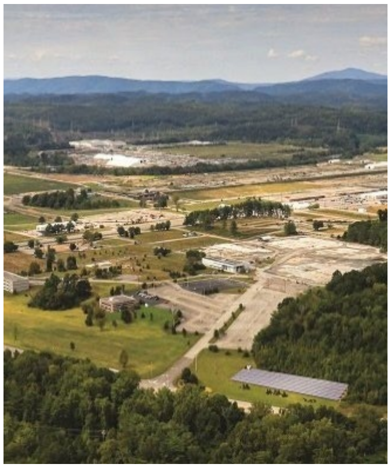


The East Tennessee Technology Park has changed greatly in recent years as remediation projects have been completed.

3

East Tennessee Technology Park

ETTP was built during World War II as part of the Manhattan Project. Formerly known as the K-25 Site, its primary mission was to enrich uranium for use in atomic weapons. After the war, the mission changed to include the enrichment of uranium for nuclear reactor fuel elements and recycling of uranium recovered from spent fuel, and the name changed to the "Oak Ridge Gaseous Diffusion Plant" (ORGDP). In the 1980s, a reduction in demand for nuclear fuel resulted in the shutdown of the enrichment process and production. The emphasis of the mission then changed to environmental management and remediation operations. In 1996, the name changed to the "East Tennessee Technology Park."

Environmental management and remediation consist of waste management, the cleanup of outdoor storage and disposal areas, the demolition and cleanup of facilities, land restoration, environmental monitoring, and the proper disposal of waste generated from production operations. Beginning in the 1990s, reindustrialization (the conversion of underused government facilities for use by the private sector) became part of ETTP's mission. State and federally mandated effluent monitoring and environmental surveillance involve the collection and analysis of air, water, soil, sediment, and biota samples from ETTP and surrounding areas. Monitoring results are used to assess exposures to the public and the environment, evaluate the performance of treatment systems, and identify concerns within permitted standards for emissions and discharges. On November 10, 2015, DOE and the US Department of the Interior (DOI) signed a memorandum of agreement (MOA) establishing the Manhattan Project National Historical Park (DOE 2015). The MOA defines agency roles and responsibilities in park administration and provisions for enhanced public access, management, interpretation, and historic preservation. The ORGDP footprint is included within the Manhattan Project National Historical Park. Details are available on the Manhattan Project National Historical Park page of the National Park Service website, **here**, and the K-25 Virtual Museum website details its history through narrative, interviews, and photographs, found **here**.

3.1. Description of Site and Operations

Construction of the K-25 Site (Figure 3.1) began in 1943 as part of the World War II Manhattan Project. The plant's original mission was the production of enriched uranium for nuclear weapons. Enrichment was initially carried out in the S-50 thermal diffusion process facility, which operated for one year, and the K-25 and K-27 gaseous diffusion process buildings. Later, the K-29, K-31, and K-33 buildings were built to increase the production capacity of the original facilities by raising the assay of the feed material entering K-27. Following the war years, the site became officially known as ORGDP.

After military production of highly enriched uranium was concluded in 1964, the two original process buildings were shut down. For the next 20 years, the plant's primary mission was the production of low enriched uranium fabricated into fuel elements for nuclear reactors throughout the world. Other missions during the latter part of this 20-year period included developing and testing the gas centrifuge method of uranium enrichment and laser isotope separation research and development.

By 1985, the demand for enriched uranium declined, and the gaseous diffusion cascades at ORGDP were placed in standby mode. That same year, the gas centrifuge program was canceled. The decision to permanently shut down the diffusion cascades was announced in late 1987, and actions necessary to implement that decision were initiated soon thereafter. Because of the termination of the original and primary missions, ORGDP was renamed the "Oak Ridge K-25 Site" in 1989. Figure 3.2 shows the ETTP site areas before the start of decontamination and decommissioning (D&D) activities. In 1996, the K-25 Site was renamed the "East Tennessee Technology Park" to reflect its new mission.

Figure 3.3 shows the ETTP areas designated for D&D activities through 2021. The ETTP mission is to reindustrialize and reuse site assets through leasing and/or transferring excess or underused land and facilities and by incorporating commercial industrial organizations as partners in the ongoing environmental restoration, D&D, and waste treatment and disposal. The site is undergoing environmental cleanup of its land, as well as D&D of most of its buildings. The cleanup approach makes land and various types of buildings (e.g., office, manufacturing) suitable for private industrial use and for title transfer to the Community Reuse Organization of East Tennessee (CROET) or other entities such as the City of Oak Ridge. The long-term DOE goal for ETTP is to transfer as much of the site property as practicable out of DOE ownership and into CROET's control for the development of a commercial business and industrial park. The facilities may then be subleased or sold, with the goal of stimulating private industry and recruiting business to the area. These transfers also reduce maintenance costs for DOE, which frees up additional money for environmental cleanup. The reuse of key facilities through title transfer is part of the site's closure plan.

UCOR, the lead environmental management contractor for ETTP, supports DOE in the reindustrialization program as part of the continuing effort to transform ETTP into a private-sector industrial park. Unless otherwise noted, information about non-DOE entities located on the ETTP site is not provided in this document.

Figure 3.1. The K-25 Site in 1946

Figure 3.2. East Tennessee Technology Park since the start of decontamination and decommissioning activities in 1991

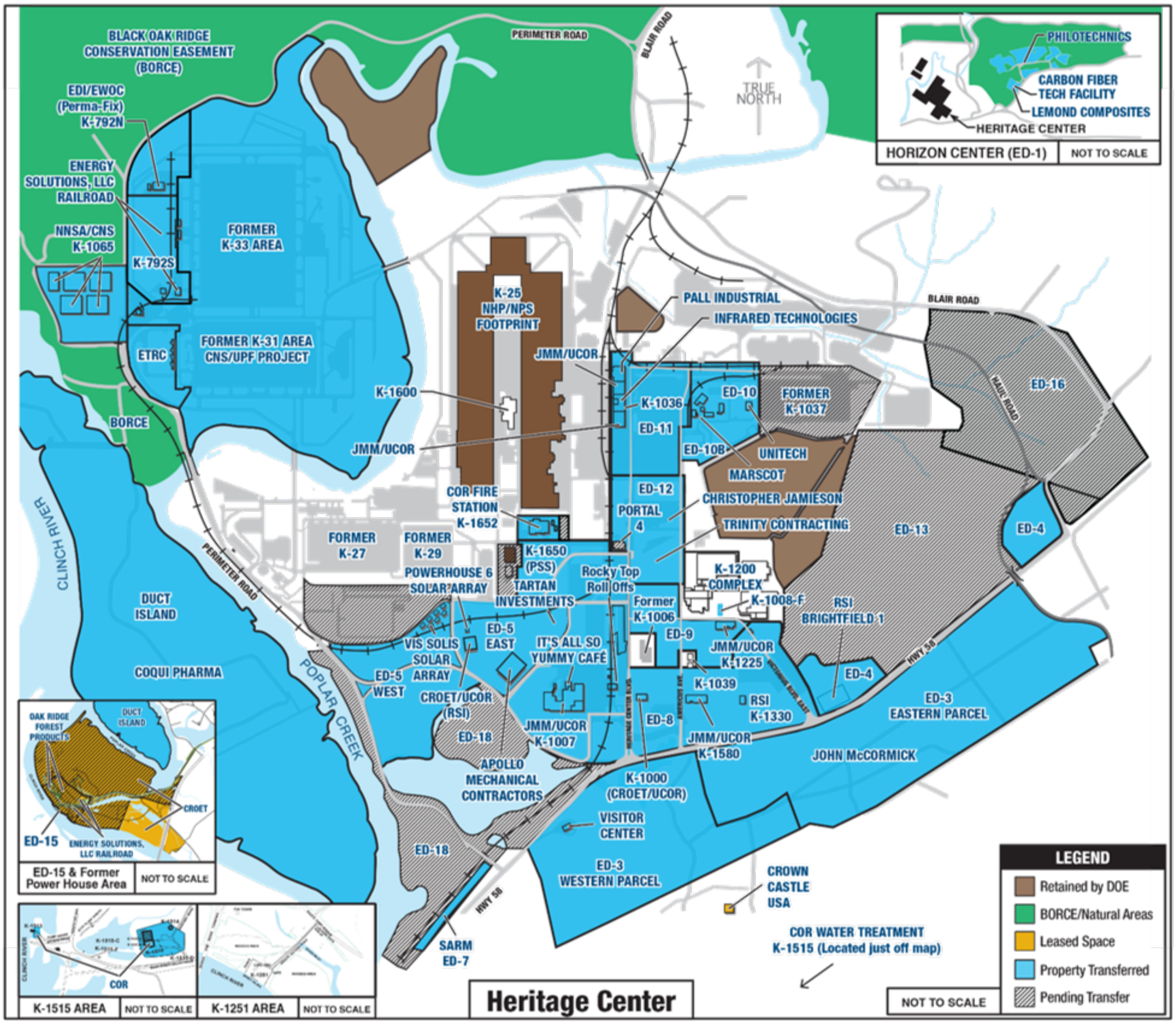


Figure 3.3. East Tennessee Technology Park in 2021, showing progress in reindustrialization

3.2. Environmental Management System

The UCOR Environmental Management System (EMS) is integrated with the UCOR Integrated Safety Management System (ISMS). UCOR's EMS is based on a graded approach for a closure and remediation contract and reflects the elements and framework contained in International Organization for Standardization (ISO) Standard 14001:2004, *Environmental management systems—Requirements with guidance for use* (ISO 2004). UCOR is committed to incorporating sound environmental management, protection, sustainability, and justice considerations in all business decisions, work processes and activities that are part of the DOE Environmental Management (EM) program in Oak Ridge, Tennessee. UCOR's environmental policy states, in part, "Our commitment to protect and sustain human, natural, and cultural resources is inherent in our mission to complete environmental cleanup safely with reduced risks to the public, workers, and the environment." To achieve this, UCOR's environmental policy adheres to the following principles:

- **Leadership Commitment**—Integrate responsible environmental practices into project operations.
- **Environmental Compliance and Protection (EC&P)**—Comply with all environmental regulations and standards.
- **Sustainable Environmental Stewardship**—Minimize the effects of our operations on the environment through a combination of source reduction, recycling, and reuse; sound waste management practices; and pollution prevention (P2).
- **Partnership/Stakeholder Involvement**—Maintain partnerships through effective two-way communications with our customers and other stakeholders.

3.2.1. Sustainable Environmental Stewardship

UCOR incorporates environmental sustainability principles, the procurement of environmentally preferable products, recycling, and P2 and waste minimization practices in its work processes and activities. As an example, Figure 3.4 presents a selection of information on UCOR's 2021 P2 recycling activities related to solid waste reduction at ETTP. UCOR recycles much of its universal waste, municipal solid waste and scrap metal, reuses large amounts of construction and demolition debris, and encourages the reduction of waste wherever possible.

UCOR's exceptional electronics stewardship earned it an award in 2021 from the Global Electronics Council for its use of Electronic Product Environmental Assessment Tool (EPEAT) methods and leadership in sustainable electronics procurement. This is the seventh consecutive year that UCOR has won an EPEAT.

Additionally, UCOR received ten nominations for its internally award program and recognized four projects and one honorable mention for their P2 and waste minimization accomplishments in 2021, which are summarized below.

- The Environmental Management Waste Management Facility (EMWMF) Landfill was recognized for implementing the 14.4 acre enhanced operational cover at the EMWMF, reducing landfill wastewater and returning clean water back to the environment, and upgrading the contact water transfer line from 4 to 8 inches, adding additional pumps, along with improved water management practices that reduced the amount of leachate generated. This resulted in reduced leachate from 42 percent to 22 percent of landfill wastewater generated; eliminated 32,400 driven miles and 50.2 MT of CO_2/year; avoided 24,870,000 gallons of wastewater generation for the year (87 percent of precipitation returned to the environment), and a project savings in excess of $279,000.
- The UCOR Records Management Going Electronic Transition Project was recognized for facilitating several groups within UCOR to transition to 100 percent electronic records. This resulted in achieving 85 percent electronic only records, avoided 11 yd^3 of waste generation, reduced 1,250 work hours annually, and a projected annual savings of $24,765.
- The UCOR Environmental Services – Regulatory Documents Submittals Project was recognized for using sustainable problem-solving to deliver regulatory documents during Limited Operations by transitioning to fully electronic submittals to DOE. Over a 9-month period this eliminated/avoided 291,180 sheets of paper, 672 CDs/cases, 1,140 plastic binders, 3,624 labels, 912 work hours, and 399 miles of travel.
- The UCOR Waste Management – Transfer of Waste Elemental Mercury to ORNL Spallation Neutron Project for Reuse was recognized for seizing the opportunity to reuse the waste elemental mercury (Hg) generated from the deactivation and demolition of the Alpha-4 West COLEX (Column Exchange) Facility by transferring the mercury to the ORNL Spallation Neutron Source Project rather than sending it off for disposal. This resulted in avoiding 1,156 pounds of elemental mercury waste and saved over $220,000 in costs of

disposal, shipping, and purchasing new elemental mercury.

- The East Tennessee Technology Park K-770 project was recognized for removal of soil from a radiologically contaminated storage area, maintaining access capability for monitoring wells, removing/incorporating duct bank vaults and other slabs and structures, integrating wetlands; locally sourcing 21-acre soil coverage that avoided shipping soil to the site; and articulated trucks to expedite the soil lay down process. The effort resulted in an 11-month schedule reduction, with an estimated 47,000 work hours saved; reduced greenhouse gas emissions; reduced costs for future projects because of generation of usable mulch and backfill; and an approximate cost savings of $3,000,000.

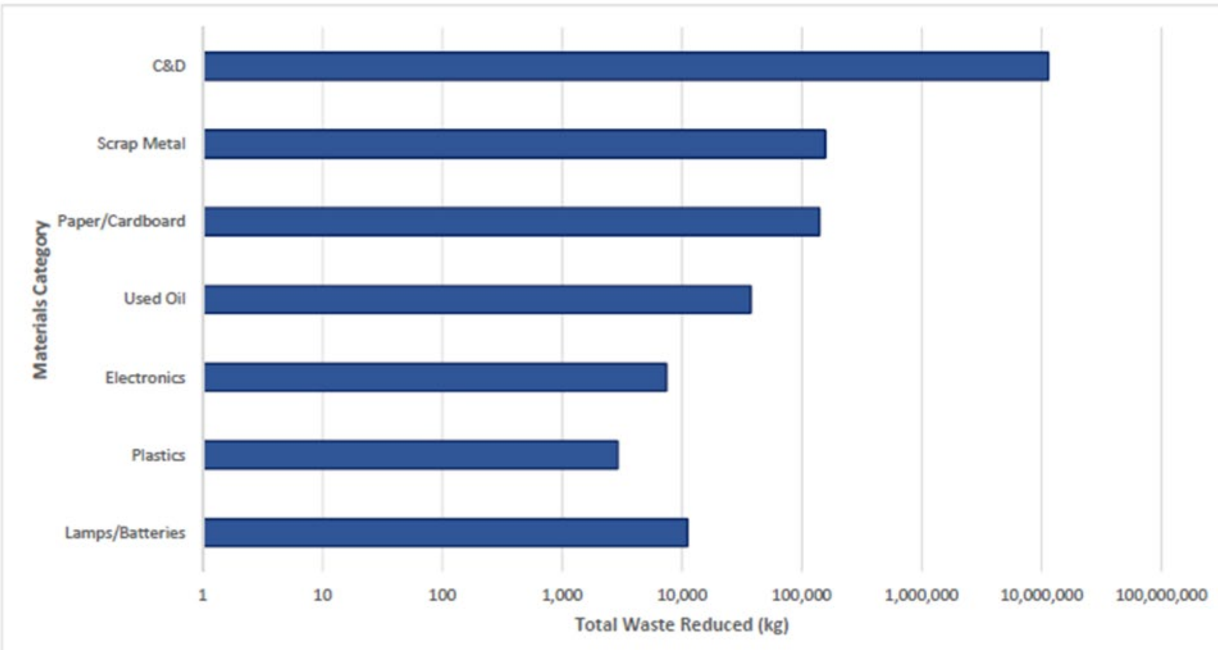


Figure 3.4. Pollution prevention recycling activities related to solid waste reduction at the East Tennessee Technology Park in fiscal year 2021

Together, the projects represented sustainability accomplishments in resource conservation, waste diversion, waste reduction, and P2. These accomplishments were the result of teamwork, leveraging a number of work control and management tools to save landfill space, reduce the use of virgin material, mitigate hazards to the environment and workers, and increase work efficiencies. In 2021, more than 58 MT of greenhouse gas emissions, 8,600 yd^3 of waste, and an estimated 49,259 work hours were saved; 24,870,000 gal of wastewater generation were avoided, and more than 33,000 miles of travel were eliminated as a result of implementation of P2 measures by the projects. In addition to lessening the impact on the environment, these P2 measures also saved more than $5,000,000.

In 2016, a significant improvement in the diversion of scrap metal was made, by petitioning and receiving agreement from the EPA and the Tennessee Department of Environment and Conservation (TDEC) to apply an unprecedented CERCLA screening process that allows noncontaminated scrap metal from CERCLA areas, previously excluded from commercial recycling services, to be safely shipped to commercial scrap-metal dealers for recycle. Effectively, the screening process removes the noncontaminated scrap metal from regulation under CERCLA; therefore, any non-CERCLA commercial scrap-metal recyclers can receive the material for recycle. This agreement continues to be successfully employed, allowing approximately 2820 lb of scrap metal to be recycled in fiscal year (FY) 2021 in lieu of land disposal and provides a path forward for additional waste diversion for the duration of the contract.

Some of the significant benefits of the scrap-metal recycling under this approval include:

- Provides funds from the recycling payments that are available to go back into the programs and support further actions in the Oak Ridge cleanup program.
- Conserves valuable landfill space. As of FY 2021, 790,262 lb of scrap metal recycled as a result of the screening process, diverting a valuable material from the landfill for reclamation, while saving capital cost, landfill capacity, historical operating costs, packing, and transportation.
- Supports EPA, TDEC, and DOE programmatic environmental stewardship goals for waste diversion.

The CERCLA screening process will continue to be used as more demolition and cleanup are continued at ETTP, ORNL, and Y-12.

In the area of alternative energy, Restoration Services, Inc. (RSI), in concert with UCOR, continued operations of ETTP's solar parks (Figure 3.5). Brightfield 1 is a 200-kW solar array located on a 0.405-ha (1-acre) tract purchased from CROET and built by RSI as part of UCOR's commitment to the revitalization of the former K-25 Site.

Figure 3.5. Oak Ridge Powerhouse Six Solar Farm

RSI self-financed the project using solar panels manufactured in Tennessee and partnering with other local small businesses for the installation. Power generated from Brightfield 1 is being sold to the Tennessee Valley Authority (TVA) through the City of Oak Ridge Electric Department using a TVA Generation Partners contract. The completed project was commissioned in April 2012 and is part of RSI's Brownfields to Brightfields initiative that works to develop restricted-use properties into solar farms. Brightfield 1 energy production in its first year was 110 percent more than projected, with no downtime due to maintenance issues. In calendar year (CY) 2021, Brightfield 1 produced 246, 500 kWh of energy.

In addition, through the cooperative efforts of DOE, UCOR, RSI, Vis Solis, Inc., CROET, and City of Oak Ridge, a second solar farm—the Powerhouse Six Solar Farm—was constructed on the west end of the park. It is a 1-MW solar farm that became operational in April 2015 and provides renewable energy, long-term lease income to CROET and bolsters development at ETTP. This project continues to provide numerous benefits to the environment and the community at large, which include the following:

- Generates enough clean energy to power more than 100 homes.
- Prevents pollution by removing the equivalent of 240 cars from the road annually (1,141 MT of CO_2).
- Provides brownfield reuse/redevelopment at ETTP.
- Supports City of Oak Ridge renewable energy goals.
- Supports TVA renewable energy initiatives.
- Offers community economic development jobs and property tax income to City of Oak Ridge.
- Demonstrates benefits of ETTP reindustrialization.
- Supports DOE renewable energy goals.

- Demonstrates collaborative success between DOE and a public utility for renewable energy development.

UCOR also continues to use environmentally sustainable products. Large quantity purchases are evaluated for less toxic alternatives. Other product purchases are first reviewed to determine if a recycled content material or biobased content alternatives are commercially available, and those alternatives are prioritized for purchase when feasible.

UCOR is one of the DOE contractors having responsibilities for land management of portions of the ORR. The Natural Resources Management Team for ORR, centered at ORNL, is partially funded by UCOR, and is responsible for the creation and implementation of an Invasive Plant Management Plan. At ETTP, these efforts have included:

- Exposure Unit (EU)-29 demonstration field invasive plant control
- Powerhouse Trail privet control
- Wheat Church Vista invasive plant control
- Black Oak Ridge Conservation Easement kudzu and invasive plant control
- Black Oak Ridge Conservation Easement greenway and trail invasive plant control

For additional information, please see Chapter 6.

3.2.2. Environmental Compliance

UCOR maintains various layers of oversight to ensure compliance with legal and other requirements. The methods of evaluation include independent assessments by outside parties, assessments conducted by functional or project organizations, and routine field walkdowns conducted by a variety of functional and project personnel. Assessments are prioritized and scheduled based on risk management principles and performed in accordance with procedures. Records are maintained for all formal assessments and audits. Issues identified in assessments are handled, as required, by ISO 14001:2004, Section 4.5.3, "Nonconformity, Corrective Action, and Preventive Action" (ISO 2004). For additional information see Section 3.4.

3.2.3. Environmental Aspects/Impacts

Using a graded approach appropriate for EMS includes an environmental policy that provides a unified strategy for the management, conservation, and protection of natural resources; the control and attenuation of risks; and the establishment and attainment of all environment, safety, and health (ES&H) goals. UCOR works continuously to improve its EMS to reduce impacts from activities and associated effects on the environment (i.e., environmental aspects) and to communicate and reinforce this policy to its internal and external stakeholders.

3.2.4. Environmental Performance Objectives and Targets

UCOR conserves and protects environmental resources by: (1) incorporating environmental protection and the elements of an enabling EMS into the daily conduct of business; (2) fostering a spirit of cooperation with federal, state, and local regulatory agencies; and (3) using appropriate waste management, treatment, storage, and disposal methods.

UCOR has established a set of core, company-level EMS objectives that remain relatively unchanged from year to year. These objectives are generally applicable to all operations and activities throughout UCOR's work scope. The core environmental objectives are based on compliance with applicable legal requirements and sustainable environmental practices contained in DOE Order 436.1, *Departmental Sustainability* (DOE 2011b), and include the following:

- Comply with all applicable environmental regulations, permits, regulatory agreements, and DOE orders.
- Reduce or eliminate the acquisition, use, storage, generation, and/or release of toxic, hazardous, and radioactive materials; waste; and greenhouse gas emissions through

acquisition of environmentally preferable products, conduct of operations, removal and safe disposition, waste minimization, and sustainable practices.

- Reduce degradation and depletion of environmental resources and potential impact on climate change through post-consumer material recycling, energy, fuel, and water conservation efforts, use or promotion of renewable energy, community engagement, and transfer for reuse valuable real estate assets.
- Reduce the environmental impact on surface water and groundwater resources.
- Reduce the environmental impact associated with project and facility activities.

The EMS objectives and targets reduce the environmental impact of UCOR activities and accomplish the DOE sustainability goals. Each year, ETTP reports its performance in the DOE Sustainability Dashboard, which collects data such as energy and water usage, greenhouse gas generation, sustainable buildings, facility metering, waste diversion, renewable energy, sustainable acquisitions, and electronic stewardship.

The Office of Management and Budget's Environmental Stewardship Scorecard is used to track and measure site-level EMS performance. During FY 2021, UCOR received a "green" for EMS performance, indicating full implementation of EMS requirements.

3.2.5. Implementation and Operation

UCOR protects the safety and health of workers and the public by identifying, analyzing, and mitigating aspects, hazards, and impacts from ETTP operations, and by implementing sound work practices. All UCOR employees and subcontractors are held responsible for complying with all ES&H requirements during all work activities and are expected to correct noncompliant conditions immediately. UCOR's internal assessments also provide a measure of how well EMS attributes are integrated into work activities through ISMS. UCOR has embodied its program for the environmental compliance and the protection of natural resources in a companywide environmental management and protection policy. The policy is UCOR's fundamental commitment to incorporating sound environmental management practices in all business decisions, work processes, and activities.

3.2.6. Pollution Prevention/Waste Minimization/Release of Property

UCOR's work control process requires that all waste-generating activities be evaluated for source reduction and that product substitution be used to produce less toxic waste, when possible. The reuse or recycling of building debris and other generated wastes is evaluated in all cases.

The ETTP EMS program fosters P2 at every level of its operations, from routine office recycling of paper, cardboard and plastics, to unique reuse and recycling at the project-field level. UCOR's P2 program is successful because it is tightly bound to its work control process. Thus, many original applications of material reuse and recycling have resulted, many of which have been captured through its internal P2 awards program. Each year, the projects that are recognized in the P2 internal awards program are often the source of UCOR's national-level awards nominations (e.g., DOE Headquarters annual award program).

DOE Order 458.1, *Radiation Protection of the Public and Environment* (DOE 2011a), requires that a process be in place to ensure that radiologically contaminated materials are not released to the public or the environment, except in compliance with permit effluent requirements or other agreements with regulatory agencies. Materials and equipment may be released to the public through an approved pollution prevention/recycling program or through property sales (procedure PROC-PR-2032, *Disposition of Personal Property* [UCOR 2020a], governs the process of releasing personal property), and real property may be transferred to the public through CROET.

Materials and equipment that are to be recycled or reused may follow one of two paths. If process knowledge is sufficient to establish that the materials and equipment have never been in contaminated areas (for example, empty beverage cans from a specified break area or an office building) then the materials may be released for recycling or reuse. Materials and equipment from areas that have, or in the past have had, radiologic areas must be examined by trained radiologic control technicians and the results documented before the materials and equipment may be released. Materials and equipment that fail to meet the free release criteria are either decontaminated to the point that they meet the free release criteria or are properly disposed of at an appropriate disposal facility. The release of property from radiologic areas is governed by procedure PROC-RP-4516, *Radioactive Contamination Control and Monitoring* (Table 3.1). In addition to the types and quantities of recycled materials and equipment shown above in Figure 3.4, 62,629 kg of office furniture, office supplies, electronics, electrical equipment, and building materials were released to the public through property sales.

Real property to be transferred must meet the release criteria established by DOE Order 458.1 (DOE 2011a) and the appropriate Record of Decision. DOE ensures that these requirements are met through independent verification by a third party. Currently, this verification is performed by Oak Ridge Associated Universities (ORAU) through a direct contract with DOE. The direct contract with DOE ensures that the evaluation is performed independently of UCOR, DOE's cleanup contractor. ORAU reviews historic data, facility use history, verification strategies, methodologies, techniques, and equipment. When ORAU deems it appropriate, additional sampling and/or radiological surveys are conducted. Results of the evaluation and verification are summarized in a report to DOE that is then submitted to DOE Headquarters for approval as part of the transfer package. Section 3.8 contains a summary of the real property releases to the public.

Table 3.1. Surface contamination values and DOE Order 458.1 authorized limits for surface activity

Radionuclide	Removable	Total (fixed + removable)
Natural Uranium, ^{235}U, ^{238}U, and associated decay products	1,000	5,000
Transuranics, ^{226}Ra,^{228}Ra,^{230}Th,^{228}Th,^{231}Pa,^{227}Ac,^{125}I,^{129}I	20	100/500
Natural Th, ^{232}Th,^{90}Sr,^{223}Ra,^{224}Ra,^{232}U,^{126}I,^{131}I,^{133}I	200	1,000
Beta-gamma emitters except ^{90}Sr and others noted above	1,000	5,000
Tritium and Special Tritium Compounds	10,000	
Hard to Detect: Pu-241, C-14, Fe-55, Ni-59, and Ni-63	10,000	50,000

Note: *Limits are shown in dpm/100 cm^2.*

3.2.7. Competence, Training, and Awareness

The UCOR training program and qualification process ensures that needed skills for the workforce are identified and developed and documents knowledge, experience, abilities, and competencies of the workforce for key positions requiring qualification. Completion and documentation of training, including required reading, are managed by the Local Education Administration Requirements Network, or LEARN.

3.2.8. Communication

UCOR communicates externally regarding environmental aspects through the UCOR public website, found **here**, which includes a link to its environmental policy statement in *Environmental Management and Protection,* POL-UCOR-007 (UCOR 2020c), and a list of environmental aspects.

A number of other documents and reports that address environmental aspects and cleanup progress are also published and made available to the public (e.g., the *Oak Ridge Annual Site Environmental Report* [ASER], DOE 2021f, DOE/CSC-2514] and the annual cleanup progress report [UCOR 2022, *2021 Cleanup Progress—Annual Report on Oak Ridge Reservation Cleanup,* OREM-21-7613]).

UCOR participates in a number of public meetings related to environmental activities at the site (e.g., Oak Ridge Site Specific Advisory Board [ORSSAB] meetings, which include community stakeholders, public permit reviews, and public CERCLA decision document reviews). Written communications from external parties are tracked using the weekly Open Action Report.

3.2.9. Benefits and Successes of Environmental Management System Implementation

An EMS program provides many benefits to an organization's success. Based upon the simplified model of Plan-Do-Act-Check, it provides a framework by which work incorporates mitigation of environmental hazards into its work control and planning. This translates into many returns to the organization. UCOR uses EMS objectives and targets, an internal P2 recognition program, environmentally preferable purchasing, work control processes, and a recycle program to meet sustainability and environmental stewardship goals and requirements. The approach is outlined in UCOR's *Pollution Prevention and Waste Minimization Program Plan for the East Tennessee Technology Park, Oak Ridge, Tennessee* (UCOR 2021, UCOR-4127/R10). The EMS program is audited by a third party triennially as for conformance to the ISO 14001:2004 standard (ISO 2004) as required by DOE Order 436.1, *Departmental Sustainability, Attachment1 Contractor Requirements Document* (DOE 2011b), with the most recent having been conducted in 2021. The results of the audit were zero findings, two observations, and three proficiencies.

3.2.10. Management Review

A formal review/presentation with UCOR senior management is conducted once per year that addresses the ISO 14001:2004 (ISO 2004) required elements, including focus areas for the upcoming year. At least two of the senior managers are present for management reviews. The environmental policy is also reviewed during the annual EMS management review and revised as necessary. Also, periodic reports are submitted to senior management on the status of EMS calendar year company level objectives and targets.

3.3. Compliance Programs and Status

During 2021, ETTP operations were conducted in compliance with contractual and regulatory environmental requirements. There were no National Pollutant Discharge Elimination System (NPDES) or Clean Air Act (CAA) noncompliances, nor did ETTP receive any Notices of Violation in 2021. Figure 3.6 shows the trend of NPDES compliance at ETTP since 2012. The following sections provide more detail on each compliance program and the environmental remediation-related activities in 2021. In addition, ETTP is tracked on EPAs Enforcement and Compliance History Online database (FRS ID 110002471094).

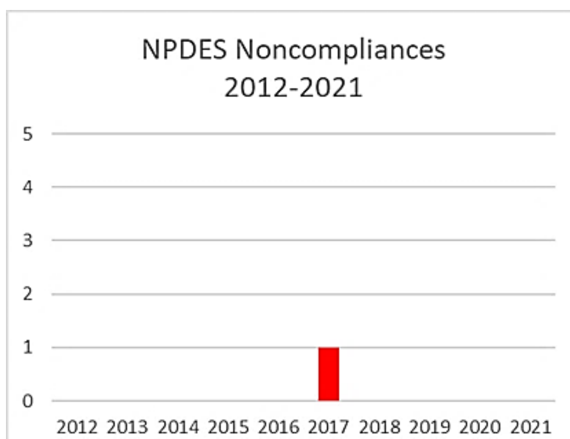


Figure 3.6. East Tennessee Technology Park National Pollutant Discharge Elimination System permit noncompliances since 2012.

3.3.1. Environmental Permits Compliance Status

Table 3.2 contains a list of environmental permits that were in effect at ETTP in 2021. ETTP received no notices of environmental violations or penalties in 2021.

Table 3.3 presents a summary of environmental audits and oversight visits conducted at ETTP in 2021.

3.3.2. National Environmental Policy Act/National Historic Preservation Act

The National Environmental Policy Act (NEPA) provides a means to evaluate the potential environmental impact of proposed federal activities and to examine alternatives to those actions. ETTP maintains compliance with NEPA through the use of site-level procedures and program descriptions that establish effective and responsive communications with program managers and project engineers to ensure NEPA is a key consideration in the formative stages of project planning. Many of the current operations at ETTP are conducted under CERCLA. NEPA reviews are part of the CERCLA planning process to ensure that NEPA values are incorporated into CERCLA projects and documentation. NEPA reviews identify new or changing environmental aspects associated with proposed activities.

During 2021, ETTP continued to operate under site-level, site-specific procedures that provide requirements for project reviews and NEPA compliance. These procedures call for a review of each proposed project, activity, or facility to determine the potential for impacts on the environment. To streamline the NEPA review and documentation process, DOE Oak Ridge Office has approved generic categorical exclusion (CX) determinations that cover certain proposed activities (i.e., maintenance activities, facility upgrades, personnel safety enhancements). A categorical exclusion is a category of actions defined in 40 *Code of Federal Regulations* (CFR) Part 1508.4 (EPA 1978) that does not individually or cumulatively have a significant effect on the human environment and for which neither an environmental assessment nor an environmental impact statement is normally required. UCOR activities on ORR are in full compliance with NEPA requirements, and procedures for implementing NEPA requirements have been fully developed and implemented. At ETTP, a checklist incorporating NEPA and EMS requirements has been developed as an aid for project planners. For routine, recurring activities, DOE generic CX determinations are used. During 2021, three review reports and one CX were generated to document UCOR activities such as construction of small support buildings, storage yards, and access road improvements.

