoring to comply with CERCLA 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:

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act

NA = not analyzed

ND = not detected

VOC = volatile organic compound

Water quality results of groundwater monitoring activities are presented in the 2024 groundwater monitoring report (CNS 2025). The groundwater sampling technicians shown in Figure 4.28 are taking water quality samples from a well in the East Fork regime.

Monitoring efforts performed specifically for CERCLA baseline and remediation evaluation are published in the FYs 2024 and 2025 Water Resources Restoration Program sampling and analysis plans (UCOR 2023, 2024 respectively) and the annual CERCLA remediation effectiveness reports (DOE 2024a, 2025). Three groundwater monitoring wells were plugged and abandoned by the Groundwater Protection Program. One of these wells (GW-954) was plugged and abandoned due to damage sustained during construction activities by the Security Infrastructure Revitalization project. The other two wells (GW-760 and GW-761) were plugged and abandoned due to construction activities at the LPF site.

In 2024, two wells (GY-053 and GY-054) were installed at the Environmental Management Waste Management Facility, and two wells (GY-055 and GY-056) were installed at Environmental Management Disposal Facility by the Water Resources Restoration Program. Five monitoring wells were plugged and abandoned at Environmental Management Disposal Facility—GW-998, GW-999, GY-001, GY-002, and DC WELL.

Figure 4.28. Groundwater monitoring well sampling in the Upper East Fork regime 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. 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 2024 include the S-2 site, Fire Training Facility, S-3 site, Waste Coolant Processing Facility, former petroleum underground storage tanks, 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 4.29, 4.31, 4.32, and 4.33) 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 2018 and 2022. The circular icons presented on the plume maps (Figures 4.29, 4.31, 4.32, and 4.33) represent 2024 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. In the past, these were ponds that received large quantities of nitric acid wastes. In 2024, there was a maximum nitrate concentration of 9,250 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 19 m (63 ft) below ground surface (Figure 4.29).

Increasing and indeterminate concentration trends are indicated by the respective time-series nitrate data for three wells in the East Fork Regime—55-2B, GW-270, and GW-275. These trends are illustrated by the time-series data for wells 55-2B and GW-270 shown in Figure 4.30. Recent data for GW-270 is beginning to show a decreasing trend, beginning in 2013, and an overall indeterminate trend through the sampling history. Future sampling will show if nitrate concentrations in well GW-270 continue to decline.

Considering the mobility of nitrate flowpaths in the Nolichucky Shale east of the S-3 site, this is consistent with both the heterogeneous transport characteristics of the groundwater flow systems as well as the conceptual model for contaminant transport for the S-3 site, whereby the center of the nitrate mass (and other intermixed contaminants) plume in the Nolichucky Shale east of the site continues to slowly move eastward (toward well GW-275) via permeable flowpaths (e.g., bedding plane fractures) that parallel geologic strike (DOE 1998).

As shown in Figure 4.30, nitrate trends in the groundwater at two well clusters in the East Fork Regime reflect differing conditions at different depth intervals at the same location. Divergent nitrate trends occur at wells GW-108/GW-109 (decreasing and indeterminate, respectively) and GW-274/GW-275 (decreasing and increasing, respectively). The monitoring depths of GW-108 and GW-109 are 49 and 114 ft below ground surface, respectively. The monitoring depths of GW-274 and GW-275 are 31 and 63 ft below ground surface, respectively. The decreasing trends at wells GW-108 and GW-274 likely reflect higher groundwater flow (e.g., flushing) in the shallow groundwater system.

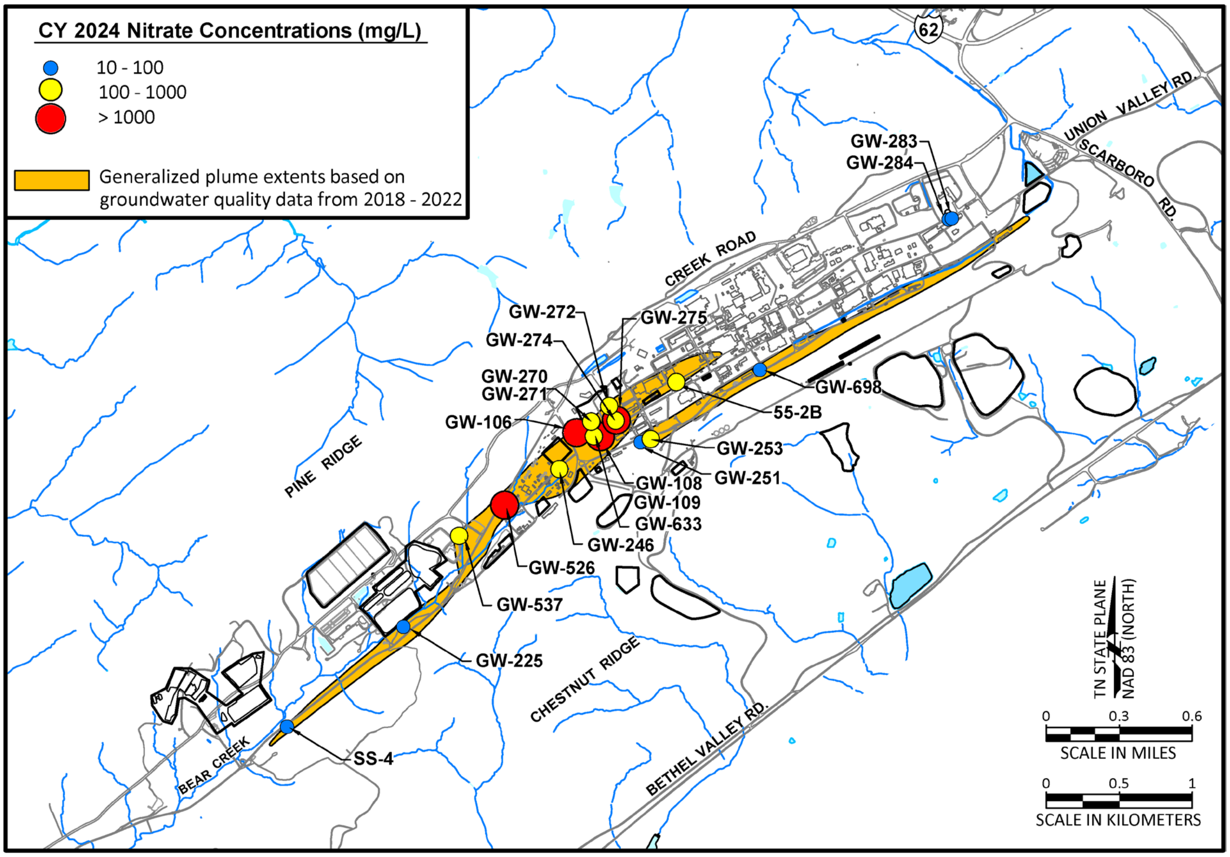


Figure 4.29. Nitrate in groundwater at Y-12

Trace metals

In 2024, 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 and S-3 sites, and upgradient of the New Hope Pond site. 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 2024, the highest summed concentration of dissolved chlorinated hydrocarbons (108,574.7 µg/L) was again observed 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 seen at well GW-658 (11,361 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.

