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The Y-12 National Security Complex

Y-12, a premier manufacturing facility operated by Consolidated Nuclear Security, LLC (CNS) for the National Nuclear Security Administration (NNSA), plays a vital role in the DOE Nuclear Security Enterprise. Drawing on more than 75 years of manufacturing excellence, Y-12 helps ensure a safe and reliable United States nuclear weapons deterrent.

Y-12's primary mission includes processing, retrieving, and storing nuclear materials; dismantling nuclear weapons; providing fuels to the nation's naval reactors; and performing complementarily working for other government and private-sector entities.

Today's environment requires Y-12 to have a new level of flexibility and versatility. Therefore, while continuing its key role, Y-12 has evolved to become the resource that the nation looks to for support in protecting America's future by developing innovative solutions in manufacturing technologies, prototyping, safeguards and security, technical computing, and environmental stewardship.

4.1. Description of Site and Operations

4.1.1. Mission

Charged with maintaining the safety, security, and effectiveness of the United States' nuclear weapons stockpile, Y-12 is a one-of-a-kind manufacturing facility that plays an important role in United States national security. Y-12's core mission is to ensure a safe, secure, and reliable United States nuclear deterrent, which is essential to national security. Every weapon in the United States nuclear stockpile has components manufactured, maintained, or ultimately dismantled by Y-12. Through life extension program activities, Y-12 produces refurbished, replaced, and/or upgraded weapons components to modernize the enduring stockpile. As the nation reduces the size of its arsenal, Y-12 has a central role in decommissioning weapons systems and providing weapons material for nonexplosive, peaceful uses.

Y-12 expertly secures highly enriched uranium, stores it with the highest security, and makes material available for nonweapon uses (e.g., in research reactors that produce cancer-fighting medical isotopes and for other research reactor purposes). Y-12 also processes highly enriched uranium from weapons removed from the nation's nuclear weapons stockpile for use by the Naval Reactors Program to fuel nuclear-powered submarines and aircraft carriers.

Located within the city limits of Oak Ridge, Tennessee, the Y-12 site covers more than 3,024 acres including 810 acres in the Bear Creek Valley, stretching 4.0 km (2.5 mi) in length down the valley and nearly 2.4 km (1.5 mi) in width across it. Additional NNSA-related facilities are located offsite from Y-12 and include the Central Training Facility, Alternate Emergency Operations Center (K-1650), Uranium Processing Facility (UPF) project laydown storage and offices, Y-12 Material Acquisition and Control Facilities (K-1065), 103 Palladium Way Development Center, Test and Demonstration Facility, Commerce Park Office Complex, and Union Valley Sample Preparation Facility.

4.1.2. Modernization

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

The ability to deliver a nuclear weapon without reusing components from legacy weapons and relying heavily on aging infrastructure does not exist. Additionally, Y-12 faces a unique need to reestablish capabilities and two material

streams—binary and special materials associated with the canned subassembly (CSA) and Radiation Case mission. A key component to reestablishing these capabilities is accelerated planning and execution of site infrastructure improvements to include:

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

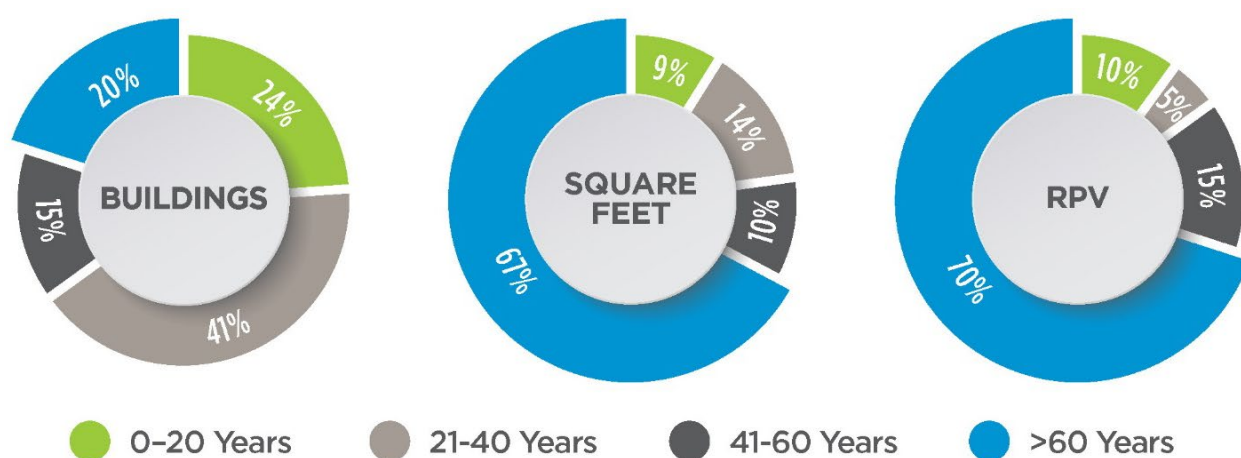
Planning for the future site is designed to ensure that Y-12 will continue to provide the infrastructure needed to support the primary capabilities and materials missions with new facilities and associated technologies. In addition to new and revitalized facilities, the security posture will be strengthened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

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

More than 50 percent of the Y-12 footprint is over 60 years old (Figure 4.1). To address this situation, Y-12 has been consolidating operations, modernizing facilities and infrastructure, and reducing the legacy footprint for more than one decade. These actions are consistent with and supportive of NNSA enterprise transformation planning. Through continued infrastructure projects, new construction, and the disposition of excess facilities, Y-12 will continue to strive

toward becoming a more responsive, sustainable enterprise.

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



Acronym: RPV = replacement plant value

Figure 4.1. Age of facilities at Y-12

4.1.3. Production Operations

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

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

- **EU:** Buildings 9212, 9215 and the UPF (2026)
- **DU:** Buildings 9215, 9201-05N, 9201-05W, 9996, and 9998
- **Lithium:** Buildings 9204-02 and 9202
- **General manufacturing and fabrication:** Building 9201-01
- **Assembly and disassembly:** Building 9204-02E
- **Special materials:** Building 9225-03
- **Storage:** Buildings 9720-82, 9720-05, 9720-32, 9720-33, 9720-59, and 9811-01

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

- Building 9212 functions are to be replaced by the UPF in 2026, with some Building 9212 processes relocated to Buildings 9215 and 9204-2E.
- Building 9215 EU functions are to be replaced by the EU Manufacturing Center by 2042.
- Building 9204-02E functions are to be replaced by the Assembly and Disassembly Center by 2045.
- Building 9204-02 lithium functions are to be replaced by the LPF by 2031.
- DU and fabricating and manufacturing functions from the Building 9215 Complex, Building 9201-05N, Building 9201-05W, and Building 9201-01 are to be replaced by a phased approach line item construction, with the first phase, the DU Manufacturing Capability (DUMC) by 2035.

4.1.4. Support Facilities

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

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

- Global Security and Strategic Partnerships
- Waste Management
- Sustainability and Stewardship

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

- Replace the Emergency Operations Center and Fire Station currently under construction, by 2023.
- Relocate some development functions from Buildings 9202 and 9203, initially by the off-site acquisition at 103 Palladium Way in 2025, and long-term, followed by the Applied Technologies Laboratory by 2035.
- Implement the WEPAR project and a new Entry Control Facility by 2024.
- Implement the Security Infrastructure Revitalization Program to replace the legacy Perimeter Intrusion Detection and Assessment System and secondary systems.
- Explore new construction for replacement facilities to support Analytical Chemistry operations.
- Construct a new Strategic Partnership Program training campus as the Oak Ridge Enhanced Technology and Training Center (ORETTC), including the Emergency Response Training Facility and the Simulated Nuclear and Radiological Activities Facility.
- Construct a new Maintenance Complex to replace the 78-year-old 9201-03 and other aging maintenance facilities.
- Construct a new Waste Management Complex to replace the aging West End Treatment Facilities.
- Implement a digital transformation and cyber security strategy.
- Refurbish existing facilities to accommodate a Protected Area Security Facility and construct a new Security Complex to enable growing requirements.

4.1.5. Excess Facility Disposition

Currently, 53 excess facilities at Y-12 and another 42 NNSA facilities are projected to be excessed within the next 10 years. The major excess process-contaminated facilities, including Building 9201-05 (Alpha 5), Building 9204-04 (Beta 4), and Building 9206, will be transitioned to 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 Building 9401-03 (Steam Plant) Complex facilities are currently 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. Construction of the Mercury Treatment Facility and the Environmental Management Disposal Facility is required before any mercury-contaminated facilities can be demolished. Surveillance and maintenance activities, along with utility reroutes, unneeded material cleanout, and fluid and oil disposition, are ongoing while the Mercury Treatment Facility and Environmental Management Disposal Facility are being constructed.

4.2. Environmental Management System

DOE Order 436.1, Departmental Sustainability, requires federal facilities to use environmental management systems. Y-12 implements an EMS using the International Organization of Standardization (ISO) 14001 standard to fulfill

compliance obligations and address risks and opportunities. By design, the “Plan-Do-Check-Act” approach of the ISO 14001 standard continually improves environmental performance. The Y-12 EMS has two areas of focus: environmental compliance and environmental sustainability. Environmental compliance consists of regulatory compliance and monitoring programs that implement federal, state and local requirements, agreements, and permits. Environmental sustainability promotes and integrates initiatives such as energy and natural resource conservation, minimizing emissions of air pollutants, waste minimization, and using sustainable products and services.

4.2.1. Integrating with Integrated Safety Management System

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

4.2.2. Policy

Y-12’s environmental policy and commitment to providing sound environmental stewardship practices through the implementation of an EMS have been defined, are endorsed by top management, and have been made available to the public via company-sponsored forums and public documents such as this one. Y-12’s ES&H policy is presented in Figure 4.3.

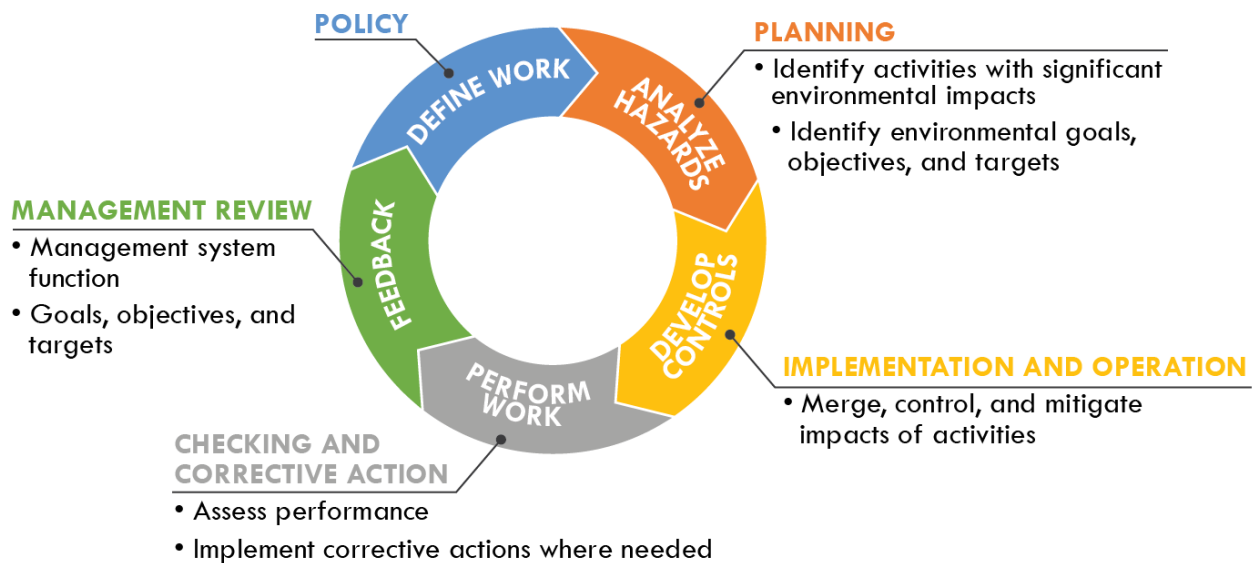


Figure 4.2. The Environmental Management System plan-do-check-act cycle of continual improvement

Y12 ENVIRONMENT, SAFETY, AND HEALTH POLICY STATEMENT

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

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

In support of these policies, we are committed to:

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

Acronym:

ES&H = environment, safety, and health

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

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

4.2.3. Planning

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

4.2.3.1. Y-12 Environmental Aspects

Environmental aspects may be thought of as potential environmental hazards associated with a facility operation, maintenance job, or work activity. The environmental aspects and their impacts (potential effects on the environment) are evaluated to ensure that the significant aspects of Y-12 activities that are identified continue to reflect stakeholder concerns and changes in regulatory requirements. The EMS provides the system to ensure that environmental aspects are systematically identified, monitored, and controlled to mitigate or eliminate potential impacts to the environment.

The analysis identified the following as significant environmental aspects in 2021:

- Storm water (runoff from roofs and outdoor storage areas)
- Surface water (process water and dike emissions to creek)
- Wastewater (sanitary sewer and process water treated and disposed)
- Radiological waste

- Excess facilities and unneeded materials and chemicals
- Aging infrastructure and equipment
- Legacy contamination and disturbance

4.2.3.2. Legal and Other Requirements

To implement the compliance commitments of the ES&H policy and to meet legal requirements, systems are in place to review changes in federal, state, or local environmental regulations and to communicate those changes to affected staff. The environmental compliance status is documented each year in this report (see Section 4.3).

4.2.3.3. Objectives, Targets, and Environmental Action Plans

CNS responds to change and pursues sustainability initiatives at Y-12 by establishing and maintaining environmental objectives, targets (goals), and action plans. Goals and commitments are established annually considering Y-12's significant environmental aspects. They are consistent with Y-12's mission, budget guidance, ES&H work scope, and DOE sustainability goals. Targets and action plans are established for broad objectives to pursue improvement in environmental performance in five areas: clean air; energy efficiency; hazardous materials; stewardship of land and water resources; and waste reduction, recycling, and buying green. Highlights of the 2021 environmental targets achieved at Y-12 are presented in Section 4.2.6.1.

4.2.3.4. Programs

NNSA has developed and funded several important programs to integrate environmental stewardship into all facets of Y-12 missions. The programs also address the requirements in DOE orders for protecting various environmental media, reducing pollution, conserving resources, and helping to promote compliance with all applicable environmental regulatory requirements and permits.

Environmental Compliance

Y-12's Environmental Compliance Department (ECD) provides environmental technical support services and oversees Y-12 line organizations to ensure that site operations are conducted in a manner that is protective of workers, the public, and the environment; in compliance with applicable standards, DOE orders, environmental laws, and regulations; and consistent with CNS environmental policy and Y-12 site procedures. ECD serves as Y-12's interpretive authority for environmental compliance requirements and as the primary point of contact between Y-12 and external environmental compliance regulatory agencies such as the City of Oak Ridge, the Tennessee Department of Environment and Conservation (TDEC), and EPA. ECD administers compliance programs aligned with the major environmental legislation that affects Y-12 activities. Compliance status and results of monitoring and measurements conducted for these compliance programs are presented in this document.

ECD also maintains and ensures implementation of Y-12's EMS and spearheads initiatives to proactively address environmental concerns, to continually improve environmental performance, and to exceed compliance requirements.

Waste Management

The Y-12 Waste Management Program supports the full life cycle of all waste streams within Y-12. While ensuring compliance with federal and state regulations, DOE orders, waste acceptance criteria, and Y-12 procedures and policies, the Waste Management Program provides services for day-to-day solid and liquid waste operations, including collection and transport, storage, on-site treatment operations, and shipment to off-site treatment and disposal. The program also provides technical support to Y-12 operations for waste planning, characterizing, packaging, tracking, reporting, and managing waste treatment and disposal subcontracts.

Sustainability and Stewardship

The Sustainability and Stewardship Program has two major missions. The first is to establish and maintain companywide programs and services to support sustainable material management operations. These sustainable operations include pollution prevention and recycling programs, excess materials programs, the PrYde Program, generator services programs, sanitary waste and landfill coordination, and destruction and recycle facility operations. Y-12 has implemented continuous improvement activities, such as an Items Available for Reuse section on the Property Accountability Tracking System website and a central telephone number (574-JUNK), to provide employees easy access to information and assistance related to the proper methods for disposing of excess materials.

The second mission is stewardship practices, the programs that manage legacy issues and assist in preventing development of new problematic issues. Stewardship programs include Clean Sweep, Unneeded Materials and Chemicals, and Targeted Excess Materials. The Clean Sweep Program provides turnkey services to material generators, including segregation, staging, and pickup of materials for excess, recycle, and disposal. Sustain areas have been established across the site to improve housekeeping through efficient material disposition. Customers place unneeded items into the transition portion of each Sustain area and Clean Sweep Program personnel take care of the rest. Additionally, at Y-12, unneeded materials are not automatically assumed to be wastes requiring disposal. Y-12 uses a systematic disposition evaluation process. The first step in the disposition process is to determine if the items can be reused at Y-12. Items that cannot be used at Y-12 are evaluated for use at other DOE facilities or government agencies. Items are then evaluated for potential sale; recycle; or, as a last resort, disposal as waste.

Combining these programs under a single umbrella improves overall compliance with EOs, DOE orders, federal and state regulations, and NNSA expectations, and eliminates duplication of

efforts while providing an overall improved appearance at Y-12.

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

Energy Management

The mission of Y-12's Energy Management Program is to incorporate energy-efficient technologies sitewide and to position Y-12 to meet NNSA energy requirement needs and reduction requirements set forth by DOE. The program identifies improvements in energy efficiency in facilities, coordinates energy-related efforts across the site, is involved with the continual Energy Savings and Performance Contracts (ESPCs), and promotes employee awareness of energy conservation programs and opportunities.

4.2.4. Implementing and Operating

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

4.2.4.1. Roles, Responsibility, and Authority

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

Environmental and Waste Management technical support personnel assist line organizations with identifying and carrying out their environmental responsibilities. Additionally, the Environmental Officer Program facilitates communication of environmental regulatory requirements and promotes EMS as a tool to drive continual

environmental improvement at Y-12. Environmental Officers coordinate their organizations' efforts to maintain environmental regulatory compliance and promote other proactive improvement activities.

4.2.4.2. Community and Community Involvement

Y-12 is committed to keeping the community informed on operations, environmental concerns, safety, and emergency preparedness. The Community Relations Council, composed of more than 20 members from a cross-section of the community, including environmental advocates, neighborhood residents, Y-12 retirees, and business and government leaders, facilitates communication between Y-12 and the community. The council provides feedback to Y-12 regarding its operations and ways to enhance community and public communications. Community outreach activities were limited in 2021 due to the COVID-19 pandemic.

Local charities receive donations from funds raised by Y-12 employee aluminum beverage can recycling efforts. Since the program began in 1994, more than \$93,000 raised by the collection of aluminum beverage cans has been donated to various local charities.

Y-12 continues to promote sustainable behaviors for environmental improvements at the site and within the community. A United Way Coat and Toiletries Drive is conducted annually to provide coats and other needed items for the Volunteer Ministry Center for the Homeless. These activities reflect Y-12 employees' commitment to reduce landfill waste and to support community outreach.

4.2.4.3. Emergency Preparedness and Response

Local, state, and federal emergency response organizations are fully involved in Y-12's emergency drill and exercise program. The annual drill and exercise schedule is coordinated with all organizations to ensure maximum possible participation. At a minimum, the Tennessee Emergency Management Agency (TEMA)

Operations Office and the DOE Headquarters Watch Office participate in all Y-12 emergency response exercises.

Exercises, performance drills, and training drills were conducted at Y-12 during fiscal year (FY) 2021. The drills and exercises focused on topics such as responding to a roof collapse, radiological fire and release, chemical release, and a response to a transportation accident involving radiological materials. Building evacuation and accountability drills were also conducted.

4.2.5. Checking

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

4.2.5.1. Monitoring and Measuring

Y-12 maintains procedures to monitor overall environmental performance and to monitor and measure key characteristics of its operations and activities that can have a significant environmental impact. Environmental effluent and surveillance monitoring programs are well established, and results of 2021 program activities are described throughout this chapter. Progress in achieving environmental goals is reported as a monthly metric on Performance Track, the senior management web portal that consolidates and maintains Y-12 site-level performance. Progress is reviewed in periodic meetings with senior management and the NNSA Production Office (NPO).

4.2.5.2. Environmental Management System Assessments

To periodically verify that EMS is operating as intended, assessments are conducted as part of the Y-12 internal assessment program. The assessments are designed to ensure that nonconformities with ISO 14001 are identified and addressed.

The Environmental Assessment (EA) Program comprises several types of assessments, each type serving a distinct but complementary purpose. Assessments range from informal observations of specific activities to rigorous audits of site-level programs.

To self-declare conformance to ISO 14001 in accordance with instructions issued by the Federal Environmental Executive and to adhere to DOE Order 436.1 (DOE 2011a) requirements, EMS must be audited at least every 3 years by a qualified party outside of the control or scope of EMS. To fulfill this requirement, a four-person audit team from The University of Tennessee Center for Industrial Services evaluated Y-12's EMS during September 2021. The Y-12 EMS was found to fully conform, and no issues were identified. The next external verification audit is scheduled for summer 2024.

4.2.6. Performance

This section discusses EMS objectives, targets, other plans, initiatives, and successes that work together to accomplish DOE goals and reduce environmental impacts. Y-12 used DOE reporting systems, including the following, to report performance:

- The Federal Automotive Statistical Tool, which collects fleet inventory and fuel use.
- The DOE Sustainability Dashboard, which collects data on metering requirements, water use, renewable energy generation and purchases, greenhouse gas (GHG) generation, and sustainable buildings. Pollution prevention waste reduction and recycling data, sustainable acquisition product purchases, electronic stewardship, and best practices data are also collected in this Dashboard system.

The DOE Office of Health, Safety, and Security Annual Environmental Progress Reports on implementing EMS requirements and sustainability goals driven by EOs and the Office of Management and Budget's Environmental Stewardship Scorecard gave Y-12 an EMS

scorecard rating for FY 2021 of green, indicating full implementation of EMS requirements.

4.2.6.1. Environmental Management System Objectives and Targets

At the end of CY 2021, Y-12 had achieved seven of 11 targets that had been established; the remaining targets were carried into future years. Highlights include the following, with additional details and successes presented in other sections of this report:

- **Clean air:** Y-12 upgraded software, training, and procedures to improve control of ozone-depleting substances that are managed onsite.
- **Energy efficiency:** Y-12 completed phase one of a project to upgrade power lines to 13.8kV service. Additional power line upgrade work will continue into 2022. Progress on several energy-saving improvements for water chillers; heating, ventilation, and air conditioning systems; and cooling towers and a Kathabar unit were made and completed by the end of CY 2021.
- **Hazardous materials:** A project to disposition and ship legacy mixed waste according to the Site Treatment Plan continued and FY 2021 milestone was completed. 2021 priorities to disposition unneeded materials and equipment in four

buildings were completed. Y-12 completed a project to reduce risks associated with inactive West End fuel tanks.

- **Land, water, and natural resources:** Y-12 completed re-roofing projects on two buildings to improve stormwater quality, and completed work on upgrading and relining approximately 88 feet of sanitary sewer line as part of a larger project to protect the sanitary sewer lines from infill and infiltration.

4.2.6.2. Sustainability and Stewardship

Numerous efforts, including increased use of environmentally friendly products and processes and reductions in waste and emissions, at Y-12 have reduced its impact on the environment. During the past few years, these efforts have been recognized by our customers, our community, and other stakeholders (see Section 4.2.7). Pollution prevention efforts at Y-12 have not only benefited the environment but have also resulted in cost efficiencies (Figure 4.4).

In FY 2021, Y-12 implemented 109 pollution prevention initiatives (Figure 4.5), with a reduction of more than 120 million lbs. of waste and projected cost efficiencies of more than \$2.8 million. The completed projects include the activities described below.

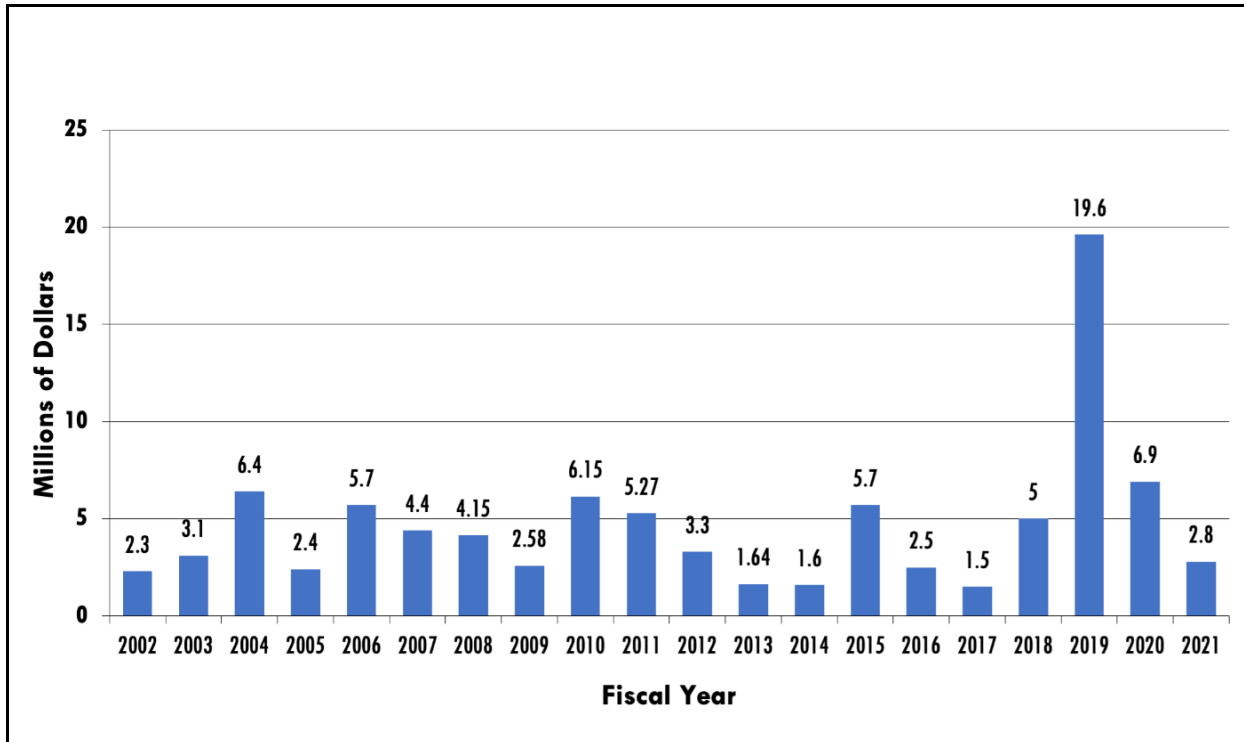


Figure 4.4. Cost efficiencies from Y-12 pollution prevention activities

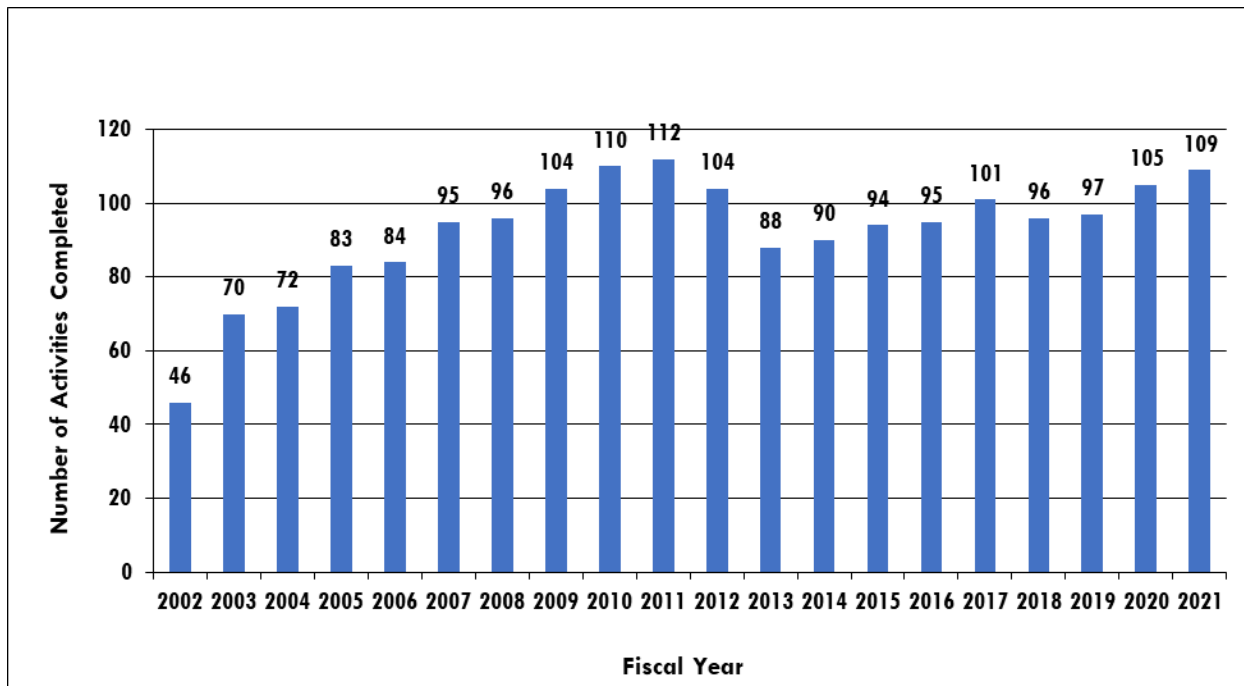


Figure 4.5. Y-12 pollution prevention initiatives

Pollution Prevention and Source Reduction

Across Y-12, sustainable initiatives have been embraced to reduce the impact of pollution on the environment and to increase operational efficiency. Many of Y-12's sustainable initiatives have pollution prevention benefits or targets eliminating the source of pollution, including the 2021 activities highlighted in this section.

Sustainable Acquisition—Environmentally Preferable Purchasing

Sustainable products, including recycled-content materials, are procured for use across Y-12. In 2021, Y-12 procured recycled-content materials valued at more than \$8.02 million for use at the site.

Solid Waste Reduction

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

In 2021, Y-12 diverted 50 percent of municipal and 64.9 percent of construction and demolition waste from landfill disposal through reuse and recycle. Y-12 diverted more than 2.9 million lbs. of municipal materials from landfill disposal through source reduction, reuse, and recycling in FY 2021. More than 116.7 million lbs. of construction and demolition materials were diverted from landfill disposal in FY 2021.

Hazardous Chemical Minimization

Generator Services Group provides a material disposition management service for generators at Y-12, which includes the technical support aspect to assist generators with determining whether the materials can be recycled, excessed, or reused rather than determining all materials received must be declared as a waste. Generator Services Group can be used by any department or generator at Y-12. During FY 2021, Generator Services Group personnel, rather than declaring materials as waste, reused, or disseminated to other Y-12 organizations for reuse, various excess materials and chemicals. In FY 2021, Legacy Facilities produced more than 1,070 gallons of hypochlorous acid, a safe, environmentally friendly, sustainable, and effective disinfectant on-site. Site produced hypochlorous acid has reduced the site's purchase of commercial disinfectants required to support COVID-19 prevention and response measures. Refillable containers are utilized to reduce the associated packaging waste materials from disinfectants.

Recycling

Y-12 has a well-established recycling program and continues to identify new material streams and expand the types of materials that can be recycled by finding new markets and outlets for the materials. As shown in Figure 4.6, more than 4.02 million lbs. of materials were diverted from landfills and into viable recycle processes during 2021. Currently, recycled materials range from office-related materials to operations-related materials, such as scrap metal, tires, and batteries. Y-12 adds at least one new recycle stream to the Recycle Program each year to continue to increase the waste diversion rate. The Recycle Program was expanded in FY 2021 to include alkaline batteries to broaden waste diversion efforts.

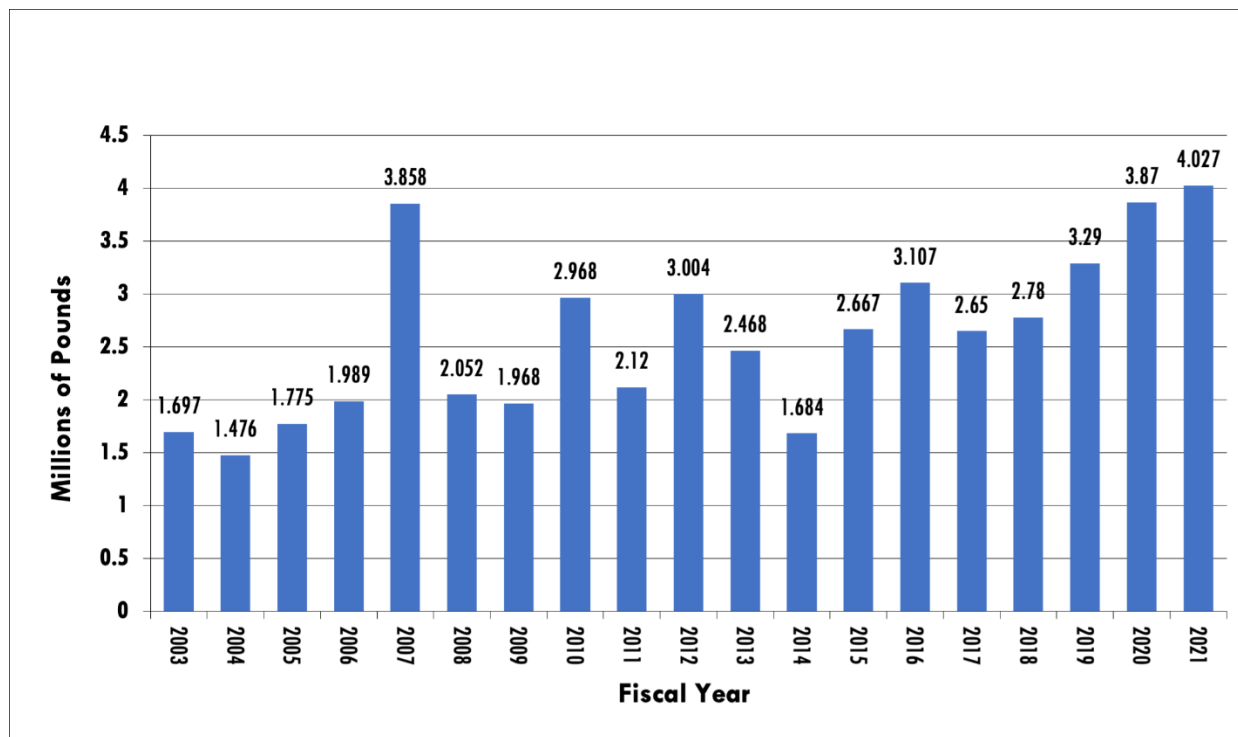


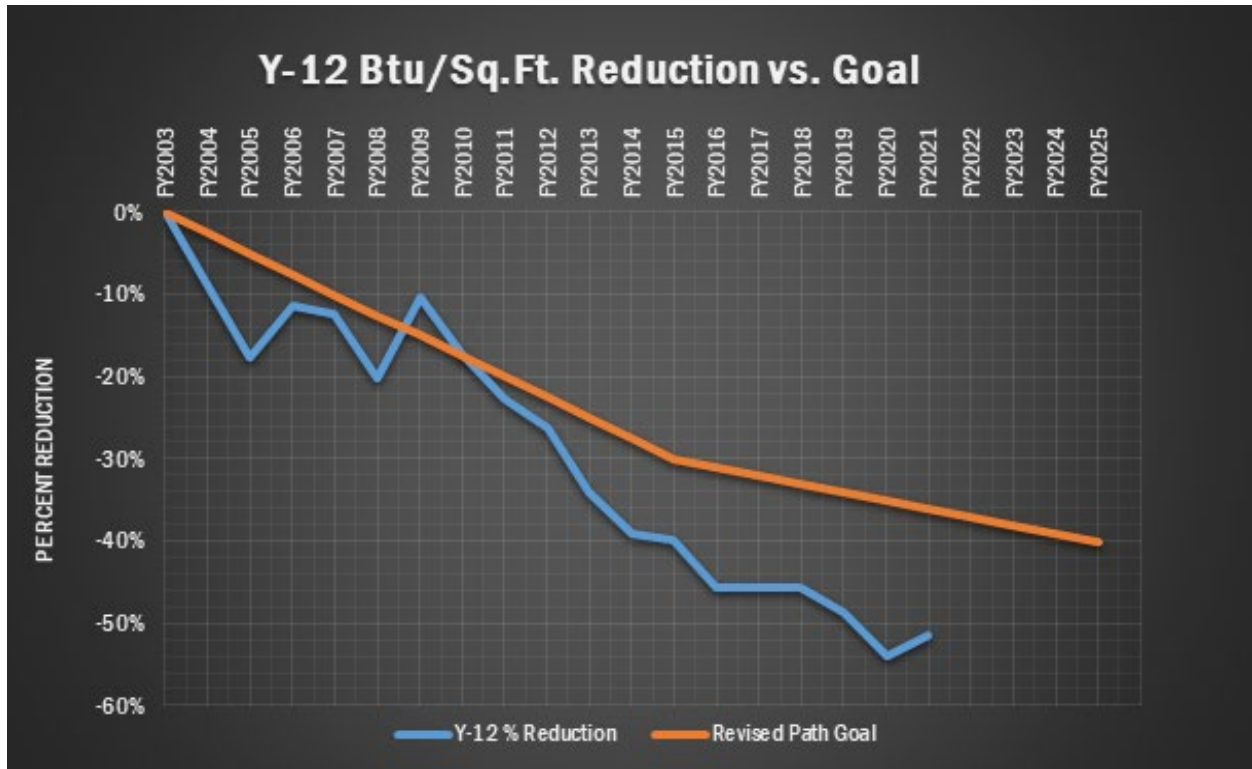
Figure 4.6. Y-12 recycling results

4.2.6.3. Energy Management

Energy Management activities are performed within the Energy Sustainability organization. Energy usage and intensity, Energy Independence and Security Act of 2007 (EISA) Benchmarking and Evaluations, Facility Metering/Monitoring in accordance with the Energy Act of 2020, and Non-Fleet Vehicles and equipment are components of Energy-Management reporting activities.