Compliance with the National Historic Preservation Act at ETTP is achieved and maintained in conjunction with NEPA compliance. The scope of proposed actions is reviewed in accordance with the ORR Cultural Resource Management Plan (Souza et al. 2001). At ETTP, there were 135 facilities eligible for inclusion on the National Register of Historic Places, a US National Park Service program to identify, evaluate, and protect historic and archeological resources in the United States, as well as numerous facilities that were not eligible for inclusion on the National Register of Historic Places. To date, more than 800 facilities have been demolished. Artifacts of historical and/or cultural significance are identified before demolition and are catalogued in a database to aid in the historic interpretation of ETTP.

On December 14, 2014, Congress authorized the establishment of the Manhattan Project National Historical Park to commemorate the history of the Manhattan Project (DOI 2015). It will comprise the three major sites: Los Alamos, New Mexico; Oak Ridge, Tennessee; and Hanford, Washington, which were dedicated to accomplishing the Manhattan Project mission. In December 2021, preliminary design documents for the K-25 Viewing Platform and other site improvements on the K-25 Preservation Footprint to support the National Historic Preservation (NHP) project were completed for review and comment.

Table 3.2. East Tennessee Technology Park environmental permits, 2021

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	State permit to operate an air contaminant source—internal combustion engine–powered emergency generators and fire water pump replaced by PBR when NOA received from TDEC	069346P, NOA Number R74133	03-03-2015 Amended 11-22-2016 NOA issued 7-19-2018	10-01-2024, none for NOA NOA terminated in 2020	DOE	UCOR	UCOR
CWA	NPDES permit for storm water discharges	TN0002950	02-01-2015	03-31-2020 Remains in effect; New permit became effective on April 1, 2022	DOE	UCOR	UCOR
CWA	SOP—waste transportation project; Blair Road and Portal 6 sewage pump and haul permit	SOP-05068	07-01-2014	02-28-2019 Remains in effect	TTS	TTS	TTS
RCRA	Hazardous waste corrective action document (encompasses entire ORR)	TNHW-164	09-15-2015	09-15-2025	DOE	DOE/All[a]	DOE/All[a]

[a] DOE and ORR contractors that are co-operators of hazardous waste permits.

Acronyms:
CAA = Clean Air Act
CWA = Clean Water Act
DOE = US Department of Energy
ETTP = East Tennessee Technology Park
ID = identification (number)
NOA = Notice of Authorization
NPDES = National Pollutant Discharge Elimination System
ORR = Oak Ridge Reservation
PBR = Permit-by-Rule
RCRA = Resource Conservation and Recovery Act
SOP = state operating permit
TDEC = Tennessee Department of Environment and Conservation
TTS = Turnkey Technical Services, LLC.
UCOR = UCOR, an Amentum-led partnership with Jacobs

Table 3.3. Regulatory oversight, assessments, inspections, and site visits at East Tennessee Technology Park, 2021

Date	Reviewer	Subject	Issues
August 20	TDEC	ETTP CWA/NPDES Inspection	0

Acronyms:
COR = City of Oak Ridge
EPA = US Environmental Protection Agency
ETTP = East Tennessee Technology Park
NPDES = National Pollutant Discharge Elimination System
RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment and Conservation

Consultation for the development of an MOA for D&D of the K-25 and K-27 Buildings started in 2001; the document, approved in 2003, required a third-party analysis of the preservation and interpretive strategies for those two buildings. In 2005, DOE, the Tennessee State Historic Preservation Office, and the Advisory Council on Historic Preservation entered into an MOA that included the retention of the north end tower (also known as the north wing and the north end) of the K-25 Building and Portal 4 (K-1028-45), among other features, as the "best and most cost-effective mitigation to permanently commemorate, interpret, and preserve the significance" of ETTP. After another series of consultation meetings from 2009 through 2011, a final mitigation plan was developed by DOE that permitted demolition of the entire K-25 Building and called for, among other mitigation measures, the designation of a commemorative area around the building's perimeter from which future surface development would largely be restricted; the retention, if possible, of the entire concrete slab or the demarcation of the building's footprint; the construction of a viewing tower and structure for equipment display; and the development of a history center within the ETTP Fire Station #4. A final MOA was signed in August 2012, finalizing the aspects set forth in the mitigation plan. A Professional Design Team and Museum Professional were selected in 2014. The museum design was completed in 2017, construction began in 2018, and the K-25 History Center opened to the public on February 27, 2020. The K-25 History Center closed in April 2020 due to the COVID-19 pandemic.

The *Memorandum of Agreement between the United States Department of the Interior and the United States Department of Energy for the Manhattan Project National Historical Park* was signed by DOI and DOE on November 10, 2015 (DOE 2015), creating the new Manhattan Project National Historical Park. The K-25 Virtual Museum website (K-25 Virtual Museum 2015), found **here**, was launched in conjunction with the signing of the MOA.

The Historic American Engineering Record (HAER) documentation was prepared for the K-25 Building and transmitted to the National Park Service.

3.3.3. Clean Air Act Compliance Status

The CAA, passed in 1970 and amended in 1977 and 1990, forms the basis for the national air pollution control effort. This legislation establishes comprehensive federal and state regulations to limit air emissions and includes five major regulatory programs: the National Ambient Air Quality Standards (NAAQS), State Implementation Plans (SIPs), New Source Performance Standards (NSPSs), Prevention of Significant Deterioration permitting programs, and National Emission Standards for Hazardous Air Pollutants (NESHAPs). Airborne discharges from DOE Oak Ridge facilities, both radioactive and nonradioactive, are subject to regulation by EPA and the TDEC Division of Air Pollution Control.

Full compliance with CAA regulations and permit conditions was demonstrated in 2021. The ETTP ambient air-monitoring program, permitted source operations tracking, and record keeping provided documentation fully supporting a 100 percent compliance rate.

3.3.4. Clean Water Act Compliance Status

The objective of the Clean Water Act (CWA) is to restore, maintain, and protect the integrity of the nation's waters. This act serves as the basis for comprehensive federal and state programs to protect the waters from pollutants (see Appendix C for water reference standards). One of the strategies developed to achieve the goals of the CWA was EPA's establishment of limits on specific pollutants allowed to be discharged in US waters by municipal sewage treatment plants and industrial facilities. EPA established the NPDES permitting program to regulate compliance with pollutant limitations. The program was designed to protect surface waters by limiting effluent discharges into streams, reservoirs, wetlands, and other surface waters. EPA has delegated authority for implementation and enforcement of the NPDES program to the state of Tennessee. In 2021, ETTP discharged storm water to the waters of the state of Tennessee under the individual NPDES permit TN0002950, which regulates storm water discharges.

In 2021, sewage discharges from routine breakrooms, restrooms, and change house showers were discharged to the City of Oak Ridge Rarity Ridge Wastewater Treatment Plant collection network.

3.3.5. National Pollutant Discharge Elimination System Permit Noncompliances

In 2021, compliance with ETTP NPDES storm water permit TN0002950 was determined by more than 150 laboratory analyses, field measurements, and flow estimates. The NPDES permit compliance rate for all discharge points for 2021 was 100 percent. There were no permit noncompliances in 2021.

3.3.6. Safe Drinking Water Act Compliance Status

Since October 1, 2014, all water at the ETTP site is supplied by the City of Oak Ridge drinking water plant, located north of the Y-12 Complex in Oak Ridge, Tennessee. ETTP operations are in full compliance with this act.

3.3.7. Resource Conservation and Recovery Act Compliance Status

ETTP is regulated as a large-quantity generator of hazardous waste because the facility generates more than 1,000 kg of hazardous waste per month. At the end of 2021, ETTP had two generator accumulation areas for hazardous or mixed waste.

TNHW-164 is the hazardous waste corrective action document, which covers ORR areas of concern and solid waste management units.

In CY 2021, ETTP prepared and submitted to the TDEC Division of Solid Waste Management the CY 2020 annual report of hazardous waste activities. This report identifies the type and amount of hazardous waste that was generated, shipped off site, or is staged for shipment. In 2021, ETTP was in full compliance with this act.

3.3.8. Comprehensive Environmental Response, Compensation, and Liability Act Compliance Status

CERCLA, also known as "Superfund," was passed in 1980 and was amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA). Under CERCLA, a site is investigated and remediated if it poses significant risk to health or the environment. The EPA National Priorities List is a comprehensive list of sites and facilities that have been found to pose a sufficient threat to human health and/or the environment to warrant cleanup under CERCLA. ORR is on the National Priorities List and numerous CERCLA decision documents are approved for ETTP site cleanup actions for both facility demolitions and soil remediation. In 2021, ETTP was in full compliance with this Act.

3.3.9. East Tennessee Technology Park RCRA-CERCLA Coordination

The *Federal Facility Agreement for the Oak Ridge Reservation* (DOE 1992, FFA-PM/18-011, DOE/OR-1014) is intended to coordinate the corrective action processes of Resource Conservation and Recovery Act (RCRA) required under the *Hazardous and Solid Waste Amendments* permit with CERCLA response actions.

3.3.10. Toxic Substances Control Act (TSCA) Compliance Status—Polychlorinated Biphenyls

On April 3, 1990, DOE notified EPA headquarters (as required by 40 CFR Part 761.205, *Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions* [EPA 1979]) that ETTP is a generator with on-site storage, a transporter, and an approved disposer of polychlorinated biphenyl (PCB) wastes.

In 2021, ETTP operated one long-term PCB waste storage area on site where nonradioactive PCB waste was stored in a facility that was not a RCRA-permitted storage facility. At this time, no PCB-contaminated electrical equipment is in service at ETTP.

Because of the age of many ETTP facilities and the varied uses for PCBs in gaskets, grease, building materials, and equipment, DOE self-disclosed unauthorized use of PCBs to EPA in the late 1980s. As a result, DOE Oak Ridge Office and EPA Region 4 consummated a major compliance agreement known as the *Oak Ridge Reservation Polychlorinated Biphenyl Federal Facilities Compliance Agreement* (DOE 2018b, ORR-PCB-FFCA), which became effective December 16, 1996, and was last revised on October 8, 2018, to Revision 6. The facilities that were included on the ORR-PCB-FFCA have been demolished and disposed.

ORR-PCB-FFCA specifically addresses the unauthorized use of PCBs in ventilation ducts and gaskets, lubricants, hydraulic systems, heat transfer systems, and other unauthorized uses; storage for disposal; disposal; cleanup and/or decontamination of PCBs and PCB items, including PCBs mixed with radioactive materials; and ORR records and reporting requirements. A major focus of the agreement is the disposal of PCB waste. As a result of that agreement, DOE and UCOR continue to notify EPA when additional unauthorized uses of PCBs, such as in paint, adhesives, electrical wiring, or floor tile, are identified at ETTP. This notification process is routinely incorporated into the CERCLA documentation for demolition and remedial actions (RAs).

The ETTP site prepares a PCB Annual Document Log (PCBADL) per 40 CFR Part 761.180(a) (EPA 1979). The written PCBADL is prepared by July 1 of each year and covers the previous calendar year. The PCBADL documents such things as container inventory, shipments, and PCB spills at the facility. Authorized representatives of EPA may inspect the PCBADL at the facility where they are maintained during normal business hours. The PCBADL must be maintained on site for a minimum of three years. In 2021, ETTP was in full compliance with this Act.

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

The Emergency Planning and Community Right-to-Know Act (EPCRA) that is also identified as Title III of SARA requires that facilities report inventory that exceed threshold planning quantities and releases of hazardous and toxic chemicals. The reports are submitted electronically and are available online for the local emergency planning committee, the state emergency response commission, and the local fire department. ETTP complied with these requirements in 2021 through the submittal of required reports as applicable under EPCRA Sections 302, 311, 312, and 313. ETTP had no reportable releases of hazardous substances or extremely hazardous substances, as defined by EPCRA, in 2021.

3.3.11.1. Chemical Inventories (EPCRA Section 312)

Inventories, locations, and associated hazards of hazardous and extremely hazardous chemicals were submitted in an annual report to state and local emergency responders, as required by EPCRA Section 312. Of the ORR chemicals identified for 2021, 10 chemicals were located at ETTP. These chemicals were lead metal (including large, lead-acid batteries), diesel fuel, unleaded gasoline, sulfuric acid (including large, lead-acid batteries), Chemical Specialties, Inc. Ultrapoles, arsenic pentoxide (the active ingredient in CCA Type C pressure-treated wood), Flexterra FGM erosion control agent, sodium polycrylate, New Pig absorbents, and various lubricating oils.

3.3.11.2. Toxic Chemical Release Reporting (EPCRA Section 313)

EPCRA Section 313 requires facilities to complete and submit a toxic chemical release inventory (TRI) form (Form R) annually. Form R must be submitted for each TRI chemical that is manufactured, processed, or otherwise used in quantities above the applicable threshold quantity. The reports address releases of certain toxic chemicals to air, water, land, and waste management, recycling, and P2 activities. Threshold determinations and reports for each of the ORR facilities are made separately. Operations involving TRI chemicals were compared with regulatory thresholds to determine which chemicals exceeded the reporting thresholds based on amounts manufactured, processed, or otherwise used at each facility. After threshold determinations were made, releases and off-site transfers were calculated for each chemical that exceeded the threshold quantity. In 2021, there were no chemicals that met the reporting requirements.

3.3.11.3. Environmental Justice

UCOR strives to increase environmental justice efforts by advocating for and facilitating disadvantaged and marginalized communities' involvement in environmental decision making. UCOR incorporates elements of Executive Order 14008, Justice40 Initiative, and environmental justice initiatives into its community investment and commitment and workforce development programs. UCOR aspires to attract and maintain a diverse workforce that reflects the East Tennessee region. This goal is achieved by increasing awareness and access to Environmental Management careers in minority and underserved communities; collaborating with labor organizations to promote diversity in the labor workforce; partnering with Historically Black Colleges and Universities (HBCUs) and Minority Serving Institutions; and maintaining a culture of inclusion and accountability.

UCOR aims to create innovative tactics to bridge the gap between our work and the community. UCOR and DOE have partnered with the historic, predominantly minority Scarboro Community throughout its contract. The UCOR senior leadership team has cultivated relationships with Scarboro community leaders and meet with them often to provide updates on environmental cleanup projects. These efforts have opened up workforce development opportunities, which resulted in six labor apprentices and a cooperative education student from the community being added to our workforce. UCOR promotes a diverse and inclusive workplace through training and worker participation in organizations such as Women in Nuclear, Tradeswomen Build Nations, and Blacks in Government. UCOR is creating a pipeline for a new generation of cleanup by partnering with HBCUs. The company has established formal Memoranda of Understanding with Tennessee State University (TSU) in Nashville, Tenn., and Benedict College in Columbia, S.C., to grow DOE's future workforce. Additionally, UCOR sponsored a Chemical Engineering Technology Program at Roane State Community College (RSCC). Eight students from underserved communities have been selected for internships with UCOR and offered employment as chemical operators after the conclusion of their internships. UCOR hosted three interns from the Mentorship for Environmental Scholars (MES) Program, which provides HBCU students with exposure to DOE Environmental Management careers. A former MES intern joined UCOR to advance our Environmental Justice program. These actions support our mission and increase our EJ efforts.

3.4. Quality Assurance Program

Integrated Assessment and Oversight Program

Quality assurance (QA) program implementation and procedural and subcontract compliance are verified through the UCOR integrated assessment and oversight program. The program identifies the processes for planning, conducting, and coordinating assessment and oversight of UCOR activities, including both self-performed and subcontracted activities, resulting in an integrated assessment and oversight process. The program is composed of three key elements: (1) external assessments conducted by organizations external to UCOR, (2) independent assessments conducted by teams composed of UCOR personnel who are not directly involved with the project/function being assessed, and (3) management assessments and surveillances conducted as self-assessments and surveillances by the organization or on behalf of the organization manager.

Self-assessments are performed by the organization/function with primary responsibility for the work, process, or system being assessed. Organizations and functions within the company plan and schedule self-assessments. Self-assessments encompass both formal and informal assessments. The formal self-assessments include management assessments and surveillances, and subcontractor oversight. Informal self-assessments include weekly inspections and routine walkthroughs conducted by subcontractor coordinators, ES&H and QA representatives, quality engineers, and line managers.

Conditions adverse to quality identified from internal and external assessments are documented, causal analyses are performed, and corrective actions are developed and tracked to closure. Analyses are conducted periodically to identify trends for management action. Senior management evaluates data from those processes to identify opportunities for improvement.

3.5. Air Quality Program

The state of Tennessee has been delegated authority by EPA to convey the clean air requirements that are applicable to ETTP operations. New projects are governed by construction and operating permit regulatory requirements. The owner or operator of air pollutant emitting sources is responsible for ensuring full compliance with any issued permit or other generally applicable CAA requirement. During 2021, ETTP DOE EM operations were under UCOR responsibility for regulatory compliance.

3.5.1. Construction and Operating Permits

UCOR ETTP operations are subject to CAA regulations and permitting under TDEC Air Pollution Control rules that are specific to stationary fossil-fueled reciprocating internal combustion engines for emergency use. TDEC originally issued an operating permit (069346P) covering six stationary emergency reciprocating internal combustion engine (e-RICE) units on March 3, 2015. An amended permit was issued on November 22, 2016, that removed one permanently shut-down unit. The last operating permit was amended on November 22, 2016, and covered four stationary e-RICE generators and one stationary e-RICE firewater booster pump. On July 19, 2018, TDEC provided a Notice of Authorization (NOA) to UCOR for coverage under Permit-by-Rule (PBR) for all of the ETTP stationary e-RICE (TDEC 2017b). During 2020 all generators and the firewater booster pump were either removed from the ETTP site or transferred to new owners; UCOR then surrendered its PBR authorization. No stationary e-RICE units were operated by UCOR at ETTP in 2021.

All other ETTP operations that emit low levels of air pollutants have been classified as insignificant under TDEC rules. Any planned stationary sources that may emit air pollutants are evaluated and compared against applicable pollutant emission limits to document this classification and pursue permitting if required under TDEC regulations.

3.5.1.1. Generally Applicable Permit Requirements

ETTP is subject to a number of generally applicable requirements that involve management and control. Asbestos, ozone-depleting substances (ODSs), and fugitive particulate emissions are specific examples.

Control of Asbestos

ETTP's asbestos management program ensures all activities involving demolitions and all other actions involving asbestos-containing materials (ACM) are fully compliant with 40 CFR Part 61, Subpart M, *National Emission Standards for Hazardous Air Pollutants*, "National Emission Standard for Asbestos" (EPA 1984, EPA 1990). This includes using approved engineering controls and work practices, inspections, and monitoring for proper removal and waste disposal of ACM. Most demolition and ACM abatement activities at ETTP are governed under CERCLA. Under this act, notifications of asbestos demolition or renovations, as specified in 40 CFR Part 61.145(b), are incorporated into CERCLA document regulatory notifications.

Non-CERCLA planned demolition or renovation activities were individually reviewed for applicability of the TDEC notification requirements of the rule. During 2021, three Notifications of Demolition and/or Asbestos Renovation (NDARs) were submitted to TDEC for non-CERCLA ETTP activities. There were no Regulated Asbestos Containing Material (RACM) demolitions during 2021.

The rule also requires an annual notification for all nonscheduled, minor asbestos renovations if the accumulated total amount of regulated or potentially regulated asbestos exceeds stipulated thresholds. For 2021, the total ETTP projected nonscheduled amounts were below thresholds that would require the submittal of an annual notification to TDEC. No releases of reportable quantities of ACM occurred at ETTP during 2021.

Stratospheric Ozone Protection

The management of ODSs at ETTP is subject to regulations in 40 CFR Part 82, Subpart F, "Recycling and Emissions Reduction" (EPA 1993); these regulations require preparation of documentation to establish that actions necessary to reduce emissions of Class I and Class II refrigerants to the lowest achievable level have been observed during maintenance activities at ETTP. The applicable actions include, but may not be limited to, the service, maintenance, repair, and disposal of appliances containing Class I and Class II refrigerants, such as motor vehicle air conditioners. In addition, the regulations apply to refrigerant reclamation activities, appliance owners, manufacturers of appliances, and recycling and recovery equipment. Figure 3.7 illustrates the historical on-site ODS inventory at ETTP. During 2021 the ODS inventory was zero.

3.5.1.2. Fugitive Particulate Emissions

ETTP has been the location of major building demolition activities, soil remediation activities, and waste debris transportation with the potential for the release of fugitive dust. All planned and ongoing activities include the use of dust control measures to minimize the release of visible fugitive dust beyond the project perimeter. This includes the use of specialized demolition equipment and water misters. Gravel roads in and around ETTP that are under DOE control are wetted with water, as needed, to minimize airborne dusts caused by vehicle traffic.

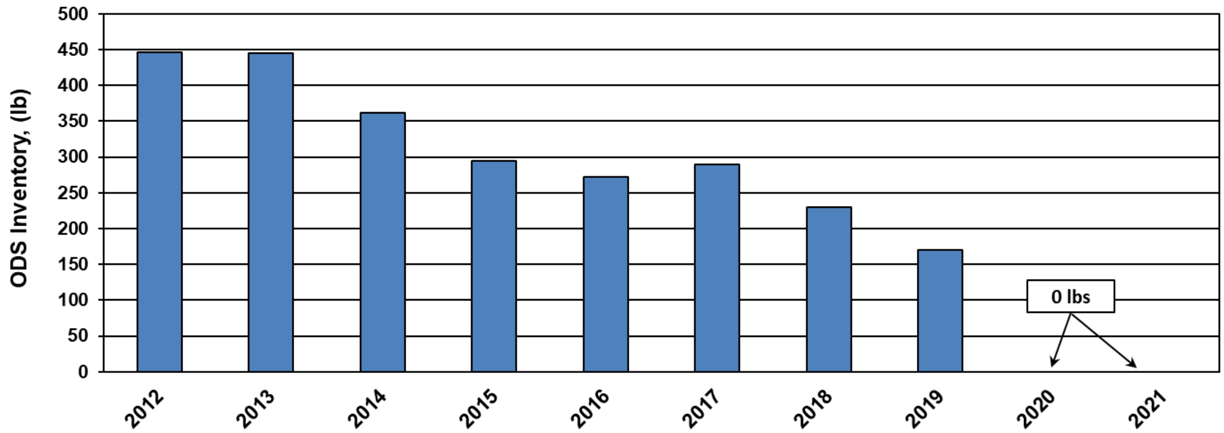


Figure 3.7. East Tennessee Technology Park total on-site ozone-depleting substances inventory, 10-year history

3.5.1.3. Radionuclide National Emission Standards for Hazardous Air Pollutants

Radionuclide airborne emissions from ETTP are regulated under 40 CFR Part 61, *National Emission Standards for Hazardous Air Pollutants (Rad-NESHAP)*. Characterization of the impact on public health of radionuclides released to the atmosphere from ETTP operations was accomplished by conservatively estimating the dose to the maximally exposed member of the public. The dose calculations were performed using the Clean Air Assessment Package (CAP-88) computer codes, which were developed under EPA sponsorship for use in demonstrating compliance with the 10 mrem/year effective dose National Emission Standards for Hazardous Air Pollutants for radionuclides (Rad-NESHAP) emission standard for the entire DOE ORR. Source emissions used to calculate the dose are determined using EPA-approved methods that can range from continuous sampling systems to conservative estimations based on process and waste characteristics. Continuous sampling systems are required for radionuclide-emitting sources that have a potential dose impact of not less than 0.1 mrem per year to any member of the public. The only ETTP Rad-NESHAP source that operated during 2021—the K-1407 Chromium Water Treatment System (CWTS) Volatile Organic Compound (VOC) Air Stripper is considered minor based on emissions evaluations using EPA-approved calculation methods. A minor Rad-NESHAP source is defined as having a potential dose impact on the public that is less than 0.1 mrem/year. Compliance is demonstrated using data collected by the ETTP ambient air monitoring program.

Quarterly radiochemical analyses are performed on composited samples collected at all ETTP ambient air sampling stations. The selected isotopes of interest were ^{234}uranium (^{234}U), ^{235}uranium (^{235}U), and ^{238}uranium (^{238}U), with the ^{99}technetium (^{99}Tc) inorganic analysis results included as a dose contributor. The concentration for each of the nuclides at each monitoring station are presented in Table 3.4 for the 2021 reporting period. Only one radionuclide analyzed for at ETTP ambient air locations was detected; that result was for ^{235}U at station K12 in the fourth quarter of 2021. Dose calculations using the concentration results are included in Chapter 7, Table 7.5.

Table 3.4. Radionuclides in ambient air at East Tennessee Technology Park, January 2021 through December 2021

Station	Concentration (µCi/mL)			
	^{99}Tc	^{234}U	^{235}U	^{238}U
K11[a]	ND[b]	ND	ND	ND
K12[a]	ND	ND	9.05E-21	ND

[a] *K11 and K12 represent an on-site business exposure equivalent to half of a yearly exposure at this location.*
[b] *ND = not detectable*

3.5.1.4. Quality Assurance

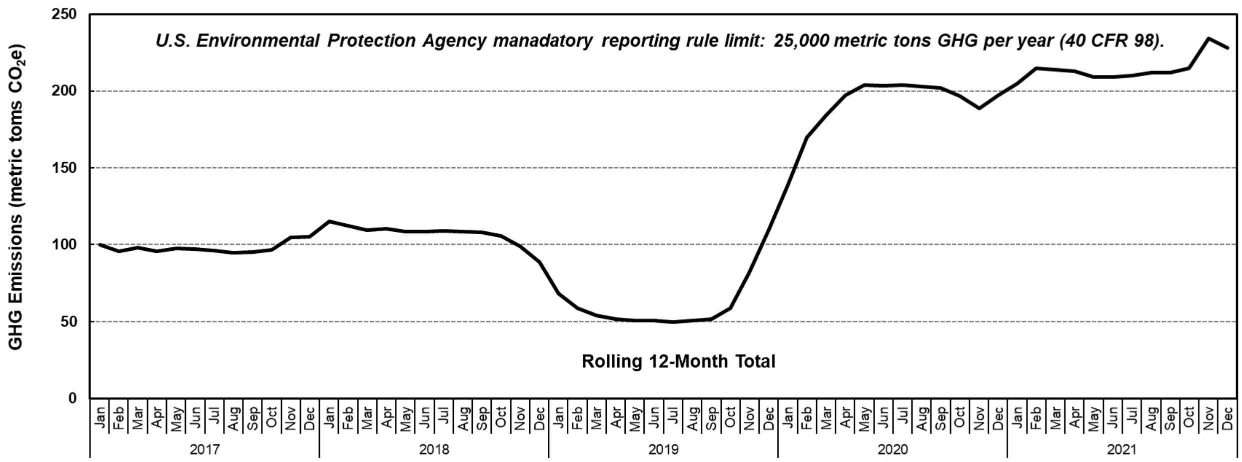
QA activities for the Rad-NESHAP program are documented in the Quality Assurance Program Plan for Compliance with Radionuclide National Emission Standards for Hazardous Air Pollutants, East Tennessee Technology Park, Oak Ridge Tennessee (UCOR 2018, UCOR-4257/R2). The plan satisfies the QA requirements in 40 CFR Part 61, Method 114 (EPA 1989), for ensuring that the radionuclide air emission measurements from ETTP are representative of known levels of precision and accuracy and that administrative controls (ACs) 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, Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities. The plan ensures the quality of ETTP radionuclide emission measurement data from continuous samplers and minor radionuclide release points. Only EPA preapproved methods are referenced through the *Compliance Plan National Emission Standards for Hazardous Air Pollutants for Airborne Radionuclides on the Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/ORO/2196, Rev. 2, May 1 DOE 2020).

3.5.1.5. Greenhouse Gas Emissions

The EPA rule for mandatory reporting of Greenhouse Gases (GHGs) (also referred to as the "Greenhouse Gas Reporting Program") was enacted October 30, 2009, under 40 CFR Part 98 (EPA 2009). According to the rule in general, the stationary source emissions threshold for reporting is 25,000 MT of CO_2 equivalent (CO_2e) or more of GHGs per year. The rule defines GHGs as:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons
- Perfluorocarbons
- Sulfur hexafluoride (SF_6)

A review was performed of ETTP processes and equipment categorically identified under 40 CFR Part 98.2 (EPA 2009) whose emissions must be included as part of a facility annual GHG report, starting with the CY 2010 reporting period. Based on total GHG emissions from all ETTP stationary sources during 2021, ETTP did not exceed the annual threshold limit and therefore was not subject to mandatory annual reporting under the GHG rule during this performance period. The total GHG emissions for any continuous 12-month period beginning with CY 2008 have not exceeded 12,390 MT CO_2e of GHGs. The most significant decrease in stationary source emissions was due to the permanent shutdown of the TSCA Incinerator in 2009. The remaining sources are predominantly comfort heating systems, hot water systems, and power generators. Figure 3.8 shows the 5-year trend up through 2021 of ETTP total GHG stationary emissions. For CY 2021, GHG emissions totaled 212 MT CO_2e, which is 0.8 percent of the 25,000 MT CO_2e per year threshold for reporting.



Note: *Shown in carbon dioxide equivalent (CO2e)*
Acronyms:
CFR = Code of Federal Regulations *GHG = greenhouse gas*

Figure 3.8. East Tennessee Technology Park stationary source greenhouse gas emissions tracking history

The increase in 2020 and 2021 resulted from the leasing of several large bays in Building K-1036; these bays are heated with natural gas.

Executive Order (EO) 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, was published in the Federal Register on October 8, 2009. The purpose of this order was to establish policies for federal facilities that will increase energy efficiency; measure, report, and reduce GHG emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse, and storm water management; eliminate waste; recycle; and prevent pollution at all such facilities. While the order deals with a number of environmental media, only its applicability to GHG is considered here. The EO defines three distinct scopes for purposes of reporting:

1. Scope 1 is essentially direct GHG emissions from sources that are owned or controlled by a federal agency.
2. Scope 2 encompasses GHG emissions resulting from the generation of electricity, heat, or steam purchased by a federal agency.
3. Scope 3 involves GHG emissions from sources not owned or directly controlled by a federal agency, but related to agency activities, such as vendor supply chains, delivery services, and employee business travel and commuting.

One goal of this order was to establish a FY 2020 Scope 1 and Scope 2 reduction target of 28 percent, as compared to the 2008 baseline year.

EO 13693, *Planning for Federal Sustainability in the Next Decade,* was published in the Federal Register on March 25, 2015. This order superseded EO 13514 and established a new Scope 1 and Scope 2 federal-wide total reduction target of 40 percent by 2025, as compared to the 2008 baseline year. For reporting purposes, GHG emission data are compared to both goals.

EO 13834, *Efficient Federal Operations*, was published in the Federal Register on May 22, 2018. This order superseded EO 13693. It requires continued tracking and reporting of GHG emissions, but no specific federal-wide total reduction target.

The information reported here includes GHG emissions from the industrial landfills at Y-12 that are managed and operated by UCOR. The landfills are not part of the contiguous ETTP site; however, DOE requested that UCOR, as the operator, include landfill GHG emissions with ETTP reporting in the Consolidated Energy Data Report. To be consistent with reporting this information, the landfill emissions are also included with ETTP ASER data. Figure 3.9 shows the trend toward meeting both the original EO 13514 Scope 1 and 2 GHG emissions reduction target of 28 percent by FY 2020 and the EO 13693 Scope 1 and 2 GHG emissions reduction target of 40 percent by FY 2025.

Scope 1 and 2 GHG emissions for FY 2021, including the landfills, totaled 16,650 MT CO_2e, which is a 73 percent reduction from emissions in the FY 2008 baseline year.