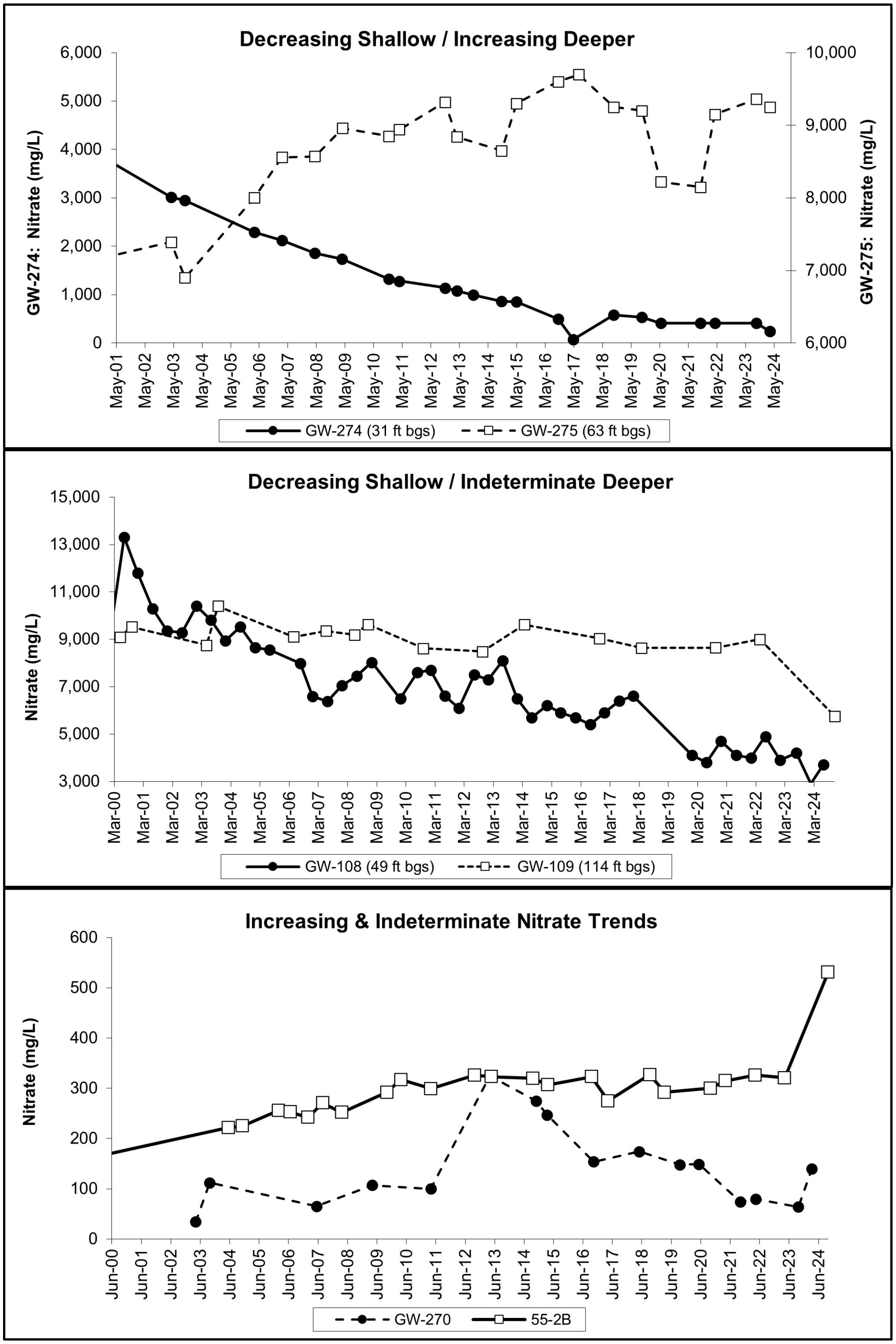


Figure 4.30. Nitrate concentration trends in surveillance monitoring wells 55-2B/GW-270 and GW-274/GW-275 in the East Fork regime

