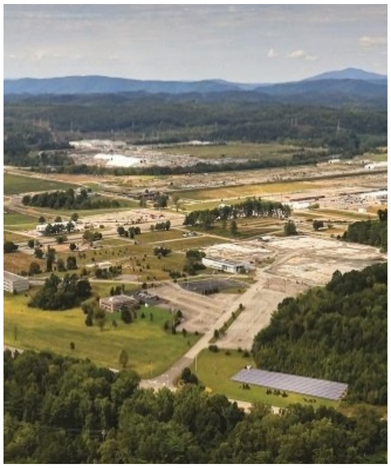


The East Tennessee Technology Park has changed greatly in recent years as remediation projects have been completed.

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 Interior signed a memorandum of agreement (MOA) establishing the Manhattan Project National Historical Park. 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 2020. 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 (COR). 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

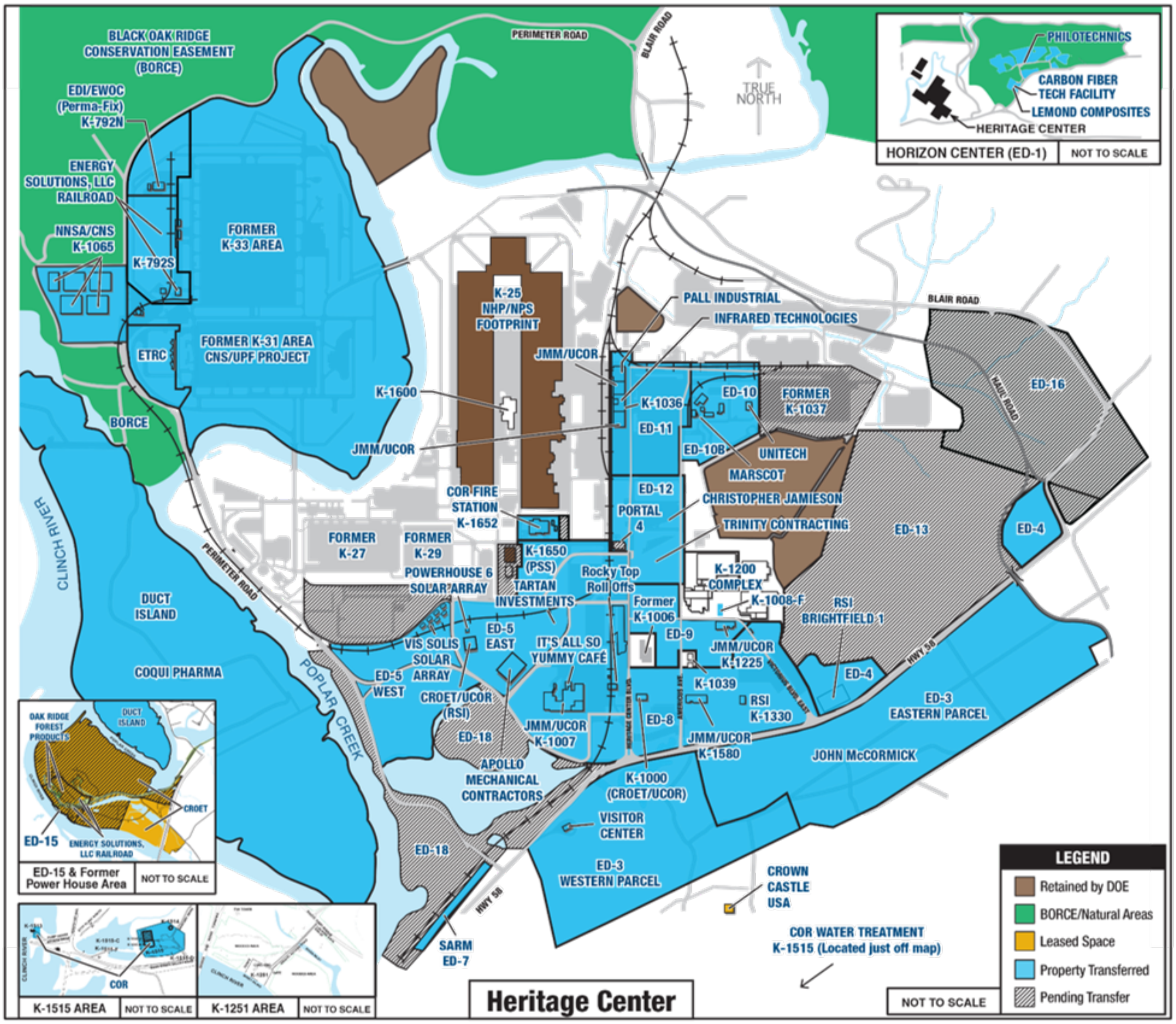


Figure 3.3. East Tennessee Technology Park in 2020, showing progress in reindustrialization

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, and sustainability practices in all 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 2020 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 2020 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 sixth consecutive year that UCOR has won an EPEAT award and the second consecutive year it was achieved at the four-star level.

Additionally, UCOR internally recognized four projects for their P2 and waste minimization accomplishments in 2020, which are summarized below.

- The East Tennessee Technology Park Decommissioning and Demolition project was recognized for recycling 178,150 lb of scrap metal from deactivation work that met Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) qualification. This effort saved 203,499 kWh of energy, 17,400 gal of water and 54 metric tons (MT) in greenhouse gas emissions while saving valuable landfill space.
- The East Tennessee Technology Park Decommissioning and Demolition project was recognized for re-purposing excavation spoils material from the ED-19 utility upgrade project as backfill at the K-832-H Basin, which avoided 730 yd^3 of waste, reduced 2.59 MT in greenhouse gas emissions, and saved over $70,000.
- The Oak Ridge National Laboratory Operations and Cleanup Enterprise project was recognized for recharacterizing radioactively contaminated equipment as CERCLA in order to dispose of it locally, which avoided 59 MT of greenhouse gas emissions and saved the project $245,000 in container, shipping, and disposal fees.
- The Y-12 National Security Complex Biology and Excess Contaminated Facilities Decommissioning and Demolition project was recognized for realizing the opportunity to reduce the size of fluorescent light tubes through use of a bulb crusher. This resulted in more efficient shipping, which avoided 3.37 MT of greenhouse gas emissions and saved $3,911.

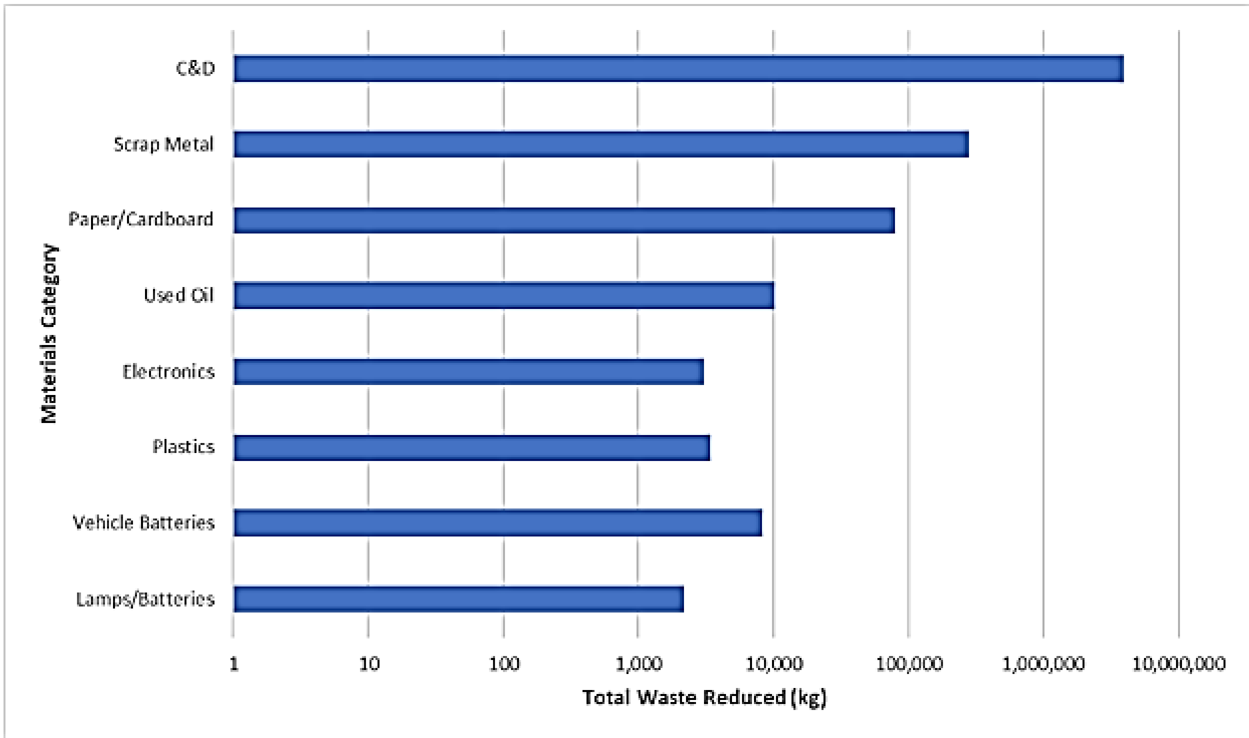


Figure 3.4. Pollution prevention recycling activities related to solid waste reduction at the East Tennessee Technology Park in calendar year 2020

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 2020, more than 189 MT of greenhouse gas emissions, 910 MT of waste, 200,000 kWh of electricity, and 17,400 gal of water were saved 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 $319,000.

In 2016, a significant improvement in the diversion of scrap metal was made, by petitioning and receiving agreement from 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 175,080 lb (79.4 MT) of scrap metal to be recycled in fiscal year (FY) 2020 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. To date, the scrap metal recycled as a result of the screening process has saved approximately 788 yd^3 of valuable landfill space, which

translates into a considerable cost savings, which takes into consideration 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, Oak Ridge National Laboratory (ORNL), and the Y-12 National Security Complex (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) 2020, Brightfield 1 produced 248,000 kWh of energy. During January 2020, Brightfield 1 continued a single downtime that had begun in December 2019 due to maintenance activities, with the seasonal timing resulting in only a negligible increase in the use of conventionally supplied power.

In addition, through the cooperative efforts of DOE, UCOR, RSI, Vis Solis, Inc., CROET, and COR, 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 COR renewable energy goals.
- Supports TVA renewable energy initiatives.
- Offers community economic development jobs and property tax income to COR.
- 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 Oak Ridge Reservation (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 2011a), and include the following:

- Comply with all environmental regulations, permits, and regulatory agreements.
- 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, and WMin 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, 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 2020, 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 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 2011), 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*, 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 in Figure 3.4 above, 187,083 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 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	

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, 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 Annual Site Environmental Report [ASER] [DOE 2020, DOE/ORO-2512] and the annual cleanup progress report [UCOR 2021a, *2020 Cleanup Progress—Annual Report to the Oak Ridge Regional Community,* OREM-20-7603]).

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 2021b, UCOR-4127/R9). 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 2011a), with the most recent having been conducted in 2018. The results of the audit were zero findings, three observations, and four 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 2020, ETTP operations were conducted in compliance with contractual and regulatory environmental requirements. There were no National Pollutant Discharge Elimination System (NPDES) permit noncompliances and no Clean Air Act (CAA) noncompliances in 2020. 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 2020.

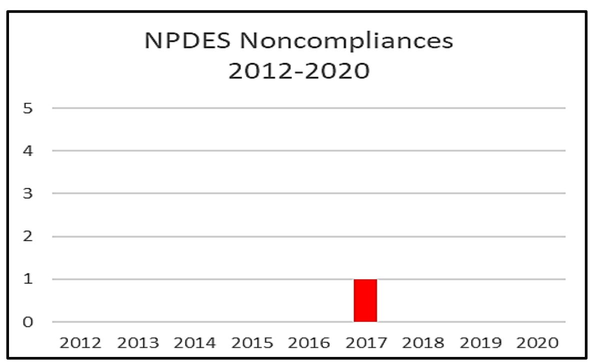


Figure 3.6. East Tennessee Technology Park National Pollutant Discharge Elimination System permit noncompliances since 2012

3.3.1. Environmental Permits Compliance Status

Table 3.2 contains a list of environmental permits that were in effect at ETTP in 2020. ETTP received no notices of environmental violations or penalties in 2020.

Table 3.3 presents a summary of environmental audits and oversight visits conducted at ETTP in 2020.

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 2020, 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 determinations that cover certain proposed activities (i.e., maintenance activities, facility upgrades, personnel safety enhancements). A categorical exclusion is one of 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 categorical exclusion determinations are used. During 2020, five review reports 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.

Table 3.2. East Tennessee Technology Park environmental permits, 2020

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	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	TFE	TFE	TFE
CWA	SOP—ETTP holding tank/haul system for domestic wastewater	SOP-99033	07-01-2015	06-30-2020 Not renewed	UCOR	UCOR	UCOR
RCRA	ETTP container storage and treatment units	TNHW-165	09-15-2015	[b]09-15-2020	DOE	UCOR	UCOR
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.*

[b] *This permit was terminated by TDEC at the request of UCOR. All hazardous waste treatment and storage units were certified/verified closed by TDEC.*

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 of 1976
SOP = state operating permit
TDEC = Tennessee Department of Environment and Conservation
TFE = Technical and Field Engineering, Inc.
UCOR = UCOR, an Amentum-led partnership with Jacobs

Table 3.3. Regulatory oversight, assessments, inspections, and site visits at East Tennessee Technology Park, 2020

Date	Reviewer	Subject	Issues
January 6	TDEC	K-1600 Closure Inspection	0
February 5	TDEC	K-1200 RCRA Compliance Inspection	0
May 12	COR	ETTP Sewage and Storm Drain Inspection	0
June 4	TDEC	K-1066-F and –G RCRA Closure Inspection	0
June 10	TDEC	ETTP CERCLA/NPDES Inspection	0
July 28	TDEC	ETTP NPDES Outfall Inspection	0
August 26	EPA/TDEC	RCRA Inspection of ETTP	0
November 19	TDEC	Air Inspection of removed generator sites	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 a 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 Department of the Interior and DOE on November 10, 2015 (DOE 2015), creating the new Manhattan Project National Historical Park. The K-25 Virtual Museum website, found **here**, was launched in conjunction with the signing of the MOA.

The Historic American Engineering Record (HAER) documentation is being prepared for the K-25 Building. The documentation will be transmitted to the National Park Service upon completion.

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 2020. 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 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 Clean Water Act was EPA 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 2020, ETTP discharged storm water to the waters of the state of Tennessee under the individual NPDES permit TN0002950, which regulates storm water discharges.

In 2020, sewage discharges from routine breakrooms, restrooms, and change house showers were discharged to the COR Rarity Ridge Wastewater Treatment Plant collection network and sewage holding tanks under permits SOP-05068 and SOP-99033. SOP-99033 was allowed to expire on June 30, 2020.

3.3.5. National Pollutant Discharge Elimination System Permit Noncompliances

In 2020, 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 2020 was 100 percent. There were no permit noncompliances in 2020.

3.3.6. Safe Drinking Water Act Compliance Status

Since October 1, 2014, all water at the ETTP site is supplied by the COR 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 2020, ETTP had two generator accumulation areas for hazardous or mixed waste.

In addition, ETTP was permitted to store and treat hazardous and mixed waste under the Resource Conservation and Recovery Act (RCRA) Part B Permit TNHW-165. However, in 2020 the last of the permitted storage and treatment units were officially closed by UCOR and verified/certified that the units were closed according to the permit Closure Plan by TDEC and the permit was terminated on September 29, 2020.

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

In CY 2020, ETTP prepared and submitted to the TDEC Division of Solid Waste Management the CY 2019 annual report of hazardous waste activities. This report identifies the type and amount of hazardous waste that was generated, shipped off site, or is currently in storage. In 2020, 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 2020, 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 2018b, DOE/OR-1014) is intended to coordinate the corrective action processes of RCRA required under the *Hazardous and Solid Waste Amendments* permit with CERCLA response actions.

3.3.10. Toxic Substances Control Act 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.

TN0890090004. In 2020, ETTP operated two PCB waste storage areas in RCRA-permitted storage buildings. These facilities were operated under 40 CFR Part 761.65(b)(2)(iii) (EPA 1979), which allows PCB storage permitted by the state authorized under Section 3006 of RCRA to manage hazardous waste in containers, and spills of PCBs are cleaned up in accordance with Subpart G of this part. 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 2018c, ORR-PCB-FFCA), which became effective December 16, 1996, and was last revised on October 8, 2018, to Revision 6.

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 2020, 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 2020 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 2020.

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 2020, 11 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, Sakrete™ Type S or N mortar mix, arsenic pentoxide (the active ingredient in CCA Type C pressure-treated wood), Flexterra FGM erosion control agent, crystalline silica, New Pig absorbents, and various lubricating oils (including motor, lubricants, distillates, hydraulic and gear 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 2020, there were no chemicals that met the reporting requirements.

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 2020, 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. Three generators have diesel-fueled engines, one generator has a natural gas-fueled engine, and the firewater booster pump engine is diesel fueled. 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. 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.

Although the PBR subsumed the previous operating permit for the ETTP stationary e-RICE generators and firewater booster pump, the compliance requirements remained essentially the same. Compliance for all units is demonstrated by following specified maintenance schedules, limiting hours of operations for non-emergencies to 100 hours per year, and record keeping. Regulations exempt any operating hours of these units during nonscheduled (emergency) power outages.

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." 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 2020, four Notifications of Demolition and/or Asbestos Renovation (NDARs) were submitted to TDEC for non-CERCLA ETTP activities. The NDAR for non-CERCLA facilities K-1039 and K-1039-1 was considered a non-regulated asbestos demolition. These two facilities had asphalt roofs that were considered Presumed Asbestos Containing Material (PACM) Category I Non-Friable. All other facilities were non-asbestos demolitions. There were no Regulated Asbestos Containing Material (RACM) demolitions during 2020.

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 2020, 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 2020.

Stratospheric Ozone Protection

The management of ODSs at ETTP is subject to regulations in 40 CFR Part 82, Subpart F, Recycling and Emissions Reduction; 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 2020 the ODS inventory was reduced to 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.

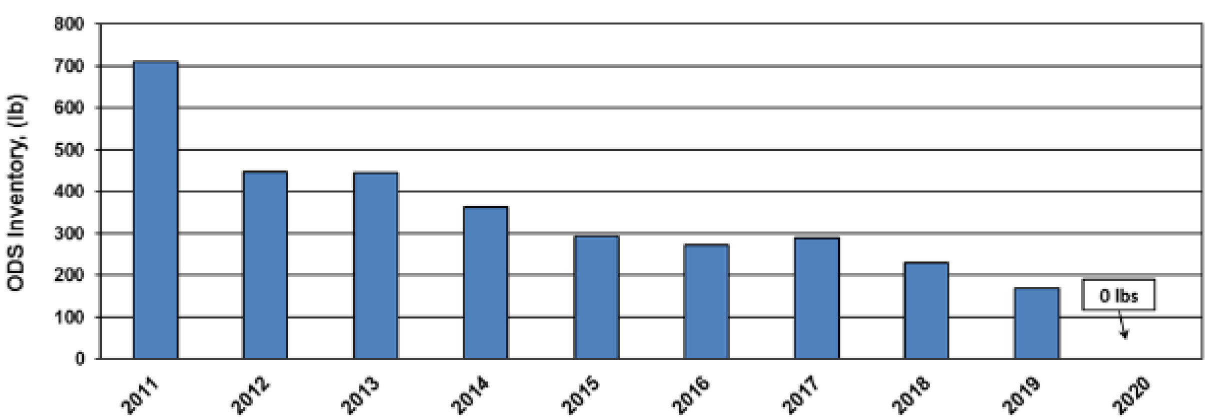


Figure 3.7. East Tennessee Technology Park total on-site ozone-depleting substances inventory, 10-year history

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 2020—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 and the total dose at each monitoring station are presented in Table 3.4 for the 2020 reporting period. No radionuclides analyzed for at ETTP ambient air locations were detected; therefore, no doses could be calculated from these results.

Table 3.4. Radionuclides in ambient air at East Tennessee Technology Park, January 2020 through December 2020

Station	Concentration (μCi/mL)			
	^{99}Tc	^{234}U	^{235}U	^{238}U
K2[a]	ND[b]	ND	ND	ND
K11[c]	ND	ND	ND	ND
K12[c]	ND	ND	ND	ND

[a] *K2 result represents a residential exposure.*
[b] *ND = not detectable.*
[c] *K11 and K12 represent an on-site business exposure equivalent to half of a yearly exposure at this location.*

Stations K11 and K12 are near on-site businesses; therefore, the estimated doses based upon residential exposures were divided by two to account for occupational exposures following approved procedures. This conservatively assumes that the on-site member of the public is at his or her workstation for half of the year. Based upon the reduced activities at ETTP that could generate air emissions, and the long term low trends at K2, the K2 air monitor was taken out of service at the end of 2020.

3.5.1.4. Quality Assurance

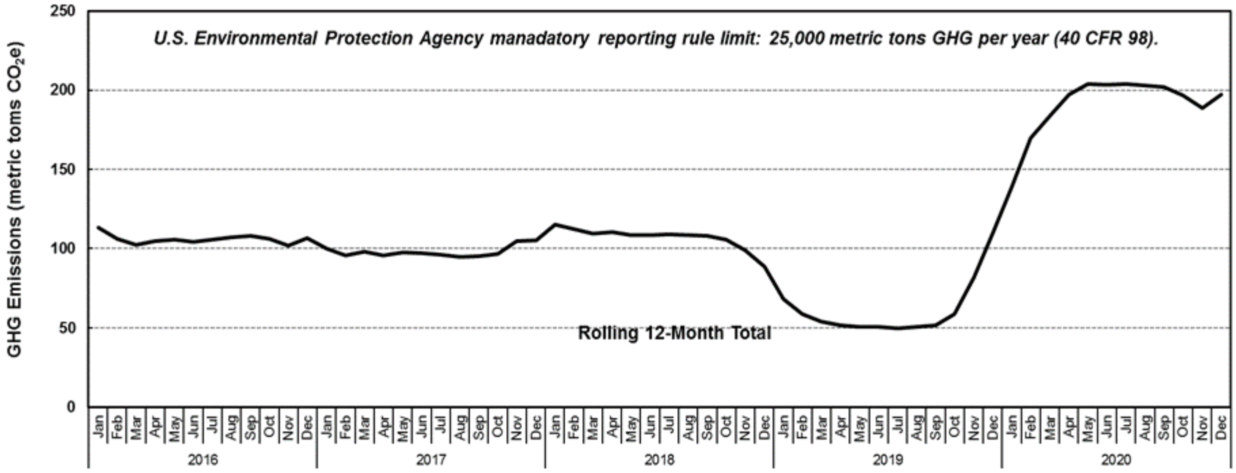
QA activities for the Rad-NESHAP program are documented in the Quality Assurance Program Plan for Compliance with Radionuclide National Emission Standards for Hazardous Air Pollutants, East Tennessee Technology Park, Oak Ridge Tennessee (UCOR 2018, UCOR-4257/R2). The plan satisfies the QA requirements in 40 CFR Part 61, Method 114, 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).

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. 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 2020 review was performed of ETTP processes and equipment categorically identified under 40 CFR Part 98.2 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 2020, 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 small comfort heating systems, hot water systems, and power generators. Figure 3.8 shows the 5-year trend up through 2020 of ETTP total GHG stationary emissions. For CY 2020, GHG emissions totaled 197 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 (CO_2e)
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 from the previous year 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 2020, including the landfills, totaled 18,476 MT CO_2e, which is a 70 percent reduction from emissions in the FY 2008 baseline year.