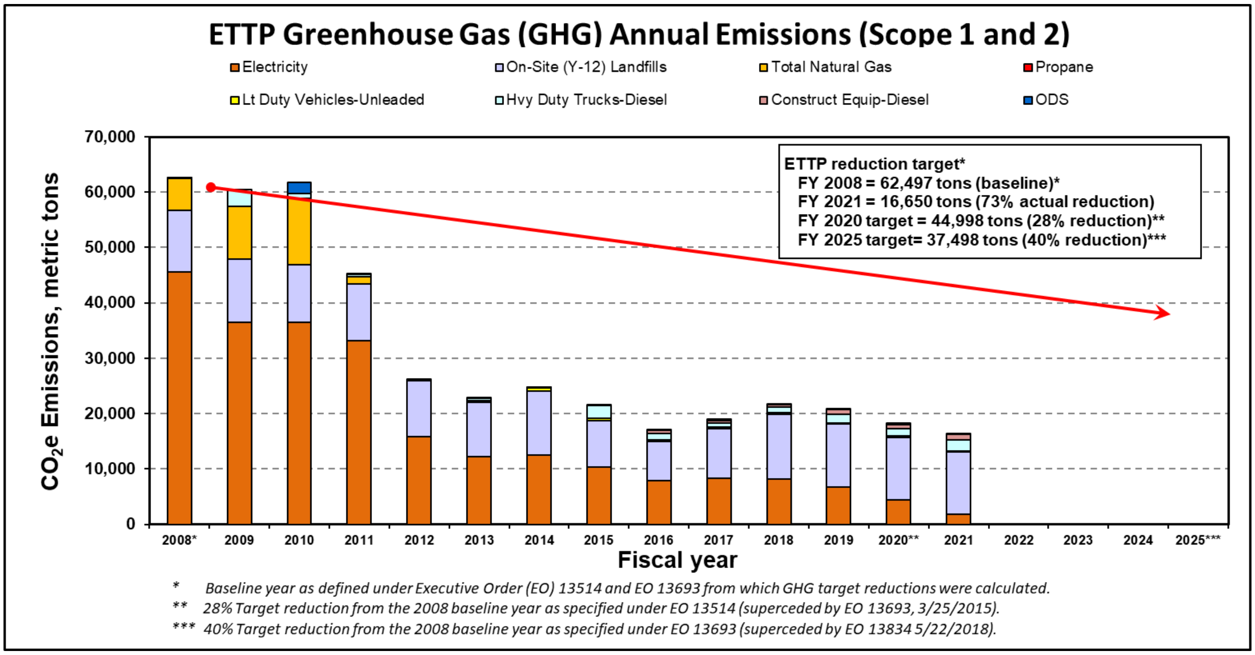
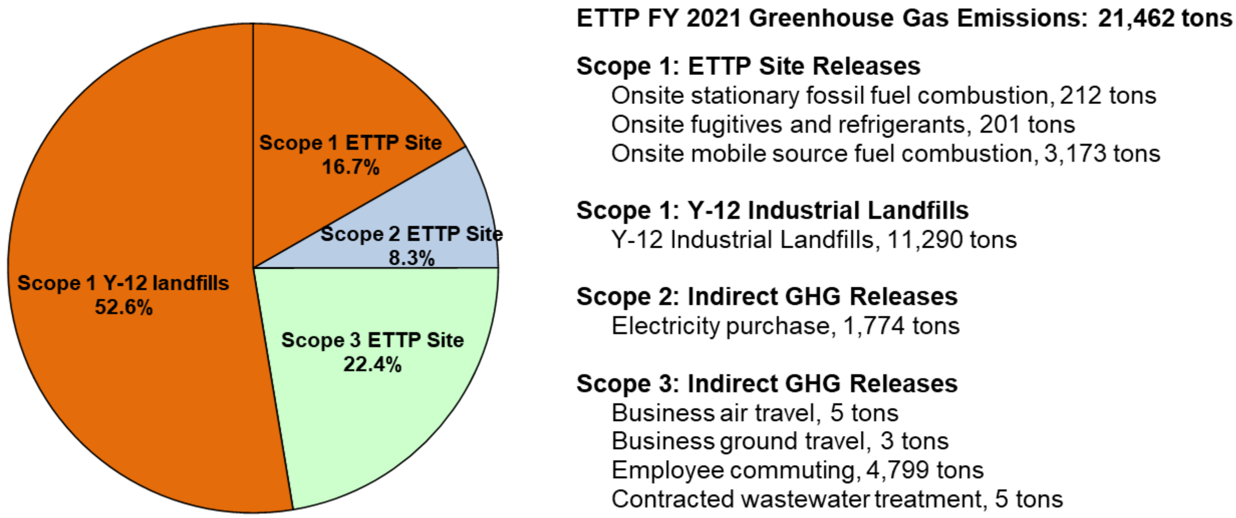


Figure 3.9. East Tennessee Technology Park greenhouse gas annual emissions (Scopes 1 and 2, including industrial landfills at Y-12)

Figure 3.10 shows the relative distribution and amounts of all ETTP FY 2021 GHG emissions for Scopes 1, 2, and 3 including the industrial landfills at Y-12. Total GHG emissions remain well below the levels first reported in the 2008 baseline year as demolition and remediation efforts continue at ETTP. Many of the early reductions were due to lower on-site combustion of fuels (stationary and mobile sources), lower consumption of electricity, and a smaller workforce. The total amount of GHG emissions for Scopes 1, 2, and 3, including landfills at Y-12, for FY 2021 was 21,462 MT CO_2e.



Acronyms:
ETTP = East Tennessee Technology Park
GHG = greenhouse gas
Y-12 = Y-12 National Security Complex

Figure 3.10. Fiscal year 2021 East Tennessee Technology Park greenhouse gas emissions by scope

3.5.1.6. Source-Specific Criteria Pollutants

ETTP operations included one functioning minor stationary source, the CWTS, with a potential to emit any form of criteria air pollutant. This unit is equipped with an air stripper to remove VOCs from the influent stream. Potential total VOC emissions from the CWTS air stripper were calculated to be 0.005 ton/year in 2021, as compared to an emission limit of 5 tons/year.

ETTP operations released airborne pollutants from a variety of minor pollutant-emitting sources, such as vents, and fugitive and diffuse activities. The emissions from all stacks and vents are evaluated following approved methods to establish their low emissions potential. This is done to verify and document their minor source permit exempt status under all applicable state and federal regulations.

3.5.1.7. Hazardous Air Pollutants (Nonradionuclide)

Unplanned releases of hazardous air pollutants are regulated through the risk management planning regulations under 40 CFR Part 68 (EPA 1994). To ensure compliance, periodic inventory reviews of ETTP operations were performed that used monthly data obtained through the EPCRA Section 311 reporting program. This program applies to any facility at which a hazardous chemical is present in an amount exceeding a specified threshold. A comparison of the EPCRA 311 monthly Hazardous Materials Inventory System (HMIS) chemical inventories at ETTP with the risk management plan threshold quantities listed in 40 CFR Part 68.130 (EPA 1994) was conducted. This is an ongoing action that documents the potential applicability for maintaining and distributing a risk management plan and ensuring threshold quantities are not exceeded.

ETTP personnel have determined that there are no processes or facilities containing inventories of chemicals in quantities exceeding thresholds specified in rules pursuant to CAA, Title III, Section 112(r), "Prevention of Accidental Releases." Therefore, activities at ETTP are not subject to the rule. Procedures are in place and implemented to continually review new processes, process changes, or activities with the rule thresholds.

3.5.2. Ambient Air

Compliance of fugitive and diffuse sources is demonstrated based on environmental measurements. The ETTP Ambient Air Quality Monitoring Program is designed to provide environmental measurements to accomplish the following:

- Tracking of long-term trends of airborne concentration levels of selected air contaminant species.
- Measurement of the highest concentrations of the selected air contaminant species that occur in the vicinity of ETTP operations.
- Evaluation of the potential impact on air contaminant emissions from ETTP operations on ambient air quality.

The three sampling programs in the ETTP area are designated as the EC&P program, TDEC program, and the ORR perimeter air monitoring program. Figure 3.11 shows an example of a typical EC&P program air monitoring station. Figure 3.12 shows the locations of all ambient air sampling stations in and around ETTP that were active during the 2021 reporting period.

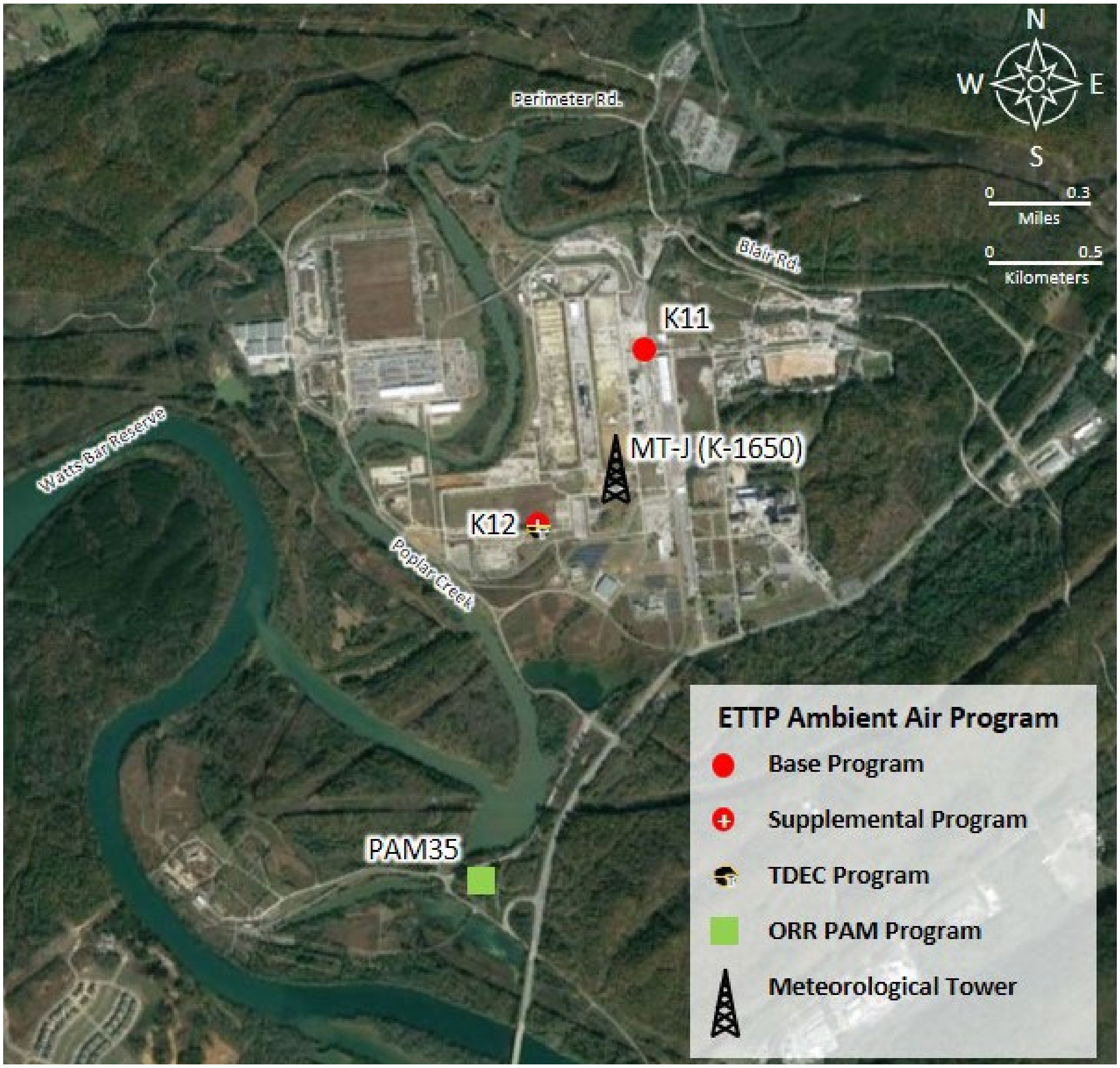
The EC&P program consisted of two sampling locations throughout 2021. All projects are operating similar high-volume sampling systems. The EC&P, TDEC, and perimeter air monitoring samplers operate continuously with exposed filters collected weekly. The radiological monitoring results for samples collected at the one ETTP area perimeter air monitoring station are the responsibility of UT-Battelle, LLC. TDEC is responsible for the data collected from their samplers. UT-Battelle, LLC and TDEC results are not included with the EC&P data presented in this section. However, results from the other programs are requested periodically for comparison.

The analytical parameters were chosen with regard to existing and proposed regulations and with respect to activities at ETTP. The principle reason for EC&P program stations is to demonstrate that radiological emissions from the demolition of ETTP gaseous diffusion buildings, supporting structures, and associated remediation activities are in compliance with the annual dose limit to the most exposed members of the public that are either on site (on ORR) or off site. K11 and K12 were key sampling locations regarding the potential dose impact on the most exposed member of the public at an on-site business location during slab removals, small structures demolition, excavation and removal of contaminated soils, and other activities.

Changes of emissions from ETTP will warrant periodic reevaluation of the parameters being sampled. Ongoing ETTP reindustrialization efforts will also introduce new locations for members of the public that may require adding or relocating monitoring site locations. To ensure understanding of the potential impacts on the public and to establish any required emissions monitoring and emissions controls, a survey of all on-site tenants is reviewed every 6 months through a request for the most recent ETTP reindustrialization map.

All EC&P program stations collected continuous samples for radiological analyses during 2021. These analyses of samples from the EC&P stations test for the isotopes ^{234}U, ^{235}U, ^{238}U, and ^{99}Tc.

Figure 3.11. East Tennessee Technology Park ambient air monitoring station



Acronyms:

ETTP = East Tennessee Technology Park
MT = meteorological tower
ORR = Oak Ridge Reservation
PAM = perimeter air monitoring
TDEC = Tennessee Department of Environment and Conservation

Figure 3.12. East Tennessee Technology Park ambient air monitoring station locations

Stations K11 and K12 are located to provide a conservative measurement of the impact to on-site members of the public.

3.6. Water Quality Program

Water quality is monitored via multiple programs at ETTP. Storm water monitoring is conducted through the NPDES Program (Section 3.6.1) and the SWPPP Program (Section 3.6.2). Surface water monitoring is conducted through the Environmental Monitoring Program (Section 3.6.3). Ground water monitoring is conducted through the Water Resources Protection Program (Section 3.6.4).

The vast majority of the radionuclide measurements in surface water at ETTP are less than 1% of the allowable standards.

3.6.1. National Pollutant Discharge Elimination System Permit Monitoring

NPDES monitoring is conducted to demonstrate compliance with the ETTP NPDES Permit. The ETTP NPDES permit in effect during 2021 became effective on April 1, 2015, and expired on March 31, 2020, but the expired permit continued in effect until the new permit was issued by the state of Tennessee. The new permit became effective on April 1, 2022. Under the ETTP NPDES Permit in effect in 2021, 27 representative outfalls are monitored annually for oil and grease, total suspended solids (TSS), pH, and flow (Figure 3.13). Outfall 170 is also monitored quarterly for total chromium and hexavalent chromium. There were no permit noncompliances in 2021.

3.6.2. Storm Water Pollution Prevention Program

In addition to the NPDES permit required monitoring, storm water is also monitored for a variety of substances, including radionuclides, metals, and organic compounds (UCOR-4028, *East Tennessee Technology Park Storm Water Pollution Prevention Program Sampling and Analysis Plan, Oak Ridge, Tennessee*, UCOR 2020d). Routine SWPPP monitoring is conducted at various locations that vary from year to year depending on activities going on within the drainage basins and historical monitoring results. SWPPP monitoring includes radiological monitoring, D&D and RA monitoring, CERCLA Phased Construction Completion Report (PCCR) monitoring, legacy contamination monitoring, and investigative monitoring.

Figure 3.13. Storm water outfall monitoring

3.6.2.1. Radiologic Monitoring of Storm Water

Radiological monitoring is conducted to determine compliance with applicable dose standards. Composite samples from five outfalls were collected following a rain event and analyzed for gross alpha activity, gross beta activity, and specific radionuclides. The estimated discharge of radionuclides from ETTP via the storm water drainage system was calculated based on the radiological monitoring results, daily rainfall data for calendar year 2021, and flow rates. Table 3.5 presents the total calculated discharge of radionuclides from storm water discharged to off-site waters from the ETTP in CY 2021.

Table 3.5. Radionuclides released to off-site waters from the East Tennessee Technology Park storm water system in 2021

Isotope	^{234}U	^{235}U	^{238}U	^{99}Tc
Activity level (Ci)	0.0083	0.00085	0.0065	0.043

3.6.2.2. Demolition and Remedial Action Monitoring of Storm Water

Demolition and RA monitoring is conducted to evaluate the effectiveness of Demolition and RAs and to ensure that storm water controls are preventing sediment and contaminants from discharging into receiving waters. Grab samples from select outfalls are collected prior to the start of demolition/RAs, following each 1-inch rain event during demolition/RAs, and after completion of demolition/RA activities.

3.6.2.3. K25 Building ^{99}Tc Contaminated Soil Remedial Action Monitoring

Demolition of the K-25 Building was completed in 2014. The last section of the east wing that was demolished was contaminated with the radioactive isotope ^{99}Tc. Rain and dust control water that contacted the ^{99}Tc-contaminated piping and other building materials is believed to have caused the migration of ^{99}Tc into soils beneath the east wing debris pile during demolition. Remediation of the ^{99}Tc-contaminated soils within the K-25 footprint was completed in 2020. Storm water monitoring in Outfalls 190 and 490, located downgradient of the former K-25 Building, continued in 2021.

Outfall 190 is sampled quarterly. Except for the sample collected in July 2021, ^{99}Tc has not been detected in storm water samples from Outfall 190 since July 2013. Based on this data, it does not appear that ^{99}Tc-contaminated groundwater from the K-25 Building D&D project is discharging to Mitchell Branch via Outfall 190.

Outfall 490 is sampled semi-annually. ^{99}Tc was detected in the storm water samples from Outfall 490 in March 2021 and July 2021 but was well below the reference standard of 390,000 pCi/L. Outfall 490 discharges into the K-1007-P1 Pond. Discharges from the K-1007-P1 Pond to Poplar Creek are monitored routinely as an exit pathway location per the ETTP EMP. The ^{99}Tc data is evaluated to determine the contribution of ^{99}Tc from the Outfall 490 drainage area to the total ^{99}Tc discharge from the K-1007-P1 pond as further discussed in Section 3.6.3.

3.6.2.4. K-1203 Sewage Treatment Plant Post-Demolition and Remedial Action Monitoring

Outfall 05A is located in the former K-1203 Sewage Treatment Plant (STP) area. Demolition of K-1203 was completed in 2019; RAs, including rerouting of the Outfall 05A discharge, were completed in 2020; and storm water monitoring continued in 2021. Samples from the newly designated outfall (referred to as Outfall 05A-2, but officially listed on the ETTP NPDES Permit as Outfall 05A) are collected and analyzed for metals. Metal concentrations fluctuated during 2021 but continue to show an overall decrease over time.

3.6.2.5. EU-19 Remedial Action Monitoring

The EU-19 area encompasses the former K-1410 Building area, the former K-1410 Neutralization Pit, the former K-1410-B Effluent Treatment Facility, the former K-1031 Building area, and the gravel, soil, and paved areas in the vicinity of where these structures were once located. These facilities were previously demolished; however, there was some remaining radiological soil contamination. RAs to remove the radiological contaminated soil were conducted in 2020. Soil removal work included recontouring the Outfall 360 and Outfall 362 drainage areas to promote sheet flow and eliminate discharges from those piping systems. Samples from Outfall 350 were collected prior to the EU-19 soil removal action (October 2019), during the soil removal action (October and November 2020) and following completion of the soil removal action (March 2021). The samples from Outfall 350 were collected following a qualifying rain event and analyzed for gross alpha activity, gross beta activity, and specific radionuclides. Since completion of the soil removal RA, none of the analytical results have exceeded reference standards. Based on these results, it appears that the radiologically contaminated soil was removed from the EU-19 area. The Outfall 360 and 362 drainage networks have been physically removed from service.

3.6.2.6. EU-21 Remedial Action Monitoring

The EU-21 area is located between the east and west wings of the former K-25 Building and includes the slab associated with the former K-1024 Maintenance Shop. The K-1024 Maintenance Shop was used for the repair and calibration of instruments and equipment used in the K-25 uranium enrichment process. The maintenance shop used solvents, including TCE, for cleaning instruments and equipment. As an accepted practice at the time, solvents were frequently discharged into the floor drains, then entered the storm drain network. The main source of TCE in the EU-21 area is presumed to be from Catch Basin 7097, located on the south side of the former K-1024 building. Although TCE is the primary contaminant of concern for the EU-21 soil RA, mercury droplets were discovered during removal of buried pipe. K-1024 was also used for cleaning mercury from line recorder chemical traps between 1946 and 1947 and the equipment shop had a problem with spilled mercury and mercury vapors.

Prior to the soil RA, the storm drain system within the proposed excavation and clean layback footprints was isolated from the active system in order to prevent sediment and contaminants from discharging to Poplar Creek via Outfalls 230 and 240. Outfall 210 receives water from the storm drain system located on the east side of the K-25 east wing (well outside of the excavation and layback footprints). All of the catch basins located on the west side of the K-25 west wing were previously plugged under a separate program.

Baseline samples were not collected prior to the start of the soil RA due to dry conditions. Monitoring of Outfalls 210, 230, and 240 is being conducted during 1-inch rain events and analyzed for VOCs, metals, mercury, and TSS. TCE has not been detected in any of the samples collected from Outfalls 210, 230, or 240 in 2021. Several other parameters have been detected, but only mercury and lead exceeded reference standards during the June 2021 and August 2021 rain events. Storm water monitoring will continue following each 1-inch rain event until the RA is complete. A final sampling event will be conducted once excavation and waste shipments have been completed.

3.6.2.7. K-832 Area Post-Demolition Monitoring

The K-832 Area included the K-832 Recirculating Water Pumphouse and the K-832-H Cooling Tower and Basin. Building K-832 was originally used to pump recirculating cooling water from the K-832-H Cooling Tower basin through the K-27 and K-29 enrichment cascade equipment. After K-832 was shut down in 1985 the building was used to store electrical equipment and batteries. The K-832 Pump House and the K-832-H Cooling Tower were demolished in 2017; the K-832-H Cooling Tower basin was demolished in 2019. The below-ground basin contained more than 2 Mgal of nonradioactive water that had to be pumped and treated. After dewatering and removing sludge, the basin was filled with rock and the entire K-832 area was covered with clean soil in 2020. Following completion of all demolition and waste handling activities, post-demolition samples were collected from Outfalls 410 and 420 in mid-August 2021 and analyzed for uranium isotopes, ^{99}Tc, PCBs, metals, mercury, hexavalent chromium, and TSS. None of the analytical results exceeded reference standards in the post-demolition samples from Outfalls 410 and 420.

3.6.2.8. Monitoring of Outfalls Designated in the CERCLA Phased Construction Completion Reports

When environmental restoration activities at ETTP are conducted in phases, progress may be documented in a CERCLA PCCR. When this occurs, a PCCR is prepared to document the completed work (e.g., demolition) and interim requirements for remaining slabs. If radiological surveys indicate that a slab exceeds the release criteria in DOE Order 5400.5, Chg. 2, *Radiation Protection of the Public and the Environment* (DOE 1993), then interim access controls are implemented, the slab is posted, and the slab is included in the radiological surveillance and monitoring program. Environmental requirements in the radiological surveillance and monitoring program include sampling designated outfall(s) once every NPDES permit cycle for gross alpha activity, gross beta activity, uranium isotopes, and ^{99}Tc. The designated outfall(s) are selected based on the drainage area and proximity to the slab(s).

Four outfalls were designated for sampling in CERCLA PCCRs in 2021. Grab samples were collected from Outfalls 158, 160, 230, and 380 and analyzed for gross alpha activity, gross beta activity, uranium isotopes, and ^{99}Tc. The CERCLA PCCR monitoring results are presented in Table 3.6.

Table 3.6. CERCLA PCCR monitoring results for 2021

Parameter	Reference standard	Outfall 158 (8/17/2021)	Outfall 160 (8/17/2021)	Outfall 230 (8/23/2021)	Outfall 380 (8/17/21)
Associated Slab(s)		K-1420 slab	K-1420 slab	K-1025-A slab K-1025-B slab K-1025-C slab K-1025-D slab K-1025-E slab K-1024 slab	K-1231-A slab K-1231-B slab K-1232-C slab K-1233 slab K-413 slab K-1131-D slab
Alpha activity (pCi/L)	15	**72.3**	**77.1**	9.55	12.8
Beta activity (pCi/L)	50	27.5	29.8	9.43	8.75
^{99}TC (pCi/L)	390,000	9.09 U	24.5	6 U	6.01 U
$^{233/234}$U (pCi/L)	1,200	42	47	6.04	6.24
$^{235/236}$U (pCi/L)	1,300	3.73	3.47	0.532	0.711
^{238}U (pCi/L)	1,400	27.9	13.1	2.86	6.5

Results in **bold** exceed the reference standard. Reference standards for gross alpha and gross beta measurements correspond to the National Primary Drinking Water Standard (40 CFR Part 141, *National Primary Drinking Water Regulations*, Subparts B and G, EPA 1975). Reference standards for radionuclides equal the derived concentration standard (DCS) for ingested water (DOE-STD-1196-2021, *Derived Concentration Technical Standard,* DOE 2021d).

3.6.2.9. Legacy Mercury Contamination Monitoring of Storm Water

Legacy mercury contamination monitoring is conducted to evaluate mercury concentrations over time and to determine if non-representative outfalls are contributing mercury to site waterways.

Outfalls 180 and 190 discharge storm water from large areas on the north side of ETTP into Mitchell Branch. There were numerous historical mercury operations within the Outfall 180 and 190 drainage areas and the Mitchell Branch subwatershed. Due to contaminated sediment within storm water networks and potential infiltration into the piping, these are potential contributors to the continuing legacy mercury discharges to Mitchell Branch. As described in Section 3.6.2.2, Outfall 05A/05A-2 routes storm water runoff and groundwater infiltration from the former K-1203 STP area to the former discharge pipe used by the K-1203 STP and into Poplar Creek. Based on the decreasing concentrations of metals, including mercury, in the samples collected from Outfall 05A/05A-2, it appears that legacy contamination in the Outfall 05A/05A-2 area has been reduced due to demolition of the K-1203 STP, subsequent RAs, and revegetation of the K-1203 footprint.

The mercury concentrations detected in Outfalls 180, 190, and 05A/05A-2 during 2021 are presented in Table 3.7. The mercury concentrations over time in Outfalls 180/190 and in Outfall 05A/Outfall 05A-2 are presented in

Figures 3.14 and 3.15, respectively. Mercury concentrations in these outfalls occasionally exceed the reference standard of 51 ng/L but show an overall decreasing trend over time.

Legacy mercury contamination monitoring was also conducted to evaluate the extent of mercury contamination in the subwatersheds. Non-representative outfalls which had not been

Table 3.7. Mercury results for Outfall 180, 190, and Outfall 05A/05A-2 in 2021

Sampling location	Reference standard (ng/L)	1/12/2021 (ng/L)	5/11/2021 (ng/L)	7/13/2021 (ng/L)	11/1/2021 (ng/L)
Outfall 180	51	**106**	**54.4**	**81.3**	**247**
Outfall 190	51	16.1	20.7	8.63	9.88
		2/11/2021 (ng/L)	6/7/2021 (ng/L)	7/14/2021 (ng/L)	12/6/2021 (ng/L)
Outfall 05A/05A-2	51	16.1	14.2	8.85	15.6

Note: *Results in bold exceed the reference standard. The reference standard for mercury corresponds to TDEC Rule 0400-40-03-.03(4)(j), Organisms Only Criteria.*

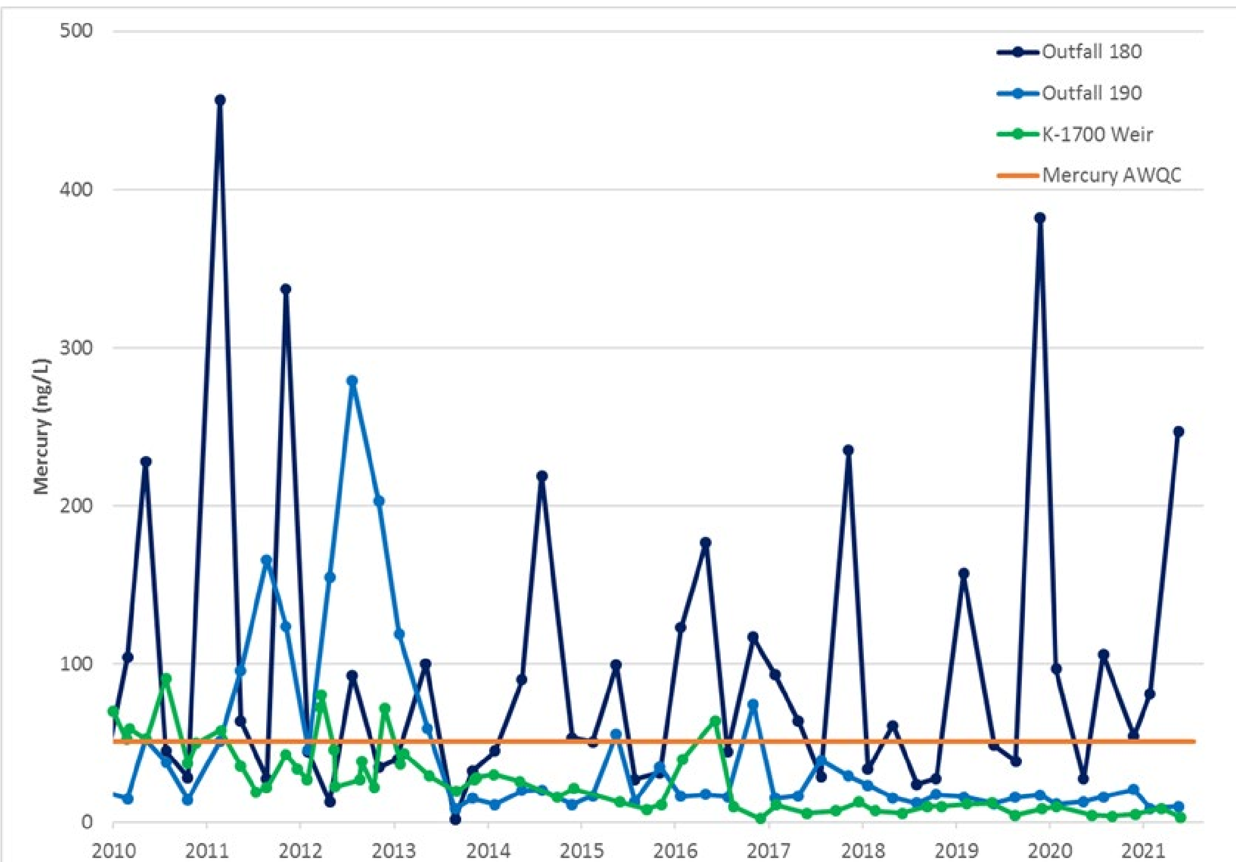


Figure 3.14. Mercury concentrations at Outfall 180, Outfall 190, and the K-1700 Weir

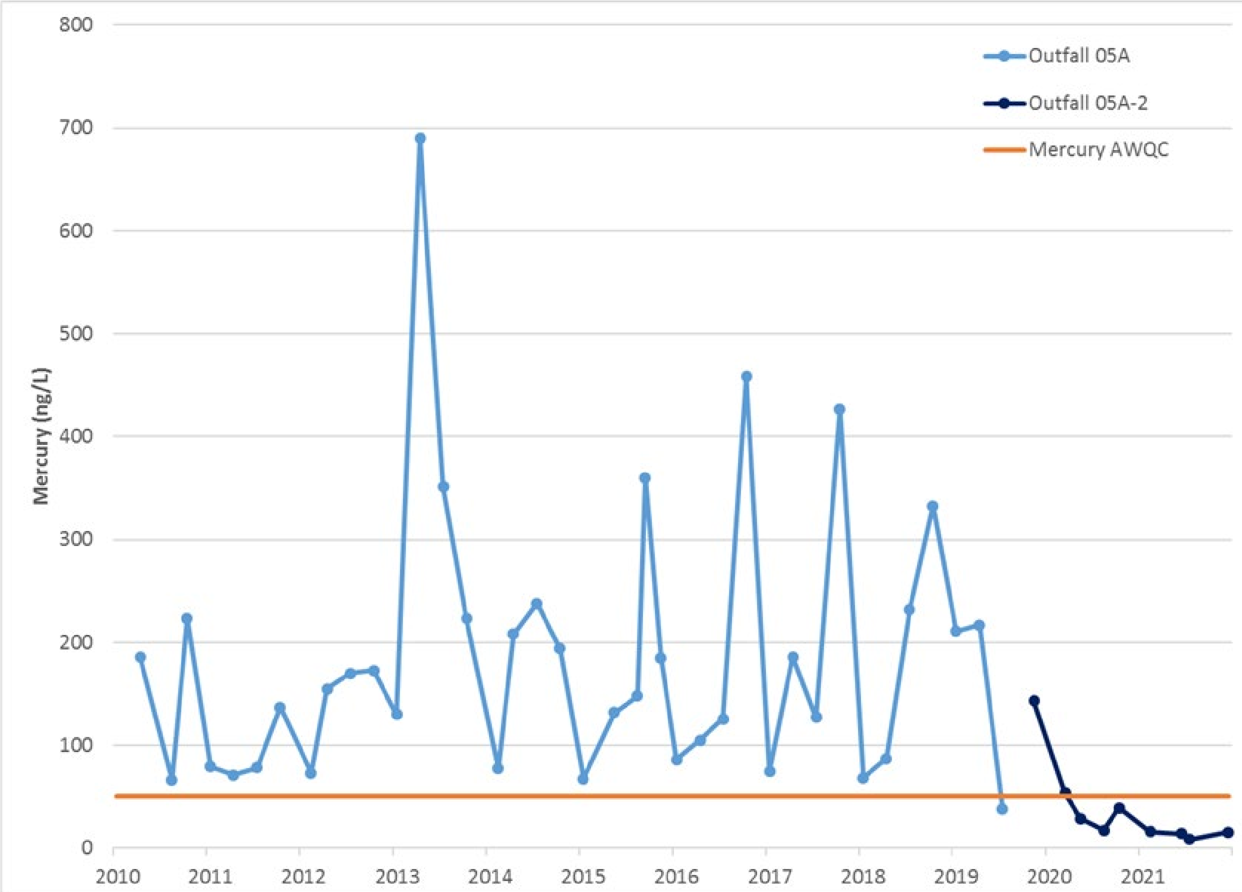


Figure 3.15. Mercury concentrations at Outfall 05A/05A-2

sampled in more than three years were selected to determine if non-representative outfalls may be contributing mercury to site waterways. Mercury was detected in all four locations sampled in February 2021 (Outfalls 210, 250, 280, and 660), but concentrations were below the reference standard. Based on these results, it does not appear that storm water discharges from non-representative outfalls are contributing mercury to site waterways.

3.6.2.10. Legacy PCB Contamination Monitoring of Storm Water

Legacy PCB contamination monitoring was conducted to evaluate the extent of PCB contamination in the subwatersheds. Non-representative outfalls which had not been sampled in more than three years were selected to determine if non-representative outfalls may be contributing PCBs to site waterways. Samples were collected from five locations in August 2021 (Outfalls 510, 520, 522, 640, and 680), but PCBs were not detected in any of the outfalls sampled. The legacy PCB contamination monitoring conducted in 2021 was part of a larger PCB investigation at ETTP over the past two years. In 2020, fifteen non-representative outfalls were sampled and analyzed for PCBs. PCBs were detected in only one of the outfalls sampled (Outfall 292). Outfall 292 is located in EU-16 and will be included in the storm water monitoring associated with an upcoming RA planned for the area. Based on these results, it does not appear that storm water discharges from non-representative outfalls are contributing PCBs to site waterways.