Y-12 exceeded the goal of meeting a 30% energy intensity (Btu per gross square foot) reduction in goal-subject buildings by FY 2015 from a FY 2003 baseline and 1% year to year reduction thereafter.

During FY 2021 energy intensity was 203,085 BTU/GSF which is a full 5.4% above the prior year (192,119 BTU/GSF). The upward trend in our energy intensity figures is largely attributed to the height of the pandemic occurring during FY 2020 and the effect of bringing a larger portion of the plant population back onto site and thus utilizing our infrastructure is reflected within this increase. Energy intensity reductions since FY 2018 will be further analyzed and it is anticipated that FY 2020 will be determined to be an anomaly. Compared to the FY 2003 baseline year, Y-12 has seen an Energy Intensity reduction of 51.47% as of FY 2021. Energy intensity can be seen in Figure 4.7



Acronym: FY = fiscal year

Figure 4.7. Y-12 energy intensity chart with baseline

4.2.6.4. Sustainable Goals and Performance

DOE is required to meet sustainability goals mandated by statute and related EOs, including goals for GHG emissions, energy and water use, fleet optimization, green buildings, and renewable energy. In 2021, the Sustainability Performance Office used the web-based DOE Sustainability Dashboard to collect DOE site-level sustainability

data and to consolidate these data sets on behalf of the Department. The Sustainability Dashboard focuses on specific sustainability goals, and Site Sustainability Plans are completed within the Dashboard. These goals are established by the DOE Sustainability Performance Office and are found in Table 4.1 below, along with the current Y-12 performance ratings.

Table 4.1. Fiscal year 2021 sustainability goals and performance

DOE Goal	Current Status
Energy Management	
Reduce energy use intensity (Btu per gross square foot) in goal-subject buildings.	Goal Met: Y-12 exceeded the reduction in energy intensity for goal subject facilities by 25% by FY 2025 relative to FY 2015 baseline
EISA Section 432 continuous (4-year cycle) energy and water evaluations.	Goal Met: Y-12 conducts EISA evaluations on a continuous 4-year cycle.
Meter individual buildings for electricity, natural gas, steam, and water, where cost-effective and appropriate.	Goal Not Met: Y-12 meters all utilities; however, not all appropriate buildings are currently metered.
Water Management	
Reduce potable water use intensity (Gal per gross square foot).	Goal Met: Y-12 exceeded the goal of reduction in water intensity by 36% by FY 2025 relative to FY 2007.
Reduce non-potable freshwater consumption (Gal) for industrial, landscaping, and agricultural.	Goal Not Applicable. Y-12 does not use industrial, landscaping, and agricultural water.
Waste Management	
Reduce non-hazardous solid waste sent to treatment and disposal facilities.	Goal Met: 50% (1,342 metric tons/2,679.5 metric tons of non-hazardous waste diverted from the landfill.
Reduce construction and demolition materials and debris sent to treatment and disposal facilities.	Goal Met: 64.9% (52,966.9 metric tons/81,632.4 metric tons) of C/D materials were diverted from the landfill in FY 2021.
Fleet Management	
Reduce petroleum consumption.	Goal Not Met: Y-12 did not meet the interim target of 20% reduction in fleet petroleum consumption. There was a 32.7% increase from the FY 2005 baseline.
Increase alternative fuel consumption.	Goal Not Applicable: Y-12 does not currently have access to alternative fuels.
Acquire alternative fuel and electric vehicles.	Goal Met: Y-12 swapped 43 older GSA leased vehicles with newer alternative fuel capable vehicles.
Clean & Renewable Energy	
Increase consumption of clean and renewable electric energy.	Goal Met: Y-12 has exceeded the interim target for 25% clean energy usage by 2025.
Increase consumption of clean and renewable non-electric thermal energy.	Goal Not Met: Y-12 had a 5% decrease in natural gas use for FY 2021.
Sustainable Buildings	
Increase the number of owned buildings that are compliant with the Guiding Principles for Sustainable Buildings.	Goal Met: 3 buildings were HPSB certified in FY 2021

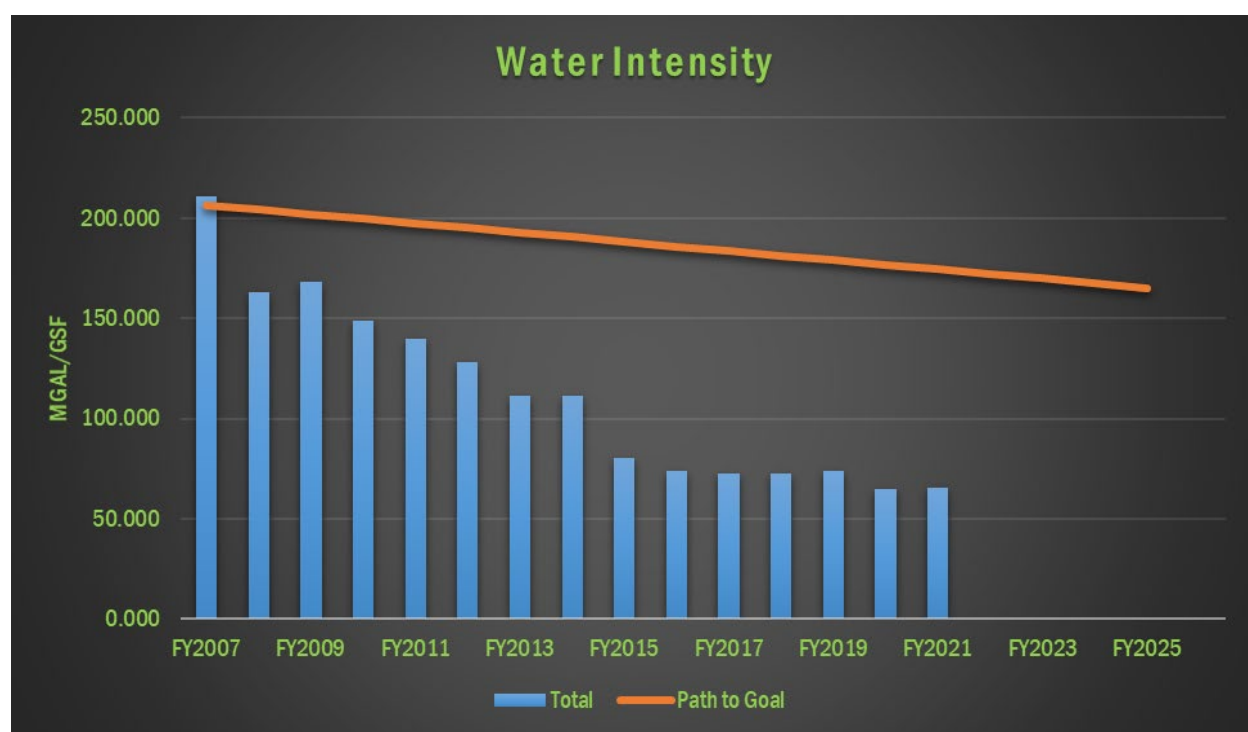
Table 4.1. Fiscal year 2021 sustainability goals and performance (continued)

DOE Goal	Current Status
Acquisition & Procurement	
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring all sustainability clauses are included as appropriate.	Goal Met: All eligible contracts after 10/1/13 contain the sustainable acquisition requirements. The CNS Sustainable Acquisition Program plans to work with contracts/procurement to review the current \$150,000 contract threshold Sustainable Acquisition requirements to be included in subcontract languages so that future appropriate contracts will have the requirements to purchase sustainably.
Efficiency & Conservation Measure Investments	
Implement life-cycle cost effective efficiency and conservation measures with appropriated funds and/or performance contracts.	Goal Met: Y-12 has supported performance contracts issued by NNSA. These contracts have been instrumental in achieving energy, water, building modernization, and infrastructure goals at Y-12.
Electronic Stewardship & Data Centers	
Electronics stewardship from acquisition, operations, to end of life.	Goal Met: Y-12 met the goal of purchasing 95% of eligible electronics as EPEAT products. Y-12 also power manages all mission critical electronics and has increased the automatic duplexing to 93.5%. Y-12's electronics recycling vendor maintained R2 certification; therefore, all FY 2021 shipments were made to a R2 certified recycler. Electronics that were not recycled were electronics that could not be radiologically cleared for release. Therefore, 100% of eligible electronics were recycled to a R2 certified recycler.
Increase energy and water efficiency in high-performance computing and data centers.	Goal Not Met: Y-12 Data centers are not currently fully metered and estimates the current PUE to be 2.4. However, as the site moves to the new modernized data centers, the overall energy and water efficiencies will continue to increase.
Adaptation & Resilience	
Implement climate adaptation and resilience measures.	Goal Met: The Y-12 National Security Complex Severe Event Emergency Response Plan addresses severe natural phenomena events, extended loss of power events, and events that result in the loss of mutual aid.
Multiple Categories	
Reduce Scope 1 & 2 greenhouse gas emissions.	Goal Met: Site scope 1 & 2 emissions were reduced by 63.7%, nearly doubling the interim target. Most of this can be attributed to the improvements to infrastructure through ESPC Projects
Reduce Scope 3 greenhouse gas emissions.	Goal Met: Site Scope 3 emissions increased by 46.3% from FY 2020 (29,491.4 MtCO ₂ e) to FY 2021 (43,142.8 MtCO ₂ e). Overall Scope 3 emissions have increased by 35.3% since the FY 2008 baseline (31,894.5 MtCO ₂ e). The increase in Scope 3 emissions in FY 2021 is primarily due to the increase in site population in support of UPF construction activities.

4.2.6.5. Water Management

The current DOE water intensity goal is a 20% reduction from a FY 2007 baseline by FY 2015 and year-to-year reductions of 0.5% thereafter. In FY 2021, Y-12's water intensity rating was 65.323 gallons per square foot, which is a 0.5% increase from the previous year and a 69.01% reduction from the 2007 baseline. This increase can be attributed to the unforeseen effects that COVID-19 has had on the workforce and operations at Y-12,

but also to the gradual reintroduction of the workforce back onsite. Of the three main utilities that Y-12 purchases, potable water consumption was the most adversely affected by the ongoing pandemic in FY 2020, but the smallest change from FY 2020 to FY 2021. The domestic use of potable water in faucets, urinals, and water closets had greatly diminished and has not risen enough to change the water intensity to pre-2020 levels of usage. An overview of water intensity performance can be found in Figure 4.8.



Acronyms:

FY = fiscal year

GSF = gross square feet

Mgal = millions of gallons

Figure 4.8. Water Intensity Graph from Baseline 2007

Actions that have contributed to the overall reduction in potable water use include:

- Steam trap repairs and improvements
- Condensate return installations, repairs, and reroutes
- Replacement of once-through air handling units
- Low-flow fixture installation
- Chiller replacements
- Cooling tower replacements, and
- Replacing steam with natural gas when possible

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

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

4.2.6.6. Fleet Management

The Y-12 fleet inventory is comprised of a total of 624 vehicles, which includes 125 Agency-owned units, 485 leased from General Services Administration (GSA) and 14 commercially-leased Special Purpose vehicles during FY 2021. The inventory consists of sedans, light-duty trucks/vans/SUVs, medium-duty trucks/vans/SUVs, and heavy-duty trucks that include road tractors, dump trucks, box trucks, flatbeds, wreckers, and service trucks. During FY 2021, Y-12 exchanged 43 older GSA-leased vehicles with new units. The new GSA replacements were all ordered with alternative fuel capabilities when available, and these new vehicles all have better fuel consumption and GHG emission figures than the older vehicles that were replaced.

The UPF construction project vehicle inventory is largely responsible for the majority of the increased mileage figures, which in turn was reflected in an increase in fuel consumption, and the vehicles assigned to this group acquire some of the highest annual mileage figures of any of the vehicles in the Y-12 fleet. A fleet of school buses in the Y-12 fleet inventory continues to transport the majority of the UPF workers to and from parking areas away from the main construction site since there is a major issue with congestion around the UPF site. The use of buses has helped tremendously to reduce the transportation/parking problems associated with the addition of the new workers there.

Y-12 has once again expanded the taxi service available for the entire site, both in vehicles and in availability, and is helping reduce the transportation needs onsite with this program, even with the increased number of onsite employees which now is over 6,200. This practice also helps reduce the number of vehicles needed, fuel consumption and GHG emissions, but is still not running at 100% capacity because of social distancing measures required that limit the number of people these taxi vans can actually transport each time. The taxi service is an important service that pays dividends and is an

asset to the overall transportation needs of the Y-12 workforce.

The Y-12 vehicle fleet achieved a 98.7% vehicle utilization rate for FY 2021 compared to 99.35% in FY 2020. Vehicle reassignments were made multiple times throughout the year to help meet those utilization goals.

FY 2021 fuel consumption at Y-12 (diesel and gasoline) increased by 13% compared with FY 2020, while mileage for those same vehicles was up 12% compared to the previous year.

Y-12 currently uses a mobile fuel tanker to dispense gasoline and diesel for vehicles at the site since there is still not a new fuel station, although there are plans in place to build one just southwest of the existing Y-12 garage at the East end of the plant. Y-12 does not utilize alternative fuel (E85) as it is not available in the area, and an Epcor 701 waiver (five miles or fifteen minutes away) for FY 2021 was granted to Y-12 as a result of this situation.

4.2.6.7. Electronic Stewardship

Y-12 has implemented a variety of 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. 100 percent of desktop computers, laptops, monitors, and thin clients purchased or leased during FY 2021 were registered Electronic Product Environmental Assessment Tool products. Y-12's standard desktop configuration specifies the procurement of Electronic Product Environmental Assessment Tool-registered and Energy Star-qualified products.

4.2.6.8. Greenhouse Gases

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

Emission reductions can be attributed primarily to decreased Scope 1 (on-site fuel burning) emissions from more-efficient steam generation and decreased Scope 2 (purchased electricity) emissions from energy efficiency projects.

Purchased electricity is by far the biggest contributor to Y-12's GHG footprint. Energy-reduction efforts include major initiatives involving production facilities and utility infrastructure completed through ESPC projects.

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

The EISA of 2007, Section 438, requires federal agencies to reduce storm water runoff from development and redevelopment projects to protect water resources. Y-12 complies with these requirements using a variety of storm water management practices, often referred to as green infrastructure or low-impact development practices. During the last few years, several green infrastructure initiatives have been implemented to reduce the size and number of impervious surfaces through the use of sustainable vegetative practices and porous pavements. No project actions contributed to the overall prevention of storm water runoff during CY 2021.

4.3. Compliance Status

During 2021, Y-12 operations were conducted to comply with contractual and regulatory environmental requirements. Table 4.2 presents a summary of environmental audits conducted at Y-12 in 2021. The following discussions summarize the major environmental programs and activities carried out at Y-12 and provide an overview of the compliance status for the year.

4.3.1. Environmental Permits

Table 4.3 lists environmental permits in force at Y-12 during 2021. More-detailed information can be found in the following sections.

Table 4.2. Summary of external regulatory audits and reviews, 2021

Date	Reviewer	Subject	Issues
February 25	TDEC	Landfill CDL-VII, Area 6, Phase II Final Inspection	0
March 3	TDEC	Annual RCRA Hazardous Waste Compliance Inspection	0
March 8-9	TDEC	Comprehensive Environmental NPDES Compliance Inspections	0
March 11	TDEC	Quarterly ORR Landfill inspection	0
March 23	City of Oak Ridge	Industrial and Commercial User Wastewater Discharge Permit Inspection	0
May 20	TDEC	Quarterly ORR Landfill Inspection	0
July 13	TDEC	Annual Air Quality Compliance Inspection	0
July 21	City of Oak Ridge	Industrial and Commercial User Wastewater Discharge Permit Inspection	0
August 20	TDEC	Quarterly ORR Landfill Inspection	0
September 9	TDEC	Quarterly Inspection of ILF-IV and Semi-annual Inspection of Closed ILF-II	0
September 20-23	UTCIS	Triennial Environmental Management System External Audit	0
October 19	TDEC	Quarterly Inspection of ILF-V and CDL-VII	0
December 9	TDEC	Quarterly Inspection of ILF-IV and a second Semiannual inspection of Closed ILF-II	0

Acronyms:

RCRA = Resource Conservation and Recovery Act

TDEC = Tennessee Department of Environment and Conservation

UTCIS = University of Tennessee Center for Industrial Services

2021 Annual Site Environmental Report for the Oak Ridge Reservation

Table 4.3. Y-12 environmental permits, CY 2021

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	Title V Major Source Operating Permit	571832	11/22/21	11/30/22	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	10/31/11	11/30/16 ^a	DOE	DOE	CNS
CWA	UPF General Storm Water Permit Y-12 (41.7 ha/103 acres)	TNR 134022	10/27/11	09/30/26	DOE	CNS	CNS
CWA	UPF NPDES General Permit for Construction Storm Water	TNR135568	08/06/18	09/30/26	DOE	BNI	BNI
CWA	Central Training Facility Berm Reinvestment Project NPDES Construction General Permit	TNR 135924	10/01/19	09/30/26	DOE	DOE	CNS
CWA	Y-12 Outfall 014 Repair Aquatic Resource Alteration Permit	NR1903.116	06/21/19	04/5/25	DOE	DOE	CNS
CWA	Central Training Facility Berm Aquatic Resource Alteration Permit	NR1903.096	05/15/19	04/5/25	DOE	DOE	CNS
CWA	Bear Creek Road Power Installation	TNR 136037	02/19/20	09/30/26	DOE	DOE	CNS
CWA	No Discharge Portal 20 Pump and Haul Permit	SOP-17014	07/8/17	07/01/22	DOE	DOE	CNS
CWA	No Discharge Portal 23 Pump and Haul Permit	SOP-17015	07/08/17	07/01/22	DOE	DOE	CNS
CWA	No Discharge Environmental Management Waste Management Facility Pump and Haul Permit	SOP-01043	09/01/17	08/31/22	DOE	UCOR	UCOR
CWA	No Discharge Portal 19 Pump and Haul Permit	SOP-13031	06/26/18	06/30/23	DOE	DOE	CNS
CWA	No Discharge Environmental Management Waste Management Facility Pump and Haul Permit	SOP-01043	09/01/17	08/31/22	DOE	UCOR	UCOR

2021 Annual Site Environmental Report for the Oak Ridge Reservation

Table 4.3. Y-12 environmental permits, CY 2021 (continued)

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CWA	Simulated Nuclear and Radiological Activities Facility Aquatic Resource Alteration Permit	NR2003.249	01/14/21	Upon Notice of Termination	DOE	DOE	CNS
CWA	Y-12 Operations Center NPDES General Construction Permit	TNR136305	01/14/21	09/30/26	DOE	DOE	CNS
CWA	Y-12 Fire Station NPDES General Construction Permit	TNR136350	03/14/21	09/30/26	DOE	DOE	CNS
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
CWA	Security Infrastructure Revitalization Program NPDES General Construction Permit	TNR136604	11/30/21	Upon Notice of Termination	DOE	DOE	CNS
RCRA	Hazardous Waste Transporter Permit	TN3890090001	12/07/21	01/31/23	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	08/05/21	08/05/31	DOE	DOE/CNS	CNS/LATS co-operator
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-127	10/06/05	10/06/15 ^a	DOE	DOE/CNS	CNS co-operator
Solid Waste	Industrial Landfill IV (operating, Class II)	IDL-01-000-0075	Permitted in 1988—most recent modification approved 12/18/18	N/A	DOE	DOE/UCOR	UCOR

2021 Annual Site Environmental Report for the Oak Ridge Reservation

Table 4.3. Y-12 environmental permits, CY 2021 (continued)

Regulatory driver	Title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
Solid Waste	Industrial Landfill V (operating, Class II)	IDL-01-000-0083	Initial permit, most recent modification approved 12/18/18	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Construction and Demolition Landfill (overfilled, Class IV subject to CERCLA ROD)	DML-01-000-0012	Initial permit 01/15/86	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Construction and Demolition Landfill VI (postclosure care and maintenance)	DML-01-000-0036	Permit terminated by TDEC 03/15/07	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Construction and Demolition Landfill VII (operating, Class IV)	DML-01-000-0045	Initial permit, most recent modification approved 11/16/18	N/A	DOE	DOE/UCOR	UCOR
Solid Waste	Centralized Industrial Landfill II (postclosure care and maintenance)	IDL-01-000-0189	Most recent modification approved 05/08/92	N/A	DOE	DOE/UCOR	UCOR
SDWA	Underground Injection Control Class V Injection Well Permit	Permit by Rule, TDEC Rule 0400-45-06	03/12/02	None	DOE	DOE	CNS

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

Acronyms:

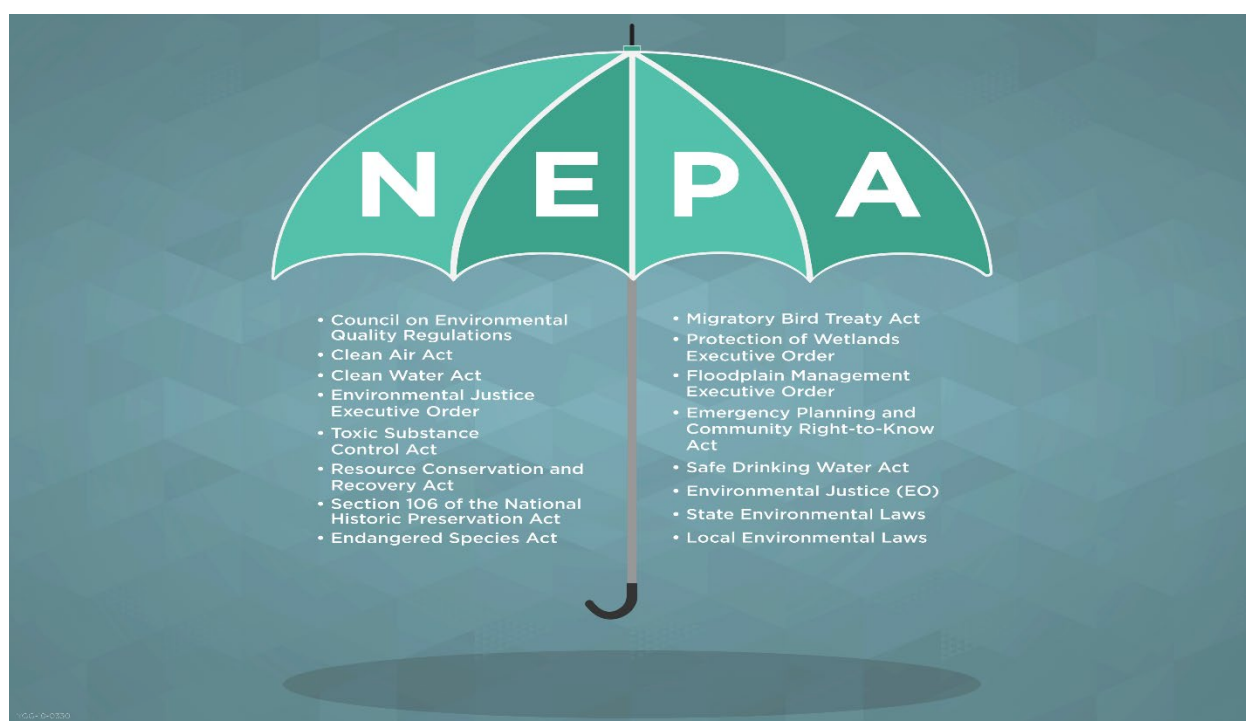
BNI = Bechtel National Inc.
 CAA = Clean Air Act
 CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
 CNS = Consolidated Nuclear Security, LLC
 CWA = Clean Water Act
 DOE = U.S Department of Energy
 LATS = LATA-Atkins Technical Services, LLC
 N/A = not applicable
 NNSA = National Nuclear Security Administration

NPDES = National Pollutant Discharge Elimination System
 ORR = Oak Ridge Reservation
 RCRA = Resource Conservation and Recovery Act
 ROD = Record of Decision
 SDWA = Safe Drinking Water Act
 TDEC = Tennessee Department of Environment and Conservation
 UCOR = URS | CH2M Oak Ridge LL
 UPF = Uranium Processing Facility
 Y-12 = Y-12 National Security Complex

4.3.2. National Environmental Policy Act

As federal agencies, DOE and NNSA comply with National Environmental Policy Act (NEPA) requirements (procedural provisions, 40 Code of Federal Regulations [CFR] 1500 through 1508), as outlined in DOE's NEPA Implementing Procedures (10 CFR 1021). NNSA's commitment to NEPA is performed by thoroughly evaluating the potential impacts of proposed federal actions that affect the quality of the environment at Y-12. NNSA ensures that reasonable alternatives for implementing

such actions have been considered in the decision-making process and that such decisions are documented in accordance with DOE and NNSA and the Council on Environmental Quality regulations. Such a prescribed evaluation process ensures that the proper level of environmental review (called a NEPA review), while considering other statutory requirements (NEPA is often referred to as the umbrella law; see Figure 4.9), is performed before an irreversible commitment of resources is made. NEPA documents for NNSA's Y-12 complex can be found [here](#).



Acronym:

NEPA = National Environmental Policy Act

Figure 4.9. National Environmental Policy Act—an umbrella law

In March 2011, the Final *Site-Wide Environmental Impact Statement for the Y-12 National Security Complex* (DOE 2011b) was issued. The Site-Wide Environmental Impact Statement (SWEIS) analyzed potential environmental impacts of ongoing and future operations (missions) and activities at Y-12, including alternatives to changes in site infrastructure (including the UPF) and levels of operation. The SWEIS and the Notice of Availability were published on March 4, 2011

(DOE-EIS-0387). NNSA issued a Record of Decision (ROD) in July 2011 (EIS-0387 ROD) (DOE 2011c). Since the ROD, NNSA has updated the strategy and design approach for the UPF. NNSA would use a hybrid approach of upgrading existing Y-12 facilities and building multiple UPF facilities, which was consistent with recommendations from a project peer review of the UPF, *Final Report of the Committee to Recommend Alternatives to the Uranium Processing*

Facility Plan in Meeting the Nation's Enriched Uranium Strategy (ORNL 2014). The updated UPF strategy was addressed in detail in a Supplement Analysis (SA) for the Final SWEIS (DOE 2016a; EIS-0387-SA-01), and NNSA amended the ROD (DOE 2016b, 81 Federal Register 45138) on July 22, 2017.

In July 2017, the Oak Ridge Environmental Peace Alliance, Nuclear Watch New Mexico, and Natural Resources Defense Council and four individual plaintiffs filed a federal lawsuit asserting that NNSA had violated NEPA by failing to prepare a supplemental SWEIS. Among other things, the plaintiffs argued that NNSA should prepare a supplemental SWEIS due to significant new information that became known after the publication of the 2011 SWEIS. More specifically, plaintiffs asserted that the seismic risk in East Tennessee had increased, as evidenced by seismic hazard maps published in 2014 by the US Geological Survey.

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

In September 2019, a Memorandum Opinion and Order was issued by the US District Court for the Eastern District of Tennessee as a result of the July 2017 federal lawsuit (USDC 2019). The Court ruled that NNSA is not required to prepare a new or supplemental SWEIS due to the decision to construct a smaller-scale UPF project and continue some EU operations in the Extended Life Program facilities. However, the Court also ruled that “new information revealed since the 2011 SWEIS requires further analysis,” and consistent with that ruling, the Court vacated the 2016 SA, the 2016 Amended ROD (AROD), and the 2018 SA. Further, the Court ordered that NNSA “shall conduct further NEPA analysis—including at a minimum, a supplemental analysis—that includes an unbounded accident analysis of earthquake

consequences at the Y-12 site, performed using updated seismic hazard analyses that incorporated the 2014 US Geological Survey map.” The Court also ruled that 69 categorical exclusion determinations were in violation of NEPA and ordered “the relevant exclusions should be prepared in a manner consistent with the letter of the relevant DOE regulations.” Consistent with the Court Order, NNSA has appropriately revised those categorical exclusion determinations for projects that were still ongoing at the time of the Court’s Order.

In October 2019, NNSA amended its July 2011 ROD for the Y-12 SWEIS to reflect its decision to continue to implement, on an interim basis, the hybrid approach previously approved in the vacated 2016 AROD. As the Court previously ruled in its Order, that hybrid approach, which combined elements of the two alternatives previously analyzed in the Y-12 SWEIS, was adequately analyzed within the range of alternatives considered in the Y-12 SWEIS. The 2019 AROD enables NNSA to conduct the required additional NEPA documentation, while continuing to implement safety improvements previously approved in the 2016 AROD, pending completion of the additional analysis ordered by the Court. Pursuant to the Court’s Order, NNSA published the *Draft Supplement Analysis for the Site Wide Environmental Impact Statement for the Y-12 National Security Complex, Earthquake Accident Analysis* (NNSA 2020) for public comment on April 9, 2020. The purpose of the SA was to determine whether the earthquake consequences constitute a substantial change that is relevant to environmental concerns, or if significant new circumstances or information relevant to environmental concerns and bearing on continued operations at Y-12 exist compared to the analysis in the 2011 SWEIS. The Draft SA was made available for public review and comment, and 142 comments were received. The Final SA was issued on July 15, 2020, and NNSA determined the potential impacts associated with an earthquake accident at Y-12 would not be significantly different than the impacts presented in the Y-12 SWEIS. Based on the results of this Final SA, NNSA determined (1) the earthquake consequences and

risks do not constitute a substantial change, (2) no significant new circumstances or information relevant to environmental concerns exist, and (3) no additional NEPA documentation is required at this time. On September 22, 2020, NNSA issued an AROD which reflected its decision to continue to implement its approach for meeting enriched uranium requirements, by upgrading existing enriched uranium processing buildings and constructing a new UPF. All other defense mission activities and non-defense mission activities conducted at Y-12 under the alternative selected for implementation in the 2011 ROD would continue to be implemented.

During FY 2021, NEPA reviews were conducted on 39 Y-12 proposed actions where a categorical exclusion was applied. The reviews included four revisions, two addendums, and nine standard categorical exclusion determinations were approved by the NNSA NEPA Compliance Officer (Table 4.4). Thirty such actions (internal NEPA reviews) that were reviewed against and determined to be consistent with Y/TS-2312, *National Environmental Policy Act General Categorical Exclusion*, Appendix B to Subpart D of Part 1021 (B&W Y-12 2012a). The majority of the proposed actions involved infrastructure upgrades, facilities and equipment modernization, enduring facilities sustainment, bridging strategies for facilities identified with an out-year replacement, and the deactivation and demolition of facilities deemed excess to Y-12's needs. As many facilities have, or are, approaching the end of design life, substantial investment is required to ensure they remain viable for the near future. NEPA reviews and evaluation were conducted for the following projects:

- Mission Security Upgrades Project to several Y-12 buildings
- Counter Unmanned Aircraft Systems Project
- Stack 11 Water Intrusion Project Building 9731 Renovations (historic building)

Table 4.4 lists the 2021 categorically excluded determination forms approved by NPO and posted on the public website.

- Building 9990-03 equipment clean-out (deactivation/decommissioning of Purification Facility's processes)
- Buildings 9212 and 9215, Potable Water and Fire Water Lateral Replacement Project
- Security Infrastructure Revitalization Program (SIRP) to supplement WEPAR
- Multiple major equipment and machinery upgrades/replacements
- Multiple supply fan and exhaust fan replacement projects
- Two fuel tank demolition projects and subsequent installation of two vehicle refueling stations
- Demolition of minor and ancillary buildings
- Expansion of the Direct Chip Melt Furnace Project
- Decoupling and re-route of utility systems for Buildings 9204-01 and 9201-02.

The NEPA review for the following projects continued for FY 2021:

- WEPAR project (including utility reroutes and disconnects, infrastructure upgrades to buildings that fall outside the new protected area, and support trailers)
- Offsite Housing for the Y-12 Development Organization at 103 Palladium Way (see below)
- LPF (see below)
- Excess Facility Disposition Program (deactivation and demolition of excess facilities and structures)

Table 4.4. National Nuclear Security Administration-approved categorical exclusions

Date issued	Title
09/14/2021	NEPA 4818, rev 2, Direct Chip Melt – Bottom Loading Furnace
09/14/2021	NEPA 4624, rev 2, Electrorefining Project (addendum)
07/28/2021	NEPA 4955, Federal Building – Fuel Tank Demolition and Disposition Project
06/24/2021	NEPA 4642, Calciner Project (addendum)
06/09/2021	NEPA 4834, West End Protected Area Reduction (WEPAR) Project
06/02/2021	NEPA 4953, Security Infrastructure Revitalization Program
06/02/2021	NEPA 4951, Demolition of Buildings 9727-04, 9727-04A, 9409-34, and Nitrogen Tower
02/23/2021	NEPA 4949, Manufacturing Sciences Corporation, Cold Hearth Furnace
02/01/2021	NEPA 4954, Y-12 National Security Complex's Public Warning Siren System

Acronyms:

NEPA = National Environmental Policy Act

NNSA = National Nuclear Security Administration

SSP = self-sufficiency parcel

Starting in July 2020, an Environmental Assessment (EA) was conducted for the replacement facility for manufacturing and production capability for lithium components. NNSA's proposed action was to construct and operate a new LPF that would provide administrative and manufacturing space for production of lithium components. The new facility would replace Building 9204-2 and ensure Y-12 maintains the required lithium production capabilities, reduces annual operating costs, and increases processing efficiencies—using safer, more-modern, more-agile, and more-responsive processes. Y-12 is the only source of secondaries, cases, lithium components, and other nuclear weapon components for the NNSA nuclear security mission. Lithium is an essential element for refurbishing and modernizing the nuclear weapons stockpile. The EA would analyze potential environmental impacts associated with constructing and operating the LPF to process and supply the lithium material and components that are needed to support the National Security Enterprise.

The proposed LPF location is within the current footprint of the Biology Complex (Figures 4.10 and 4.11) on the east end of Y-12. DOE Oak Ridge Office of Environmental Management (OREM) has committed to demolishing several of the Biology Complex buildings (completed), removing slabs and/or footings, and remediating any contaminated soil. DOE OREM will need to gain regulatory concurrence that no further action will be required to address soil contamination (within the defined construction footprint) for NNSA to proceed.

The LPF would be designed and constructed to meet the high-hazard classification for occupancy described in Section 307 of the International Building Code. The LPF is anticipated to be a nonnuclear, hazardous material facility. For a nonnuclear facility, the International Building Code establishes minimum requirements to safeguard public safety and safety to life and property from fire and other hazards, and provides building classification based on the purpose(s) for which they are used. The two primary functions of the LPF are (1) recovery and purification, and (2) processing.



Note: Demolition is currently in process.

Figure 4.10. Biology Complex on the east side of Y-12

The constructed facility (see artist rendering in Figure 4.12) would consist of a reinforced concrete and steel structure, approximately 135,000 ft² in size, and made up of eight independent wings. To an outside observer, the eight wings would be adjoining such that the LPF would appear as a single structure. The majority of the LPF would be 10- to 20-ft high, although portions of the facility with high bays would be approximately 5-ft high. Operations would be expected to begin in about 2030. The operational workforce at the LPF is estimated to be 70 persons.

The Draft EA was approved and published in December 2020 and received seven public comments. The Final EA included responses to public comments received, including those from TEMA. The NNSA Production Office (NPO) Field Office Manager approved the finding of no significant impact (FONSI) on March 19, 2021. The Biology Complex was demolished to ground

surface and the concrete slabs remediated and removed in early 2022.

In January 2020, CNS proposed to relocate the majority of the Y-12 Development Organization (Y-12 Development) and their research and development (R&D) work to an off-site facility at the Horizon Center Industrial Park. This bridging strategy would house NNSA's R&D work for the next 15 years. Y-12 Development is currently housed in Buildings 9202 and 9203, which are greater than 70 years old, heavily contaminated, and have failing structural, electrical, ventilation, cooling water, and climate controls. To execute their mission, Y-12 Development requires facilities that safely and efficiently house the necessary research equipment and instrumentation, provide modern laboratory facilities to attract and retain top scientists and engineers, and are adaptable to a changing mission.