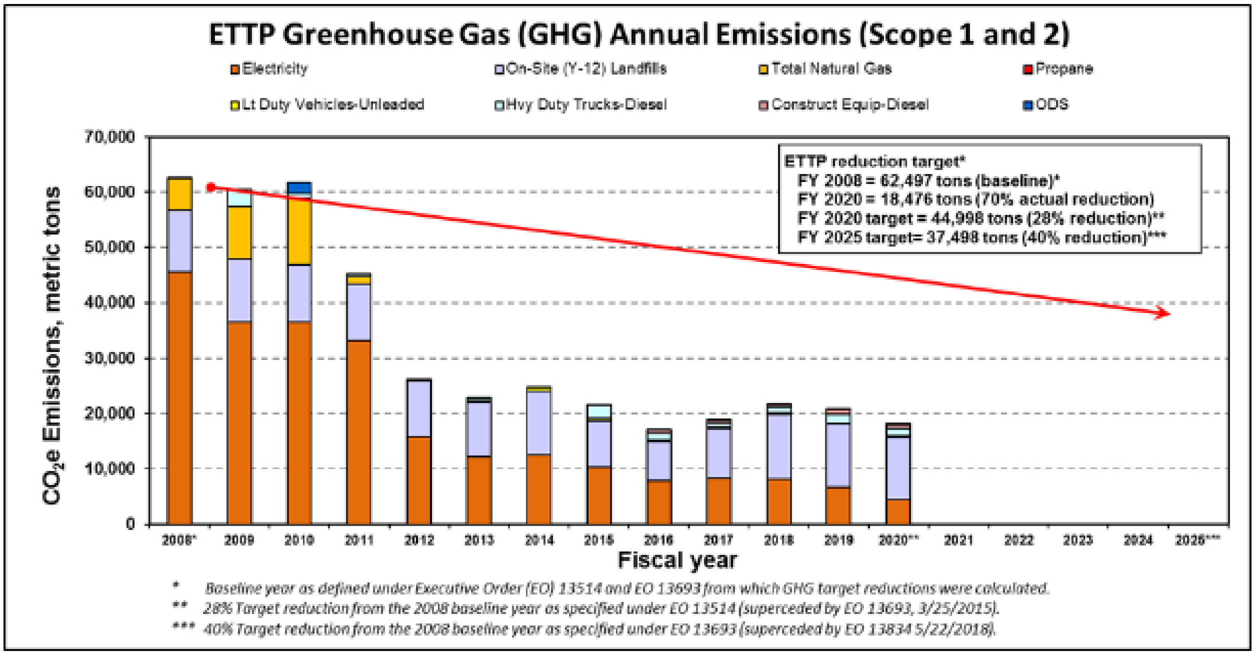
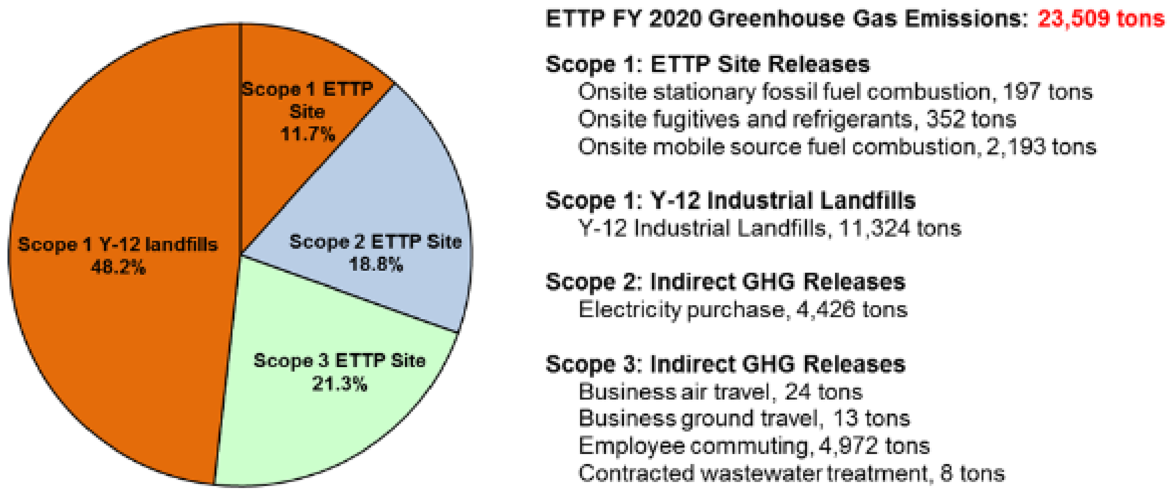


Figure 3.9. East Tennessee Technology Park greenhouse gas annual emissions (Scopes 1 and 2, including industrial landfills at Y-12)

Figure 3.10 shows the relative distribution and amounts of all ETTP FY 2020 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 2020 was 23,509 MT CO_2e.



Acronyms:
ETTP = East Tennessee Technology Park
GHG = greenhouse gas
SF_6 = sulfur (hexafluoride)
Y-12 = Y-12 National Security Complex

Figure 3.10. Fiscal year 2020 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 effluent stream. All process data records and the calculated potential maximum VOC emission rates for the CWTS air stripper were below levels that would require permitting. The calculated VOC annual emissions during 2020 for CWTS were only 0.006 ton/year as compared to an emission limit of 5 tons/year. The annual potential emissions for this facility would be well below the 5 ton/year limit assuming it operated at the maximum hourly emission rate continuously for the entire year.

Federal regulations amended in January 2013 require TDEC permitting for existing and new stationary reciprocating internal combustion engine-powered emergency generators and firewater booster pumps. Permitting actions do not apply to e-RICE covered under CERCLA projects. However, specific maintenance and recordkeeping requirements specified in the federal regulations are applicable to CERCLA projects operating e-RICE.

The 2020 operations included four e-RICE powered emergency generators (K-1007, K-1039, K-1095, and K-1652), and one e-RICE powered firewater booster pump (K-1310-RW). TDEC issued a NOA to UCOR on July 19, 2018, for e-RICE at ETTP to operate under the PBR provisions of Rule 1200-03-09-.07 for stationary emergency internal combustion engines. This authorization (number R74133) subsumed the previous operating permit.

During 2020 the emergency generators at K-1007, K-1039, and K-1095 were all removed from the ETTP site. The emergency generator at K-1652 was transferred to the City of Oak Ridge. The K-1310-RW firewater booster pump was transferred to Consolidated Nuclear Security, LLC. The PBR authorization for UCOR was then surrendered.

Regulations limit e-RICE nonemergency and maintenance operations to 100 h of operations per 12-month rolling total (i.e., 100 h of running the engines for testing and maintenance purposes per year). Additionally, nonemergency operations are limited to 50 h of the 100-h annual limit. PBR provisions also require performing scheduled maintenance and recordkeeping. These requirements were met in CY 2020.

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. 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 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.

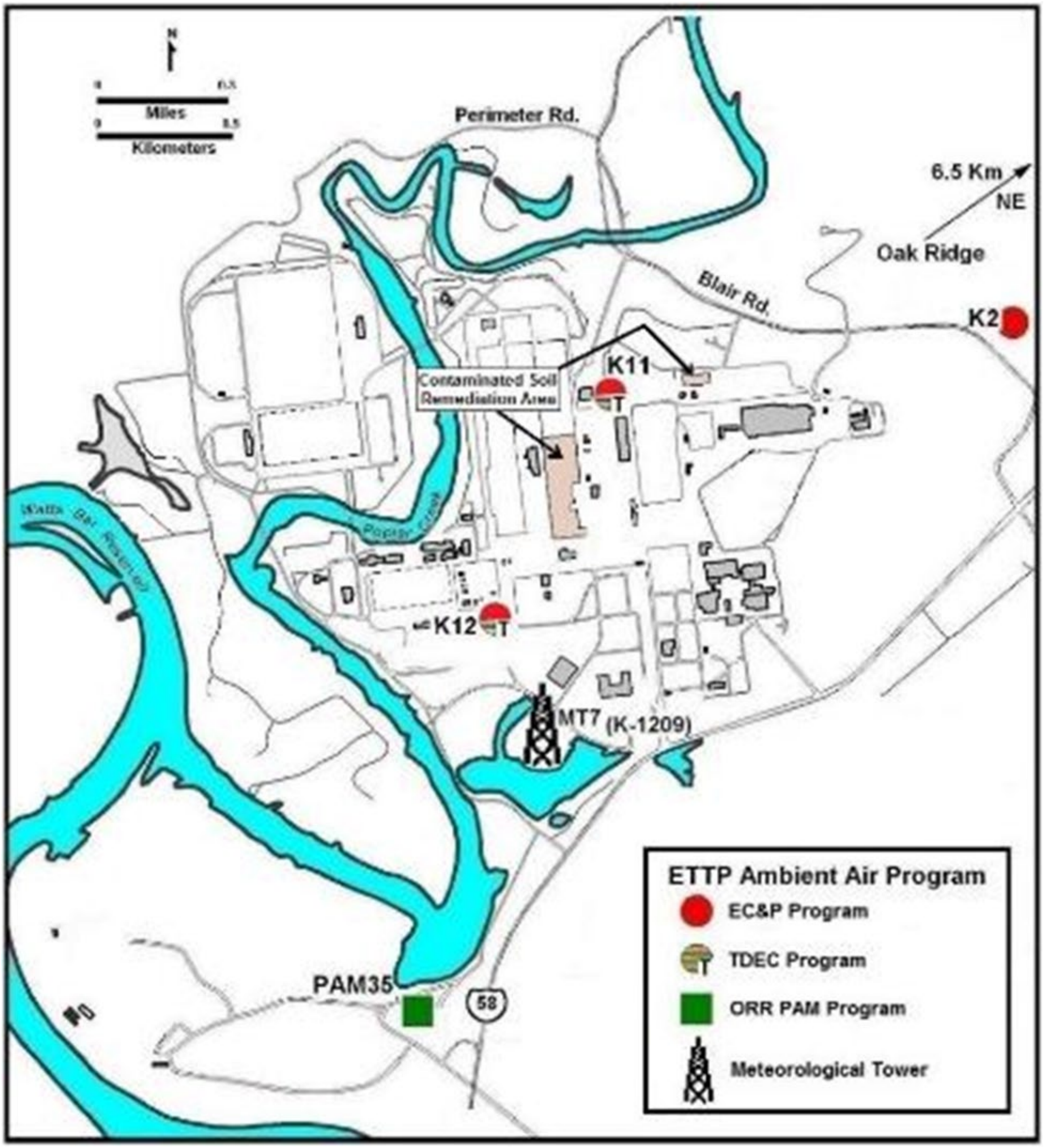
3.5.2. Ambient Air

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 2020 reporting period.

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

The EC&P program consisted of three sampling locations throughout 2020. 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 the demolition of the K-1600 Complex, K-1004-J Lab Complex, K-1200 Centrifuge Complex, and K-832 Basin, as well as slab removals, small structures demolition, and the excavation and removal of ^{99}Tc-contaminated soil from the Building K-25 footprint.

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 2020. These analyses of samples from the EC&P stations test for the isotopes ^{234}U, ^{235}U, ^{238}U, and ^{99}Tc.

Station K2 is in the prevailing topography of influenced downwind directions that are for identifying the impact to off-site members of the public. As previously noted, the K2 air monitor was taken out of service at the end of 2020. 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

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

Water quality is monitored via multiple programs at ETTP. Stormwater 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).

3.6.1. National Pollutant Discharge Elimination System Permit Monitoring

NPDES monitoring is conducted to demonstrate compliance with the ETTP NPDES Permit. The latest ETTP NPDES permit became effective on April 1, 2015 and expired on March 31, 2020. The permit renewal application was submitted to TDEC on September 18, 2019. The expired permit will continue in effect until a new permit is issued by the State of Tennessee. Under the ETTP NPDES Permit, 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 2020.

Figure 3.13. Storm water outfall monitoring

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. 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 remedial action monitoring, CERCLA PCCR monitoring, legacy contamination monitoring, and investigative monitoring.

Investigative monitoring is triggered by elevated analytical results, CERLCA requirements, and changes in site conditions. Investigative samples were collected from the Powerhouse Area Outfalls and the Outfall 690 Network in 2020. Storm water sampling results were reviewed and evaluated to provide feedback for the next round of investigative sampling, generate suggested modifications and improvements to storm water runoff controls, and provide input for CERCLA project cleanup decisions.

3.6.2.1. Radiologic Monitoring of Storm Water

Radiological monitoring of storm water discharges is performed to determine compliance with applicable dose standards. Selected outfalls are sampled for gross alpha and gross beta radioactivity, as well as specific radionuclides. Analytical results are used to estimate the total discharge of each radionuclide from ETTP via the storm water discharge system. No reference standards were exceeded at outfalls monitored in CY 2020. Table 3.5 contains the total calculated discharge of radionuclides from storm water outfalls in CY 2020. Overall, 2020 saw a decrease in the discharge of radionuclides relative to the discharges of 2019.

Table 3.5. Radionuclides released to off-site waters from the East Tennnessee Technology Park storm water system in 2020

Isotope	^{234}U	^{235}U	^{238}U	^{99}Tc
Activity level (Ci)	0.018	0.0017	0.014	0.064

3.6.2.2. Storm Water Monitoring Associated with D&D Activities

Stormwater monitoring is performed before, during, and after demolition to evaluate the effectiveness of remedial actions. Storm water samples are collected prior to the initiation of D&D activities in order to determine baseline conditions. Storm water samples are also collected at potentially affected outfalls and storm water catch basins after remedial activities have been undertaken and after they have been completed to help gauge the potential effectiveness of the remediation.

3.6.2.3. Technetium-99 Monitoring of Storm Water Associated with D&D Activities

Outfall 190 is sampled quarterly for ^{99}Tc. During sampling conducted in CY 2020, ^{99}Tc was not detected in samples collected at Outfall 190. 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 storm water Outfall 190.

Outfall 490 drains the area that was once occupied by the ^{99}Tc operations area in the K-25 Building. Consequently, ^{99}Tc samples are collected in conjunction with routine storm water runoff samples collected at Outfall 490. Results from this monitoring effort in 2020 showed that ^{99}Tc concentrations in discharges from Outfall 490 were approximately 0.3% of the Derived Concentration Standards Sum of Fractions values.

The maximum ^{99}Tc measurement at K-1700 during the last decade, obtained in February 2014, was 258 pCi/L, which is well below the ^{99}Tc derived concentration standard value of 44,000 pCi/L and the drinking water maximum contaminant level (MCL) of 900 pCi/L. The cumulative radionuclide (^{99}Tc and uranium isotopes) measurements at the Mitchell Branch exit weir K-1700 location are calculated to be in the range of 1%-2% of the Derived Concentration Standards Sum of Fractions values.

3.6.2.4. D&D of the K-1203 Sewage Treatment Plant

Post-demolition sampling was undertaken in January and February 2020 at Outfall 05A-2.

Water samples were collected from behind the gravel berm that is located in front of the Outfall 05A-2 piping system inlet. Analytical results that exceeded reference standards are shown in Table 3.6.

Table 3.6. Analytical results exceeding reference standards from the Outfall 05A-2 sampling effort, February 6, 2020

Reference standards[a]	Copper 9 µg/L (CCC)	Lead 2.5 µg/L (CCC)
Outfall 05A-2 behind berm - unfiltered	12.4	11.7
Outfall 05A-2 behind berm - filtered	11.3	10.9

[a] *Reference standards sources are defined as follows:*
CCCTDEC Rule 0400-40-03-.03(3)(g), Criterion Continuous Concentration
REC OOTDEC Rule 0400-40-03-.03(4)(j), Organisms Only Criteria

Routine quarterly SWPPP samples were collected at Outfall 05A-2 on March 3, 2020, May 19, 2020, August 13, 2020, and October 29, 2020. The March 3, 2020, sample was collected using an automatic sampler. This may have led to elevated copper, mercury, and lead results in the sample due to sediments being suctioned up by the sampler. The May 19, August 13, and October 29, 2020 samples were collected by manual grab. Analytical results exceeding reference standards are shown in Table 3.7. Based on the results from these SWPP Program samples, previous guidance concerning collection of samples at Outfall 05A-2 was revised. It was determined that all future samples from this location be collected by the grab sampling technique if possible to avoid any sediment being included in the sample. In addition, collection of filtered samples may be performed to further reduce the effect of sediment on analytical results.

Table 3.7. Analytical results exceeding reference standards from quarterly SWPPP monitoring at Outfall 05A-2, March 3, 2020, May 19, 2020, August 13, 2020, and October 29, 2020

Location	Date Sampled	Copper	Lead	Mercury
		Reference standard 9 µg/L (CCC) 13 µg/L (CMC)	Reference standard 2.5 µg/L (CCC)	Reference standard 51 ng/L (REC OO) 51 ng/L (REC WO)
Outfall 05A-2	3/3/20	20.5	18.7	54
Outfall 05A-2	5/19/20	---	4.7	---
Outfall 05A-2	8/13/20	9.2	7.28	---
Outfall 05A-2	10/29/20	14.4	11.8	---

Reference standards sources are defined as follows:
CCC TDEC Rule 0400-40-03-.03(3)(g), Criterion Continuous Concentration
CMC TDEC Rule 0400-40-03-.03(3)(g), Criterion Maximum Concentration
REC OO TDEC Rule 0400-40-03-.03(4)(j), Organisms Only Criteria
REC WO TDEC Rule 0400-40-03-.03(4)(j), Water & Organisms Criteria

3.6.2.5. D&D of Buildings K-131/K-631

A small amount of flow still discharges from Outfall 382 on occasion despite the upper portion of the outfall's piping system having been plugged. The source of the flow is believed to be groundwater that infiltrates the piping system below the final plugged area of the Outfall 382 piping system. Samples of the discharge from Outfall 382 were collected on February 10, 2020 to determine if the outfall continued to discharge contaminants at levels above reference standards despite the drainage system being plugged. Analytical data from this sampling event are shown in Table 3.8.

Additional investigation into potential sources of lead, copper, and thallium in the ongoing discharge from Outfall 382 may be conducted as part of future ETTP SWPP Program sampling activities.

Table 3.8. Analytical results exceeding reference standards from Outfall 382 monitoring, February 10, 2020

Reference standards[a]	Copper	Lead	Thallium
	Reference standard 9 µg/L (CCC) 13 µg/L (CMC)	Reference standard 2.5 µg/L (CCC)	Reference standard 0.47 µg/L (REC OO) 0.24 µg/L (REC WO)
Outfall 382	24.1	37.1	0.586

[a] *Reference standards sources are defined as follows:*
CCC TDEC Rule 0400-40-03-.03(3)(g), Criterion Continuous Concentration
CMC TDEC Rule 0400-40-03-.03(3)(g), Criterion Maximum Concentration
REC OO TDEC Rule 0400-40-03-.03(4)(j), Organisms Only Criteria
REC WO TDEC Rule 0400-40-03-.03(4)(j), Water & Organisms Criteria

3.6.2.6. Monitoring Conducted in the Exposure Unit 19 Area

Storm Water Outfall 362 receives storm water runoff from the EU-19 area. Remedial actions for the EU-19 area began in summer of CY 2019. Samples collected from Outfall 362 on July 17, 2019, indicated the presence of metals, mercury, and PCBs at levels exceeding reference standards, as well as elevated levels of several radiological contaminants.

On February 11, 2020, a follow-up sample of the total flow at Outfall 362 was collected. Table 3.9 shows the parameters in this sample that exceeded reference standards.

Table 3.9. Analytical results exceeding reference standards from samples collected at Outfall 362, February 11, 2020

Location	Gross alpha Reference standard[a] 15 pCi/L (DWS)	Gross beta Reference standard[a] 50 pCi/L (DWS)	PCB-1254 Reference standard[a] 0.00064 µg/L (REC OO and REC WO)
Outfall 362	349	75.6	0.0811 J

[a] Reference standards for radionuclides equal Derived Concentration Standard (DCS) for ingested water (DOE-STD-1196-2011, Derived Concentration Technical Standard). Derived Concentration Guide (DCG) values for ingested water (DOE Order 5400.5 Chg. 2, Radiation Protection of the Public and the Environment, Chap. III) are also listed because they remain in effect for certain CERCLA activities. Reference standards for gross alpha and gross beta measurements correspond to national primary drinking water standards (40 CFR Part 141, National Primary Drinking Water Regulations, Subparts B and G).

Reference standards sources are defined as follows:

REC OO TDEC Rule 0400-40-03-.03(4)(j), Organisms Only Criteria

REC WO TDEC Rule 0400-40-03-.03(4)(j), Water & Organisms Criteria

Each of the analytical results from samples collected at Outfall 362 that exceeded reference standards is believed to have been a result of legacy operations conducted at K-1410 and associated facilities. The remedial actions will eliminate the sources discharging through Outfall 362 and then remove the outfall piping itself, after which the outfall will be removed from the ETTP NPDES permit.

Soil removal activities in the Outfall 350 drainage network were ongoing during the fourth quarter of CY 2020. Samples were collected on October 29, 2020, and on November 12, 2020, as part of these removal actions. None of the analytical results for any of the radiological samples collected on these occasions exceeded reference standards. It is believed that any radiologically contaminated soil was removed as part of the remedial actions conducted in the Outfall 350 drainage network.

3.6.2.7. D&D of the J-Labs Complex and Building K-1023

Monitoring was performed during the demolition of the J-Labs Complex and Building K-1023. None of the analytical results from sampling events conducted during D&D activities exceeded reference standards. Sampling was also performed on February 6, 2020, after D&D activities had been completed. None of the analytical results from this sampling event exceeded reference standards.

3.6.2.8. D&D of the K-1210/K-1220 Complex

Demolition activities began at the K-1210/K-1220 Complex (Figure 3.14) in March 2020. A pre-demolition sample was collected at Outfall 100 on February 6, 2020, to establish baseline conditions. None of the analytical results from this sampling event exceeded reference standards. Samples were also collected on May 28, 2020, during demolition activities. None of the analytical results from this sampling event exceeded reference standards. A final monitoring event was conducted on September 14, 2020, at the conclusion of the demolition, when waste handling and any potential post-demolition mitigation actions were assessed (Figure 3.15). The analytical result for PCB-1248 (0.0497 µg/L) exceeded the reference standard for PCBs. However, it is not believed that the D&D activities performed at the K-1210/K-1220 Complex were responsible for this result, since Outfall 100 has had elevated levels of PCBs as part of past monitoring efforts, and no PCBs had been detected during other sampling activities conducted in association with the K-1210/K-1220 Complex.

Figure 3.14. K-1200 Complex before decontamination and demolition

Figure 3.15. K-1200 Complex after decontamination and demolition

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

Samples were collected from storm water outfalls that are required to be monitored as part of the Phased Construction Completion Reports (PCCRs). The outfalls that were selected to be sampled included those specified in the PCCRs that are not NPDES permit representative outfalls as well as NPDES permit representative outfalls where the last available analytical data was collected at least three years prior. Analytical results for the indicated parameters are shown in Table 3.10.

Table 3.10. Analytical results for monitoring of storm water runoff from building slabs

Parameter	Reference standard[a]	Outfall 170	Outfall 294	Outfall 362	Outfall 490
Alpha activity (pCi/L)[a]	15 (DWS)	11.2	6.06	**190**	Not sampled
Beta activity (pCi/L)[a]	50 (DWS)	14.5	6.74	**51.9**	Not sampled
^{99}Tc (pCi/L)	44,000 (DCS) 100,000 (DCG)	2.23 U	0.914 U	Not sampled	115
$^{233/234}$U (pCi/L)	680 (DCS) 500 (DCG)	2.2	2.9	71.5	1.06
$^{235/236}$U (pCi/L)	720 (DCS) 600 (DCG)	0.178 U	0.19 U	6.29	0.104 U
^{238}U (pCi/L)	750 DCS 600 (DCG)	0.807	2.324	72.6	0.374

***Note: Bold** indicates reference standard exceeded.*

[a] *Reference standards for radionuclides equal Derived Concentration Standard (DCS) for ingested water (DOE-STD-1196-2011, Derived Concentration Technical Standard). Derived Concentration Guide (DCG) values for ingested water (DOE Order 5400.5 Chg. 2, Radiation Protection of the Public and the Environment, Chap. III) are also listed because they remain in effect for certain CERCLA activities. Reference standards for gross alpha and gross beta measurements correspond to national primary drinking water standards (40 CFR Part 141, National Primary Drinking Water Regulations, Subparts B and G).*

3.6.2.10. Legacy Mercury Investigation Monitoring

Mercury levels that exceed the AWQC of 51 nanograms per liter (ng/L) have been identified in the Mitchell Branch watershed, as well as in a number of storm water outfalls, surface water locations, and groundwater monitoring wells at ETTP. In addition, knowledge of known historical mercury processes at the facility has increased substantially. These factors have led to an ongoing facility investigation to more precisely detect and quantify the extent of any mercury contamination that may exist. Table 3.11 contains analytical data from mercury sampling performed at Outfalls 180, 190, and 05A during 2020.

Figures 3.16 and 3.17 indicate results from the quarterly monitoring performed at Outfalls 180 and 190, respectively, as well as other SWPP Program sampling that was conducted at the outfall during the period covered by these graphs. Because the discharges from Outfalls 180 and 190 occasionally contain mercury at levels above the reference standard, these outfalls are thought to be the major contributors of mercury to Mitchell Branch as well. Mitchell Branch mercury levels are monitored routinely at the K-1700 Weir as part of the ETTP Environmental Monitoring Program. Figure 3.18 shows mercury levels at the K-1700 Weir from CY 2010 through CY 2020 were well below the reference standards for the past three years. For additional information on monitoring along Mitchell Branch, see Section 3.6.4.

Storm water Outfall 05A once drained portions of the former K-1203 Sewage Treatment Plant that discharged into the K-1203-10 sump. The D&D of the K-1203 Sewage Treatment Plant was completed in 2019. Figure 3.19 shows mercury concentrations at storm water Outfall 05A-2 since the remediation was completed.