3.6.2.11. Investigative Monitoring of Storm Water

Investigative monitoring is conducted based on elevated analytical results, CERCLA requirements, and/or changes in site conditions. Investigative monitoring was conducted at Outfalls 660, 690, and 694, as well as the Outfall 780 network, in 2021.

Outfalls 660, 690, and 694. Outfalls 660, 690, and 694 were sampled to evaluate the current concentrations of mercury and/or PCBs and to evaluate the current contaminant trends observed at each outfall. Grab samples were collected when storm water runoff was observed discharging and analyzed for PCBs and/or mercury. Depending on the results, outfalls were evaluated for proposed removal from the current ETTP NPDES permit.

Outfalls 660 and 694 were permanently plugged and the associated headwalls removed as part of reindustrialization efforts in August 2021.

PCBs were detected in Outfall 690. The Outfall 690 network was sampled to evaluate the possible sources and extent of PCB contamination. Samples were collected from the K-897-A Oil/Water Separator and six upstream catch basins December 2020. A follow-up sampling event was conducted in January 2021 to verify the sampling results. A final decision regarding RAs to be taken for the Outfall 690 network and the K-897-A Oil/Water Separator are under consideration. Outfall 690 remains in place and will be sampled again for PCBs in 2022.

Outfall 780 Network. Outfall 780 is located in the Powerhouse area. In 2018, a select group of non-representative outfalls were sampled to determine if they were contributing mercury and PCBs to site waterways. Outfall 780 had elevated concentrations of mercury and PCBs. Recent activities being conducted in the area were not suspected as the cause of the elevated mercury and PCB concentrations, although process knowledge indicated that they could be legacy contaminants. Outfall 780 once carried storm water runoff from former Buildings K-724 and K-725. These buildings were originally part of the S-50 thermal diffusion plant; Building K-725 was later used for beryllium processing. Building K-725 contained mercury traps that occasionally released mercury. In addition, mercury was reportedly “swept down the floor drains” and into the storm drain system during cleanup activities in the 1970s. Mercury may also have been present in the dust collection system and transported to the storm drain system via storm water runoff during demolition of K-725 in the 1990s. Outfall 780 also received storm water from the K-722 area, where approximately 1,000 gallons of oil was landfarmed for dust suppression in the 1980s.

A commercial wood yard and chipping facility operates at the K-722 site. While it is doubtful that these operations caused an increase in mercury or PCBs in the Outfall 780 drainage network, in 2021 they appeared to discharge water from an unknown source. This discharge was dark brown and appeared in relatively small quantities on an ongoing basis. Before the facility began operation, Outfall 780 was dry and did not discharge water to the Clinch River except during substantial storm events. It is possible that the discharge from this facility may be mobilizing contaminants that have been dormant in the Outfall 780 network for years.

In an effort to identify where potential sources of these legacy contaminants were entering the Outfall 780 drainage system, follow-up sampling was initiated in 2019. Most of the Outfall 780 network consists of open ditches and channels, so samples were collected from three locations upstream from the end of the pipe (Outfall 780 D2, Outfall 780 D3, and Outfall 780 D3). Outfall 780 D4 is located in a ditch near ongoing logging operations. Samples collected from Outfalls 780 D2 and Outfall 780 D3 in 2019 and 2020 had elevated concentrations of mercury and PCBs that exceeded reference standards. The sample collected from Outfall 780 D4 in May 2021 had a lower concentration of mercury that did not exceed the reference standard and was non-detect for PCBs. Based on these results, Outfall 780 was determined to be a potential representative outfall under the NPDES Permit.

3.6.2.12. Permit Renewal Monitoring

Permit renewal monitoring was conducted to evaluate Outfall 780 as a potential representative outfall. Outfall 780 is located in the Powerhouse area, has recent evidence of legacy mercury and PCB contamination, and could potentially be impacted by ORFP operations as described in the previous section. In order to support the recommendation, samples were collected and analyzed for a wide variety of parameters. Although elevated concentrations of mercury, PCBs, and radionuclides have been detected in samples from Outfall 780 during the past three years, none of the analytes detected in 2021 exceeded a reference standard. Outfall 780 is no longer recommended for inclusions as a representative outfall; however, additional monitoring of legacy contaminants will be conducted as part of the SWPPP in 2022.

3.6.2.13. Chromium Water Treatment System and Plume Monitoring

The Chromium Water Treatment System (CWTS) (Figure 3.16) was constructed to intercept a plume of contaminated groundwater before it enters Mitchell Branch.

The CWTS consists of interceptor wells, pumps, holding tanks, a treatment system, and an air stripper. Effluent is discharged through the pipeline that originally carried effluent from the Central Neutralization Facility (which was previously demolished). In CY 2021, monitoring was conducted at monitoring well 289 (TP-289), the chromium collection system wells, Outfall 170, and Mitchell Branch kilometer (MIK) 0.79. Figures 3.17 and 3.18 show the results for the analyses for total chromium and hexavalent chromium, respectively.

The analytical data indicate that both total and hexavalent chromium levels at TP-289 and the collection wells may fluctuate slightly but are relatively consistent over the long term. In 2021, levels of total chromium and hexavalent chromium at Outfall 170 and MIK 0.79 exhibited wider variability. After years of low concentrations, results for hexavalent chromium at Outfall 170 equaled or exceeded the ambient water quality criterion (AWQC) of 11 µg/L in three of four samples collected in 2021. Results for total chromium at Outfall 170 were within historic ranges, and well below the AWQC in 2021. The levels of both hexavalent and total chromium at MIK 0.79 fluctuated in 2021, but remained below the AWQC for hexavalent chromium of 11 µg/L and well below the total chromium AWQC of 185 µg/L. These results demonstrate the continuing positive impact of the collection well system to minimize the release of chromium into Mitchell Branch.

Figure 3.16. The Chromium Water Treatment System

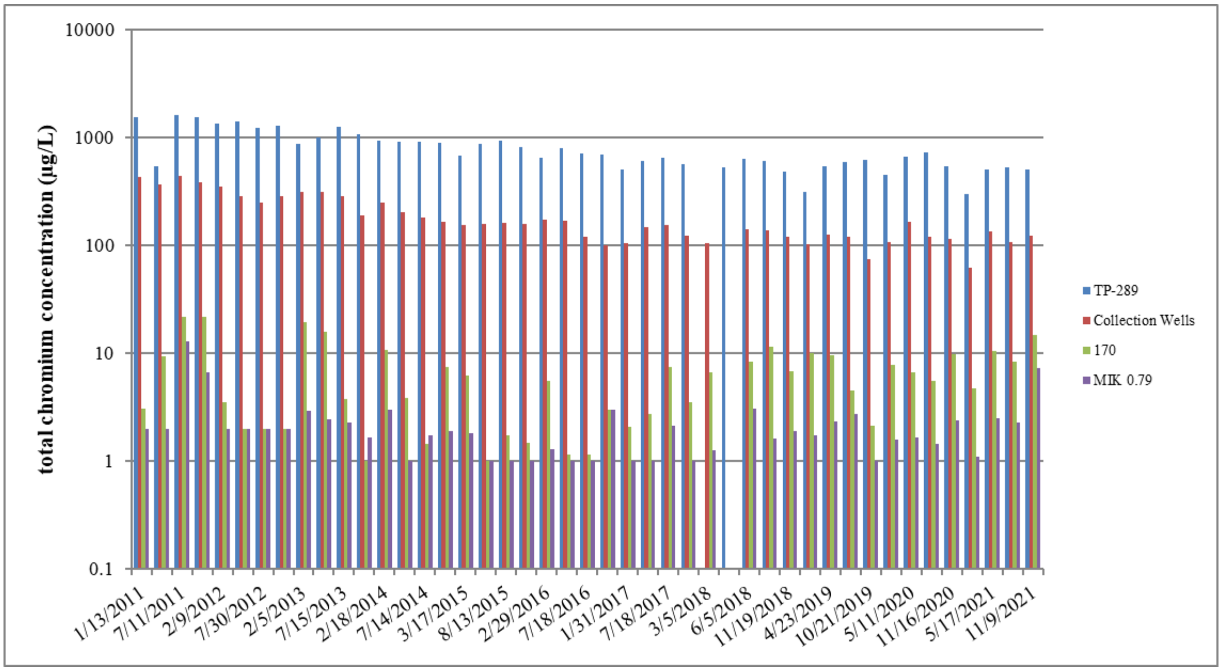


Figure 3.17. Total chromium sample results for the chromium collection system

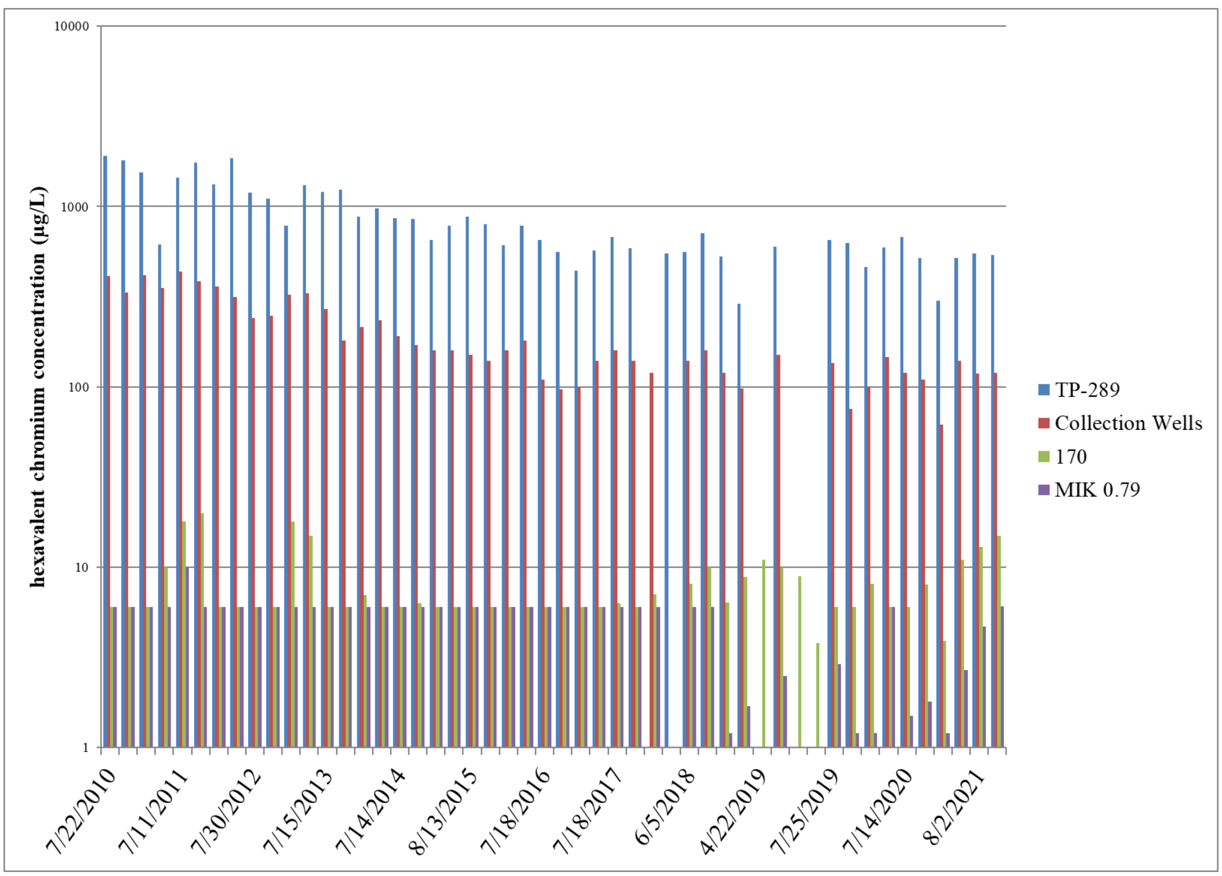
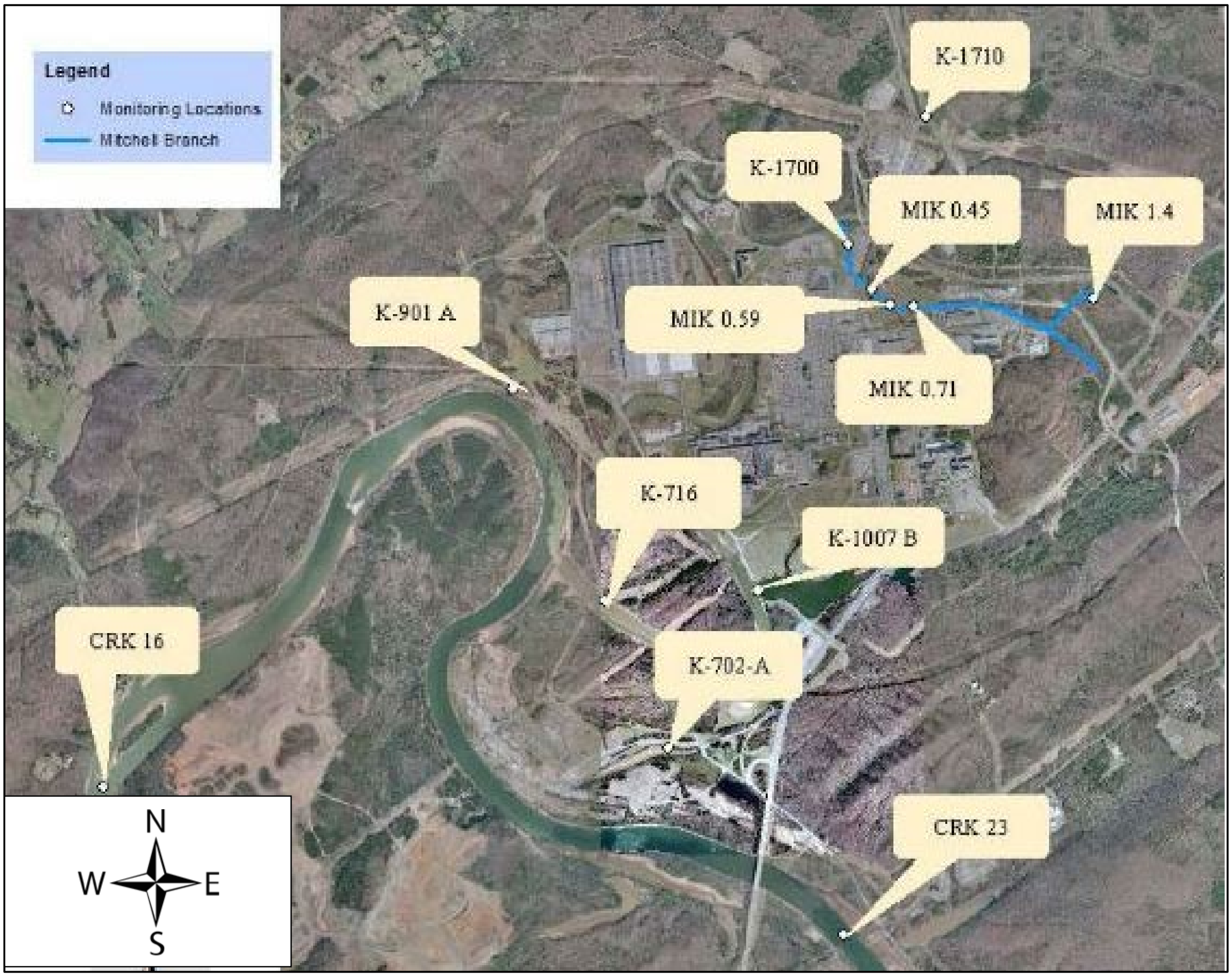


Figure 3.18. Hexavalent chromium sample results for the chromium collection system

3.6.3. Surface Water Monitoring

During 2021, the ETTP EMP personnel conducted environmental surveillance activities at 12 surface water locations (Figures 3.19 and 3.20) to monitor surface water conditions at watershed exit pathway locations (K-1700, K-1007-B, and K-901-A) or ambient stream conditions (Clinch River kilometers [CRKs] 16 and 23; K-1710; K-716; the K-702-A slough; and MIKs 0.45, 0.59, 0.71, and 1.4). Monitoring locations K-1700 and MIKs 0.45, 0.59, 0.71, and 1.4 were sampled quarterly; and monitoring locations CRKs 16 and 23, K-716, K-1007-B, K-901-A, and the K-702-A slough were sampled semiannually.

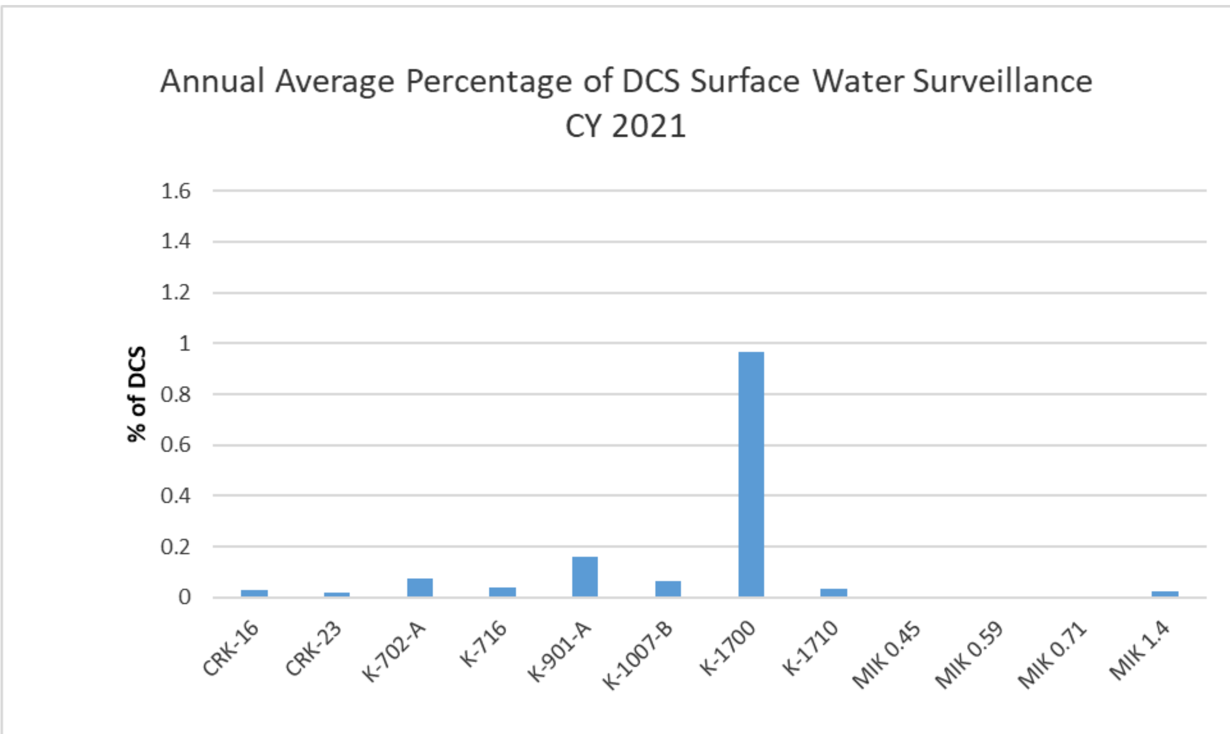
Figure 3.19. Surface water surveillance monitoring



Acronyms:
CRK = Clinch River kilometer *MIK = Mitchell Branch kilometer*

Figure 3.20. East Tennessee Technology Park Environmental Monitoring Program surface water monitoring locations

Results of radiological monitoring were compared with the derived concentration standard (DCS) values in DOE Standard 1196, *Derived Concentration Technical Standard* (DOE 2021d). Radiological data are reported as fractions of DCSs for reported radionuclides, and the fractions for all of the isotopes are added together to produce the sum of fractions (SOF) and averaged to produce a rolling 12-month average. The average SOF is recalculated whenever new data become available. If the average SOF for a location exceeds the DCS requirement of remaining below 1.0 (100 percent) for the year, a formal source investigation is required. Sources exceeding DCS requirements would need an analysis of the best available technology to reduce the SOF of the radionuclide concentrations to less than 1.0 (100 percent). In 2021, the monitoring results yielded SOF values of less than 0.01 (1 percent of the allowable DCS) at all surface water surveillance locations at ETTP (Figure 3.21). At K-1700, the annual average SOF was 0.00969 (0.97 percent). At MIKs 0.45, 0.59, and 0.71, quarterly monitoring is conducted for ^{99}Tc only.



Acronyms: *CRK = Clinch River kilometer   DCS = derived concentration standard   MIK = Mitchell Branch kilometer*

Figure 3.21. Annual average percentage of derived concentration standards at surface water monitoring locations, 2021

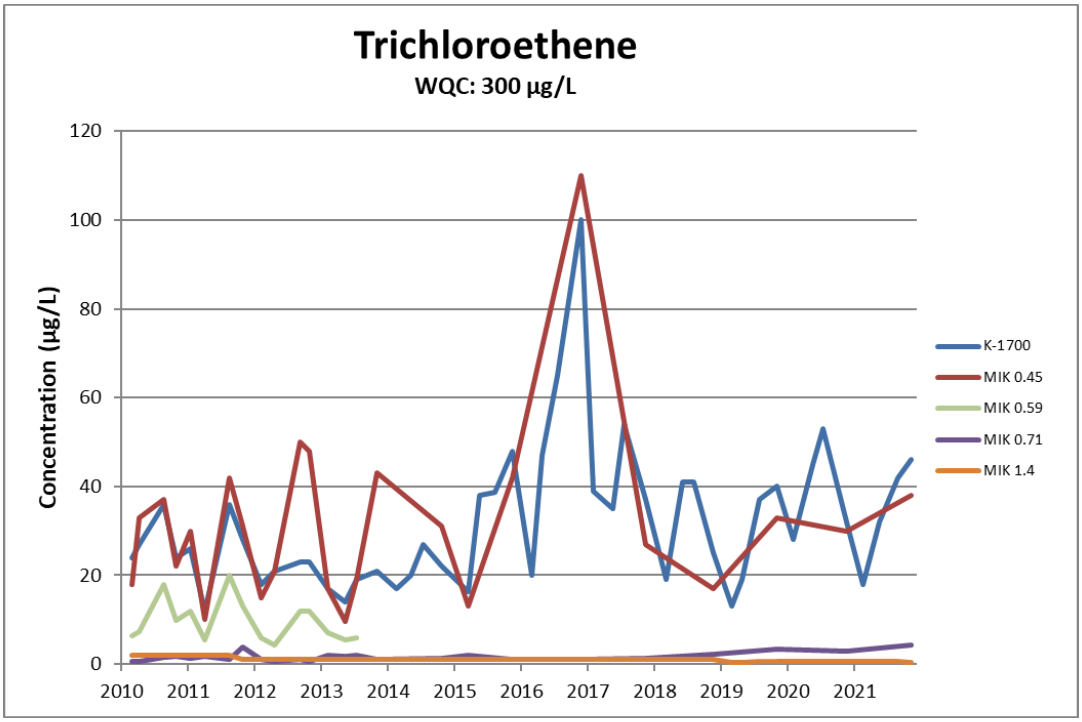
The vast majority of the results from monitoring of surface water at ETTP are well within the Ambient Water Quality Criteria. The most common exceedance, low dissolved oxygen levels, is a result of natural conditions (high biological activity during periods of low flow).

Depending on the monitoring location, water samples may be analyzed for pH, selected metals, and VOCs. In 2021, 1818 analytical results and 159 field readings were collected under the EMP. The vast majority of these results were well within the appropriate AWQC. There were three exceptions in 2021. During the third quarter, there were two failures to meet the minimum level of dissolved oxygen (5.0 mg/L). Dissolved oxygen levels were measured at 4.2 mg/L at K-901-A, and at 3.6 mg/L at K-1007-B. These readings were collected at a time of elevated temperatures and very low flow due to the drought conditions, which favor high biological activity and the resulting depletion of dissolved oxygen. Both readings were within historic ranges for these two locations. During the fourth quarter, a thallium result of 0.488 µg/L was measured at MIK 0.45. This estimated value barely exceeded the AWQC of 0.47 µg/L. Thallium is not typically detected at this location (nor was it detected at any other location during CY 2021), and the cause of this result is unclear.

Figure 3.22 illustrates the concentrations of TCE (trichloroethene) from the Mitchell Branch monitoring locations. Although VOCs are routinely detected at K-1700 and MIK 0.45, they are rarely detected at other surface water surveillance locations across ETTP. In the samples collected on November 22, 2016, results for several VOCs, including TCE and cis-1,2-dichloroethene, at several of the Mitchell Branch monitoring locations were reported at levels significantly higher than seen in recent monitoring. It should be noted that the November 22, 2016, sample date was at the end of an extended dry weather period that began in August 2016. Furthermore, even at the increased levels, the results are still well within the AWQC. Concentrations of TCE and total 1,2-DCE are below the AWQCs for recreation, organisms only (300 µg/L for TCE and 10,000 µg/L for trans-1,2-DCE), which are appropriate standards for Mitchell Branch. In addition, vinyl chloride has sometimes been detected in Mitchell Branch water. VOCs have been detected in groundwater in the vicinity of Mitchell Branch and in building sumps discharging into storm water outfalls that discharge into the stream; these compounds have generally not been detected in storm water during the monitoring of network discharges. It appears that the primary source of these compounds is contaminated groundwater.

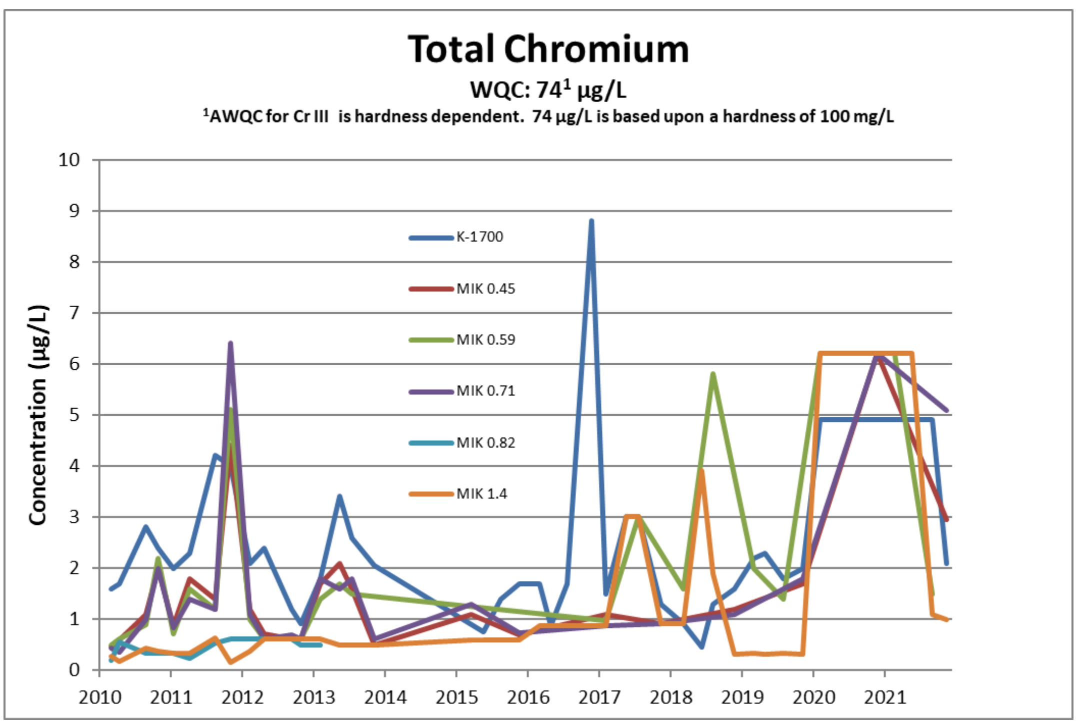
Since CWTS was installed, chromium levels in Mitchell Branch have dropped dramatically, with levels of total chromium being routinely measured at less than 6 µg/L (Figure 3.23). In 2021, hexavalent chromium levels in Mitchell Branch were all below the AWQC of 11 µg/L.

In CY 2021, ETTP did not conduct surface water monitoring for per- and polyfluoroalkyl substances (PFAS) compounds. Instead, groundwater was sampled for PFAS compounds. See section 3.6.4 for details.



Acronym: *MIK = Mitchell Branch kilometer*

Figure 3.22. Trichloroethene concentrations in Mitchell Branch



Note: *The AWQC for Cr(III), which is hardness-dependent, is 74 µg/L, based on a hardness of 100 mg/L. The AWQC for Cr(IV) is 11 µg/L.*

Acronyms: *AWQC = ambient water quality criterion MIK = Mitchell Branch kilometer*

Figure 3.23. Total chromium concentrations in Mitchell Branch

3.6.4. Groundwater Monitoring at ETTP

ETTP was divided into two zones to complete the primary source RA work. Zone 1 comprises 1,290 acres outside the ETTP Main Plant Area, and Zone 2 comprises 806 acres of the ETTP Main Plant Area. Actions under the two Records of Decision (RODs) have been on-going to characterize and address soil, buried waste, and subsurface structures for the protection of human health and to limit further contamination of groundwater through source reduction or removal (*Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* [Zone 1 Interim ROD; DOE/OR/01-1997&D2, DOE 2002] and *Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee* [Zone 2 ROD; DOE/OR/01-2161&D2, DOE 2005a]). The cleanup of the remaining environmental media at ETTP, e.g., groundwater, surface water/sediment, and remaining ecological receptors will be addressed under future CERCLA decision documents, and these projects were started. Concurrent with these RAs, demolition of buildings at ETTP has been performed via the *Policy on Decommissioning Department of Energy Facilities Under CERCLA* (DOE-EPA 1995) and DOE's Removal Action authority.

Planning continued in FY 2021 for future Records of Decision. The *East Tennessee Technology Park Main Plant Groundwater Focused Feasibility Study, Oak Ridge, Tennessee* (MP FFS, DOE/OR/01-2894&D1, DOE 2021c); the *Remedial Investigation/Feasibility Study Report for the K-31/K-33 Area at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2893&D1/R1, DOE 2021b); the *Zone 1 Groundwater Plumes Remedial Investigation Work Plan, East Tennessee Technology Park, Oak Ridge Tennessee* (DOE/OR/01-2903&D1, DOE 2021e); and the *Remedial Investigation Work Plan for Remaining Ecology/Surface Water/Sediment at East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2912&D1, DOE 2021g) were submitted to EPA and TDEC for review.

The data screen and trend assignments show that contaminant concentration trends are highly variable across the site as numerous remediation activities are underway.

- VOC concentrations in wells monitored downgradient of K-1070-C/D show that a broad area is affected by releases from the past disposal of liquid VOCs at G-Pit. While evaluations for data collected within the most recent five years indicate stable, indeterminate, or decreasing concentrations in wells monitored in the area, very high VOC concentrations affect wells DPT-K1070-5 and DPT-K1070-6. The persistent, very high concentrations of these VOCs suggest an ongoing contaminant source release.
- In the K-31/K-33 area, chromium continues to be measured at levels near the MCL. During FY 2021, antimony results were detected below the MCL screening concentration (6 µg/L) in an unfiltered sample from well BRW-030. Maximum chromium results (160 µg/L) in unfiltered and field-filtered samples from BRW-030 were just slightly above the 100 µg/L MCL. Nickel is present in groundwater samples from one well (UNW-043) at concentrations greater than the Tennessee MCL of 100 µg/L.
- At the K-27/K-29 area groundwater contamination migrates toward Poplar Creek in both north and south directions from the area facilities. In 2021, alpha activity and uranium concentrations continued to decline but remained above their respective MCLs. In the northern area, TCE continues to exceed the MCL screening level (5 µg/L) at wells BRW-041 (no significant trend), UNP-007 (stable trend) and UNW-028 (no significant trend). Uranium exceeds the MCL screening concentration (30 µg/L) in filtered and unfiltered samples form well UNP-007. In the southern area, carbon tetrachloride was equal to the MCL screening concentration (5 µg/L) in well UNW-088 having exhibited an increasing trend over 10 years but no trend during the past five years. Chromium exceeded its MCL screening concentration

(100 µg/L) in both filtered and unfiltered samples from well UNW-087 equaled the MCL in the unfiltered sample from well UNW-096. Nickel exceeded its MCL screening concentration (100 µg/L) in the filtered and unfiltered sample from wells UNW-036 and UNW-096. TCE continues to exceed the MCL screening concentration (5 µg/L) in wells BRW-069, UNW-037, UNW-038, UNW-085, UNW-087, UNW-088, and UNW-096. Most of the TCE trends in the K-27/K-29 southern area are no significant trend, stable, or decreasing with exception of an increasing trend determination for wells UNW-037 and UNW-096. In 2021, the maximum vinyl chloride concentration was equal to the screening concentration (2 µg/L) in well UNW-086 (stable and/or no significant trends).

- At PC-0 spring, TCE was detected in samples collected in January and May 2021, but not in the sample collected in August 2021. The maximum TCE result from PC-0 spring was 8.58 µg/L in the January 2021 sample. No TCE transformation products (1,2-DCE or VC) were detected in PC-0 spring samples during 2021, with the exception of a cis-1,2-DCE concentration of 0.47 "J" µg/L seen in the December 2021 sample. At spring 10-895, TCE was detected in samples collected in all four fiscal quarters of 2021. The maximum measured TCE concentration at spring 10-895 was 7 µg/L in August 2021. No TCE transformation products were detected at spring 10-895 in 2021.
- In the K-770 Area, alpha activity concentrations at UNW-015 were less than the 15 pCi/L MCL.
- At wells near the K-1007-P1 Holding Pond, alpha activity was detected at a concentration less than the 15 pCi/L MCL in well UNW-108 and was not detected in well BRW-084. TCE was detected in the March 2021 sample from well BRW-084 at 2 µg/L, which is slightly less than the 5 µg/L MCL.
- Monitoring results from wells in the K-1407-B/C Ponds Area are generally consistent with results from previous years and show several fold concentration fluctuations in seasonal and longer-term periods. The detection of VOCs at concentrations well above 1,000 µg/L and the steady concentrations over recent years suggest the presence of dense non-aqueous phase liquid (DNAPL) in the vicinity of well UNW-003.