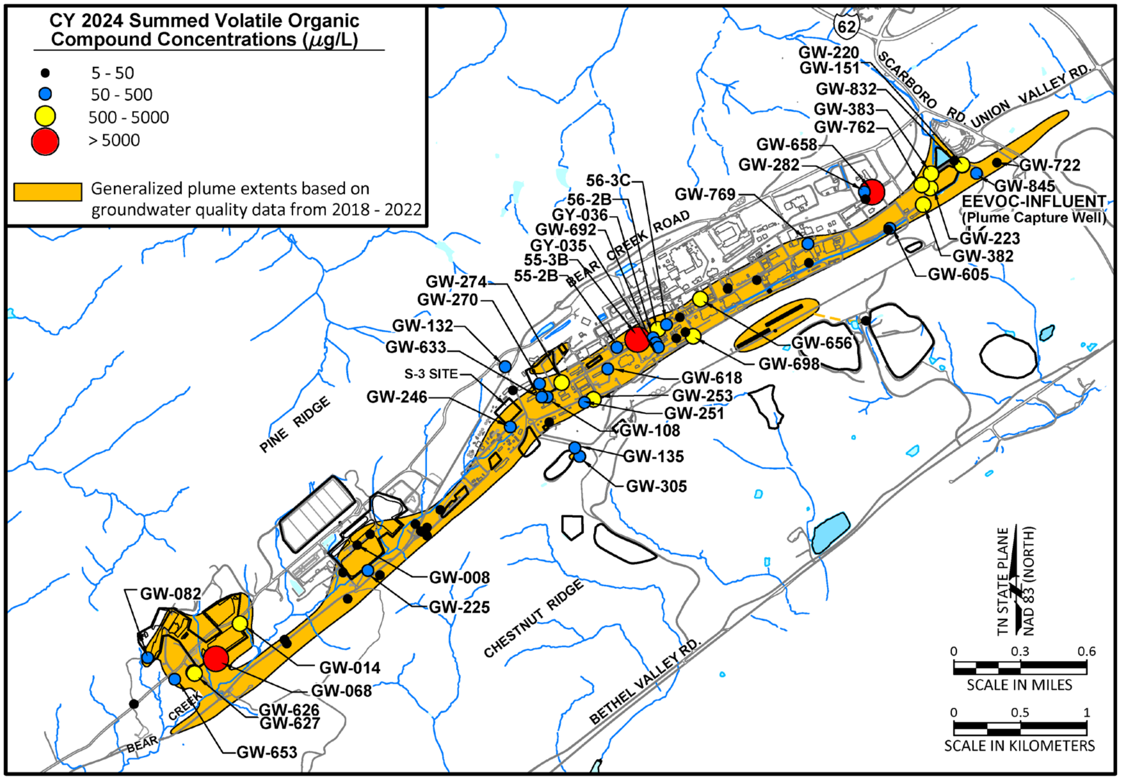


Figure 4.31. Summed volatile organic compounds in groundwater at Y-12

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, as well as 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 2024 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 in the east end near the former oil skimmer basin at the former inlet to New Hope Pond, which was capped in 1988. In 2024, the maximum occurrence of gross-alpha activity in groundwater in the Upper EFPC regime was 350 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 2024 from well GW-108 (2,800 pCi/L), down from a maximum gross-beta (21,300 pCi/L) in 2008 in the same well.

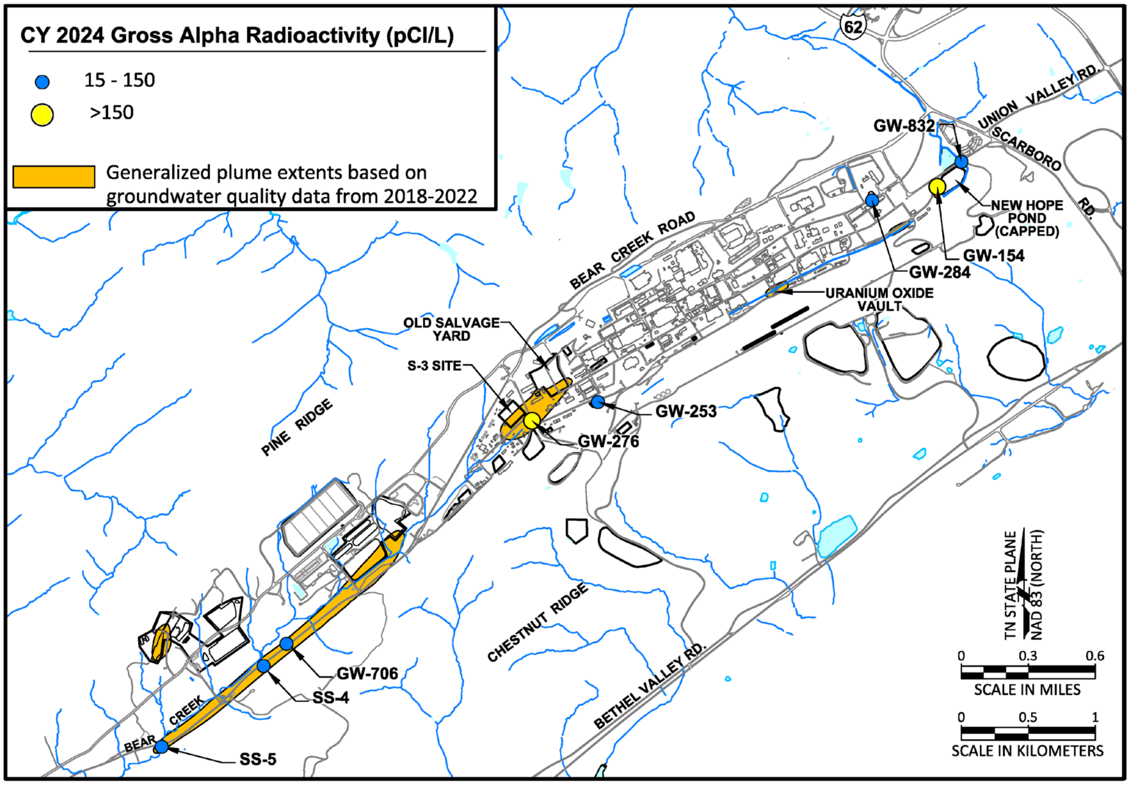


Figure 4.32. Gross-alpha activity in groundwater at Y-12

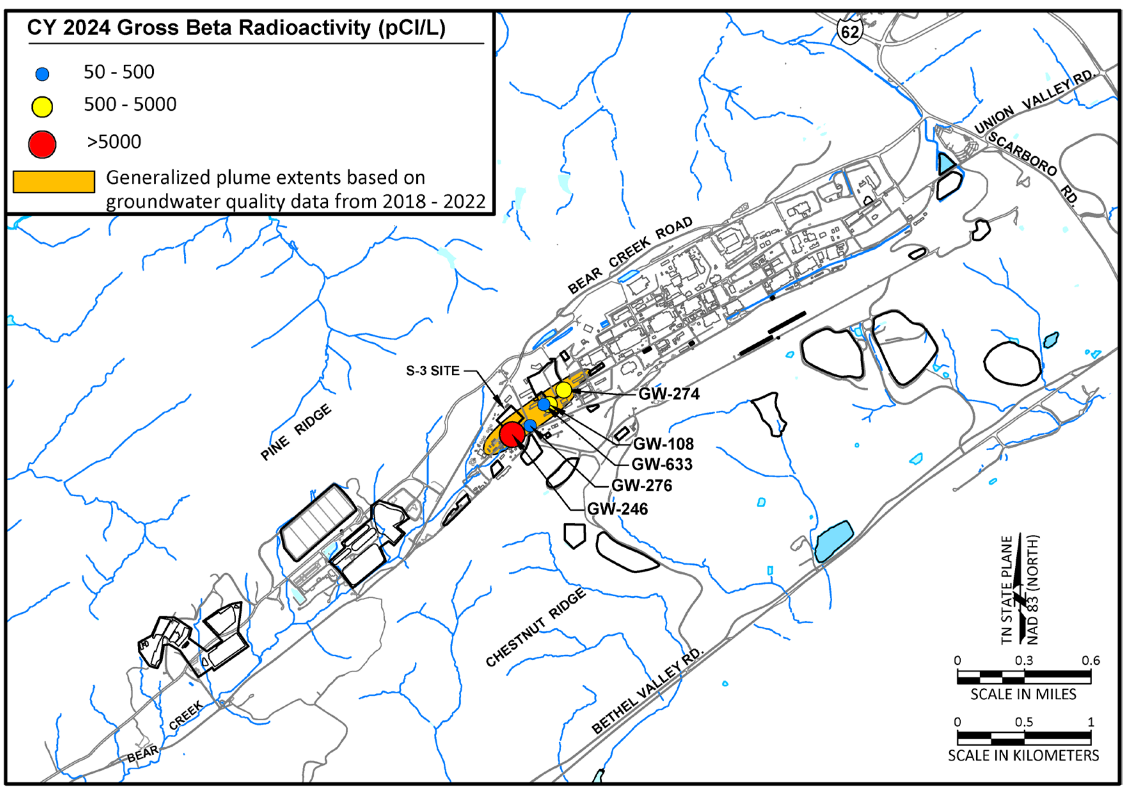


Figure 4.33. Gross-beta activity in groundwater at Y-12

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 2024a, 2025).