Table 3.11. Quarterly NPDES/SWPP Program mercury monitoring results, calendar year 2020

Sampling location	1st Quarter CY 2020 (ng/L)	2nd Quarter CY 2020 (ng/L)	3rd Quarter CY 2020 (ng/L)	4th Quarter CY 2020 (ng/L)
Outfall 180	38.5	**382**	**96.7**	27.4
Outfall 190	15.7	17.2	11.4	12.8
Outfall 05A-2	**54**	28.8	17.4	39.1

Notes:

1. *Results in **bold** exceed the reference standard for mercury (51 ng/L REC OO and REC WO).*
   REC OOTDEC Rule 0400-40-03-.03(4)(j), Organisms Only Criteria
   REC WOTDEC Rule 0400-40-03-.03(4)(j), Water & Organisms Criteria
2. *No mercury sample was collected at Outfall 05A-2 due to remedial activities being conducted in the outfall watershed.*

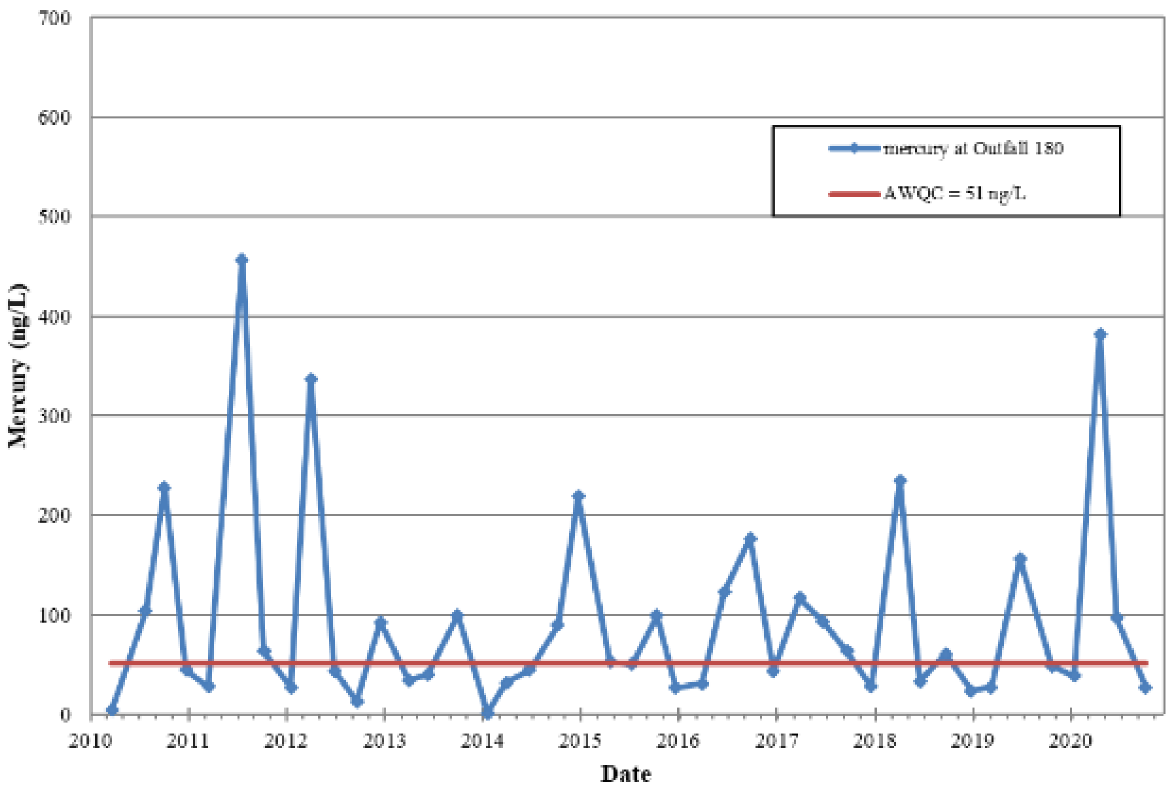


Figure 3.16. Mercury concentrations at Outfall 180

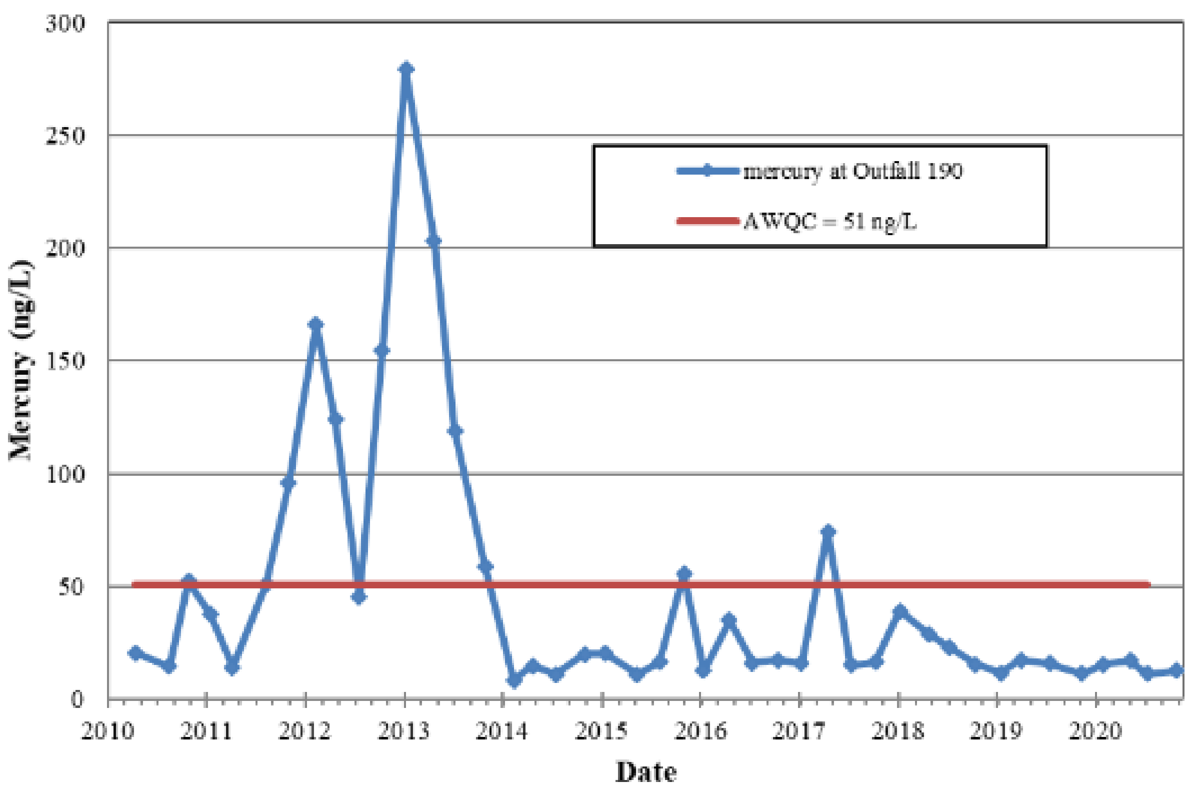


Figure 3.17. Mercury concentrations at Outfall 190

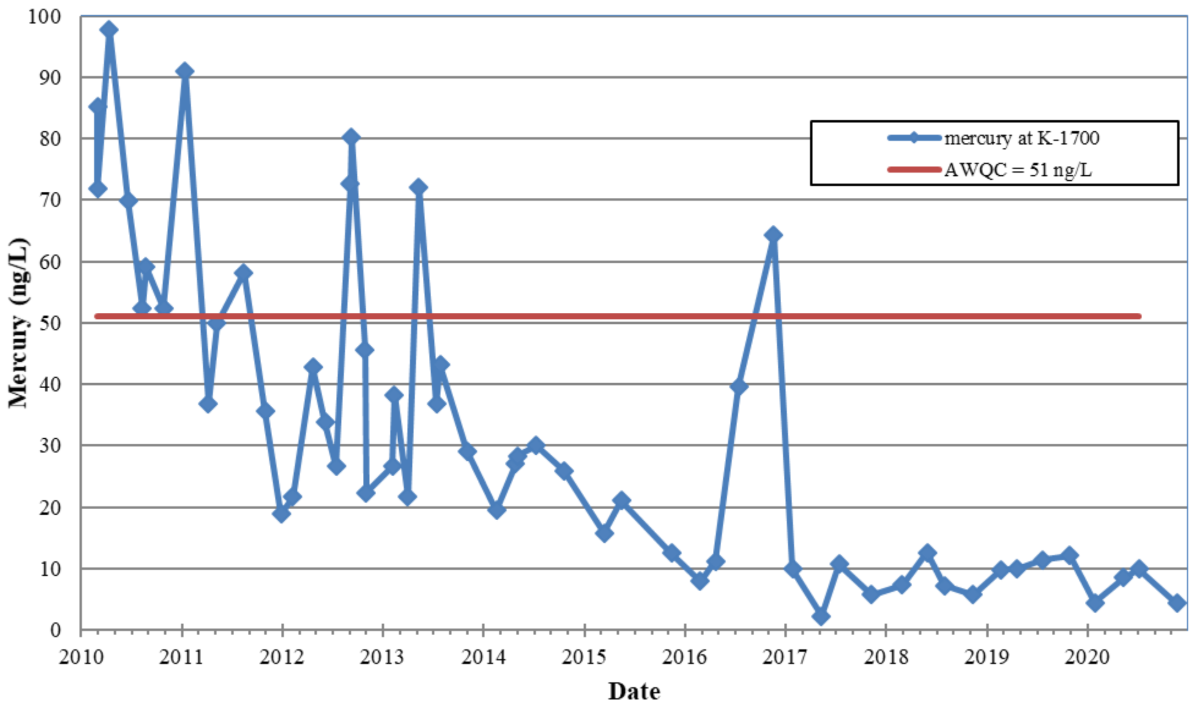


Figure 3.18. Mercury concentrations at the K-1700 Weir

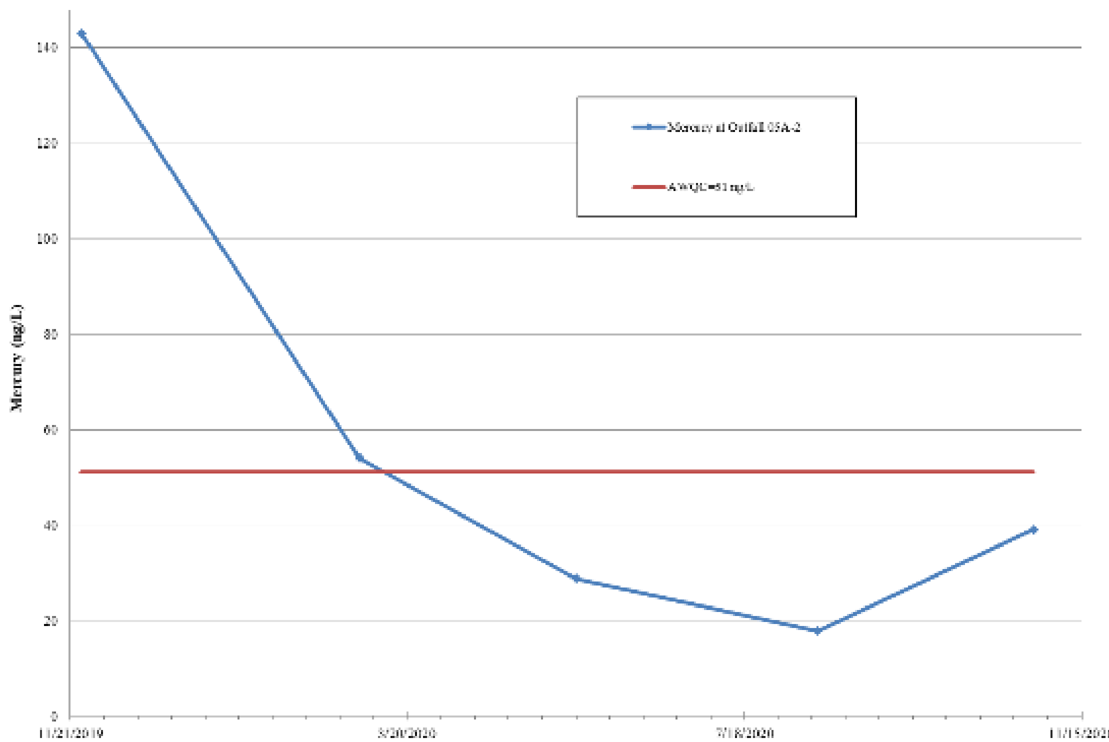


Figure 3.19. Mercury concentrations at Outfall 05A-2

Non-representative outfalls that were grouped with the representative outfalls where mercury has been identified and have not been sampled in several years were selected to be sampled as part of the 2020 SWPP Program. Analytical results from this sampling effort are shown in Table 3.12, with results in bold indicating exceedance of the reference standard.

Table 3.12. Analytical results from mercury sampling at selected storm water outfalls

Location	Mercury Reference standard 51 ng/L (REC OO) 50 ng/L (REC WO)
Outfall 195	7.63
Outfall 200	9.62
Outfall 240	22.2
Outfall 382	**68.4**
Outfall 850	21.9

REC OO TDEC Rule 0400-40-03-.03(4)(j), Organisms Only Criteria
REC WO TDEC Rule 0400-40-03-.03(4)(j), Water & Organisms Criteria

3.6.2.11. Investigation of Powerhouse Area Outfalls

Additional monitoring of selected Powerhouse outfalls was performed as part of the FY 2020 SWPP Program sampling and analysis plan. Analytical results that exceeded reference standards for this sampling effort are shown in Table 3.13.

Monitoring of mercury performed in CY 2020 confirmed that mercury is present in several locations in the Outfall 780 drainage network at levels exceeding reference standards.

Parameters that exceeded reference standard levels from follow-up sampling efforts at Outfall 780 are indicated in Table 3.14. Historic results are also included for purposes of comparison.

The mercury, PCBs, and radiological analytes are likely to be legacy contaminants that remain from past Powerhouse operations that were conducted in the drainage area of Outfall 780.

Table 3.13. Analytical results exceeding reference standards from samples collected at Powerhouse storm water outfalls

Reference Standards[a]	Gross alpha	Thallium	Mercury	PCB-1248	PCB-1254	PCB-1260	Lead
	15 pCi/L (DWS)	0.24 µg/L (REC WO)	0.51 ng/L (REC WO)	0.00064 µg/L (REC OO)	0.00064 µg/L (REC OO)	0.00064 µg/L (REC OO)	2.5 µg/L (CCC)
Outfall 830	15.4	0.273	72.8		0.0844 J	0.137	
Outfall 870							17
Outfall 890			123	0.0664	0.0632		

Reference standards sources are defined as follows:
CCC TDEC Rule 0400-40-03-.03(3)(g), Criterion Continuous Concentration
REC OO TDEC Rule 0400-40-03-.03(4)(j), Organisms Only Criteria
REC WO TDEC Rule 0400-40-03-.03(4)(j), Water & Organisms Criteria
Reference standards for radionuclides equal Derived Concentration Standard (DCS) for ingested water (DOE-STD-1196-2011, Derived Concentration Technical Standard). Derived Concentration Guide (DCG) values for ingested water (DOE Order 5400.5 Chg. 2, Radiation Protection of the Public and the Environment, Chap. III) are also listed because they remain in effect for certain CERCLA activities. 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).

Table 3.14. Results exceeding reference standards for the Outfall 780 monitoring effort

Sampling location	Mercury (ng/L)	PCB-1254 (µg/L)	PCB-1260 (µg/L)
Reference Standards	51.0	0.00064	0.00064
Outfall 780 (March 2018 results)	691.0	below detection	0.626
Outfall 780 (March 2019 results)	no discharge	no discharge	no discharge
Outfall 780 (October 2020 results)	no discharge	no discharge	no discharge
Outfall 780 D2 (March 2019 results)	66.7	0.0452	0.041
Outfall 780 D2 (October 2020 results)	Within standard	0.0871	0.21
Outfall 780 D3 (March 2019 results)	102.0	0.0408	0.0342
Outfall 780 D3 (October 2020 results)	105.0	below detection	below detection

3.6.2.12. PCB Monitoring at ETTP Storm Water Outfalls

Outfalls where PCBs have been identified and have not been sampled in several years were selected to be sampled as part of the FY 2020 SWPP Program sampling program. Analytical results from samples collected as part of this sampling effort are shown in Table 3.15. The presence of PCB-1260 in the storm water runoff from Outfall 292 may be related to legacy operations conducted in portions of the K-1064 peninsula area.

Table 3.15. Analytical results from fiscal year 2020 SWPP Program PCB sampling

Location	Parameter[a]	Reference Standard[b] 0.00064 µg/L (REC OO)
Outfall 148	Individual PCBs	No detectable PCBs
Outfall 156	Individual PCBs	No detectable PCBs
Outfall 240	Individual PCBs	No detectable PCBs
Outfall 250	Individual PCBs	No detectable PCBs
Outfall 292	Individual PCBs	PCB-1260 – 0.188 µg/L
Outfall 340	Individual PCBs	Outfall plugged
Outfall 360	Individual PCBs	No detectable PCBs
Outfall 390	Individual PCBs	No detectable PCBs
Outfall 410	Individual PCBs	No detectable PCBs
Outfall 420	Individual PCBs	No detectable PCBs
Outfall 570	Individual PCBs	No detectable PCBs
Outfall 610	Individual PCBs	No detectable PCBs
Outfall 760	Individual PCBs	No detectable PCBs
Outfall 810	Individual PCBs	No detectable PCBs
Outfall 900	Individual PCBs	No detectable PCBs

[a] *PCB analysis includes PCB-1016, -1221, -1232, -1242, -1248, -1254, -1260, -1262, and -1268.*

[b] *Reference standards sources are defined as follows:*

REC OOTDEC Rule 0400-40-03-.03(4)(j), Organisms Only Criteria

3.6.2.13. Storm Water Monitoring in the Outfall 690 Drainage Network

PCBs have been identified at Outfall 690 as part of previous sampling efforts. It was speculated that the source of the PCBs at Outfall 690 was likely the K-897-A oil/water separator. In order to better identify potential sources of PCBs in the Outfall 690 drainage network additional PCB samples were collected on December 14, 2020. Analytical results from this sampling effort are shown in Table 3.16 that show PCBs were detected in the storm drain network upstream from, and below stream of, the oil/waterseparator.

Table 3.16. Analytical results from Outfall 690 network sampling, December 14, 2020

Location	Parameter[a]	Reference Standard – 0.00064 ug/L (REC OO)[b]
Catch Basin 1027	Individual PCBs	PCB-1254 – 0.0512 ug/L
Catch Basin 1028	Individual PCBs	No detectable PCBs
Catch Basin 1032	Individual PCBs	No detectable PCBs
Catch Basin 1B020	Individual PCBs	PCB-1254 – 0.0346 ug/L
Catch Basin 1B024	Individual PCBs	No detectable PCBs
Catch Basin 1B025	Individual PCBs	PCB-1254 – 0.142 ug/L PCB-1260 – 0.0806 ug/L PCB-1268 – 0.0369 ug/L
Outfall 690 Headwall	Individual PCBs	PCB-1254 – 0.0365 ug/L
Outfall 690	Individual PCBs	No detectable PCBs

[a] *PCB analysis includes PCB-1016, -1221, -1232, -1242, -1248, -1254, -1260, -1262, and -1268.*
[b]*Reference standards sources are defined as follows: REC OO: TDEC Rule 0400-40-03-.03(4)(j), Organisms Only Criteria*
***Acronym:** PCB = polychlorinated biphenyl*

3.6.2.14. Chromium Water Treatment System and Plume Monitoring

The Chromium Water Treatment System (CWTS) (Figure 3.20) 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 2020, monitoring was conducted at monitoring well 289 (TP-289), the chromium collection system wells, Outfall 170, and Mitchell Branch kilometer (MIK) 0.79. Figures 3.21 and 3.22 show the results for the analyses for total chromium and hexavalent chromium, respectively.

The analytical data indicate that both total and hexavalent chromium levels may fluctuate slightly at TP-289 and the collection wells but are relatively consistent but slow decline over the long term. Figures 3.21 and 3.22 also show the continuing low level results over a long period for total chromium and hexavalent chromium at Outfall 170 and MIK 0.79. These results demonstrate the continuing positive impact of the collection well system to minimize the release of chromium into Mitchell Branch.

Figure 3.20. The Chromium Water Treatment System

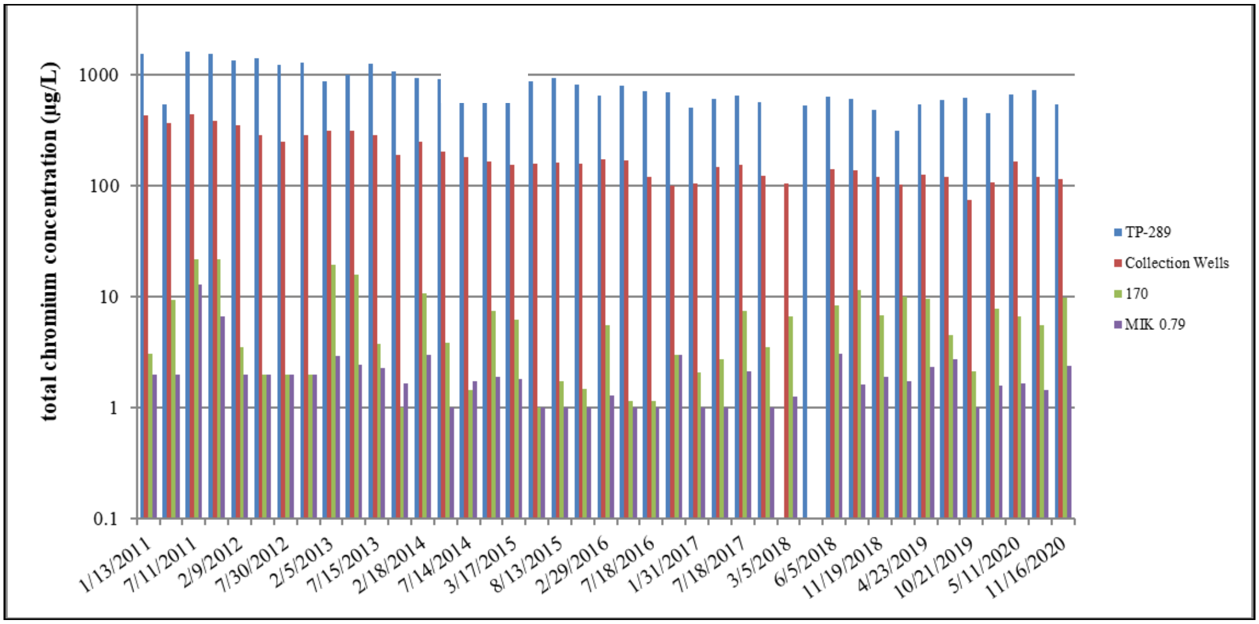


Figure 3.21. Total chromium sample results for the chromium collection system

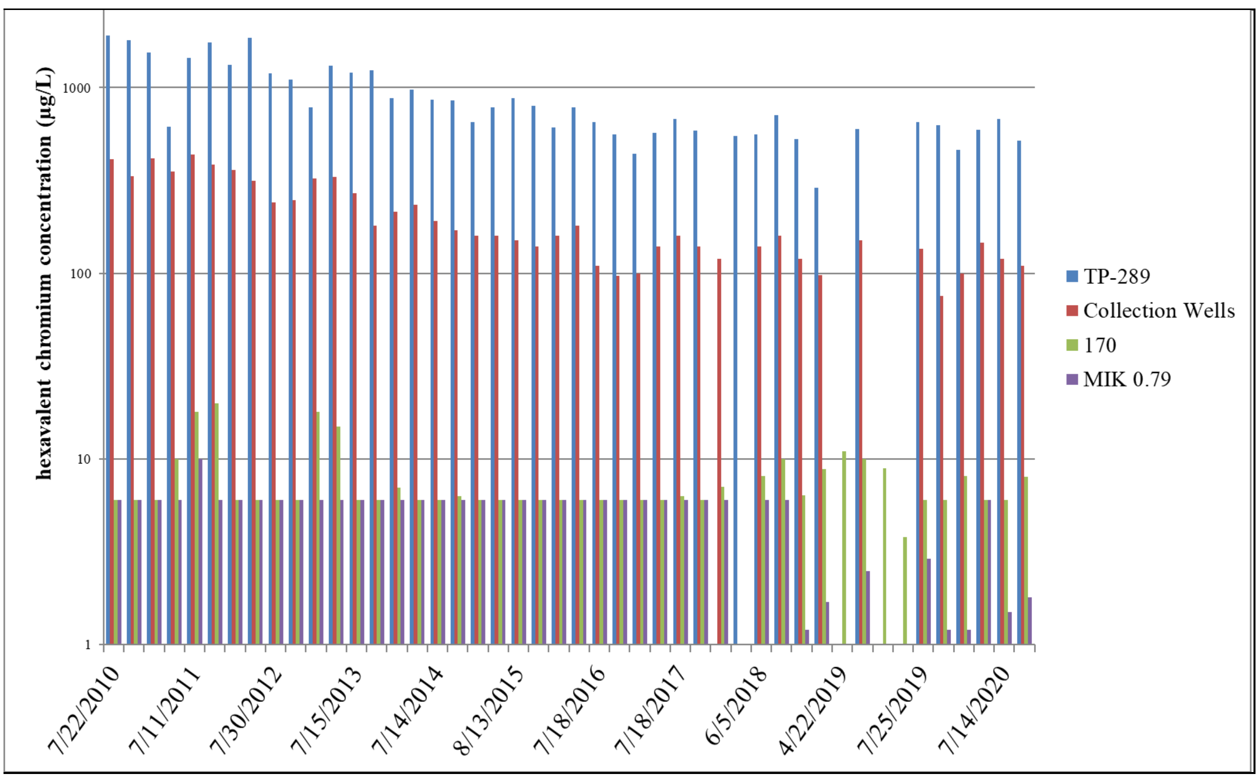
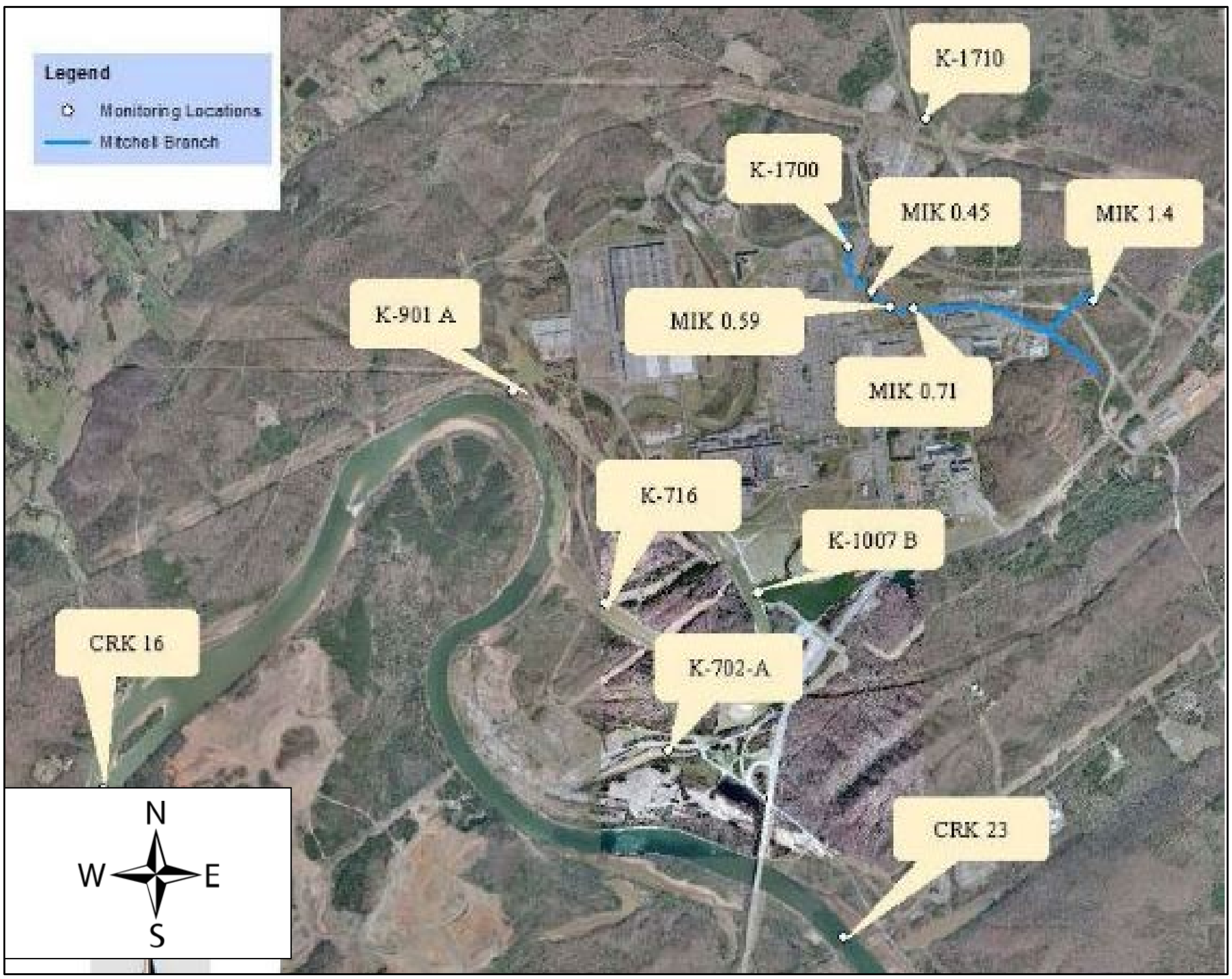


Figure 3.22. Hexavalent chromium sample results for the chromium collection system

3.6.3. Surface Water Monitoring

During 2020, the ETTP EMP personnel conducted environmental surveillance activities at 12 surface water locations (Figures 3.23 and 3.24) 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.