The principal groundwater contaminants at ETTP are chlorinated VOCs (primarily TCE and its degradation products such as 1,2-dichloroethene and vinyl chloride) and ^{99}Tc. Despite the fact that ETTP is a former gaseous diffusion plant used for uranium enrichment, the occurrence of elevated uranium concentrations in groundwater is relatively uncommon at the site. The reason for this is that the uranium enrichment process used gaseous uranium hexafluoride (UF_6), which was contained inside process equipment and depleted UF_6 was returned to storage cylinders where it returned to solid form upon cooling. The Water Resources Restoration Program (WRRP) analyzes total uranium in samples from 52 wells and three springs. During FY 2021, the uranium MCL, 30 µg/L, was exceeded in samples from one well located north of the K-27 Building footprint. Well UNP-007 has exhibited uranium MCL exceedances since 2017. During FY 2021, uranium concentrations continued to decrease. Chromium and nickel (and less frequently lead) are the most common metal contaminants in groundwater, and they are relatively widespread at ETTP as well as elsewhere on the ORR. Chromium was used in the hexavalent form in the recirculating cooling water and fire protection water systems to prevent corrosion of pipes. Leaks of pipes that circulated the corrosion inhibiting additives were common and in some cases were of quite large volume. In the Mitchell Branch plume area near the former K-1420 facility, hexavalent chromium in groundwater is collected and treated prior to discharge to protect the water quality in Mitchell Branch and maintain instream chromium concentrations compliant with the 11 µg/L ambient water quality criteria (For more information, see Section 3.6.3.12 above.). The origin of nickel as a groundwater contaminant is not readily tied to site processes that would have created releases of soluble nickel to the subsurface. Lead was widely used at the DOE facilities as shielding material and for other typical industrial purposes. Lead materials were sometimes stored outdoors, in the open, and some was disposed in waste burial areas either as material shielding or as waste.

Chromium, nickel, and lead are widespread in ORR soils. The ORR background soils report indicates that for Knox and Chickamauga group soils the chromium concentrations are in the range of about 40-50 mg/kg at 95th percentile of the median. Nickel concentrations in Knox and Chickamauga group soils are in the ranges of about 10–30 mg/kg in the Knox and about 25-45 mg/kg in the Chickamauga group soils. Lead concentrations in soils are typically somewhat higher than the chromium and nickel levels. Chromium and nickel are also constituents of the stainless steel that comprises many of the monitoring well casings and screens. There is literature documentation that microbial induced corrosion can cause elevated chromium and nickel in groundwater monitoring wells at levels that can exceed the water quality criterion. In many instances, metals contamination detected in ETTP groundwater monitoring is particle associated material as demonstrated by either much lower, or non-detect concentrations measured in field-filtered sample aliquots than in the unfiltered aliquots. These factors lead to uncertainty in the interpretation of chromium and nickel (and other metals) data from groundwater monitoring because of multiple potential sources of metals—especially when data indicate that the metals are particle associated in the samples.

DOE has compiled the analytical data for groundwater contaminants in wells included in the routine WRRP monitoring program at ETTP to evaluate contaminant concentrations with respect to the EPA's National Primary Drinking Water Regulations (NPDWR) maximum contaminant levels (MCLs) and DCSs) in order to determine if statistically significant trends are occurring (EPA 1975). Data are compared to MCLs or DCSs for radionuclides. Data were compartmentalized into a maximum time period of 10 years for longer duration trend evaluation and a secondary time period of five years to evaluate more recent trends. Trend evaluations were made using the annual maximum concentration values over the 10-year period. The reason for the additional trend evaluation is to determine if the frequently observed seasonal concentration fluctuations mask trends that appear to be present based on visual examination of contaminant history graphs.

Former Buildings K-27 and K-29 were gaseous diffusion uranium enrichment process buildings. A number of process support facilities, including wastewater treatment, were located to the north of building K-27 and south of Poplar Creek. Groundwater contamination in the K-27/K-29 areas includes alpha activity, metals (including uranium), and VOCs. Contaminant concentration trends are quite mixed with some increasing, some decreasing, and many for which no trend can be confidently assigned.

The central plant area of ETTP includes the majority of the former gaseous diffusion process and support facilities. Figure 3.24 shows groundwater plume evaluation areas and several VOC plume areas. TCE is the principal chlorinated solvent that comprises the VOC plume sources although lesser amounts of tetrachloroethene, 1,1,1 trichloroethane, and Freon-113 are present in selected areas. TCE-rich dense non-aqueous phase liquid (DNAPL) has been confirmed to be present beneath the former K-1401 facility where parts cleaning using vapor degreasing facilities occurred. DNAPL is suspected to be present in the central portion of the K-1070-C/D plume area based on liquid waste disposal records for the "G-Pit" site. On the basis of continuing high concentration TCE signatures in groundwater, DNAPL is also suspected to be present at the K-1070-C/D South/K-1200 area, the K 1035 site, and near Mitchell Branch related to the K-1407-A neutralization pit and/or the K-1407-B Pond. The Zone 2 RA program has identified a significant source of TCE beneath the center of the K-25 Building where a soil RA will be required

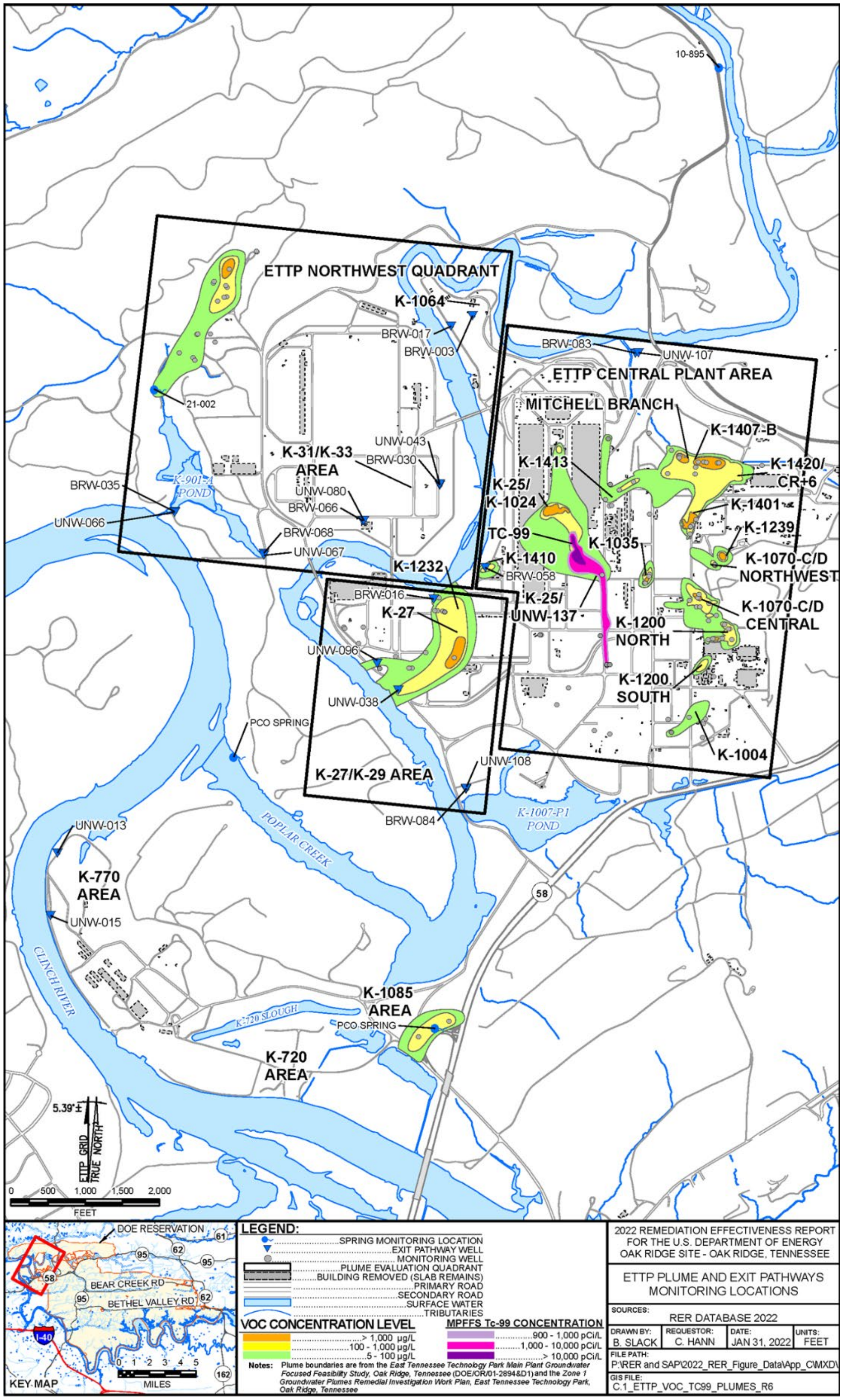


Figure 3.24. East Tennessee Technology Park volatile organic compound and ^{99}Tc plumes

consistent with the *Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2161&D2, DOE 2005a). No monitoring wells exist in that area to allow ongoing groundwater sampling and thus no groundwater trend evaluations are possible in that area. The ^{99}Tc contamination beneath the K-25 Building East Wing was remediated by excavation and much of the ^{99}Tc plume shown on figures is based on groundwater grab samples obtained from exploratory soil sample borings installed through the course of the ^{99}Tc RA project over the past several years. Since these samples were obtained from uncased borings with no wells, there will not be further sampling of the locations to allow trend evaluation. Groundwater investigations in support of a groundwater feasibility study for the central plant area included installation of wells that provide the possibility of future monitoring at selected locations.

Six plume evaluation areas have been established within the central plant area. For information concerning conditions at the K-1401 site, readers are referred to the *Design Characterization Completion Report for the Sitewide Groundwater Treatability Study at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 2018a, DOE/OR/01-2768&D1), which includes the detailed characterization of the confirmed DNAPL source area.

The ETTP Northwest Quadrant includes former K-1070-A Burial Ground, the K-31/K-33 area, K-1064, and the K-901-A Holding Pond. The K-1070-A Burial Ground was remediated by excavation of buried waste materials in the early 2000s and a TCE-dominated groundwater plume remains. At the K 1064 site, various waste handling and material storage activities occurred during the gaseous diffusion process operations and low concentration residual groundwater contaminants include arsenic and TCE. The K-31 and K-33 buildings were gaseous diffusion process buildings that have undergone decontamination and decommissioning. The principal groundwater contaminants at K-31/K-33 are metals that have mostly decreased in concentration to levels less than their MCLs. At the K-901 groundwater exit pathway, the only groundwater contaminant that has been present at greater than 80 percent of its MCL within the past decade is alpha activity which has decreased in concentration to levels less than 50 percent of the MCL or non-detectable levels.

The K-770 Area is the site of the former electrical generating powerhouse that provided the first electrical power for the gaseous diffusion plant in 1944. A portion of the northern K-770 Area was used for the storage of radioactively contaminated scrap metal for many years. Radiological materials associated with that scrap metal caused contamination of the underlying soil and groundwater. The scrap metal was removed and disposed and an RA was conducted to remove contaminated soil. Groundwater contamination is indicated by alpha activity, which has decreased in concentration over time to levels below the 15 pCi/L MCL.

Across ETTP, contaminant conditions in the groundwater exit pathway areas are generally stable and similar to conditions in recent years. For additional information, see the *2022 Remediation Effectiveness Report for the U.S. Department of Energy, Oak Ridge Site, Oak Ridge Tennessee* (DOE/OR/01-2916&D1, DOE 2021a).

In CY 2021, groundwater at ETTP was monitored for per- and polyfluoroalkyl substances (PFAS) compounds. Although several compounds were detected at a number of locations across ETTP, only a single compound (perfluorobutane sulfonic acid) was detected at individual concentrations exceeding the 40 ng/L screening level, and this was at only two locations (Unconsolidated Well (UNW)-80 and UNW-81). These wells are located to the south and southeast of the former K-31 building. The concentrations at both of these locations did exceed the 70 ng/L recommended preliminary remediation goal (PRG).

3.7. Biological Monitoring

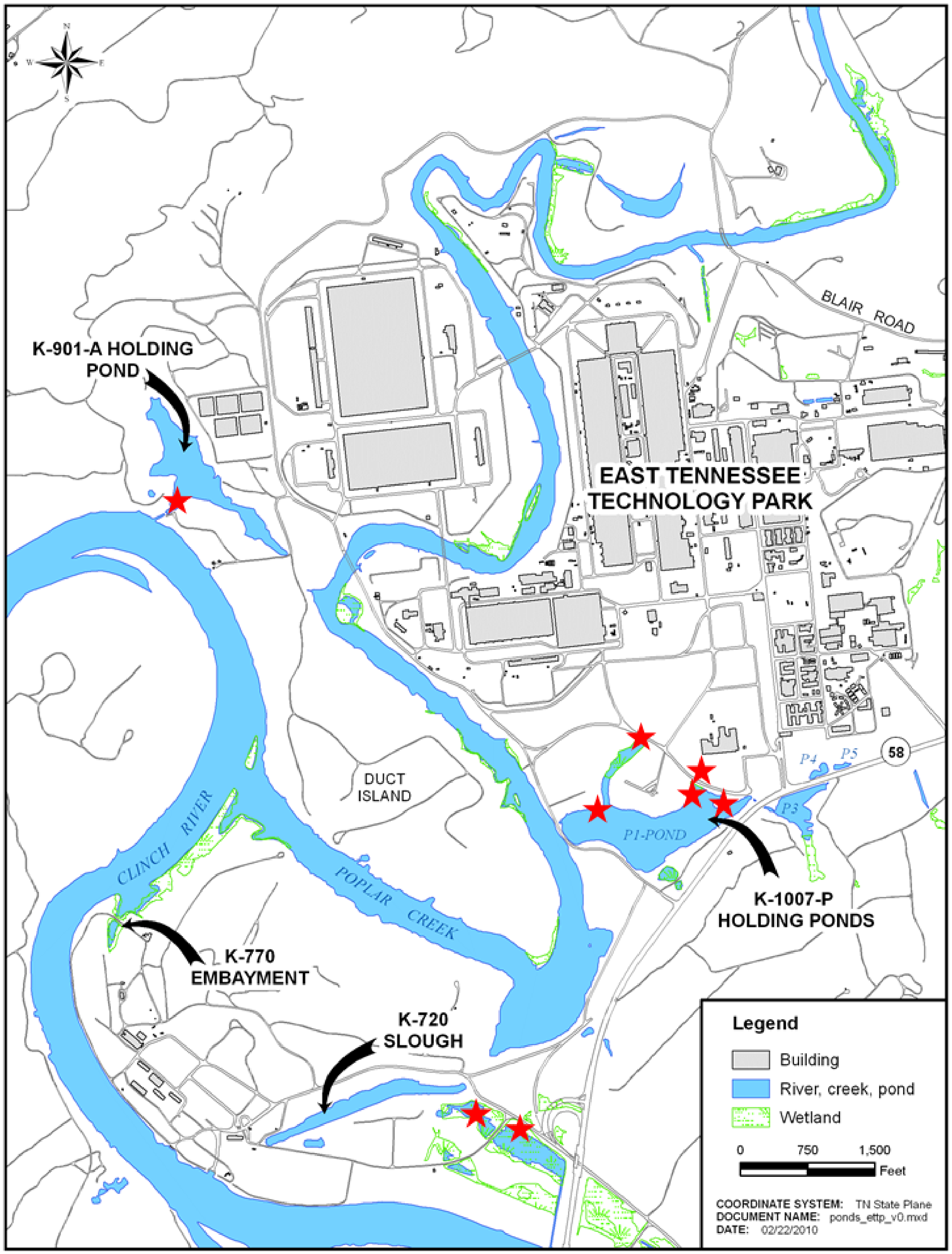
The ETTP BMAP consists of two tasks designed to evaluate the effects of ETTP legacy operations on the local environment, identify areas where abatement measures would be most effective, and test the efficacy of the measures. The results from this program will support future CERCLA cleanup actions. These tasks are: (1) bioaccumulation studies, and (2) instream monitoring of biological communities. Figure 3.25 shows the major water bodies at ETTP and Figure 3.26 shows the BMAP monitoring locations along Mitchell Branch.

3.7.1. Task 1: Bioaccumulation Monitoring

Bioaccumulation monitoring for the ETTP BMAP has focused on evaluating the impact of PCB discharges into the environment because of historical operations at the ETTP complex. It was previously assumed that mercury (Hg) flux into Poplar Creek and the Clinch River originated largely from Y-12 Complex discharges into East Fork Poplar Creek (EFPC). However, more recently monitoring has shown that water in ETTP storm drains and biota from lower Mitchell Branch have elevated mercury concentrations. Mercury bioaccumulation monitoring is routinely conducted in the watersheds adjacent to ETTP by the Y-12 and ORNL BMAPs, both on and off ORR. The available Hg bioaccumulation monitoring data will be presented in the following subsections with long-term trends in PCB contamination in resident fish and caged clams from ETTP waters.

Because the consumption of contaminated fish represents the largest dose of Hg and many other bioaccumulative contaminants to humans, fish fillet concentrations are relevant to assessing human health risks, whereas whole body fish are relevant to assessing ecological risks. Largemouth bass (*Micropterus salmoides*) and various sunfish species are used to monitor Hg and PCB fillet concentrations, and gizzard shad (*Dorosoma cepedianum*) and bluegill (*Lepomis macrochirus*) are used to monitor whole body concentrations at various locations over time. Largemouth bass are larger, upper trophic level predatory fish and are, therefore, susceptible to Hg and PCB bioaccumulation. Fillet concentrations in these fish represent the near maximum potential dose to humans, if eaten. Largemouth bass tend to live in larger, deeper pools of water and are collected in the ponds at ETTP (K-1007-P1 Pond, K-901-A Pond, and K-720 Slough) as well as in off-site river and reservoir locations. Sunfish are short-lived and have small home ranges, so fillet Hg and PCB concentrations in these fish are representative of exposure at the site of collection. These fish are used in long-term studies to monitor changes in bioaccumulation at a given site over time. Collections of sunfish are restricted to sizes large enough to be taken by sport anglers (generally 50–150 g total weight) to minimize effects of covariance between size and contaminant concentrations, as well as for spatial and temporal comparability. The target sunfish species for bioaccumulation studies in Mitchell Branch and other ORR stream sites is redbreast sunfish (*Lepomis auritus*), but where these fish are not present, other species with similar feeding habits (e.g., bluegill sunfish [*Lepomis macrochirus*]) are collected.

For bioaccumulative contaminants such as Hg and PCBs, fish bioaccumulation data have become important measures of compliance for both the CWA and CERCLA. For Hg, the EPA National Recommended Water Quality Criterion for Hg in fish (0.3 µg/g) is used as the trigger point for fish consumption advisories in Tennessee, the target concentration for NPDES permit compliance, and the threshold for impairment designations that require a Total Maximum Daily Load (TMDL) assessment. In addition to fish Hg limits, the state of Tennessee continues to use the statewide AWQC for Hg of 51 ng/L in water, based on organisms only, and 50 ng/L for recreation-water and organisms. Regulatory guidance and human health risk levels have varied more widely for PCBs, depending on the regulatory program and the assumptions used in the risk analysis. The Tennessee water quality criteria for individual Aroclors and total PCBs are both 0.00064 µg/L under the recreation designated use classification and are the target for PCB-focused TMDLs, including for local reservoirs (Melton Hill, Watts Bar, and Fort Loudon). However, most conventional PCB water analyses have detection limits much higher than the PCB AWQC.



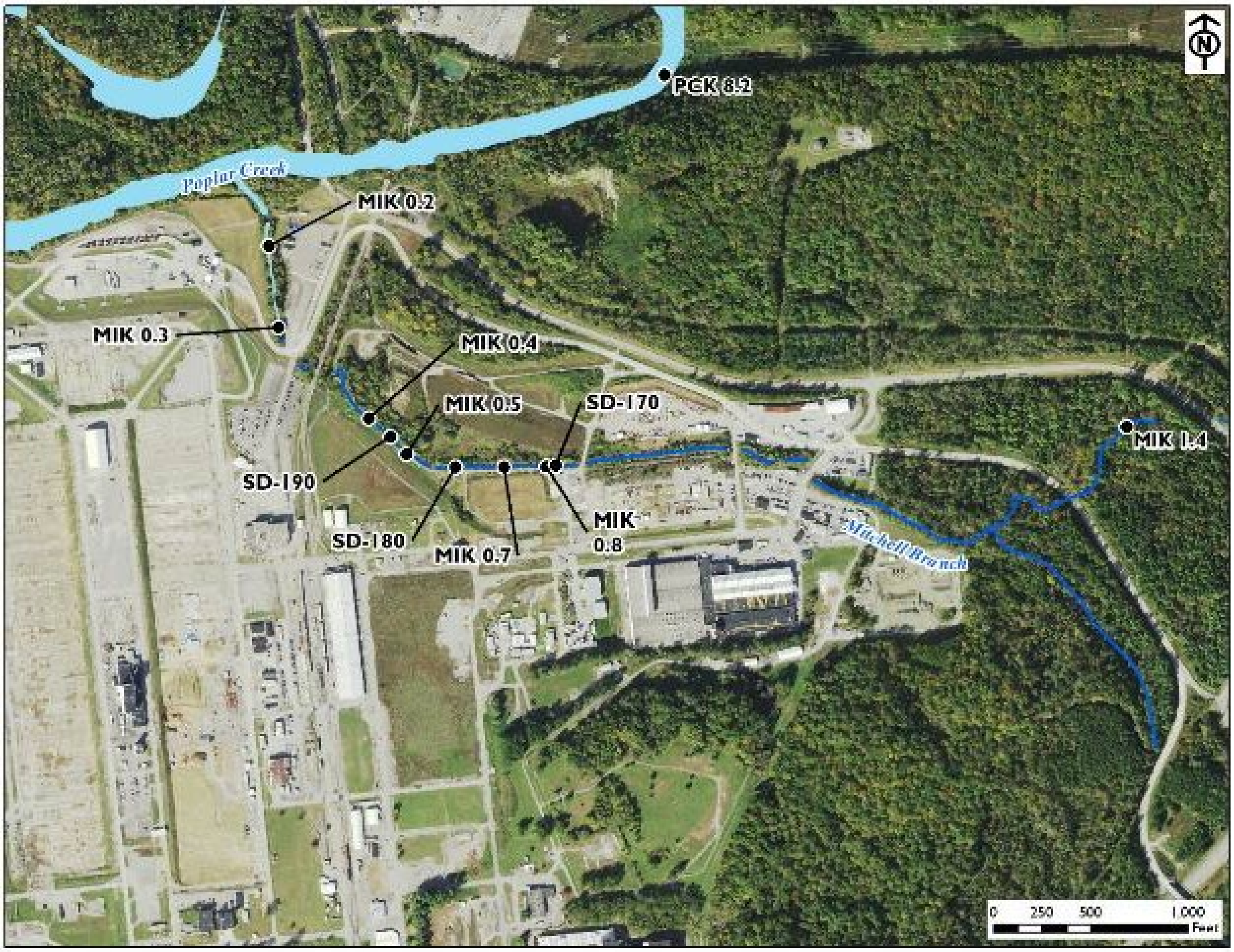
Note: *Red stars indicate clam sampling locations in and around the ETTP complex in 2021 (Mitchell Branch sites not shown).*

Acronyms:

CRM = Clinch River mile PCK = Poplar Creek kilometer MIK = Mitchell Branch kilometer SD = storm drain

Figure 3.25. Water bodies at the East Tennessee Technology Park

Therefore, in Tennessee and in many other states, assessments of impairment for water body segments, as well as public fishing advisories for PCBs, are based on fish tissue concentrations. Historically, the US Food and Drug Administration (FDA) threshold limit of 2 µg/g in fish fillet was used for PCB advisories; then for many years in Tennessee, an approximate range of 0.8 to 1 µg/g was used, depending on the data available and factors such as the fish species and size. The remediation goal for fish fillet at the ETTP K-1007-P1 Pond is 1 µg/g. Most recently, the water quality criterion that has been used by TDEC to calculate the fish tissue concentration triggering a determination of impairment and a TMDL, and this concentration is 0.02 µg/g in fish fillet. The fish PCB concentrations at and near ETTP are well above this most conservative concentration.



Acronyms:
BMAP = Biological Monitoring and Abatement Program
MIK = Mitchell Branch kilometer
SD = storm drain/storm water outfall

Figure 3.26. Major storm water outfalls and biological monitoring locations on Mitchell Branch

In addition to monitoring for human health and ecological risks as well as long-term trends, bioaccumulation monitoring also includes investigations of sources of contamination to ETTP waterways. Caged Asiatic clams (*Corbicula fluminea*) are used as bioindicators of contaminant sources in Mitchell Branch and other sites around ETTP. These clams are collected from an uncontaminated reference site (Little Sewee Creek in Meigs County, Tennessee) and are divided into groups of 10 clams of equal mass. In 2021, clams were placed in baskets to be deployed at strategic locations around ETTP (i.e., in and around storm drains) for a 4-week exposure period (May 6–June 3, 2021). Two clam baskets were placed at each site with 10 clams in each basket.

Because these animals are sedentary filter feeders, they accumulate contaminants that are present in the water and in suspended particles at a given site. They are useful indicators of the bioavailable (and therefore potentially toxic) portion of contaminants that enter the environment at a given location, and they provide spatial resolution of contamination on a finer scale than is possible with fish bioaccumulation studies. Caged clams have been used for more than 25 years to evaluate the importance of storm drains and other inputs of PCBs into the waterways around ETTP and for the past 10 years to monitor total mercury (Hg_T) and methylmercury (MeHg) inputs to Mitchell Branch. Whereas most of the Hg in the environment is inorganic mercury (Hg^{2+}), a small fraction of Hg^{2+} is converted to the more toxic and bioaccumulative MeHg. Because MeHg biomagnifies in aquatic systems, increasing in concentration as it moves up through the food chain, more than 90 percent of the Hg in upper trophic level fish is MeHg. Clams, which feed on periphyton and detritus at the base of the food chain, have a much smaller proportion of MeHg in their tissues but are still good indicators of MeHg hotspots and sources. The soft tissues of the clams from each cage were homogenized, and aliquots were taken for PCB and Hg analysis.

To assess spatial and temporal variability in exposure to PCBs following remediation activities, water samples have been collected for analysis of aqueous PCBs and total suspended solids (TSS) from the outfalls of K-1007-P1 and K-901-A, upper and lower SD-100, and an uncontaminated reference site (upper First Creek, ORNL). Samples are collected four times each year (March/April, June, July, and August).

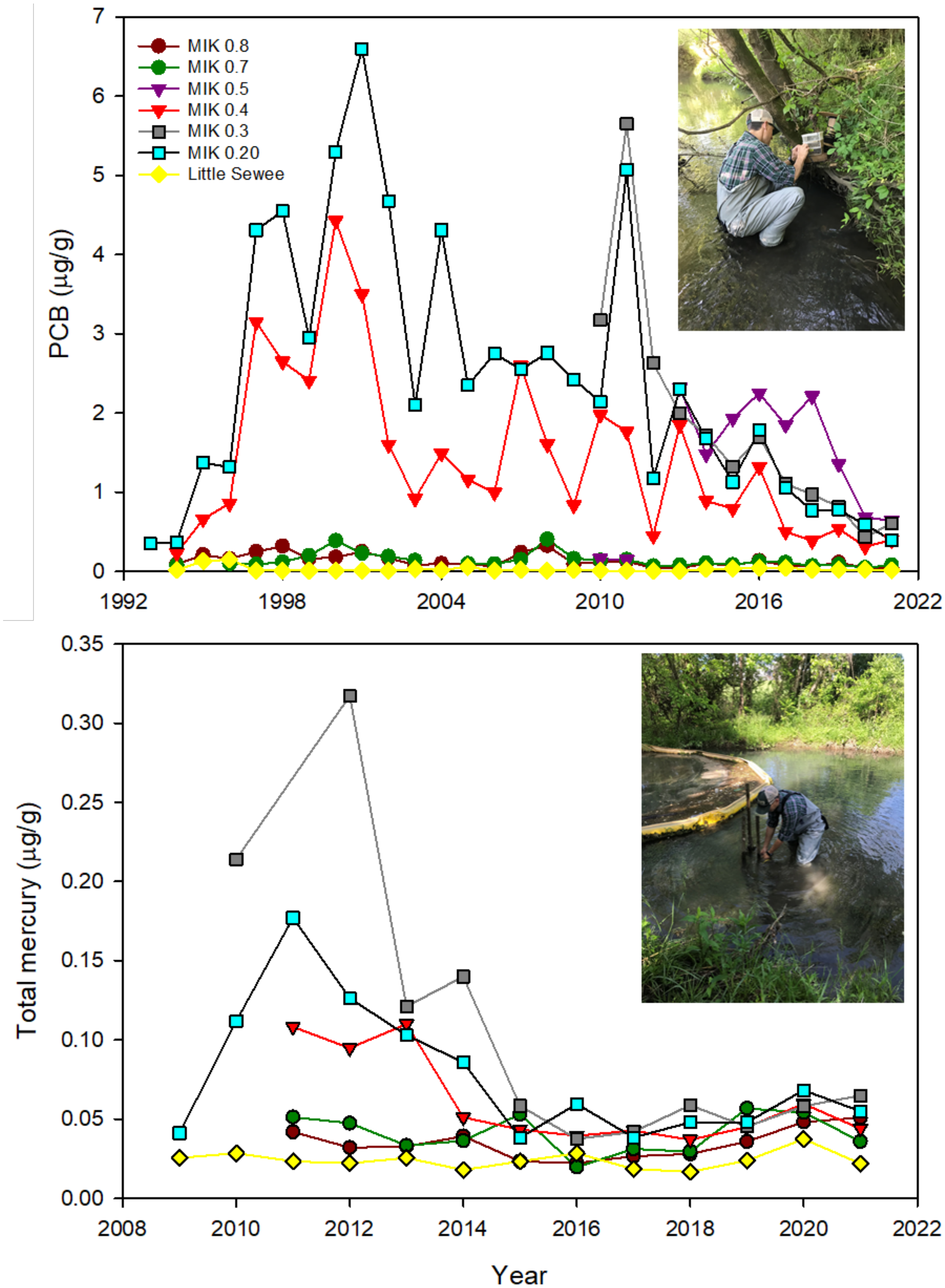
3.7.1.1. Mitchell Branch

Figure 3.27 shows long-term monitoring results in caged clams deployed at various sites in Mitchell Branch. The lower portion of this stream (MIK 0.5, SD 190, MIK 0.2) has historically been a "hot spot" for both Hg and PCB contamination. In 2021 PCB concentrations in biota in this stretch of the creek continued to be slightly elevated (~0.5-1 µg/g) with respect to other Mitchell Branch and reference sites. Although there is considerable interannual variability, PCB concentrations in clams placed in lower Mitchell Branch appear to be generally trending downward since peak years in 2000-2001. While there was a slight bump up in PCB concentrations at Mitchell Branch sites in 2016, concentrations since then have dropped back down, continuing the overall decreasing trend. PCB concentrations in the upper portion of Mitchell Branch were similar to previous years' concentrations and were slightly elevated (0.04-0.08 µg/g) with respect to the reference site (0.01 µg/g).

Mercury concentrations in clams deployed in Mitchell Branch in 2021 were generally similar to concentrations seen in 2020 and were only slightly elevated in Mitchell Branch relative to the reference site (Figure 3.28). Within the Mitchell Branch system, the highest Hg concentrations were seen in clams deployed at SD190 (0.08 µg/g). At SD180, where the highest concentrations have been seen for the past six years, concentrations decreased from 0.12 µg/g in 2020 to 0.07 µg/g in 2021. Mercury concentrations in clams deployed at the K-1007-P1 and K-901-A Ponds were again comparable to reference site concentrations. Clams deployed at two locations at the Beaver Ponds had Hg concentrations similar to those of the reference site. Unlike in fish tissue, MeHg in the soft tissues of clams generally made up a small proportion of HgT (Figure 3.28). MeHg concentrations in clams remained low in 2021, comparable to or slightly lower than concentrations in 2020.

Figure 3.33 shows long-term monitoring results in redbreast sunfish (*Lepomis auritus*) at MIK 0.2. Average PCB concentrations in fish collected at MIK 0.2 in 2021 (0.59 ± 0.04 μg/g) were lower than those seen in 2020 (1.49 ± 0.25 μg/g) but remained comparable to concentrations seen at this site in recent years (Figure 3.32). Although there is not a regulatory limit for PCBs in fish, the level most often used in practice to issue fish consumption advisories in the state of Tennessee, as previously stated, is 1 μg/g. In 2021, the mean PCB concentration in sunfish fillets collected from MIK 0.2 was below this limit. While the observed fish tissue concentrations in Mitchell Branch are lower than they have historically been, they are still two to three orders of magnitude higher than concentrations seen in the same species at the Hinds Creek reference site in Anderson County.

Total mercury has been monitored more sporadically in redbreast sunfish fillets at MIK 0.2. Figure 3.29 shows long-term trends in HgT concentrations (μg/g) in these fish. A rapid increase in fillet HgT concentrations was observed in the early 1990s and concentrations have generally remained elevated, with mean concentrations exceeding the AWQC (0.3 μg/g) in most years. Similar to the PCB concentrations in fish from this site, HgT concentrations at MIK 0.2 have been oscillating around the EPA's recommended AWQC for the past several years. Mean mercury concentrations in redbreast at this site remained just above the mercury tissue criterion, averaging 0.39 + 0.05 μg/g in 2021.