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, downgradient detection of these compounds 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 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 2024, 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 (16 μg/L) measured at zone 722-20 (333 ft below ground surface). Zone 722-20 also exceeded the drinking water standard for PCE at 6.7 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 2024, the summed concentrations of VOCs at the New Hope Pond distribution channel underdrain remained low (16.8-17.4 μg/L).

Upper EFPC flows north, exiting Y-12 through a gap in Pine Ridge. As mentioned previously, shallow groundwater mimics the creek and also moves through this exit pathway. A groundwater monitoring well in this pathway gap was monitored in 2024, 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. Another location monitors an upper reach of Mill Branch, which discharges into the residential areas along Wiltshire Drive. The remaining location monitors Gum Hollow Branch as it flows adjacent to the Country Club Estates community. There were no indications that contaminants were being discharged from ORR into those communities.

Union Valley monitoring

Groundwater monitoring data obtained in the early 1990s provided the first indication that VOCs were being transported off 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 2024, monitoring locations in Union Valley continued to show overall decreasing or low concentration stable trends. Vinyl chloride at 2.2 µg/L (above the maximum contaminant level of 2 µg/L) was detected at monitoring well GW-230, located in the University of Tennessee Arboretum (approximately 3,500 ft east of the ORR boundary). A groundwater flow divide west of 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, 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 1997).

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.

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. 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 2018 and 2022. The circular icons presented on the figures represent 2024 monitoring results.

Nitrate

Data from 2024 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 (3,080 mg/L) was observed at well GW-526 adjacent to the S-3 site at a depth of 123 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 2024, concentrations of nitrate appear to be lower in the Bear Creek Regime. Concentrations exceeding the drinking water standard were detected in groundwater as far as 2,438 m (8,000 ft) west of the S-3 site, from spring location SS-4 (13 mg/L). Monitoring well GW-537, located 762 m (2,500 ft) from the S-3 site, showed elevated concentrations above the drinking water standard (114 mg/L) as shown in Figure 4.34.

Natural attenuation processes have reduced nitrate levels in the shallow groundwater downgradient of the site. These trends are shown in the time-series data for wells GW-246 and GW 537 in Figure 4.34. Decreasing nitrate levels in the groundwater from these wells primarily reflect the substantially reduced flux of nitrate in the subsurface after the S-3 site was closed and covered with a multilayer low permeability cap.

Despite the slightly elevated nitrate results for aquitard well GW-537 in 2023 and 2024, the overall decreasing trend in nitrate 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 1992 and 8.44 mg/L in 2020) were sustained by nitrate-contaminated groundwater upwelling from deeper flowpaths in the Nolichucky Shale (DOE 1997b).

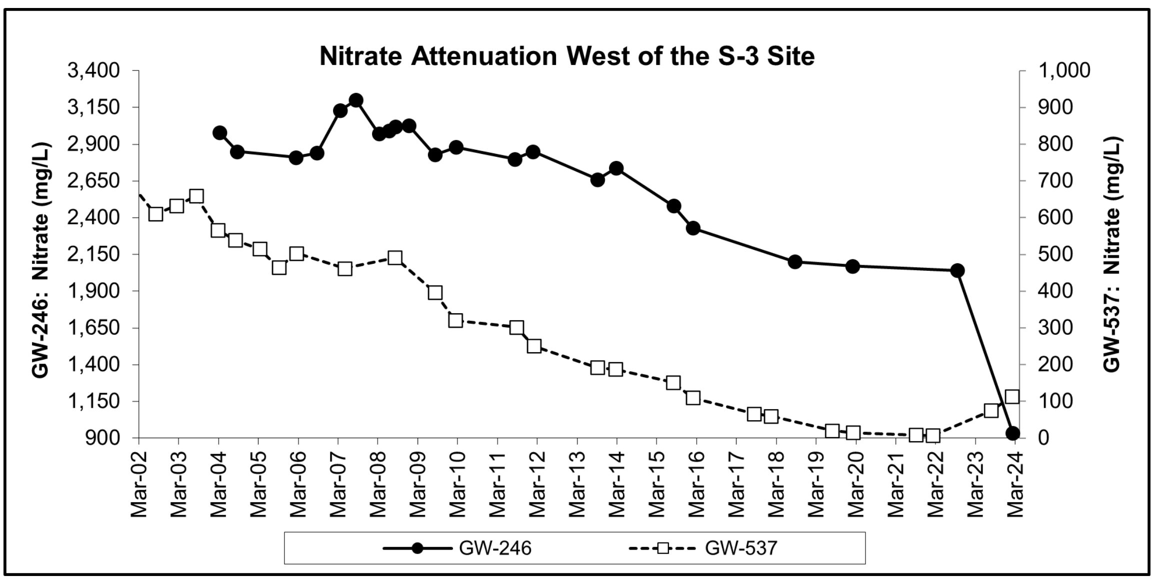


Figure 4.34. Nitrate trend in surveillance monitoring wells GW-246 GW-537, west of S-3 site, Bear Creek Regime, 2002–2024

Trace metals

During 2024, arsenic, barium, beryllium, cadmium, chromium, lead, 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 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, as shown in Table 4.19; 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 4.19. 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	2020–2024
BCK[b]-11.84 to 11.97	Nitrate	91.9	75.2	43.4	24.8
(~0.5 miles downstream)	Uranium	1.61	0.124	0.183	0.164
BCK-09.20 to 09.47	Nitrate	12.4	11.3	4.8	2.9
(~2 miles downstream)	Uranium	0.096	0.115	0.061	0.058
BCK-04.55	Nitrate	3.8	2.5	0.96	0.98
(~5 miles downstream)	Uranium	0.033	0.028	0.018	0.016

[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 2024 occurred in the Nolichucky Shale aquitard at the Bear Creek Burial Ground waste management area, with a maximum summed VOC concentration of 8,672.94 in well GW-068, which included cis-1,2-DCE (3,890 µg/L), 1,1-DCE (1,930 µg/L), benzene (965 µg/L), and vinyl chloride (904 µg/L).

As illustrated by respective time-series plots for wells GW-008, GW-225, and GW-626 shown in Figure 4.35, the summed VOC concentrations either show wide temporal concentrations fluctuations that do not display any consistently increasing or decreasing long-term trend or exhibit a generally stable trend that suggest little corresponding change in the overall flux of dissolved VOCs via the groundwater flow and transport pathways intercepted by the well.