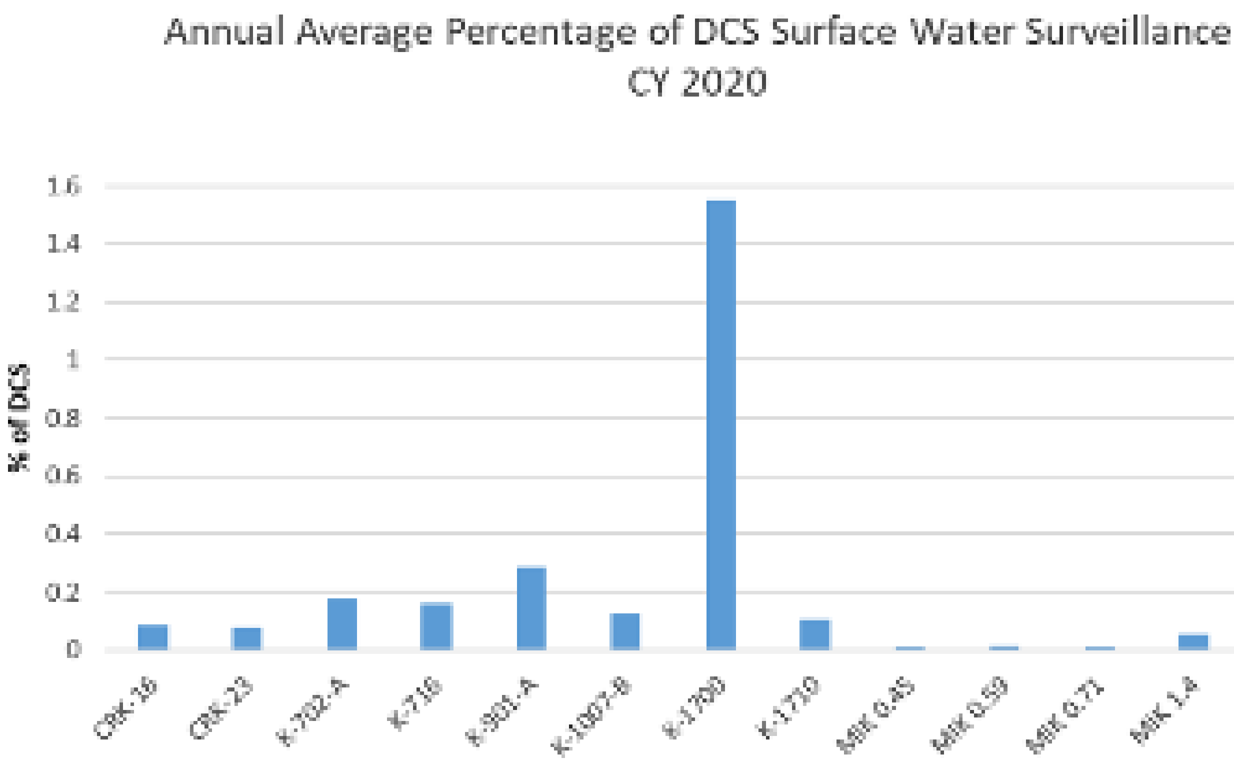
Figure 3.23. Surface water surveillance monitoring



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

Figure 3.24. East Tennessee Technology Park Environmental Monitoring Program surface water monitoring locations

Results of radiological monitoring were compared with the DCS values in DOE Standard 1196 (DOE 2011b). 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 2020, 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, with the exception of monitoring location K-1700 (Figure 3.25). At K-1700, the annual average SOF was 0.0155 (1.55 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 3.25. Annual average percentage of derived concentration standards at surface water monitoring locations, 2020

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).

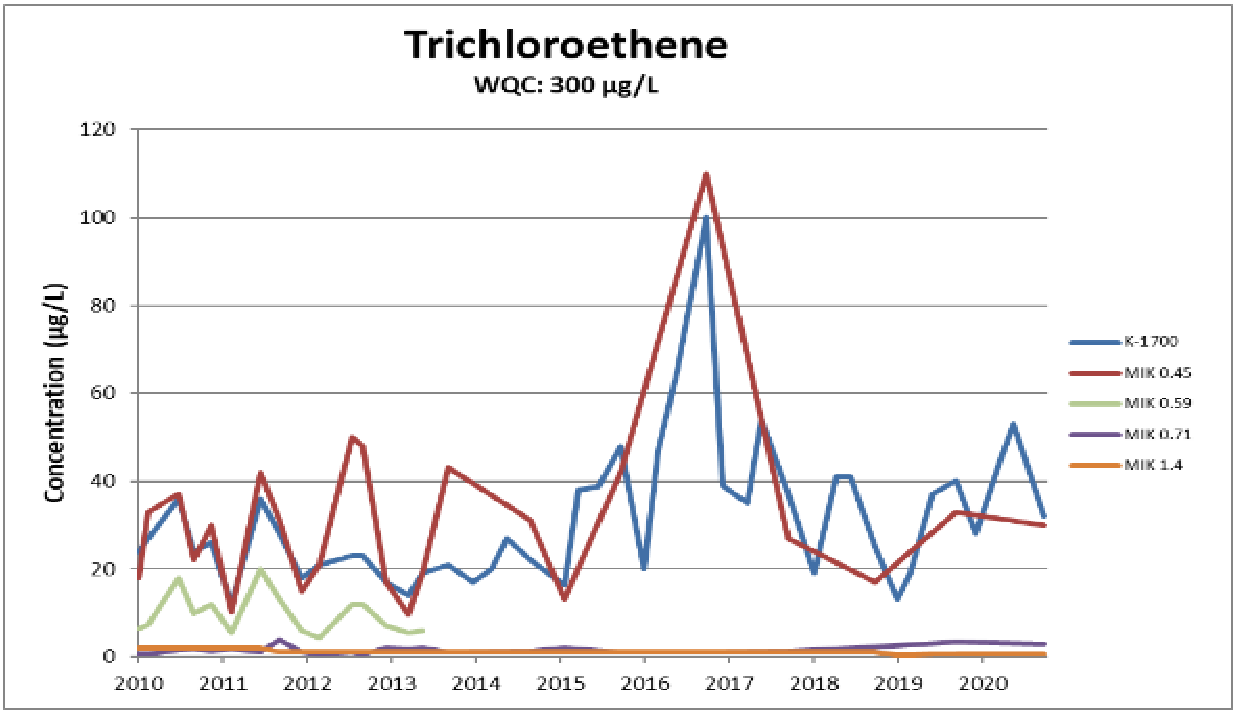
Depending on the monitoring location, water samples may be analyzed for pH, selected metals, and VOCs. In 2020, 1553 analytical results and 156 field readings were collected under the EMP. The vast majority of these results were well within the appropriate AWQC. There were two exceptions in 2020. During 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 3.9 mg/L at K-1007-B, and at 4.7 mg/L at K-1700. 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. In the fourth quarter monitoring, all results met the AWQC.

Figure 3.26 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.

It should be noted that 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.

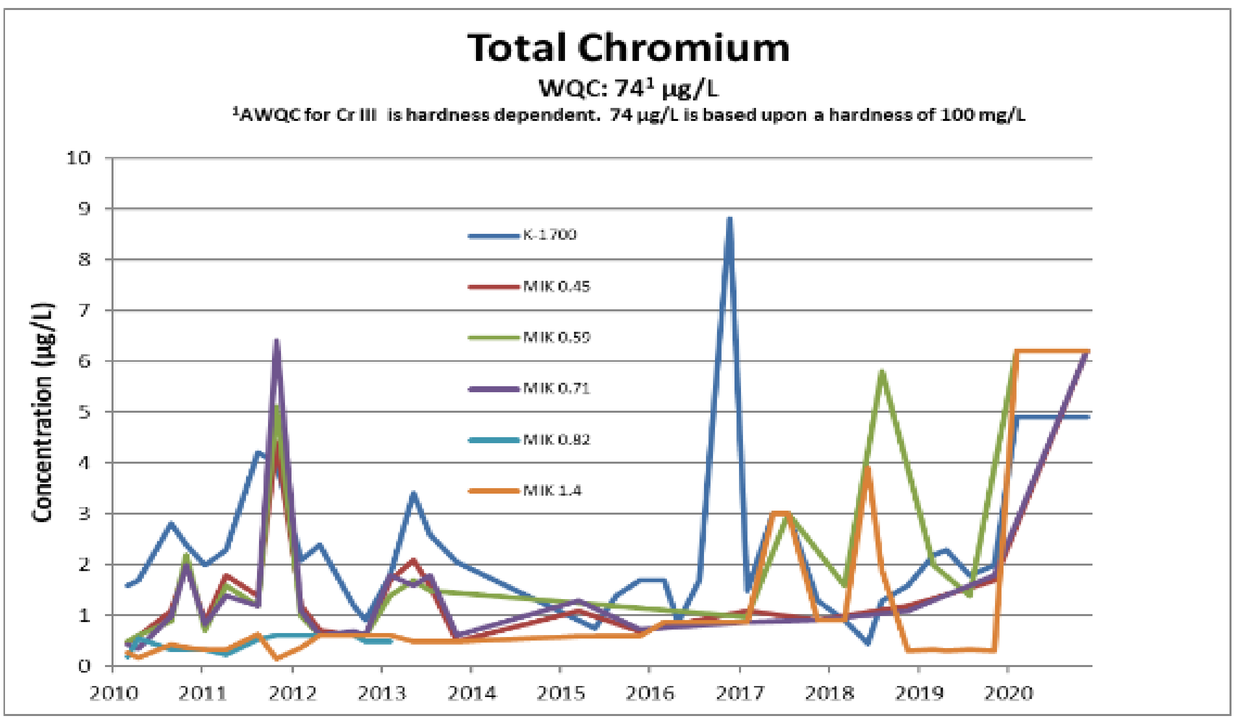
Since CWTS was installed, chromium levels in Mitchell Branch have dropped dramatically, with levels of total chromium being routinely measured at less than 6 μg/L (Figure 3.27). In 2020, hexavalent chromium levels in Mitchell Branch were all below the sample quantitation limit.

The completed Zone 1 actions through FY 2021 do not specify post-RA collection and analysis of environmental monitoring data. However, at the request of EPA, DOE agreed to conduct preliminary surface water screening for the presence of the emerging contaminant per- and polyfluoroalkyl substances (PFAS) compounds at exit pathway points in all ORR watersheds. DOE conducted reconnaissance sampling for PFAS compounds in surface water at four surface water monitoring locations, (K-901-A, K-1007-B, K-1700, and MIK 0.39). Table 3.17 includes results of the reconnaissance sampling and analysis. Individual concentrations at K-1007-P1 weir, K-901A weir, and the K-1700 weir were all less than the 40 ng/L screening level (sl), and the combined concentrations of PFOS+PFOA for these locations were less than the 70 ng/L recommended preliminary remediation goal (PRG). The duplicate sample collected at MIK 0.39 contained PFOS at 40 ng/L (equal to the sl) and PFOA at 30.2 ng/L which yielded a total PFAS concentration of 70.2 ng/L, slightly greater than the recommended PRG (70 ng/L). Historic fire training activities at the former K-1435 building near Mitchell Branch are the presumed source of PFAS detected in Mitchell Branch.



Acronym: *MIK = Mitchell Branch kilometer*

Figure 3.26. 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 3.27. Total chromium concentrations in Mitchell Branch

Table 3.17. East Tennessee Technology Park Site PFAS (PFOA/PFOS) surface water reconnaissance results

Location	Chemical Name	Result (ng/L)[a,b]	Combined PFAS Total (ng/L)[b]
K-1007 P1-Weir, Zone 1	PFOS	10.1	19.6
	PFOA	9.52	
K-901A Weir, Zone 1	PFOS	1.13 J	1.9
	PFOA	0.725 U	
K-1700 Weir, Zone 2	PFOS	29 J	51.1
	PFOA	22.1 J	
MIK 0.39, Zone 2	PFOS	40 J	**70.2**
	PFOA	30.2 J	
	PFOS	37.4	63.7
	PFOA	26.3	

[a] *Individual results were screened against the recommended groundwater SL based on a target Hazard Quotient of 0.1 for PFOA or PFOS individually, which is currently 40 ng/L.*

[b] *Individual and combined results were screened against the PFOA and PFOS Lifetime Drinking Water Health Advisories of 70 ng/L as the recommended PRG for groundwater that is a current or potential source of drinking water.*

Bold *= values that exceed the SL or PRG.*

HQ = Hazard quotient.

PFOA = Perfluorooctanoic acid.

PFOS = Perfluorooctane sulfonate

PRG = Preliminary remediation goal.

SL = Screening level.

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] 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]). 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 remedial actions, demolition of buildings at ETTP has been performed via the *Policy on Decommissioning Department of Energy Facilities Under CERCLA* (EPA and DOE 1995) and DOE's Removal Action authority.

Planning continued in FY 2020 for the ETTP Main Plant Area and K-31/K-33 groundwater RODs. The *K-31/K-33 Area Groundwater Remedial Site Evaluation Report for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2765&D2; RSE) was submitted to EPA and TDEC in May 2019. In June 2020, DOE requested a 253-day extension to address D1 regulatory comments.

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 2020, antimony slightly exceeded the MCL screening concentration (0.006 mg/L) in a filtered sample from well BRW-066). Maximum chromium results in unfiltered and field-filtered samples from BRW-030 were just slightly above the 0.1 mg/L MCL. Nickel is present in groundwater samples from one well (UNW-043) at concentrations greater than the Tennessee MCL of 0.1 mg/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 the northern area chromium continues to exceed the MCL at well UNW-028, TCE continues to exceed the MCL screening level (0.005 mg/L) at wells BRW-041 (increasing trend), UNP-007 (stable trend) and at wells UNW-028 and UNW-29 (no significant trend), and uranium exceeds the MCL screening concentration (0.030 mg/L) in filtered and unfiltered samples form well UNP-007. In the southern area, carbon tetrachloride was equal to the MCL screening concentration (0.005 mg/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 (0.1 mg/L) in unfiltered samples from wells UNW-036 and UNW-087 and in the filtered sample from well UNW-087. Nickel exceeded its MCL screening concentration (0.1 mg/L) in the unfiltered sample from well UNW-036. TCE continues to exceed the MCL screening concentration (0.005 mg/L) in wells BRW-069, UNW-036, UNW-037, UNW-085, UNW-087, and UNW-088. Most of the TCE trends in the K-27/K-29 southern area are no significant trend or decreasing with exception of an increasing trend determination for well UNW-037.
- At PC-0 spring, TCE was detected in samples collected in December 2019 and February 2020, but TCE was not detected in samples collected during March and September 2020. The maximum TCE result from PC-0 spring was 1.7 µg/L in February 2020. No TCE transformation products (1,2-DCE or VC) were detected in PC-0 spring samples during FY 2020. At spring 10-895, TCE was detected in samples collected in all four fiscal quarters of 2020. The maximum measured TCE concentration at spring 10-895 was 3.7 µg/L in May 2020. Cis-1,2-DCE was detected at 0.58 J µg/L in September 2020.
- In the K-770 Area, alpha activity concentrations at UNW-015 decreased to a level 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 wells BRW-084 and UNW-108. TCE was detected in the March 2020 sample from well BRW-084 at 0.002 mg/L, which is slightly less than the 0.005 mg/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 trichloroethene [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 53 wells, two springs, and one surface water location. During FY 2019, the uranium MCL, 30 µg/L, was exceeded in samples from two wells located north of the K-27 Building footprint. One of these uranium MCL exceedances was a result of well BRW-016 having been flooded by water associated with local decontamination and decommissioning activities. The well has subsequently been re-developed to clean up the well casing and remove groundwater within capture zone. The second well (UNP-007) has exhibited uranium MCL exceedances since 2017. During FY 2020, alpha activity and uranium concentrations in these two wells 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 Oak Ridge Reservation. 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 0.011 mg/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 U.S. Environmental Protection Agency's National Primary Drinking Water Regulations MCLs and maximum contaminant level derived concentrations (MCL-DCs) and to determine if statistically significant trends are occurring. Data are compared to MCLs or MCL-DC 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 Area 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 3.28 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 remedial action (RA) program has identified a significant source of TCE beneath the center of the K-25 Building where a soil RA will be required 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). 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 is being 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.

Five 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 2018d, 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 2000's 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% of its MCL within the past decade is alpha activity which has decreased in concentration to levels less than 50% of the MCL or non-detectable levels.

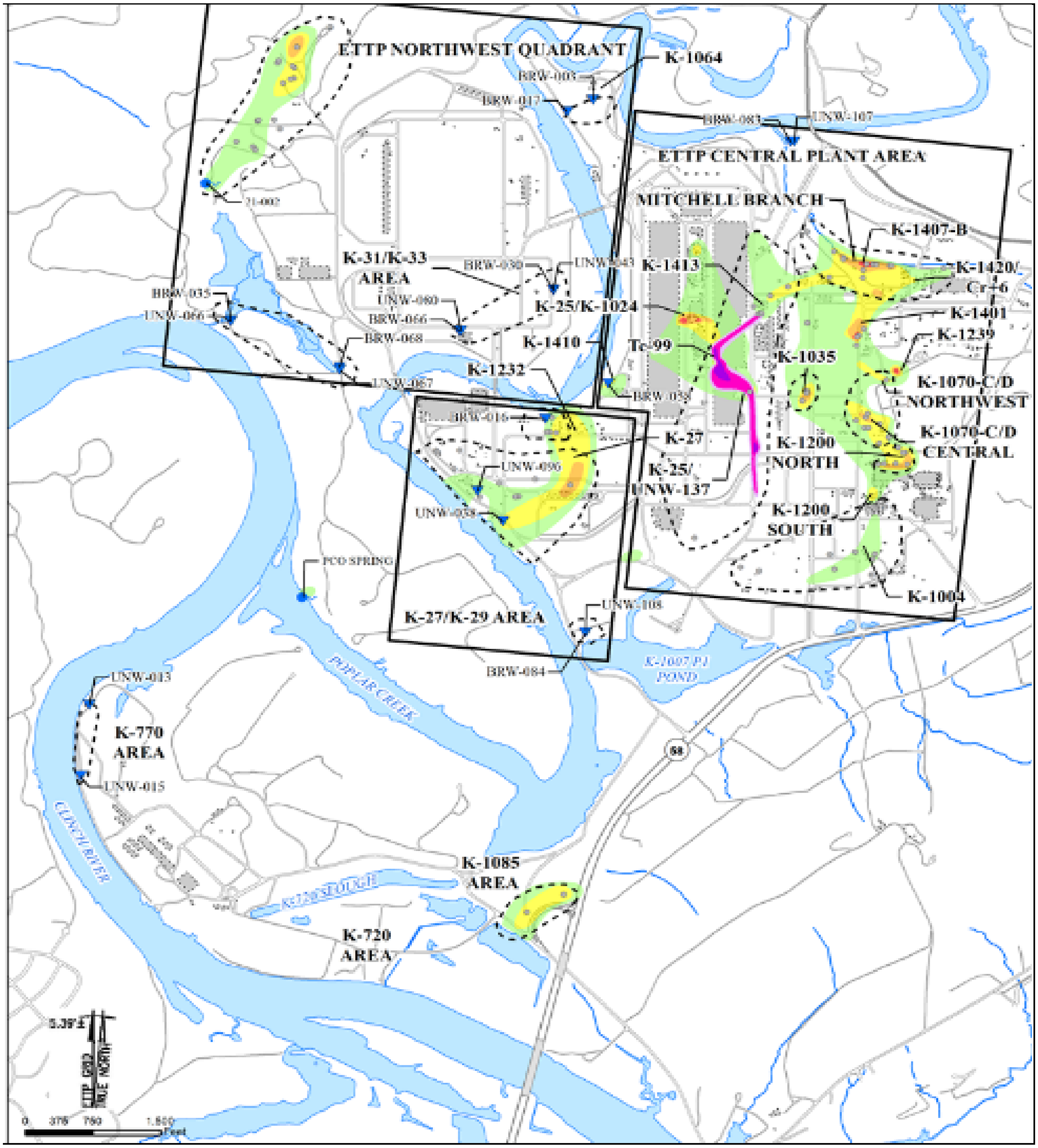


Figure 3.28. East Tennessee Technology Park volatile organic compound and ^{99}Tc plumes

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 a 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 2020 Remediation Effectiveness Report for the U.S. Department of Energy, Oak Ridge Site, Oak Ridge Tennessee (DOE 2020).

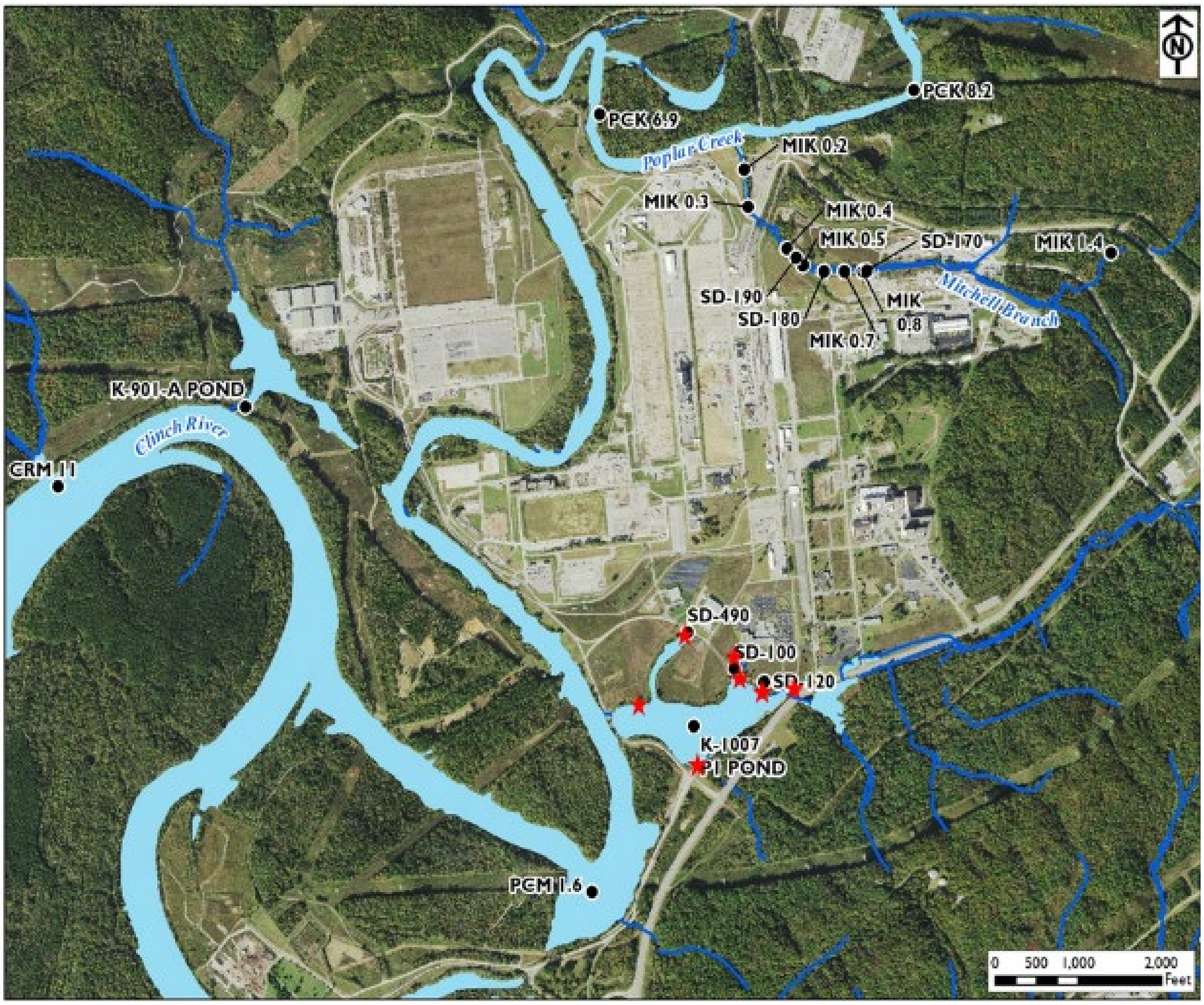
3.7. Biological Monitoring

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 3.29 shows the major water bodies at ETTP and Figure 3.30 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. Recent tabular results were provided in the FY 2020 ETTP BMAP Report.

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.