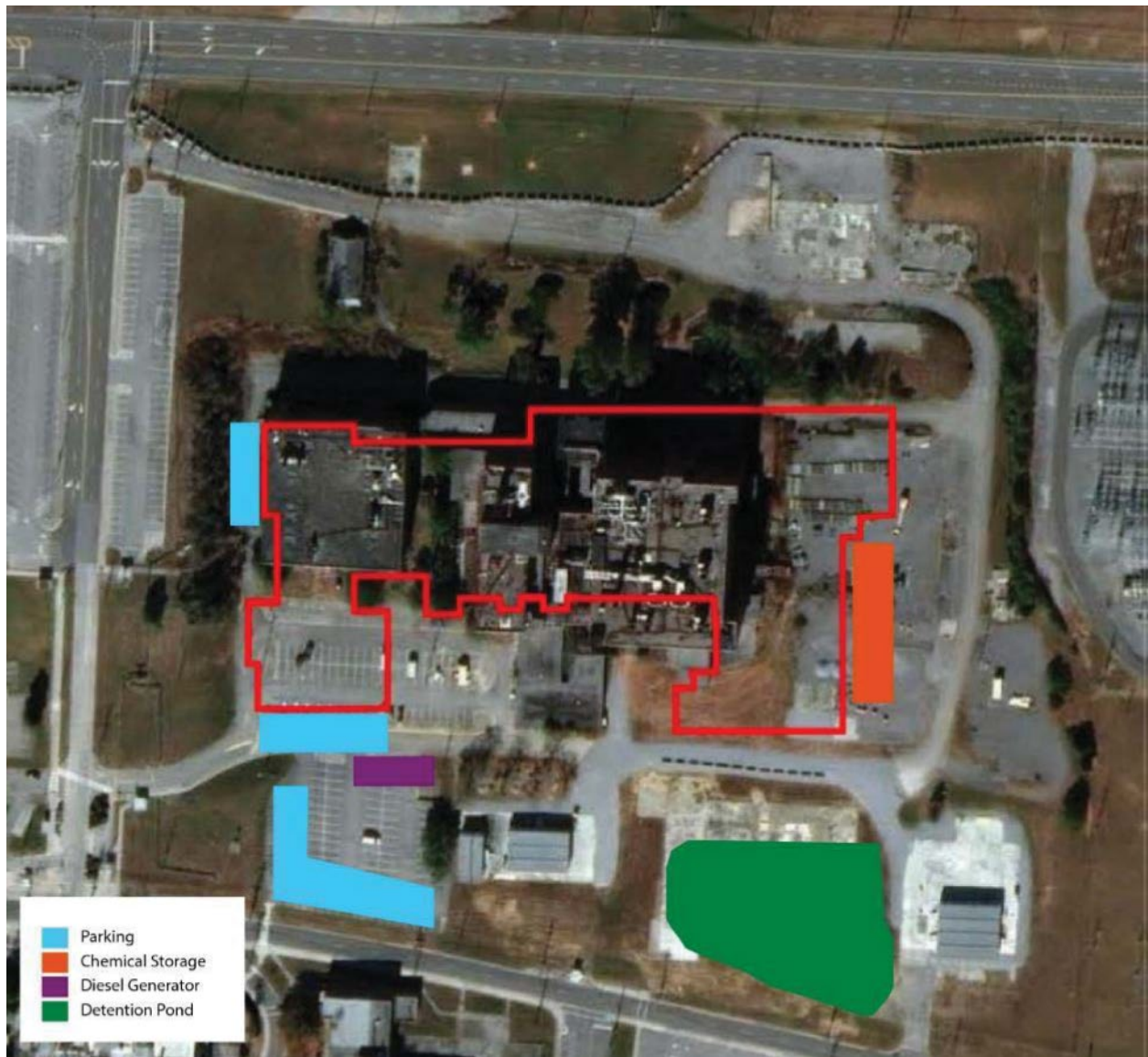


Figure 4.11. Lithium Processing Facility construction footprint



Figure 4.12. Artist rendering of the Lithium Processing Facility

In October 2020, NNSA determined an EA (10 CFR 1021.321) was required to evaluate the proposed action—to acquire the existing facility at 103 Palladium Way, Horizon Center Industrial Park (approximately 10 mi from Y-12, see Figures 4.13 and 4.14), and the surrounding 21 acres, and to transition and house the current and future mission of Y-12 Development for the next 15, or more, years. The facility is located on a secure and fenced campus with approximately 73,000 ft² of high-tech interior space. The facility would be modified for Y-12 Development’s needs, including installing multiple chemical hoods; modifying exhaust ductwork; installing or modifying utilities; constructing partitions between radiological and nonradiological areas; upgrading sensors and security; and upgrading, as necessary, cyber connectivity. The main facility would be a nonnuclear facility (i.e. less than Hazard Category 3 threshold quantities of radiological materials¹), but will contain low quantities of radiological material. The adjoining storage vault (to be

constructed) will be a Risk Category IV level storage² facility and contain the following materials: DU, low enriched uranium, small quantities of highly enriched uranium (<400 g), lithium, and other special materials in laboratory quantities.

There would be no change to the constructed footprint, exterior wall structure, or outside appearance of the building. Because only internal modifications of the existing facility would be required, no land disturbance would occur. Y-12 Development would relocate some 50 laboratories, including laboratory instrumentation, prototype and demonstration models, metallurgy machining equipment, foundry equipment, and various other laboratory equipment. Operations would be expected to begin in about 2025 and the facility would house Y-12 Development operations for at least 15 years. The operational workforce is estimated to be 70 to 100 persons.

¹ DOE-STD-1027-2018 Chg Notice 1, *Hazard Categorization of DOE Nuclear Facilities*

² DOE-STD-1020-2016, *Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities*



Acronyms:

ETTP = East Tennessee Technology Park ORNL = Oak Ridge National Laboratory

Y-12 = Y-12 National Security Complex

Figure 4.13. Horizon Center Industrial Park



Acronym: ORNL = Oak Ridge National Laboratory

Figure 4.14. 103 Palladium Way facility and surrounding 21 acres

A Draft EA was published in April 2021 (3 newspapers, NNSA Reading Room, and the Y-12 public webpage) and NPO allowed a 37-day public comment period. A total of six comments were received. In preparing the Final EA, NNSA reviewed and considered all public comments. A FONSI was prepared and NPO approved the Final EA and FONSI on July 21, 2021. Both the EA and FONSI were published in August and can be found [here](#). The purchase of the facility occurred in December 2021. The 103 Palladium Way facility is now named the John M. Googin Technology Development Facility.

4.3.3. National Historic Preservation Act

In accordance with the National Historic Preservation Act of 1966, the NNSA is committed to identifying, preserving, enhancing, and protecting its cultural resources. The prescribed evaluation process ensures that the proper level of environmental review is performed before an irreversible commitment of resources is made. Compliance activities in 2021 included completing Section 106 reviews of ongoing and new projects, working to develop an updated Cultural Resource Survey of the Y-12 site, and collecting and storing historic artifacts.

In CY 2021, 39 proposed projects were evaluated to determine whether any historic properties eligible for inclusion in the National Register of Historic Places would be adversely impacted. The Integrated Facilities Disposition Project proposed project to demolish Buildings 9201-05 and 9204-04 was determined to have adverse effects on historic properties eligible for listing in the National Register of Historic Places. In accordance with the *Programmatic Agreement Among the Department of Energy, Oak Ridge Operations Office, the National Nuclear Security Administration, the Tennessee State Historic Preservation Office, and the Advisory Council on Historic Preservation Concerning the Management of Historical and Cultural Properties at the Y-12 National Security Complex (PA)*, required Section 106 recordation, interpretation, and documentation information have been prepared and will be submitted to the State Historic Preservation Office (SHPO) for

concurrence to demolish these two major process facilities.

The *National Historic Preservation Act Historic Preservation Plan, Y/TS-1893 (HPP)* for the Y-12 National Security Complex stipulates that the HPP be reviewed every five years in order to maintain its effectiveness as a guiding document for the National Historic Preservation Act Program at Y-12. In its last review, it was determined that this document and the PA require updating to accurately reflect the changes at the Y-12 National Security Complex since the documents' completion in 2003. To this end, Y-12 is continuing the completion of an updated Cultural Resource Survey which will evaluate all extant DOE-owned Y-12 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. This Cultural Resource Survey is being developed in consultation with the SHPO, and will inform the strategies for the updated HPP and PA documents.

The Y-12 Oral History Program continues efforts to identify leads to conduct oral interviews and to document the knowledge and experience of those who worked at Y-12 during World War II and the Cold War era. The interviews also provide information on day-to-day operations of Y-12, use and operation of significant components and machinery, and how technological innovations occurred over time. Some of the information collected from past interviews is available in various media, including digital versatile discs shown in the Y-12 History Center.

Due to COVID-19 and applicable restrictions, there have been very little to no public activities at Y-12. All NHPA outreach activities to local and visiting schools, agencies, and organizations, including tours and presentations on the rich and significant history of Y-12 and Oak Ridge, have stopped due to the current restrictions. The Y-12 History Center remains accessible to employees and badged visitors, and will resume its availability to the public once COVID-19 restrictions are lifted. The Y-12 History Center, located in the New Hope

Center, features informational posters, a history library, and a video-viewing area.

4.3.4. Clean Air Compliance Status

Permits issued by the state of Tennessee are the primary vehicle used to impose clean air requirements that are applicable to Y-12. New projects are governed by construction permits and modifications to the Title V operating air permit, and eventually the requirements are incorporated into the sitewide Title V operating permit. Y-12 is currently governed by Title V Major Source Operating Permit 571832.

The permit requires recordkeeping and annual and semiannual reports. More than 2,000 data points are obtained and reported each year. All reporting requirements were met during CY 2021, and there were no permit violations or exceedances during the reporting period.

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

Section 4.4 provides detailed information on 2020 activities conducted at Y-12 in support of the Clean Air Act (CAA).

4.3.5. Clean Water Act Compliance Status

During 2021, Y-12 continued its excellent record for compliance with the National Pollutant Discharge Elimination System (NPDES) water discharge permit limits. Data obtained as part of the NPDES program are provided in a monthly report to TDEC. The percentage of compliance with permit discharge limits for 2021 was 100 percent. However, a Notice a Violation was issued for three fish kills caused by chlorinated water discharges, two oily sheens caused by construction activities and CERCLA remediation

activities, and a cloudy discharge also caused by CERCLA remediation activities.

Approximately 2,500 data points were obtained from sampling required by the NPDES permit. Y-12's NPDES permit in effect during 2021 (TN0002968) was issued on October 31, 2011, and became effective on December 1, 2011. A modification was effective in May 2014. It expired on November 30, 2016.

An application for a new permit was prepared and submitted to TDEC in May 2016. The currently expired NPDES permit continues in effect until the new permit is issued by the state of Tennessee.

4.3.6. Safe Drinking Water Act Compliance Status

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

Tennessee Regulations for Public Water Systems and Drinking Water Quality, Chapter 0400-45-01 (TDEC 2019), sets limits for biological contaminants, chemical activities, and chemical contaminants. Sampling for total coliform, chlorine residuals, lead, copper, and disinfectant byproducts is conducted by Y-12's ECD, with oversight by a state-certified operator.

Y-12's potable water distribution system was last reviewed by TDEC in 2021 and received a sanitary survey score of 100 out of a possible 100 points and, thus, retained its approved status as a public water system in good standing with TDEC. All total coliform samples collected during 2021 were analyzed by the state of Tennessee laboratory, and all results were negative. Analytical results for disinfectant byproducts (total trihalomethanes and haloacetic acids) for Y-12's water distribution system were within allowable TDEC and Safe Drinking Water Act limits for the yearly average. Y-12's potable water system is currently sampled

triennially for lead and copper. The system sampling was last completed in 2020. These results were below TDEC and Safe Drinking Water Act limits and met established requirements.

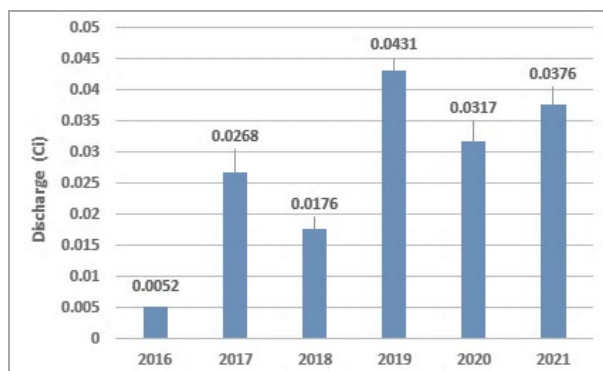
4.3.7. Resource Conservation and Recovery Act Compliance Status

The Resource Conservation and Recovery Act (RCRA) regulates hazardous wastes that, if mismanaged, could present risks to human health or the environment. The regulations are designed to ensure that hazardous wastes are managed from the point of generation to final disposal. In Tennessee, EPA delegates the RCRA program to TDEC, but EPA retains an oversight role. Y-12 is considered a large-quantity generator because it may generate more than 1,000 kg of hazardous waste in a month and because it has RCRA permits to store hazardous wastes for up to 1 year before shipping offsite to licensed treatment and disposal facilities. Y-12 also has a number of satellite accumulation areas and 90-day waste storage areas.

Mixed wastes are materials that are both hazardous (under RCRA guidelines) and radioactive. The Federal Facility Compliance Act requires that DOE work with local regulators to develop a Site Treatment Plan to manage mixed waste. Development of the plan has two purposes: to identify available treatment technologies and disposal facilities (federal or commercial) that can manage mixed waste produced at federal facilities, and to develop a schedule for treating and disposing of the waste streams.

The ORR Site Treatment Plan is updated annually and submitted to TDEC for review. The current plan (TDEC 2020) documents the mixed-waste inventory and describes efforts undertaken to seek new commercial treatment and disposal outlets for various waste streams. NNSA has developed a disposition schedule for the mixed waste in storage and will continue to maintain and update the plan, as a reporting mechanism, as progress is made. Y-12 has developed disposition milestones to address its remaining inventory of legacy mixed waste. Disposition milestones for the final inventory are FYs 2016 through 2026 (see Figure 4.15). In FY 2021, Y-12 staff dispositioned

57 percent of the legacy mixed waste inventory listed in the ORR Site Treatment Plan.



Note:

As part of the Oak Ridge Reservation Site Treatment Plan.

Figure 4.15. Path to eliminate Y-12's legacy mixed waste inventory by fiscal year

The quantity of hazardous and mixed wastes generated by Y-12 in 2021 was steady compared to the previous year (Figure 4.16). Y-12 is a state-permitted treatment, storage, and disposal facility. Under its permits, Y-12 received 2,799 kg of hazardous and mixed waste from offsite in 2021.

In addition, 448,720 kg of hazardous and mixed waste was shipped to DOE-owned and commercial treatment, storage, and disposal facilities. More than 10 million (10.056895 kg for updating the graph) kg of hazardous and mixed wastewater was treated at on-site wastewater treatment facilities.

4.3.7.1. Resource Conservation and Recovery Act Underground Storage Tanks

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

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

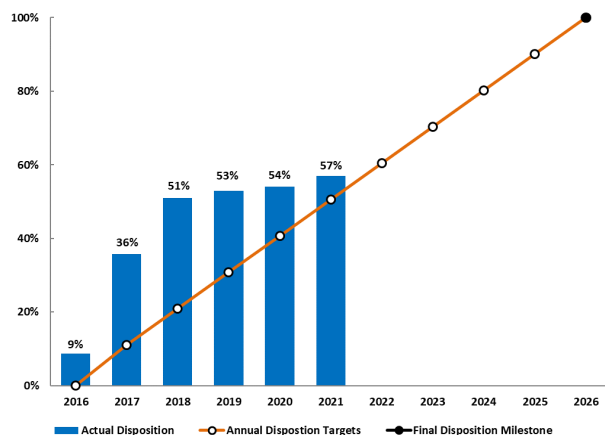


Figure 4.16. Hazardous waste generation, 2016–2021

4.3.7.2. Resource Conservation and Recovery Act Subtitle D Solid Waste

The ORR landfills operated by the DOE EM Program 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 m³ and has been the subject of a CERCLA remedial investigation and feasibility study. A CERCLA ROD for Spoil Area 1 was signed in 1997 (DOE 1997a). One Class II facility (Landfill II) has been closed and is subject to post-closure care and maintenance. Associated TDEC permit numbers are noted in Table 4.3. Additional information about the operation of these landfills is addressed in Section 4.8.2.

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

The intent of the ORR Federal Facility Agreement (DOE 2017) is to coordinate the corrective action processes of RCRA required under the Hazardous Waste Corrective Action document (formerly known as the Hazardous and Solid Waste Amendments permit) with CERCLA response actions.

During CY 2015, ORR Corrective Action TNHW-164 was renewed for the 10-year period from September 15, 2015, through September 15, 2025. As required in TNHW-164, the annual update of solid waste management units and areas of concern was submitted to TDEC in January 2022 as an update of the previous CY 2021 activities.

4.3.9. Toxic Substances Control Act Compliance Status

Storage, handling, and use of polychlorinated biphenyls (PCBs) are regulated under the Toxic Substances Control Act (TSCA). Capacitors manufactured before 1970 believed to be oil-filled are handled as though they contain PCBs, even when that cannot be verified from manufacturer records. Certain equipment containing PCBs and PCB waste containers must be inventoried and labeled. The inventory is updated by July 1 of each year and was last submitted on June 23, 2021.

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

The removal of legacy PCB waste, some of which had been stored since 1997, in accordance with the terms of the ORR PCB Federal Facility Compliance Agreement, was completed in 2011.

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

The Emergency Planning and Community Right-to-Know Act requires that facilities report inventories (i.e., Tier II Report sent to state and local emergency responders) and releases (i.e., toxic release inventory report submitted to state and federal environmental agencies) of certain

chemicals that exceed specified thresholds. Y-12 submitted reports for reporting year 2021 in accordance with requirements under Emergency Planning and Community Right-to-Know Act Sections 302, 303, 311, 312, and 313.

Y-12 had no unplanned release of a hazardous substance that required notification of the regulatory agencies (see Section 4.3.11 for more information). LSC Environmental Edge, a chemical reported by UCOR, exceeded the 10,000 pounds reporting threshold and was added to the 2021 inventory. Inventories, locations, and associated hazards of over-threshold hazardous and extremely hazardous chemicals were submitted to TEMA and local emergency responders in the annual Tier II Report required by Section 312. Data submittal was through the E-Plan web-based reporting system, as requested by TEMA. Some local emergency responders also accepted data through the E-Plan system, but others require that electronic copies of the Tier II Reports be submitted via email. Y-12 reported 43 chemicals that were over Section 312 inventory thresholds in 2021.

Y-12 operations are evaluated annually to determine the applicability for submittal of a toxic release inventory report to TEMA and EPA in accordance with Emergency Planning and Community Right-to-Know Act Section 313 requirements. The amounts of certain chemicals manufactured, processed, or otherwise used are calculated to identify those that exceed reporting thresholds. After threshold determinations are made, releases and off-site transfers are calculated for each chemical that exceeds a threshold. Submittal of the data to TEMA and EPA is made through the Toxics Release Inventory-Made Easy (abbreviated as TRI-ME) web-based reporting system operated by EPA. Total 2021 reportable toxic releases to air, water, and land and waste transferred off-site for treatment, disposal, and recycling were 279737 kg (616,715 lb). Table 4.5 lists the reported chemicals for Y-12 for-2020 and 2021 and summarizes releases and off-site waste transfers for those chemicals.

Table 4.5. Emergency Planning and Community Right-to-Know Act Section 313 toxic chemical release and off-site transfer summary for Y-12, 2020–2021

Chemical	Year	Quantity ^a (lb) ^b
Chromium	2020	6,897
	2021	7601
Cobalt	2020	964
	2021	NR
Copper	2020	4,035
	2021	331,722
Lead compounds	2020	26,699
	2021	169,300
Manganese	2020	6,631
	2021	57,735
Mercury	2020	1,055
	2021	NR
Methanol	2020	11,585
	2021	44,583
Nickel	2020	8,615
	2021	5,774

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

^b 1 lb = 0.4536kg.

4.3.11. Spill Prevention, Control, and Countermeasures

Clean Water Act, Section 311, regulates the discharge of oils or petroleum products to waters of the United States and requires spill prevention, control, and countermeasure (SPCC) plans be developed and implemented to minimize the potential for oil discharges. The major requirements for SPCC plans are contained in Title 40 CFR Part 112. These regulations require that SPCC plans be reviewed, evaluated, and amended at least once every 5 years, or earlier if significant changes occur. The SPCC rule includes requirements for oil spill prevention, preparedness, and response to prevent oil discharges to navigable waters and adjoining shorelines. The rule requires specific facilities to prepare, amend, and implement SPCC plans.

The *Spill Prevention, Control, and Countermeasure Plan for the U.S. Department of Energy Y-12 National Security Complex* (CNS 2020a) was revised in September 2020 to update general Y-12 changing site infrastructure. This plan presents the SPCC requirements to be implemented by Y-12 to prevent spills of oil and the countermeasures to be invoked should a spill occur. In general, the first response of an individual discovering a spill is to call the Y-12 Plant Shift Superintendent. Spill response materials and equipment are stored near tanks and drum storage areas and other strategic areas of Y-12 to facilitate spill response. All Y-12 personnel and subcontractors are required to have initial spill and emergency response training before they can work on the site.

4.3.12. Unplanned Releases

Y-12 has procedures for notifying off-site authorities of categorized events at Y-12. Off-site notifications are required for specified events according to federal statutes, DOE orders, and the Tennessee Oversight Agreement. As an example, certain observable oil sheens on East Fork Poplar Creek (EFPC) must be reported to the EPA National Response Center in addition to other reporting requirements. Spills of CERCLA reportable quantity limits must be reported to the EPA National Response Center, DOE, TEMA, and the Anderson County Local Emergency Planning Committee.

In addition, Y-12's Occurrence Reporting Program provides timely notification to the DOE community of Y-12 events and site conditions that could adversely affect public or worker health and safety, the environment, national security, DOE safeguards and security interests, DOE facilities' function, 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.

On March 1, 2021, an oil sheen was observed on East Fork Poplar Creek coming from Outfall 21. A high-reach excavator used in the Biology Complex demolition ruptured a hydraulic line spilling less than three gallons of hydraulic oil. Overspray from a water truck washed some of the oil to a nearby storm drain resulting in a sheen. Oil-absorbent pads and booms were used to capture the sheen on site. Notifications were made to TDEC, EPA, and NRC. During 2021, there were no reportable radiological air emission releases for Y-12.

4.3.13. Audits and Oversight

A number of federal, state, and local agencies oversee Y-12 activities. In 2021, Y-12 was inspected by federal, state, or local regulators on four occasions. Table 4.2 summarizes the results, and additional details follow.

As part of the City of Oak Ridge's pretreatment program, city personnel collect samples from the Y-12 monitoring station to conduct compliance monitoring, as required by the pretreatment regulations. City personnel also conduct compliance inspections twice yearly. No issues were identified in 2021.

Personnel from the TDEC Division of Solid Waste Management conducted a RCRA hazardous waste compliance inspection of Y-12 on March 3, 2021. The inspections covered waste storage areas and records reviews. No issues were identified.

Personnel from the TDEC Division of Water Resources performed Comprehensive Environmental Inspections to evaluate compliance with NPDES Permit TN0002968 on March 8 and 9, 2021. No issues were identified.

Personnel from the TDEC Division of Air Pollution Control conducted an air quality inspection July 13, 2021. The inspection covered 12 air emission sources, including some emergency generators, and inspections of the facilities. Title V air permit records were also reviewed. No issues were identified.

Per DOE Order 436.1, *Departmental Sustainability*, an external audit of the Environmental Management System (EMS) is required every three years by a qualified party in order to declare conformance to International Organization for Standardization (ISO) 14001. This audit was conducted September 20-23, 2021, by personnel from the University of Tennessee Center for Industrial Services (UTCIS). UTCIS auditors found Y-12 EMS to be in conformance with all ISO 14001 requirements (with no major or minor nonconformities); met the sustainability, energy and environmental management requirements of the EO and DOE orders; noted positive practices and opportunities for continual improvement; and stated the Y-12 EMS continues to advance and provide an excellent platform for ongoing improvement initiatives.

In July 2019, as the result of a self-identified issue, shipments to the Nevada National Security Site were suspended due to incomplete characterization of weapons material and weapons-related material. Consequently, investigations, a series of improvement activities, and layers of self-critical audits have been conducted. Additional actions to enhance the waste certification program and prepare for resumption of weapon material/weapon-related material (WM/WRM) shipments were completed in FY 2021. Real-time radiography (RTR) capability for unclassified radiological-contaminated combustibles was established and 250 drums were analyzed. This original RTR unit was replaced with RTR-4, which has the capability to analyze boxes in addition to drums. That unit is in place and should be operational in the third quarter of FY 2022. Process mapping sessions for the new WM/WRM disposition program were conducted and job analyses for roles involved in the WM/WRM disposition process were completed and issued. Procedures and manuals have been updated in support of the new WM/WRM disposition process and Y17-014, Characterization of Weapon Material and Weapon-Related Material, was created which proceduralized the characterization process for WM/WRM. Engineering components training was developed and implemented to address identified gaps, and need-to-know issues with Sandia National Laboratories have been resolved.

Progress will continue on additional waste profiles, analyzing drums and boxes through the RTR-4 unit, and resumption actions for WM/WRM shipments in FY 2022.

4.3.14. Radiological Release of Property

Clearance of property from Y-12 is conducted in accordance with approved procedures that comply with DOE Order 458.1, *Radiation Protection of the Public and the Environment* (DOE 2011e). Property consists of real property (i.e., land and structures) and personal property (property of any type except real property). At Y-12, three paths for releasing property to the public exist based on the potential for radiological contamination, and each will be discussed in detail in subsequent sections.

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

Table 4.6 summarizes some examples of the quantities of property released in 2021. During FY 2021, Y-12 recycled more than 4.02 million lb of materials offsite for reuse, including computers, electronic office equipment, used oil, scrap metal, tires, batteries, lamps, and pallets.

Sections 4.3.14.1, *Property Potentially Contaminated on the Surface*, and section 4.3.14.2, *Property Potentially Contaminated in Volume (Volumetric Contamination)*, utilize DOE Order 458.1 pre-approved authorized limits. These limits utilize screening levels originating from American National Standard Institute (ANSI)/Health Physics Society (HPS) N13.12-2013, *Surface and Volume Radioactive Standards for Clearance* (ANSI 2013). The basis of these standards is to limit the dose to any member of the public to a maximum of 1.0 mrem (0.01 mSv) per year Total Effective Dose (TED) from clearance of 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 2021.

Table 4.6. Summary of materials released, 2021

Category	Amount released
Real property (land and structures)	None
Computer equipment recycle:	82,423 lb
–Computers	
–Monitors	
–Printers	
–Mainframes	
Recycling examples:	
–Used oils	7,112 gal
–Used tires	17,280 lb
–Scrap metal	2,048,902 lb
–Lead acid batteries	31,924 lb
Public and negotiated sales: ^a	
–Brass	13,388 lb
–Miscellaneous furniture	1,460 lb
–Vehicles and Miscellaneous Equipment/Materials	355,720 lb
External transfers ^b	N/A

^a Sales during fiscal year 2021.

^b Vehicles, miscellaneous equipment, and materials transferred to various federal, state, and local agencies for reuse during fiscal year 2021. During fiscal year 2021, Y-12 transferred property with an acquisition value of approximately \$106,100; however, the amount of the transferred items in pounds was unable to be quantified.

4.3.14.1. Property Potentially Contaminated on the Surface

Property that is potentially contaminated on the surface is subject to a complete survey, unless it can be released based on process knowledge or via a survey plan that provides survey instructions, along with technical justification (process knowledge) for the survey plan based on the *Multi-Agency Radiation Survey and Site Investigation Manual* (NRC 2000) and the *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual* (NRC 2009). The surface contamination limits used at Y-12 to determine whether materials and equipment (M&E) are suitable for release to the public are provided in Table 4.7.

Y-12 uses an administrative limit for average and maximum activity of 240 dpm/100 cm² for radionuclides in Group 3 and 2,400 dpm/100 cm² for radionuclides in Group 4 (see Table 4.7). Y-12 also uses an administrative limit for removable activity of 240 dpm/100 cm² for radionuclides in Group 3 (see Table 4.7). The use of the more-restrictive administrative limits ensures that M&E do not enter into commerce exceeding the definition of contamination for high-toxicity alpha emitters and for beta and gamma emitters, respectively, found in 49 CFR 173, *Shippers—General Requirements for Shipments and Packaging*.

4.3.14.2. Property Potentially Contaminated in Volume (Volumetric Contamination)

Materials, such as activated materials, smelted-contaminated metals, liquids, and powders, are subject to volumetric contamination (e.g., radioactivity per unit volume or per unit mass) and are treated separately from surface-contaminated objects. Materials that may be subject to volumetric contamination are evaluated for release by one of the following three methods:

- **Unopened, sealed containers:** Material is still in an original commercial manufacturer's sealed, unopened container. A seal can be a visible manufacturer's seal (i.e., lock tabs, heat shrink) or a manufacturer's seal that cannot be seen (e.g., unbroken fluorescent bulbs, sealed capacitors), as long as the container remains unopened once received from the manufacturer.
- **Process knowledge:** If contamination being able to enter a system is unlikely, then process knowledge is documented and used as the basis for release. Often, this is accompanied by confirmatory surveys.
- **Analytical:** The material is sampled, and analytical results are evaluated against the DOE Order 458.1, *Pre-Approved Authorized Limits*. If Pre-Approved Authorized Limits have not been approved, then analytical results are evaluated against measurement method critical levels or background levels from materials that have not been impacted by Y-12 activities. If results meet defined criteria, then they are documented and the material is released.

Table 4.7. DOE Order 458.1 preapproved authorized limits for surface contamination^{a,b}

Radionuclide ^c	Average ^{d,e}	Maximum ^{d,e}	Removable ^f
Group 1—Transuranics, ¹²⁵ I, ¹²⁹ I, ²²⁷ Ac, ²²⁶ Ra, ²²⁸ Ra, ²²⁸ Th, ²³⁰ Th, ²³¹ Pa	100	300	20
Group 2—Th-natural, ⁹⁰ Sr, ¹²⁶ I, ¹³¹ I, ¹³³ I, ²²³ Ra, ²²⁴ Ra, ²³² U, ²³² Th	1,000	3,000	200
Group 3—U-Natural, ²³⁵ U, ²³⁸ U, associated decay products, alpha emitters	5,000	15,000	1,000
Group 4—Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission), except ⁹⁰ Sr and others noted above ^g	5,000	15,000	1,000
Tritium (applicable to surface and subsurface) ^h	N/A	N/A	10,000

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

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

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

^d Measurements of average contamination should not be averaged over an area of more than 1 m². Where scanning surveys are not sufficient to detect levels in the table, static counting must be used to measure surface activity. Representative sampling (static counts on the areas) may be used to demonstrate by analyses of the static counting data. The maximum contamination level applies to an area of not more than 100 cm².

^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 cm² 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 cm² 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 ⁹⁰Sr that is present in them. It does not apply to ⁹⁰Sr that has been separated from other fission products or mixtures where ⁹⁰Sr has been enriched.

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

Acronyms:

DOE = US Department of Energy

N/A = not applicable

4.3.14.3. Property Potentially Contaminated in Volume (Volumetric Contamination)

Materials, such as activated materials, smelted-contaminated metals, liquids, and powders, are subject to volumetric contamination (e.g., radioactivity per unit volume or per unit mass) and are treated separately from surface-

contaminated objects. Materials that may be subject to volumetric contamination are evaluated for release by one of the following three methods:

- **Unopened, sealed containers:** Material is still in an original commercial manufacturer's sealed, unopened container. A seal can be a visible manufacturer's seal (i.e., lock tabs, heat shrink) or a manufacturer's seal that cannot

be seen (e.g., unbroken fluorescent bulbs, sealed capacitors), as long as the container remains unopened once received from the manufacturer.

- **Process knowledge:** If contamination being able to enter a system is unlikely, then process knowledge is documented and used as the basis for release. Often, this is accompanied by confirmatory surveys.
- **Analytical:** The material is sampled, and analytical results are evaluated against the DOE Order 458.1, *Pre-Approved Authorized Limits*. If Pre-Approved Authorized Limits have not been approved, then analytical results are evaluated against measurement method critical levels or background levels from materials that have not been impacted by Y-12 activities. If results meet defined criteria, then they are documented and the material is released.

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

4.3.14.4. 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 (Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual 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 (Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual Class I). The

process knowledge evaluation processes are described in Y-12 procedures.

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

- All M&E from rad-free zones
- Pallets generated from non-contaminated areas
- Pallets that are returned to shipping during the same delivery trip
- Lamps from non-contaminated areas
- Drinking water filters
- M&E approved for release by radiological engineering technical review
- Portable restrooms used in non-contaminated areas
- Documents, mail, diskettes, compact disks, and other office media
- Personal M&E
- Paper, plastic products, water bottles, aluminum beverage cans, and toner cartridges
- Office trash, house-keeping materials, and associated waste
- Breakroom, cafeteria, and medical wastes
- Medical and bioassay samples generated in non-contaminated areas
- Subcontractor, vendor, and privately owned vehicles, tools, and equipment used in non-contaminated areas
- M&E that are administratively released
- M&E that were delivered to stores in error and that have not been distributed to other Y-12 locations
- New computer equipment distributed from the Central Computing Facility
- Subcontractor, vendor, and privately owned vehicles, tools, and equipment that have not been used in contaminated areas or for excavation activities
- New cardboard
- Consumer glass containers

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

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

^c Because of potential ground-water concerns, the volume radioactivity values for 129I when disposal to landfills or direct disposal to soil is anticipated is assigned to Group 0.

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

^e The natural uranium screening levels for clearance shall be lowered from Group 2 to Group 1 if decay-chain progeny are present (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% from 238U, plus 48.9% from 234U, plus 2.2% from 235U). This approach is consistent with summing radionuclide fractions discussed in ANSI/HPS N13.12-2013, Section 4.4.

^f Each individual limit applies to the particular radionuclides, but must be summarized and the Sum of Fractions must be <1.

Acronym:

DOE = US Department of Energy

4.4. Air Quality Program

Sections of Y-12's Title V Permit 571832 contain requirements that are generally applicable to most industrial sites. Examples include requirements associated with control of asbestos, stratospheric ozone-depleting chemicals, and fugitive emissions, and general administration of the permit. The Title V permit also contains specific requirements directly applicable to individual sources of air emissions at Y-12. Major requirements in that section include the Radiological National Emission Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR 61) and numerous ones associated with emissions of criteria pollutants and other, nonradiological hazardous air pollutants. In addition, a number of sources that are exempt from permitting requirements under state rules but subject to listing on the Title V Permit application are documented, and information about them is available upon request from the Y-12 Clean Air Program.

4.4.1. Construction and Operating Permits

The following Title V permitting actions were submitted and approved in 2021:

- Minor permit modification to add the revised National Emission Standards for Hazardous Air Pollutants for Airborne Radionuclides Compliance Plan to the Title V operating air permit.
- Minor permit modification to add a new machine to Building 9202 Beryllium Laboratory Operation of the Title V operating air permit.
- Minor permit modification request to remove the Air Bearing Operations, Emission Source Y-9212-M(1083), and the Purification Operations, Emission Source Y-9225-3-A(1144), from the Title V operating air permit.
- Operational flexibility request to add a new machine (lathe) to the M-Wing Machining Operations in Building 9215.
- Insignificant activity exemptions were completed for Lithium Hydride Operation, Processing Laboratory Operations, Electropolishing Solution Operation, Depleted Uranyl Nitrate Hexahydrate Operation, and a small Lithium Wet Chemistry Process located in Building 9202.
- Insignificant activity exemption was completed for the Laboratory 42 Power Mixing Operation and Ink/Etchant Production Process located in Building 9203.
- Minor permit modification revisions to Uranium Processing Facility new stationary emergency/standby use internal combustion engines/generators.
- Operational flexibility request to add a new front-load furnace to M-Wing Machining Operations, Emission Source Y-9215-A(3).
- Minor permit modification request and insignificant activity request determination to add new stationary emergency use internal combustion engines/generators for the new emergency operating center and fire station to the Title V operating air permit.
- Insignificant activity exemption was completed for the welding operation located in Building 9212 Head House Basement.

Demonstrating compliance with air permits conditions is a significant effort at Y-12. Key elements of maintaining compliance are maintenance and operation of control devices, monitoring, record keeping, and reporting. High-efficiency particulate air filters and scrubbers are control devices used at Y-12. High-efficiency particulate air filters are found throughout the complex, and in-place testing of high-efficiency particulate air filters to verify the integrity of the filters is routinely performed. Scrubbers are operated and maintained in accordance with source-specific procedures. Monitoring tasks consist of continuous stack sampling, one-time stack sampling, and operation of control devices. Examples of continuous stack sampling are the radiological stack monitoring systems on numerous sources throughout Y-12.

The Y-12 sitewide permit requires annual and semiannual reports. One report is the overall Annual ORR Radiological NESHAPs Report, which includes specific information regarding Y-12 radiological emissions; another is an Annual Title V Compliance Certification Report, which indicates compliance status with all conditions of the permit. A third is a Title V Semiannual Report, which covers a 6-month period for some specific

emission sources and consists of monitoring and record-keeping requirements for the sources. Another annual report is the Boiler Maximum Available Control Technology Report for the Y-12 Steam Plant, which requires the boilers to be tuned-up on an annual basis. Table 4.9 details the actual emissions versus allowable emissions for the Y-12 Steam Plant.