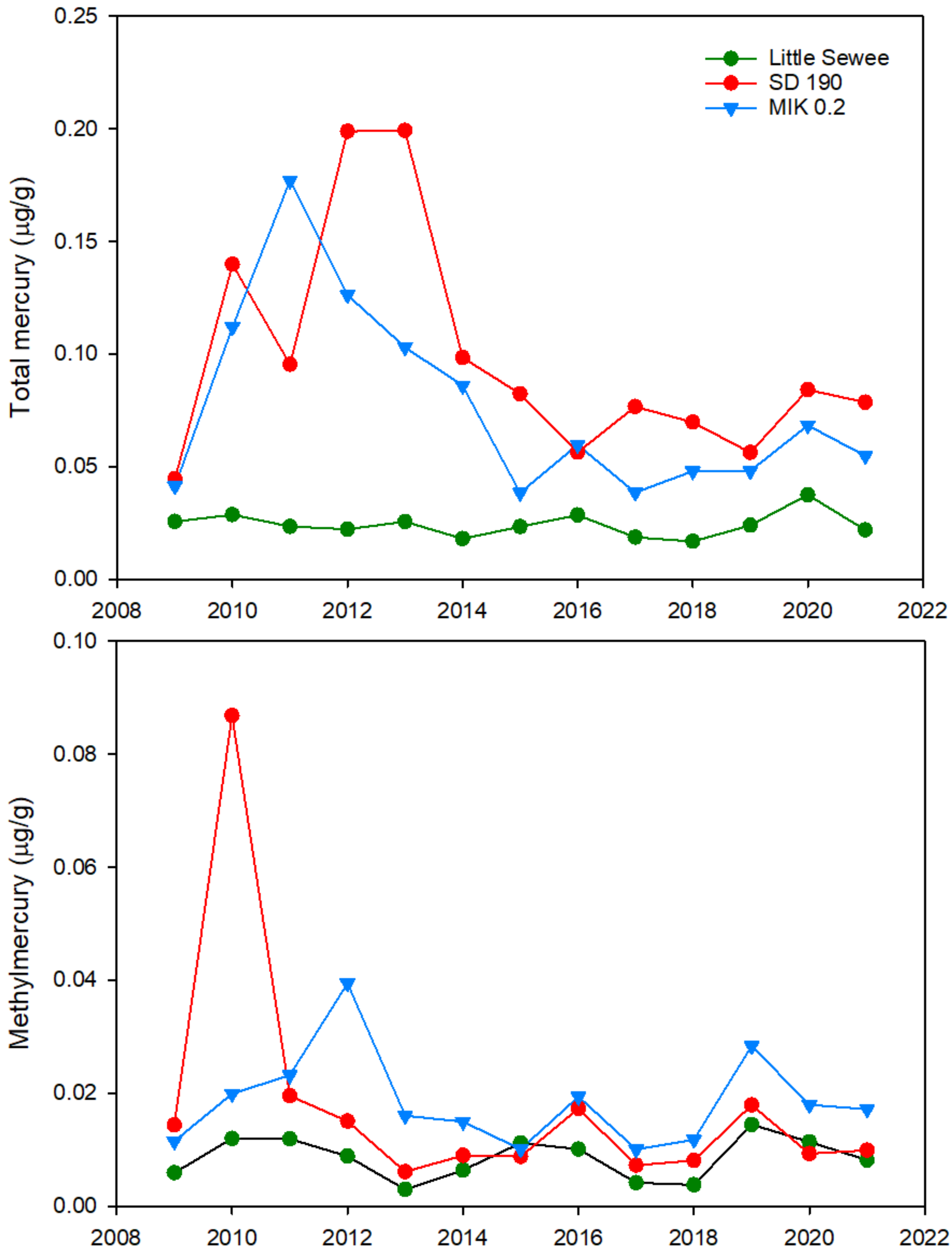


Notes:

1. *N = 2 composites of 10 clams each per year.*
2. *Shown in yellow are data for clams collected from the reference site, Little Sewee Creek (Meigs County, Tenn.).*
3. *Total PCBs is defined as the sum of Aroclors 1248, 1254, and 1260.*

Acronyms: *MIK = Mitchell Branch kilometer PCB = polychlorinated biphenyl*

Figure 3.27. Mean total PCB (Top: µg/g, wet wt; 1993–2021) and mercury (Bottom: µg/g wet wt; 2009–2021) concentrations in the soft tissues of caged Asiatic clams deployed in Mitchell Branch

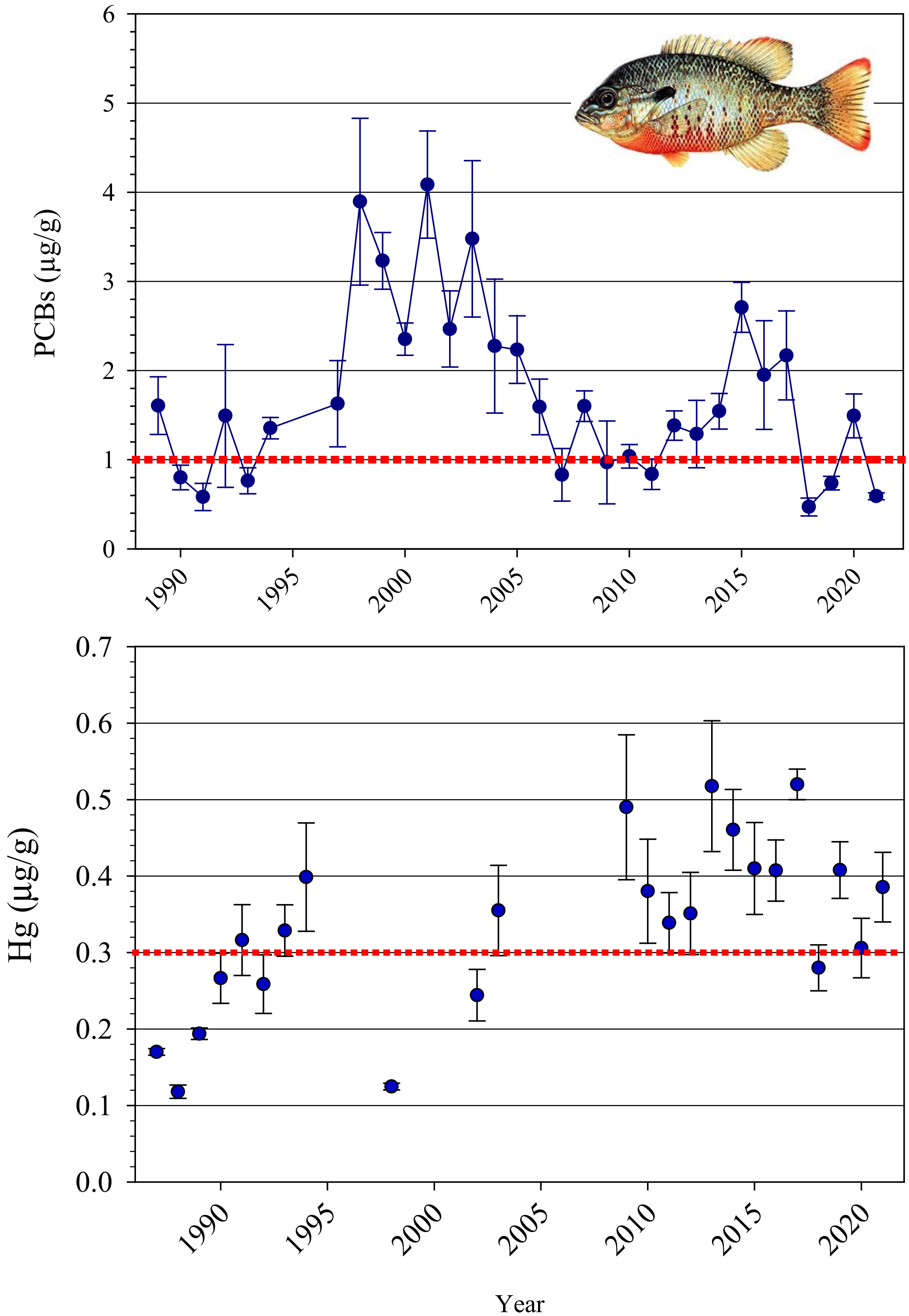


Notes:

1. *N = 2 composites of 10 clams each per year.*
2. *Shown in yellow are data for clams collected from the reference site, Little Sewee Creek (Sweetwater, Tennessee)*

Acronyms: *MIK = Mitchell Branch kilometer SD = storm drain*

Figure 3.28. Total (top panel) and methylmercury (bottom panel) concentrations in the soft tissues of caged Asiatic clams deployed in Mitchell Branch (µg/g wet wt; 2009–2021)



Notes:

1. 1989–2021 N = 6 fish per year.

2. Shown in red is the fish advisory level for PCBs (1 µg/g) and mercury concentration (0.3 µg/g).

Acronyms:

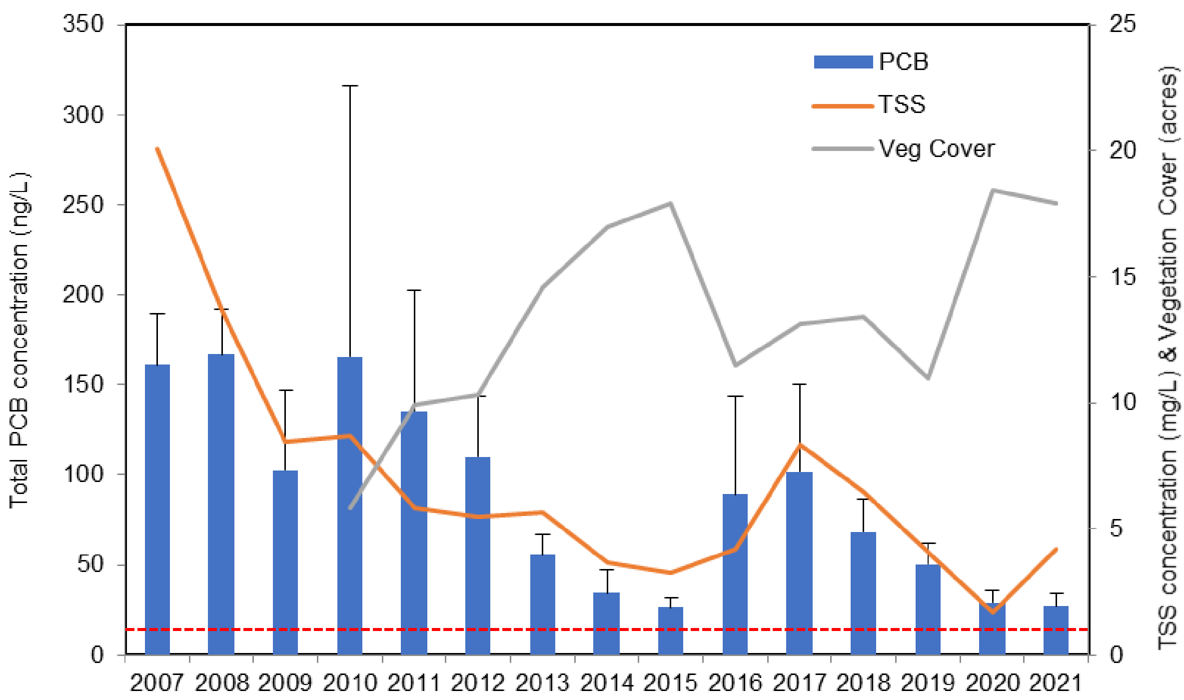
Hg = mercury MIK = Mitchell Branch kilometer PCB = polychlorinated biphenyl

Figure 3.29. Mean PCB (top panel) and mercury (bottom panel) concentrations (µg/g, wet wt) in redbreast sunfish fillets in Mitchell Branch (MIK 0.2)

3.7.1.2. 1007-P1 Pond

Over the past decade, mean aqueous PCB concentrations in the K-1007-P1 Pond have fluctuated significantly but have generally been lower than concentrations seen before 2009 remediation activities (e.g., 27 ng/L in 2021 compared with 161 ng/L in 2007; Figure 3.30). Concentrations in 2021 were comparable to 2020, and were also comparable to the lowest recorded average PCB concentration since remediation (26 ng/L in 2015). As hydrophobic contaminants, PCBs tend to be particle associated and are positively correlated with total suspended solids (TSS). The fluctuations in PCB and TSS concentrations in water in the K-1007-P1 Pond could be related to fluctuations in aquatic plant coverage which can affect sediment stability. The aqueous PCB concentrations measured in the K-1007-P1 Pond are above concentrations seen at the First Creek reference site (< 0.3 ng/L) and are above the state of Tennessee water quality criterion for the protection of fish and wildlife (14 ng/L).

PCB concentrations in clams placed at lower and upper SD100 locations have fluctuated significantly since remediation actions in 2009, and were on an overall decreasing trajectory until the significant increases seen in 2017 and 2018 (Figure 3.31). Concentrations in clams deployed in lower SD100 in 2021 were similar to those in 2020. Concentrations in clams deployed in upper SD100 increased slightly compared to 2020, but were still lower than the elevated concentrations seen between 2017 and 2019. Both upper and lower SD100 concentrations remained elevated with respect to the reference site. PCB concentrations in clams placed at the K-1007-P1 outfall were also higher since the increase in 2017, but have been steadily falling since then, and in 2021 were comparable to concentrations seen just after remediation actions in this pond (Figure 3.31).

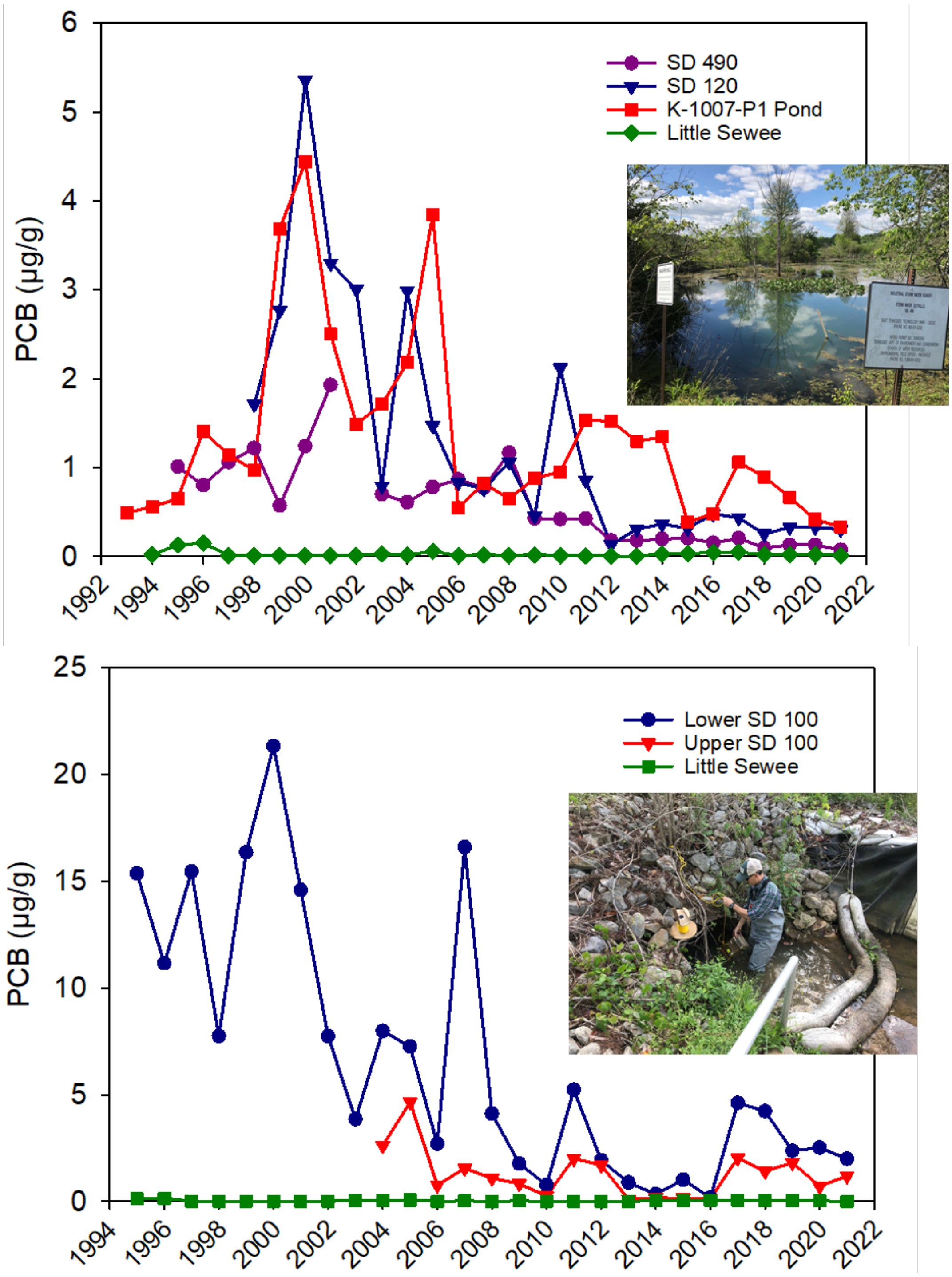


Notes:

1. *Means for PCBs in water and TSS are based on results across all collections made each year.*
2. *Note that mean concentrations of PCBs in water from First Creek were <0.3 ng/L in all years.*

Acronyms: *PCB = polychlorinated biphenyl ITSS = total suspended solids*

Figure 3.30. Mean aqueous total PCB concentrations, total suspended solids, and vegetation cover in the K-1007-P1 Pond, 2007–2021

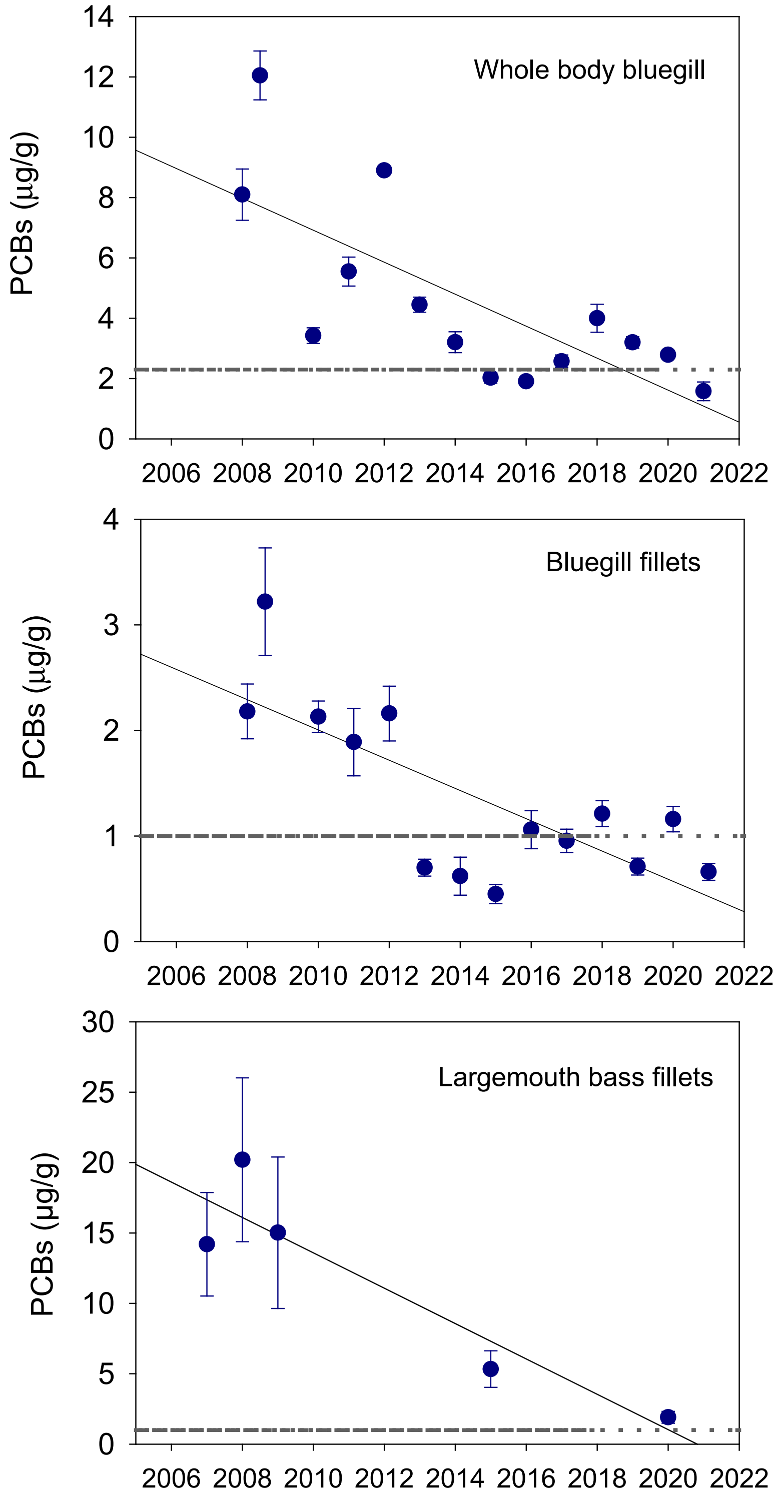


Notes:

1. *N = 2 clam composite samples per site/year.*
2. *Total PCBs defined as the sum of Aroclors 1248, 1254, and 1260.*
3. *Photos: Upper graph shows the SD-490 location; lower graph photo shows placement of clam cages in the Upper SD-100 location.*

Acronyms: *PCB = polychlorinated biphenyl SD = storm drain*

Figure 3.31. Mean total PCB concentrations (µg/g, wet wt) in caged clams placed at K-1007-P1 outfalls compared with reference stream clams (Little Sewee Creek), 1993–2021



Notes:

1. *For largemouth bass, N = 6 fish per site/year. For bluegill sunfish, N = 20 for fillets and N = 6 composites of 10 whole body fish.*
2. *The target for fillet (1 µg/g) and whole-body concentrations (2.3 µg/g) is shown with the gray dotted lines.*

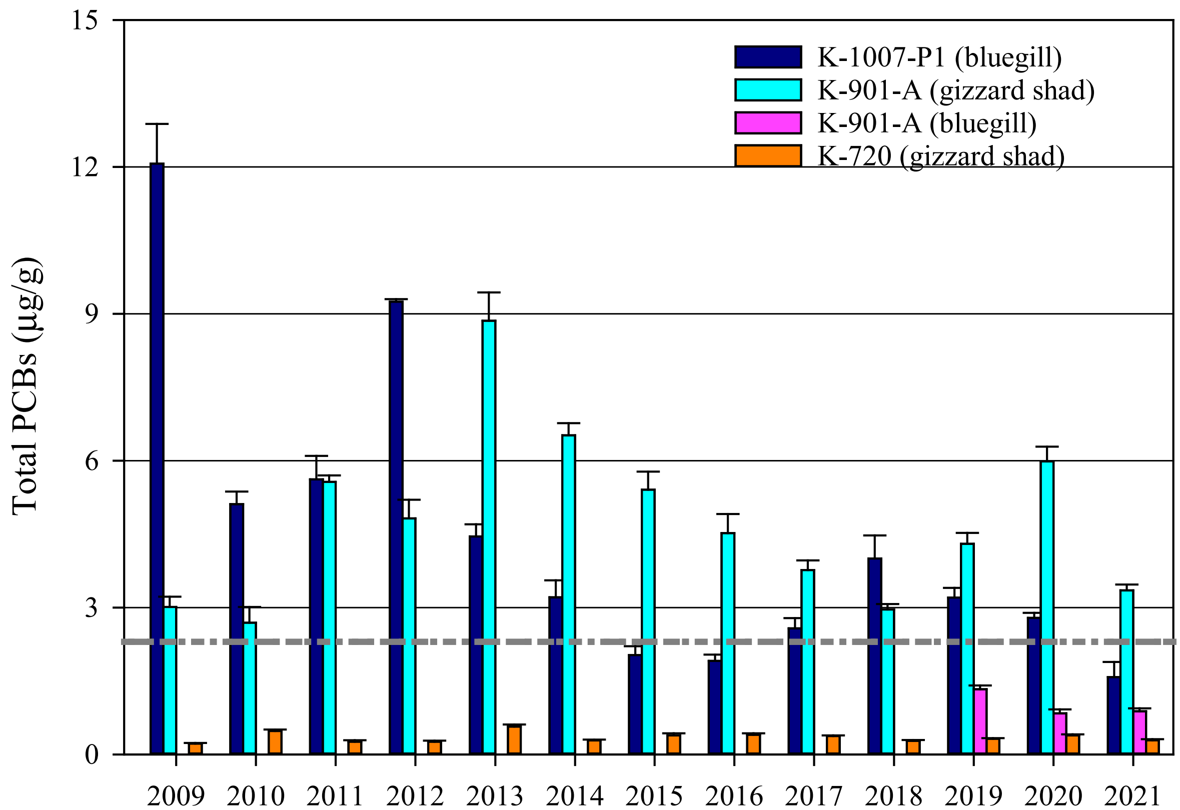
Acronym: *PCB = polychlorinated biphenyl*

Figure 3.32. Mean PCB concentrations (µg/g, wet wt) in fish from the K-1007-P1 Pond, 2007–2021

Similar trends have been observed in fish tissue PCB concentrations in the K-1007-P1 Pond (Figure 3.32). Since 2009, the target species for bioaccumulation monitoring in the K-1007-P1 Pond has been bluegill sunfish (*Lepomis macrochirus*). As in previous years, fillets from 20 individual bluegill and 6 whole body composites (10 bluegill per composite) from the K-1007-P1 Pond were analyzed for PCBs in 2021 to assess the ecological and human health risks associated with PCB contamination in this pond. In addition, fillets from 6 largemouth bass collected from this pond were analyzed for PCBs.

While PCB concentrations in fish and in caged clams at K-1007-P1 Holding Pond have been fluctuating for the past few years, in 2021 biota concentrations decreased such that both fillets and whole-body concentrations in bluegill were below the targets for this pond. Mean PCB concentrations in bluegill fillets in the K-1007-P1 Pond decreased from 1.17 µg/g in 2020 to 0.66 µg/g in 2021, below the remediation goal for this pond (1 µg/g total PCBs in fillets). Mean concentrations in whole-body bluegill decreased from 2.79 µg/g in 2020 to 1.58 µg/g in 2021, falling below the remediation target for this pond (2.3 µg/g in whole-body composites). (Table 3.8, Figures 3.32 and 3.33).

The interannual fluctuations in PCB concentrations could be due to water quality changes that have taken place in this pond, (e.g., higher TSS, PCB inputs, fluctuations in vegetation cover; Figures 3.32 and 3.33). The observed fluctuations in PCB concentrations seen in biota suggest that this system is still in transition and that as the fish and plant communities stabilize, further decreases in PCB bioaccumulation may become apparent.



Notes:

1. *Total PCBs are defined as the sum of Aroclors 1248, 1254, and 1260.*
2. *The dotted line signifies the target PCB concentration of 2.3 µg/g in whole body fish.*

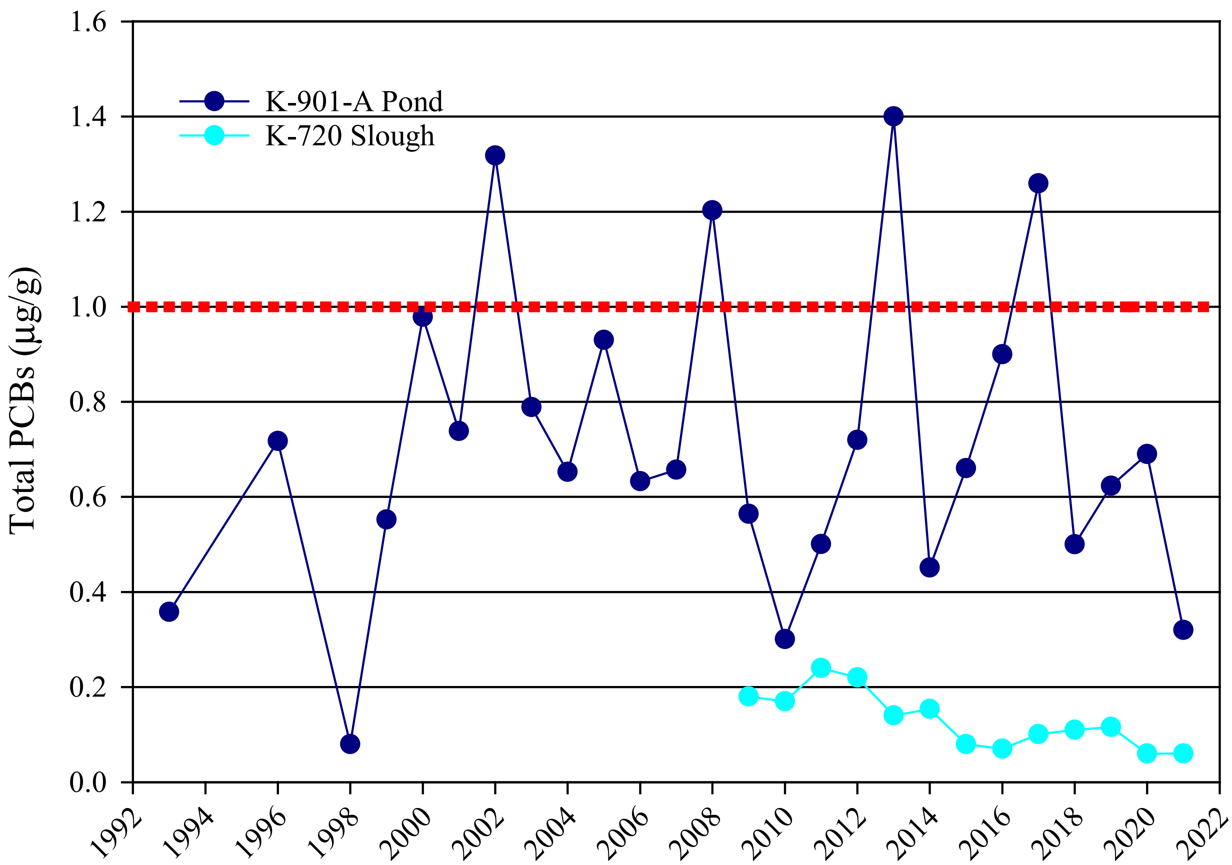
Acronym: *PCB = polychlorinated biphenyl*

Figure 3.33. Mean (+1 standard error) total PCB concentrations (µg/g, wet wt) in whole body fish from K1007-P1 Pond, K-901-A Holding Pond, and K-720 Slough, 2009–2021

3.7.1.3. K-901-A Pond

The target fish species for analysis of PCBs in the K-901-A Holding Pond were gizzard shad (*Dorosoma cepedianum*) and largemouth bass (*Micropterus salmoides*).

At the K-901-A Holding Pond, PCB concentrations in largemouth bass were lower than (0.32 µg/g) to concentrations seen in 2020 (0.69 µg/g) and were below the target concentration set for the K-1007-P1 Pond of 1 µg/g total PCBs (Figure 3.34). Whole body gizzard shad from the K-901-A Holding Pond, collected as a measure of potential ecological risk to terrestrial wildlife, were substantially higher in concentration (3.35 µg/g) than the fillets of bass and carp, remaining above the target concentration set for the K-1007-P1 Holding Pond for whole body fish (2.3 µg/g) (Figure 3.37). However, mean PCB concentrations in whole-body bluegill (0.88 µg/g) were lower than concentrations in this same species collected from the K-1007-P1 Pond, were below the target concentration for whole-body fish in the K-1007-P1 Pond (2.3 µg/g) (Figure 3.37). PCB concentrations in clams deployed in the K-901-A Pond were lower than those deployed in the K-1007-P1 Pond and were similar in 2021 (0.10 µg/g) to concentrations seen in 2020 (Figure 3.35).