In addition, data for each well show indeterminate trends for each of the VOCs detected above screening levels. The indeterminate trends likely reflect the combined influence of (1) the large volume of VOCs in the subsurface at each source area, (2) low permeability of the groundwater flow and transport pathways monitored by the wells, and/or (3) minimal natural attenuation of the VOCs during residence time or transport in the subsurface.

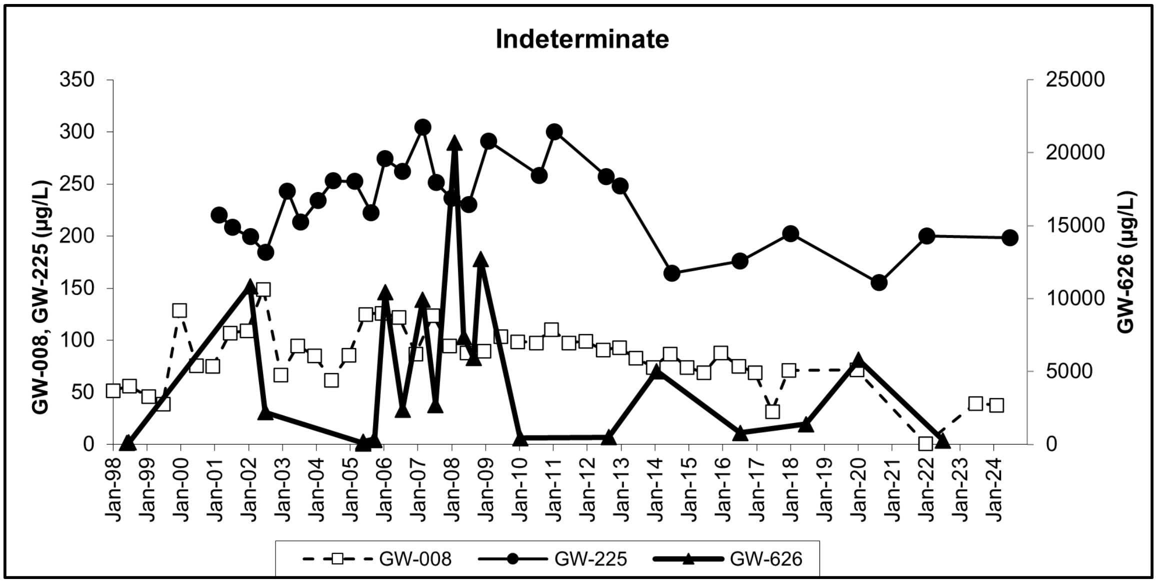


Figure 4.35. Indeterminate VOC trends in surveillance monitoring wells GW-008, GW-225, and GW-626

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 2024 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 4.32).

In 2024, the highest gross-alpha activity observed in a monitoring well in the Bear Creek regime (111 pCi/L) was in GW-276, which is adjacent to the S-3 site (Figure 4.32). Although GW-276 has the highest concentration, gross-alpha activity is decreasing in the S-3 site plume. These trends are illustrated by the time-series data for wells GW-246 and GW-276 in Figure 4.36. These trends reflect reduced flux of uranium isotopes (and alpha-emitting daughter products) via the groundwater flow and transport pathways monitored by the wells.

In 2024, the highest gross-beta activity in groundwater in the Bear Creek regime was also at GW-246 at 11,000 pCi/L (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).