Table 4.9. Actual versus allowable air emissions from the Y-12 Steam Plant, 2021

Emissions (tons/yr)^a			
Pollutant	Actual	Allowable	Percentage of allowable
Particulate	2.81	41.0	6.9
Sulfur dioxide	0.22	39.0	0.6
Nitrogen oxides ^b	11.84	81.0	14.6
VOCs ^b	2.03	9.4	21.6
Carbon monoxide ^b	31.08	139.0	22.36 +

Note:

The emissions are based on fuel usage data for January through December 2021. The VOC emissions include VOC hazard air pollutant emissions.

^a 1 ton = 907.2 kg.

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

Acronyms:

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

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 2021. There

were four notifications and two revisions to the notifications of asbestos demolitions and renovations. Asbestos, ozone-depleting substances, and fugitive particulate emissions are notable examples.

Stratospheric Ozone Protection and Hydrofluorocarbon Phasedown

As required by the CAA Title VI Amendments of 1990, and in accordance with 40 CFR Part 82, actions have been implemented to comply with the prohibition against intentionally releasing ozone-depleting substances during maintenance activities performed on refrigeration equipment. During 2017, EPA enacted major revisions to the stratospheric ozone rules to include 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 2021 triggering this reporting. On October 1, 2021, EPA began the implementation of the HFC phasedown requirements of the American Innovation and Manufacturing (AIM) Act of 2020 which seeks to reduce HFC consumption and production to 15 percent of a 2011–2013 baseline by 2036 (*Final Rule—Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program under the AIM Act* (EPA 2022) [here](#)). Sitewide use of HFCs is being evaluated to understand future effects of AIM Act phasedowns.

Fugitive Particulate Emissions

As modernization reduction efforts increase at Y-12, the need also increases for good work practices and controls to minimize fugitive dust emissions from construction and demolition activities. Y-12 personnel continue to use a mature project-planning process to review, recommend, and implement appropriate work practices and controls to minimize fugitive dust emissions. Precautions used to prevent particulate matter from becoming airborne include the following:

- Using, where possible, water or chemicals to control dust when demolishing existing buildings or structures, performing construction operations, grading roads, or clearing land.
- Applying asphalt, water, or suitable chemicals on dirt roads, material stockpiles, and other surfaces that can create airborne dusts.
- Installing and using hoods, fans, and fabric filters to enclose and vent dusty materials.

4.4.1.2. National Emission Standards for Hazardous Air Pollutants for Radionuclides

The release of radiological contaminants, primarily uranium, into the atmosphere at Y-12 occurs almost exclusively as a result of plant production, maintenance, and waste management activities. The major radionuclide emissions contributing to the dose from Y-12 are ^{234}U , ^{235}U ,

^{236}U , and ^{238}U , which are emitted as particulates (Figure 4.17). The particle size and solubility class of the emissions are determined based on review of the operations and processes served by the exhaust systems to determine the quantity of uranium handled in the operation or process, the physical form of the uranium, and the nature of the operation or process. The four categories of processes or operations that are considered when calculating the total uranium emissions are:

- Those that exhaust through monitored stacks.
- Unmonitored processes for which calculations are performed per Appendix D of 40 CFR 61.
- Processes or operations exhausting through laboratory hoods, also involving 40 CFR 61 Appendix D calculations.
- Emissions from room ventilation exhausts (calculated using radiological control monitoring data from the work area).

Continuous sampling systems are used to monitor emissions from a number of process exhaust stacks at Y-12. In addition, a probe-cleaning program is in place, and the results from the probe cleaning at each source are incorporated into the respective emission point source terms. In 2021, 24 process exhaust stacks were continuously monitored, 23 of which were major sources; the remaining 1 stack was a minor source and its contribution to Y-12's air emissions was conservatively accounted for using Appendix D calculations, as noted below. The sampling systems on the stacks have been approved by EPA Region 4.

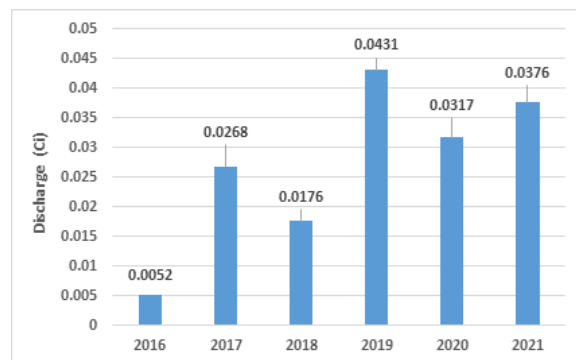


Figure 4.17. Total curies of uranium discharged from Y-12 to the atmosphere, 2015–2021

During 2021, unmonitored uranium emissions at Y-12 occurred from 40 points associated with on-site unmonitored processes and laboratories operated by CNS. Emission estimates for the processes and laboratory stacks were made using inventory data with emission factors provided in 40 CFR Part 61, Appendix D. The Y-12 source term includes an estimate of these emissions.

Y-12's Analytical Chemistry Organization operates out of two main laboratories. One is located onsite in Building 9995; the other is located in a leased facility on Union Valley Road, about 0.3 mi east of Y-12, and is not within the ORR boundary. In 2021, there were no radionuclide emission points (or sources) in the off-site laboratory facility.

Additionally, estimates from room ventilation systems are considered using radiological control data on airborne radioactivity concentrations in the work areas. Where applicable, exhausts from any area where the monthly concentration average exceeds 10 percent of the derived air concentration, as defined in the ORR Radionuclide Compliance Plan (DOE 2020d), are included in the annual source term. Annual average concentrations and design ventilation rates are used to arrive at the annual emission estimate for those areas. Six emission points from room ventilation exhausts were identified in 2021, where emissions exceeded 10 percent of the derived air concentration. Five of these emission points fed to monitored stacks, and any radionuclide emissions were accounted for as noted for monitored emission points. The remaining exhaust emission point were the result of cleanup activities only (no mechanical or chemical processes) and are considered fugitive emissions. Therefore, it is not included in the total overall source term for Y-12.

Y-12 Title V (Major Source) Operating Permits contain a sitewide, streamlined alternate emission limit for EU and DU process emission units. A limit of 907 kg/yr of particulate was set for the sources for the purposes of paying fees. The compliance method requires the annual actual mass emission particulate emissions to be generated using the same monitoring methods required for Radiological NESHAPs compliance. An estimated

0.0376 Ci (34.0 kg) of uranium was released into the atmosphere in 2021 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 2021 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. See Chapter 7 for an explanation of how the airborne radionuclide dose was determined.

Lastly, the UPF is presently being designed and constructed. This facility is intended to house some of the processes that are currently in existing production buildings. The UPF project was issued a Construction Air Permit (967550P) in March 2014. With concurrence from TDEC Air Division, the UPF was included in the 2018 update of Y-12's Title V Operating Permit 571832. The UPF Construction Air Permit was incorporated into the Y-12 Title V air permit on February 18, 2019. The Title V air permit expires on November 30, 2022. The UPF project will be maintained on inactive status until operational readiness and startup.

4.4.1.3. Quality Assurance

Quality assurance (QA) activities for the Radiological NESHAPs Program are documented in the *Y-12 National Security Complex Quality Assurance Project Plan National Emission Standards for Hazardous Air Pollutants Radionuclide Emission Measurements* (CNS 2020b). The plan satisfies the QA requirements in 40 CFR Part 61, Method 114, for ensuring that radionuclide air emission measurements from Y-12 are representative to known levels of precision and accuracy and that administrative controls are in place to ensure prompt response when emission measurements indicate an increase over normal radionuclide emissions. The requirements are also referenced in TDEC Regulation 1200-3-11-08 (TDEC 2015). The plan ensures the quality of Y-12 radionuclide emission measurements data from the continuous samplers and minor radionuclide release points. It specifies

the procedures for managing activities affecting data quality. QA objectives for completeness, sensitivity, accuracy, and precision are discussed. Major programmatic elements addressed in the QA plan are the sampling and monitoring program, emissions characterization, analytical program, and minor source emission estimates.

4.4.1.4. Source-Specific Criteria Pollutants

Proper maintenance and operation of a number of control devices (e.g., high-efficiency particulate air filters and scrubbers) are key to controlling emissions of criteria pollutants. The primary source of criteria pollutants at Y-12 is the steam plant, where only natural gas and Number 2 fuel oil are permitted to be burned. Information regarding actual versus allowable emissions from the steam plant is provided in Table 4.9.

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

Use of solvent 140/142 and methanol throughout Y-12 and use of acetonitrile at a single source are primary sources of volatile organic compound (VOC) emissions. Material mass balances and engineering calculations are used to determine annual emissions. The calculated amounts of solvent 140/142 and methanol emitted for CY 2021 are 2,654.85 lb (1.33 tons) and 15,240 lb (7.62 tons), respectively.

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

Title 40 of CFR Part 98, *Mandatory Reporting of Greenhouse Gases* (EPA 2010), establishes mandatory GHG reporting requirements for owners and operators of certain facilities that directly emit GHGs and for certain fossil fuel suppliers and industrial GHG suppliers. The purpose of the rule is to collect accurate and

timely data on GHG emissions that can be used to inform future policy decisions.

The mandatory reporting of GHGs rule requires reporting of annual emissions of carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons, perfluorochemicals, and other fluorinated gases (e.g., nitrogen trifluoride and hydrofluorinated ethers). These gases are often expressed in metric tons of carbon dioxide equivalent (CO₂e).

Y-12 is subject only to the Subpart A general provisions and reporting from stationary fuel combustion sources covered in 40 CFR 98, Subpart C, General Stationary Fuel Combustion (EPA 2010). Currently, the rule does not require control of GHGs; rather, it requires only that sources emitting above the 25,000-CO₂e threshold level monitor and report emissions.

The Y-12 Steam Plant is subject to this rule. The steam plant consists of four boilers. The maximum heat input capacity of each boiler shall not exceed 99 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 ft³/h, are used to preheat tooling associated with a forging and forming press. In Building 9204-2, natural gas is used to heat two electrolytic cells. The maximum rated heat input to the burners on each cell is 550,000 Btu/h.

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

The emissions report is submitted electronically in a format specified by the EPA Administrator. Each report is signed by a designated representative of the owner or operator, certifying under penalty of law that the report has been prepared in accordance with the requirements of the rule. The total amount of GHGs, subject to the mandatory reporting rule, emitted from Y-12 is shown in Table 4.10. The decrease in emissions from 2010 to 2017 is associated with the fact that coal is no longer burned since the natural gas-fired steam plant came online. The slight increase in CO_{2e} emissions was because fuel oil was burned for a few days in December 2018.

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

Year	GHG emissions (metric tons CO _{2e})
2010	97,610
2011	70,187
2012	63,177
2013	61,650
2014	58,509
2015	51,706
2016	50,671
2017	50,292
2018	51,010
2019	45,971
2020	46,126
2021	43,812.7

Acronyms:

CO_{2e} = CO₂ equivalent

GHG = greenhouse gas

Y-12 = Y-12 National Security Complex

4.4.1.6. Hazardous Air Pollutants (Nonradiological)

Beryllium emissions from machine shops are regulated under a state-issued permit and are subject to a limit of 10 g/24 h. Compliance is demonstrated through a one-time stack test and through monitoring of control device operations. Hydrogen fluoride is used at one emission source, and emissions are controlled through the use of scrubber systems. The beryllium control devices

and the scrubber systems were monitored during 2021 and were found to be operating properly.

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

Mercury is a significant legacy contaminant at Y-12, and cleanup is being addressed by OREM. Like methanol emissions, mercury air emissions from legacy sources are fugitive in nature and, therefore, are not subject to specific air emission limits or controls. On-site monitoring of mercury is conducted and is discussed 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 came online 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 (see 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 one-time energy assessment of the boilers to meet these requirements.

No numeric emission-limit requirements exist for the steam plant. The new rule requires that a one-time energy assessment for the steam plant must be completed on or after January 1, 2008. The new rule requires that tune-ups for the boilers must be completed 13 months from the previous tune-ups. To comply with that requirement, an energy assessment for the Y-12 Steam Plant, performed

by a qualified energy assessor, was completed in July 2013. The tune-ups for boilers were completed on February 1 and 2, 2021.

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* (EPA 1990). Therefore, Y-12 is not subject to that rule. Procedures are in place to continually review new processes and/or process changes against the rule thresholds.

EPA has created multiple national air pollution regulations to reduce air emissions from reciprocating internal combustion engines. Two types of federal air standards are applicable to reciprocating internal combustion engines—new source performance standards (Title 40 CFR Part 60, Subpart IIII), and NESHAPs (EPA 2013; Title 40 CFR Part 63, Subpart DDDDD). The compression ignition engines and generators located at Y-12 are subject to these rules. EPA is concerned how reciprocating internal combustion engines are used and the emissions generated from these engines in the form of both hazardous air pollutants and criteria pollutants.

All previous stationary, emergency engines and generators were listed in Y-12's Title V air permit application as insignificant activities. However, on January 16, 2013, EPA finalized revisions to standards to reduce air pollution from stationary engines that generate electricity and power equipment at sites of major sources of hazardous air pollutants. Regardless of engine size, the rules apply to any existing, new, or reconstructed stationary reciprocating internal combustion engine located at a major source of hazardous air pollutant emissions.

To comply with the rules, Y-12 prepared a significant permit modification to its Title V (Major Source) Operating Air Permit to add numerous stationary, emergency-use engines and generators located throughout Y-12. The permit application was submitted to TDEC on May 6,

2013, for review and approval. TDEC downgraded the significant modification to a minor modification per EPA's review and request. In a prior, updated permit application for renewal of Y-12's Title V (Major Source) Operating Air Permit dated March 9, 2011, Y-12 staff identified Title 40 CFR, Part 60, Subpart IIII, and Standards of Performance for Stationary Compression Ignition Internal Combustion Engines, as requirements applicable to the stationary, emergency-use engines located at Y-12. TDEC issued Y-12 a minor permit modification to the Title V air permit on March 3, 2014, for the emergency engines and generators. Compliance for the engines and generators is determined through monthly records of the operation of the engines and generators that are recorded through a nonresettable hour meter on each engine and generator. Documentation of how many hours are spent for emergency operation, maintenance checks and readiness testing, and nonemergency operation must be maintained. Each engine and generator must use only diesel fuel with low sulfur content (15 parts per million) and an acetane index of 40.

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

The emergency engines and generators are used to provide power for critical systems in the event

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

4.4.2. Ambient Air

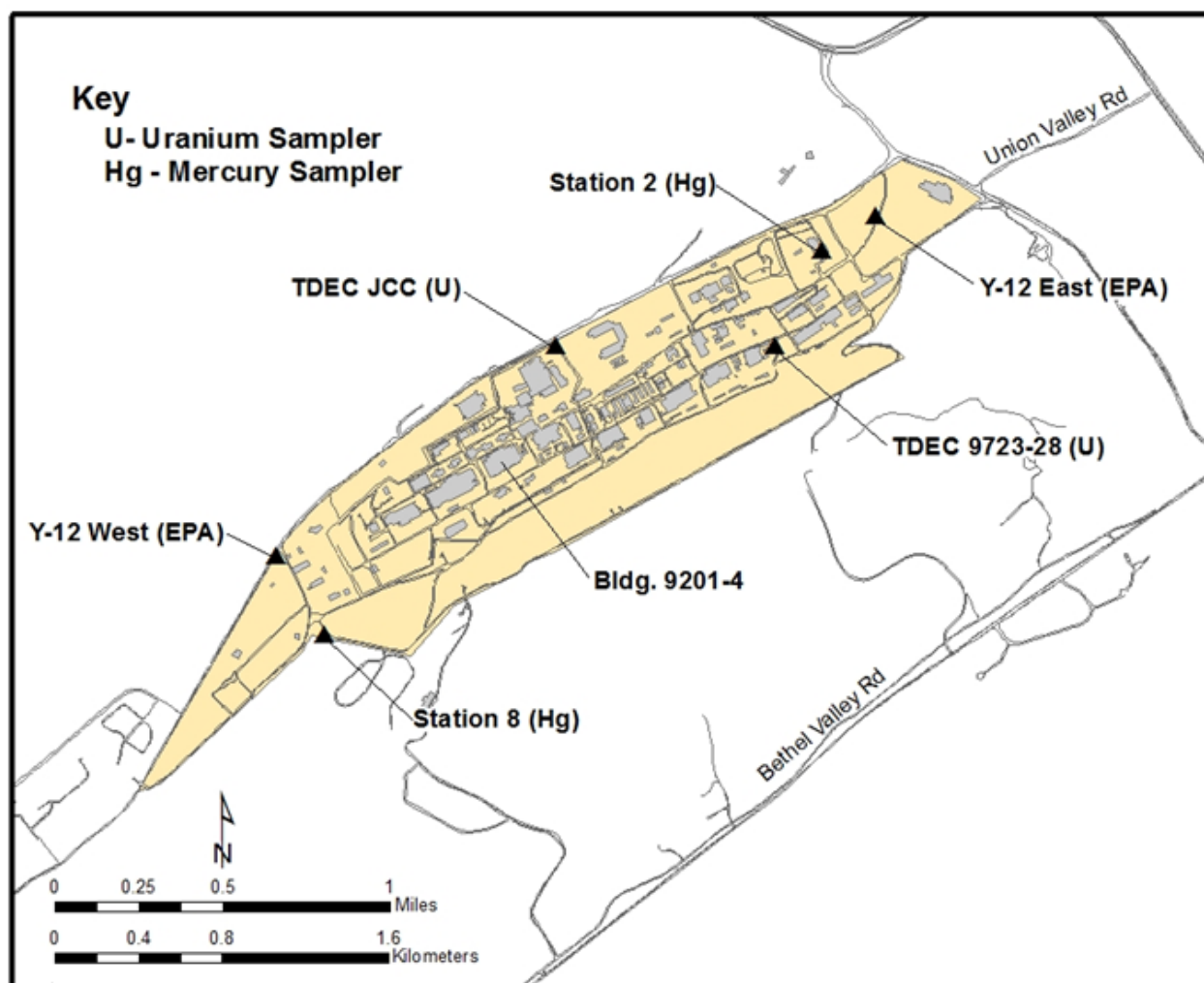
To understand the complete picture of ambient air monitoring in and around the Y-12 Complex, data from on- and off-site monitoring conducted specifically for the Y-12 Complex, DOE reservation wide monitoring, and on- and off-site monitoring conducted by EPA and TDEC personnel must be considered.

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

4.4.2.1. Mercury

The Y-12 Complex ambient air monitoring program for mercury was established in 1986 as a best management practice. The objectives of the program have been to maintain a database of mercury concentrations in ambient air, to track long-term spatial and temporal trends in ambient mercury vapor, and to demonstrate protection of the environment and human health from releases of mercury to the atmosphere at the Y-12 Complex. Originally four monitoring stations were operated at the Y-12 Complex, including two within WEMA (i.e., the former west end mercury-use area at Y-12). The two atmospheric mercury monitoring stations currently operating at the Y-12 Complex, AAS2 and AAS8, are located near the east and west boundaries of the Y-12 Complex, respectively (Figure 4.18). Since their establishment in 1986, AAS2 and AAS8 have monitored mercury in ambient air continuously with the exception of short intervals of downtime because of electrical or equipment outages. In addition to the monitoring stations located at the Y-12 Complex, two additional monitoring sites were operated: a reference site (rain gauge 2) was operated on Chestnut Ridge in the Walker Branch Watershed for a 20-month period in 1988 and 1989 to establish a reference concentration and a site was operated at New Hope Pond for a 25-month period from August 1987 to September 1989.

To determine mercury concentrations in ambient air, airborne mercury vapor is collected by pulling ambient air through a sampling train consisting of a Teflon filter and an iodinated-charcoal sampling trap. A flow-limiting orifice upstream of the sampling trap restricts airflow through the sampling train to ~1 L/min. Actual flows are measured bi-weekly with a calibrated Gilmont flowmeter in conjunction with the bi-weekly change-out of the sampling trap. The charcoal in each trap is analyzed for total mercury using cold vapor atomic fluorescence spectrometry after acid digestion. The average concentration of mercury vapor in ambient air for each 14-day sampling period is then calculated by dividing the total mercury per trap by the volume of air pulled through the trap during the corresponding 14-day sampling period.

**Acronyms:**

EPA = US Environmental Protection Agency (sampler)

TDEC = Tennessee Department of Environment and Conservation

JCC = Jack Case Center

Figure 4.18. Locations of ambient air monitoring stations at the Y-12 Complex

As reported previously, average mercury concentration at the ambient air monitoring sites has declined significantly since the late 1980s. Recent average annual concentrations at the two boundary stations are comparable to concentrations measured in 1988 and 1989 at the Chestnut Ridge reference site (Table 4.11). Average mercury concentration at the AAS2 site for 2021 is $0.0040 \mu\text{g}/\text{m}^3$ ($N = 26$), comparable to averages measured since 2003. After an increase in average concentration at AAS8 for the period 2005 through 2007, thought to be possibly due to increased D&D work on the west end, the average

concentration at AAS8 for 2021 was $0.0030 \mu\text{g}/\text{m}^3$ ($N = 26$), similar to levels reported for 2008 and the early 2000s.

Table 4.11 summarizes the 2021 mercury results with results from the 1986 through 1988 period included for comparison. Figure 4.19 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 2021 [parts (a) and (b)] and seasonal trends at AAS8 from 1994 through 2021 [part (c)]. The dashed line superimposed on the plots in

Figure 4.19(a) and (b) is the EPA reference concentration of 0.3 µg/m³ for chronic inhalation exposure. The large increase in mercury concentration at AAS8 observed in the late 1980s [part (b)] was thought to be related to disturbances of mercury-contaminated soils and sediments during the Perimeter Intrusion

Detection Assessment System installation and storm drain restoration projects under way at that time within WEMA. In 4.19(c), a monthly moving average has been superimposed over the AAS8 data to highlight seasonal trends in mercury at AAS8 from January 1994 through 2021.

Table 4.11. Summary of data for the Y-12 National Security Complex ambient air monitoring program for mercury for CY 2021

Ambient air monitoring stations	Mercury vapor concentration (µg/m ³)			
	2021 Minimum	2021 Maximum	2021 Average	1986–1988 ^a Average
AAS2 (east end of the Y-12 Complex)	0.0008	0.0162	0.0040	0.010
AAS8 (west end of the Y-12 Complex)	0.0013	0.0052	0.0030	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 '80s with elevated ambient air mercury levels; shown for comparison.

^b Data for period from February 9 through December 31, 1988.

^c Data for period from January 1 through October 31, 1989.

Acronyms:

AAS = ambient air (monitoring) station

CY = calendar year

Y-12 Complex = Y-12 National Security Complex

In conclusion, 2021 average mercury concentrations at the two mercury monitoring sites were comparable to reference levels measured for the Chestnut Ridge reference site in 1988 and 1989. More importantly, measured concentrations continue to be well below current environmental and occupational health standards for inhalation exposure to mercury vapor (i.e., the National Institute for Occupational Safety and Health recommended exposure limit of 50 µg/m³, time-weighted average [TWA] for up to a 10 h workday, 40 h workweek; the American Conference of Governmental Industrial Hygienists workplace threshold limit value of 25 µg/m³ as a TWA for a normal 8 h workday and 40 h workweek; and the current EPA reference concentration of 0.3 µg/m³ for elemental mercury for a continuous inhalation exposure to the human population without appreciable risk of harmful effects during a lifetime.).

The dashed lines superimposed on (a) and (b) represent the US Environmental Protection Agency reference concentration of 0.3 µg/m³ for chronic inhalation exposure. In (c) (note different concentration scale), a monthly moving average has been superimposed over the data to highlight seasonal trends in mercury at ambient air station 8 from January 1993 to December 2021, with higher concentrations generally measured during the warm weather months.

4.4.2.2. Quality Control

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

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

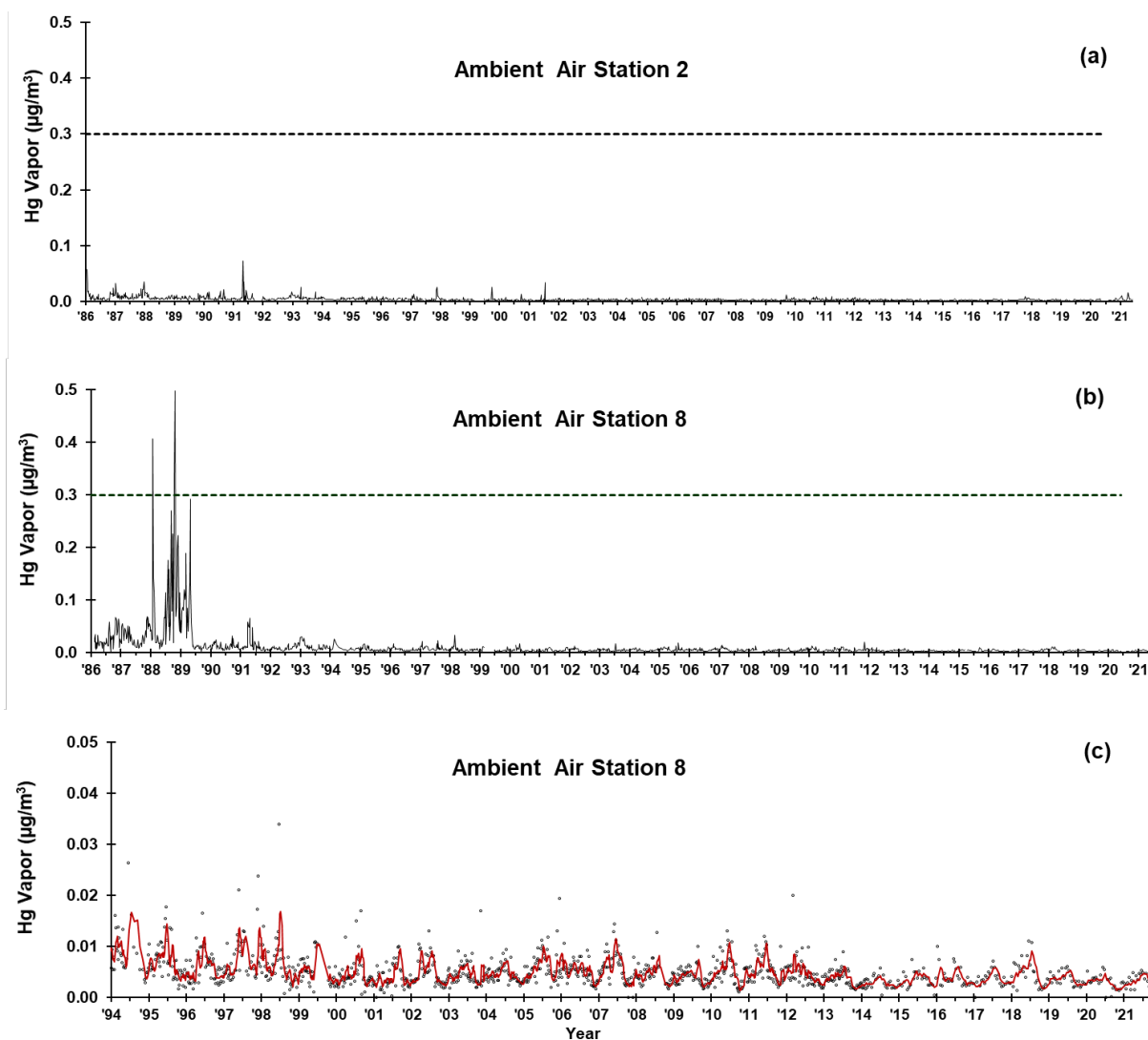


Figure 4.19. Temporal trends in mercury vapor concentration for the boundary monitoring stations at the Y-12 Complex, July 1986 to December 2021 [(a) and (b)] and January 1994 to December 2021 for ambient air station 8 [(c)]

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

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

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

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

A field performance evaluation is conducted annually by the project manager to ensure that proper procedures are followed by the sampling

technicians. One general note was a new construction area was opened approximately 100 ft to the west side of the Station 2 sampling building and a designated “smoking” area had been positioned immediately to the east of building. No problems were noted during sample collection at time of evaluation. Evaluation was conducted on December 7, 2021.

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% at five or more times the detection limit are to be rerun [third duplicate] to resolve the discrepancy), and
- Archiving all primary laboratory records for at least 1 year

4.4.2.3. Ambient Air Monitoring Complementary to the Y-12 Complex Ambient Air Monitoring

Ambient air monitoring is conducted at multiple locations near ORR to measure radiological and other selected parameters directly in the ambient air. These monitors are operated in accordance with DOE orders. Their locations were selected so that areas of potentially high exposure to the public are monitored continuously for parameters of concern. This monitoring provides direct measurement of airborne concentrations of radionuclides and other hazardous air pollutants, allows facility personnel to determine the relative level of contaminants at the monitoring locations during an emergency, verifies that the contributions of fugitive and diffuse sources are insignificant, and serves as a check on dose-modeling calculations. As part of the ORR network, an AAS located in the Scarboro Community of Oak Ridge (Station 46) measures off-site impacts of Y-12 Complex operations. This station is located near the theoretical area of

maximum public pollutant concentrations as calculated by air-quality modeling. ORR network stations are also located at the east end of the Y-12 Complex (Station 40) and just south of the Country Club Estates neighborhood (Station 37).

In addition to the monitoring described above, the state of Tennessee (TDEC) and EPA perform ambient air monitoring to characterize the region in general and to characterize and monitor DOE operations locally. Specific to Y-12 operations, two uranium, ambient air, high-volume samplers provide isotopic uranium monitoring capability (Figure 4.19) within the Y-12 boundary that are used by TDEC personnel in their environmental monitoring program. These are located on the east side of the Jack Case Center and on the south side of the Building 9723-28 change house. EPA performs ambient air monitoring on the east end of the plant near the intersection of Scarboro Road and Bear Creek Road and on the west end of the plant near the intersection of Bear Creek Road and Old Bear Creek Road.

In addition, TDEC DOE Oversight Division air quality monitoring includes several other types of monitoring on ORR, for example:

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

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

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

4.5. Water Quality Program

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

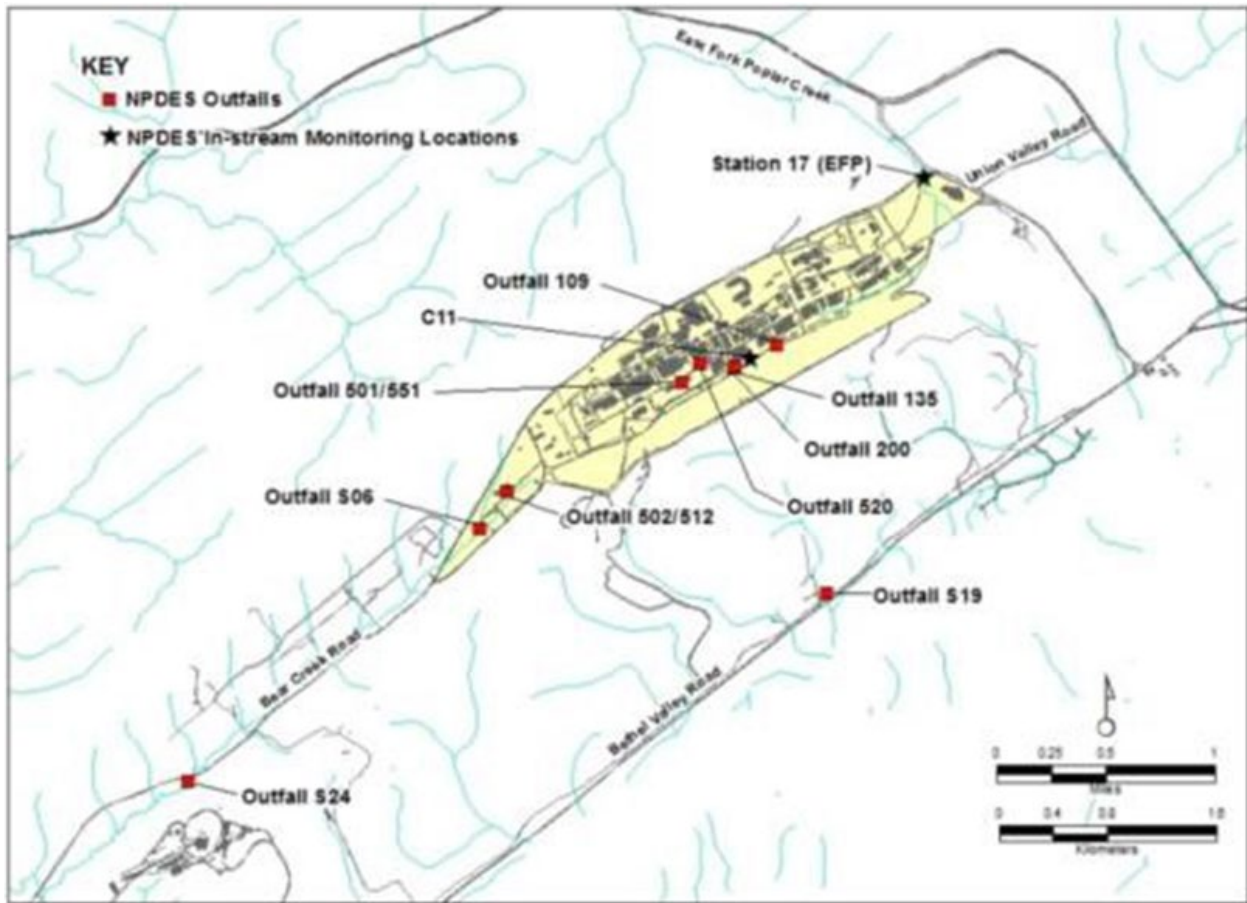
The current Y-12 NPDES permit (TN0002968) requires sampling, analysis, and reporting for about 56 outfalls. Major outfalls are depicted in Figure 4.20. The number is subject to change as outfalls are eliminated or consolidated or if permitted discharges are added. Currently, Y-12 has outfalls and monitoring points in the following water drainage areas: EFPC, Bear Creek, and several tributaries on the south side of Chestnut Ridge, all of which eventually drain to the Clinch River.

Discharges to surface water allowed under the permit include storm drainage; cooling water; cooling tower blowdown; steam condensate; and treated process wastewaters, including effluents from wastewater treatment facilities.

Groundwater inflow into sumps in building basements and infiltration to the storm drain system are also permitted for discharge to the creek. The monitoring data collected by sampling and analyzing permitted discharges are compared with NPDES limits where applicable for each parameter. Some parameters, defined as monitor only, have no specified limits.

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

Requirements of the NPDES permit for 2021 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 2021 was 100 percent (see Table 4.12).