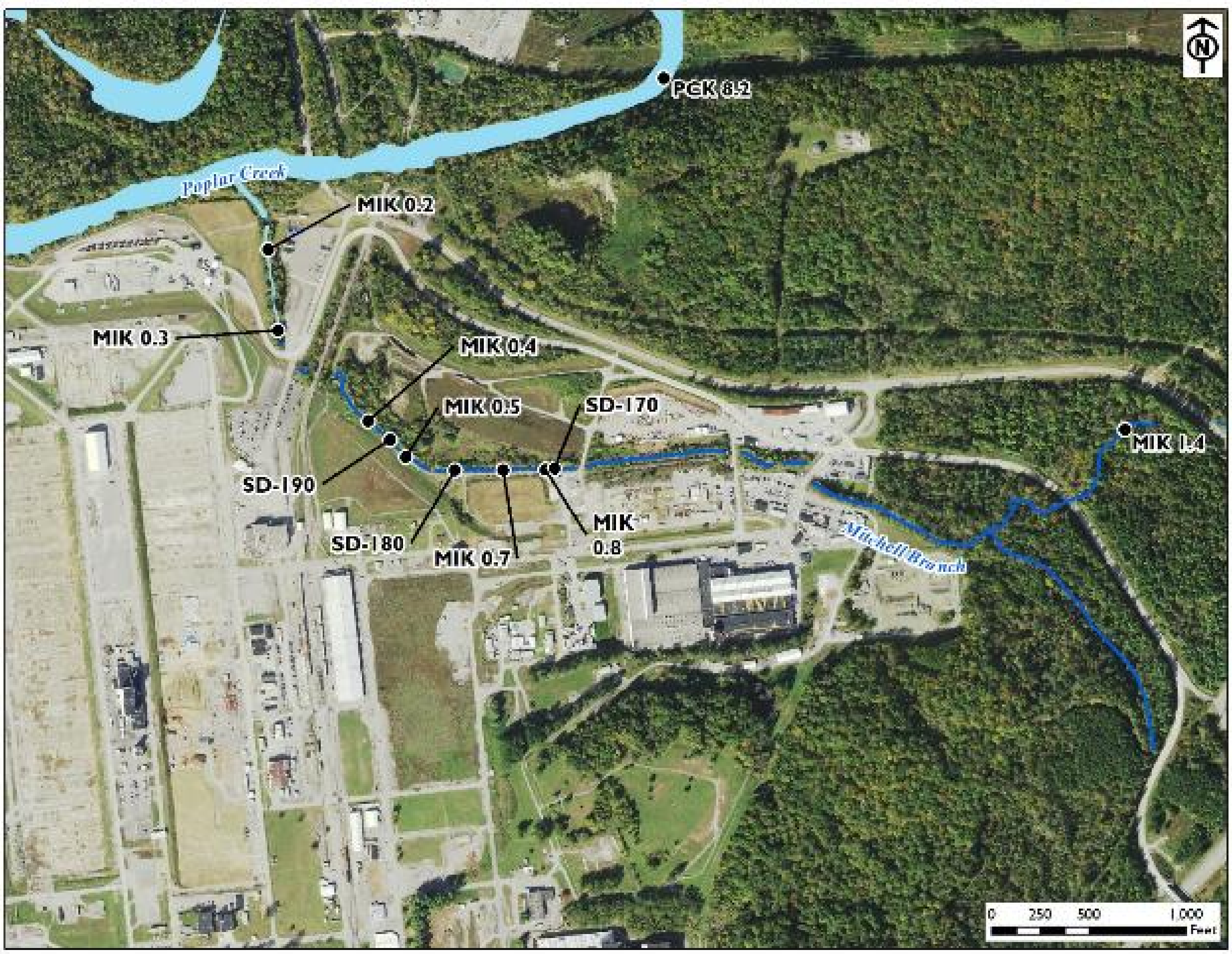


Note:
1. *Red stars indicate clam sampling locations in and around the K-1007-P1 Pond in 2020.*

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

Figure 3.29. Water bodies at the East Tennessee Technology Park

For bioaccumulative contaminants such as Hg and PCBs, US fish bioaccumulation data have become important measures of compliance for both the Clean Water Act 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 (TDEC 2013). 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) (TDEC 2010a, 2010b, 2010c). However, most conventional PCB water analyses have detection limits much higher than the PCB AWQC. 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 (TDEC 2010a, 2010b, 2010c). 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 3.30. 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 2020, 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 4–June 1, 2020). 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 outfall of K-1007-P1 and an uncontaminated reference site (upper First Creek, ORNL). Samples from K-1007-P1 are collected four times each year (March/April, June, July, and August).

3.7.1.1. Mitchell Branch

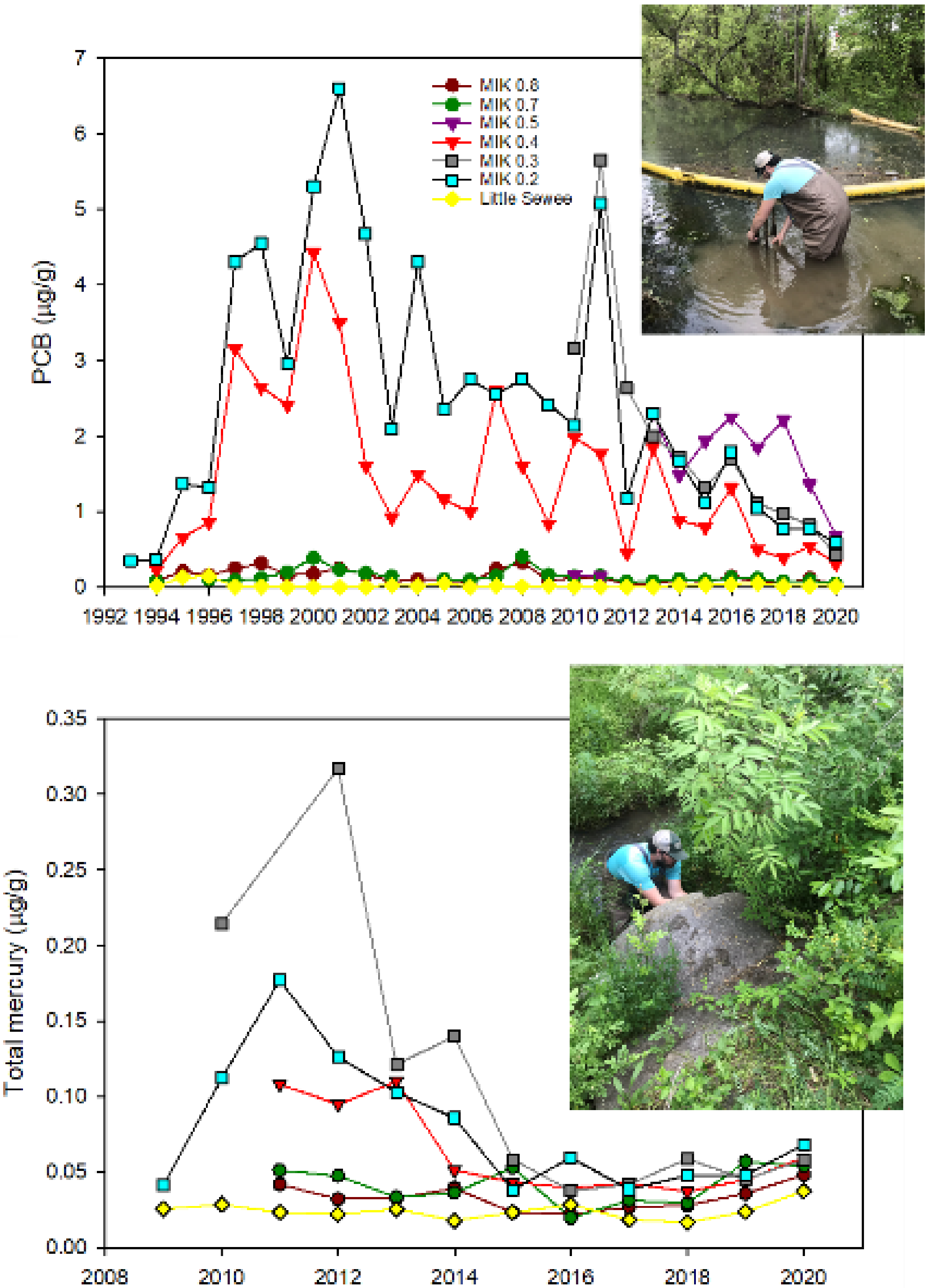
Figure 3.31 shows long-term monitoring results in caged clams deployed at various sites in Mitchell Branch. The lower portion of this stream (MIK 0.5, SD 190, MIK 0.2) has historically been a "hot spot" for both Hg and PCB contamination, and in 2020 PCB concentrations continued to be elevated (~1–2 µg/g) with respect to other Mitchell Branch and reference sites with concentrations remaining comparable to those seen in recent years. 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 µg/g) with respect to the reference site (0.02 µg/g).

Surface water monitoring conducted by various programs (e.g., ETTP Compliance, WRRP) has shown that aqueous Hg concentrations in Mitchell Branch may fluctuate significantly, with concentrations occasionally exceeding the AWQC. This level of variability is typical of stream systems because aqueous Hg concentrations can change with various environmental factors (e.g., flow, suspended solids, etc.) as well as with sample collection methods. Variation in aqueous Hg concentrations is not uncommon and illustrates that aqueous concentrations in a grab sample taken on a certain day reflect a snapshot of the conditions during that sampling period. In addition, the relationship between aqueous Hg concentrations and MeHg concentrations is not a straightforward one, leading to further complexities with respect to Hg bioaccumulation. Although monitoring aqueous concentrations is still indicative of gauging the relative importance of different Hg sources to a given watershed, bioaccumulation data are informative in that they reflect an integrative measure of the bioavailable portion of Hg exposure at a given site. Monitoring eHg concentrations in clams is illustrative in that they highlight the complexity of Hg bioaccumulation—whereas Hg_T concentrations in clams varied greatly between sites, MeHg concentrations in Mitchell Branch were elevated with respect to the reference site but did not vary as much as total Hg between sites or between years.

Mercury concentrations in clams deployed in Mitchell Branch in 2020 were slightly higher than concentrations seen in 2019 (Figure 3.32). In 2020, concentrations throughout Mitchell Branch were only slightly higher than at the reference site, which also experienced a slight increase in Hg concentrations. Within the Mitchell Branch system, the highest Hg concentrations were again seen in clams deployed at SD180 (0.12 μg/g). 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 oil skimmers (K-897-A and K-897-J) 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 3.32). Although MeHg concentrations in clams remained low in 2020, they were either comparable to or slightly higher than concentrations in 2019.

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 2020 (1.49 ± 0.25 μg/g) were higher than those seen in 2019 (0.74 ± 0.08 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 2020, the mean PCB concentration in sunfish fillets collected from MIK 0.2 was above 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 3.33 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 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 0.31 + 0.004 μg/g in 2020.

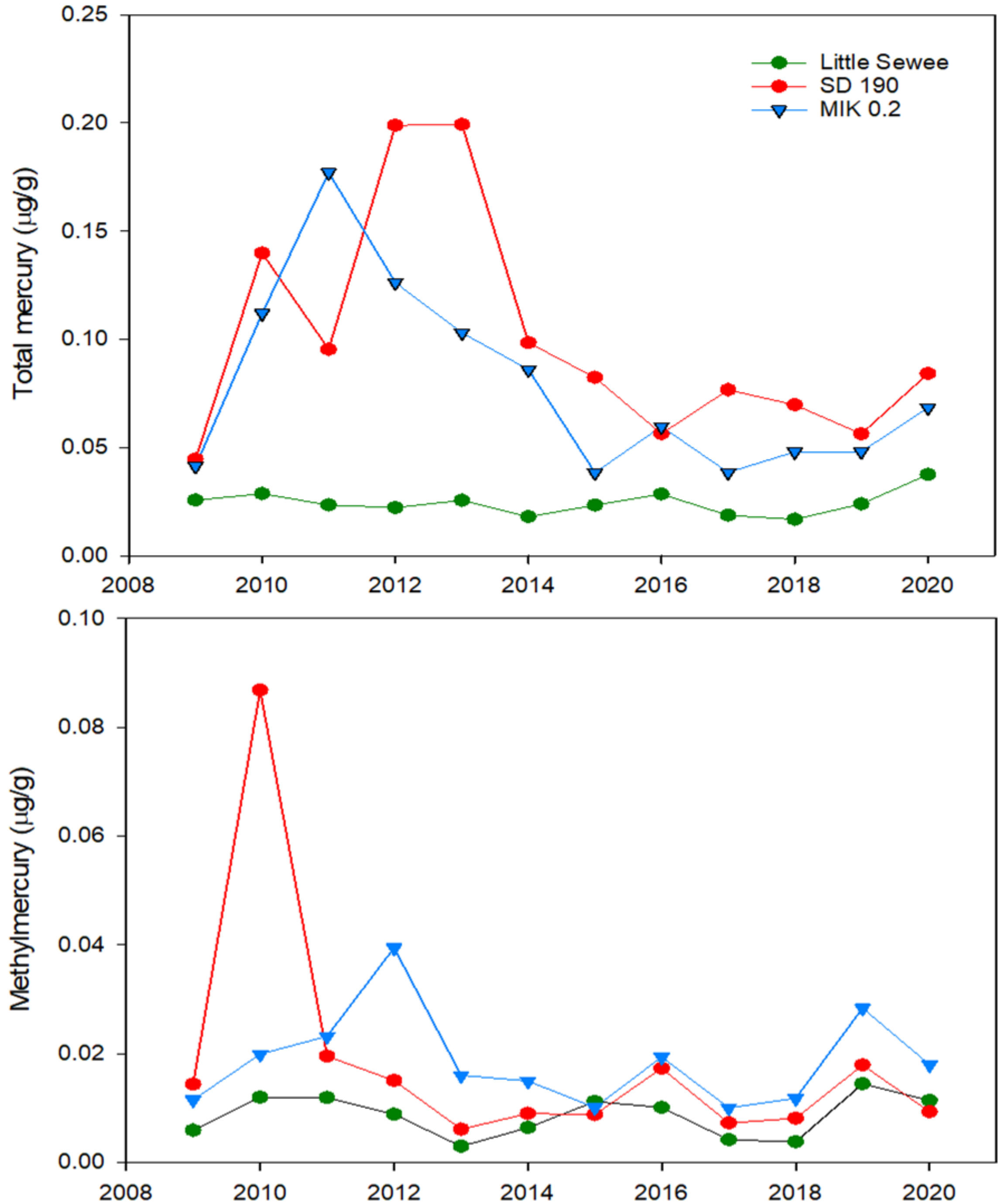


Notes:

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, Tennessee).*
3. *Total PCBs is defined as the sum of Aroclors 1248, 1254, and 1260.*

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

Figure 3.31. Mean total PCB (Top: µg/g, wet wt; 1993–2020) and mercury (Bottom: µg/g wet wt; 2009–2020) concentrations in the soft tissues of caged Asiatic clams deployed in Mitchell Branch

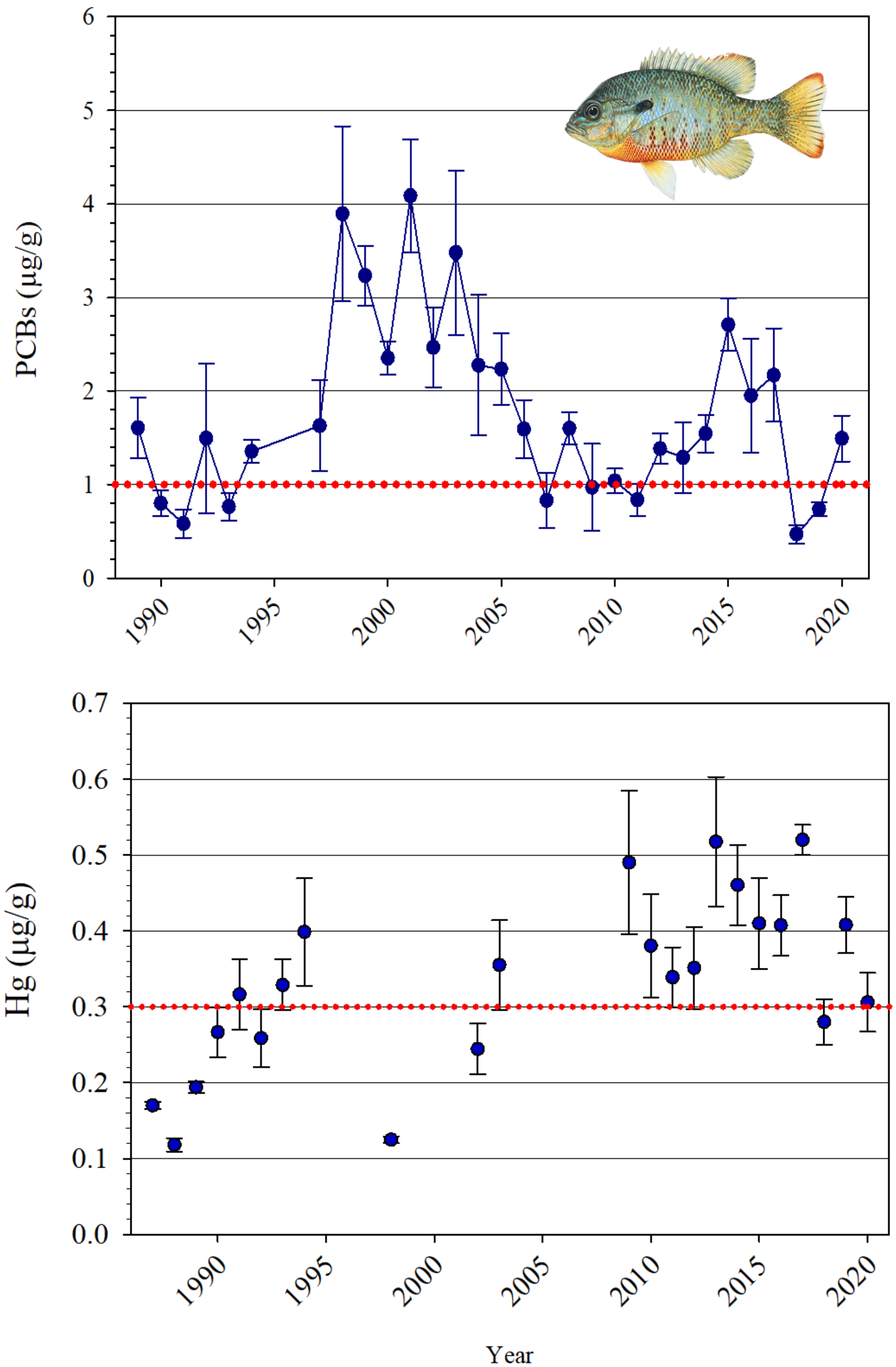


Notes:

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*
3. *Black bars denote MeHg concentrations, where the total height of bars (color and black band) represents HgT concentration.*

Acronyms and abbreviations: *HgT = total mercury MIK = Mitchell Branch kilometer SD = storm drain MeHg = methylmercury PCB = polychlorinated biphenyl*

Figure 3.32. Total (top panel) and methylmercury (bottom panel) concentrations in the soft tissues of caged Asiatic clams deployed in Mitchell Branch (µg/g wet wt; 2009–2020)



Notes:

1. *1989–2020 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 and abbreviations:

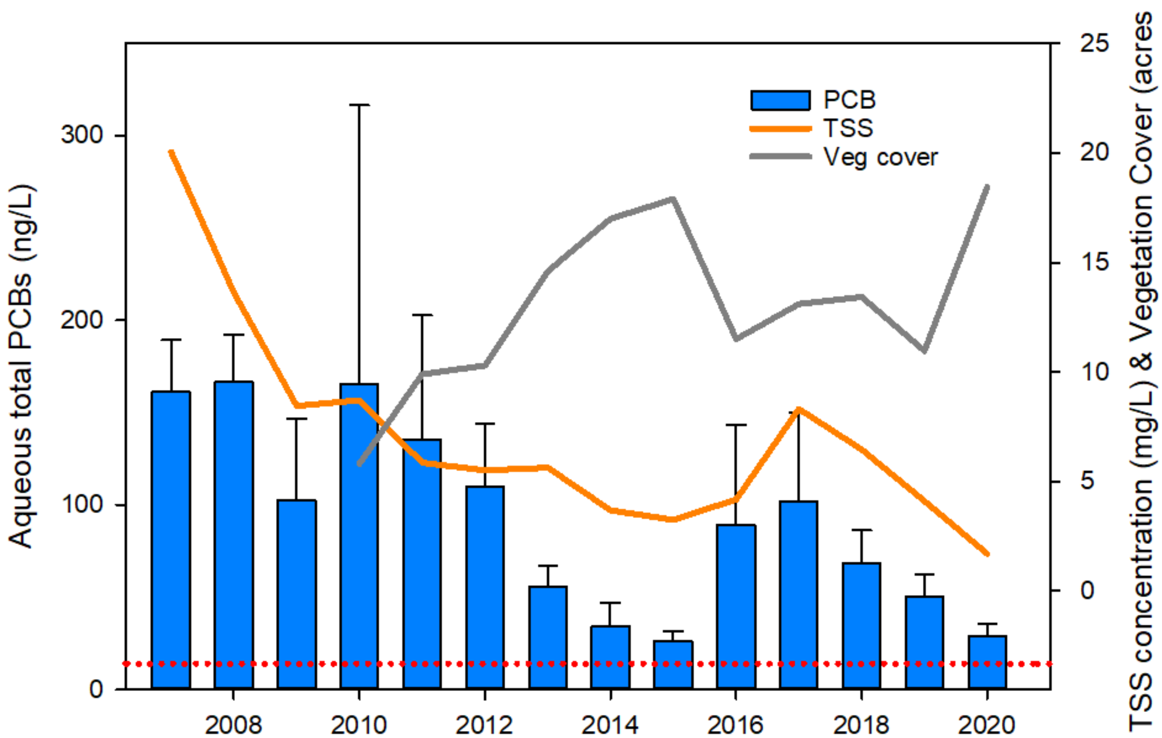
Hg = mercury MIK = Mitchell Branch kilometer MeHg = methylmercury PCB = polychlorinated biphenyl

Figure 3.33. 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., 29 ng/L in 2020 compared with 161 ng/L in 2007; Figure 3.34). Concentrations in 2020 were slightly lower than they have been for the past 3 years, and were 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) (TDEC 2019).

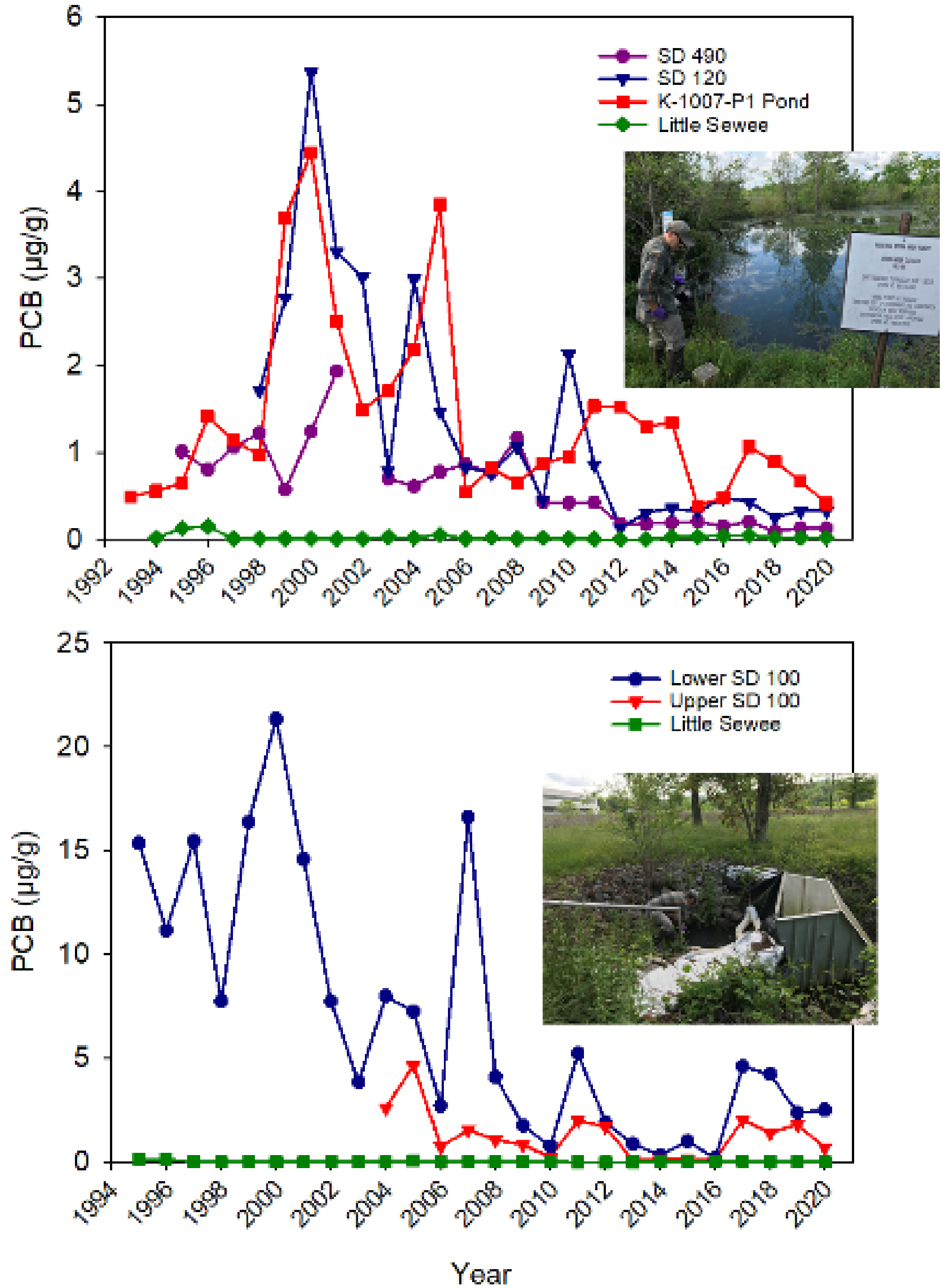
PCB concentrations in clams placed at lower and upper SD-100 locations have fluctuated significantly since remediation actions in 2009, and were on an overall decreasing trajectory until the significant increases seen in 2017 and 2018 (Figure 3.35). Concentrations in clams deployed in lower SD-100 in 2020 were similar to those in 2019, but concentrations in clams deployed in upper SD-100 decreased slightly compared with those seen in 2017 to 2019, and 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 2020 were comparable to concentrations seen just after remediation actions in this pond (Figure 3.36).