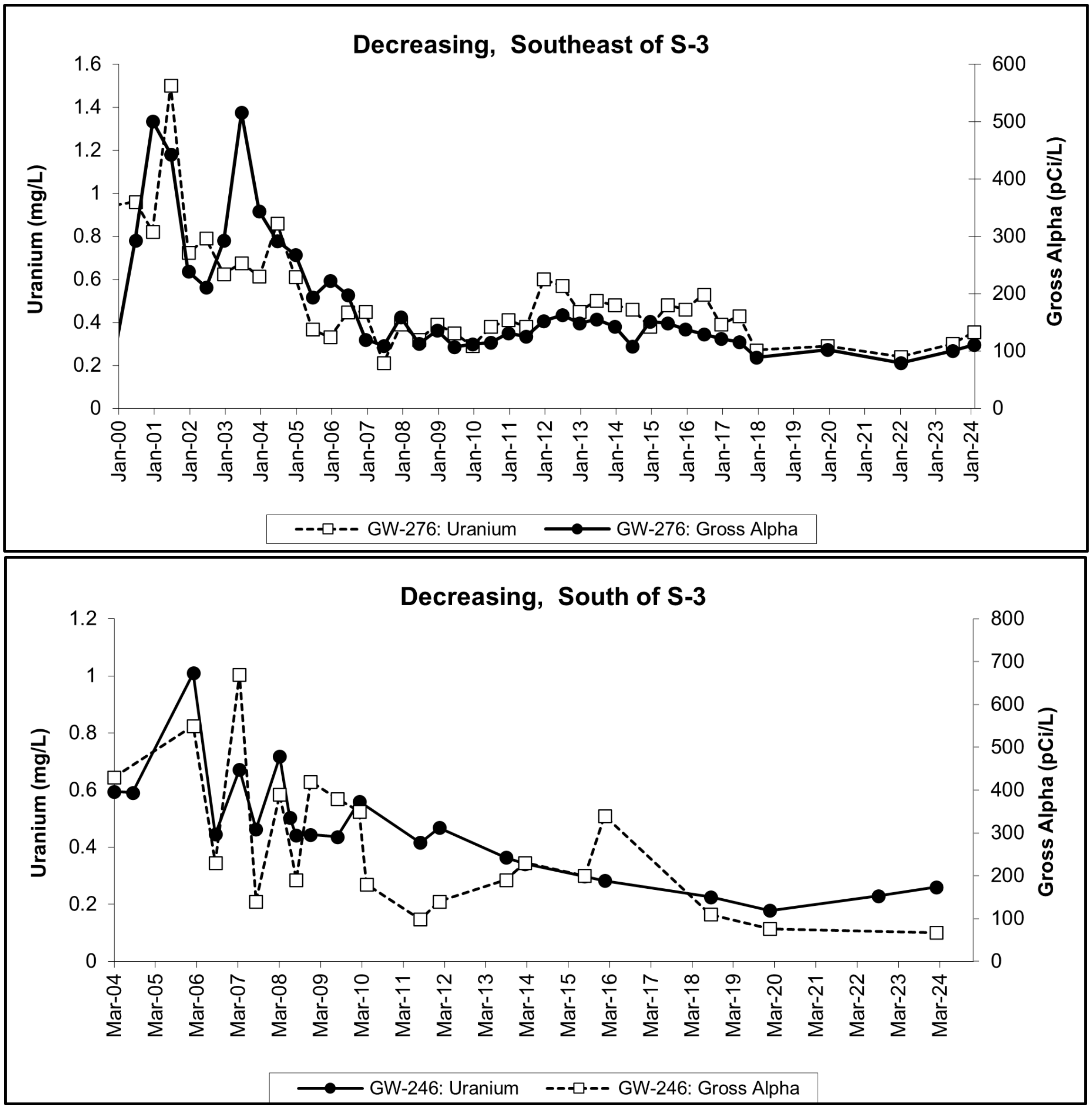
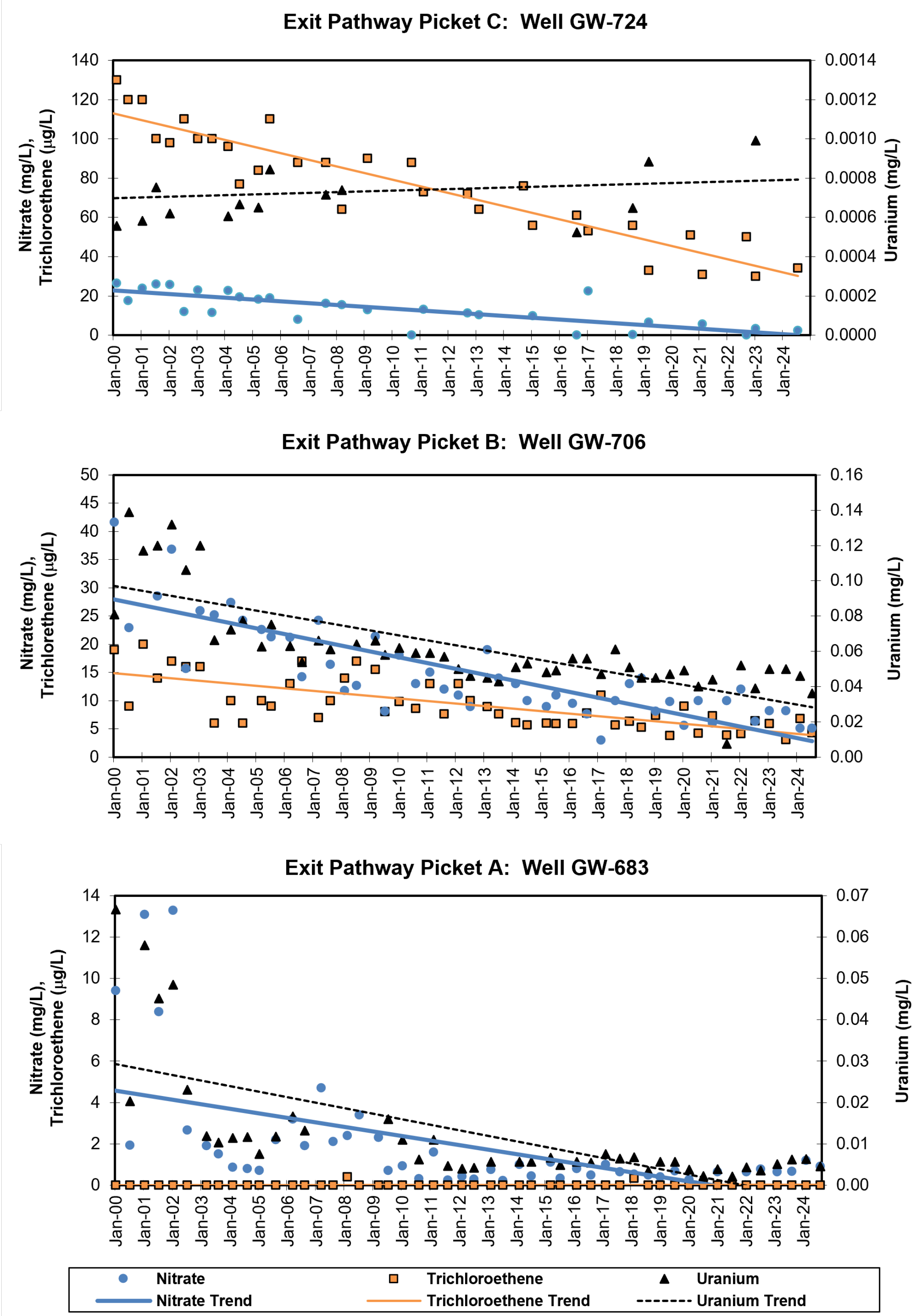


Figure 4.36. Gross alpha concentration trends in surveillance monitoring wells GW-246 and GW-276

Exit pathway monitoring continues at four exit pathway transects (A, B, C, and W; Figure 4.26) also referred to as pickets, and selected springs and surface water stations. Data obtained during 2024 indicate groundwater is contaminated above drinking water standards in the Maynardville Limestone as far as Picket W. The drinking water standard for uranium was exceeded (0.035 mg/L) in shallow well GW-715. Concentration trends throughout the exit pathway continue to be generally stable to decreasing, as shown in Figure 4.37.

In 2024, GW-710, GW-711, and GS-714 in exit pathway transect W showed trace concentrations of VOCs (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 transect W but has never been detected above drinking water standards.



Note: *Only nitrate and uranium results above the detection limit are plotted; non-detected trichloroethene results are plotted at zero.*

Figure 4.37. Concentrations of selected contaminants in exit pathway monitoring wells in the Bear Creek hydrogeologic regime

Surface water samples collected in 2024 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. This location is 4,724 m (15,500 ft) west of the S-3 site. The concentrations in the creek generally decrease with distance downstream of the waste disposal sites (Table 4.19).

Exit pathway monitoring stations sampled in 2024 show that gross-alpha activity in the Maynardville Limestone exceeds the drinking water standard as far as 3,353 m (11,000 ft) west of the S-3 site at Spring SS-5 (15 pCi/L). The alpha activity at this spring recently shows a decreasing trend.

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.

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 2022 indicate the western lateral extent of the VOC 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, since 2021, no VOCs were detected at this spring.

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 2018 and 2022. The circular icons presented on the figure represent 2024 monitoring results.

Nitrate

Nitrate concentrations continue to be below the drinking water standard at all monitoring stations in the Chestnut Ridge regime in 2024.

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 because, in part, of erosion channels forming around the wetland. During 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 2024, 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.

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, with the 2024 concentration at 80.06 µg/L. GW-305 was sampled in January and July 2024 with results for 1,1 DCE of 4.14 µg/L and 6.26 µg/L, respectively. (The drinking water standard for this compound is 5 ug/L.)

Radionuclides

In 2024, no gross-alpha (15 pCi/L) or gross-beta (50 pCi/L) above the drinking water standards were observed in the Chestnut Ridge hydrogeologic regime.