Acronyms:

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

Figure 4.20. Major Y-12 National Pollutant Discharge Elimination System outfalls and monitoring locations

Table 4.12. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, January–December 2021

Discharge point	Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
Outfall 501 (Central Pollution Control)							
	pH, standard units			^a	9.0	^b	0
	Total suspended solids			31.0	40.0	^b	0
	Total toxic organic				2.13	^b	0
	Hexane extractables			10	15	^b	0
	Cadmium	0.16	0.4	0.07	0.15	^b	0
	Chromium	1.0	1.7	0.5	1.0	^b	0
	Copper	1.2	2.0	0.5	1.0	^b	0
	Lead	0.26	0.4	0.1	0.2	^b	0
	Nickel	1.4	2.4	2.38	3.98	^b	0
	Nitrate/Nitrite				100	^b	0
	Silver	0.14	0.26	0.05	0.05	^b	0
	Zinc	0.9	1.6	1.48	2.0	^b	0
	Cyanide	0.4	0.72	0.65	1.2	^b	0
	PCB				0.001	^b	0
Outfall 502 (West End Treatment Facility)							
	pH, standard units			^a	9.0	100	4
	Total suspended solids		31		40	100	3
	Total toxic organic				2.13	100	3
	Hexane extractables			10	15	100	3
	Cadmium		0.4		0.15	100	3
	Chromium		1.7		1.0	100	3
	Copper		2.0		1.0	100	3
	Lead		0.4		0.2	100	3
	Nickel		2.4		3.98	100	3
	Nitrate/Nitrite				100	100	3
	Silver		0.26		0.05	100	3
	Zinc		0.9		1.48	100	3
	Cyanide		0.72		1.20	100	3
	PCB				0.001	100	4
Outfall 512 (Groundwater Treatment Facility)							
	pH, standard units			^a	9.0	100	12
	PCB				0.001	100	1
Outfall 520							
	pH, standard units			^a	9.0	^b	0
Outfall 200 (North/South pipes)							
	pH, standard units			^a	9.0	100	53
	Hexane extractables			10	15	100	13
	Cadmium			0.001	0.023	100	12

Table 4.12. National Pollutant Discharge Elimination System compliance monitoring requirements and record for Y-12, January–December 2021 (continued)

Discharge point	Effluent parameter	Daily average (lb)	Daily maximum (lb)	Monthly average (mg/L)	Daily maximum (mg/L)	Percentage of compliance	Number of samples
	IC ₂₅ <i>Ceriodaphnia</i>			37% Minimum		100	1
	IC ₂₅ <i>Pimephales</i>			37% Minimum		100	1
	Total residual chlorine			0.024	0.042	100	12
Outfall 551							
	pH, standard units			^a	9.0	100	52
	Mercury			0.002	0.004	100	52
Outfall C11							
	pH, standard units			^a	9.0	100	13
Outfall 135							
	pH, standard units			^a	9.0	100	13
	IC ₂₅ <i>Ceriodaphnia</i>			9% Minimum		100	1
	IC ₂₅ <i>Pimephales</i>			9% Minimum		100	1
Outfall 109							
	pH, standard units			^a	9.0	100	8
	Total residual chlorine			0.010	0.017	100	4
Outfall S19							
	pH, standard units			^a	9.0	100	1
Outfall S06							
	pH, standard units			^a	9.0	100	2
Outfall S24							
	pH, standard units			^a	9.0	100	4
Outfall EFP							
	pH, standard units			^a	9.0	100	13
Category I outfalls							
	pH, standard units			^a	9.0	100	36
Category II outfalls							
	pH, standard units			^a	9.0	100	17
	Total residual chlorine				0.5	100	16
Category III outfalls							
	pH, standard units			^a	9.0	100	7
	Total residual chlorine			^a	0.5	100	6

^a Not applicable.^b No discharge.**Acronyms:**IC₂₅ = 25-percent inhibition concentration

PCB = polychlorinated biphenyl

Y-12 = Y-12 National Security Complex

4.5.2. Radiological Monitoring Plan and Results

A radiological monitoring plan is in place at Y-12 to address compliance with DOE orders and is provided to TDEC as a matter of comity under NPDES Permit TN0002968. Y-12 submits results from the radiological monitoring plan quarterly as an addendum to the NPDES Discharge Monitoring Report. There were no discharge limits set by the NPDES permit for radionuclides; the requirement is to monitor and report. The radiological monitoring plan was developed based on an analysis of operational history, expected chemical and physical relationships, and historical

monitoring results. Under the existing plan, effluent monitoring is conducted at four types of locations: treatment facilities, other point-source and area-source discharges, instream locations, and storm water runoff from production area roofs. Operational history and past monitoring results provide a basis for parameters routinely monitored under the plan (Table 4.13). The *Radiological Monitoring Plan for the Oak Ridge Y-12 National Security Complex: Surface Water* (B&W Y-12 2012b) was revised and reissued in January 2012. It was again revised and issued in October 2020. The revised plan was implemented on November 1, 2020. This revision added outfall 109 and roof runoff from production areas.

Table 4.13. Radiological parameters monitored at Y-12, 2020

Parameters	Specific isotopes	Rationale for monitoring
Uranium isotopes	^{238}U , ^{235}U , ^{234}U , total U, weight % ^{235}U	These parameters reflect the major activity, uranium processing, throughout the history of Y-12 and are the dominant detectable radiological parameters in surface water.
Fission and activation products	^{90}Sr , ^{99}Tc , ^{137}Cs	These parameters reflect a minor activity at Y-12, processing recycled uranium from reactor fuel elements from the early 1960s to the late 1980s, and will continue to be monitored as tracers for beta and gamma radionuclides, although their concentrations in surface water are low.
	^3H	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 , $^{239/240}\text{Pu}$	These parameters are related to recycle uranium processing. Monitoring has continued because of their half-lives and presence in groundwater.
Other isotopes of interest	^{232}Th , ^{230}Th , ^{228}Th , ^{226}Ra , ^{228}Ra	These parameters reflect historical thorium processing and natural radionuclides necessary to characterize background radioisotopes.

Acronym:

Y-12 = Y-12 National Security Complex

Radiological monitoring during storm water events is accomplished as part of the storm water monitoring program. Uranium is monitored at three major EFPC storm water outfalls, two instream monitoring locations, and an outfall on Bear Creek. In addition, the monthly 7-d composite sample for radiological parameters taken at Station 17 on EFPC likely includes rain events.

Radiological monitoring plan locations sampled in 2021 are noted on Figure 4.21. Table 4.14 identifies the monitored locations, the frequency of monitoring, and the sum of the percentages of the derived concentration standards for radionuclides measured in 2021. Radiological data were well below the allowable derived concentration standards, with the exception of the Stack 47 storm runoff.

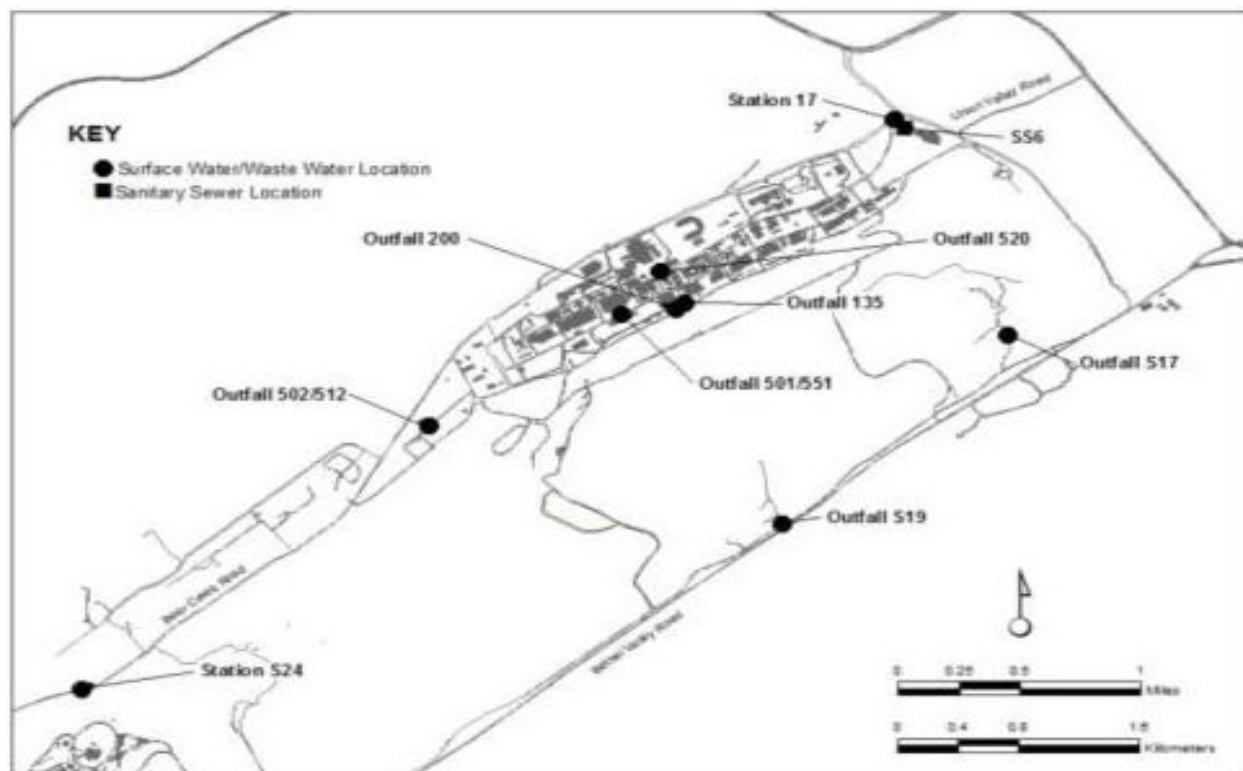


Figure 4.21. Surface water and sanitary sewer radiological sampling locations at Y-12

Table 4.14. Summary of Y-12’s radiological monitoring plan sample requirements and 2021 results

Location	Sample frequency	Sample type	Sum of derived concentration standards percentages
Y-12 wastewater treatment facilities			
Central Pollution Control Facility	1/batch	Composite during batch operation	No flow
West End Treatment Facility	1/batch	24-h composite	7.7
Groundwater Treatment Facility	4/yr	24-h composite	5.0
Steam Condensate	1/yr	Grab	No flow
Central Mercury Treatment Facility	4/yr	24-h composite	0.93
Other Y-12 point- and area-source discharges			
Outfall 109	4/yr	24 h composite	2.7
Outfall 135	4/yr	24-h composite	1.3
Kerr Hollow Quarry	1/yr	24-h composite	6.0
Rogers Quarry	1/yr	24-h composite	2.7
Y-12 instream locations			
Outfall S24	1/yr	7-d composite	3.0
East Fork Poplar Creek, complex exit (east)	1/month	7-d composite	0
North/south pipes	1/month	24-h composite	1.7
Y-12 Production Roof Run off			
9215 Fan Room	4/yr	Grab during rain	3.0
Stack 47	4/yr	Grab during rain	48

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

In 2021, the total mass of uranium and associated curies released from Y-12 at the easternmost monitoring station, Station 17 on upper EFPC, was 139 kg or 0.063 Ci (Table 4.15).

Table 4.15. Uranium release from Y-12 to the off-site environment as liquid effluent, 2014–2021

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

^a 1 Ci = 3.7E+10 Bq.

Acronym:

Y-12 = Y-12 National Security Complex

Figure 4.22 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 of Oak Ridge, although no city-established radiological limits exist. Alpha and beta levels are measured weekly, and subsequent uranium analyses are performed if the alpha or beta levels are above prescribed levels. Potential sources of radionuclides discharging to the sanitary sewer have been identified in previous studies at Y-12 as part of an initiative to meet goals to keep levels as low as reasonably achievable. Results of radiological monitoring were reported to the City of Oak Ridge in 2021 quarterly monitoring reports.

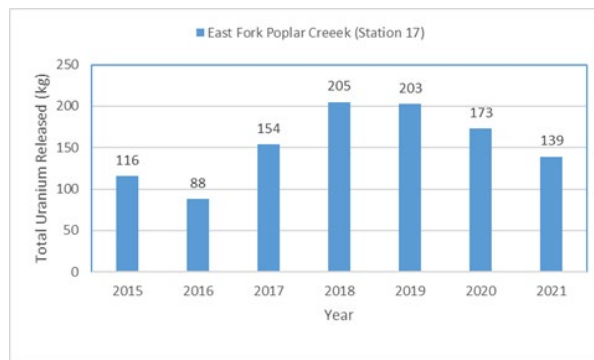


Figure 4.22. Six-year trend of Y-12 uranium releases to East Fork Poplar Creek

4.5.3. Storm Water Pollution Prevention

The Stormwater Pollution Prevention Plan at Y-12 is designed to minimize the discharge of pollutants in storm water runoff. The plan identifies areas that can reasonably be expected to contribute contaminants to surface water bodies via storm water runoff and describes the development and implementation of storm water management controls to reduce or eliminate the discharge of such pollutants. This plan requires characterizing storm water by sampling during storm events, implementing measures to reduce storm water pollution, facility inspections, and employee training.

Y-12’s Stormwater Pollution Prevention Plan underwent a significant rewrite in March 2022. Significant changes include incorporation of site-wide Best Management Practices (BMP) Plans and overall text revision. The NPDES permit defines the primary function of Y-12 to be a fabricated metal products industry. However, it also requires that storm water monitoring be conducted for three additional sectors: scrap and waste recycling activities; landfill and land-application activities; and discharges associated with treatment, storage, and disposal facilities as they are defined in the Tennessee Storm Water Multi Sector General Permit for Industrial Activities (TNR050000). Each sector has prescribed benchmark values, and some have defined sector mean values. The rationale portion of the NPDES permit for Y-12 states, “These benchmark values were developed by the EPA and the state of Tennessee and are based on data submitted by

similar industries for the development of the multisector general storm water permit. The benchmark concentrations are target values and should not be construed to represent permit limits.”

Storm water sampling was conducted in 2021 during rain events that occurred on March 25, April 8, and June 3. Results were published in the *Annual Stormwater Report for the Y-12 National Security Complex* (CNS, 2021a) which was submitted to TDEC Division of Water Resources in January 2022. Consistent with permit requirements, storm water monitoring is performed each year for sector outfalls, three major outfalls that drain large areas of Y-12, and two instream monitoring locations on EFPC (Figure 4.23).

An area of concern continues to be the concentration of mercury being measured in the discharge from Outfall 014. Since the first unexpected, elevated result in 2013 (7.12 µg/L), this sector outfall has been on an annual monitoring schedule; however, no monitoring was conducted in 2018 or 2019 due to the degraded condition of the outfall piping and the inability to gather reliable flow rate data. However, the maintenance work on Outfall 014 was completed and sampling was resumed in 2020. Data collected to date are presented in Table 4.16.

Table 4.16. Mercury concentrations at Outfall 014

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

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

4.5.4. Y-12 Ambient Surface Water Quality

To monitor key indicators of water quality, a network of real-time monitors located at three instream locations along upper EFPC is used. The Surface Water Hydrological Information Support System is available for real-time water quality measurements, such as pH, temperature, dissolved oxygen, conductivity, and chlorine. The locations are shown in Figure 4.23. The primary

Sampling conducted in 2021 revealed:

- Outfall 014: Aluminum and zinc concentrations were above the benchmark values. The exact cause of the aluminum and zinc results being above the benchmark for Outfall 014 is unknown; however, it is noteworthy that construction activity for a new Fire Station is underway on the Outfall 014 network.
- Outfall 067: Zinc concentrations were slightly above the benchmark value. The cause of the elevated zinc results is unknown.
- Outfall S30: The copper value is slightly above the benchmark value, but well below the sector median value. The cause of the elevated copper result is unknown.
- Outfall S18: The total recoverable iron value is above the sector median value. The cause of the elevated total recoverable iron result is unknown.
- Outfall S06, the magnesium concentration exceeds both the benchmark and sector median values and the cadmium concentration is slightly above the benchmark and sector median values. The geology of this portion of the Tennessee valley typically results in abnormally high levels of magnesium, and the cause of the elevated cadmium result is unknown.

function of the Surface Water Hydrological Information Support System is to indicate potential adverse conditions that could be causing an impact on water quality in upper EFPC. It is operated as a best management practice.

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

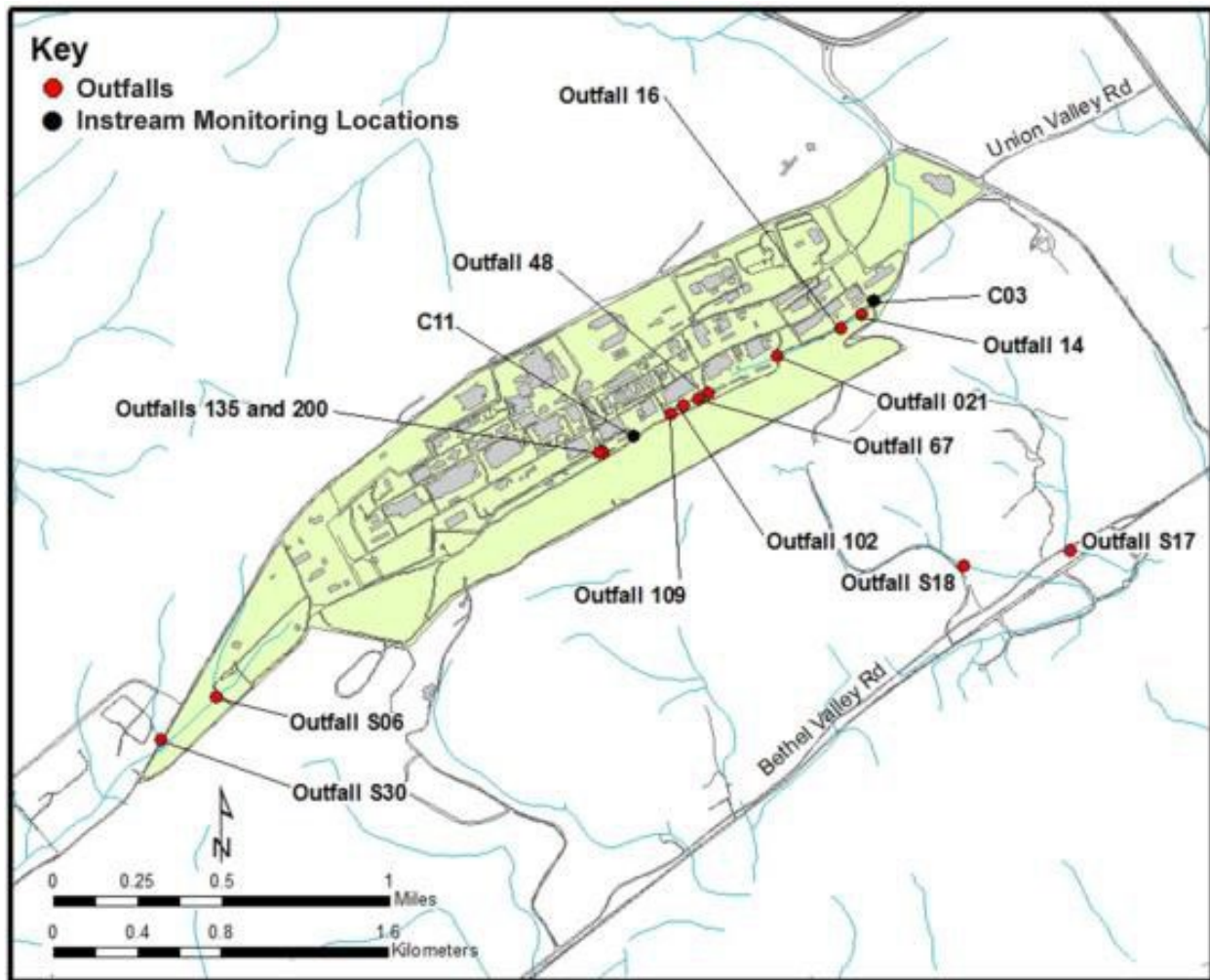


Figure 4.23. Y-12 storm water monitoring locations, East Fork Poplar Creek

4.5.5. Industrial Wastewater Discharge Permit

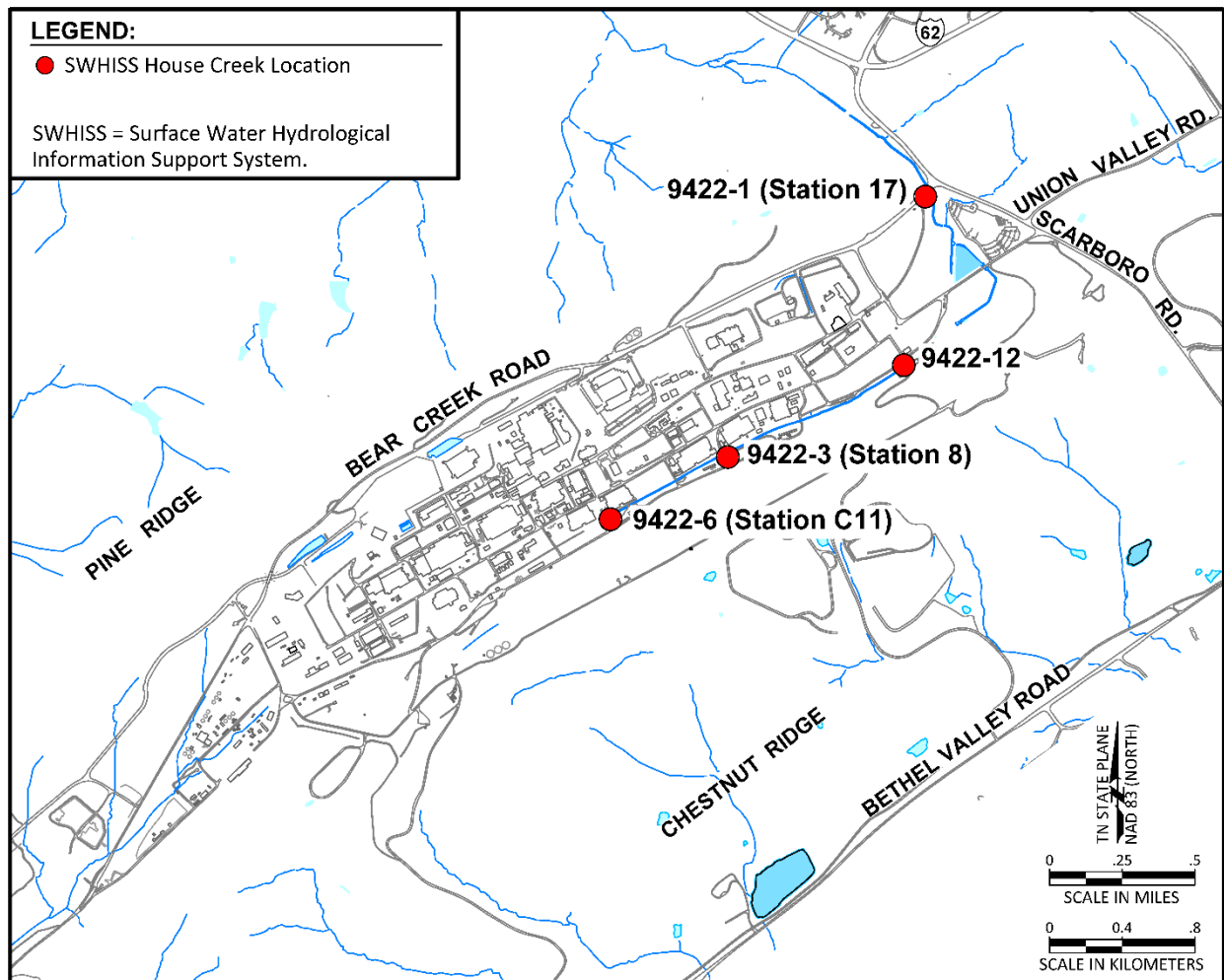
Industrial and Commercial User Wastewater Discharge Permit 1-91 defines requirements for the discharge of wastewaters to the sanitary sewer system as well as prohibitions for certain types of wastewaters. It prescribes requirements for monitoring certain parameters at the East End Sanitary Sewer Monitoring Station. The permit sets limits for most parameters. Samples for gross alpha, gross beta, and uranium are taken in a weekly 24-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, see Figure 4.24) to conduct compliance monitoring as required by the pretreatment regulations. City personnel also conduct twice-yearly compliance inspections.

Monitoring results from 2021 are contained in Table 4.17. There were six exceedances of permit limits in 2021—one exceedance of the cyanide limit; one exceedance of the phenols limit; and four exceedances of the 2,100-gal/min instantaneous flow limit. In order to reduce stormwater inflow and infiltration, a project has been initiated to evaluate and rehabilitate approximately 15,000 linear feet of the Y-12 sewage collection system. The project has

evaluated the collection system via smoke tests and video inspection, and is now performing needed repairs identified during the evaluation. The collection system refurbishment involves manhole relining, pipe bursting, installing cured in place piping, and other repairs. The repair work in the B-449 network is complete and the C-409A network repairs have started. Initial flow evaluation indicates this project has reduced inflow and infiltration.



Acronym:
 SWHISS = Surface Water Hydrological Information Support System

Figure 4.24. Surface Water Hydrological Information Support System monitoring locations

Table 4.17. Y-12 discharge point SS6

Effluent parameter	Number of samples	Average value	Daily maximum (gal/min) ^a	Monthly average (effluent limit) ^a	Number of limit exceedances
Max flow rate (gal/min)	Continuous	N/A	2,100	N/A	4
Flow (average kgpd)	90	459	N/A	500 ^b	0
January through March					
Flow (average kgpd)	91	347	N/A	500 ^b	0
April through June					
Flow (average kgpd) July through September	92	396	N/A	500 ^b	0
October through December					
Flow (average kgpd)	92	436	N/A	500 ^b	0
pH (standard units)	48	N/A	N/A	9 and 6 ^c	0
Biochemical oxygen demand	13	49.6	N/A	200	0
Kjeldhal nitrogen	13	19.5	N/A	45	0
Phenols—total recoverable	26	<0.12	N/A	0.15	1
Oil and grease	13	<8.2	N/A	25	0
Suspended solids	13	77.2	N/A	200	0
Cyanide	33	<0.0048	N/A	0.005	1
Arsenic	10	<0.0012	N/A	0.010	0
Cadmium	10	<0.0005	N/A	0.0033	0
Chromium, hexavalent	8	0.005U	N/A	0.053	0
Copper	10	0.019	N/A	0.14	0
Iron	10	0.692	N/A	10	0
Lead	10	<0.0025	N/A	0.049	0
Mercury	16	0.0095 ^d	N/A	0.035 ^d	0
Nickel	10	<0.005	N/A	0.021	0
Silver	10	<0.001	N/A	0.05	0
Zinc	10	0.106	N/A	0.35	0
Molybdenum	10	0.036	N/A	0.05 ^e	N/A
Selenium	10	<0.0025	N/A	0.01 ^e	N/A
Toluene	4	0.005U	N/A	0.005 ^e	N/A
Ammonia	5	18.8	N/A	0.10 ^e	N/A
Methanol	4	1.0U	N/A	1.0 ^e	N/A
Benzene	4	0.005U	N/A	0.005 ^e	N/A
1,1,1-Trichloroethane	4	0.005U	N/A	0.005 ^e	N/A
Ethylbenzene	4	0.005U	N/A	0.005 ^e	N/A
Carbon tetrachloride	4	0.005U	N/A	0.005 ^e	N/A
Chloroform	4	0.003UJ	N/A	0.004 ^e	N/A
Tetrachloroethene	4	0.004J	N/A	0.004 ^e	N/A
Trichloroethene	4	0.005U	N/A	0.005 ^e	N/A
trans-1,2-Dichloroethene	4	0.005U	N/A	0.005 ^e	N/A
Methylene chloride	4	0.005U	N/A	0.005 ^e	N/A

^a Industrial and commercial users wastewater permit limits.

^b Average daily flow allowed in gal/d.

^c Maximum and minimum value.

^d Units are lb/d.

^e This parameter does not have a permit limit. This value is the required detection limit. All units are mg/L unless noted otherwise.

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

4.5.6. Quality Assurance and Quality Control

The Environmental Monitoring Management Information System is used to manage surface water monitoring data at Y-12. It uses standard sample definitions to ensure that samples are taken at the correct location at a specified frequency using the correct sampling protocol.

Field sampling QA encompasses many practices that minimize error and evaluate sampling performance. Some key quality practices include the following:

- Using standard operating procedures for sample collection and analysis
- Using chain-of-custody and sample identification, customized chain-of-custody documents, and sample labels provided by the Environmental Monitoring Management Information System
- Standardizing, calibrating, and verifying instruments
- Training sample technicians
- Preserving, handling, and decontaminating samples
- Using QC samples (i.e., field and trip blanks, duplicates, and equipment rinses)

Surface water data are entered directly by the analytical laboratory into the Laboratory Information Management System on the day of approval. The Environmental Monitoring

Management Information System routinely accesses the Laboratory Information Management System electronically to capture pertinent data. Generally, the system will store data in the form of concentrations.

A number of electronic data management tools enable automatic flagging of data points and allow for 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 checks on the data, including comparisons of the individual results against any applicable screening criteria, regulatory thresholds, compliance limits, best management practices, or other water quality indicators, and produces required reports.

4.5.7. Biomonitoring Program

The NPDES permit for Y-12 (TN0002968, Part III, Section E) contains chronic toxicity testing requirements. These requirements specify that chronic toxicity testing (a 3-Brood *Ceriodaphnia dubia* survival and reproduction test and a 7-d fathead minnow larval survival and growth test) is required annually at Outfalls 135 and 200 to determine whether the effluent is contributing chronic toxicity to the receiving water. According to permit requirements, chronic toxicity testing is to be performed using 100 percent effluent and the dilution series shown in Table 4.18.

Table 4.18. Serial dilutions for whole effluent toxicity testing, as a percent of effluent

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

Note:

The effluent water is diluted with control laboratory water.

Table 4.19 summarizes the results of the 2021 outfall biomonitoring tests in terms of the 25-percent inhibition concentration (IC₂₅), 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 IC₂₅, the more toxic the effluent. According to the NPDES permit, toxicity is demonstrated if the IC₂₅ is less than or equal to the permit limit (9-percent whole effluent for Outfall 135 and 37-percent whole effluent for Outfall 200).

Table 4.19. Y-12 biomonitoring program summary information for Outfalls 200 and 135, 2021^a

Water collection dates	Outfall	Test type	Test organism	End point	Metric	IC ₂₅ ^b (%)
07/14/21– 07/21/21	135	Chronic	Fathead minnow	Survival	IC ₂₅	>36%
			(<i>Pimephales promelas</i>)	Growth	IC ₂₅	>36%
			Water fleas	Survival	IC ₂₅	>36%
			(<i>Ceriodaphnia dubia</i>)	Reproduction	IC ₂₅	>36%
07/14/21– 07/21/21	200	Chronic	Water fleas	Survival	IC ₂₅	>100%
			(<i>Ceriodaphnia dubia</i>)	Reproduction	IC ₂₅	>100%
			Fathead minnow	Survival	IC ₂₅	>100%
			(<i>Pimephales promelas</i>)	Growth	IC ₂₅	>100%

^a IC₂₅ is summarized for the discharge monitoring locations, Outfalls 200 and 135.

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

Acronyms:

IC₂₅ = 25-percent inhibition concentration

Y-12 = Y-12 National Security Complex

Note: Annual NPDES permit testing was conducted in July 2021 with effluent from Outfalls 200 and 135. Effluent from Outfall 135 did not reduce fathead minnow (*Pimephales promelas*) survival or growth or water fleas' (*Ceriodaphnia dubia*) survival or reproduction by 25 percent or more at any of the tested concentrations compared to the control treatment. For both species, the IC₂₅ for survival, growth, or reproduction was greater than 36 percent (the highest concentration of this effluent that was tested) (Table 4.19). Effluent from Outfall 200 did not reduce fathead minnow (*Pimephales promelas*) survival or growth or water fleas' (*Ceriodaphnia dubia*) survival or reproduction by 25 percent or more at any of the tested concentrations. For both species, the IC₂₅ for survival, growth, or reproduction was greater than 100 percent (Table 4.19).

4.5.8. Biological Monitoring and Abatement Program

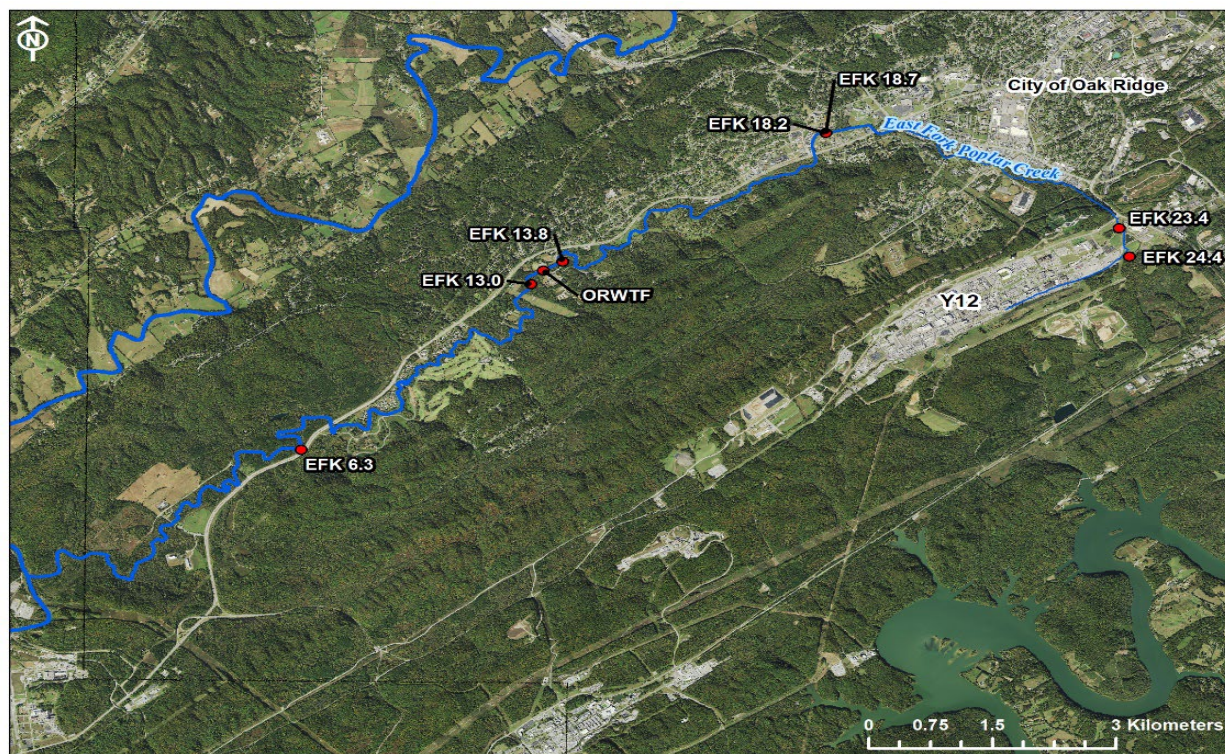
The NPDES permit issued for Y-12 mandates a Biological Monitoring and Abatement Program, with the objective of demonstrating that the effluent limitations established for the facility protect the classified uses of the receiving stream—EFPC. The 2021 Biological Monitoring

and Abatement Program sampling efforts reported in this chapter follow the NPDES-required Y-12 Biological Monitoring and Abatement Program Plan (Peterson et al. 2013). Y-12's Biological Monitoring and Abatement Program, which has been monitoring the

ecological health of EFPC since 1985, currently consists of three major tasks that reflect complementary approaches to evaluating the effects of Y-12 discharges on the aquatic integrity of EFPC: bioaccumulation monitoring, benthic macroinvertebrate community monitoring, and fish community monitoring. Data collected on contaminant bioaccumulation and the composition and abundance of communities of aquatic organisms directly evaluate the effectiveness of abatement and remedial measures in improving ecological conditions in the stream.

Monitoring is currently being conducted at seven primary EFPC sites (Figures 4.25 and 4.26), although sites may be excluded or added depending on the specific objectives of the various tasks. The primary sampling sites include Upper

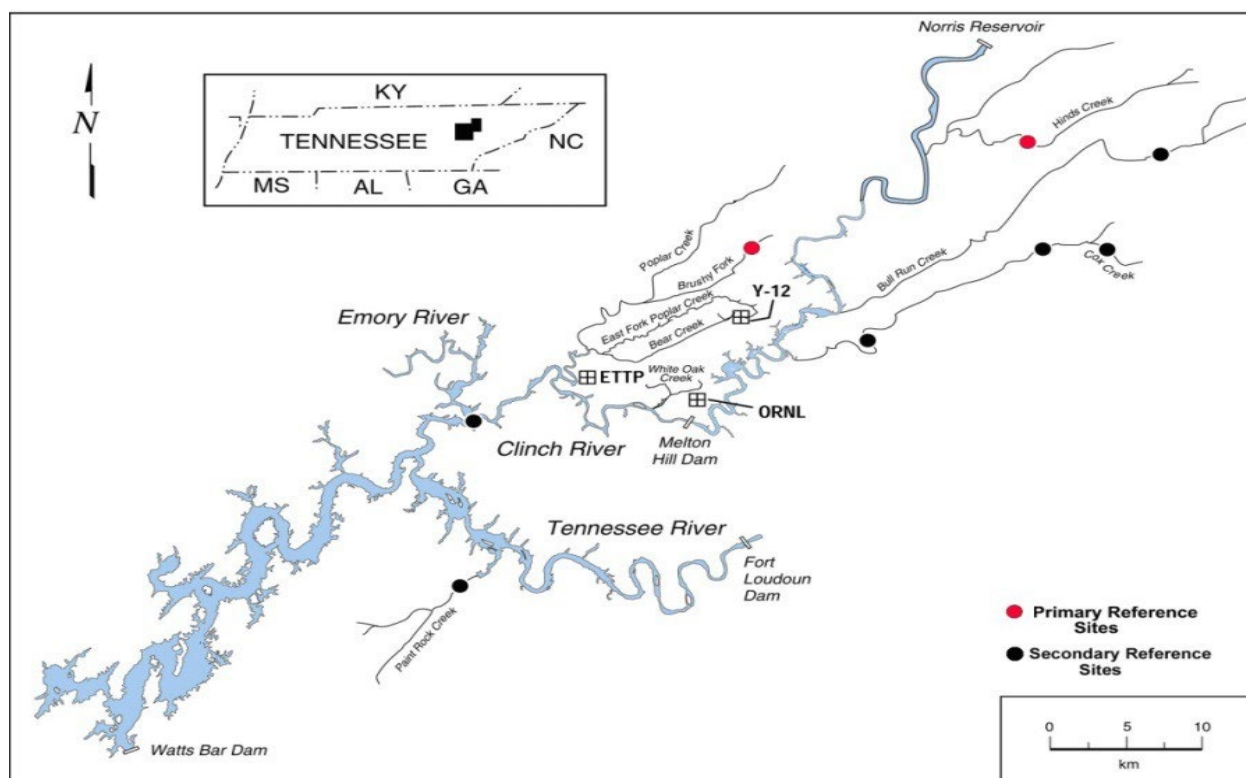
EFPC at EFPC kilometers (EFKs) 24.4 and 23.4, located upstream and downstream of Lake Reality, respectively; EFKs 18.7 and 18.2, located off ORR and below an area of intensive commercial and light industrial development, respectively; EFKs 13.8 and 13.0, located upstream and downstream of the Oak Ridge Wastewater Treatment Facility, respectively; and EFK 6.3, located about 1.4 km downstream of the ORR boundary (Figure 4.29). Brushy Fork at Brushy Fork kilometer 7.6 is used as a reference stream in two Biological Monitoring and Abatement Program tasks (fish and macroinvertebrate community tasks). Hinds Creek at Hinds Creek kilometer 20.6 is also used as a reference for the macroinvertebrate community monitoring task.