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 3.34. Mean aqueous total PCB concentrations, total suspended solids, and vegetation cover in the K-1007-P1 Pond, 2007–2020

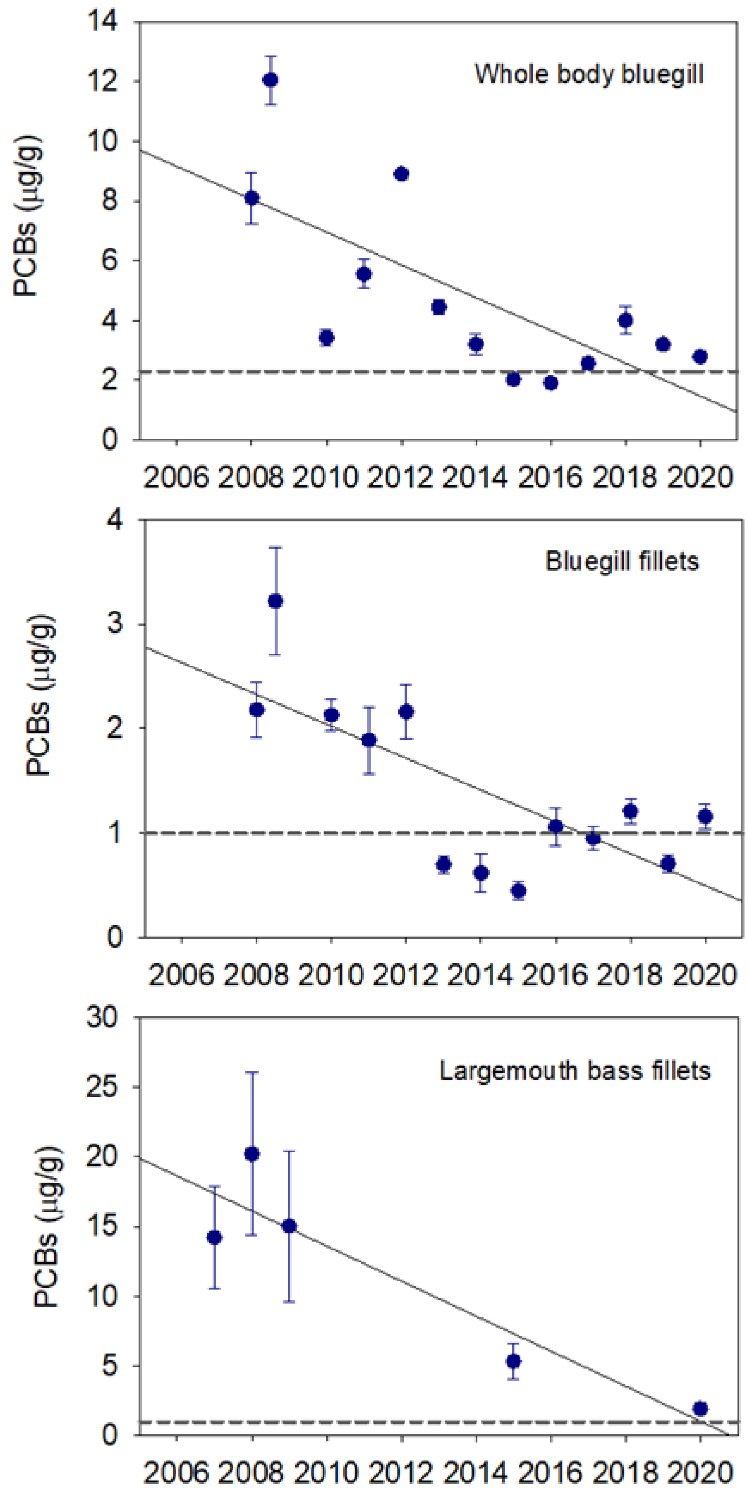


Notes:

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 a clam basket in a storm drain, and Little Sewee Creek; lower graph photo shows placement of clam cages in Upper SD-100 (upper photo) and Lower SD-100 locations.*

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

Figure 3.35. 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), 1993–2020



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.*

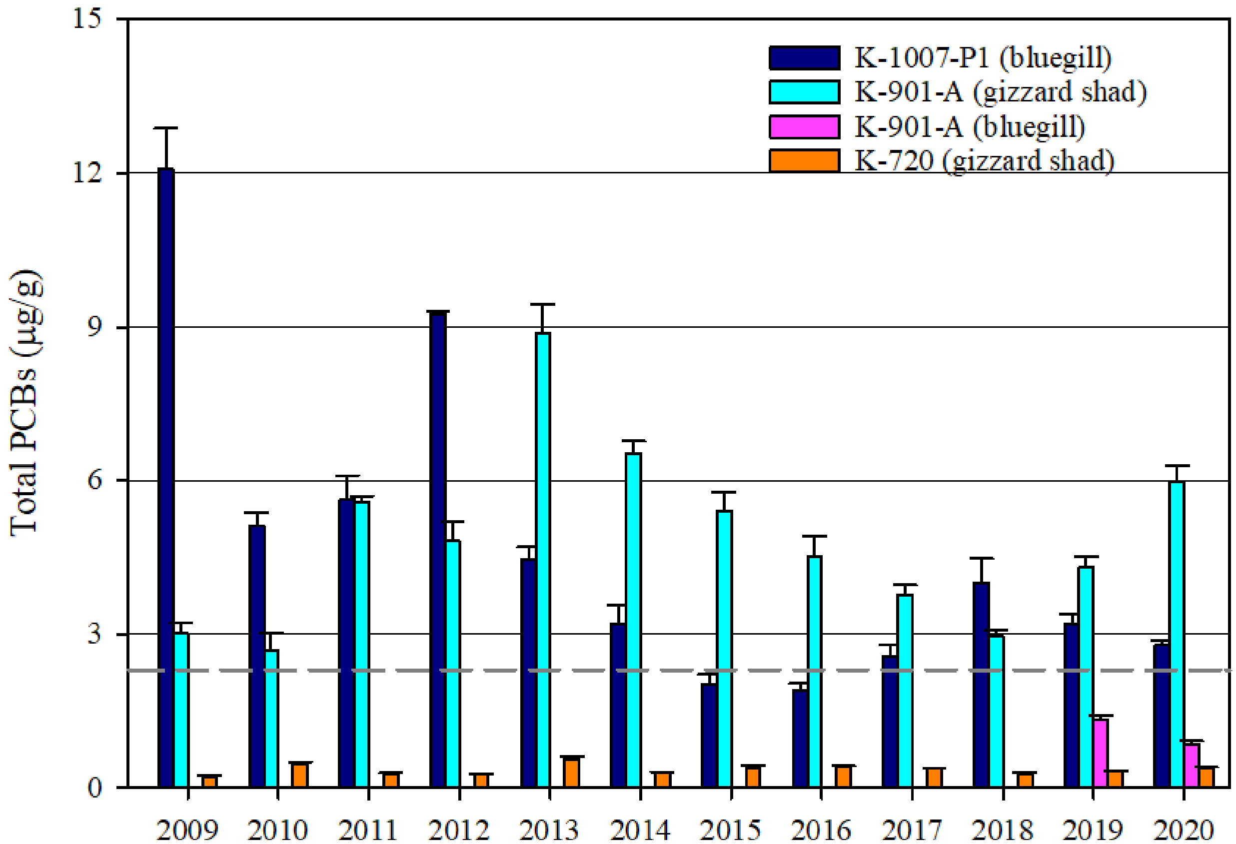
Acronym: *PCB = polychlorinated biphenyl*

Figure 3.36. Mean PCB concentrations (µg/g, wet wt) in fish from the K-1007-P1 Pond, 2007–2020

Similar trends have been observed in fish tissue PCB concentrations in the K-1007-P1 Pond (Figure 3.37). 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 2020 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.

Average PCB concentrations in fish fillets and whole-body composites have decreased significantly over the past 10 years since remediation activities, with significant fluctuations. Concentrations were lowest in the 2013-2015 time period but have slightly increased over the past three years. The mean concentration in whole body composites of bluegill collected from the K-1007-P1 Holding Pond was lower in 2020 (2.79 µg/g) than in 2019 (3.20 µg/g), remaining above the target concentration for whole body fish in this pond (2.3 µg/g) (Table 3.18, Figures 3.39 and 3.40). Although fillet concentrations had dropped below the remediation target of 1 µg/g, averaging 0.71 µg/g in FY 2019, concentrations increased to 1.16 µg/g in FY 2020, slightly exceeding the target concentration. Mean PCB concentrations in largemouth bass fillets were 1.91 µg/g, which—while slightly above the target fillet concentration of 1 µg/g for this pond—is significantly lower than concentrations seen in this species 5 years ago (5.33 µg/g) and is an order of magnitude lower than concentrations seen prior to remediation actions (20.2 µg/g in 2008).

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 3.30 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

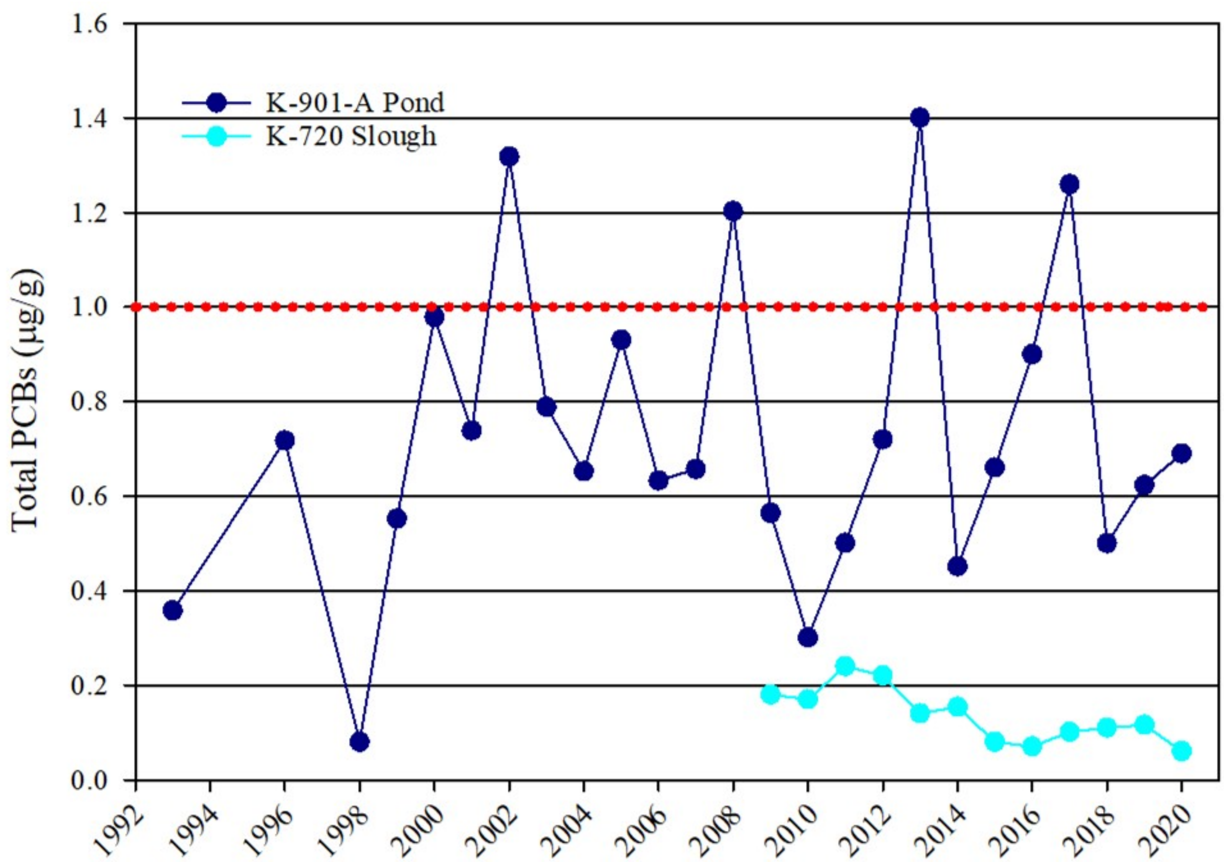
Figure 3.37. Mean (+1 standard error) total PCB concentrations (µg/g, wet wt) in whole body fish from K1007-P1 Pond, K-901-A Holding Pond, and K-720 Slough, 2009–2020

3.7.1.3. K-901-A Pond

The target fish species for analysis of PCBs in the K-901-A Holding Pond and K-720 Slough were gizzard shad (*Dorosoma cepedianum*) and largemouth bass (*Micropterus salmoides*). It was not possible to collect the target number of 20 bass from each body of water, so common carp (*Cyprinus carpio*) also were collected to provide a combined total of 20 fish. Carp were selected as a surrogate species for bass because they are widely distributed, are present at both locations, and have been used historically in other monitoring efforts on ORR for contaminant analyses.

At the K-901-A Holding Pond, PCB concentrations in largemouth bass were comparable (0.69 µg/g) to concentrations seen in 2019 (0.62 µg/g) and were below the target concentration set for the K-1007-P1 Pond of 1 µg/g total PCBs (Figure 3.38). Mean PCB concentrations in carp collected from the K-901-A Holding Pond were above the target concentration of 1 µg/g in fillets in 2020 (3.77 µg/g) and were higher than concentrations measured in 2019 (1.22 µg/g). Carp are not the target species in this pond and are generally undesirable fish to have in a pond affected by PCBs because they tend to stir up sediments, which exposes them and other organisms to elevated PCB concentrations.

However, when a full collection of largemouth bass cannot be collected, carp are collected to complete the collection. 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 (5.99 µg/g) than the fillets of bass and carp, and were higher than the concentrations seen in this species in the past three years, remaining above the target concentration set for the K-1007-P1 Holding Pond for whole body fish (2.3 µg/g) (Figure 3.40). However, mean PCB concentrations in whole-body bluegill (0.84 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), and were lower than those observed in 2019 (1.33 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 2020 (0.13 µg/g) to concentrations seen in 2019 (Figure 3.39).



Notes:

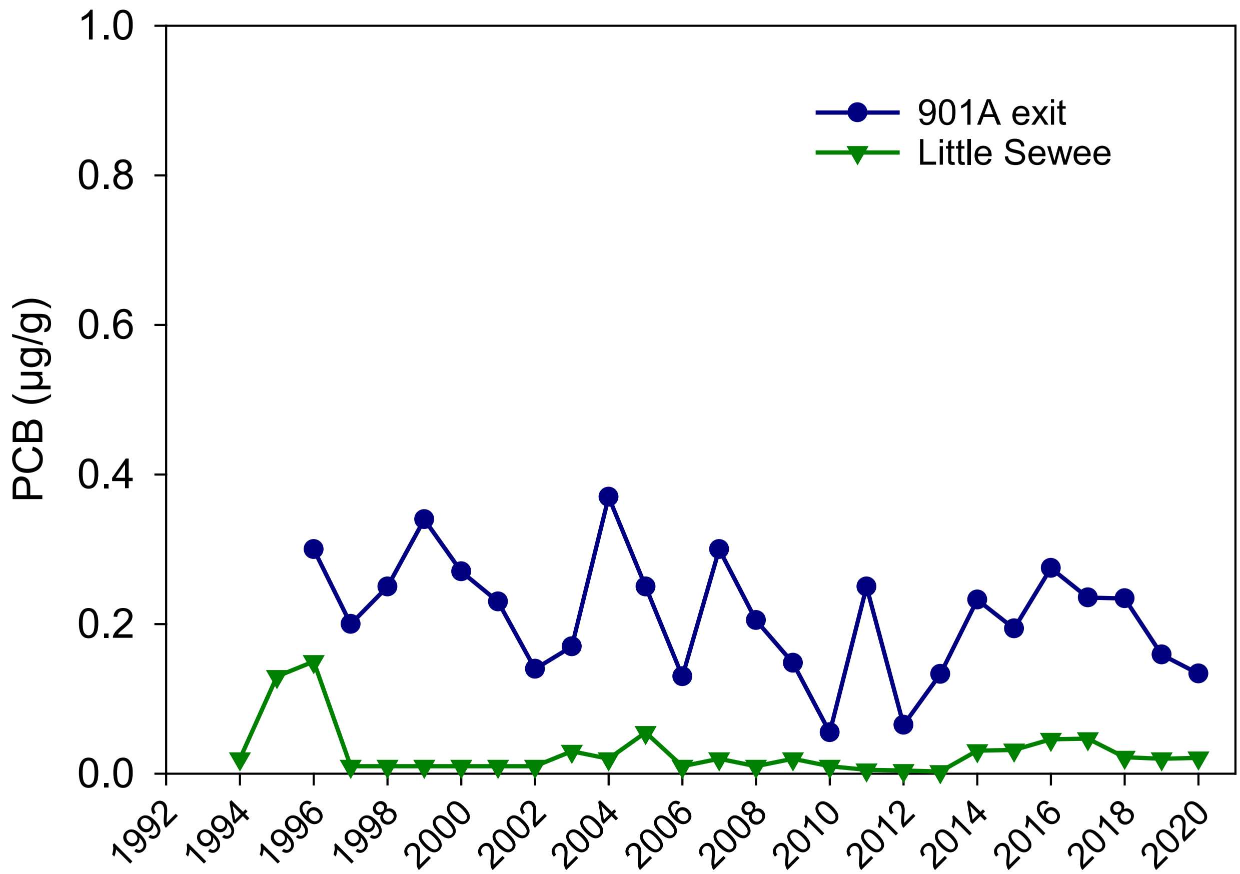
1. *Mean PCBs (± 1 SE) in largemouth bass fillets, 1993-2020 (µg/g).*
2. *N = 6 fish per year, when possible.*
3. *The dotted red line shows the advisory level for PCBs in fish fillets (1 µg/g).*

Acronyms:

PCB = polychlorinated biphenyl

SE = standard error

Figure 3.38. 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, Tennessee).*

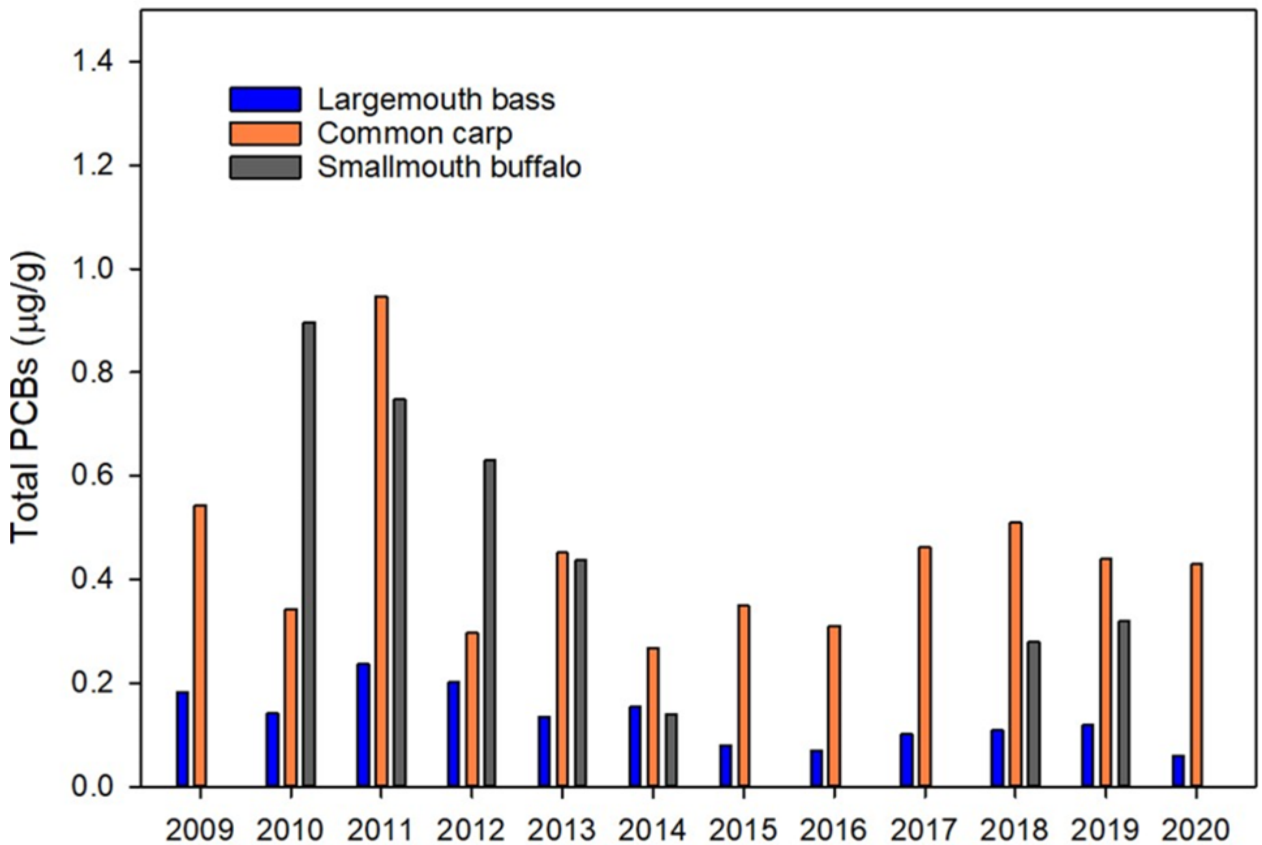
Acronym:

PCB = polychlorinated biphenyl

Figure 3.39. Mean total PCB (µg/g, wet wt; 1993–2020) 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 3.40). 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 3.40 shows the temporal trends in fish fillet concentrations in the slough. In 2020, 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 3.18). 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 2020. Concentrations in carp collected from the slough were higher than concentrations in bass, averaging 0.43 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 0.39 µg/g in 2020.



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 3.40. Mean total PCB (µg/g, wet wt; 2009–2020) concentrations in the fillets of largemouth bass, common carp, and smallmouth buffalo collected from the K-720 Slough

Table 3.18. Average concentrations of total PCBs in fillets and whole-body composites of fish collected in 2020 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	1.17 ± 0.12	0.43–2.91	12/20
		Whole-body composites	6	2.79 ± 0.10	2.47–3.1	6/6
	Largemouth bass	Fillets	6	1.91 ± 0.42	0.98–3.42	5/6
K-901-A Pond	Largemouth bass	Fillets	16	0.69 ± 0.21	0.22–3.67	2/16
	Common carp	Fillets	4	3.77 ± 0.78	1.94–5.46	4/4
	Bluegill	Fillets	20	0.78 ± 0.13	0.04–2.06	5/20
		Whole-body composites	6	0.84 ± 0.08	0.60–1.14	0/6
	Gizzard shad	Whole-body composites	6	5.99 ± 0.30	5.37–7.21	6/6
K-720 Slough	Largemouth bass	Fillets	13	0.06 ± 0.00	0.04–0.10	0/13
	Common carp	Fillets	7	0.43 ± 0.12	0.07–0.88	0/7
	Gizzard shad	Whole-body composites	6	0.39 ± 0.02	0.33–0.45	0/6
CRM 11.0	Bluegill	Whole-body composites	6	0.10 ± 0.02	0.06–0.21	0/6
	Gizzard shad	Whole-body composites	6	0.19 ± 0.06	0.01–0.31	0/6
PCM 1.0	Bluegill	Whole-body composites	6	0.20 ± 0.06	0.11–0.48	0/6
	Gizzard shad	Whole-body composites	6	0.36 ± 0.10	0.23–0.57	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 3.41 and 3.42). 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 3.41. 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 2020 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 2011; TDEC 2017). TDEC protocol guidance was updated in August 2017 and the most recent 2017 guidance was used for all invertebrate and habitat surveys. 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 3.19). 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 3.42. Sampling for benthic macroinvertebrates with TDEC protocols

Table 3.19. 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 (1986–2020) in all Mitchell Branch sites (Figure 3.43). 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 3.43). 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 four years (Figure 3.44). In April 2020, total taxa richness and EPT taxa richness were highest at MIK 0.7 and MIK 0.8 and lowest in MIK 0.4 (Figure 3.43). As previously seen in 2019, EPT taxa richness patterns among sites in 2020 again differed from 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 3.43).