Notes:

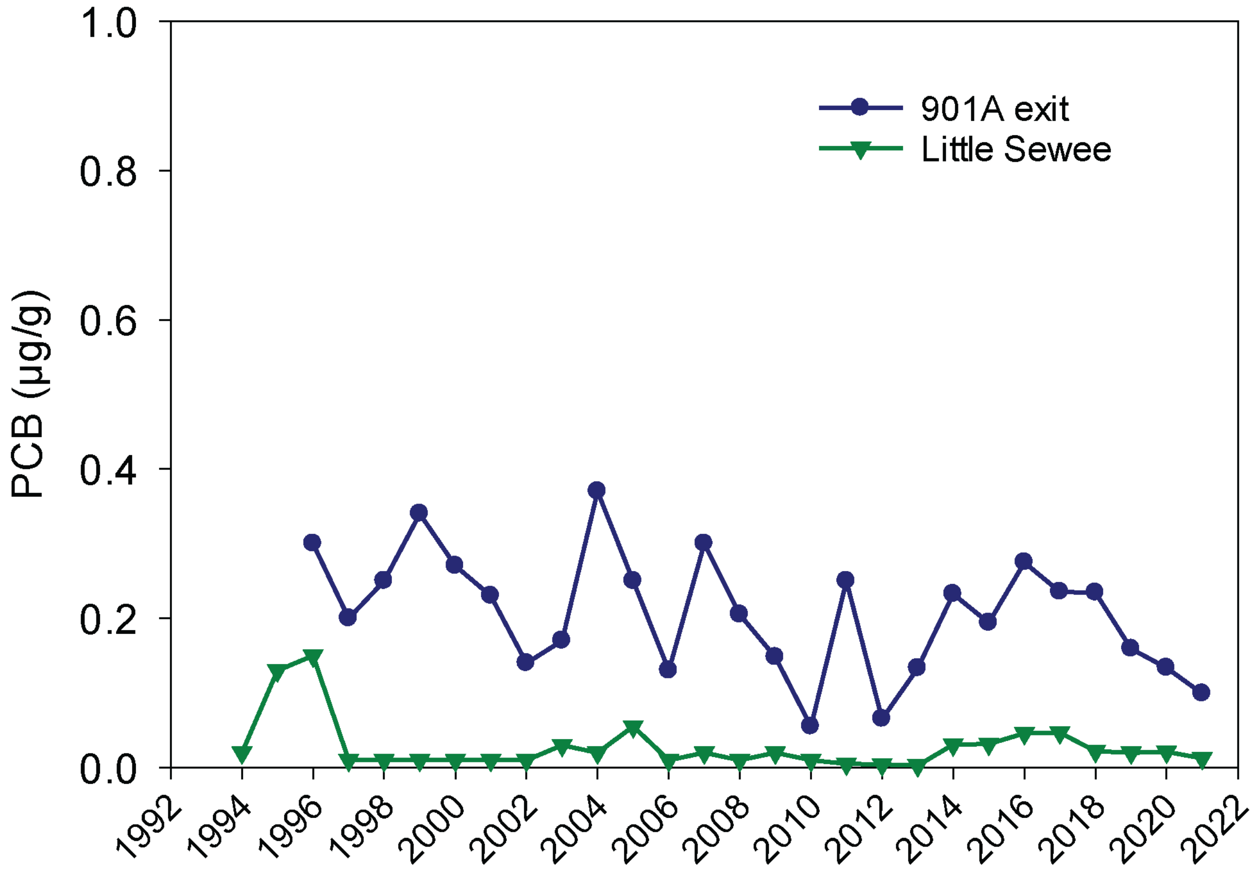
1. *Mean PCBs (± 1 SE) in largemouth bass fillets, 1993-2021 (µg/g).*
2. *N = 6 fish per year, when possible.*
3. *The dotted red line shows the advisory level for PCBs in fish fillets (1 µg/g).*

Acronyms:

PCB = polychlorinated biphenyl

SE = standard error

Figure 3.34. Mean total PCB concentrations in largemouth bass from the K-901-A Pond and the K-720 Slough



Notes:

1. *Total PCBs defined as the sum of Aroclors 1248, 1254, and 1260.*
2. *N = 2 composites of 10 clams each per year.*
3. *Shown in green are data for clams collected from the reference site, Little Sewee Creek (Sweetwater, Tenn.).*

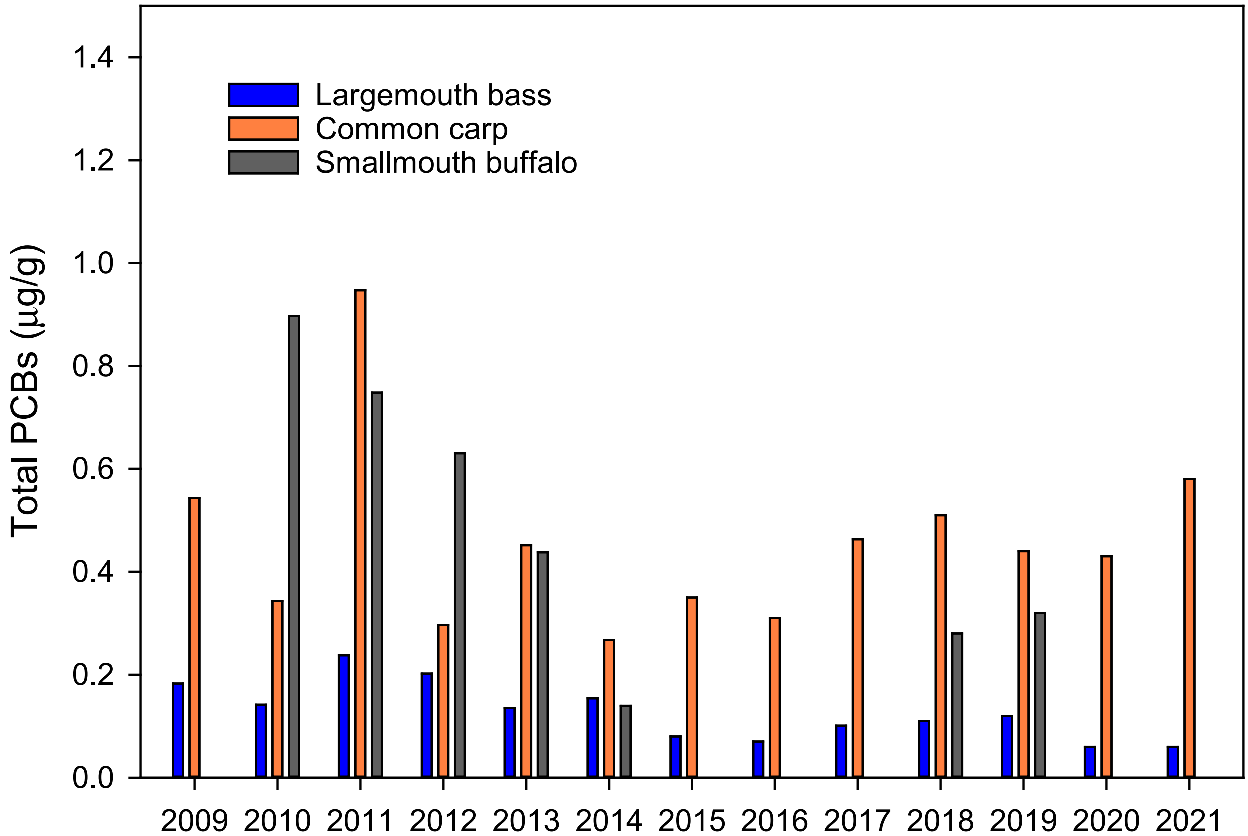
Acronym:

PCB = polychlorinated biphenyl

Figure 3.35. Mean total PCB (µg/g, wet wt; 1993–2021) concentrations in the soft tissues of caged Asiatic clams deployed in the K-901-A Pond for a 4-week period

3.7.1.4. K-720 Slough

Routine bioaccumulation monitoring in the K-720 Slough began in 2009 (Figure 3.36). Although the target species for fish fillet monitoring in this slough is largemouth bass, as in the K-901-A Pond it has been difficult to collect a full sample of 20 fish of this species; to complete the collection, common carp also are collected for a total of 20 fish. Figure 3.36 shows the temporal trends in fish fillet concentrations in the slough. In 2021, PCB concentrations in both fish species monitored were below the state advisory limit of 1 µg/g. In all cases PCB levels in fish collected from the K-720 Slough were significantly lower than in the K-901-A Holding Pond for the same species (Table 3.8). PCB concentrations in largemouth bass collected from the K-720 Slough were significantly lower than those in the other monitored ponds, averaging 0.06 µg/g in 2021. Concentrations in carp collected from the slough were higher than concentrations in bass, averaging 0.58 µg/g. Total PCBs in whole body gizzard shad from the K-720 Slough were similar to those seen in recent years and were lower than those seen in whole body fish collected from the other monitored ponds, averaging 0.29 µg/g in 2021.



Notes:

1. *Total PCBs defined as the sum of Aroclors 1248, 1254, and 1260.*
2. *The target sample was 20 largemouth bass, but because these fish are not abundant in the slough, carp and smallmouth buffalo were collected to complete the sample size of 20 fish.*

Acronym:

PCB = polychlorinated biphenyl

Figure 3.36. Mean total PCB (µg/g, wet wt; 2009–2021) concentrations in the fillets of largemouth bass, common carp, and smallmouth buffalo collected from the K-720 Slough

Table 3.8. Average concentrations of total PCBs in fillets and whole-body composites of fish collected in 2021 near the East Tennessee Technology Park

Site	Species	Sample type	Sample size (n)	Total PCBs (mean ± SE)	Range of PCB values	No. > target (PCBs)/n
K-1007-P1 Pond	Bluegill	Fillets	20	0.66 ± 0.08	0.14–1.43	3/20
		Whole-body composites	6	1.58 ± 0.31	1.23–3.13	1/6
K-901-A Pond	Largemouth bass	Fillets	20	0.32 ± 0.01	0.10–0.62	0/20
	Bluegill	Fillets	20	0.76 ± 0.10	0.12–1.93	3/20
		Whole-body composites	6	0.88 ± 0.06	0.61–1.03	0/6
	Gizzard shad	Whole-body composites	6	3.35 ± 0.12	2.98–3.78	6/6
K-720 Slough	Largemouth bass	Fillets	8	0.06 ± 0.01	0.04–0.16	0/8
	Common carp	Fillets	12	0.58 ± 0.05	0.14–2.16	2/12
	Gizzard shad	Whole-body composites	6	0.29 ± 0.02	0.25–0.35	0/6
CRM 11.0	Bluegill	Whole-body composites	6	0.05 ± 0.003	0.05–0.07	0/6
	Gizzard shad	Whole-body composites	6	0.18 ± 0.03	0.10–0.15	0/6
PCM 1.0	Bluegill	Whole-body composites	6	0.16 ± 0.01	0.13–0.22	0/6
	Gizzard shad	Whole-body composites	6	0.30 ± 0.04	0.20–0.42	0/6

Notes:

1. *Average concentrations = µg/g, wet wt.*
2. *Total PCBs = Aroclors 1248, 1254, and 1260.*
3. *Values are mean concentrations (µg/g) ± 1 SE.*
4. *Each whole-body composite sample is composed of 10 individual fish.*
5. *Also shown are the ranges of values observed for PCBs and the number of fish whose fillet PCB concentrations exceeded 1 µg/g out of the total number of fish (or composites) sampled (n). (1 µg/g total PCBs in fish fillets and 2.3 µg/g in whole-body composites).*

Acronyms and abbreviations:

CRM = Clinch River mile
PCB = polychlorinated biphenyl
SE = standard error
No. = number
PCM = Poplar Creek mile

3.7.2. Task 2: Instream Benthic Macroinvertebrate Communities

Benthic macroinvertebrate communities in Mitchell Branch are sampled using ORNL and TDEC protocols (Figures 3.37 and 3.38). Evaluation of long-term trends of macroinvertebrate communities in the stream make it possible to document the effectiveness of pollution abatement activities or remediation efforts as well as to assess the potential consequences of unanticipated events as sitewide remediation continues (e.g., chromium release into Mitchell Branch).

Figure 3.37. Collecting an invertebrate sample using Oak Ridge National Laboratory Biological Monitoring and Abatement Program protocols

3.7.2.1. Benthic Macroinvertebrates

The major objectives of the benthic macroinvertebrate task are: (1) to help assess the ecological condition of Mitchell Branch, and (2) to evaluate changes in stream ecology associated with changes in facilities operations and RAs within the Mitchell Branch watershed. To meet these objectives, the condition of the benthic macroinvertebrate community of Mitchell Branch has been monitored routinely since late 1986. This summary includes results of samples collected each April from 1987 to 2021 following ORNL BMAP quantitative sampling protocols and samples collected annually (August/September) with TDEC semi-quantitative sampling protocols for estimating the Tennessee Macroinvertebrate Biotic Index and the Habitat Index (TDEC 2017a). For both sets of protocols, four sites were assessed in Mitchell Branch—MIKs 0.4, 0.7, 0.8, and 1.4. MIK 1.4 serves as the primary reference site, but narrative Biotic Index results for TDEC protocols are based on reference conditions established by TDEC from a suite of reference sites in the same ecoregion as Mitchell Branch. Finally, also included in this summary is a comparison between the macroinvertebrate community structure at the four Mitchell Branch sites and five other reference sites on ORR. Most of these reference sites—spanning a range of stream sizes both smaller and larger than Mitchell Branch (based on watershed area)—have been monitored using ORNL protocols since the mid-1980s for other biological monitoring projects on ORR (ORNL BMAP and WRRP/Bear Creek Biological Monitoring Program) (Table 3.9). This summary provides information on how invertebrate community structure at Mitchell Branch sites, including MIK 1.4, compares with the community structure of a range of relatively unaffected reference sites on ORR.

Figure 3.38. Sampling for benthic macroinvertebrates with TDEC protocols

Table 3.9. Stream sites included in the comparison between Mitchell Branch and other reference sites on the Oak Ridge Reservation

Site	Location		Watershed area (km^2)	Program
	Latitude (N)	Longitude (W)		
Mitchell Branch				
MIK 0.4	35.93859	84.39040	1.554	ETTP BMAP
MIK 0.7	35.93786	84.38792	1.347	ETTP BMAP
MIK 0.8	35.93786	84.38682	1.269	ETTP BMAP
MIK 1.4 (reference)	35.93790	84.37662	0.311	ETTP BMAP
Other ORR reference sites				
First Creek (FCK 0.8)	35.92670	84.32355	0.596	ORNL BMAP
Fifth Creek (FFK 1.0)	35.93228	84.31746	0.596	ORNL BMAP
Gum Hollow Branch (GHK 2.9)	35.96385	84.31594	0.777	Bear Creek BMP/WRRP
Walker Branch (WBK 1.0)	35.95805	84.27953	1.010	ORNL BMAP
White Oak Creek (WCK 6.8)	35.94106	84.30145	2.072	ORNL BMAP

Acronyms:
BMAP = Biological Monitoring and Abatement Program
BMP = Biological Monitoring Program
ETTP = East Tennessee Technology Park
MIK = Mitchell Branch kilometer
ORNL = Oak Ridge National Laboratory
ORR = Oak Ridge Reservation
WRRP = Water Resources Restoration Program

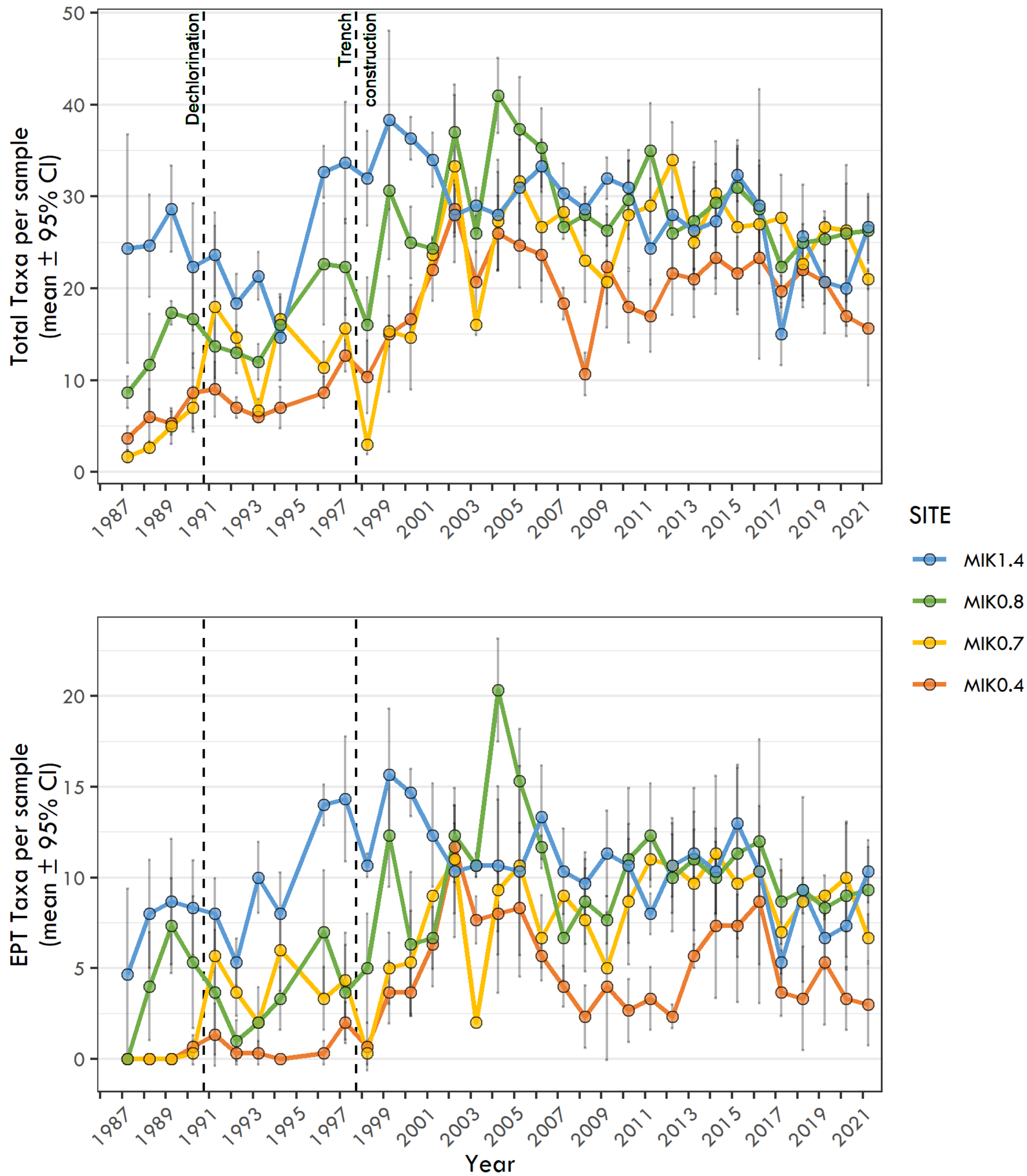
3.7.2.2. Mitchell Branch–ORNL and TDEC Protocols

Total taxa richness (i.e., the total number of taxa per sample) and Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa richness (i.e., the total number of pollution-intolerant EPT taxa [mayflies, stoneflies, and caddisflies] per sample) measured using ORNL protocols has varied over the measurement period (1987–2021) in all Mitchell Branch sites (Figure 3.39). Both total taxa richness and EPT taxa richness increased in MIKs 0.4, 0.7, and 0.8 from 1987 to the late 1990s, and then reached fairly consistent values, albeit with considerable year to year variation (Figure 3.39). Total taxa richness and EPT taxa richness have been fairly consistent throughout the measurement period in the reference site, MIK 1.4, though values have been lower in three of the past five years (Figure 3.40). In April 2021, total taxa richness and EPT taxa richness were highest at MIK 1.4 and MIK 0.8 and lowest in MIK 0.4 (Figure 3.39). EPT taxa richness patterns among sites in 2021 returned to the pattern observed in 2018 and in 2010–2016, where EPT taxa richness was highest upstream at MIK 1.4 and lowest downstream at MIK 0.4 (Figure 3.39).

The percent density of the pollution-intolerant taxa (higher values are indicative of good condition) was highest at MIK 1.4, the reference site, and lowest at MIK 0.4 in April 2021, which is a pattern that has been observed in most years since monitoring began in 1987 (Figure 3.39). In 2021, as in most years, the percent density of pollution-tolerant taxa (lower values are indicative of good conditions) was lowest at the reference site, MIK 1.4. An exception to this pattern occurred during 2019 and 2020 when the percent density of pollution-tolerant taxa was higher at MIK 1.4 than MIK 0.8 but still lower than at MIK 0.4 and MIK 0.7 (Figure 3.39). In 2021, the percent of pollution-tolerant taxa at MIK 1.4 decreased after two years (2019 and 2020) that had the highest values seen since monitoring began and were only surpassed in 1988 and 1992 (Figure 3.40). Continued monitoring will determine if those higher values at MIK 1.4 reflect increased interannual variability or a stochastic deviation from long-term patterns.

Based on TDEC 2017 protocols, scores for the Tennessee Macroinvertebrate Biotic Index (TMI) in 2021 rated the invertebrate community as passing biocriteria guidelines at MIK 1.4 while TMI scores at MIK 0.4, MIK 0.7, and MIK 0.8 fell below these guidelines (Figure 3.41). TMI scores in 2021 remained stable (MIK 0.4) or declined (MIK 1.4, MIK 0.8, MIK 0.7) compared to 2020 scores, with the most dramatic decrease occurring at MIK 0.8 (Figure 3.45). In 2021, MIK 1.4 scores decreased for percentage of clingers but remained stable for all other metrics (Table 3.10). MIK 0.8 decreased in all metrics except for the percentage of oligocheates and chironomids while MIK 0.7 metrics decreased for percent of EPT taxa and percentage of nutrient-tolerant organisms. Both MIK 0.8 and MIK 0.7 received low scores for all metrics except percentage of oligochates and chironmids, which was high across all sites in Mitchell Branch, and the TMI scores for MIK 0.8 and MIK 0.7 fell below MIK 0.4 for the first time since 2017. MIK 0.4 received low scores for total taxa richness, EPT taxa richness, and percentage EPT, but received the highest scores possible for all other invertebrate metrics except the percentage of nutrient-tolerant taxa (Table 3.10). Since sampling using TDEC protocols began in 2008 in Mitchell Branch, TMI scores at have almost always rated the invertebrate community at MIK 1.4 as passing biocriteria guidelines, MIK 0.4 as falling below biocriteria guidelines, and MIK 0.7 and MIK 0.8 as oscillating between passing and falling below biocriteria guidelines (Figure 3.41).

Based on TDEC stream habitat protocols, habitat quality was above the ecoregion 67f guideline at all sites within Mitchell Branch (Figure 3.41). Habitat scores increased at MIK 0.7 and MIK 0.8 but decreased at MIK 1.4 and MIK 0.4 in 2021 compared to 2020. In general, declines from the previous year were primarily seen in epifaunal substrate/available cover, channel flow, and sediment deposition at some but not all sites. Poor substrate quality (dominance of gravel instead of cobble) and unstable, highly erodible banks continued to be an issue at multiple sites.

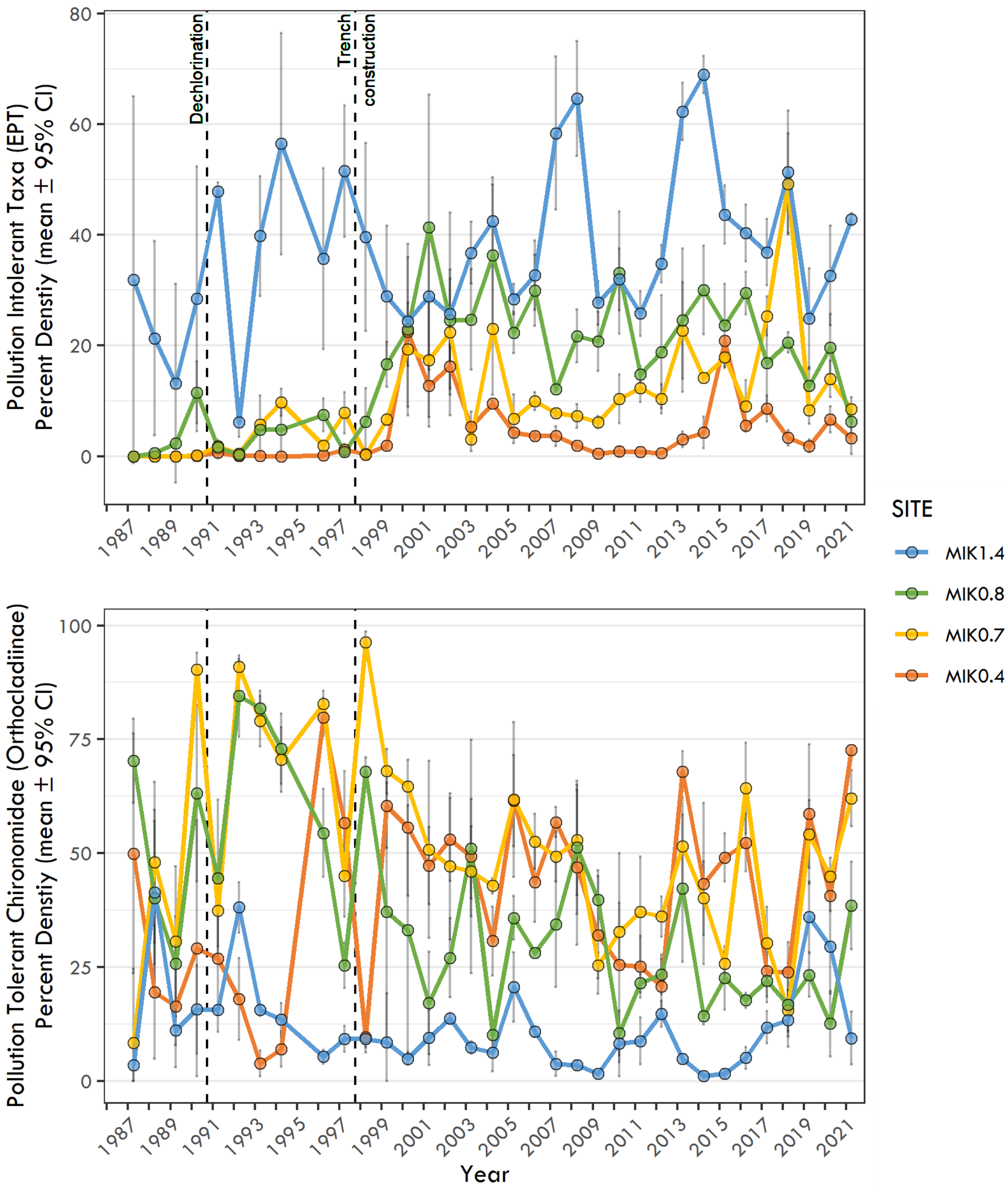


Note: *Samples were not collected in April 1995.*

Acronyms:

EPT = Ephemeroptera, Plecoptera, and Trichoptera *MIK = Mitchell Branch kilometer* *CI = confidence interval*

Figure 3.39. Mean (± 95% confidence interval) total taxonomic richness (top) and richness of the pollution-intolerant taxa per sample (bottom) for Mitchell Branch sites, April 1987–2021



Notes:

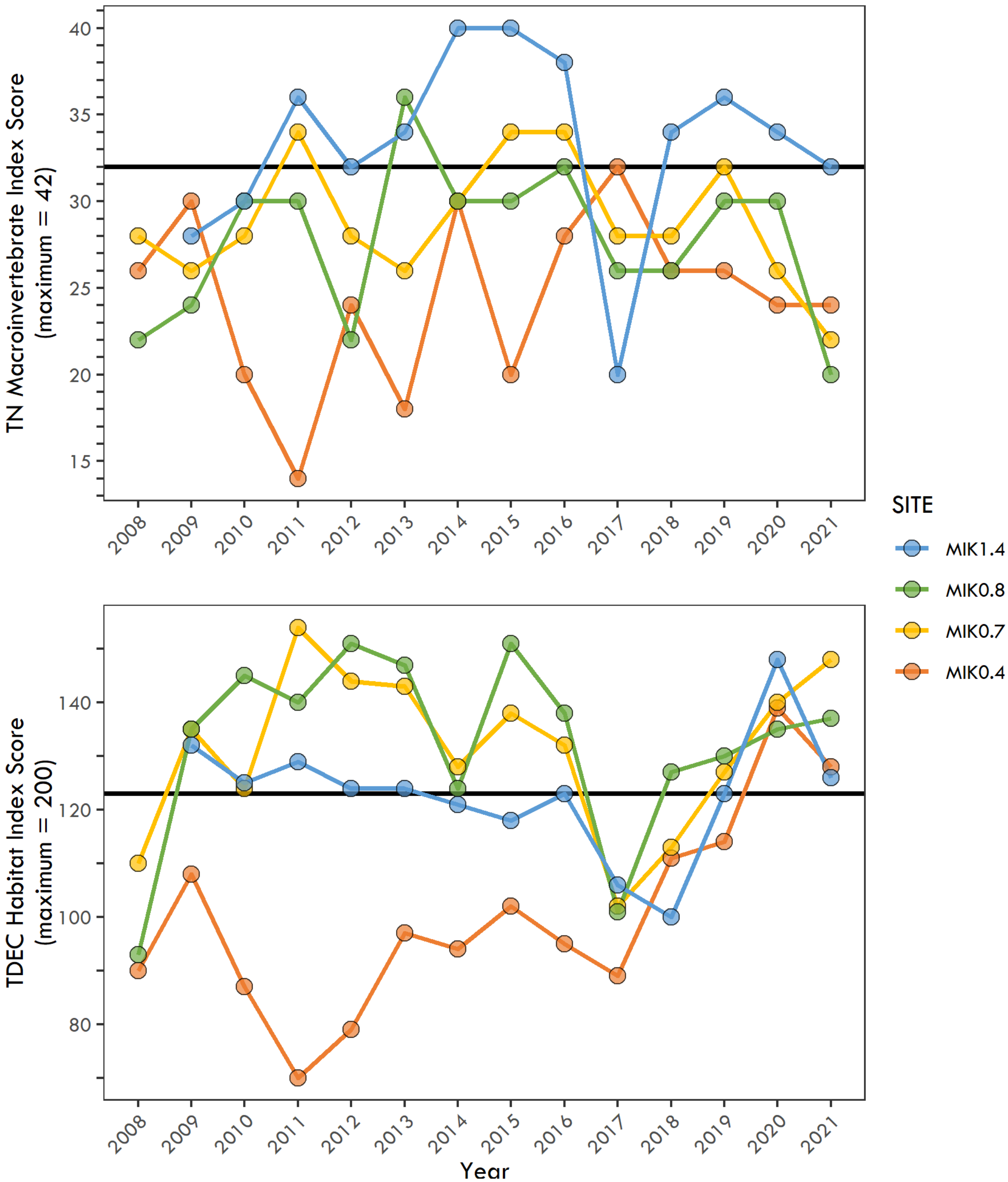
1. *Pollution-intolerant taxa, i.e., stoneflies, mayflies, and caddisflies or Ephemeroptera, Plecoptera, and Trichoptera taxa (top).*
2. *Percentages were based on total densities for each site.*
3. *Samples were not collected in April 1995.*

Acronyms:

MIK = Mitchell Branch kilometer CI = confidence interval

EPT = Ephemeroptera, Plecoptera, and Trichoptera (pollution-intolerant taxa)

Figure 3.40. Mean percent density of pollution-intolerant taxa and of the pollution-tolerant Orthocladiinae midge larvae (Chironomidae) at Mitchell Branch sites, April 1987–2021



Notes:

1. *Mitchell Branch site MIK 1.4 was not sampled with TDEC protocols in 2008.*
2. *The horizontal line on each graph shows the rating threshold for each index for ecoregion 67f; TDEC macroinvertebrate index threshold is 32; TDEC habitat index threshold is 123. Values above the thresholds are indicative of passing biocriteria or habitat guidelines.*

Figure 3.41. Temporal trends in the TDEC Macroinvertebrate Index (top) and Stream Habitat Index (bottom) scores for four Mitchell Branch sites, August 2008–2021

Table 3.10. Tennessee Macroinvertebrate Index metric values and scores and index scores for Mitchell Branch, August 30, 2021[a,b,c]

Site	Metric values							Metric scores							TMI[d]
	Taxa rich	EPT rich	%EPT	%OC	NCBI	%Cling	%TN Nuttol	Taxa rich	EPT rich	%EPT	%OC	NCBI	%Cling	%TN Nuttol	
MIK 0.4	12	3	1.9	4.9	3.6	84.6	36.4	2	0	0	6	6	6	4	24
MIK 0.7	16	5	11.7	15	5.7	74.2	65.3	2	2	0	6	4	6	2	22
MIK 0.8	18	7	9.5	10.1	5.9	45.2	66.8	2	2	0	6	4	4	2	20
MIK 1.4	29	10	42.4	16.1	4	51.2	34.1	4	4	4	6	6	4	4	32 [pass]

[a] *TMI metric calculations and scoring and index calculations are based on Tennessee Department of Environment and Conservation (TDEC) protocols for ecoregion 67f: TDEC 2017a, Quality System Standard Operating Procedures for Macroinvertebrate Stream Surveys, TDEC Division of Water Pollution Control, Nashville, Tennessee. Available* **here**.

[b] *Taxa rich = Taxa richness; EPT rich = Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies) taxa richness; %EPT = EPT abundance excluding Cheumatopsyche spp.; %OC = percent abundance of oligochaetes (worms) and chironomids (nonbiting midges); NCBI = North Carolina Biotic Index; %Cling = percent abundance of taxa that build fixed retreats or otherwise attach to substrate surfaces in flowing water excluding Cheumatopsyche spp; %TN Nuttol. = percent abundance of nutrient-tolerant organisms.*

[c] *MIK = Mitchell Branch kilometer.*

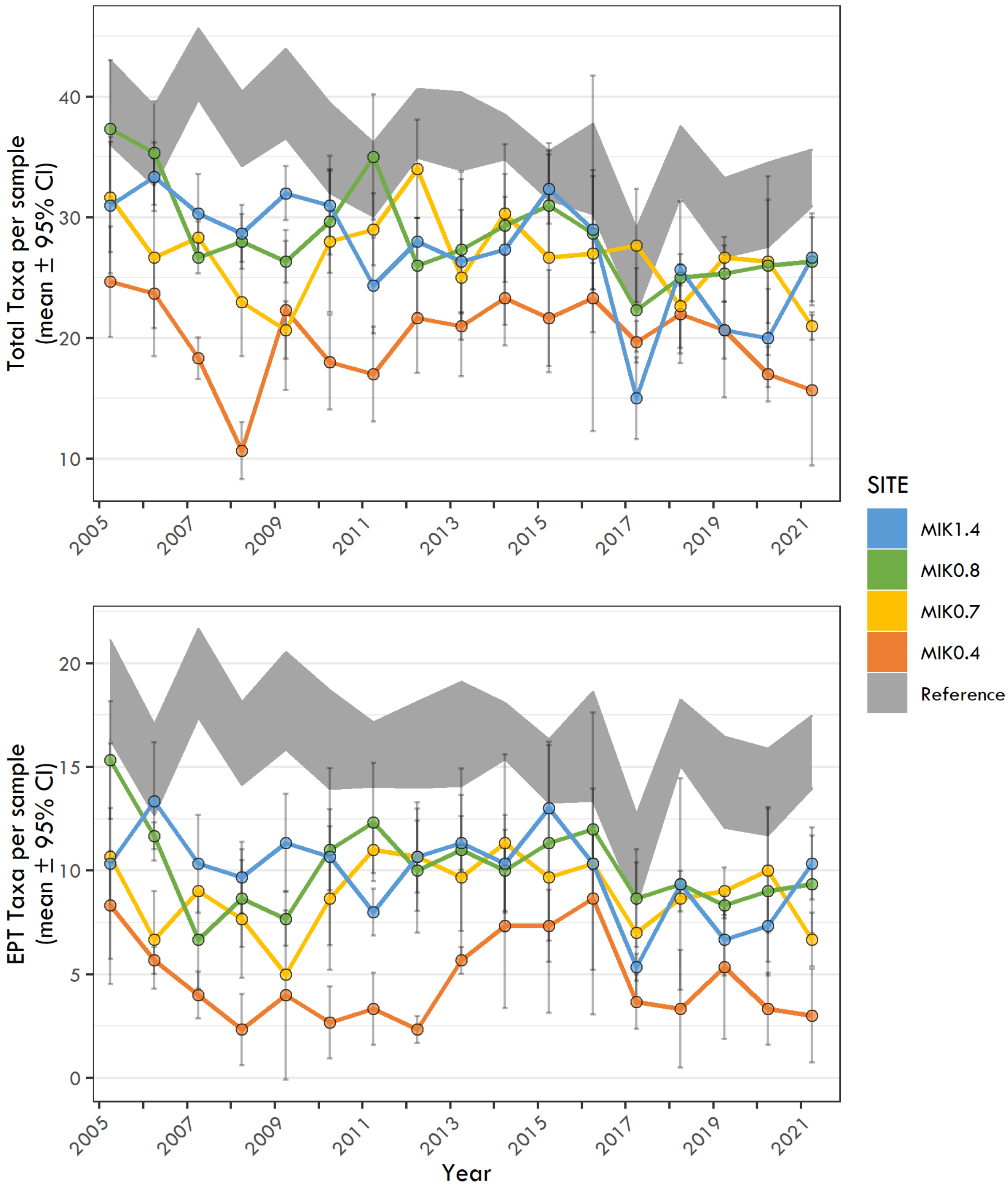
[d] *TMI = Tennessee Macroinvertebrate Index score. TMI is the total index score, and higher index scores indicate higher-quality conditions. A score of ≥ 32 is considered to pass biocriteria guidelines.*

3.7.2.3. Comparison between Mitchell Branch and Other Reference Sites on ORR

Here the benthic macroinvertebrate communities in Mitchell Branch are compared to ORR reference streams over a 17-year period since 2005. Mean values for total taxa richness and taxa richness of pollution-intolerant (EPT) taxa for Mitchell Branch are shown in Figure 3.42, and percent density of the pollution-intolerant and pollution-tolerant taxa are shown in Figure 3.43. Also shown in Figures 3.46 and 3.47 is the 95 percent confidence interval for the five reference sites on ORR, First Creek kilometer 0.8, Fifth Creek kilometer 1.0, White Oak Creek kilometer 6.8, Walker Branch kilometer 1.0, and Gum Hollow Branch kilometer 2.9, in gray shading.