Acronyms:

- EFK = East Fork Poplar Creek kilometer
- ORWTF = Oak Ridge Wastewater Treatment Plant
- Y-12 = Y-12 National Security Complex

Figure 4.25. Biological monitoring sites in East Fork Poplar Creek relative to Y-12

**Acronyms:**

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

Figure 4.26. Biological monitoring reference site locations relative to Y-12

Generally, the number of invertebrate and fish species in EFPC has increased over the last three decades (primarily in the upstream sites), demonstrating that the overall ecological health of the stream continues to improve. However, the pace of improvement in Upper EFPC near Y-12 has slowed in recent years, and fish and invertebrate communities continue to have fewer species than the corresponding communities in reference streams.

4.5.8.1. Bioaccumulation Studies

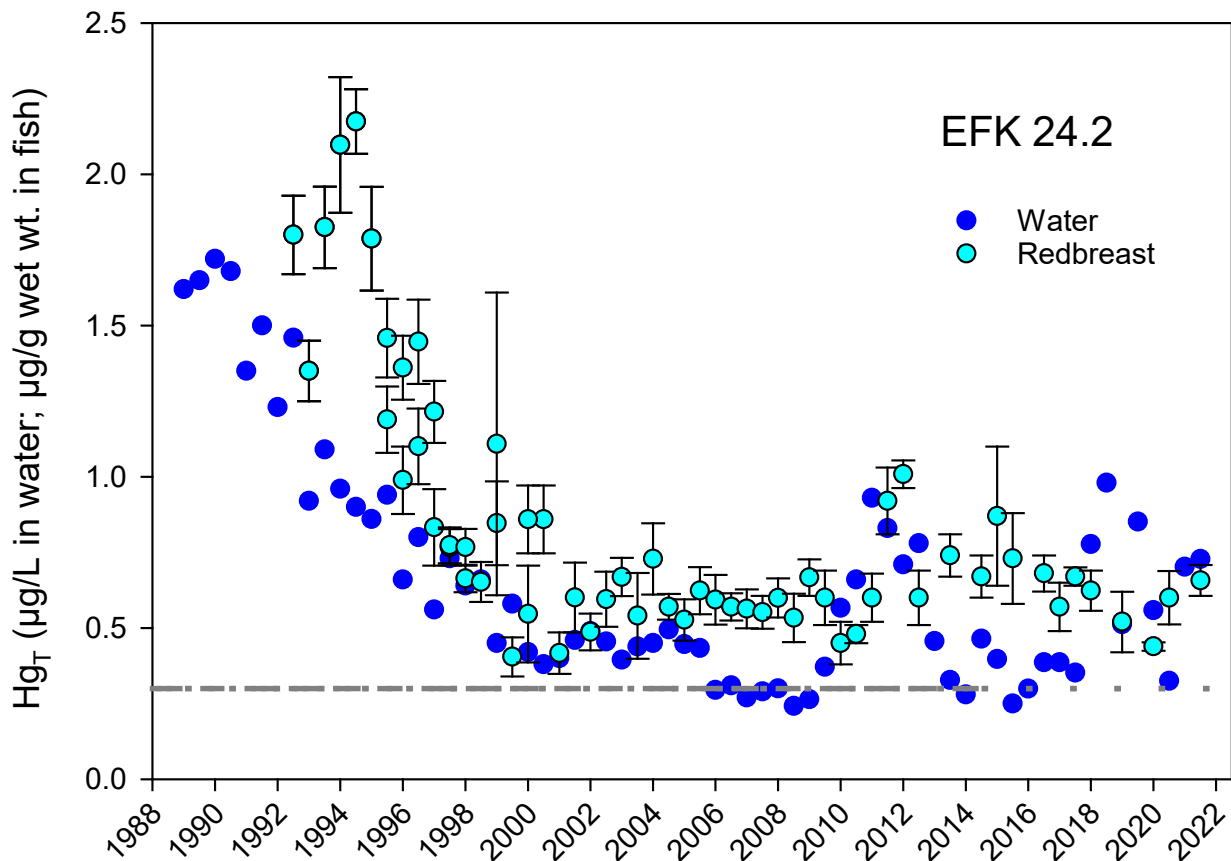
Historically, mercury and PCB concentrations in fish from EFPC have been elevated relative to fish in uncontaminated reference streams. Fish in EFPC are monitored regularly for mercury and PCBs to assess spatial and temporal trends in bioaccumulation associated with ongoing remedial activities and Y-12 operations.

As part of this monitoring effort, redbreast sunfish (*Lepomis auritus*) and rock bass (*Ambloplites rupestris*) are collected from five sites throughout the length of EFPC and are analyzed for tissue concentrations of mercury (twice yearly) (Figure 4.27) and PCBs (annually) (Figure 4.28). Mercury concentrations remained higher in fish from EFPC in 2021 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 4.27 shows temporal trends for mercury concentrations in water collected from EFK 23.4 (Station 17) and in fish collected just upstream of this monitoring station at EFK 24.4. Waterborne mercury concentrations in the upper reach of EFPC have decreased substantially over the years in response to various remedial actions, first over the 1990s time period and then again in response

to the Big Springs Treatment System in 2006. Significant fluctuations in aqueous mercury concentrations (thought to be the result of storm drain relining and cleanout) have been seen at EFK 23.4 since 2009. In July 2018, aqueous mercury concentrations spiked as a result of a one-time flux of mercury that occurred during construction and demolition activities at the west end of Y-12. The elevated mercury concentrations

were associated with toxicity and a fish kill (Mathews et al. 2019). Aqueous mercury concentrations at Station 17 were elevated in 2021, and mean mercury concentrations in fish collected at EFK 24.4 increased slightly in 2021 (0.65 µg/g) remaining above the EPA-recommended ambient water quality criterion for mercury (0.3 µg/g mercury as methylmercury in fish fillet).



Notes:

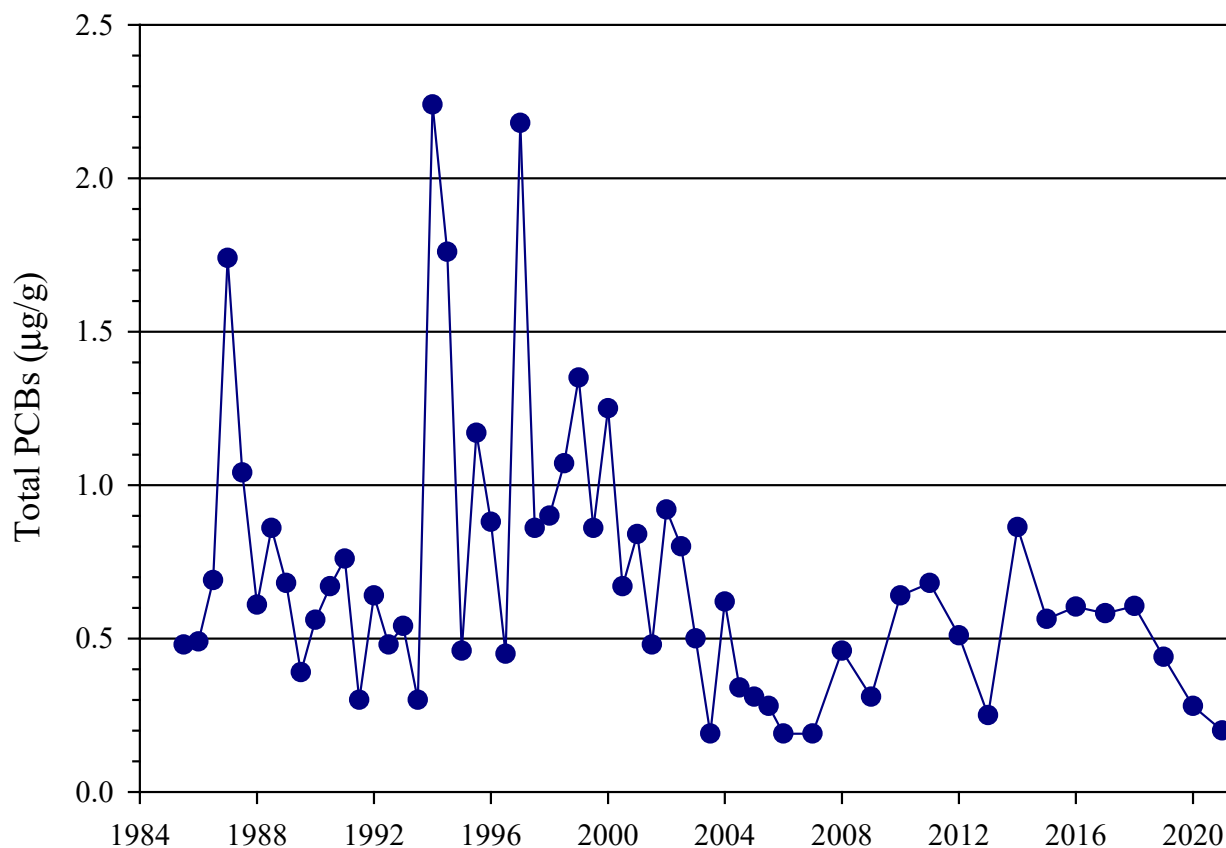
1. Dashed grey line represents the ambient water quality criterion for methylmercury in fish fillets (0.3 µg/g).
2. Water: at East Fork Poplar Creek kilometer 23.4.
3. Fish: at East Fork Poplar Creek kilometer 24.4.

Figure 4.27. Semiannual average mercury concentration in muscle fillets of redbreast sunfish and water from East Fork Poplar Creek, fiscal year 2021

The relationship between aqueous total mercury concentrations and fish tissue concentrations is complex. Aqueous mercury concentrations vary by orders of magnitude throughout the various watersheds across ORR, but fish tissue concentrations tend not to vary greatly (twofold to threefold). Multiple ongoing investigations are being conducted to better understand mercury bioaccumulation dynamics in EFPC and to better predict how remedial changes may impact mercury concentrations in fish in the future.

The mean total PCB concentration in sunfish fillets at EFK 23.4 was 0.20 µg/g in FY 2021, slightly

lower than concentrations seen in FY 2020 (0.28 µg/g) (Figure 4.28). Regulatory guidance and human health risk levels have varied widely for PCBs, depending on the regulatory program and the assumptions used in the risk analysis. The Tennessee water quality criterion for both individual aroclors and total PCBs is 0.00064 µg/L under the recreation designated-use classification and is the target for PCB focused total maximum daily loads, including for local reservoirs (Melton Hill, Watts Bar, and Fort Loudoun; TDEC 2010a, 2010b, 2010c).



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

Figure 4.28. Annual mean concentrations of polychlorinated biphenyls in rock bass muscle fillets, fiscal year 2021

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- $\mu\text{g/g}$ PCBs in fish fillets was used for advisories, and then for many years, an approximate range of 0.8 to 1 $\mu\text{g/g}$ 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 2007). This concentration is 0.02- $\mu\text{g/g}$ PCBs in fish fillets (TDEC 2010a, 2010b, 2010c). The mean fish PCB concentration in Upper EFPC, 0.20 $\mu\text{g/g}$ in fish fillets, is well above this concentration.

4.5.8.2. Benthic Invertebrate Surveys

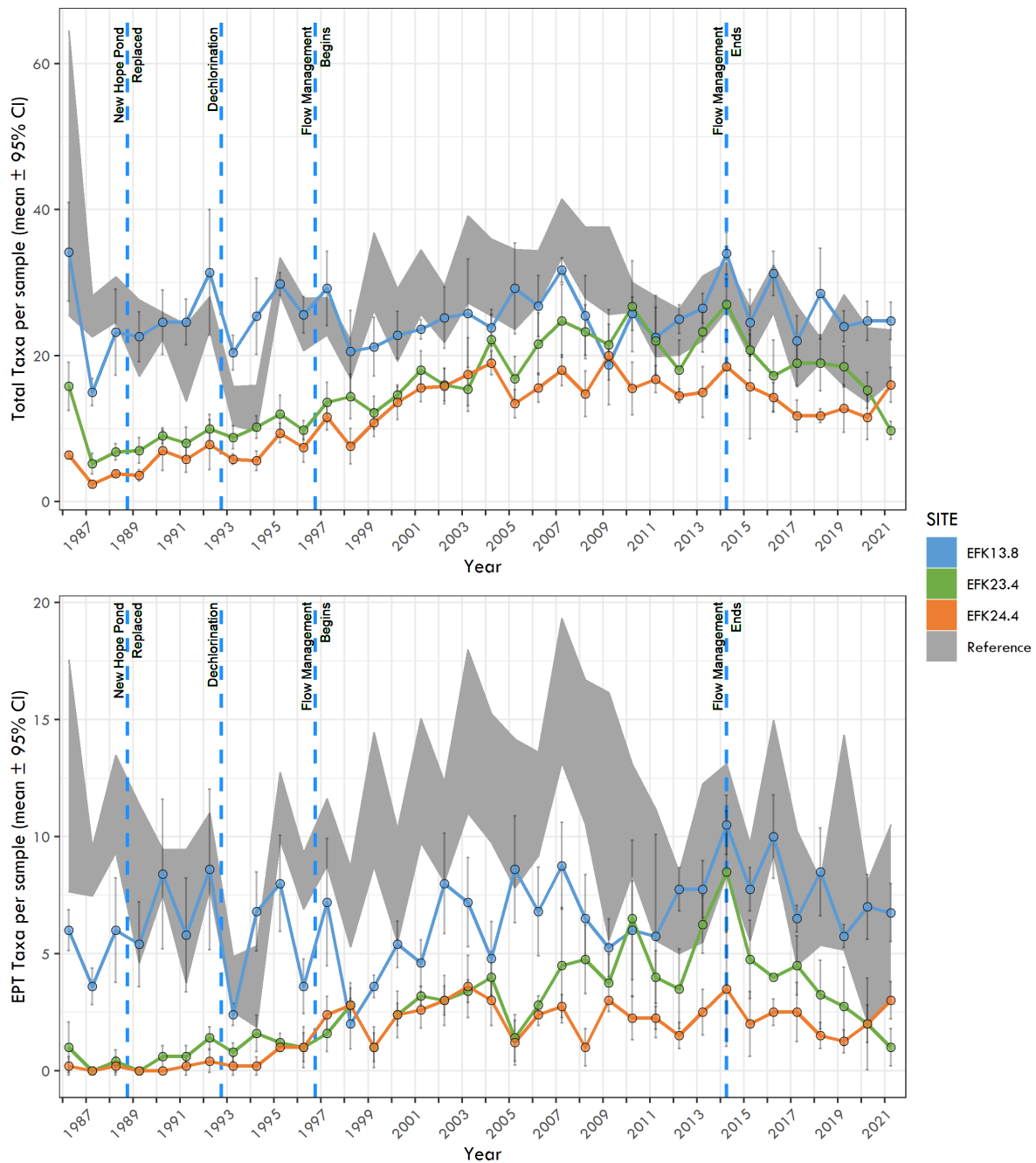
Monitoring the benthic macroinvertebrate community continued in the spring of 2021 at three sites in EFPC and at two reference streams (Brushy Fork and Hinds Creek). There have been long-term changes in the macroinvertebrate community at EFPC sites since monitoring began in 1986 (Figure 4.29).

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 4.29). After flow management ended in 2014, total taxa richness decreased at EFK 24.4 and has remained at these lower values since that time, although taxa richness in 2021 increased to a value similar to that measured before 2014. Total taxa richness at EFK 23.4 steadily increased since monitoring began, and values also decreased after flow management ceased (Figure 4.29). In 2021, this decline continued and total taxa richness at EFK 23.4 reached a value last seen in the late 1990s. Total taxa richness at EFK 13.8 and the reference sites has been fairly consistent over the entire monitoring period (Figure 4.29). 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 fallen within or above the 95-percent confidence interval of reference site values, especially in the past decade (Figure 4.29). 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 4.29).

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 4.29). 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, though values in 2021 increased to the highest levels observed in the past seven years (Figure 4.29). EPT taxa richness at EFK 23.4 steadily increased since 1986, but decreased after flow management ended (Figure 4.29). In 2021, EPT taxa richness at EFK 23.4 reached one of the lowest values observed in recent years (Figure 4.29). 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, albeit with large interannual variation. EPT taxa richness values at EFK 13.8 have been within the reference site confidence limits since 2012 (Figure 4.29).

The implications of ending flow management in 2014 on invertebrate communities in EFPC are still uncertain. After flow augmentation ceased, EPT taxa richness at EFK 23.4 has consistently declined (Figure 4.29). EPT taxa richness at EFK 24.4 has also shown a slight decrease since flow augmentation ended, with some recovery evident in 2020 and 2021 (Figure 4.29). The effects of ending flow augmentation on Lower EFPC (EFK 13.8) do not seem as evident, which makes sense as flow augmentation contributed a smaller percentage of total discharge at downstream sites. The long-term effects of ending flow management on the invertebrate community of in EFPC will become more evident as conditions stabilize and additional data become available.



Notes:

1. Top: total taxonomic richness (mean number of taxa per sample with 95 percent confidence interval).
2. Bottom: taxonomic richness of the pollution-intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera [EPT] (mean number of Ephemeroptera, Plecoptera, and Trichoptera taxa per sample with 95 percent confidence interval). April 1986–2021.
3. The timing of various activities within the watershed is shown with vertical blue lines.
4. Reference streams are Brushy Fork and Hinds Creek.

Acronyms:

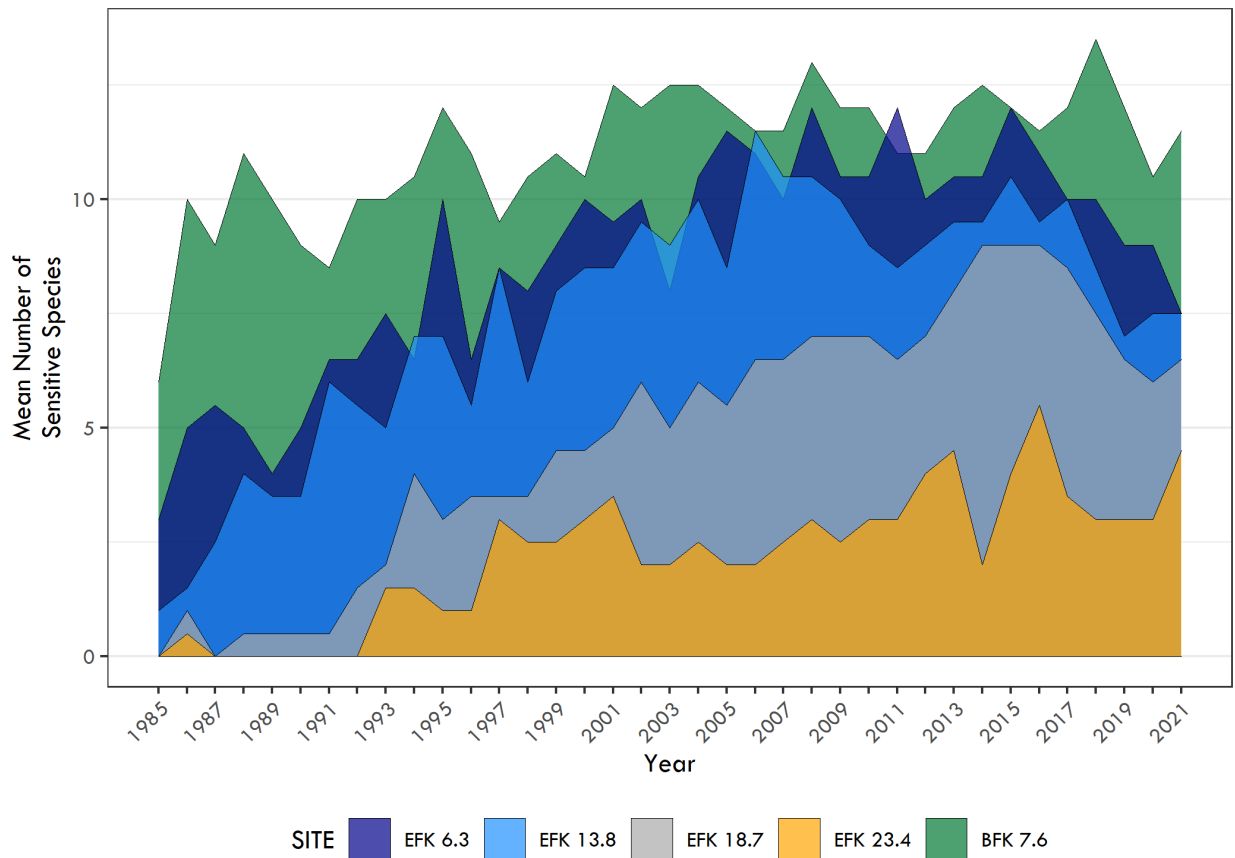
EFK = East Fork Poplar Creek kilometer
 EPT = Ephemeroptera, Plecoptera, and Trichoptera

Figure 4.29. Benthic macroinvertebrate communities in three sites along East Fork Poplar Creek and the 95 percent confidence interval for two nearby reference streams

4.5.8.3. Fish Community Monitoring

Fish communities were monitored in the spring and fall of 2021 at five sites along EFPC and at a comparable local reference stream (Brushy Fork). In the past three decades, overall species richness, density, biomass, and number of pollution-sensitive fish species improved at all sampling locations below Lake Reality. Some seasonal conditions, such as flooding and drought, can cause minor fluctuations in values but rarely cause long-term impacts on larger systems such as EFPC. However, some species of fish are considered sensitive, require very specific habitat

conditions to survive, and can only tolerate a narrow range of environmental disturbance. The mean number of sensitive species at four sites in EFPC and the reference stream is shown in Figure 4.30, dramatically highlighting major improvements in the fish community in the middle to lower sections (EFKs 6.3 and 13.8) of the stream. However, the EFPC fish community continues to lag behind the reference stream community (Brushy Fork kilometer 7.6) in the most important metrics of fish diversity and community structure, especially at the monitoring sites closest to Y-12 (EFKs 23.4 and 24.4).



Notes:

1. Mean sensitive species richness refers to the number of species.
2. Showing years 1985–2021.
3. Reference site is Brushy Fork.

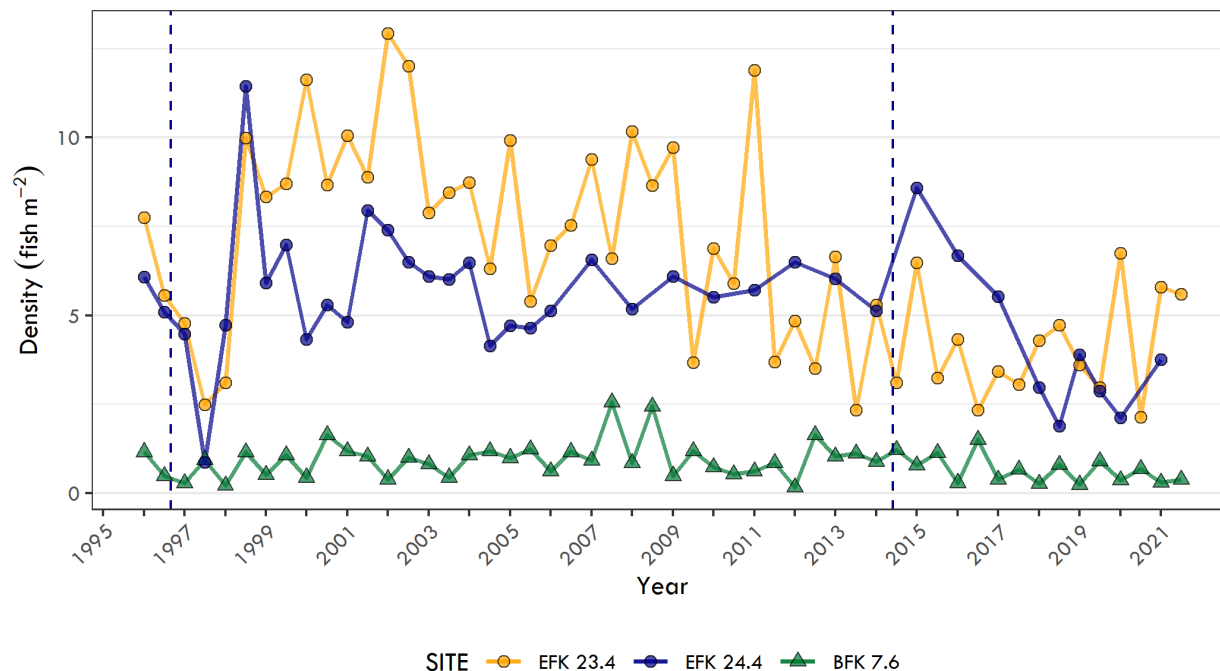
Acronyms:

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

Figure 4.30. Comparison of mean sensitive species richness collected each year from four sites in East Fork Poplar Creek and a reference site

Fish communities in Upper EFPC in 2021 continued to fluctuate in density. Reduced stream flows associated with the termination of flow augmentation from Melton Hill in April 2014 and occasional unexpected fish kills are likely factors driving the decrease in fish densities in these upper sites (Figure 4.31). Despite this, fish

diversity remained relatively consistent. Very high densities are not always a positive indicator of fish health, and the most abundant species within these sites continue to be those that are considered tolerant. Continued monitoring will provide additional insight into these variabilities.



Notes:

1. The interval of time between the dashed lines represents the period of flow management in East Fork Poplar Creek.
2. Fish density refers to the number of fish per m².
3. Reference site is Brushy Fork.

Acronyms:

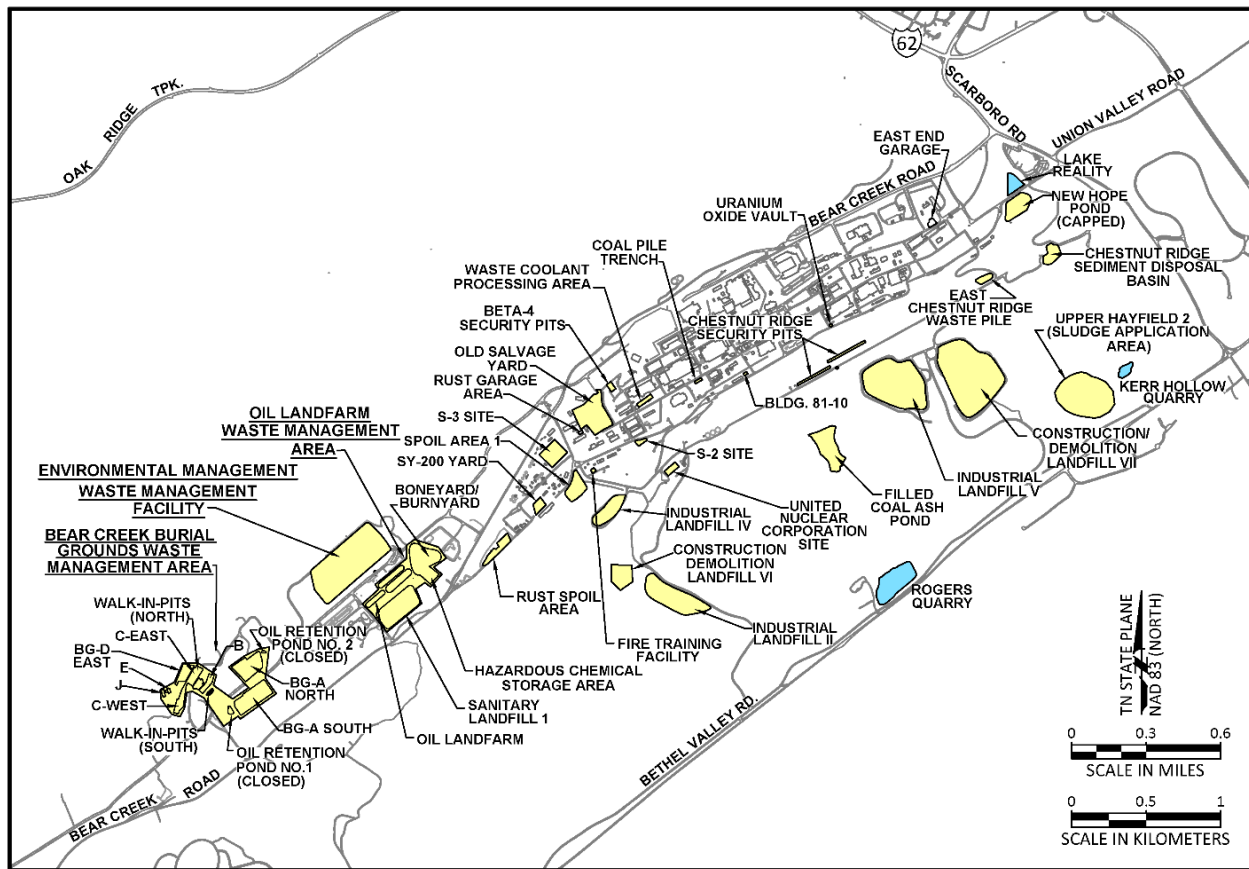
BFK = Brushy Fork kilometer
 EFK = East Fork Poplar Creek kilometer

Figure 4.31. Fish density for two sites in Upper East Fork Poplar Creek and a reference site, 1996–2021

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 2022). 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 4.32 depicts major source areas where groundwater is monitored.



Acronyms: Bldg. = building Rd = road

Figure 4.32. Known or potential contaminant source areas where groundwater is monitored at the Y-12 National Security Complex

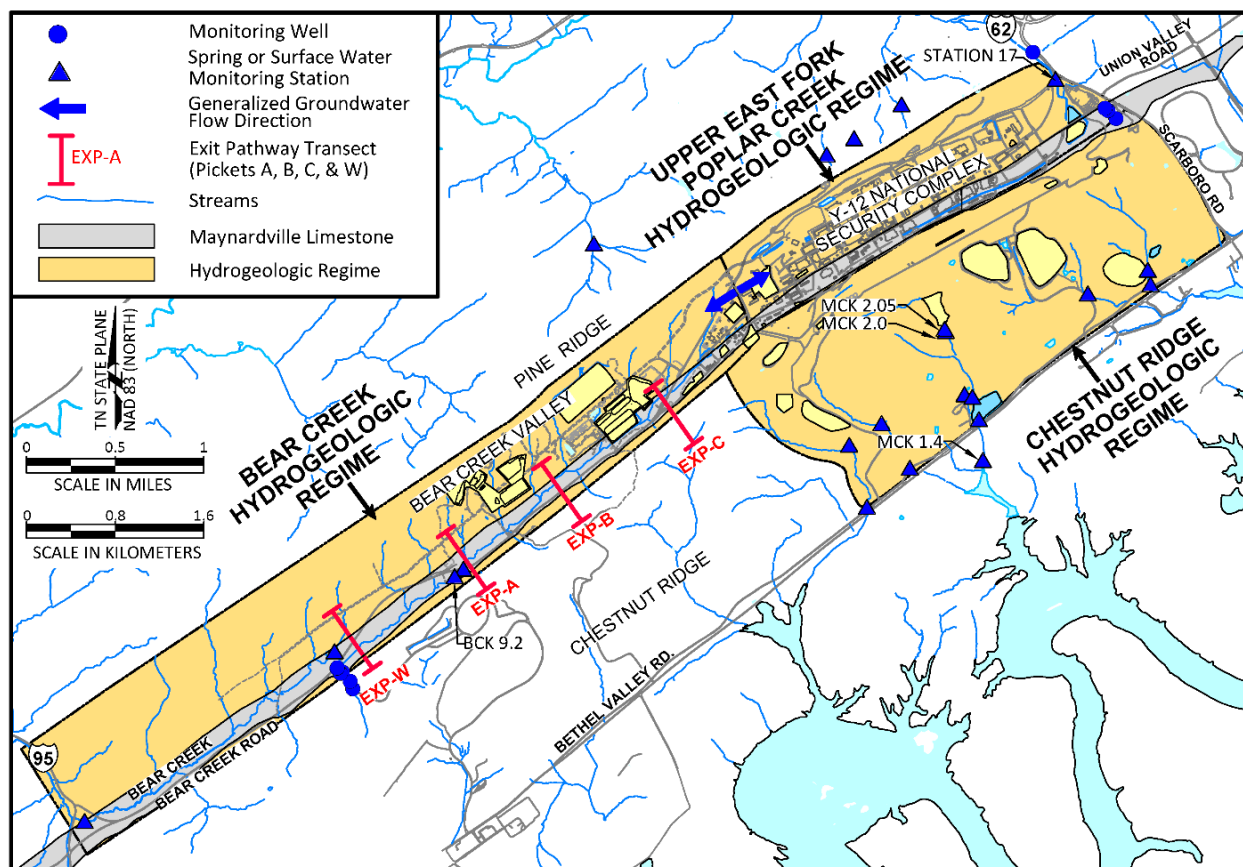
4.6.1. Hydrogeologic Setting

Y-12 is divided into three hydrogeologic regimes: Bear Creek, Upper EFPC, and Chestnut Ridge (Figure 4.33). 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 4.34). 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 4.33). Karst development in the Maynardville Limestone has a significant impact on groundwater flow paths in the water table and intermediate intervals. Groundwater flow rates in Bear Creek Valley vary; they are slow within the deep interval of the fractured non-carbonate rock (less than 10 ft/yr), but can be quite rapid within solution conduits in the Maynardville Limestone (10 to 5,000 ft/d).



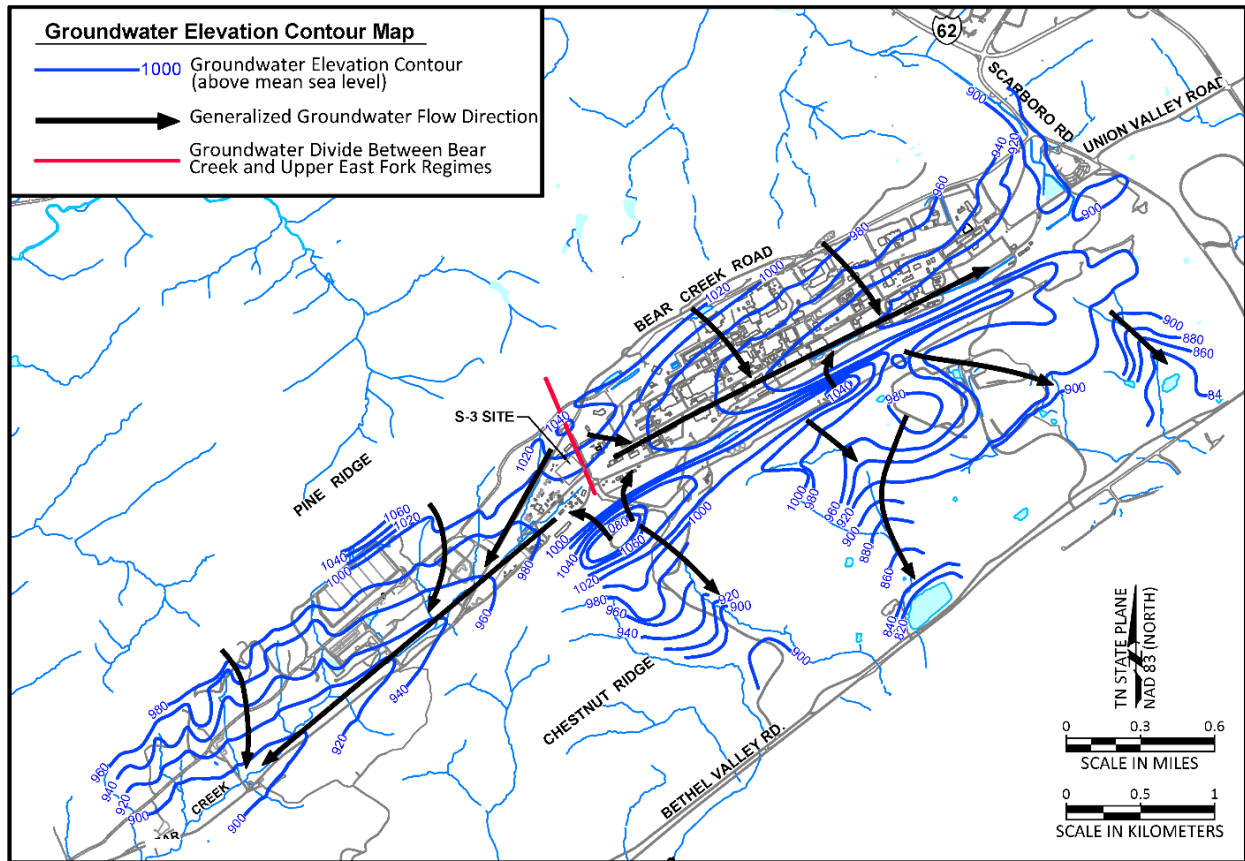
Acronym: MCK = McCoy Branch kilometer

Figure 4.33. Hydrogeologic regimes, flow directions, perimeter/exit pathway locations, and position of Maynardville Limestone at the Y-12 National Security Complex

Contaminants are transported, along with flowing groundwater, through the pore spaces, fractures, or solution conduits of the hydrogeologic system. Strike-parallel transport of some contaminants can even occur within the aquitard units for significant distances, where they discharge to surface water tributaries or underground utility and storm water distribution systems in Y-12's industrial area. For example, elevated levels of nitrate (a contaminant from legacy waste disposals) within the fractured bedrock of the aquitard are known to extend east and west from the S-2 and S-3 sites for thousands of feet. Extensive VOC contamination from multiple sources is observed in both the Bear Creek and Upper EFPC regimes, and to a lesser extent in the Chestnut Ridge regime. VOCs (e.g., petroleum products, coolants, and solvents) in groundwater

within the fractured bedrock of the aquitard units can remain close to source areas for long durations. This is because they tend to adsorb to the bedrock matrix, diffuse into pore spaces within the matrix, and very slowly diffuse back out of the matrix when concentration gradients change before migrating to exit pathways, where more rapid transport occurs for longer distances.