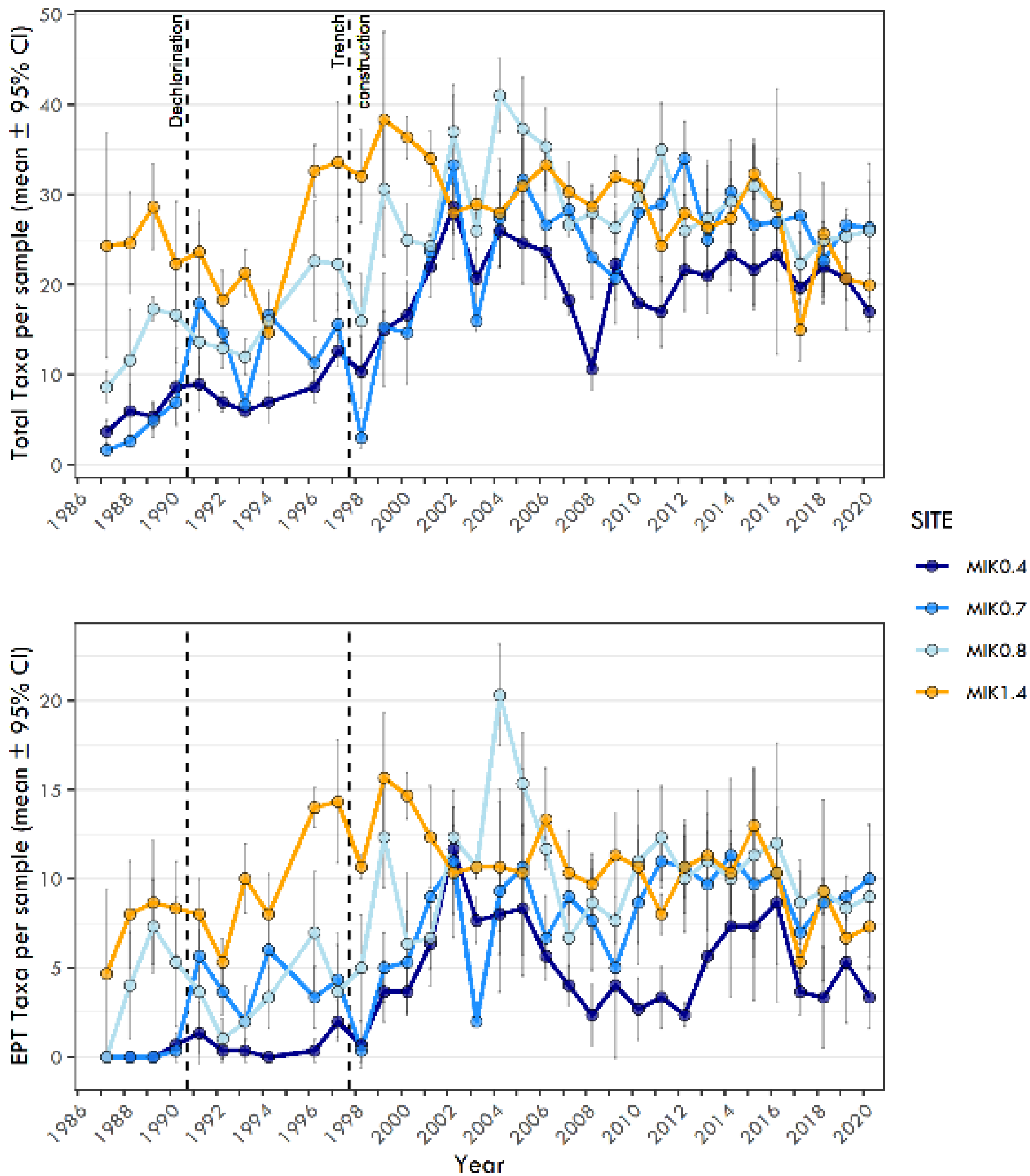
The percent density of the pollution-intolerant taxa (higher values are indicative of good condition) was highest at MIK 1.4, the reference site, and lowest at MIK 0.4 in April 2020, which is a pattern that has been observed in most years since monitoring began in 1987 (Figure 3.44). In most years, the percent density of pollution-tolerant taxa (lower values are indicative of good conditions) was lowest at the reference site, MIK 1.4. However, in April 2019 and 2020, 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 3.44). In 2020, the percent of pollution-tolerant taxa at MIK 1.4 decreased from 2019, which was one of the highest values seen since monitoring began and only surpassed in 1988 and 1992 (Figure 3.44). Continued monitoring will determine if these higher values at MIK 1.4 persist or rather reflect interannual variability.

Based on TDEC 2017 protocols, scores for the Tennessee Macroinvertebrate Biotic Index (TMI) in 2020 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 3.45). TMI scores in 2020 remained stable (MIK 0.8) or declined (MIK 1.4, MIK 0.7, MIK 0.4) compared to 2019 scores (Figure 3.45). In 2020, MIK 1.4 scores decreased for percentage of EPT taxa and percentage of nutrient-tolerant taxa, but increased for percentage of clingers (Table 3.20). Both MIK 0.8 and MIK 0.7 received low scores for EPT taxa richness and percentage of EPT taxa while MIK 0.7 also received low scores for total taxa richness (Table 3.20). 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 3.20).

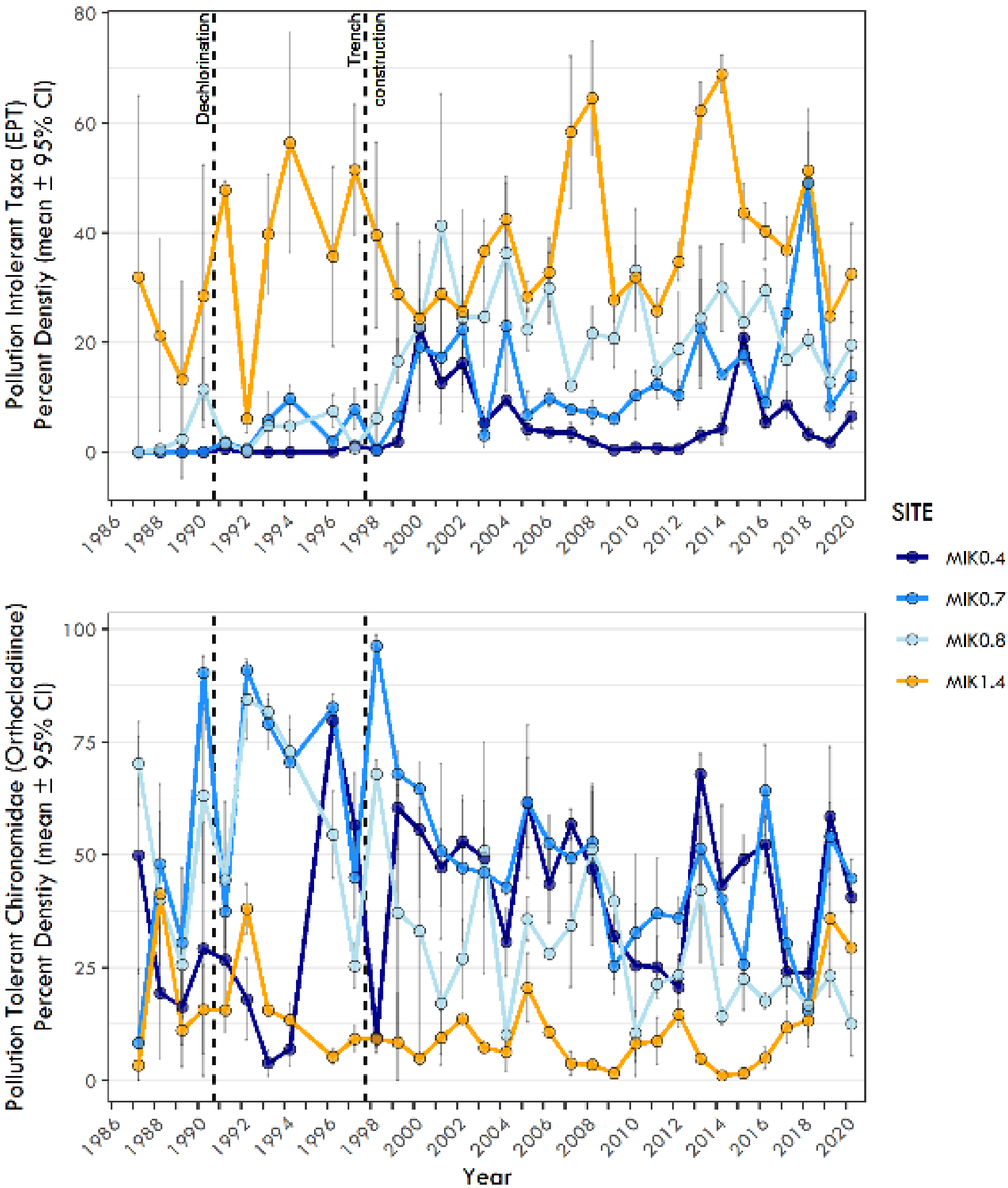
Since sampling using TDEC protocols began in 2008 in Mitchell Branch, TMI scores at have almost always rated the invertebrate community at MIK 1.4 as passing biocriteria guidelines, MIK 0.4 as falling below biocriteria guidelines, and MIK 0.7 and MIK 0.8 as oscillating between passing and falling below biocriteria guidelines (Figure 3.45). TDEC protocol states that TMI scores should only be calculated for samples with 160–240 invertebrates identified to genus (TDEC 2017). In August 2020, only 138, 111, and 78 individuals were collected from MIK 1.4, MIK 0.7, and MIK 0.4 respectively, so results from these sites should be interpreted with caution.

Based on TDEC stream habitat protocols, habitat quality was above the ecoregion 67f guideline at all sites within Mitchell Branch (Figure 3.45). Habitat scores increased at all sites from 2018 to 2020. In general, improvements from the previous three years were primarily seen in epifaunal substrate/available cover, channel flow, sediment deposition, embeddedness, and vegetative protection. However, poor substrate quality (dominance of gravel instead of cobble) and unstable, highly erodible banks continued to be an issue at multiple sites. Habitat conditions related to riffle stability (i.e., frequency of reoxygenation zones) improved at all sites except MIK 0.4.



Note:
1. Samples were not collected in April 1995.
Acronyms:
EPT = Ephemeroptera, Plecoptera, and Trichoptera MIK = Mitchell Branch kilometer CI = confidence interval

Figure 3.43. Mean (± 95% confidence interval) total taxonomic richness (top) and richness of the pollution-intolerant taxa per sample (bottom) for Mitchell Branch sites, April 1987–2020



Notes:

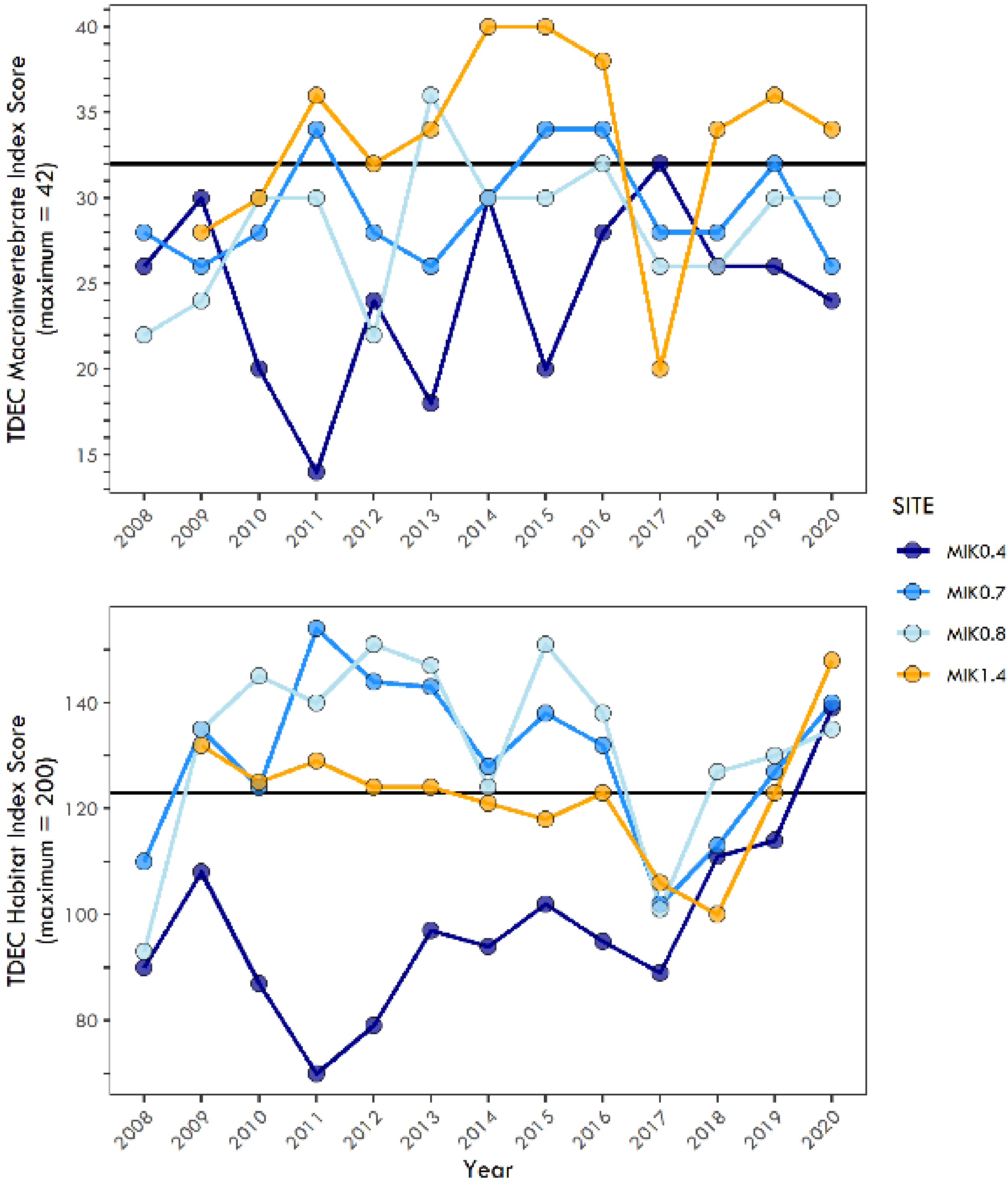
1. *Pollution intolerant taxa = stoneflies, mayflies, and caddisflies.*
2. *Percentages were based on total densities for each site.*
3. *Samples were not collected in April 1995.*

Acronyms:

MIK = Mitchell Branch kilometer   CI = confidence interval

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

Figure 3.44. Mean percent density of pollution-intolerant taxa and of the pollution-tolerant Orthocladiinae midge larvae (Chironomidae) at Mitchell Branch sites, April 1987–2020



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; TDEC macroinvertebrate index threshold is 32; TDEC habitat index threshold for ecoregion 67f is 123. Values above the thresholds are indicative of passing biocriteria or habitat guidelines.*
3. *TDEC 2017 guidance used for all years.*

Figure 3.45. Temporal trends in the TDEC Macroinvertebrate Index (top) and Stream Habitat Index (bottom) scores for four Mitchell Branch sites, August 2008–2020

Table 3.20. Tennessee Macroinvertebrate Index metric values and scores and index score for Mitchell Branch, August 19, 2020 [a,b,c]

Site	Metric values							Metric scores							TMI[d,e]
	Taxa rich	EPT rich	%EPT	%OC	NCBI	%Cling	%TN Nuttol	Taxa rich	EPT rich	%EPT	%OC	NCBI	%Cling	%TN Nuttol	
MIK 0.4	11	2	1.3	7.7	3.7	83.3	32.1	2	0	0	6	6	6	4	24
MIK 0.7	18	5	20.7	11.7	5.3	63.1	38.7	2	2	2	6	4	6	4	26
MIK 0.8	20	6	26.8	5.7	4.6	85.2	45.9	4	2	2	6	6	6	4	30
MIK 1.4	28	8	36.2	12.3	4.5	56.5	41.3	4	4	4	6	6	6	4	34 [**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 2017, 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.*

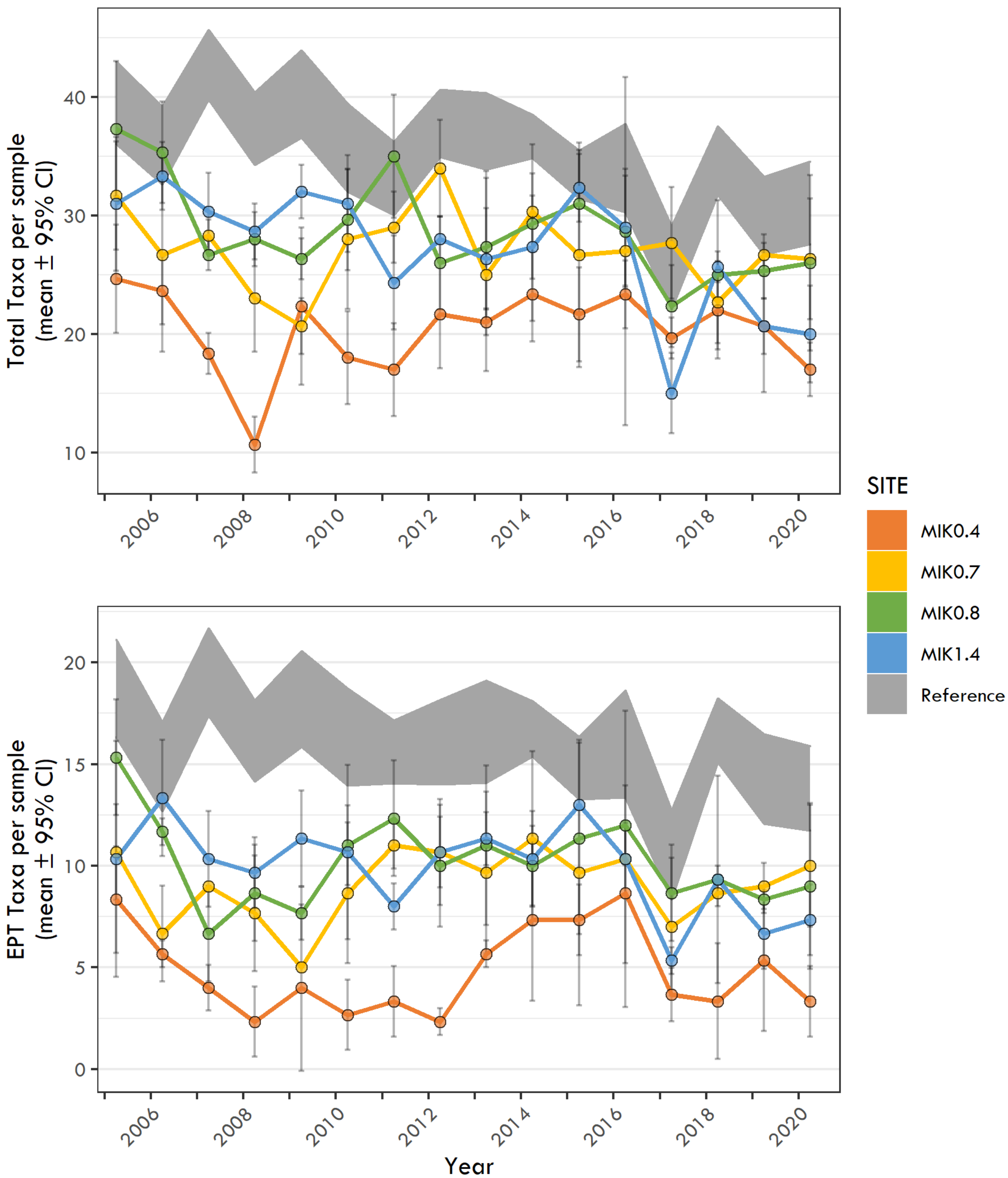
[e] *TDEC protocol states that TMI scores should only be calculated for samples with 160–240 invertebrates identified to genus (TDEC 2017). In August 2020, only 78, 111, and 138 individuals were collected from MIK 0.4, MIK 0.7, and MIK 1.4, respectively, so results from these sites should be interpreted with caution.*

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 15-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 3.46, and percent density of the pollution-intolerant and pollution-tolerant taxa are shown in Figure 3.47. Also shown in Figures 3.46 and 3.47 is the 95% 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.

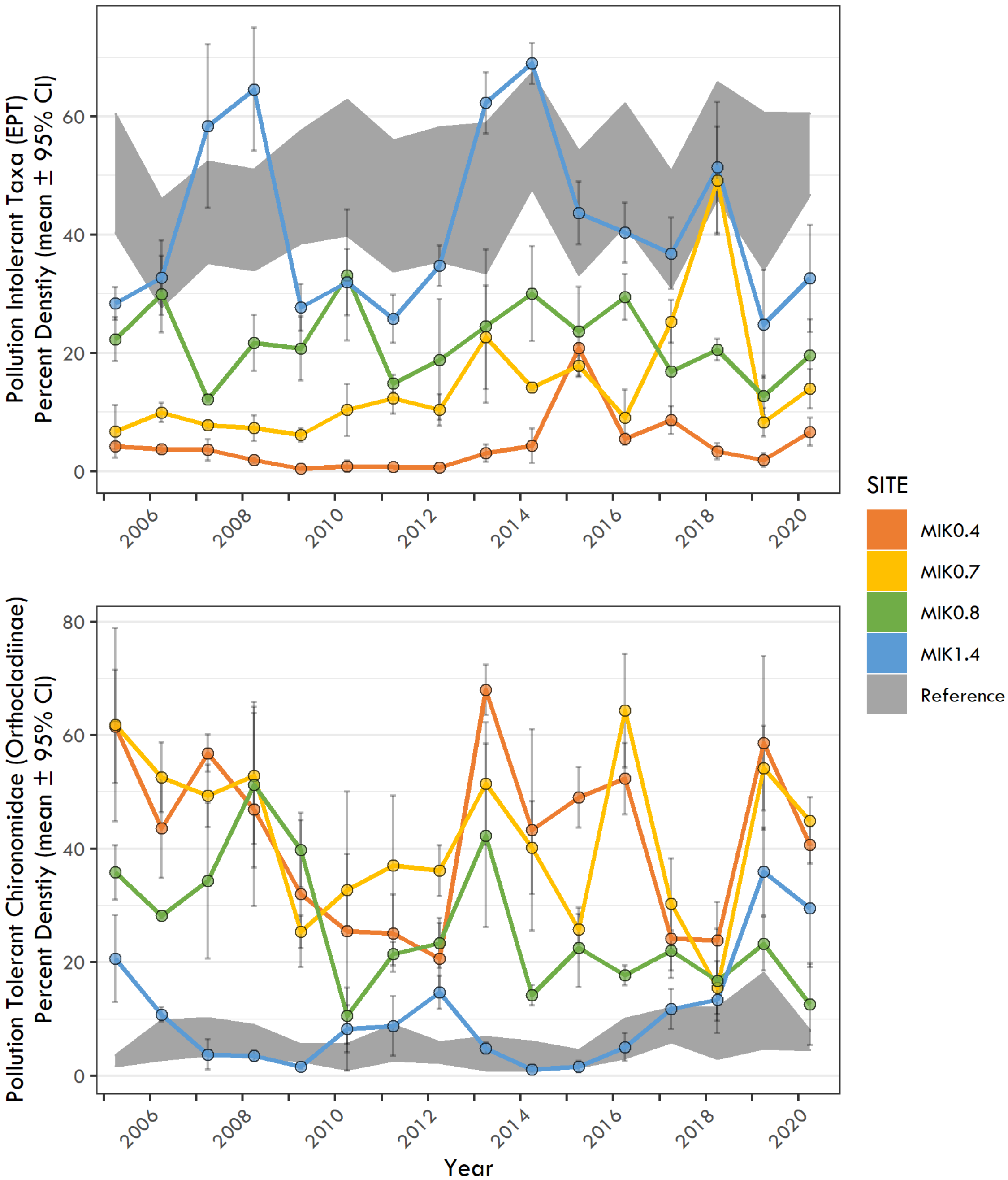
In 2020, total taxa richness and taxa richness of pollution-intolerant (EPT) taxa at Mitchell Branch sites, including MIK 1.4, were less than both the 95% confidence interval for the five reference sites (Figure 3.46). This trend was observed since these comparisons began in 2005, with some exceptions (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 rarely outside of the 95% confidence interval for the reference sites (Figure 3.47). As noted above, the percent density of pollution-tolerant taxa at MIK 1.4 decreased in 2020 from one of the highest values measured (in 2019) since monitoring began; however, higher values were also observed at some of the reference sites (Figure 3.47). 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% confidence interval, while the percent density of pollution-tolerant taxa was higher than the reference 95% confidence interval. MIK 0.4 has largely remained well outside the 95% confidence intervals for reference sites in every year (Figure 3.47).