In 2021, total taxa richness and taxa richness of pollution-intolerant (EPT) taxa at Mitchell Branch sites, including MIK 1.4, were less than both the 95 percent confidence interval for the five reference sites (Figure 3.44). This trend was observed since these comparisons began in 2005, with some exceptions (e.g., 2011, 2017). In contrast to richness metrics, the mean percent densities of pollution-intolerant and pollution-tolerant taxa at MIK 1.4 were not often outside of the 95 percent confidence interval for the reference sites (Figure 3.43). As noted above, the percent density of pollution-tolerant taxa at MIK 1.4 decreased again in 2021 from one of the highest values measured (in 2019) since monitoring began (Figure 3.43). Since 2005, the mean percent density of pollution-intolerant taxa at MIK 0.8 and MIK 0.7 have fluctuated but have largely remained below the reference 95 percent confidence interval, while the percent density of pollution-tolerant taxa at these sites were higher than the reference 95 percent confidence interval. MIK 0.4 has largely remained well outside the 95 percent confidence intervals for reference sites in every year (Figure 3.43).

These results from the comparison of Mitchell Branch sites with the reference sites, combined with the long-term results for all Mitchell Branch sites discussed above, suggest that from the standpoint of reference sites, MIK 1.4 falls near the lower distribution of expected reference conditions on ORR. Factors potentially contributing to excursions of invertebrate community metrics outside of the 95 percent confidence interval for other reference sites include the somewhat smaller size of MIK 1.4 compared with the other reference sites (based on watershed area, Table 3.10), which may limit the range of invertebrate species that can colonize and thrive at the site, and habitat characteristics that have typically contributed to the lower-quality habitat at the site, such as low flow and poor substrate quality (Figures 3.40 and 3.41). These results also support the contention that sites downstream of MIK 1.4 continue to exhibit evidence of mild to moderate degradation.



Note: *The gray shading on each graph shows the 95% confidence interval of values at five additional reference stream sites on ORR from 2005 to 2021.*

Acronyms:

CI = confidence interval

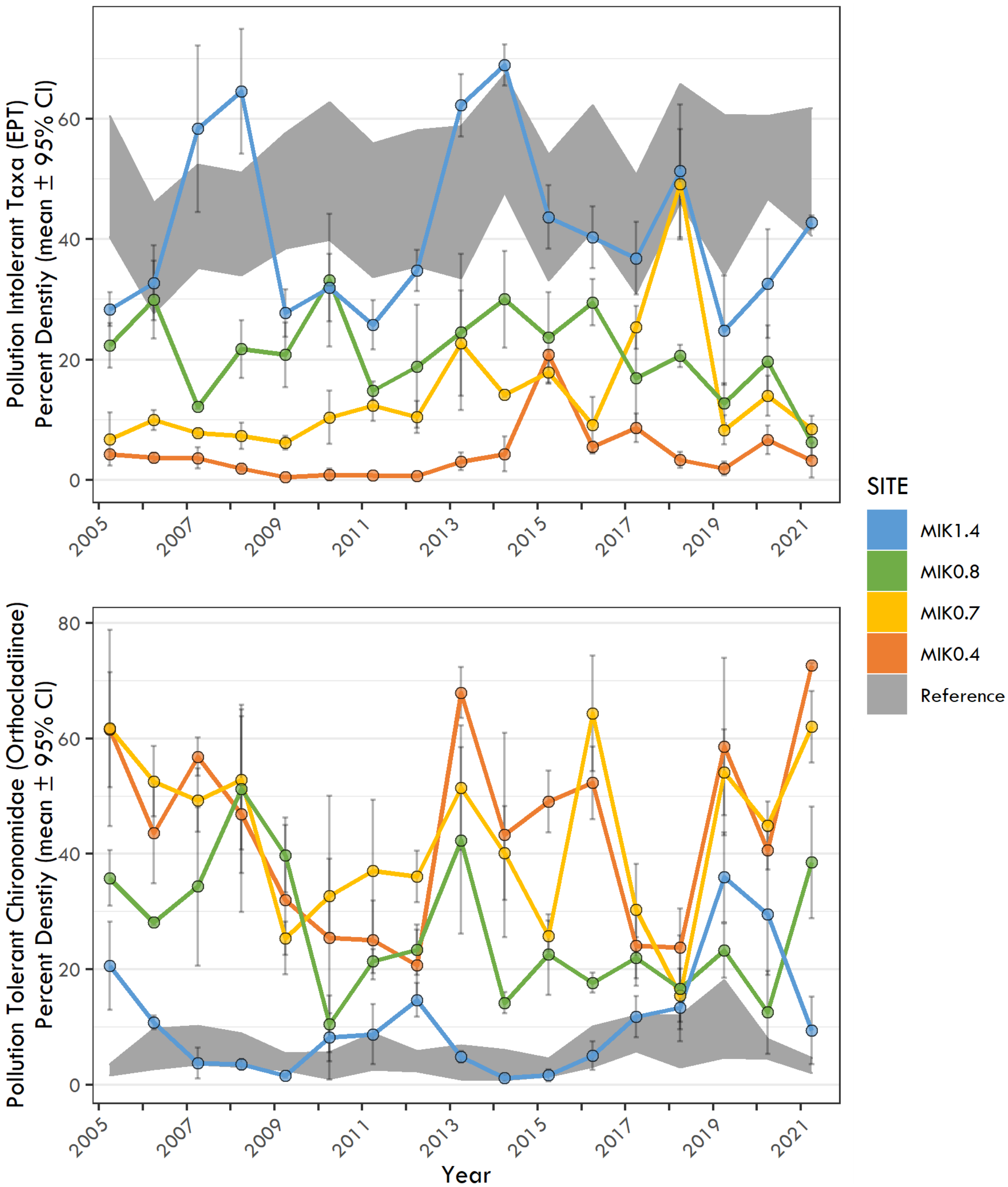
EPT = Ephemeroptera, Plecoptera, and Trichoptera

MIK = Mitchell Branch kilometer

MIK 1.4 = reference site

ORR = Oak Ridge Reservation

Figure 3.42. Mean total taxonomic richness (top) and pollution-intolerant taxa per sample (bottom) for the benthic macroinvertebrate community at Mitchell Branch and the 95% confidence interval for ORR reference sites, April 2005–2021



Notes:

1. *Pollution-intolerant taxa, i.e., stoneflies, mayflies, and caddisflies or Ephemeroptera, Plecoptera, and Trichoptera taxa (top).*
2. *Pollution-tolerant Orthocladiinae midge larvae (bottom).*
3. *Percentages were based on total densities for each site.*
4. *The gray shading on each graph shows the 95% confidence interval for values at five additional reference sites on ORR from 2005 to 2021.*

Acronyms:

CI = confidence interval MIK 1.4 = reference site EPT = Ephemeroptera, Plecoptera, and Trichoptera
ORR = Oak Ridge Reservation MIK = Mitchell Branch kilometer

Figure 3.43. Mean percent density of pollution-intolerant taxa (top) and pollution-tolerant Chironomidae (bottom) in Mitchell Branch the 95% confidence interval for ORR reference sites, April 2005–2021

3.7.3. Task 3: Fish Community

Fish population and community studies are used to evaluate the biotic integrity (or general ecological health) of Mitchell Branch. The fish community is sampled quantitatively at two sites in Mitchell Branch, MIK 0.4 (downstream of SD 190) and MIK 0.7 (downstream of SD 170) and at local reference streams each spring.

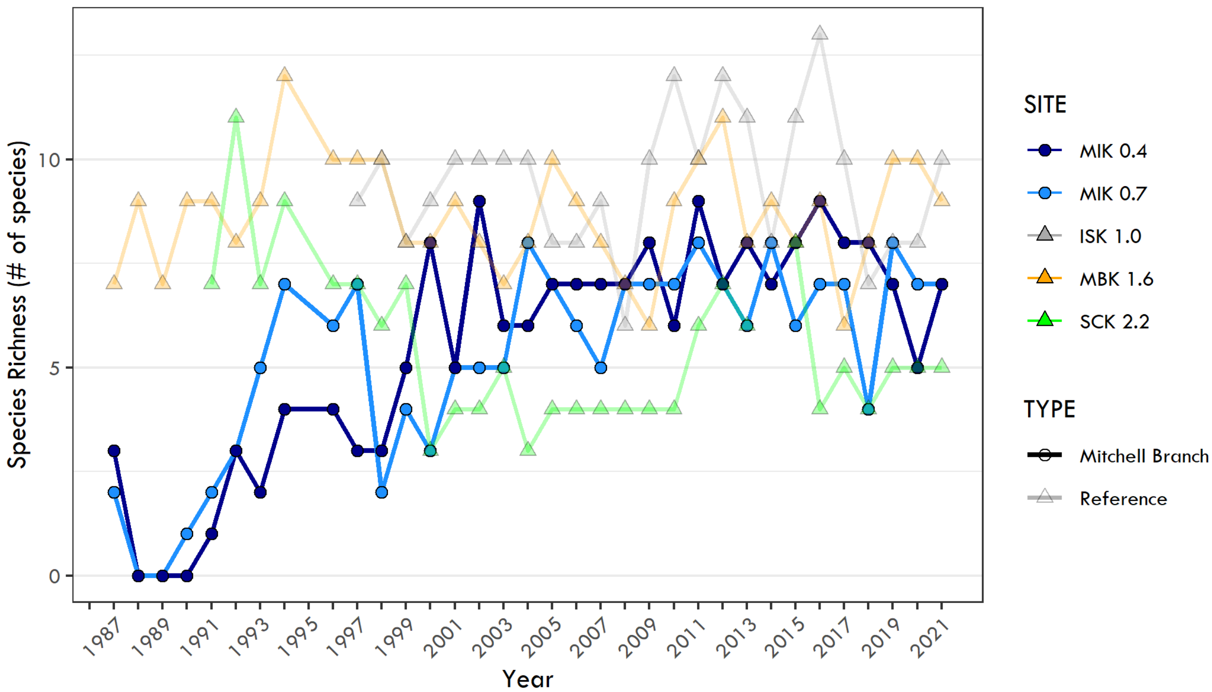
Historically, the fish community in Mitchell Branch was most severely affected in the late 1980s and early 1990s. After some recovery in the mid-1990s, Mitchell Branch was affected negatively again in 1998 in association with a remedial activity that replaced a large section of stream bottom with a liner and interlocking rock substrate (Figure 3.48). In recent years, this reach of stream appears to be developing more natural habitat, including a more robust riparian plant community and some instream riffle/pool sequences as substrate is slowly beginning to accumulate throughout the reach (Figure 3.49). This has added to the complexity of the habitat available for fishes to colonize. Since 2000, the fish community has had relatively stable species diversity but rather large variations in fish density and biomass, which are often reflective of unstable, impaired streams. Streams that experience high density and biomass of tolerant fish species are often indicative of either high nutrient influences on a fish community (i.e., more algal growth means more food at the base of the food chain) or poor instream habitat—and often a combination of both. Of the two sites sampled for fish community, MIK 0.7 has experienced the greatest fluctuations in these community parameters. This is likely due to the modified stream channel and riparian areas and poor instream habitat associated with the remediation work in this reach. Similar conditions are seen in other area streams on ORR, including sections of EFPC where tolerant species dominate the concrete- and bedrock-lined channel, which supports little riparian protection. In addition, extremely low precipitation amounts which often occur in the summer result in very low flows in many area streams. Small first and second order streams without springs or groundwater influence are most severely affected by these conditions. This may partially explain the decreased density and biomass numbers observed in some years and the apparent return of higher values in following years.

Figure 3.44. Construction of lined section of Mitchell Branch, MIK 0.7, in 1998

Figure 3.45. More recent habitat conditions at Mitchell Branch in 2021

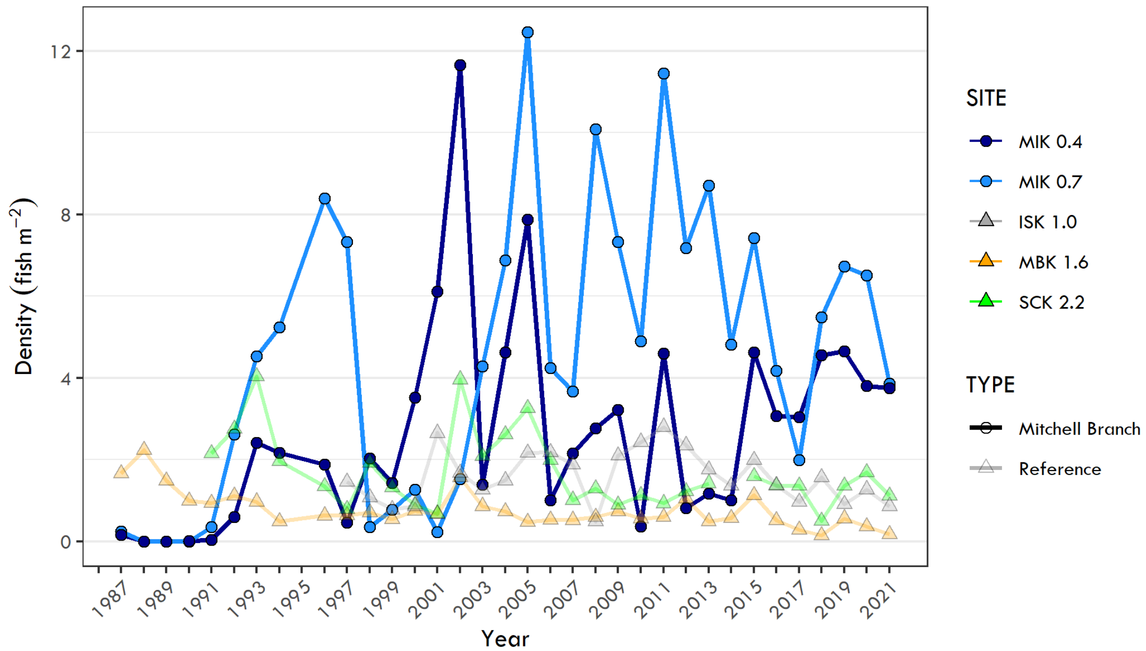
At both MIK 0.4 and MIK 0.7, the 2021 sample of fish community parameters indicated continued variation. Species richness (number of species) at the lower site increased slightly while richness at the lower site remained stable compared to 2020 values (Figure 3.46). Both sites have species richness comparable with similar sized reference streams. Density (number of fish) at both sites still remains well above reference conditions (Figure 3.47). Biomass (weight) also remains elevated at both sites (Figure 3.48). Both the lower Mitchell Branch site and the upper site had reduced diversity and density of sensitive fish species in 2021 compared to reference sites.

Over the last five years, there has been a slight uptick in sensitive species diversity and density at both sampled sites in Mitchell Branch, which can be attributed to the presence of fish such as banded sculpin (*Cottus carolinae*) that appear to be a resident species in Mitchell Branch, and also occasional occurrences of other more sensitive fish. In 2021, no new species were observed in the two sites. However, new species of darters, suckers, and sunfish continue to show up within Mitchell Branch in recent years, and some represent unique sensitive species in this reach of stream.



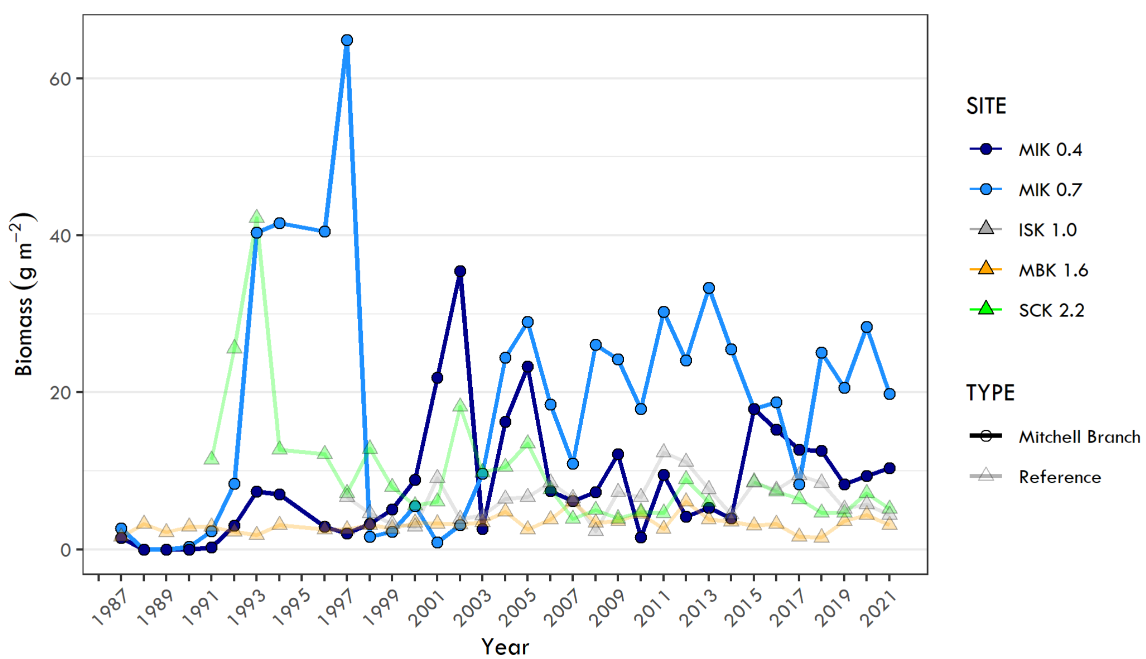
Acronyms:
ISK = Ish Creek
MBK = Mill Branch kilometer
MIK = Mitchell Branch kilometer
SCK = Scarboro Creek

Figure 3.46. Species richness for the fish communities at sites in Mitchell Branch and in reference streams Mill Branch, Scarboro Creek, and Ish Creek, 1987–2021



Acronyms:
ISK = Ish Creek
MBK = Mill Branch kilometer
MIK = Mitchell Branch kilometer
SCK = Scarboro Creek

Figure 3.47. Density for the fish communities at sites in Mitchell Branch and in reference streams Mill Branch, Scarboro Creek, and Ish Creek, 1987–2021

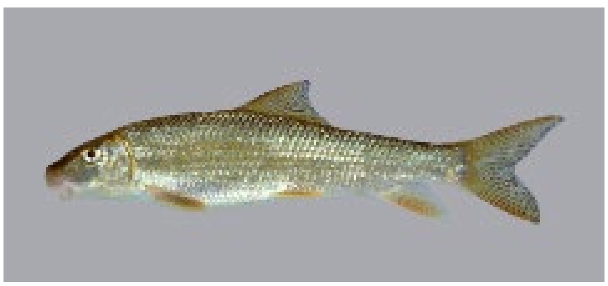


Acronyms:
ISK = Ish Creek
MBK = Mill Branch kilometer
MIK = Mitchell Branch kilometer
SCK = Scarboro Creek

Figure 3.48. Biomass for the fish communities at sites in Mitchell Branch and in reference streams Mill Branch, Scarboro Creek, and Ish Creek, 1987–2021

In general, the Mitchell Branch fish communities at MIK 0.4 and MIK 0.7 continue to lack diverse resident species that are sensitive to stress or that have specialized feeding or reproductive requirements, such as darters or suckers that occur consistently at higher frequencies in the reference streams. Like the benthic communities, fish community monitoring provides an integrated response to *all* of the various water chemistry and habitat influences in a stream. Identifying the major stressor influences on the community (i.e., causal analysis) would require additional investigatory strategies coupled with the monitoring data.

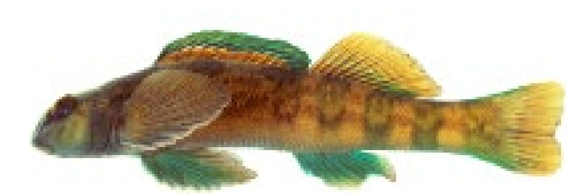
During routine bioaccumulation sampling, several species of fish are collected regularly at MIK 0.2 that are infrequently observed in the Mitchell Branch fish community monitoring activities at the upstream sites. These included four pollution-sensitive species: black redhorse (*Moxostoma duquesnei*), snubnose darter, greenside darter (*Etheostoma blennioides*), and northern hogsucker (*Hypentelium nigricans*) (clockwise, Figure 3.49). Future monitoring will help determine if these species are becoming established farther upstream in Mitchell Branch or are merely seasonal migrants to the stream's lower section, which is easily accessible from the much larger Poplar Creek.



Black redhorse *(Moxostoma duquesnei)*

Snubnose darter *(Etheostoma simoterum)*

Northern hogsucker *(Hypentelium nigricans)*



Greenside darter *(Etheostoma blennioides)*

Photos: Chris Bryant

Figure 3.49. Sensitive fish species observed in lower Mitchell Branch

K-1007-P1 Pond Fish Community

The fish communities in the K-1007-P1 pond are assessed annually. This sampling is conducted to evaluate the effectiveness of remediation efforts implemented in 2009 and is aimed at reducing the PCBs available for transfer out of the pond via natural routes (i.e., trophic transfer). The RAs included capping contaminated sediment with fill dirt, planting native aquatic vegetation to stabilize sediment, and removing potentially contaminated fish from the pond. Fish initially were removed from the pond using a piscicide (Rotenone), and uncontaminated native fish were stocked in the pond with the goal of establishing a sunfish-dominated community. Sunfish have a shorter lifespan than many other species of fish, especially higher trophic level fish, and they have a prey source that is generally varied but consistently lower on the aquatic food chain compared with species such as largemouth bass, thus reducing the likelihood that contaminants would biomagnify within the system.

Despite efforts to remove all unwanted fish from the pond, an unexpected breach in the weir separating the K-1007-P1 pond from the adjacent Poplar Creek in May 2010 allowed numerous fish to enter the pond during high waters. These unwanted fish constituted several species that were unfavorable to the pond action—including: (1) nonnative species and (2) species with life history traits that undermined the remediation efforts, such as being long-lived and having feeding habits that disturb potentially contaminated sediments. Continued work to remove these unwanted fish has been productive, and only limited numbers of the most long-lived species, such as common carp (*Cyprinus carpio*) and smallmouth buffalo (*Ictiobus bubalus*), are encountered in annual monitoring.

Two additional species that returned to the pond after the weir breach were gizzard shad (*Dorosoma cepedianum*) and largemouth bass (*Micropterus salmoides*). Gizzard shad feed on phytoplankton and zooplankton in natural environments such as larger reservoirs, but in smaller ponds such as P1, they often turn to feeding on algal growth at the surface of the pond sediment, which can disturb soils and potentially resuspend contaminants in the pond substrate. Largemouth bass tend to be a long-lived species and are a top predator in aquatic environments, making them particularly susceptible to bioaccumulation. They also are a game fish highly prized by many anglers as well as a common table fare. These two species also have been targeted for removal during continued remediation efforts and fish surveys.

Overall, the K-1007-P1 Pond fish community surveys conducted in January 2021 revealed the presence of 12 species of fish. An observation of particular importance from previous surveys is the abundance of sunfish species (bluegill, redear sunfish, and warmouth), which constitute approximately 85 percent of the total fish population (Figure 3.50). Bluegill, the most prevalent of these species, were historically the dominant sunfish species in the pond, and they are the desired bioindicator fish species to have in the remediated pond. Although largemouth bass continue to persist in the pond, their abundance remains relatively low. Despite removal efforts, their presence is likely to continue, given the habitat conditions currently in the pond (i.e., abundant prey sources and open water). Gizzard shad (*Dorosoma cepedianum*) continue to be present in the pond and are suspected of reproducing some years. Although they constituted a much larger portion of the fish population in 2020 than in previous years, they were almost absent in 2021 sampling. Their abundance has had some minor fluctuations each year but in general has remained relatively low compared with earlier years.

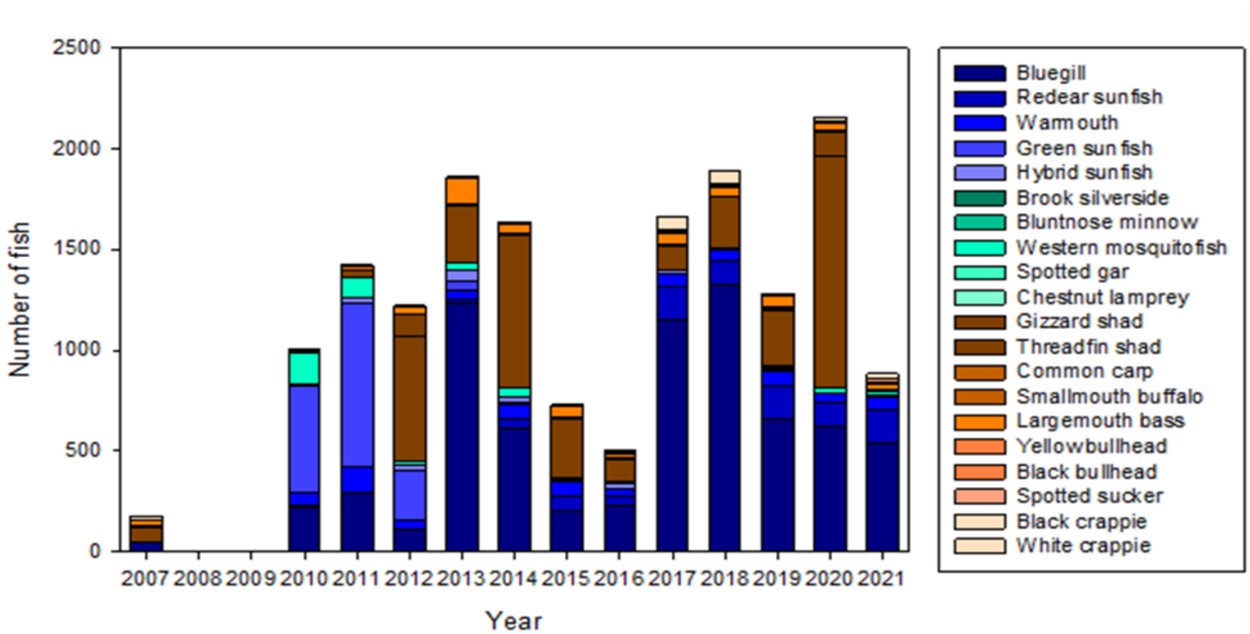


Figure 3.50. Changes in the K-1007-P1 Pond fish community from 2007 to 2021

3.8. Environmental Management and Waste Management Activities

Remediation activities were underway across ETTP in 2021. Wastes were generated during these operations and were handled in accordance with the applicable regulations.

3.8.1. Waste Management Activities

Restoration of the environment, D&D of facilities, and management of legacy wastes constitute the major operations at ETTP. In 2020, all of the major D&D work at ETTP was completed. However, several smaller projects, and the finishing touches of the cleanup activities, continue.

CWTS is a small water treatment unit for chromium-contaminated groundwater that sits within the existing Central Neutralization Facility footprint. CWTS came online in late 2012 and handles purge water from groundwater monitoring, as well as the chromium collection system water. Effluent from CWTS discharges into the Clinch River through an existing Central Neutralization Facility discharge line. Section 3.6.2.14 provides a more detailed discussion of CWTS operations.

3.8.2. Environmental Remediation Activities

During 2020, the final major cleanup project was completed. The ultimate goal of the remediation work is to make parcels of land available for a general aviation airport, conservation areas, and private-sector development that can economically benefit the region. Highlights of this effort are given below. For details, please see the *2021 Cleanup Progress—Annual Report to the Oak Ridge Regional Community* (UCOR 2022, OREM-21-7613).

3.8.2.1. Soil Remediation

UCOR's soil remediation efforts at ETTP are helping to prepare the site for future commercial industrial use. The site is divided into two cleanup regions: Zone 1, a 1,400-acre area outside the main plant area, and Zone 2, the 800-acre area that comprises the main plant area. The areas in these zones are divided into EUs that vary in size. Remediation efforts are designed to protect groundwater, wildlife, and the future workforce. Remediation activities include removal of facilities, excavation of soil, and land use covenants. In FY 2021, four projects to eliminate risk to wildlife in the Zone 1 area were completed. These projects were the remediation of the K-901-Drainagae Ditch and North Disposal Area, K-1085, Blair Quarry, and the K-722 Powerhouse Area. In the Zone 2 area, soil contaminated with uranium and other radiologic contaminants was removed from Exposure Unit (EU)-19 and EU-30. Soil contaminated with VOCs was removed from EU-25 (the former K-1423 facility) and EU-35 (the former Central Neutralization Facility). Removal of VOC contaminated soils also began in EU-21 (inside the former K-25 Building footprint) and EU-25 (the former K-1413 facility). Several concrete slabs were removed, including those at the former K-1036-A, K-1024, and K-1025 A-E facilities. The slab at the former K-1200 Centrifuge Complex in EU-42 was also removed. (See also Section 3.6.2.8.)

At the end of 2021, the soils at only 15 EUs remain to be remediated.

3.8.2.2. K-1200 Centrifuge Project Demolition Completed

The K-1200 Centrifuge Complex was a large complex of facilities that were designed to develop and test technologies associated with the use of centrifuges for uranium enrichment. In 2020, the last of these facilities were demolished, leaving a concrete slab that had served as the building's foundation. In 2021, the concrete slab was removed, and the area was backfilled with more than 30,000 cubic yards of clean soil and revegetated. This restored the site to a grassy field, suitable for repurposing. See also Section 3.6.2.8.

3.8.2.3. Small Scale Demolition Projects Completed

All of the major facilities at ETTP had been demolished by the end of 2020. However, various minor structure remained. Several of these structures, such as the water tank on McKinney Ridge, the Central Receiving Facility, and a meteorological tower (MT), were demolished in 2021.

3.8.2.4. Powerhouse Area Remediation Completed

The extreme western side of ETTP once contained a fossil-fueled powerplant, support facilities, and a large scrap metal storage area. Portions of the area had been remediated in earlier decontamination and demolition efforts, including the removal of 50,000 tons of scrap metal in 2007, followed by the removal of contaminated soil. In 2021, the area was recontoured using 76,000 cubic yards of backfill and 27,000 cubic yards of topsoil. This project redirected water to nearby wetlands, and resulted in a swath of land that has been proposed for future recreational development. In a related project, a 2-foot soil cover was placed over the 9-acre site that once held the powerhouse oil tanks. A global positioning system was used to ensure proper soil placement and contouring.

3.8.3. Reindustrialization

With major demolition projects complete in 2020, ETTP moved closer to achieving the three end state goals of a multi-use industrial park, national historic preservation, and conservation/greenspace areas.

Multi-Use Industrial Park

In 2021, DOE completed transfer of Access Portals 4 and 11. Portal 4 and one block sections of both 9th and 10th Streets were transferred to CROET and comprise 0.84 acres of land. Portal 11 (0.52 acres) was transferred to the COR as a complement to their existing Fire Station. Work continued on the transfer of additional areas of ETTP, including a former switchyard, the former K-1037 area, and the former TSCA Incinerator area (27.9 acres) to CROET for economic development opportunities. All transfers are in the review process and pending approval. DOE also continued to support the proposed general aviation airport project, which is in the planning stages to be constructed along State Route 58. DOE and UCOR assisted CROET in the sale of the former K-31/K-33 area to Kairos Power. Kairos Power plans to deploy a demonstration reactor on the site.

Conservation/Greenspace

DOE continued to work with the Tennessee Wildlife Resources Agency (TWRA) on greenspace initiatives and waterway access to enhance public recreation opportunities at ETTP.

To date, DOE has transferred almost 1,300 acres. A new End State and Closure Plan was developed in 2021 to address the remaining scope of work and necessary land transfers, as well as to provide a vision on how the site will look in the future.

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