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 2024, two 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. Six springs and three surface water monitoring locations were sampled during 2024. 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.

The following actions and activities were conducted at Y-12 during 2024 to address these emerging contaminants of concern:

- Y-12 continues to maintain compliance with the DOE requirements pertaining to PFAS storage, use, and disposal (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 2024. One waste storage building (Building 9720-09) has an active AFFF fire suppression system that is only approved for fire emergencies. This system undergoes periodic maintenance and post-maintenance testing, which generate AFFF wastes that contain PFAS. There was one spill during post-maintenance testing, which was cleaned immediately with no release to the environment. Corrective actions were implemented following the event for future maintenance/testing cycles to prevent a similar release.

- Y-12 has a fire department and fire training facility. The Y-12 Fire Department has one firetruck with a foam induction system that uses a fluorine-free foam.
- Uses of PFAS or PFAS-related substances are tracked. No PFAS substances were used in excess of the Emergency Planning and Community Right-to-Know Act Toxics Release Inventory reporting threshold during 2024.
- No production-related activities, equipment, or processes are known to have generated or released PFAS to the environment; however, several products and/or chemicals containing PFAS have been used in small quantities, primarily in the Analytical Chemistry laboratories and in the Development facilities.
- Y-12 personnel sampled the drinking water system quarterly in 2024 to support the EPA Unregulated Contaminant Monitoring Rule 5 (EPA 2024). The Safe Drinking Water Act requires that, once every 5 years, the EPA issue a list of unregulated contaminants to be monitored by public water systems. The new rule requires that samples be collected for 30 chemical contaminants between 2023 and 2025 using standard analytical methods. Twenty-nine of these contaminants are PFAS. This action provides scientifically valid data on the national occurrence of these contaminants in drinking water to improve the agency's understanding of the frequency of detection and concentrations of PFAS in the nation's drinking water systems. The monitoring data on PFAS will help determine future regulations and other actions to protect public health. Results from sampling showed only one detected concentration (3.6 ng/L) of perfluorobutanesulfonioc acid (PFBS) above the detection limit. This result did not exceed the drinking water standard established for this PFAS chemical and was only observed during one quarter of sampling.

4.7. Quality Assurance Program

Y-12's QA Program establishes a quality policy and requirements for the Y-12 site. Internal procedures detail the methods used to carry out work processes safely and securely and in accordance with established procedures. They also describe mechanisms in place to identify and correct findings and prevent 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. The following are some key quality practices:

- 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

The Y-12 Environmental Sampling Services organization is responsible for field sampling activities, sample preservation and handling, chain-of-custody, and field QC sample transport in accordance with Y-12 Environmental Compliance 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 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 early detection of problems that may arise from contamination, inadequate calibrations, calculation errors, or improper procedure performance. Internal laboratory QA/QC programs include routine calibrations of counting instruments; yield determinations; frequent use of check sources and background counts, replicate and spiked sample analyses, and matrix and reagent blanks; and maintenance of control charts to indicate analytical deficiencies. These activities are supported by using standard materials or reference materials (e.g., materials of known composition that are used to calibrate instruments, methods standardization, spike additions for recovery tests, and other practices). Certified standards traceable to the National Institute of Standards and Technology, DOE sources, or EPA are used, when available.

Y-12's Analytical Chemistry organization has an internal manual that describes 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 laboratory operates in accordance with DOE Order 414.1D, *Quality Assurance* (DOE 2011c).

Other internal practices used to ensure laboratory results represent of actual conditions and include training and managing staff; maintaining adequacy of the laboratory environment; ensuring safety; controlling the storage, integrity, and identity of samples; maintaining recordkeeping; maintaining and calibrating instruments; and using technically validated and properly documented methods.

Y-12's Analytical Chemistry organization participated in Mixed Analyte Performance Evaluation Program studies conducted in 2024 for water and soil matrices for metals, organics, and radionuclides. The overall acceptability rating from both studies was 95.25 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 who 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 limits the number of facilities used and avoids or discontinues using 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 4.20 lists treatment, storage, and disposal facilities used in 2024 for the disposition of radiological and hazardous waste.

Table 4.20. Treatment, storage, and disposal facilities used to disposition radiological and hazardous waste, 2024

Facility name	Location	Identification number
Clean Harbors Colfax Facility	Colfax, Louisiana	LAD981055791
Clean Harbors Baton Rouge	Baton Rouge, Louisiana	LAD010395127
Clean Harbors Deer Park Incineration Facility	La Porte, Texas	TXD055141378
Clean Harbors El Dorado Incineration Facility	El 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
Clean Harbors Reidsville	Reidsville, North Carolina	NCD000648451
Diversified Scientific Services, Inc.	Kingston, Tennessee	TND982109142
Energy*Solutions* Bear Creek Processing Facility	Kingston, Tennessee	TND982157570
Energy*Solutions* Clive Disposal Facility	Grantsville, Utah	UTD982598898
Nevada National Security Site	Mercury, Nevada	NV3890090001
Safety-Kleen Systems	Smithfield, Kentucky	KYD053348108
Veolia ES Technical Solutions	Port Washington, Wisconsin	WID988566543
Waste Control Specialists	Andrews, Texas	TXD988088464

4.8. Environmental Management and Waste Management Activities

The three sites on ORR have a rich history of research, innovation, and scientific discovery. 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 *2024 Cleanup Progress: Annual Report on Oak Ridge Reservation Cleanup* (UCOR 2024a) provides detailed information on DOE EM cleanup activities.

4.8.1. Environmental Management Activities

At Y-12, DOE EM is addressing excess and contaminated facilities, removing mercury soil and groundwater contamination, and enabling modernization efforts that allow NNSA to continue its crucial national security and nuclear nonproliferation responsibilities.

Demolition begins on Alpha 2 Complex

Demolition is underway at one of the Manhattan Project-era complexes at Y-12. The main facility in the complex is Building 9201-2, also referred to as Alpha 2. The Alpha 2 facility occupies just over two acres of land. At nearly 325,000 ft^2, the 1940s-era Alpha 2 building is one of the largest high-risk excess contaminated facilities EM is addressing at Y-12.

Workers began deactivating the Alpha 2 complex in 2020 by removing the last of the hazardous waste, draining oil from equipment, and clearing various areas of the basement to allow it to be filled with controlled low-strength material that will provide structural support for the heavy equipment that will be on the slab during demolition.

While deactivation was going on inside Alpha 2, a separate project was underway to reroute utilities, including steam, instrument air, plant air, argon gas, nitrogen gas, and demineralized water, around the area. Workers installed four new structural steel bridges for the rerouted utilities across Second Street, which is the main road adjacent to Alpha 2. Each bridge weighs more than 2,000 lb and took more than a year to design and build.