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 frequent excursions of invertebrate community metrics outside of the 95% confidence interval surrounding other reference sites include the somewhat smaller size of MIK 1.4 compared with the other reference sites (based on watershed area, Table 3.20), 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 3.44 and 3.45). 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 2020.
Acronyms:
CI = confidence interval
EPT = Ephemeroptera, Plecoptera, and Trichoptera
MIK = Mitchell Branch kilometer
MIK 1.4 = reference site
ORR = Oak Ridge Reservation

Figure 3.46. Mean total taxonomic richness (top) and pollution-intolerant taxa per sample (bottom) for the benthic macroinvertebrate community at Mitchell Branch and reference sites, April 2005–2020



Notes:

1. *Pollution intolerant taxa, i.e., stoneflies, mayflies, and caddisflies or Ephemeroptera, Plecoptera, and Trichoptera taxa (top).*
2. *Polution 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 2020.*

Acronyms:

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

Figure 3.47. Mean percent density of pollution-intolerant taxa (top) and pollution-tolerant Chironomidae (bottom) in Mitchell Branch, with reference site mean values, April 2005–2020

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. 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 (Figure 3.49), 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 3.48. Construction of lined section of Mitchell Branch, MIK 0.7, in 1998

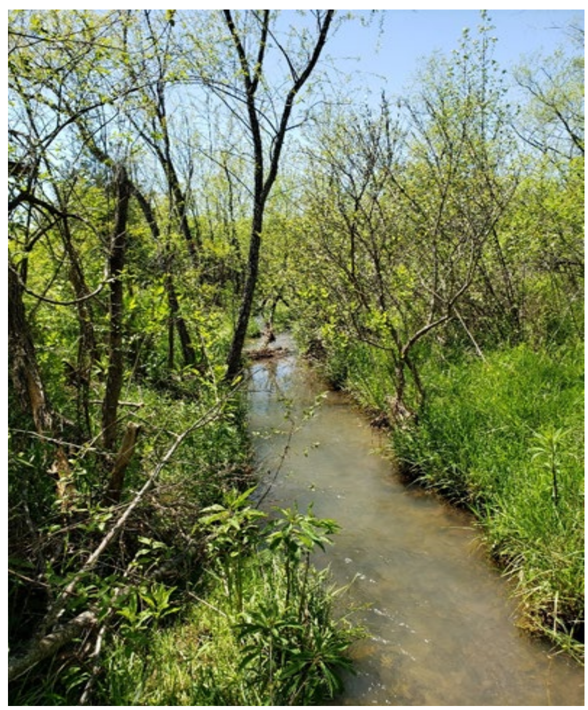
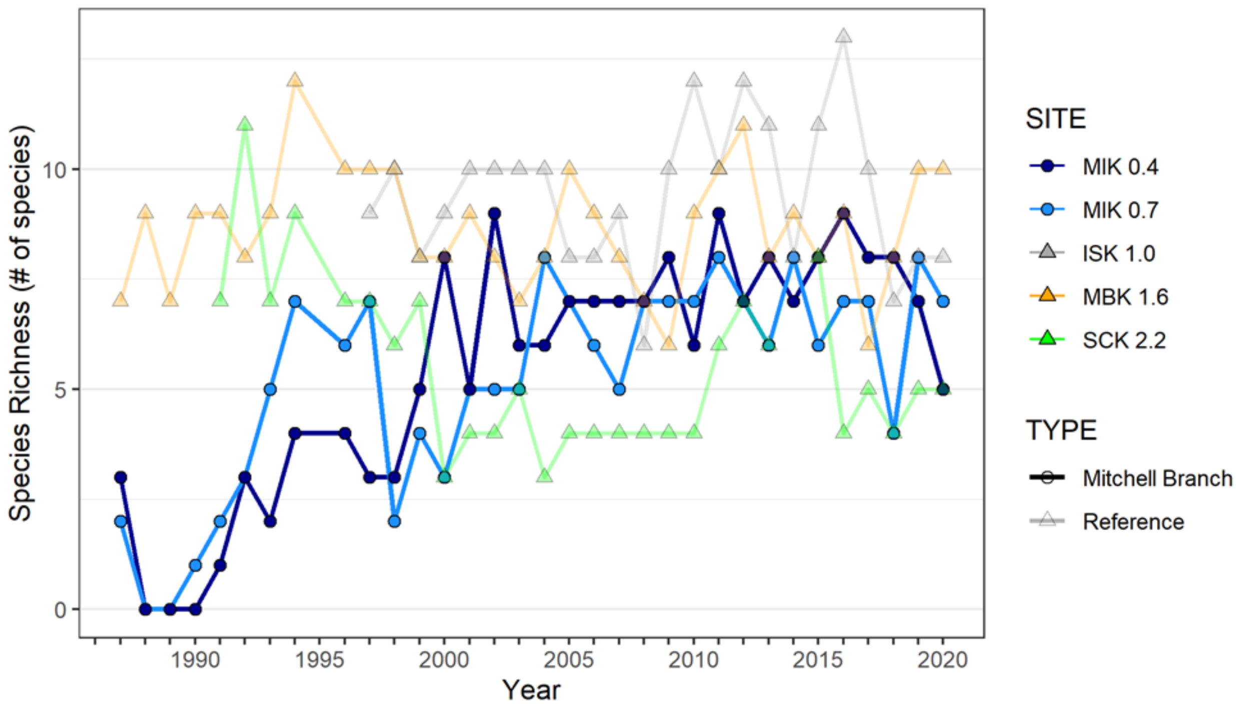


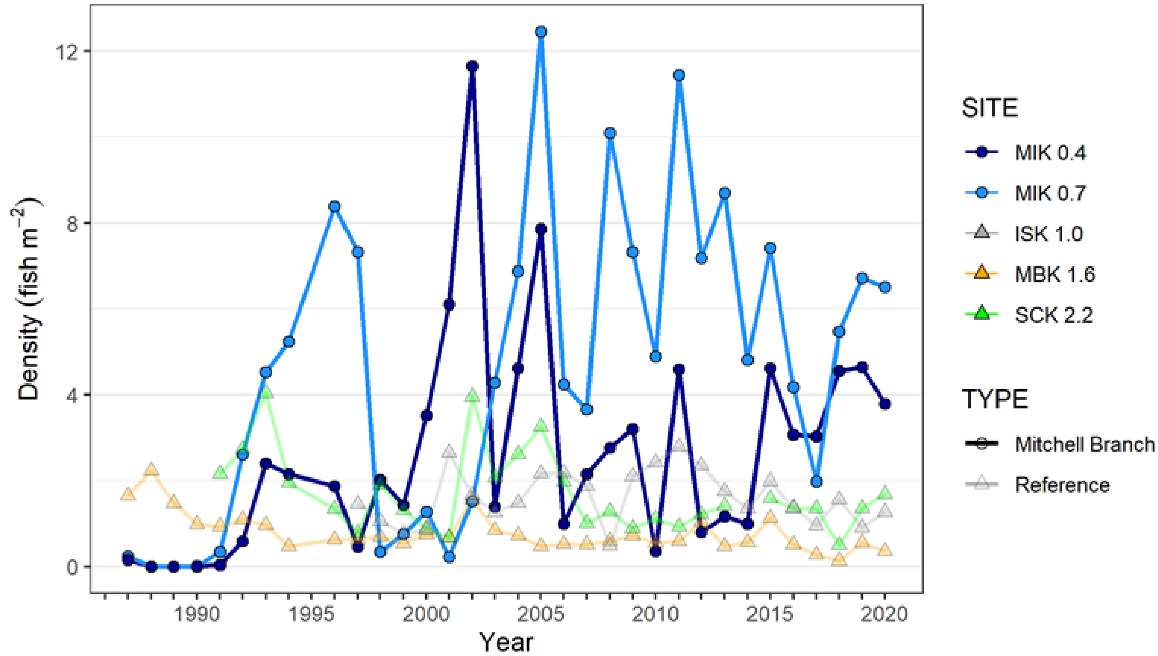
Figure 3.49. More recent habitat conditions at Mitchell Branch in 2020

At both MIK 0.4 and MIK 0.7, the 2020 sample of fish community parameters indicated continued variation. Species richness (number of species) at both sites experienced a slight decrease from 2019 values (Figure 3.50). 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 3.51). Biomass (weight) also remains above elevated at both sites however, MIK 0.4 is approaching reference values in recent samples (Figure 3.52). Both the lower Mitchell Branch site and the upper site had reduced diversity and density of sensitive fish species in 2020. Overall 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*), which appear to be a resident species in Mitchell Branch, and also occasional occurrences of other more sensitive fish. In 2019-2020 a new species were observed in the upper site. Snubnose darter (*Etheostoma simoterum*) were collected both years, and represents a unique sensitive species in this reach of stream. They have been observed at the very mouth of the system in past samples.



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

Figure 3.50. Species richness for the fish communities at sites in Mitchell Branch and in reference streams Mill Branch, Scarboro Creek, and Ish Creek, 1987–2020



Acronyms:

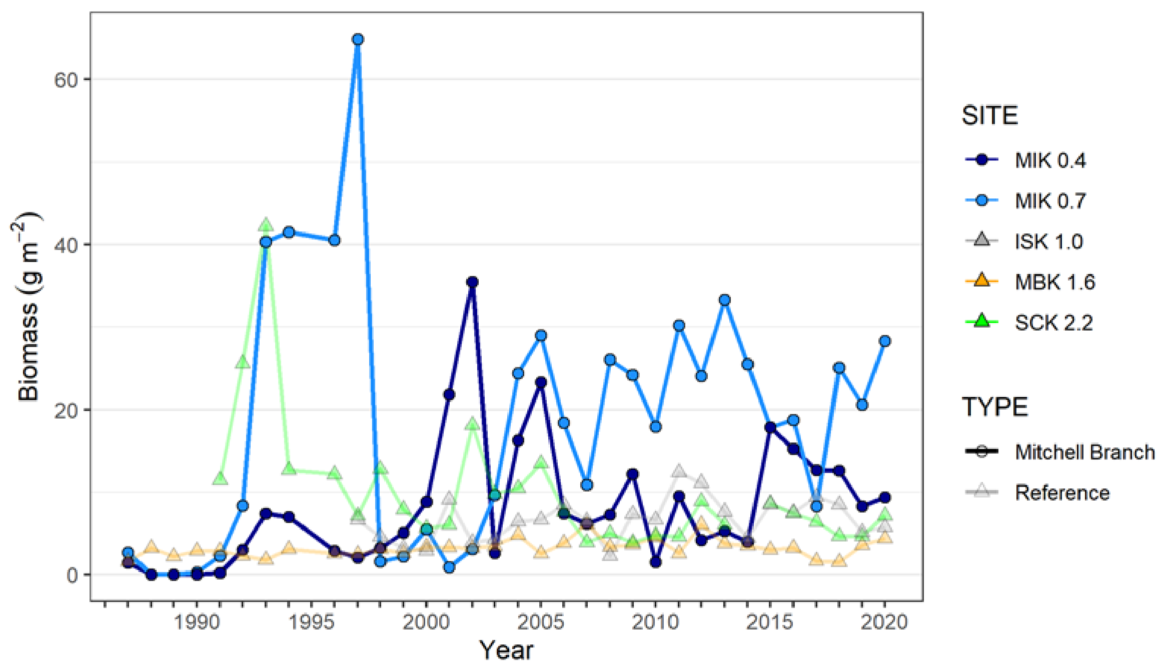
ISK = Ish Creek

MBK = Mill Branch kilometer

MIK = Mitchell Branch kilometer

SCK = Scarboro Creek

Figure 3.51. Density for the fish communities at sites in Mitchell Branch and in reference streams Mill Branch, Scarboro Creek, and Ish Creek, 1987–2020



Acronyms:

ISK = Ish Creek

MBK = Mill Branch kilometer

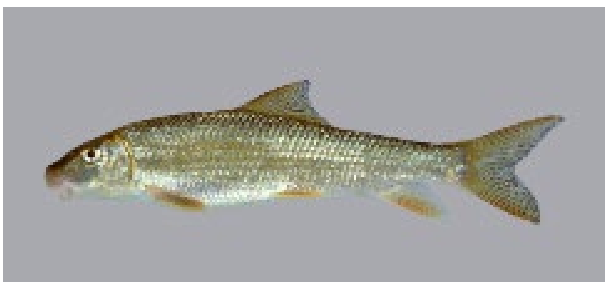
MIK = Mitchell Branch kilometer

SCK = Scarboro Creek

Figure 3.52. Biomass for the fish communities at sites in Mitchell Branch and in reference streams Mill Branch, Scarboro Creek, and Ish Creek, 1987–2020

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 almost never observed in the Mitchell Branch fish community monitoring activities at the upstream sites. These included four pollution-sensitive species: snubnose darter, greenside darter (*Etheostoma blennioides*), black redhorse (*Moxostoma duquesnei*), and northern hogsucker (*Hypentelium nigricans*) (Figure 3.53). 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 3.53. 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 202019 revealed the presence of 24 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 70 percent of the total fish population (Figure 3.54). 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 continue to be present in the pond and are suspected of reproducing; they constituted a much larger portion of the fish population in 2020 than in previous years. Their abundance has had some minor fluctuations each year but in general has remained relatively low compared with earlier years until 2020. The increased abundance of gizzard shad observed in 2020 likely reflects periodic increased fecundity, as has been observed for shad in other aquatic systems in Tennessee.

3.8. Environmental Management and Waste Management Activities

Remediation actiivites were underway across the ETTP in 2020. 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, remain to be completed.

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.

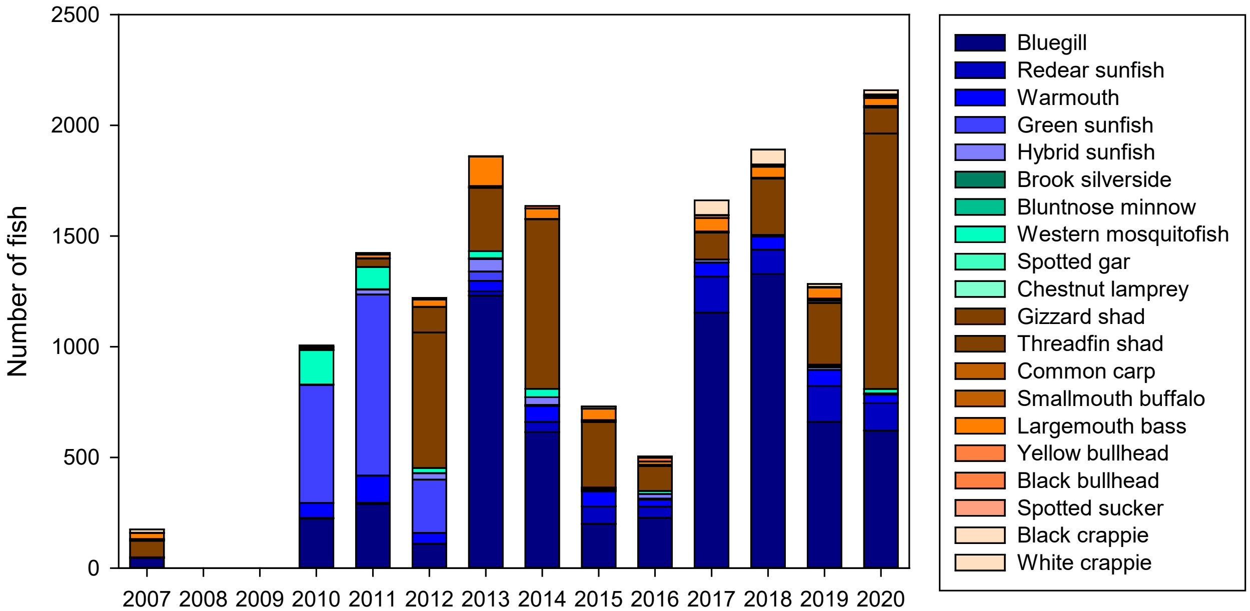


Figure 3.54. Changes in the K-1007-P1 Pond fish community from 2007 to 2020

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 *2020 Cleanup Progress—Annual Report to the Oak Ridge Regional Community* (UCOR 2021a, OREM-20-7603).

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 fiscal year 2020, planning began on a project to eliminate risk to wildlife in the Zone 1 area. In addition, two vaults associated with the abandoned underground utility system at the Powerhouse were remediated, and steps were initiated to address an area that contains buried asbestos. In the Zone 2 area, the removal of soil contaminated with ^{99}Tc was completed. Also in Zone 2, the abandoned K-1203 Sewage Treatment Plant and the K-832 Cooling Water Basin were remediated, leaving a grassy field at the site.

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. See also Section 3.6.2.8.

3.8.2.3. Building K-1600 Demolition Completed

Building K-1600 was the last remaining major structure within the footprint of the K-25 Building. It had been used to test new enrichment technologies.

3.8.2.4. Smaller Facilities Demolition Completed

The demolition of several smaller facilities was completed in 2020. The K-1039 telecommunications facilities were demolished, as were the K-1095 Paint Shop, the K-1006 support facility, and the Segmentation Shop. The Segmentation Shop had been used to process waste piping, contaminated equipment, and other items that required size reduction and recyclable materials.

3.8.2.5. Commemoration of the K-25 Site

National historic preservation initiatives at ETTP continued in 2020. The K-25 History Center (Figure 3.55) is located on the second floor of the COR-owned Fire Station #4 at ETTP. The K-25 History Center opened in February, 2020. Visitors to the K-25 History Center will be invited to explore the rich history of this Manhattan Project site. This facility features exhibits, audio-visual displays, period artifacts, equipment replicas, and workers' oral histories, placing K-25 in its proper historical context in World War II and the Cold War.

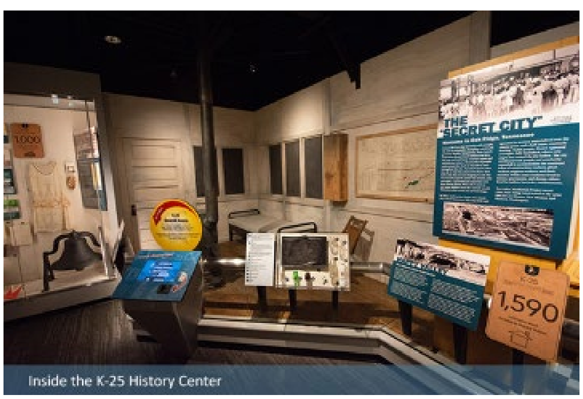


Figure 3.55. Exhibit at the K-25 History Center

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 2020, DOE initiated transfer of Access Portals 4 and 11, two roadways, the former K-1037 pad and the former Toxic Substances Control Act Incinerator (TSCAI) area. Portal 4 and one block sections of both 9th and 10th Streets were requested by the Community Reuse Organization of East Tennessee (CROET) and comprise 0.84 acres of land. Portal 11 (0.52 acres) was requested by the City of Oak Ridge as a complement to their existing Fire Station. The K-1037 pad and TSCAI area (27.9 acres) were requested by 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. Management of the project was transferred to the City in CY2020 and it was determined that a different alignment and additional acreage would be needed. DOE assisted the City with the transfer requests for approximately 65 acres, adding to the 170 acres previously requested for transfer.

Additionally, DOE completed an Environmental Assessment to support potential development at the Horizon Center, including land use changes.

Conservation/Greenspace

DOE continued to work with the Tennessee Wildlife Resources Agency on greenspace initiatives and waterway access to enhance public recreation opportunities at ETTP. The team also supported the development of the *Natural Asset Guidebook* which was published in early 2020 by the Legacy Parks Foundation. The Guidebook describes how to maximize the area's natural assets and provide connectivity throughout the greater Oak Ridge community and the surrounding region.

To date, DOE has transferred a total of 1,280 acres. The continued transfer of parcels, as more of the site cleanup is completed, provides the best opportunities to date for industrial and commercial development of ETTP.

3.9. References

DOE 2002. *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee.* DOE/OR/01-1997&D2. US Department of Energy, Office of Environmental Management, Oak Ridge, Tennessee.

DOE 2005a. *Compliance Plan National Emission Standards for Hazardous Air Pollutants for Airborne Radionuclides on the Oak Ridge Reservation, Oak Ridge, Tennessee*. DOE/ORO/2196. US Department of Energy, Oak Ridge Office, Oak Ridge, Tennessee.

DOE 2005b. *Record of Decision for Soil, Buried Waste, and Subsufrace Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee*. DOE/OR/01-2161&D2. US Department of Energy, Office of Environmental Management, Oak Ridge, Tennessee.

DOE 2011a. *Departmental Sustainability*. DOE Order 436.1. Approved May 2, 2011. US Department of Energy, Washington, DC.

DOE 2011b. *Radiation Protection of the Public and the Environment*. DOE Order 458.1. Approved February 11, 2011. US Department of Energy, Washington, DC.

DOE 2011c. *Derived Concentration Technical Standard.* DOE-STD-1196. Approved May 5, 2011. US Department of Energy, Washington, DC.

DOE 2015. *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*, November 10, 2015, Washington, DC. Retrieved April 22, 2021, from https://home.nps.gov/mapr/upload/FinalSignedMOA01132016B.pdf

DOE 2018a. *Federal Facility Agreement for the Oak Ridge Reservation*. FFA-PM/18-011, DOE/OR-1014, latest revision, US Department of Energy, Office of Environmental Management, Oak Ridge, Tennessee. Retrieved April 22, 2021, from http://www.ucor.com/RegAgreements.html#ffa (FFA and associated documents) and http://www.ucor.com/Annotated_Outlines.html (FFA Primary Documents Annotated Outlines, amended April 4, 2019).

DOE 2018b. *Oak Ridge Reservation Polychlorinated Biphenyl Federal Facilities Compliance Agreement*. ORR-PCB-FFCA. Revision 6, October 8, 2018. US Department of Environmental Protection Agency, US Department of Energy, Oak Ridge Field Office, Oak Ridge, Tennessee.

DOE 2018c. *Design Characterization Completion Report for the Sitewide Groundwater Treatability Study at the East Tennessee Technology Park, Oak Ridge, Tennessee*. DOE/OR/01-2768&D1. US Department of Energy, Oak Ridge Office of Environmental Management, Oak Ridge, Tennessee.

DOE 2019. *2019 Remediation Effectiveness Report for the U.S. Department of Energy, Oak Ridge Site, Oak Ridge Tennessee, Data and Evaluations*. DOE/OR/01-2787&D1, US Department of Energy, Oak Ridge Office of Environmental Management, Oak Ridge, Tennessee. Retrieved April 22, 2021, from https://doeic.science.energy.gov/uploads/A.0100.064.2630.pdf

DOE 2020a. *Oak Ridge Reservation Annual Site Environmental Report*. DOE/CSC-2513. September 2020. US Department of Energy, Oak Ridge Office of Environmental Management, Oak Ridge, Tennessee.

DOE 2020b. *2020 Remediation Effectiveness Report for the U.S. Department of Energy, Oak Ridge Site, Oak Ridge Tennessee*, DOE/OR/01-2844&D1, US Department of Energy, Oak Ridge Office of Environmental Management, Oak Ridge, Tennessee.

DOE 2020c. *K-31/K-33 Area Groundwater Remedial Site Evaluation Report for the East Tennessee Technology Park, Oak Ridge, Tennessee.* DOE/OR/01-2765&D2, US Department of Energy, Oak Ridge Office of Environmental Management, Oak Ridge, Tennessee.

DOE-EPA 1995. *Policy on Decommissioning Department of Energy Facilities Under CERCLA.* May 22, 1995, US Department of Energy and US Environmental Protection Agency, Washington, DC. Retrieved June 15, 2021, from https://www.etec.energy.gov/Library/Main/1995DOE-EPAD&DMemo.pdf.

DOI 2015. Manhattan Project National Historical Park, National Park Service. US Department of the Interior, Washington DC. https://www.nps.gov/mapr/learn/management/index.htm

EO 13514. *Federal Leadership in Environmental, Energy, and Economic Performance*, October 8, 2009, Federal Register, Vol. 74(194).

EO 13693. *Planning for Federal Sustainability in the Next Decade*, March 25, 2015, Federal Register, Vol 80(57).

EO 13834. *Efficient Federal Operations*, May 22, 2018, Federal Register, Vol. 83 (99).

EPA 1973. *National Emission Standards for Hazardous Air Pollutants*. April 6, 1973, 40 CFR Part 61. US Environmental Protection Agency, Washington, DC.

EPA 1978. *Terminology and Index*, "Categorical exclusion." November 29, 1978, 40 CFR Part 1508.4. US Environmental Protection Agency, Washington, DC.

EPA 1979. *Polychlorinated Biphenyls (PCBS) Manufacturing, Processing, Distribution in Commerce, And Use Prohibitions.* May 31, 1979, 40 CFR Part 761. US Environmental Protection Agency, Washington, DC.

EPA 1984. *National Emission Standards for Hazardous Air Pollutants*, "National Emission Standard for Asbestos," April 5, 1984, 40 CFR Part 61, Subpart M. US Environmental Protection Agency, Washington, DC.

EPA 1989. *National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities.* December 15, 1989, 40 CFR Part 61, Subpart H. US Environmental Protection Agency, Washington, DC.

EPA 1990. *National Emission Standards for Hazardous Air Pollutants*, Subpart M—National Emission Standard for Asbestos, Standard for demolition and renovation, Notification requirements. November 20, 1990, 40 CFR Part 61.145(b). US Environmental Protection Agency, Washington, DC.

EPA 1993. *Protection of Stratospheric Ozone*, "Recycling and Emissions Reduction." May 14, 1993, 40 CFR Part 82, Subpart F. US Environmental Protection Agency, Washington, DC.

EPA 1994. *Chemical Accident Prevention Provisions*. January 31, 1994, 40 CFR Part 68. US Environmental Protection Agency, Washinton,DC.

EPA 2009. *Mandatory Greenhouse Gas Reporting*. October 30, 2009, 40 CFR Part 98. US Environmental Protection Agency, Washington, DC.

ISO 2015. *Environmental management systems—Requirements with guidance for use*. ISO 14001:2015. International Organization for Standardization, Geneva, Switzerland. Retrieved April 22, 2021, from https://www.iso.org/standard/60857.html.

K-25 Virtual Museum 2015. K-25 Virtual Museum website. 2015. UCOR LLC, US Department of Energy, Oak Ridge, Tennessee.

Souza et al. 2001. Souza, Peter A., Glyn D. DuVall, and Melisa J. Hart, *Cultural Resource Management Plan, DOE Oak Ridge Reservation, Anderson and Roane Counties, Tennessee*. DOE/ORO/2085, US Department of Energy, Washington, DC.

TDEC 2018. *Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities*. TDEC Rule 1200-03-11-08, September 2018 revised (1996). Tennessee Department of Environment & Conservation, Nashville, Tennessee.

UCOR 2018. *Quality Assurance Program Plan for Compliance with Radionuclide National Emission Standards for Hazardous Air Pollutants, East Tennessee Technology Park, Oak Ridge, Tennessee*. UCOR-4257/R2, UCOR LLC, Oak Ridge, Tennessee. (Not available for public release.)

UCOR 2020a. *Disposition of Personal Property.* PROC-PR-2032, Rev. 8, UCOR LLC, Oak Ridge, Tennessee. (Not available for public release.)

UCOR 2020b. *Radioactive Contamination Control and Monitoring.* PROC-RP-4516, Rev. 12, . UCOR LLC, Oak Ridge, Tennessee. (Not available for public release.)

UCOR 2020c. *Environmental Management and Protection*. POL-UCOR-007, Rev. 5, UCOR LLC, Oak Ridge, Tennessee. (Not available for public release.)

UCOR 2020d. *East Tennessee Technology Park Storm Water Pollution Prevention Program Sampling and Analysis Plan, Oak Ridge, Tennessee.* UCOR 4028/R11, UCOR LLC, Oak Ridge, Tennessee. (Not available for public release.)

UCOR 2021a. *2020 Cleanup Progress—Annual Report to the Oak Ridge Regional Community*. OREM-20-7603, UCOR LLC, Oak Ridge, Tennessee. Retrieved April 22, 2021, from https://www.energy.gov/orem/about-us/news/cleanup-progress-reports

UCOR 2021b. *Pollution Prevention and Waste Minimization Program Plan for the East Tennessee Technology Park, Oak Ridge, Tennessee.* UCOR-4127/R9, UCOR LLC, Oak Ridge, Tennessee. (Available for public release by request.)