Groundwater flow in the Chestnut Ridge regime is through fractures and solution conduits in the Knox Group aquifer. Discharge points for intermediate and deep flow are not well known. However, following the crest of the Chestnut Ridge, water table elevations decrease from west to east, demonstrating an overall easterly trend in groundwater flow.



Acronym: Rd = road

Figure 4.34. Groundwater elevation contours and flow directions at the Y-12 National Security Complex

4.6.2. Calendar Year 2021 Groundwater Monitoring

Groundwater monitoring in CY 2021 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 194 wells and 50 surface water

locations and springs (Table 4.20). (Locations sampled for research projects [not compliance requirements] are not included in the totals of 194 and 50 in the previous sentence.) Specific wells of interest based on CY 2021 data are called out later in this section. However, Figure 4.33 shows the locations of perimeter/exit pathway stations that are routinely monitored.

Table 4.20. Summary of groundwater monitoring at the Y-12 National Security Complex, 2021

Purpose for which monitoring was performed					
	Restoration ^a	Waste management ^b	Surveillance ^c	Other ^d	Total
Number of active wells	56	33	105	36	230
Number of other monitoring stations (e.g., springs, seeps, and surface water)	29	6	15	3	53
Number of samples taken ^e	179	125	121	13	438
Number of analyses performed	9,257	8,331	9,657	13	27,258
Percentage of analyses that are non-detects	65.0	93.2	83.9	NA	80
Ranges of results for positive detections, VOCs (µg/L) ^f					
Chloroethenes	0.24–2,900	2.94–6.33	1–62,000	NA	
Chloroethanes	0.29–290	63.3–67.9	1–1,400	NA	
Chloromethanes	0.33–1,000	ND	1–560	NA	
Petroleum hydrocarbons	0.21–5,700	ND	1–660	NA	
Uranium (mg/L)	0.00012–0.29	0.0001–0.00597	0.000517–0.31	NA	
Nitrates (mg/L)	0.006–4,700	0.54–1.29	0.0657–9,700	NA	
Ranges of results for positive detections, radiological parameters (pCi/L) ^g					
Gross-alpha activity	2.54–470	1.3–5.06	4.2–260	NA	
Gross-beta activity	0.89–4,750	2.59–13.4	7.9–630	NA	

^a Monitoring to comply with Comprehensive Environmental Response, Compensation, and Liability Act requirements.

^b Solid waste landfill detection monitoring and CERCLA landfill detection monitoring.

^c US Department of Energy (DOE) Order surveillance monitoring.

^d Research-related groundwater monitoring associated with activities of the DOE Oak Ridge Field Research Center and Ecosystems and Networks Integrated with Genes and Molecular Assemblies.

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

^f These ranges reflect concentrations of individual contaminants (not summed VOC concentrations):

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

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

Chloromethanes—includes carbon tetrachloride, chloroform, and methylene chloride.

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

^g pCi = 3.7×10^{-2} Bq

Acronyms:

NA = not analyzed

ND = not detected

VOC = volatile organic compound

Water quality results of groundwater monitoring activities in CY 2021 are presented in the *Calendar Year 2021 Groundwater Monitoring Report* (CNS 2022). The groundwater sampling technicians shown in Figure 4.35 are taking water quality samples from a well at the crest of Chestnut Ridge. The wells at the crest of the ridge are deep and compressed nitrogen is used to push the groundwater up from depth (see the red hose in the photo).

Monitoring efforts performed specifically for CERCLA baseline and remediation evaluation are published in the FYs 2021 and 2022 Water Resources Restoration Program Sampling and Analysis Plans (UCOR 2020, 2021a, respectively) and the Annual CERCLA Remediation Effectiveness Reports (DOE 2021b, 2022).

No wells were installed, and no wells were plugged and abandoned in CY 2021.



Figure 4.35. Groundwater monitoring well sampling at the Y-12 National Security Complex

4.6.3. Y-12 National Security Complex Groundwater Quality

Historical monitoring shows that four primary contaminants adversely affect groundwater quality at Y-12: nitrate, VOCs, metals, and radionuclides. Of those, VOCs are the most widespread. Uranium and ^{99}Tc are the radionuclides of greatest concern. Trace metals (e.g., arsenic, barium, cadmium, chromium, and mercury), the least extensive groundwater contaminants, generally occur close to source areas because of their high adsorption characteristics. Data show that plumes from multiple-source units have mixed with one another and that contaminants are not always easily associated with a single source.

4.6.3.1. Upper East Fork Poplar Creek Hydrogeologic Regime

Among the three hydrogeologic regimes, the Upper EFPC regime contains most of the known and potential sources of contamination. (Summary descriptions of waste management sites shown on Figure 4.32 were provided in previous-year ASERs—e.g., for CY 2017 and before—and are not repeated this year.) Contaminants from the S-3 site (nitrate and ^{99}Tc) and VOCs from multiple source areas are observed in groundwater in the western portion of the Upper EFPC regime, whereas groundwater in the eastern portion of the regime is predominantly contaminated with VOCs.

Plume Delineation

Sources of contaminants monitored during CY 2021 include the S-2 site, Fire Training Facility, S-3 site, Waste Coolant Processing Facility, former petroleum USTs, New Hope Pond, Old Salvage Yard, and process/production buildings throughout Y-12. The S-3 site is near the hydrologic divide that separates the Upper EFPC regime from the Bear Creek regime, and has contributed groundwater contamination to both regimes. Contaminant plumes in both regimes (shown in orange shading on Figures 4.36, 4.37, 4.40, and 4.41) are elongated as a result of

preferential transport of contaminants parallel to strike (parallel to the valley axis) in both the Knox aquifer and the fractured bedrock of the aquitard.

The plumes depicted reflect the average concentrations and radioactivity in groundwater between CYs 2013 and 2017. The circular icons presented on the plume maps (Figures 4.36, 4.37, 4.40, and 4.41) represent CY 2021 monitoring results for the Upper EFPC regime (discussed in this section), the Bear Creek regime (discussed in Section 4.6.4.2), and the Chestnut Ridge regime (discussed in Section 4.6.4.3).

Nitrate

Nitrate is highly soluble and moves easily with groundwater. In the central and western portions of Upper EFPC, nitrate concentrations exceed the 10-mg/L drinking water standard. (A list of the national drinking water standards is presented in Appendix C.) The two primary sources of nitrate contamination are the S-2 and S-3 sites. Formerly, these were ponds that received large quantities of nitric acid wastes. In CY 2021, there was a maximum nitrate concentration of 8,150 mg/L in well GW-275. This well is located ~396 m (1,300 ft) east of the S-3 site and is screened in the shallow-intermediate bedrock interval about 20 m (65 ft) below ground surface (Figure 4.36).

The divergent concentration trends in nitrate at wells GW-274 and GW-275 demonstrate the complex nature of the subsurface flow systems. Over the last two decades, GW-275 has shown an increasing trend (approximately 7,000 to approximately 9,000 mg/L), while the nearby shallower well (GW-274, screened at 31 ft below ground surface) has a decreasing trend, including nitrate, at 408 mg/L in CY 2021 compared to 5,410 mg/L in CY 2010. The increasing trend in well GW-275 indicates that the nitrate plume center of mass is approaching the well, while the decreasing trend in well GW-274 could reflect the higher groundwater flow through the shallow subsurface, which flushes the zone with uncontaminated water, thus attenuating concentrations. The next highest nitrate concentration was found in well GW-108 at 4,700 mg/L.

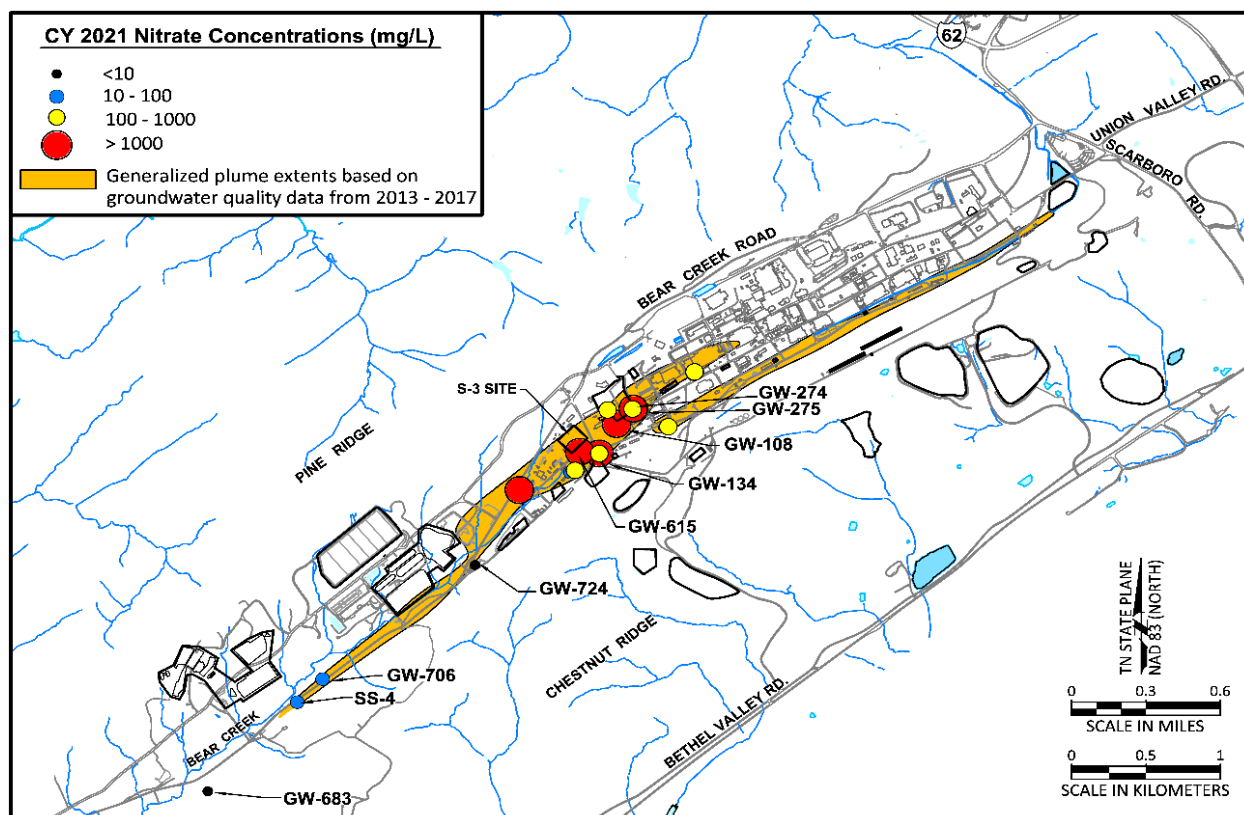


Figure 4.36. Nitrate in groundwater at the Y-12 National Security Complex, 2021

Trace Metals

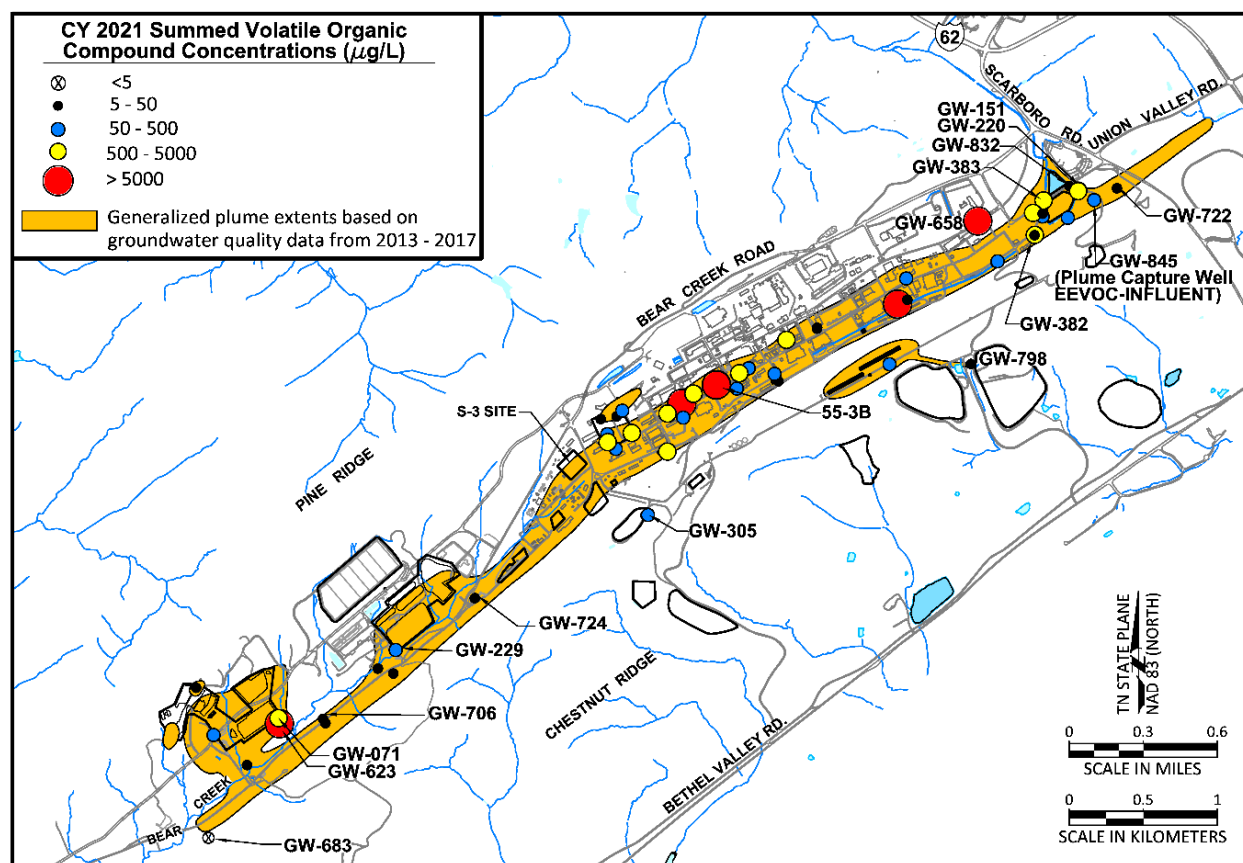
In CY 2021, antimony, barium, beryllium, cadmium, chromium, copper, nickel, thallium, and uranium exceeded primary drinking water standards in groundwater in the Upper EFPC regime. Uranium was found predominately downgradient of the S-2, S-3, and New Hope Pond sites. Trace metal concentrations above standards occur adjacent to source areas because of their low solubility and high adsorption to the clay-rich soils and bedrock.

VOCs

VOCs, the most widespread contaminants in the Upper EFPC regime, consist of chlorinated and petroleum hydrocarbons. In CY 2021, the highest summed concentration of dissolved chlorinated hydrocarbons (73,157 $\mu\text{g/L}$) was again at well 55-3B in the western portion of Y-12, adjacent to currently inactive manufacturing facilities. The

highest dissolved concentration of petroleum hydrocarbons was again at well GW-658 (13,863 $\mu\text{g/L}$) 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 4.37). Additional sources are the Waste Coolant Processing Facility, fuel facilities (Rust Garage and East End Garage), and other waste disposal and production areas. Chloroethene compounds (tetrachloroethene [PCE], trichloroethene [TCE], dichloroethene [DCE], and vinyl chloride) tend to dominate the VOC plume in the western and central portions of Y-12. However, PCE is almost ubiquitous throughout, indicating many source areas. Chloromethane compounds (carbon tetrachloride, chloroform, and methylene chloride) are the predominant VOCs in the eastern portion of Y-12.

**Acronyms:**

CY = calendar year

EEVOC = East End Volatile Organic Compound

Rd = road

Figure 4.37. Summed volatile organic compounds in groundwater at the Y-12 National Security Complex, 2021

Variability in concentration trends of chlorinated and petroleum VOCs is seen within the Upper EFPC regime. 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. As shown in Figure 4.38, well GW-382 has shown a decrease in summed VOCs. These decreasing and stable trends west of New Hope Pond are indicators that contaminants are attenuating due to (1) dilution by uncontaminated groundwater, (2) dispersion through a network of fractures and conduits, (3) degradation by chemical or biological means, and/or (4) adsorption by surrounding bedrock

and soil media. In addition to the factors mentioned above, in CY 2000, plume capture well GW-845 began operations to capture the East End VOC plume, mitigating migration off the ORR into Union Valley (see additional information in the Exit Pathway and Perimeter Monitoring section). There appears to be a correlation between the decrease in VOC concentrations in well GW-382 and the initiation of pumping at well GW-845 in CY 2000. In contrast, some wells, such as shallow well GW-383 (with an increasing VOC trend) do not appear to be impacted by this plume capture system.

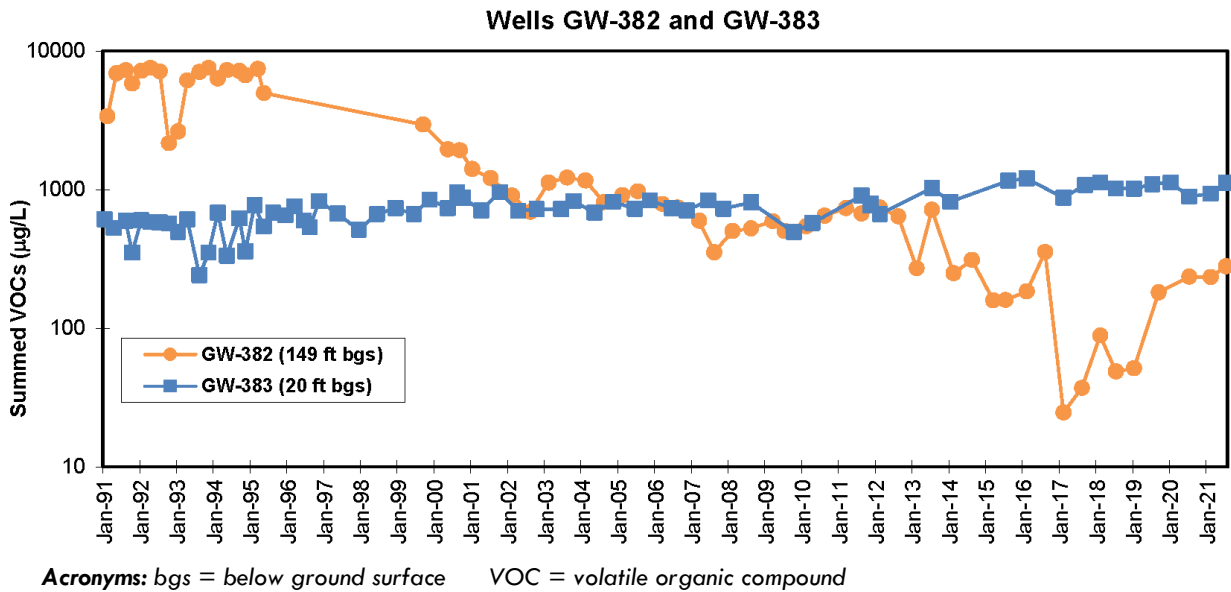


Figure 4.38. Summed volatile organic compounds for GW-382 and GW-383 in the East Fork regime

Increasing trends have been observed in wells associated with the Rust Garage, Old Salvage Yard, and S-3 site; some legacy sources at production/process facilities in central areas; and even the East End VOC plume (see Figure 4.39). These trends near the East End VOC plume show that contaminants in shallow-intermediate wells

located perpendicular to strike across lithologic units from the plume capture system installed in GW-845 may be mobilized by the system. However, no downgradient detection of these compounds is apparent; therefore, migration is limited.

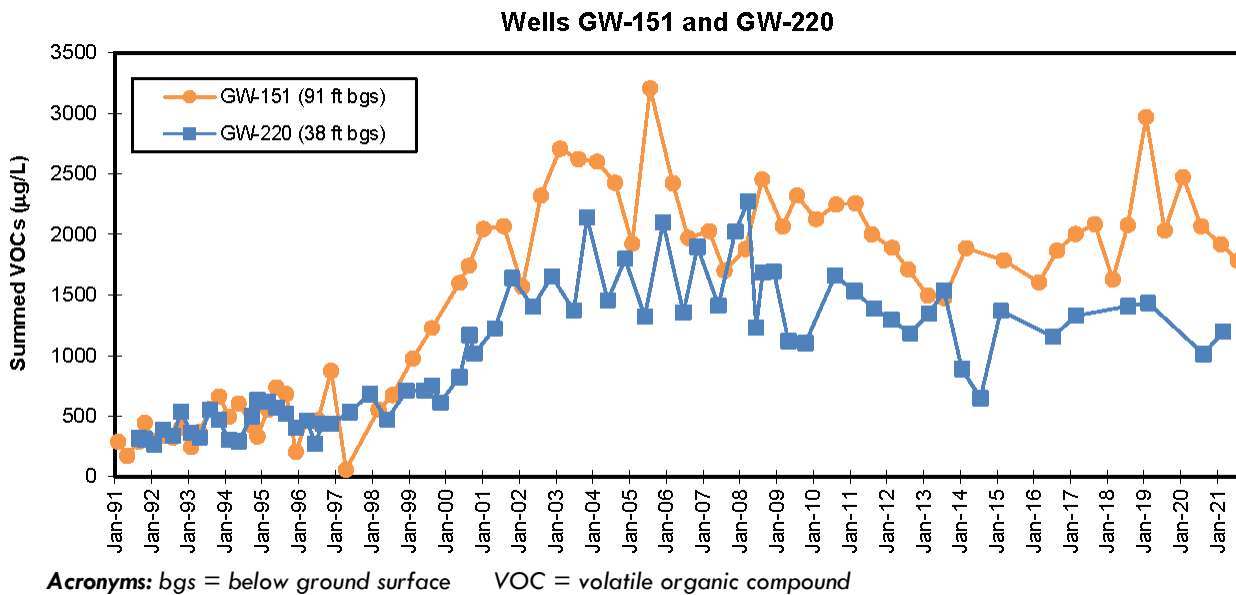


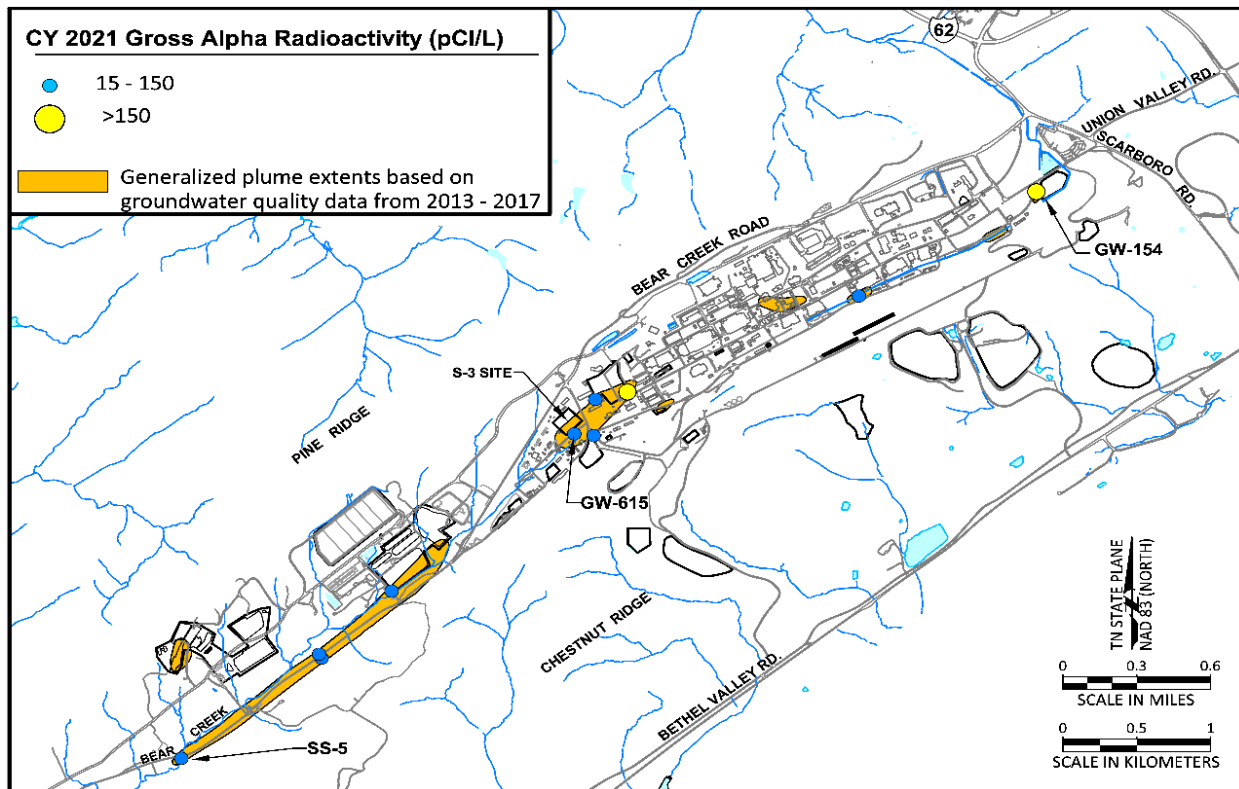
Figure 4.39. Summed volatile organic compounds for GW-151 and GW-220 in the East Fork regime

Radionuclides

The primary alpha-emitting radionuclides found in the Upper EFPC regime during CY 2021 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 CY 2021, the maximum occurrence of gross-alpha activity in groundwater in the Upper EFPC regime was 470 pCi/L, again at well GW-154 near the former oil skimmer basin. (See Figure 4.40.)

The primary beta-emitting radionuclides observed in the Upper EFPC regime are ⁹⁹Tc and isotopes of uranium. Historically, elevated gross-beta activity in groundwater shows a pattern similar to that observed for gross-alpha activity. (See Figure 4.41.)

Technetium-99 is the primary contaminant exceeding the gross-beta screening level of 50 pCi/L; the source is the S-3 site. The highest gross-beta activity in groundwater was observed during CY 2021 from well GW-108 (4,750 pCi/L), lower than the 9,300 pCi/L measured in CY 2020.



Acronyms: CY = calendar year Rd = road

Figure 4.40. Gross-alpha activity in groundwater at the Y-12 National Security Complex, 2021

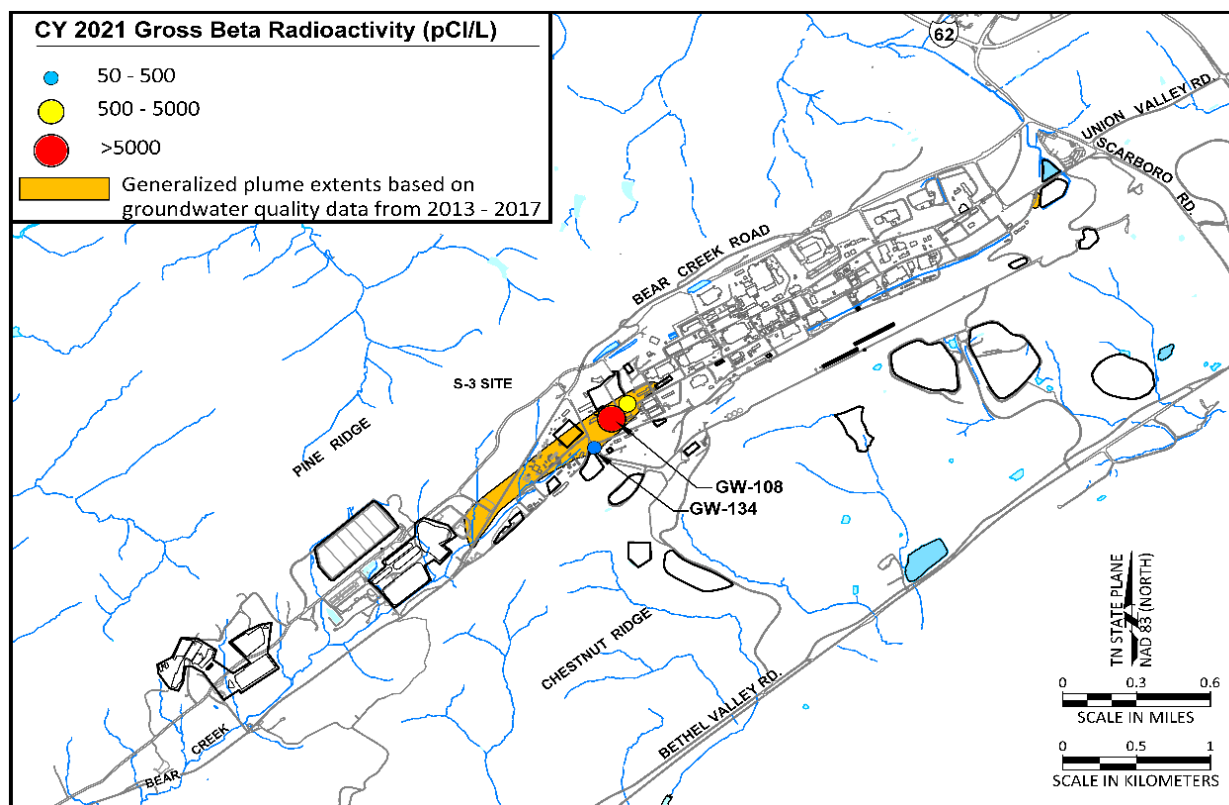


Figure 4.41. Gross-beta activity in groundwater at the Y-12 National Security Complex, 2021

Exit Pathway and Perimeter Monitoring

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

Due to 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 4.37) and began continuous operation in October 2000.

Groundwater is continuously pumped from the Maynardville Limestone at about 95 L/min (25 gal/min), passes through a treatment system to remove the VOCs, and then discharges to Upper EFPC. The effectiveness of this system is reported annually in Remediation Effectiveness Reports published by DOE EM (DOE 2021b, 2022).

As explained previously for well GW-382, monitoring wells near the plume capture system continue to show an encouraging response. Another example is observed in the Westbay system installed in well GW-722. This multiport well, located downgradient from the East End VOC Treatment System, allows sampling of several vertically discrete zones within the Maynardville Limestone. Monitoring results from well GW-722 indicate reductions in VOCs due to the plume capture system, derived from summed VOC levels above 1,000 $\mu\text{g/L}$ before the treatment system was installed to below 50 $\mu\text{g/L}$ in the last three CYs.

Five zones in well GW-722 were sampled in CY 2021, with all zones showing summed VOCs greater than 5 $\mu\text{g/L}$. Four zones exceeded the drinking water standard for carbon tetrachloride, with the highest concentration (22 $\mu\text{g/L}$) measured at zone 722-20 (333 ft below ground

surface). This zone 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 CY 2021, the summed concentrations of VOCs at the New Hope Pond distribution channel underdrain remained low (19.7–22.9 µg/L).

Upper EFPC flows north exiting Y-12 through a gap in Pine Ridge. As mentioned previously, shallow groundwater mimics the creek and also moves through this exit pathway. One well in this pathway gap was monitored in CY 2021, and no groundwater contaminants were observed above primary drinking water standards.

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

Union Valley Monitoring

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

In CY 2021, monitoring of locations in Union Valley continued, showing overall decreasing or

low-concentration stable trends. Vinyl chloride at 1.5 µg/L (below the maximum contaminant level of 2 mg/L) was detected at monitoring well GW-230, located east of Illinois Avenue in the University of Tennessee Arboretum (off the map and approximately 3,500 ft east of the ORR boundary). A groundwater flow divide west of well GW-230, coincident with Scarboro Creek, Illinois 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 ROD, administrative controls (i.e., restrictions on potential future groundwater use) have been established and maintained. Additionally, the previously discussed plume capture system (well GW-845) was installed to mitigate the migration of groundwater contaminated with VOCs into Union Valley (DOE 1997b).

In July 2006, the Agency for Toxic Substances and Diseases Registry—the principal federal public health agency charged with evaluating the human health effects of exposure to hazardous substances in the environment—published a report in which groundwater contamination across 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 ROD do not provide for reduction in toxicity, mobility, or volume of contaminants of concern, but it concluded the controls are protective of public health to the extent that they limit or prevent community exposure to contaminated groundwater in Union Valley.

4.6.3.2. Bear Creek Hydrogeologic Regime

Located west of Y-12 in Bear Creek Valley, the Bear Creek regime is bounded to the north by Pine Ridge and to the south by Chestnut Ridge. The regime encompasses the portion of Bear Creek Valley extending from the west end of Y-12 to State Highway 95. Descriptions of waste management sites in the Bear Creek regime and shown on Figure 4.32 were provided in previous year ASERs (e.g., in CY 2017 and previous) and are not repeated this year.

Plume Delineation

The primary contaminants in the Bear Creek regime are nitrate, trace metals, VOCs, and radionuclides. The S-3 site is a source of all four contaminants. The Bear Creek Burial Grounds and Oil Landfarm waste management areas are sources of uranium, other trace metals, and VOCs. Chlorinated hydrocarbons and PCBs have been observed in groundwater as deep as 82 m (270 ft) below the Bear Creek Burial Grounds (MMES 1990).

Contaminant plume boundaries are constrained by the bedrock formations (particularly the Nolichucky Shale) that underlie the waste disposal areas in the Bear Creek regime. This fractured aquitard unit is north of and adjacent to the exit pathway unit, the Maynardville Limestone (an aquifer). The elongated shape of the plumes in the Bear Creek regime is the result of preferential transport of the contaminants parallel to strike (parallel to the valley axis).

The plumes in the Bear Creek regime (Figures 4.36, 4.37, 4.40, and 4.41) represent the average concentrations and radioactivity between CYs 2013 and 2017. The circular icons presented on the figures represent CY 2021 monitoring results.

Nitrate

CY 2021 data indicate nitrate in groundwater continues to exceed the drinking water standard (10 mg/L) in an area that extends west from the S-3 site. The highest nitrate concentration (9,700 mg/L) was observed at well GW-615 adjacent to the S-3 site at a depth of 75 m (247 ft) below ground surface. Historically, elevated concentrations of nitrate (>1,000 mg/L) have been detected at greater depths (>700 ft below ground surface) near the S-3 site. In CY 2021, a concentration exceeding the drinking water standard was detected in groundwater as far as 2,438 m (8,000 ft) west of the S-3 site, from spring location SS-4 (11 mg/L).

WestBay multiport monitoring well GW-134 was sampled in CY 2021. Figure 4.42 shows a diagram of four of the well ports along with nitrate data from CYs 1999, 2011, and 2021. The data show a continuing decreasing trend in the two shallow zones and a continuing increasing trend in the two deep zones indicating a dip-controlled, density-driven movement of the plume created by historic waste management practices at the former S-3 Ponds.