Deactivation continues at former enrichment facilities

Deactivation activities continued at three large former uranium processing facilities throughout FY 2024—Building 9204-01, Building 9201-04, and Building 9204-4.

Building 9204-01 is a 210,500-ft^2, three-story, former uranium enrichment facility. Workers completed deactivation of the aboveground floors, and treated 5.7 million gal of water that was pumped from the basement. Weather-based water intrusion will continue to be mitigated. In addition, 100 linear ft of old thorium-contaminated piping was safely removed and prepared for disposal. Demolition is expected in 2026.

Activities during 2024 to bring Building 9201-04 closer to "cold and dark" status included addressing mercury vapors and supporting repackaging containers for eventual disposition of legacy waste. Roughly 50 percent of the facility's waste was characterized, and 227 legacy waste containers were shipped

Planning is underway to start work in Building 9204-4. Once all plans are reviewed and approved, crews will begin to move the facility toward the "cold and dark" state.

Progress continues at the Mercury Treatment Facility

Progress continued on construction of the Outfall 200 Mercury Treatment Facility. The facility is the linchpin for DOE EM's cleanup strategy at Y-12. This vital piece of infrastructure will open the door for demolishing 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.

In FY 2024, UCOR assumed construction responsibility for the facility and began construction of the treatment plant and headworks facility.

At the headworks site, workers are building concrete structures for handling normal flows and higher storm flows. They made progress throughout the year on these structures with approximately 600 yd^3 of concrete poured, bringing the total amount of concrete poured to date for the project to 2,400 yd^3 of concrete.

At the treatment site, workers completed construction of a gravity filter and installed additional tanks. The completion of the gravity filter allows workers to complete the structural steel and roofing of the eventual operations building.

Plans are being finalized for the next phases of construction.

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

Soil remediation efforts being planned

Soil remediation is essential to ensuring environmental safety and allowing reuse of currently contaminated land. Several remediation efforts are underway in the Upper EFPC and Bear Creek areas.

DOE EM and UCOR meet regularly with the NNSA Y-12 Field Office and CNS to share information and develop a plan for addressing legacy soil contamination in the Y-12 main plant area.

The group is focused on understanding the probability and type of contamination in the soil at specific areas of the plant due to historical operations and processes. This includes areas that will become accessible once buildings are demolished. Additionally, Y-12 employees evaluate potential challenges associated with performing soil sampling and soil excavation work on an active site.

White Wing Scrap Yard. Planning is underway to transfer Self Sufficiency Parcel 2 in the ORR north-central area. The former White Wing Scrapyard occupies part of this parcel. The group held a data quality objectives session with EPA and TDEC to develop a site characterization plan. In addition, a remedial investigation work plan was prepared and submitted to EPA and TDEC for review. Due to DOE's intent to accelerate the parcel's transfer, initial surface soil sampling was completed within the scrapyard's footprint. This sampling provided initial site characterization data to inform follow-on sampling and support early remedial action planning.

Bear Creek Burial Ground. The Bear Creek Burial Ground is a former disposal area that received a variety of Y-12 industrial wastes from approximately 1955 to 1993. These wastes contained large amounts of uranium as well as chemical solvents, oils, and PCBs. DOE EM completed actions in 1994 to close disposal units and isolate the remaining waste. To reduce contamination discharges to nearby streams, crews have installed engineered caps and soil covers over waste disposal units, as well as leachate collection systems.

Numerous studies have shown that the site continues to contribute contaminants, including uranium and organic solvents, to surface water and groundwater. In 2024, DOE EM and UCOR began developing a plan to conduct a comprehensive remedial investigation to characterize current conditions, assess risk to human health and the environment, and develop and evaluate alternatives to remediate the contaminant sources working toward a final remedy. A preliminary field investigation was completed in FY 2024 on current contaminant levels in Bear Creek Burial Ground tributaries and groundwater. Results of that investigation support the remedial investigation work plan.

North Tributary 8. In September 2024, DOE EM and UCOR submitted an action memorandum for North Tributary 8 (DOE 2024c). The tributary carries runoff and contaminants from the western end of the Bear Creek Burial Ground to Bear Creek. Uranium discharges in Bear Creek from the area have exceeded the surface water goals in the Record of Decision for Phase I activities in Bear Creek Valley since 2001 (DOE 2000).

Previous investigations confirmed the eastern branch of North Tributary 8 is the principal source of uranium, making this a trackable issue under the 2016 remediation effectiveness report evaluation requiring a final resolution (DOE 2016). The Federal Facility Agreement parties agreed to conduct a non-time-critical removal action to address these releases. The action memorandum documents the selection of the non-time-critical interim removal action, which includes a geomembrane cap, surface water diversion controls, and surface water monitoring.

Bear Creek Valley Mercury Sources Remedial Site Evaluation. In 2024, DOE EM and UCOR conducted a remedial site evaluation to support the mercury management approach outlined for Bear Creek in the Environmental Management Disposal Facility Record of Decision (DOE 2022b). This evaluation did not identify a mercury source that significantly contributes to the Bear Creek mercury contamination or that would warrant active remediation. To identify potential source areas for mercury and methylmercury in the environment and determine if active remediation was warranted, DOE EM and UCOR sampled surface water, channel sediment, and stream bank and floodplain soils at 15 locations along Bear Creek and an off-site reference location. Routine fish tissue sample data was also evaluated. Although mercury was detected in the media sampled, concentrations are low compared to other ORR mercury-contaminated sites, and fish tissue mercury concentrations continue to decrease.

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. CERCLA Waste Disposal

Most of the waste generated during FY 2024 cleanup activities in Oak Ridge went to disposal facilities on the ORR. The Environmental Management Waste Management Facility received 1,526 waste shipments, totaling 12,978 yd^3, from cleanup projects at ETTP and ORNL. 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 2024, these three active landfills received 9,959 waste shipments, totaling 153,217 yd^3 of waste.

4.8.2.3. Wastewater Treatment

Safe and compliant treatment of more than 50 million gallons of wastewater and groundwater generated from both production and environmental cleanup activities was provided at various facilities during 2024:

- The West End Treatment Facility and the Central Pollution Control Facility processed approximately 329,550 gal of wastewater, primarily in support of NNSA operational activities.
- The Big Springs Water Treatment System treated more than 29.5 million gal of mercury-contaminated groundwater.
- The East End VOC Treatment System treated 16.1 million gal of VOC-contaminated groundwater.
- The Liquid Storage Facility and Groundwater Treatment Facility treated more than 1.9 million gal of leachate from burial grounds and well purge waters from remediation areas.

- The Central Mercury Treatment System treated approximately 2.1 million gal of mercury-contaminated sump waters from Building 9201-04.

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