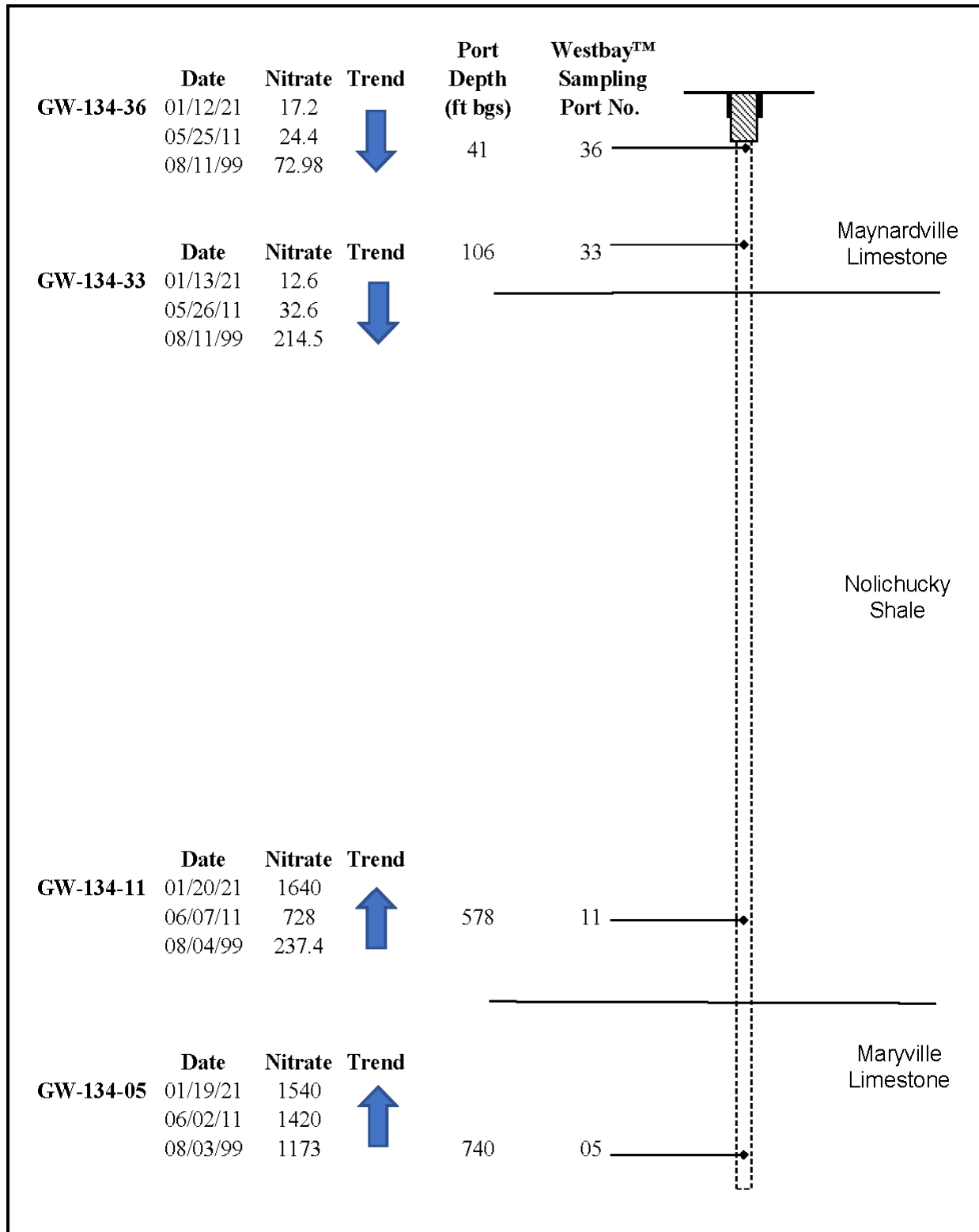


Figure 4.42. Nitrate for four zones in GW-134 in the Bear Creek regime, 2021

Trace Metals

During CY 2021, arsenic, barium, cadmium, and uranium were identified as trace metal contaminants in the Bear Creek regime that exceeded primary drinking water standards. Elevated concentrations of many of the trace metals were observed at shallow depths near the S-3 site. Disposal of acidic liquid wastes at the S-3 site reduced the pH of the groundwater, which allows the metals to remain in solution longer and migrate further from the source area. In other areas of the Bear Creek regime, where natural

geochemical conditions prevail, the trace metals may occur sporadically and in close association with source areas because conditions are typically not favorable for dissolution and migration.

The most prevalent trace metal contaminant is uranium. There has been a decrease in uranium in Bear Creek since 1990 (Table 4.2); 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 4.21. 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	2020–2021
BCK ^b -11.84 to 11.97 (~0.5 miles downstream)	Nitrate	91.9	75.2	43.4	24.0
	Uranium	1.61	0.124	0.183	0.174
BCK-09.20 to 09.47 (~2 miles downstream)	Nitrate	12.4	11.3	4.8	2.65
	Uranium	0.096	0.115	0.061	0.05
BCK-04.55 (~5 miles downstream)	Nitrate	3.8	2.5	0.96	1.04
	Uranium	0.033	0.028	0.018	0.015

^a Excludes results that do not meet data quality objectives.

^b BCK = Bear Creek kilometer, measured upstream from the confluence with East Fork Poplar Creek.

VOCs

VOCs are widespread in groundwater in the Bear Creek regime. The primary compounds are PCE; TCE; cis-1,2-DCE; vinyl chloride; and 1,1-dichloroethane. In most areas, they are dissolved in groundwater and can occur in bedrock at depths up to 92 m (300 ft) below ground surface. VOCs that occur in groundwater of the fractured bedrock aquitard units are found within about 305 m (1,000 ft) laterally of source areas.

The highest concentration observed in CY 2021 occurred in the Nolichucky Shale aquitard at the Bear Creek Burial Ground waste management area, with a maximum summed VOC concentration of 6,833 µg/L in well GW-623 (Figure 4.37); TCE at 3,800 µg/L, 1,1-dichloroethane at 1,400 µg/L, and PCE at 1,100 µg/L comprised most of the summed total. Decreasing trends of summed VOCs and cis-1,2-DCE are shown in GW-071 and GW-229, respectively (see Figures 4.43 and 4.44). Biodegradation at GW-229 is indicated by an increase in vinyl chloride.

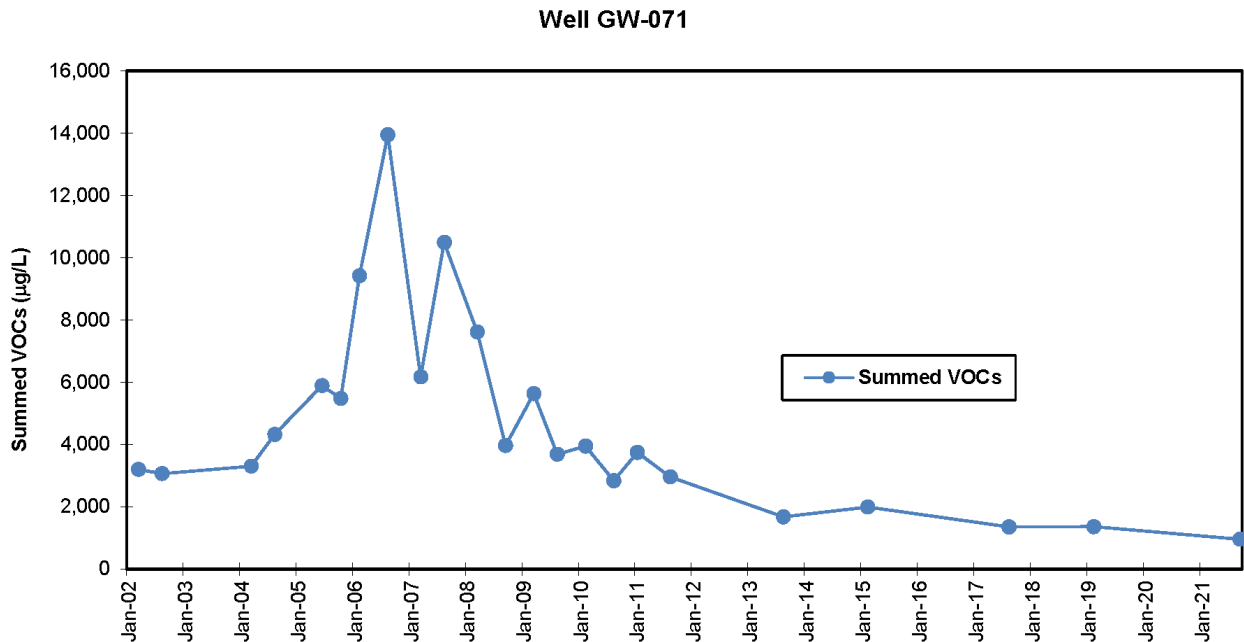


Figure 4.43. Volatile organic compounds in GW-071 at the Bear Creek Burial Ground waste management area, 2021

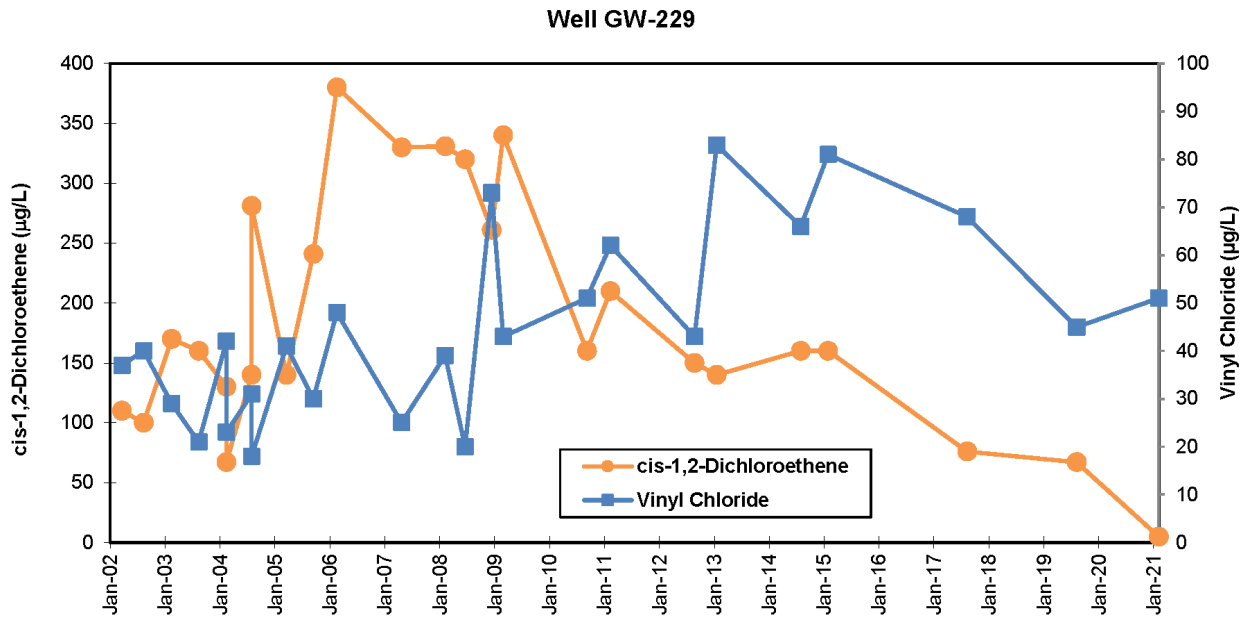


Figure 4.44. Volatile organic compounds in GW-229 at the Bear Creek Burial Ground waste management area, 2021

Radionuclides

As in the EFPC regime, the primary radionuclides identified in the Bear Creek regime are isotopes of uranium and ^{99}Tc . The extent of radionuclides in groundwater in the Bear Creek regime during CY 2021 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 4.40).

In CY 2021, the highest gross-alpha activity observed in a monitoring well in the Bear Creek regime (110 pCi/L) was in GW-615 (see Figure 4.40).

In CY 2021, the highest gross-beta activity in groundwater in the Bear Creek regime was in zone 5 (750 ft bgs) at well GW-134 (82 pCi/L) adjacent to the S-3 site (see Figure 4.41).

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 been performed identifying 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 (Picket W)

serves as the perimeter well location for the Bear Creek regime (Figure 4.33).

Exit pathway monitoring consists of continued monitoring at four well transects (pickets) and selected springs and surface water stations. Data obtained during CY 2021 indicate groundwater is contaminated above drinking water standards in the Maynardville Limestone as far as Picket W (Figure 4.37). The drinking water standard for gross-alpha was exceeded (23.4 pCi/L) in deep well GW-710. Historically, this well has presented elevated levels of gross-alpha activity. This well at 164.6 m (540 ft) below ground surface is affected by deep brine water that likely contains radium and radon, which could account for the elevated gross-alpha activity. Concentration trends throughout the exit pathway continue to be generally stable to decreasing (Figure 4.45).

In CY 2020, GW-713 in exit pathway transect W (Figure 4.33) showed a trace concentration (0.62 $\mu\text{g/L}$) of TCE (below drinking water standards), thus indicating migration of contaminants potentially thousands of feet from likely sources areas to the east (e.g., Boneyard/Burnyard, the S-3 site, or Spoil Area 1). However, TCE in this same well in CY 2021 was not detected.

Surface water samples collected in CY 2021 indicate water in Bear Creek contains many of the same compounds found in the groundwater. Uranium concentrations exceeding the drinking water standard have been observed in surface water west of the Burial Grounds as far as Picket W. The concentrations in the creek generally decrease with distance downstream of the waste disposal sites (Table 4.21).

Exit pathway monitoring stations sampled in CY 2020 show that gross-alpha activity in the Maynardville Limestone and the surface waters of Bear Creek was undetectable at SS-5 for the first time since CY 2005. This location is over 3,353 m (11,000 ft) west of the S-3 site, and in the recent past, has shown activities of 31 pCi/L in CY 2017, 19 pCi/L in CY 2018, and 17 pCi/L in CY 2019, continuing with the decreasing trend in CY 2020. However, in CY 2021, the gross-alpha activity was 16 pCi/L, back above the drinking water standard of 15 pCi/L.

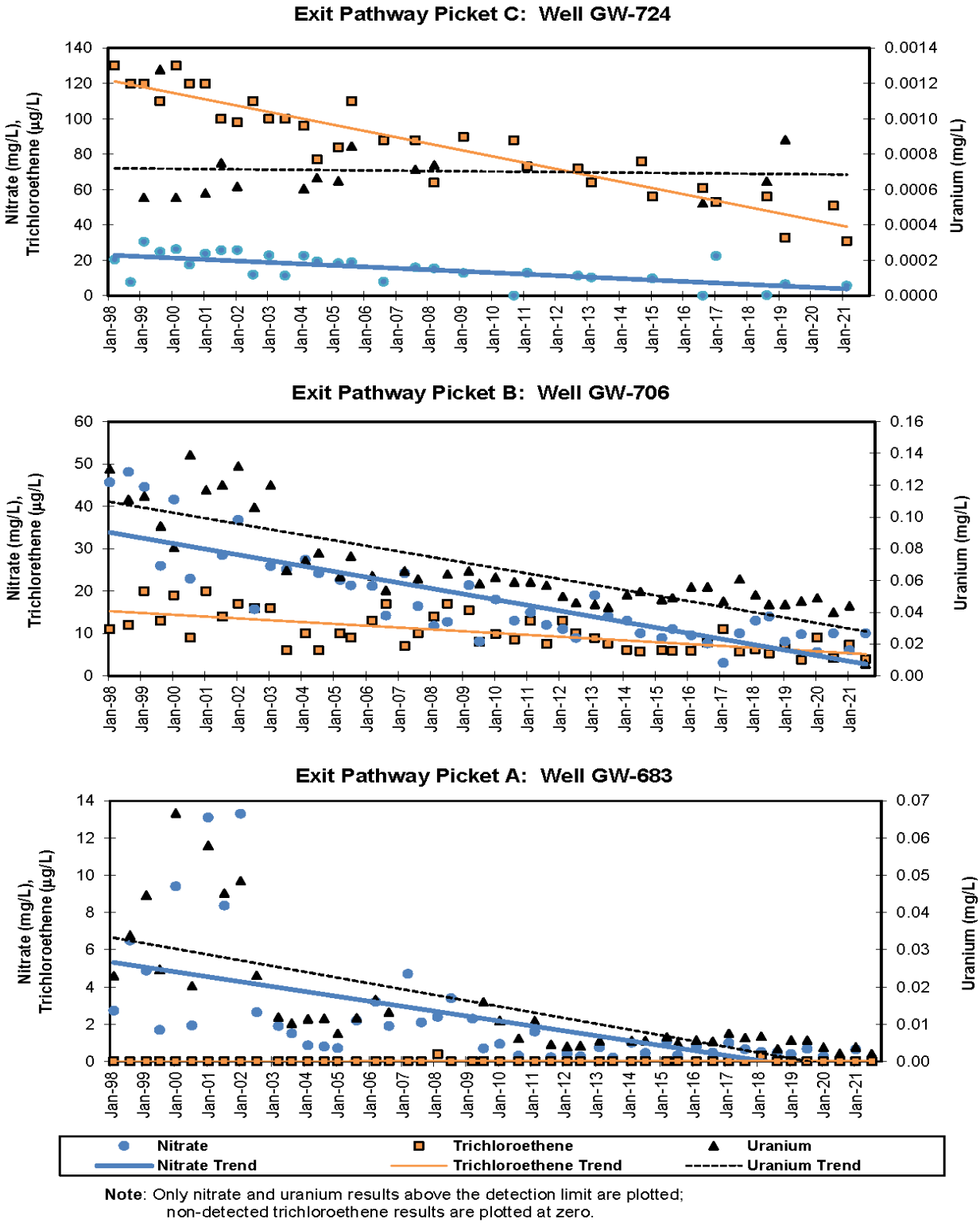


Figure 4.45. Concentrations of selected contaminants in exit pathway monitoring wells in the Bear Creek hydrogeologic regime, 2021

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 4.33). The regime encompasses the portion of Chestnut Ridge extending from Scarboro Road, east of the complex, to Dunaway Branch, located just west of Industrial Landfill II. Descriptions of waste management sites in the Chestnut Ridge regime and shown on Figure 4.32 were provided in previous year ASERs (i.e., CY 2017 and previous) and are not repeated this year.

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

Plume Delineation

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

Data obtained during CY 2021 indicate the western lateral extent of the VOCs plume at the site has not changed significantly. VOC contaminants at a well about 458 m (1,500 ft) southeast and downgradient of the Chestnut Ridge Security Pits (well GW-798 at 10.73- $\mu\text{g}/\text{L}$ summed total VOCs; Figure 4.37) continue to show some migration of the eastern plume has occurred. Additionally, previously performed dye tracer test results and the intermittent detection of trace concentrations of VOCs (similar to those found in wells adjacent to the Chestnut Ridge Security Pits) at a natural spring about 2,745 m (9,000 ft) to the east and along geologic strike may suggest that Chestnut Ridge Security Pits contaminants have migrated further than the monitoring well network indicates. However, as in CY 2019 and

CY 2020, no VOCs were detected at this spring in CY 2021.

The Chestnut Ridge Security Pits plume in the Chestnut Ridge regime (shown by orange shading on Figure 4.37) represents the average VOC concentrations between CYs 2013 and 2017. The circular icons presented on the figure represent CY 2021 monitoring results.

Nitrate

Nitrate concentrations continue to be below the drinking water standard at all monitoring stations in the Chestnut Ridge regime in CY 2021.

Trace Metals

Concentrations of arsenic above drinking water standards have been observed in two surface water monitoring locations downstream from the Filled Coal Ash Pond, which is monitored under a CERCLA ROD (DOE 1996). Under the ROD, migration of contaminated effluent from the Filled Coal Ash Pond is reduced by a constructed wetland area. In recent years, it became apparent the wetland efficiency was decreasing, in part, because of erosion channels forming around the wetland. During CY 2019, a maintenance activity was conducted at the site to improve the aquatic habitat for plant growth and to increase retention time for water within the wetland (DOE 2020e). The elevated arsenic levels were detected both upgradient (McCoy Branch kilometer [MCK] 2.05) and downgradient (MCK 2.0) of this wetland area (Figure 4.33). In CY 2021, the passive wetland treatment area continued to be effective in reducing arsenic. A surface water monitoring location (MCK 1.4) about 1,021 m (3,900 ft) downstream from the Filled Coal Ash Pond was also sampled during CY 2021. Arsenic concentrations were detected below the drinking water standard (0.010 mg/L) at 0.0032 mg/L in March and 0.003 mg/L in September, and are an order of magnitude below the arsenic concentrations at the MCK 2.0 and MCK 2.05 locations.

VOCs

Overall, concentrations of VOCs in groundwater at the Chestnut Ridge Security Pits have decreased since 1988. The maximum summed VOC concentration observed at well GW-798 during CY 2021 was 10.73 µg/L, down from 65.66 µg/L in CY 2019 and 30.57 µg/L in CY 2020. The VOCs detected in well GW 798 continue to be characteristic of the Chestnut Ridge Security Pits.

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 4.37), exhibited increasing trends of summed VOCs from 1992 to 2014, but has stabilized since with the CY 2021 concentration at 73.94 µg/L. GW-305 was sampled in January and July 2020 with results for 1,1-DCE of 7.21 µg/L and 7.14 µg/L, respectively; both above the drinking water standard (7 µg/L). In January and July of CY 2021, the 1,1-DCE results were 6.04 µg/L and 6.33 µg/L, both below the drinking water standard.

Radionuclides

In CY 2021, no gross-alpha or gross-beta activity above the drinking water standards of 15 and 50 pCi/L, respectively, was observed in the Chestnut Ridge hydrogeologic regime.

Exit Pathway and Perimeter Monitoring

Contaminant and groundwater flow paths in the karst bedrock underlying the Chestnut Ridge regime have not been well characterized. Tracer studies have been conducted that show groundwater from Chestnut Ridge discharging into Scarboro Creek (approximately 9,000 ft from the Chestnut Ridge Security Pits) and other tributaries that feed into Melton Hill Lake. However, no springs or surface streams that represent discharge points for groundwater have been conclusively correlated to a waste management unit or operation at Y-12 that is a known or potential groundwater contaminant source. Springs along Scarboro Creek are monitored for water quality, and trace

concentrations of VOCs are intermittently detected. The detected VOCs are suspected to originate from the Chestnut Ridge Security Pits; however, this has not been confirmed. In CY 2021, 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. Seven springs and three surface water monitoring locations were sampled during CY 2021. 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)

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

In CY 2021, Y-12 Environmental Sampling Services and TDEC-DoR-OR performed reconnaissance soil and sediment sampling for PFAS at four locations along Bear Creek and one location at Pinkhook Branch (see Figure 4.46). The samples were analyzed for 18 different PFAS using method EPA 537.1. The results are shown in Table 4.22.

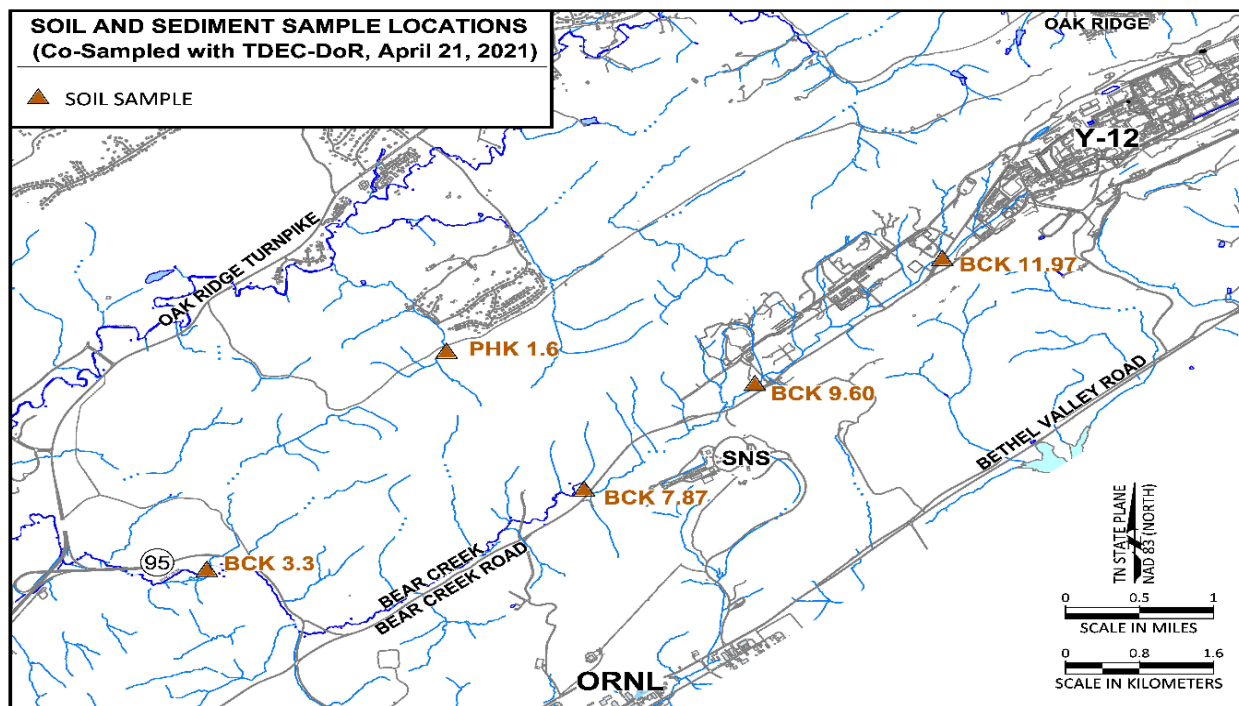


Figure 4.46. Soil and Sediment Sample Locations for PFAS reconnaissance co-sampling with TDEC

Table 4.22. Summary of soil and sediment sampling results for PFAS at the Y-12 National Security Complex, April 21, 2021

	PFOS(ng/g)	PFOA(ng/g)	GenX(ng/g)	PFBS(ng/g)	Other(ng/g) ^a	ND ^b
BCK11.97	4.78	0.364*	ND*	ND*	0.428*-0.407*	72
BCK09.60	3.96	0.908	ND	ND	0.733-0.337*	61
BCK07.87	1.74	0.455*	ND	ND	0.342*-0.212*	67
BCK3.3	0.579*	ND	ND	ND	ND	95
PHK1.6 ^c	0.721	ND	ND	ND	ND	95

* Result is estimated

^a Value reflects range of concentrations of individual PFAS

^b Percentage of analysis that resulted in no detection of PFAS

^c This location was the designated background location for this reconnaissance sampling effort.

Acronyms:

GenX = Hexafluoropropyleneoxide dimer acid

ND = not detected

ng/g = nanograms per gram

PFAS = Per- and polyfluoroalkyl substances

PFBS = Perfluorobutane sulfonic acid

PFOA = Perfluorooctanoic acid

PFOS = Perfluorooctane sulfonic acid

The following actions and activities were conducted at Y-12 during CY 2021 to address these emerging contaminants of concern:

- Y-12 became compliant with new DOE requirements pertaining to PFAS storage, use, and disposal during CY 2021 (DOE, 2021b, DOE 2021c).
 - No PFAS-containing aqueous film-forming foam (AFFF) was used for training purposes and no new AFFF systems were installed in CY 2021. Existing AFFF systems are only approved for use in fire emergencies.
 - Measures were taken to minimize fire protection personnel and the environment from exposure to PFAS-containing AFFF.
 - PFAS-containing AFFF are stored in accordance with DOE orders and directives, laws, and regulations. No disposal of PFAS-containing AFFF occurred during CY 2021.
 - Any new releases or spills of PFAS-containing AFFF will be reported to DOE Headquarters.
- Current and historic uses of 176 PFAS or PFAS-related substances are being tracked using the Y-12 Hazardous Material Information System. No PFAS substances were used in excess of the EPCRA TRI reporting threshold during CY 2021.
- One waste storage building (9720-09) has an AFFF fire suppression system.
 - Y-12 personnel drained and replaced the AFFF from this system. The replacement AFFF contains short-chain C-6 fluorochemicals manufactured using a fluorotelomer-based process. The fluorotelomer process produces no PFOS, and the C-6 chains do not break down to yield Perfluorooctanoic acid (PFOA). This new product meets the goals of the EPA 2010/2015 PFOA Stewardship Program.

- Post maintenance testing protocols of the AFFF system were improved during CY 2021 and will be carried out in all future testing of the system.
- Y-12 has a fire department and fire training facility onsite. The Y-12 Fire Department has one firetruck with a foam induction system.
 - The foam used in the foam induction system was changed to a fluorine-free foam in CY 2021.
 - There were no releases of AFFF to the environment by the Y-12 Fire Department during CY 2021.
- No production-related activities, equipment, or processes are known to have generated or released PFAS to the environment. However, a number of products/chemicals containing PFAS have been used in small quantities, primarily in the Analytical Chemistry Organization laboratories and in the Development Organization Facilities.

4.7. Quality Assurance Program

Y-12's QA Program establishes a quality policy and requirements for the overall QA Program for the Y-12 site. Management requirement E-SD-0002, *Quality Assurance Program Description*, details the methods used to carry out work processes safely and securely and in accordance with established procedures (CNS 2019). It also describes mechanisms in place to seek continuous improvements by identifying and correcting findings and preventing recurrences.

Many factors can potentially affect the results of environmental data-collection activities, including sampling personnel, methods, and procedures; field conditions; sample handling, preservation, and transport; personnel training; analytical methods; data reporting; and record keeping. QA programs are designed to minimize these sources of variability and to control all phases of the monitoring process.

Field sampling QA encompasses many practices that minimize error and evaluate sampling performance. Some key quality practices include the following:

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

Y-12's Environmental Sampling Services are responsible for field sampling activities, sample preservation and handling, chain-of-custody, and transport field QC samples in accordance with Y-12 Environmental Compliance's internal procedures. Environmental Sampling Services developed a Standards and Calibration Program that conforms to ISO/International Electrotechnical Commission 17025, *General Requirements for the Competence of Testing and Calibration Laboratories* (ISO 2005, 2017), and provides a process for uniform standardization, calibration, and verification of measurement and test equipment. The Standards and Calibration Program ensures measurements are made using appropriate, documented methods; traceable standards; appropriate measurement and test equipment of known accuracy; trained personnel; and technical best practices.

Analytical results may be affected by a large number of factors inherent to the measurement process. Laboratories that support Y-12 environmental monitoring programs use internal QA/QC programs to ensure the early detection of problems that may arise from contamination, inadequate calibrations, calculation errors, or improper procedure performance. Internal

laboratory QA/QC programs include routine calibrations of counting instruments; yield determinations; include frequent use of check sources and background counts, replicate and spiked sample analyses, and matrix and reagent blanks; and include maintenance of control charts to indicate analytical deficiencies. These activities are supported by the use of standard materials or reference materials (e.g., materials of known composition that are used in the calibration of instruments, methods standardization, spike additions for recovery tests, and other practices). Certified standards traceable to National Institute of Standards and Technology, DOE sources, or EPA are used (when available) for such work.

Y-12's Analytical Chemistry Organization QA Manual describes QA Program elements that are based on Y-12's QA Program; customer-specific requirements; certification program requirements; ISO/International Electrotechnical Commission 17025, *General Requirements for Competence of Testing and Calibration Laboratories* (ISO 2005, 2017); federal, state, and local regulations; and waste acceptance criteria. As a government-owned, contractor-operated laboratory that performs work for DOE, the Analytical Chemistry Organization laboratory operates in accordance with DOE Order 414.1D, Quality Assurance (DOE 2011e).

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

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

Verification and validation of environmental data are performed as components of the data-

collection process, which includes planning, sampling, analyzing, and performing data review. Some level of verification and validation of field and analytical data collected for environmental monitoring and restoration programs is necessary to ensure that data conform to applicable regulatory and contractual requirements. Validation of field and analytical data is a technical review performed to compare data with established quality criteria to ensure that data are adequate for the intended use. The extent of project data verification and validation activities is based on project-specific requirements.

For routine environmental effluent monitoring and surveillance monitoring, data-verification activities may include processes of checking whether data have been accurately transcribed and recorded, appropriate procedures have been followed, electronic and hard-copy data show one-to-one correspondence, 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 the identification of data that do not meet predetermined QC criteria or in the ultimate rejection of data for their intended use. Typical criteria evaluated in the validation of contract laboratory program data include the percentage of surrogate recoveries, spike

recoveries, method blanks, instrument tuning, instrument calibration, continuing calibration verifications, internal standard response, comparison of duplicate samples, and sample holding times.

4.8. Environmental Management and Waste Management Activities

The three sites on ORR have a rich history of research, innovation, and scientific discovery that shaped the course of the world. Unfortunately, today, 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 OREM is working to clean those areas under the Federal Facility Agreement with the EPA and TDEC. The *Cleanup Progress: Annual Report on Oak Ridge Reservation Cleanup* (UCOR 2021) provides detailed information on DOE OREM's 2021 cleanup activities [here](#).

4.8.1. Environmental Management Activities

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

Biology Complex Demolition

In 2021, DOE OREM finished tearing down the former Biology Complex at Y-12. This high-priority project involved tearing down the massive six-story, 255,000 square-foot Building 9207 and the three-story, 65,000-square-foot Building 9210. These were the final two structures remaining from the original 11-building complex that dated back to the 1940s. This effort eliminated deteriorating, high-risk facilities, and it

cleared an 18-acre area that Y-12 will reuse to support national security missions.

Alpha 4 COLEX Equipment Deactivation

Alpha-4, also known as Building 9201-4, is one of Y-12's largest high-risk, excess facilities due to its deteriorated condition and mercury contamination. Cleanup contractor UCOR undertook planning to deactivate the four-story, 500,000-square-foot facility and began deactivating one of the two remaining collections of old, mercury-contaminated equipment connected to the facility—known as column exchange process (COLEX) equipment.

In 2018, UCOR demolished the COLEX equipment on the west end of the building after retrieving 4.6 tons of mercury. The effort prevented a possible significant release of mercury into the surrounding environment.

UCOR completed deactivating the COLEX structures on the east end of the building in 2021, and crews captured another 1.25 tons of mercury from cleanup in those pipes and tanks. This project prevents a potential significant environmental release and moves EM a step closer to addressing the Alpha-4 facility.

Mercury Treatment Facility Construction

Progress continues on construction of the Outfall 200 Mercury Treatment Facility. Excavation activities took place at both the Treatment Plant and Headworks sites. Shoring walls were being installed at the Headworks site during the fiscal year. Crews have poured concrete pads and installed rebar for the walls of the treatment plant.

The facility is the linchpin for OREM's cleanup strategy at Y-12. This vital piece of infrastructure will open the door for demolition of Y-12's large, deteriorated, mercury-contaminated facilities and subsequent soil remediation by providing a mechanism to limit potential mercury releases into the Upper East Fork Poplar Creek. When operational, the facility will be able to treat 3,000 gallons of water per minute and help Oak Ridge meet regulatory limits in compliance with EPA and state of Tennessee requirements.

The facility is slated to be operational in 2025.

New Technologies Assisting in Mercury Cleanup

Mercury remediation is OREM's highest priority at the Y-12 National Security Complex due to the large losses of the element in buildings, soils, and surface waters in previous decades.

OREM is making significant investments into the development of new remediation technologies to help address the complex mercury challenge at Y-12. In the near-term, mercury technology development activities will support the successful completion of the demolition of Y-12's mercury-contaminated facilities and soils remediation, waste disposition, and reduction of mercury-related ecological risks in East Fork Poplar Creek.

Experiments are underway in ORNL's newly upgraded Aquatic Ecology lab, which provides a testbed for evaluating the effectiveness of remediation technologies in a flow-through system using actual water from East Fork Poplar Creek. This upgrade allows for the testing of technologies beyond the bench-scale and creates a more environmentally relevant testing conditions to ensure greater effectiveness when remediation strategies are implemented in the field.

Researchers have conducted studies to evaluate alternative treatment chemicals on mercury flux, the effect of sorbents on mercury and methylmercury concentrations in the presence of dissolved organic matter, and the use of mussels as a tool for reducing mercury in the water column.

In FY 2021, a new task was added that focuses on understanding how periphyton, a complex assemblage of algae and bacteria, varies with space, time, and other environmental variables (light, nutrients, etc.) in stream environments. Periphyton have been recognized to play a major role in mercury methylation and bioaccumulation, but the factors controlling periphyton abundance are not well understood. Unmanned aerial vehicles equipped with sensors were used to better understand the spatial coverage of periphyton in mercury-contaminated streams.

In addition to the technology development activities, efforts have been initiated to identify and demonstrate emerging technologies to aid in addressing the mercury challenges. A mercury review committee has been chartered and consists of members from DOE, its contractors, and subject matter experts. The committee serves as the primary resource to evaluate and select proposed new technologies for relevance and potential value, to help identify key technology needs for mercury projects at Y-12, to determine priorities and timing for demonstrations, and to evaluate demonstration results.

Deactivation of Unneeded Y-12 Facilities

Several Y-12 facilities are being deactivated in preparation for eventual demolition. Among them were Alpha-2 (Building 9201-2) and Beta-1 (Building 9204-1). The three-story Alpha-2 building, with a footprint of 107,619 square-feet, is in a cold and dark state, meaning all power sources to the building have been cut. The multi-level Beta-1 facility stands on a footprint of 75,012 square feet. Workers removed more than 31 tons of asbestos and universal waste from Alpha-2 and Beta-1 combined.

4.8.2. Waste Management Activities

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

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

Most of the waste generated during FY 2021 cleanup activities in Oak Ridge went to disposal facilities on the ORR. The Environmental Management Waste Management Facility received 9546 waste shipments, totaling 65,400 yd³, from cleanup projects at ETTP, ORNL, and Y-12. This engineered landfill consists of six disposal cells that only accept low-level radioactive and

hazardous waste meeting specific criteria. These wastes include soil, dried sludge and sediment, building debris, and personal protective equipment.

4.8.2.2. Solid Waste Disposal

DOE operates and maintains solid waste disposal facilities called the ORR Landfills. In FY 2021, these three active landfills received 11,842 waste shipments, totaling 145,289 yd³ of waste.

4.8.2.3. Wastewater Treatment

NNSA at Y-12 treats wastewater generated from both production and environmental cleanup activities. Safe and compliant treatment of more than 65 million gal of wastewater and groundwater was provided at various facilities during CY 2021:

- The West End Treatment Facility and the Central Pollution Control Facility at Y-12 processed approximately 784,000 gal of wastewater, primarily in support of NNSA operational activities.
- The Big Springs Water Treatment System treated more than 49 million gal of mercury-contaminated groundwater.
- The East End VOC Treatment System treated 13 million gal of VOC-contaminated groundwater.
- The Liquid Storage Facility and Groundwater Treatment Facility treated more than 2.5 million gal of leachate from burial grounds and well purge waters from remediation areas.
- The Central Mercury Treatment System treated approximately 1.2 million gal of mercury-contaminated sump waters from the Alpha-4 building.

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